January 10, 1974

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THE TWO FACES OF 1974

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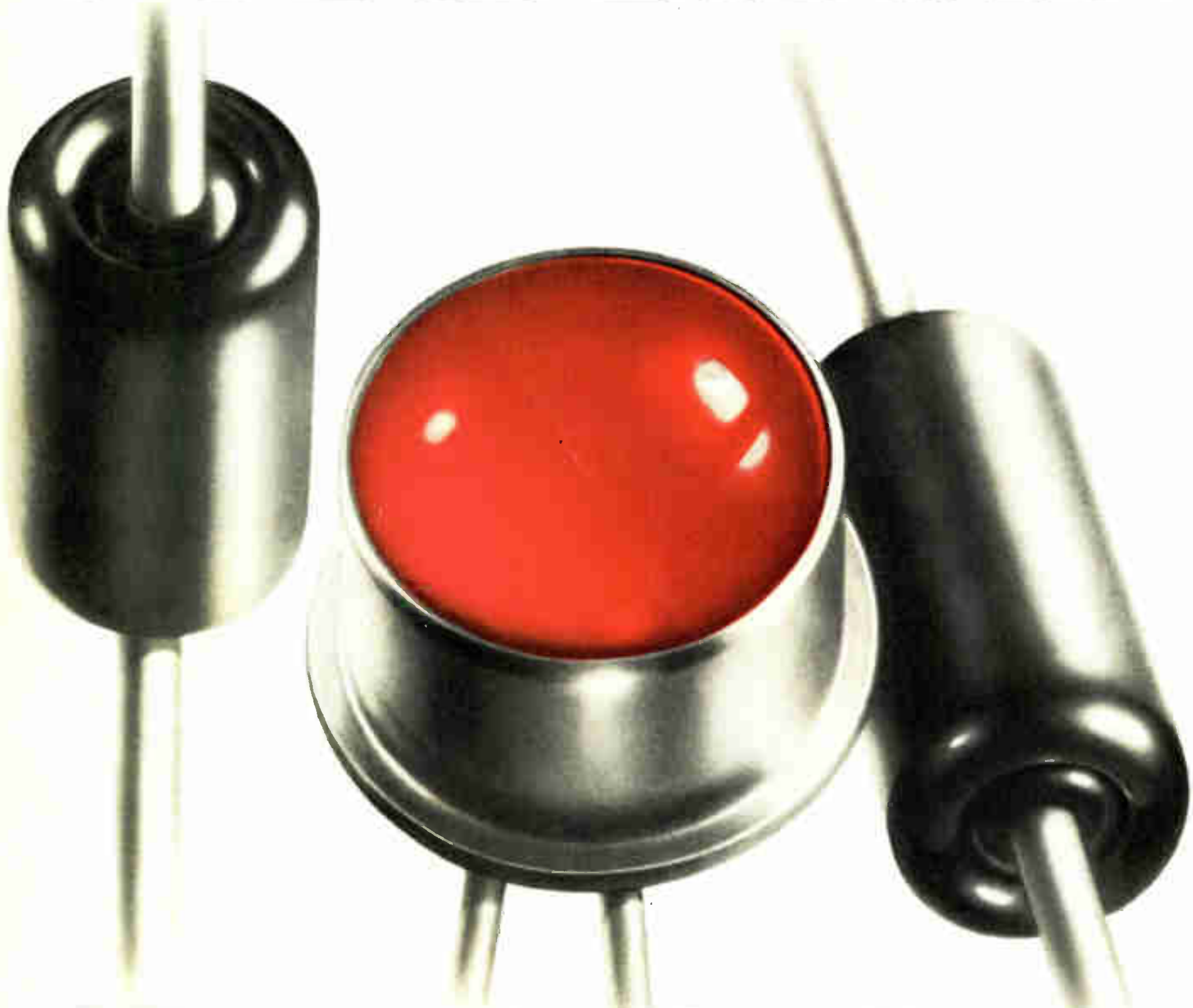

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Electronics

The International Magazine of Electronics Technology

Vol. 47, No. 1 • January 10, 1974

Highlights

The cover: Mixed feelings about the New Year, 93
The highly profitable 1973, as *Electronics*' annual survey of the U.S. electronics markets shows, would certainly trigger almost as good a 1974—if it weren't for the energy crisis and a slowdown in the rest of the economy. This situation, however, could even promote sales of computers and automatic production and test equipment. Cover sculpture is by William Shields.

A detailed breakdown of the various markets is given in the pullout chart on page 117.

Executives weigh 1974's shortages, inflation, 71
Though differing in the importance they attach to the energy and materials shortages and the shakiness of the economy, the heads of electronics companies and divisions agree that the difficulties can be survived.

A simple technology for complex displays, 123
In an ac-coupled gas-discharge display, which operates on capacitive instead of the usual resistive principles, addressing and multiplexing is straightforward since a small digit segment and a large message block can share the same drive line.

Circuits that take their lead from LEDs, 138
The light-emitting diode's unique combination of electrical and optical properties is exploited in circuits for checking power-supply connections, regulating C-MOS voltages, monitoring overvoltages, and tuning FSK demodulators.

And in the next issue . . .
Electronic vision for the blind . . . a power transistor with built-in overload protection . . . how to choose between methods of high-frequency counting.

Electronics

Publisher's letter

Our annual trilogy of market reports is rounded out in this issue with the in-depth report on how the U.S. electronics industries have fared in 1973—and where they are headed as 1974 begins. You'll find the start of the report on page 93 and a four-page foldout chart detailing the market categories following page 116.

Taken together, the reports for the U.S., for Europe, which ran in the December 20 issue, and for Japan, which was in the November 22 issue, show quite well how sudden were the effects of the Arab "oil diplomacy" moves.

When we began research for the Japan report back in September, there was some concern about energy supplies, but only in the future. There was no inkling of the blow about to be dealt by the Middle East oil-producing countries. The big concern in Japan was over maintaining its all-important markets in Europe and America.

Then the energy crisis struck with full force, changing the tone of our European report. While Europe's electronics companies were doing well, the sudden curtailment of oil shipments—and the ensuing disruption of material supplies and transportation patterns—caused many executives to hedge their predictions. Indeed, there started to be genuine concern for next year.

Finally, when the *Electronics* staff fanned out over the U.S. to complete the domestic market report, electronics firms were no longer just assessing the impact of the energy crisis, but they were beginning to adjust to, and develop alternate plans for, living with fuel curtailments. In fact, many were mapping ways to help ease the situation by marketing electronic devices and systems for controlling energy consumption.

Major questions still remain, despite the over-all optimism endemic in the electronics industries. No one is yet certain whether or not fuel cutbacks will stall the boom electronics is now enjoying. But, as traced in our three market reports, the sudden arrival of a worldwide crisis is having a major impact on the worldwide electronics market.

And what do the leaders of U.S. electronics companies think of the problems facing them as 1974 begins? We've asked the captains of the electronics industries to talk about what's troubling them—from energy and materials shortages to the possibility of a recession. We've wrapped up their views—which are remarkably varied—in the Probing the News section (see p. 71).

Should the Government take a strong hand to prevent what a consensus feels will be a recession, however mild, in 1974? Or should the Government keep its hands off and its nose out of things? The answer: yes—depending on who you're talking to. What's more, about as many executives think the energy crisis won't matter much as think it is a very worrisome situation. Others are convinced shortages will hurt, but there are some who see no slowing of their materials flow. But all are worried about something as they greet 1974.

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Readers comment

Ranking military DACs

To the Editor: There appears to be an error in the Electronics Newsletter, "10-bit DAC needs but 30 mw," [*Electronics*, Dec. 6, 1973, p. 35]. It was claimed that Analog Devices' unit "is the first microelectronic DAC—either monolithic or hybrid—to operate monotonically over the full military-temperature range." This is inaccurate.

Since 1970, Precision Monolithics has supplied monotonic monolithic DACs that operate over the full military-temperature range. Furthermore, these devices have guaranteed linearity and a full-scale temperature coefficient.

Stephen R. Pass
Precision Monolithics Inc.
Santa Clara, Calif.

Correcting drift

To the Editor: In your Designer's Casebook, "Capacitor corrects drift for analog data amplifier [*Electronics*, July 19, 1973, p. 114], Charles A. Walton describes a principle first developed and utilized by me in the latter part of 1964 and disclosed publicly on June 14, 1965, and again as a news release in April 1966.

Carl A. Budde
Euro-Pacific Financial Corp.
Encino, Calif.

■ The author replies: Mr. Budde's publication of the principles consists of less than a full sentence near the end of an article and, in my opinion, is insufficient to convey the concept to a reader. It certainly would not appear in standard technical bibliographies.

The automatic-zeroing principle has been around for some time. A version of it appeared in "Analog Computers" in the 1950s. It occurred to me independently in 1960, when I modeled it with relays. A reference in British literature pointed out that, for a vacuum-tube amplifier, when the input is grounded and feedback is unity, then the drift voltage appears at the output.

I put it all together with field-effect transistors, part of the multiplexer, and the existing switchable gain-control circuits. I made it work and published the method.

Electronic switching in France

To the Editor: Your article, "Telecommunications market in France is up for grabs," [*Electronics*, Electronics International, Nov. 8 1973], implies that the maximum capacity of the E10 Platon time-division-multiplex switching equipment is 6,000 lines; it is actually 15,000.

And, although the article gives the contrary impression, there are many more lines in operation with E10 exchanges than with E11 (Metaconta space-division-multiplex) types. As of Oct. 31, 1973, there were 16,000 E10 lines and 900 E11s.

Henri Bustarret
French National Telecommunications Research Center
Paris, France

Watching the weather

To the Editor: "Your article, "Weathermen look to Finland," [Sept. 13, 1973, p.86] creates the mistaken impression that all the advances in weather measurement are being made abroad. Much of this technology was conceived and developed in the U.S. and is now being used by the National Weather Service. The use of long-range navigation aids for windfinding was proposed by Beukers Laboratories Inc. in 1965, and Beukers equipment is being used by a number of countries.

Samuel H. Goldstein
Great Neck, N.Y.

The comedian was not human

To the Editor: In my Engineer's notebook, "Getting the most out of the digital voltmeter," [*Electronics*, Dec. 6, 1973, p. 134]. The "calibration" currents shown as 5 milliamperes should have been 1 mA for the 200-ohm and 2-kilohm ranges.

It would seem that you have a comedian in the typesetting department. My name is published as Louis M. Xuster Jr., IBM Korp.

Louis M. Puster Jr.
Kingston, N.Y.

■ *Mr. Puster is korrect. There was a comedian in the typesetting department, but it was a machine—not a man. The names were garbled in transmission of our computer-typeset copy to the printer.*

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40 years ago

From the pages of Electronics, January, 1934

Electronic progress looks ahead

The year 1934 opens with many new developments in electronics in sight. Not only is research driving further into the fundamental characteristics of electron behavior, but phenomena of the laboratory are being harnessed and put to work in the shop, while applications already made in everyday life are bound to spread and increase in number.

Electron velocities such as never before attained, short of the cosmic-ray particles themselves, are the basis of new experimentation in Massachusetts and California. Television has become myriad-eyed, with new possibilities of detail and new intensities of screen projection. The new science of "electron optics" is receiving special study, as new uses loom ahead for the cathode-ray tube. Facsimile may become as common in the home as the loudspeaker. And the millions of hours of enforced leisure under the New Deal will result in increased markets for radio sets, sound-pictures, and other electronic amusement devices, with an accelerated special prosperity of which the electronic industries already had a taste in the closing months of 1933.

In radio broadcasting, the 500-kw. station commands the American scene, and undoubtedly others will be installed to keep WLW company during 1934. Even the Federal Radio Commission now accepts "high power" to the extent of 50 kw. for regular operation, and the value of strong signals to override static and carry entertainment to far-off farm dwellers, is recognized. Improvement in tone-quality of transmission is still a primary concern, although the broadcasters are apparently still far ahead of the average home installation, with its carelessly slapped-up antenna and inadequate receiver.

The present difficulty of improving tone fidelity, by extending the upper limit beyond 3000 cycles, is the vast quantity of man-made and natural static and the comparative weakness of even the largest broadcast stations to override that noise.

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The old way

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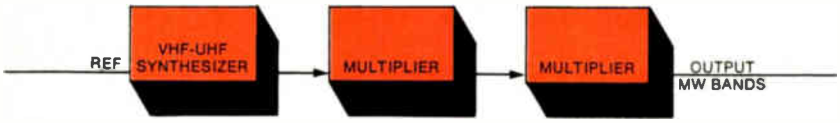


The S-D way

No multipliers. No noise multiplied.

Comparison of phase-locked systems providing F_0 to 4 GHz.

Specifications Model 1603

Leveled output +13 dBm ±0.5 dB

Frequency accuracy as good as reference oscillator

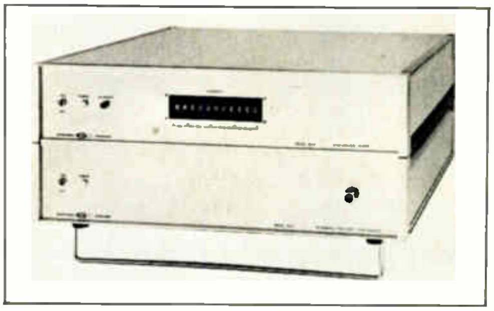
Frequency resolution 10 KHz standard, 1 Hz optional

Frequency stability (internal oscillator) 3 x 10^{-9} per 24 hours

Phase noise −85 dB at 1 KHz from carrier in a 1 Hz bandwidth

Spurs −70 dBm minimum

Harmonics −20 dBm minimum



So, in one grand stroke, S-D's design reduces unwanted noise problems, slashes systems costs, and significantly telescopes system size by eliminating multipliers. (S-D's panel is 7" high.)

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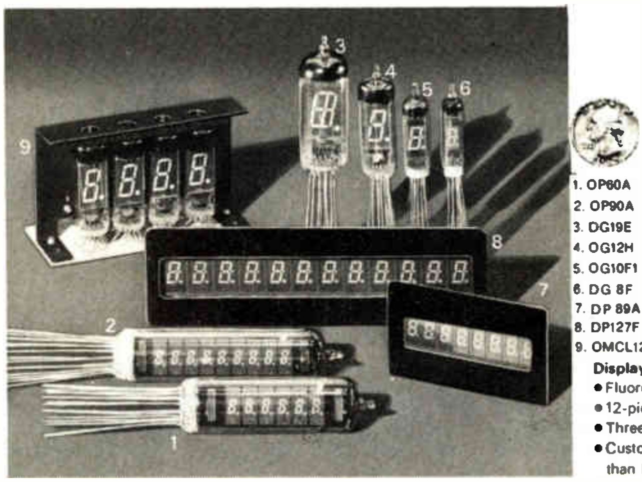
They're a difference you can see.



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Editorial

Energy and electronics

The energy crisis and its consequences are now a major preoccupation of our industry, as it is of most thoughtful Americans. As our annual market survey and forecast in this issue shows, uncertainty is diluting what would normally be jubilance on emerging from a fantastically prosperous year of growth and entering another period of solid gains.

The electronics industries must cope with the energy shortage on two levels. Of immediate concern is whether energy allocations will permit the diffusion furnaces to stay on, the lathes to turn, and the soldering irons to keep warm at a rate that will permit order backlogs to be filled. Longer term, how much will the energy difficulties of electronics' industrial customers blunt the insatiable demand that sparked the record growth of 1973?

Up to this point, there has been remarkably poor leadership coming out of Washington, and that has led to the confusion and planning vacuum that now seem to exist. Amid the controversies now being engendered by talk of rationing, allocations, and cutbacks in industrial output and services, there's danger that the contribution that electronics technology can make toward solving the energy problem might be overlooked.

Part of the solution lies in attaining a greater measure of independence from fossil fuels through the development of economical and plentiful alternatives. But President Nixon's Project Independence or any other development program will take at least a decade. And in the meantime, with the help of electronics technology, our society can and should convert from a consuming society to a conserving one.

The optimization of any fuel-consumption situation, whether it is in a car, at home, or in an industrial plant, is basically a measurement and control problem. And this is precisely where electronics technology shines. The possibilities are vast for eliminating the substantial waste that occurs in energy consumption in industry, on the road, and in the home. Electronic controls for heating, lighting, and air conditioning, for example, can make all these systems more efficient. Controls on appliances could assure that they use only the energy they need for the job, and no more.

In autos, electronics can measure conditions of temperature, pressure, and speed and then adjust the fuel-air ratio for maximum efficiency. Electronics can control the ignition to eliminate waste. Electronics can signal the driver audibly and visually that he is exceeding a preset speed limit—or even prevent him from doing so.

On a larger scale, and in the longer term, any alternative energy systems—be they nuclear, coal-gasification, or solar-generating systems—will require electronic instrumentation and controls. And electronics can play a significant role in monitoring and controlling pollutants from these new energy sources.

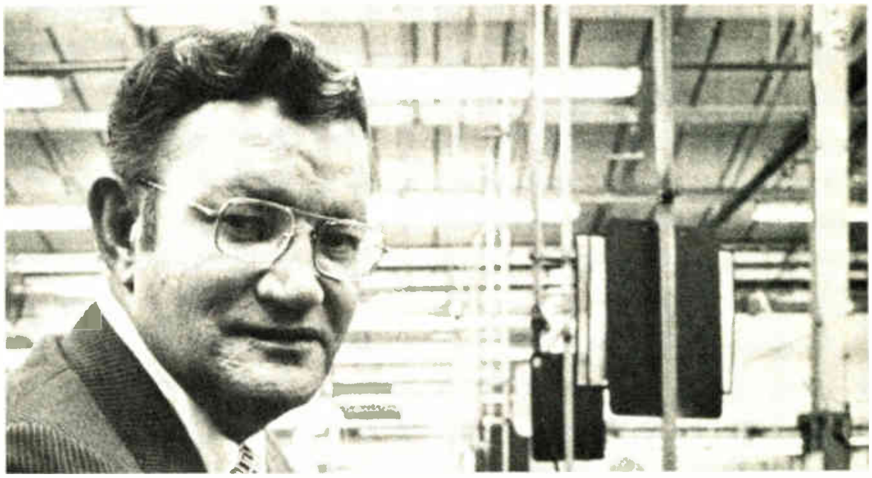
If travel is going to be curtailed by the energy crisis, then electronics can help by obviating the necessity to travel, for instance, to business meetings or technical conferences. If video telephones and data terminals became universally available at reasonable cost—coupled with fast facsimile transmitters—much traveling could be eliminated, and human as well as mechanical energy would be conserved.

Obviously, these steps alone are not going to be enough. Major legislation involving limits on size, horsepower, and gasoline consumption of cars; a renaissance of mass transit, and above all a large infusion of funds to underwrite the required R&D are vital necessities.

In the past, America responded to grave national emergencies, such as world wars, or well-defined national goals, such as the space program, with unsparing technological efforts that were ultimately successful. The energy crisis has the same elements and requires no less. The electronics community has the technology, the ability, and the will to participate—and even lead—in such an effort.

People

Buchholz predicts growth in computers and communication systems



Manager of presidents. Bunker Ramo's John Buchholz predicts growth in computers, peripherals, telecommunications, telephony, and in overseas markets.

In a recent reorganization, Bunker Ramo Corp. centralized its management and moved more of its corporate officers to company headquarters in Oakbrook, Ill. Emerging from the shuffle in one of the top spots is John Buchholz, previously group executive at Amphenol and now a senior vice president—what he calls "a manager of a bunch of presidents." To be exact, he is the manager of 17 Amphenol and Borg Instrument division presidents, 27 plants, and 9,000 people.

While Buchholz was group executive, Amphenol revenues grew over 50% in the past two years, "and we like to believe that our market opportunities haven't grown 50%." But gaining a bigger share of market dollars is a tough task in the mature connector industry: "every one of our major rivals is an extremely well run, formidable company," Buchholz explains.

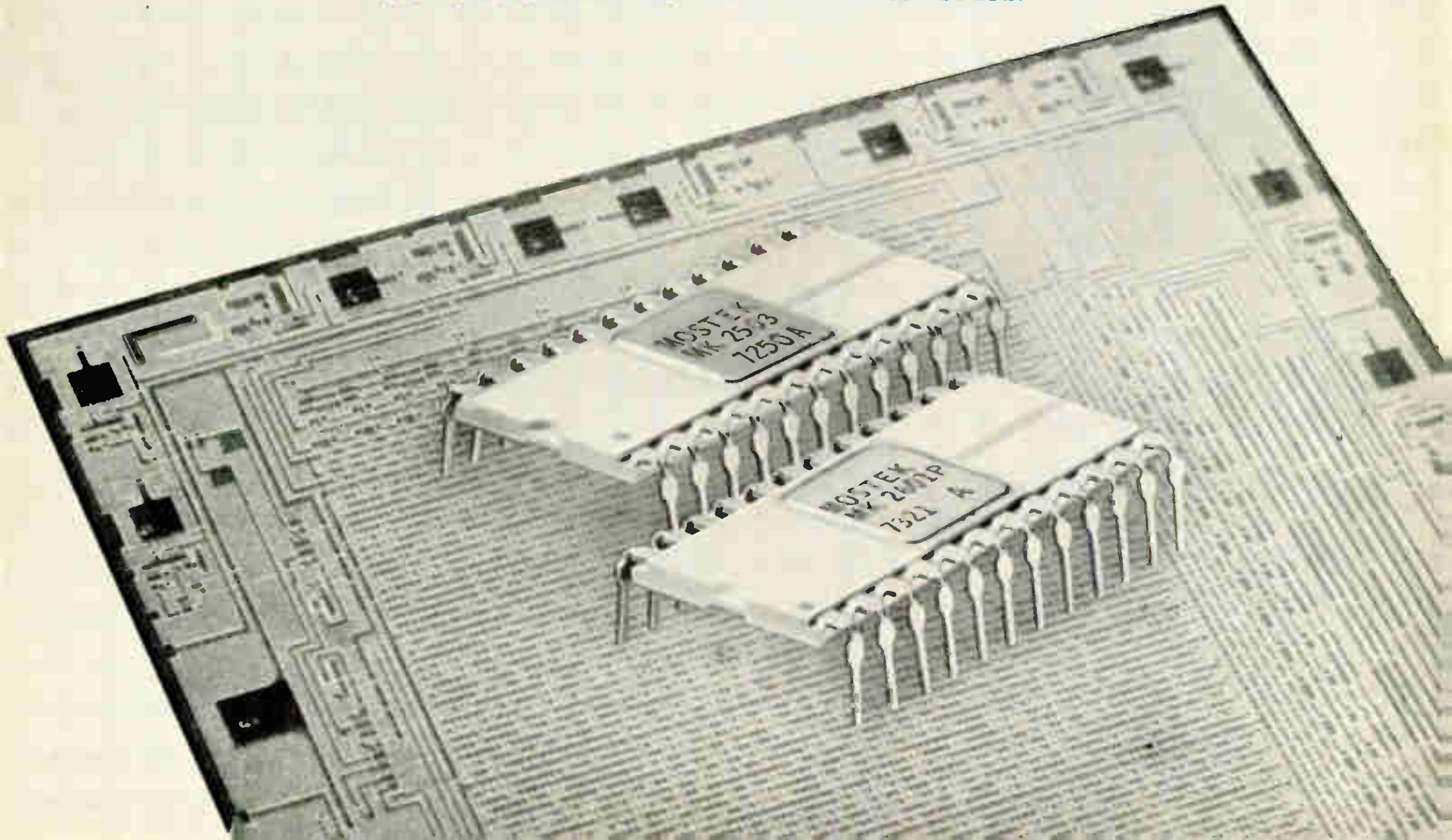
The new senior vice president expects growth for the next several years to come from computers and peripherals, telecommunications and telephony, and, especially for Amphenol, from international markets. Buchholz feels that "internal growth is the way to grow with the greatest possible assurance of success. It's a simple philosophy of ours—the devil you know is better than the devil you don't know."

Buchholz predicts sluggish growth rate for Amphenol in 1974, followed by a resumption of growth in the mid-1970s. He does not know where the impact of the energy crisis will be felt most—from suppliers, customers, or Government—but does not anticipate production cutbacks. The strongest pressures may be intangible. The rather clumsy handling of the energy crisis, coming on top of the effects of Watergate, is eroding confidence in the Government, "and prosperity, after all, is basically man's confidence in his country and himself," Buchholz observes.

Marren heads changes at AMI

American Microsystems Inc., Santa Clara, Calif., is about to undergo one of the most crucial changes in its corporate life: switching from MOS products that are about 90% custom to a balanced mix of one-third custom, one-third standard, and one-third memory products. The man behind the change in product mix is Bernard Marren, recently named vice president and chief operating officer.

The metamorphosis, expected to be finished by 1976, was contem-



People

plated before Howard S. Bobb, formerly president, handed the reins over to Marren. The product change was necessary, says Marren, because AMI at any given time "either had too much or too little business." An-

Marren's challenge: anticipating trends.

other hazard of the custom business, he adds, is that when "a customer catches a cold, we catch pneumonia." Standard products are a "different game," he says, and a tougher one. But for Marren, the product change simply provides a big challenge—"anticipating trends."

Another change in AMI is the doubling of its sales since the first of the year, with a "proportional increase in marketing. We've beefed up R&D, since that's what keeps us in a leadership position," Marren says.

The firm is gearing up for the future, when AMI will branch into the subsystems business, as well as components, timing devices, auxiliary-memory products, shift registers, and circuits for musical instruments, watches, and appliances "Heavy concentration" will be placed on memory products (such as RAMS and ROMS), says Marren, because "it's a huge market, and we must have a major position."

Already, Marren has forecast AMI's RAM production at 10% for 1973 and about 33% by 1976. The company will make three new RAMS in 1974, and it is working on a fast n-channel cache memory.

1937-1973

The Danameter. $195.

1 Year Battery Life.

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In measuring voltage, you're accustomed to swapping leads to get a reading.

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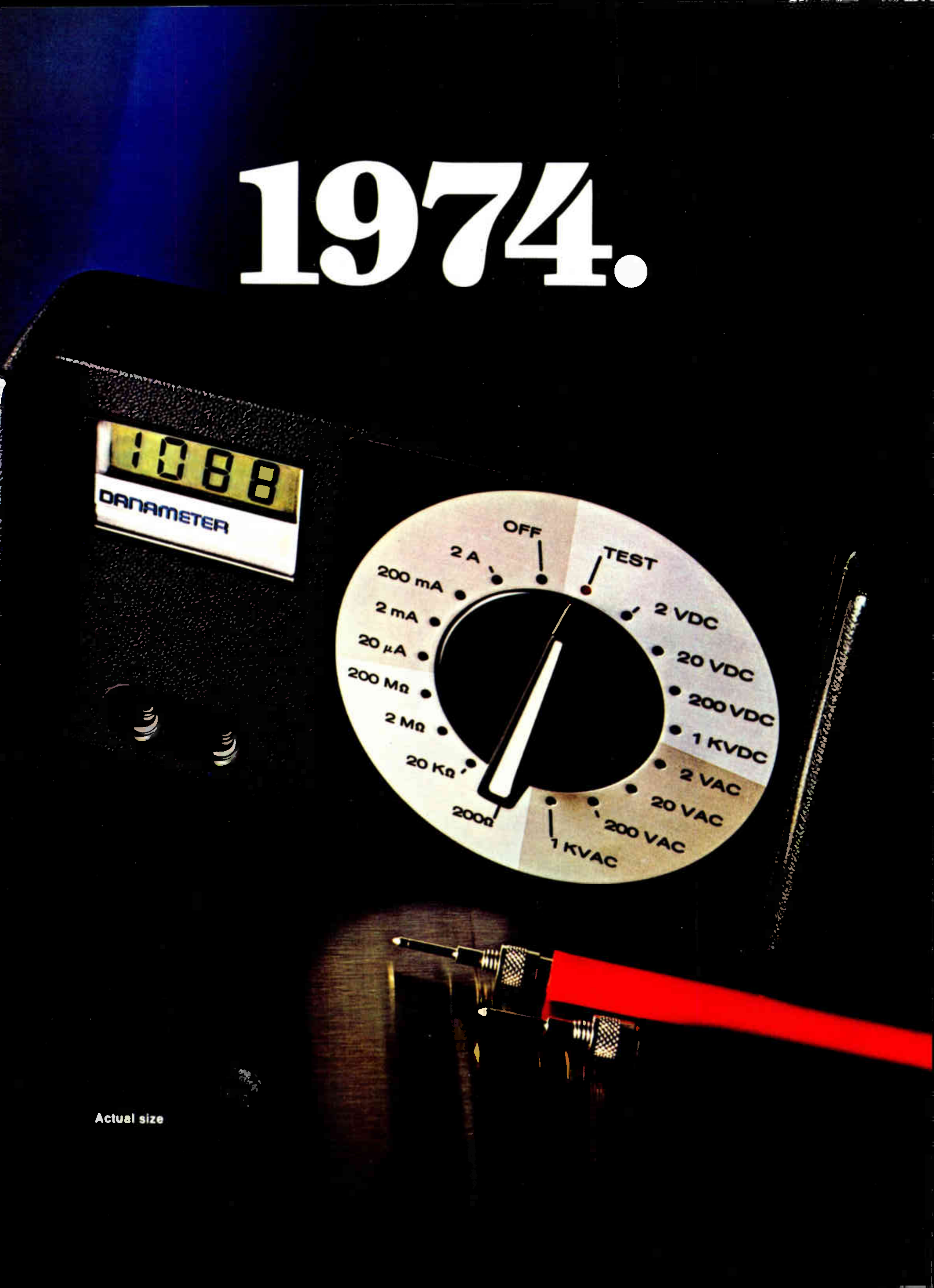
The Danameter has only one function selector. It's recessed behind the molded edges of its cycolac case. You can drop it on concrete. You can kick it down the hall.

When you pick it up, it'll be working perfectly.

It's the first true portable instrument of its kind. For $195.


1974.
DANAMETER
OFF
2 A
TEST
200 mA
2 VDC
2 mA
20 µA
20 VDC
200 MΩ
200 VDC
2 MΩ
1 KVDC
20 KΩ
2 VAC
20 VAC
200Ω
200 VAC
1 KVAC
Actual size

Model 2000 Danameter Specifications

Warranty: 1 year.
Measurement Functions: (4) DC volts, DC current, AC volts and ohms.

Typical Specifications:

DC Volts

Ranges	2V, 20V, 200V, and 1KV
Resolution	1mV
Overload protection	1000V DC or peak AC, any range
Accuracy	±(.5% Rdg. + .05% Range)
Polarity	Automatic
Input Resistance	10 Megohms
Normal mode rejection	50 dB min. at or near 60 Hz

AC Volts

Ranges	2V, 20V, 200V, and 1KV
Resolution	1mV
Overload protection	1000V peak AC, 250V DC, any range
Accuracy	±(1.5% Rdg. + .15% Range) to 5 KHz
Input Resistance	2 Megohms

DC Current

Ranges	20μa, 2 mA, 200 mA and 2A
Resolution	.01 μa
Accuracy	±(1.5% Rdg. + .1% Range)
Overload protection	250V DC or RMS

OHMS

Ranges	200Ω, 20KΩ, 2MΩ and 200MΩ
Resolution	.1 ohm
Accuracy	±(2% Rdg. + .15% Range)
Maximum current through unknown	1 mA
Overload	250V DC or RMS

General

Battery	One 9V dry battery
Est. battery life	1 year at normal usage
Test leads	Included
Size	4"H x 7¼"W x 2¼"D
Weight	1 lb.
Overload	Fully protected on all ranges

Price

Model 2000 Danameter	$195.00

Accessories

Part No.	
2040	R.F. Probe (to 200MHz)
2030	H.V. Probe (to 30Kv)
2020	Carrying Case
2060	Extra Test Leads

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DANA

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Telephone (714) 833-1234, Teletype 910-595-1136, Telex 678-341

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Circle 21 on reader service card

DIVA'S COMPUTROLLER BEGAT AND...

An Episode in the True Chronicle of the DIVAS, Proudest Peripheral Family in the Computerworld.

Forever stored in the computerworld memory is that incredible marriage four years ago, immortalized by this painting, of mini processor technology to DIVA controller — a marriage that united distinguished minicomputer families with great storage capacity disc drives of the IBM 2311 and 2314 types.

Once again, the elite of the computerworld find themselves at what appears to be a joyful celebration. They had been summoned here by a mysterious masked messenger who said only that they must come to witness an astonishing event. Marvel at the great throng! DEC, Data General, TI, Interdata — all of those with whom DIVA controller has interfaced in the past are here. A driving murmur fills the hall as all speculate upon the possible reason for this grand assemblage. Bits of conversation issue from the minis.

"They say mini processor and DIVA controller are now proud parents. They say we are here to see the spin off."

"No, no," unwinds another mini. "Another marriage is my input. DIVA plans a bold coupling that will further maximize us minis. That's the way I read it."

"Saving money. A million dollars saved on the purchase of a DIVA system, as compared with a comparable IBM system. *That's* news. *That's* why we're here."

On and on minis calculate. Discs and tapes drive and search. Output increases rapidly. Information is being transferred at fantastic rates — up to 624K bytes/sec by a DIVA Disc Drive 30 system alone. The combined interchange of data reaches din-like proportions.

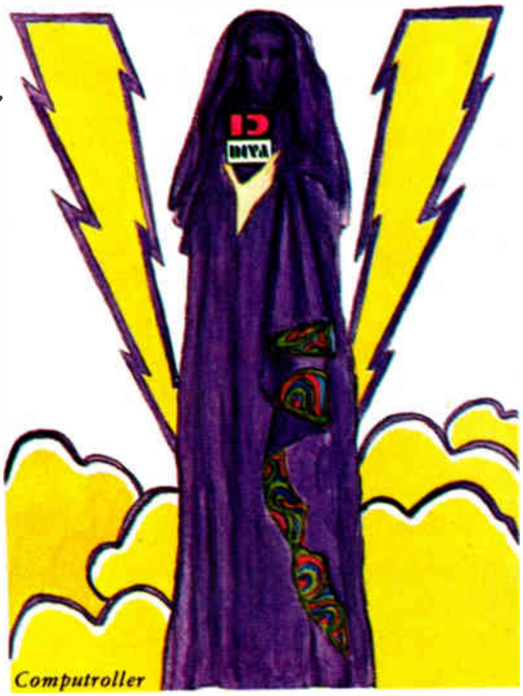
BUT WHAT HAS HAPPENED?

Two awful, blinding electronic flashes coupled with ear-piercing, supersonic cracks of sound reveal a shrouded figure holding up the DIVA medallion. Instantaneously all eyes focus upon this commanding sight. A shuddering gasp sweeps the hall, followed by electric silence. The newcomer steps forward and a sonorous pronouncement issues from deep behind royal purple robes.

"I am DIVA COMPUTROLLER here to tell you of my mighty workings."

COMPUTROLLER? COMPUTROLLER? All units go into search mode.

"Nor will you find me in your memories. I was not.



I am *NOW*. Born full-blown of mini processor and DIVA controller. Brought to maturity by expanded research facilities and a rapid growth curve. I was begat to interface all minis with IBM compatible 3330 type drives."

A tumultuous spontaneous exclamation of surprise and joy thunders from the throng. Mesmerized by this magnetic figure, they see he is a DIVA in every way: powerfully-built, solid-state throughout, capable of simultaneous control of up to eight disc drives in either mini or IBM formatting.

Holding up his medallion for silence, COMPUTROLLER speaks again. "Today I take a mini bride. Come rejoice with me. Learn how greatly I expand the memory and speed of my chosen one."

DIVA'S COMPUTROLLER, PDP 11, AND 3330 TYPE DISC DRIVE UNITE.

AN INCREDIBLE MARRIAGE.

An Episode in the True Chronicle of the DIVAS, Proudest Peripheral Family in the Computerworld.

The computerworld stares in awe at the incredible wedding scene which has unfolded before them. The bride is minicomputer PDP 11, offspring of the illustrious maxi-computer clan, begat of Abacus. The bridegroom is DIVA COMPUTROLLER, scion of this proud, most respected peripheral family. Officiating at the ceremony is Duke DIVA Disc Drive, direct descendant of IBM compatible 3330 type disc drives.

Realizing the great impact this interfacing will have on the computerworld, our happy guests monitor the wedding with joyous solemnity.

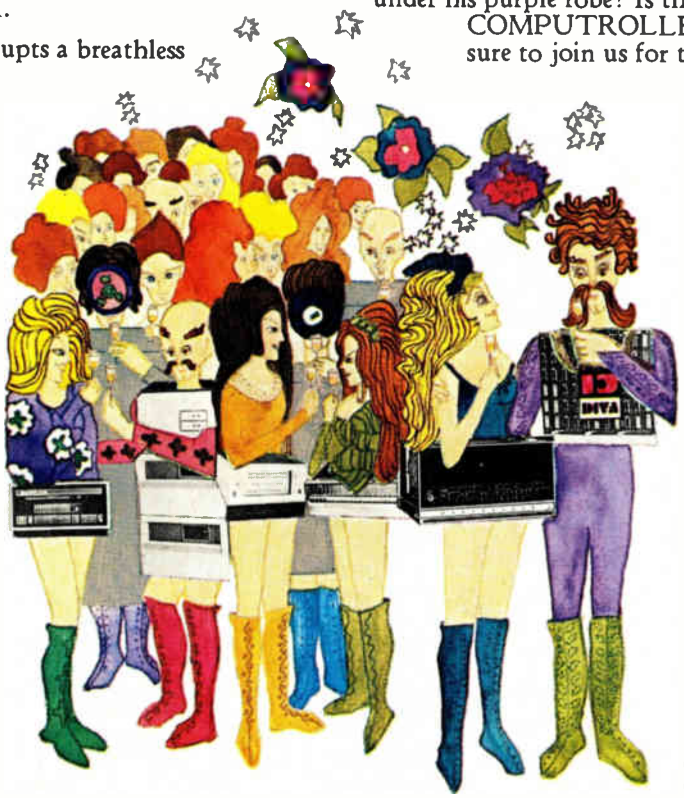
"Mated," Interdata 70 whirrs, "PDP 11 will have access to 100 million bytes of data on a single spindle or 200 million bytes on a dual spindle disc drive unit within an average access time of 32 msecs."

"And with COMPUTROLLER providing a buffering sector, data will be transferable at the rate of 645,000 bytes/sec," marvels Nova II.

"And keep in mind," interrupts a breathless TI 980A, "that with COMPUTROLLER controlling eight drives, mini will have access to 1.6 billion 8-bit bytes of data!!"

But, hush! Listen to Duke DIVA repeating those always-inspiring words: "With the data stored in me, and with provided interconnecting cables and distribution panel, I now pronounce you linked in holy matrimony."

Resounding cheers befitting the occasion arise from the crowd. "A toast! A toast! A toast!" they roar. As is the custom, the proud parents, mini processor and DIVA controller, propose the toast to the dazzling couple: "To the most splendid and significant union in all our memories."



"*Vive*, DIVA! *Vive*, DIVA! *Vive*, DIVA!" Everyone unwinds.

But even as we listen to the clink of ceremonial glasses and the exuberant laughter, we sense an underlying sadness. Those unchosen minis — do they count for nothing now? Will they not be able to enter the world of high speed data storage/access and low cost/bit performance? And why — throughout this entire festivity — has COMPUTROLLER remained hidden under his purple robe? Is there more to COMPUTROLLER than meets the eye? Be sure to join us for the next episode in the True Chronicle of the DIVAS when we will hear the horrendous accusation: "Bigamy! BIGAMIST!"

In the meantime, learn COMPUTROLLER'S inside story. Find out about the free implementation and training courses, the software packages, and warranties that go with each disc system. All you PDP 11 users call George Roessler at 201-544-9000 for cost and delivery information.
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Circle 23 on reader service card

Meetings

Annual Meeting: American Association of Small Research Companies, Quality Inn, Washington, D.C., Jan. 23, 24

Reliability and Maintainability Symposium: IEEE, Biltmore, Los Angeles, Calif., Jan. 29–31.

International Solid State Circuits Conference: IEEE, University of Pennsylvania, Marriott Hotel, Philadelphia, Feb. 13–15.

Computer Conference (Compcon): IEEE, Jack Tarr Hotel, San Francisco, Feb. 26–28.

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

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

International Convention (Intercon): IEEE, Coliseum and Statler Hilton Hotel, New York, N. Y. March 25–29.

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

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.

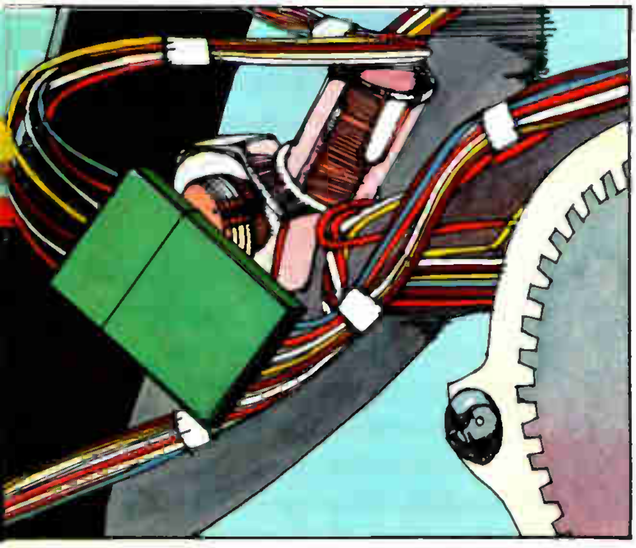
International Circuits and Systems Symposium: IEEE, Sir Francis Drake Hotel, San Francisco, April 21–24.

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.

Growing with the

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



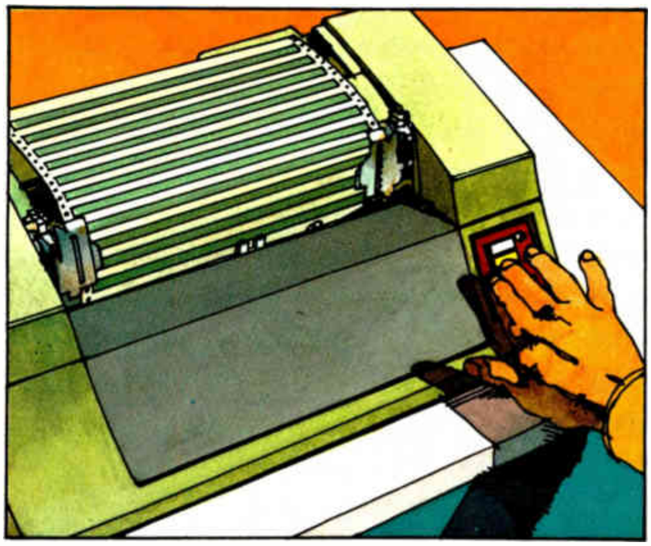
Meat merchandising has taken a big step forward with advanced solid state circuitry. The system includes a scale, mini-computer, and a printer in an integrated modular package that can weigh and price meat in seconds.

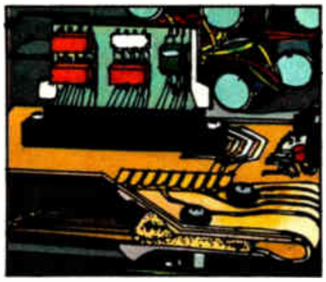
Amphenol 221 Series micro-miniature connectors share the responsibility for transmitting weight and price data to the mini-computer. Their low cost, sturdy design, and high-reliability contact configuration make them ideal for this application.

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

new electronics

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

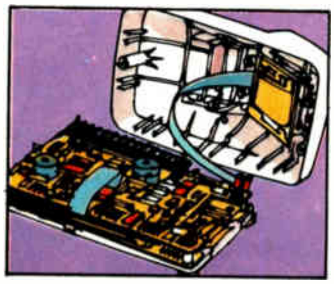




A unique modular matrix printer was recently developed to interface with mini-computers, medium-speed batch terminals, and other installations requiring high speed data output. Data is received at up to 75,000 characters per second. The data is then carried through PC cards to a printing head with an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

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

Amphenol assembly services help produce new credit card verifier.



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

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

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

BUNKER RAMO AMPHENOL

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

Circle 27 on reader service card

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EC62

Circle 28 on reader service card

Rockwell rivals bipolar, N-MOS with C-MOS RAM . . .

Aiming to stake a claim to a major portion of the high-performance standard-memory market, **Rockwell International will introduce in March the industry's first 1,024-bit C-MOS random-access memory to be built on a sapphire substrate.** Although smaller C-MOS/SOS random-access memories are available, the RAM from Rockwell's Microelectronics division in Anaheim, Calif., offers the same 1-kilobit single-chip capability that's become so cost-effective in high-speed semiconductor memories. And the speed-power tradeoff, when compared to that of bipolar or MOS 1,024-bit RAMs, is extremely attractive.

The access time of the Rockwell static RAM at 10 volts is a swift 60 nanoseconds, compared with 60 to 80 ns for bipolar and 100 ns for MOS. Power dissipation is only 100 milliwatts when operating, 10 mw in standby; for the other types, the operating drain is 300 to 500 mw. And like the others, the Rockwell part, which will be come in a 16-pin DIP, can be driven at 5 v at slower speeds.

. . . as company prepares trio of new memories

Also coming from Rockwell's standard-memory department are three additional devices. There's a 4,096-bit C-MOS-on-sapphire read-only memory that boasts a 60-nanosecond access time, while dissipating only 1 milliwatt of standby power, an erasable (or read-mostly) ROM built with nitride technology, **and what promises to be the first commercially available nonvolatile MNOS RAM**—a 1,024-bit, 5-microsecond device, scheduled for early 1974, that will be guaranteed nonvolatile for 60 days.

Diffusion-furnace controller permits easy power cuts

With the pressure on semiconductor makers to somehow reduce the power consumption of their diffusion furnaces, **a control device developed by the Lindberg division of Sola Basic Industries may attract a lot of attention.** The control reduces furnace temperatures during nonprocessing periods, such as weekends, without damaging the quartz tubes. For example, the company says that cutting a process temperature of 1,200°C to 900°C for 60 hours can mean a kilowatt-hour saving of 16% per tube.

Says William McEntire, product manager: **"The control device does away with the need to reprofile an array of diffusion tubes by adjusting temperature controls. Such an adjustment might require an entire day."** Lindberg says its controller, marketed through Lindberg-Tempress in Los Gatos, Calif., permits the mere flip of a switch to bring the temperature back up to set point in 10 to 35 minutes.

ICs tested at high temperature for little added cost

A new machine that allows ICs to be tested dynamically at high temperatures for only a fraction of a cent more than tests at room temperature **may revive the controversy over guardband testing.** Developed by International Production Technology, Sunnyvale, Calif., the machine heats dual-in-line packages to temperatures as high as 125°C in a hot-air chamber and loads and unloads a test fixture at a rate of 3,600 packages an hour.

IPT developed the machine, which interfaces with most automatic test systems, for computer manufacturers **concerned that guardband**

tests would be inadequate to check the reliability of MOS dynamic RAMS operating in high-density memory systems, where hot spots may occur during system operation. In guardband tests, the circuits are tested at room temperature, and test limits are adjusted to allow for expected performance changes at high temperatures. The technique is generally used to test commercial circuits.

Fairchild plans subnanosecond-ECL line

Now that Fairchild has entered subnanosecond ECL by introducing a few simple Isoplanar II gates about a year ago [*Electronics*, Feb. 15, 1973, p. 41], **it has developed an improved ECL line at those speeds.** Gates are ready for introduction in a few weeks, says Thomas A. Longo, vice president and general manager of the Digital Products group. In a few months he says the company will begin marketing complex special functions—starting with a gigahertz-frequency prescaler for TV tuners and communications systems.

Intersil readies 4,096-bit PROM

The growing demand for programable read-only memories for microprograming has induced Intersil to develop a 4,096-bit PROM that's scheduled for appearance in the second half of 1974. The new device will join Intersil's recently announced 2,048-bit PROM. Joseph Rizzi, vice president of R&D, says **the 4,096-bit memory is fabricated with a dielectrically isolated bipolar process that uses thin epitaxial layers, two levels of metalization, and Schottky diodes.** A program is recorded by means of a new version of Intersil's blown-junction technique. Rizzi maintains that, although other 4,096-bit PROMs are available, **the Intersil isolation process "results in smaller devices having higher yields and potentially lower prices."**

Hughes utilizes pad relocation for C-MOS, ECL

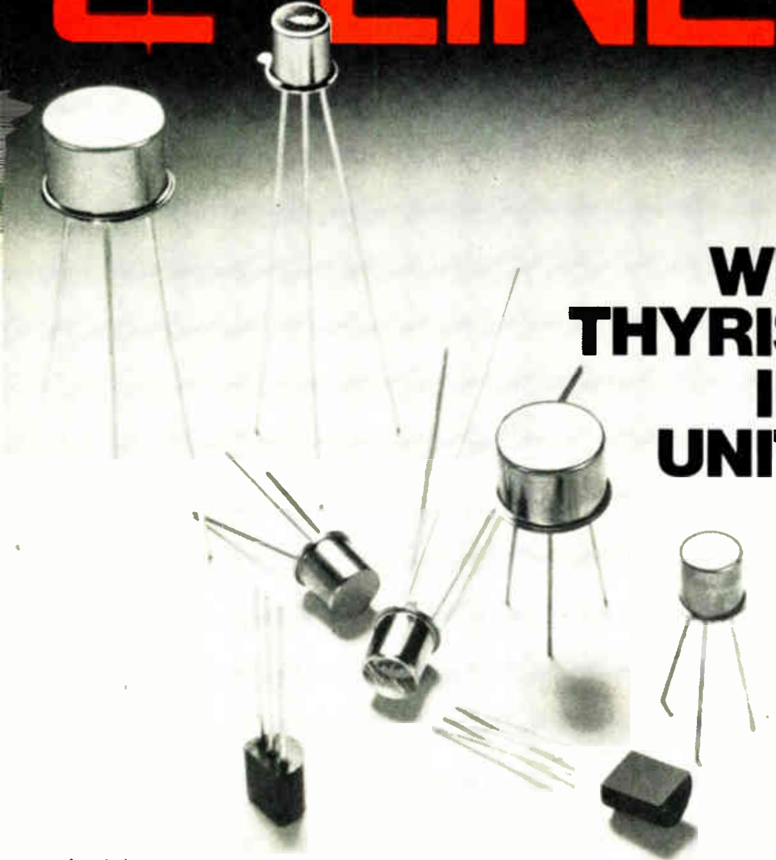
Hughes Aircraft Co. is applying to C-MOS and ECL its pad-relocation technique for full-chip LSI. The company's work up to now has been in the ubiquitous TTL family using 5400-type circuits, **but ECL and C-MOS appears to offer significant advantages over TTL. ECL is much faster, and C-MOS dissipates minimum power.** Hughes says the pad-relocation technique [*Electronics*, Sept. 13, 1973, p. 40] is an alternative to printed-circuit boards with the addition of much higher density and lower costs.

In ECL, using the same pad-relocation techniques and only part of a wafer, **the Hughes group has made a 4-bit ECL multiplexer that operates at 50 megahertz.** The 0.5-by-1-in. chip is packed in a 78-pin standard package 1 by 2 in.

Addenda

The IEEE has made good on its threat to move the Intercom show from New York to Boston in alternate years [*Electronics*, Feb. 15, 1973, p. 27]. Intercon will be combined with Nerem, a meeting traditionally held in Boston in the fall. The first joint show will be in Boston **in 1976 and then alternate between the two cities each spring. . . .** Gallium-arsenide Gunn diodes with power levels near those of the newest Impatt diodes [*Electronics*, Dec. 20, 1973, p. 25] may be available soon from Varian Associates. The company says it has started supplying samples with 5 and 10 watts peak power output at less than 1% duty cycle. . . . MCI has won an injunction in Federal court requiring Bell System companies to provide interconnection for MCI's network.

C-LINE SCRs



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It's what you would expect from a company that makes thyristors a major part of its effort—not just a sideline.

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See EEM Section 4800 and EBG Semiconductors Section for more complete product listing.

Circle 31 on reader service card

First oxide-isolated C-MOS circuits cut chip area by one-third

Fairchild's Isoplanar process promises full C-MOS capability and could lead to C-MOS LSI devices

The benefits of passive isolation, previously available only in memory circuits, are now being offered in logic circuits as well. Fairchild Semiconductor's Isoplanar C-MOS standard logic family [*Electronics*, Dec. 20, 1973, p. 25] provides pin-to-pin compatible with the standard 4000 series but in a format almost one-third the size of conventional 4000 C-MOS. This cuts the chip size of a typical C-MOS logic chip—a quad gate—down from about 3,000 to 2,000 square mils. More significantly, because the Isoplanar technique almost doubles the density of transistors in the internal logic stages, Fairchild is planning faster medium-scale-integrated C-MOS and is even thinking of large-scale-integrated C-MOS.

Fairchild will start introducing the family, dubbed 34000 C-MOS, this month with a dozen logical equivalents of RCA 4000 types. Besides additional 4000 types, the family will include proprietary data-processing, watch, clock, and automobile circuits.

The process is similar to the one that Fairchild initially developed to make high-speed emitter-coupled-logic circuits [*Electronics*, Feb. 15, 1973, p. 41]. In fact, the C-MOS wafers are manufactured by the Bipolar Logic division.

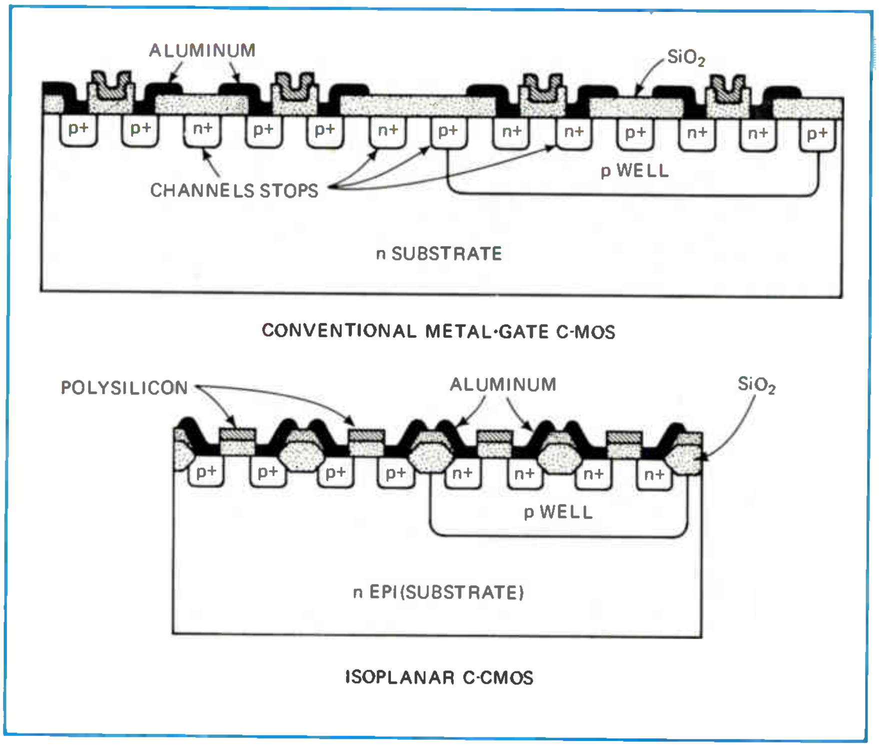
The Isoplanar process eliminates the guard rings, or channel stops, that must ordinarily be diffused around every C-MOS transistor. In Isoplanar C-MOS, those diffusions are replaced by etching away the edges of the transistors and growing silicon dioxide in the holes.

Another departure from conventional C-MOS processing is the use of epitaxial wafers. The Isoplanar and epitaxial processes are combined with silicon-gate MOS and ion-implantation methods.

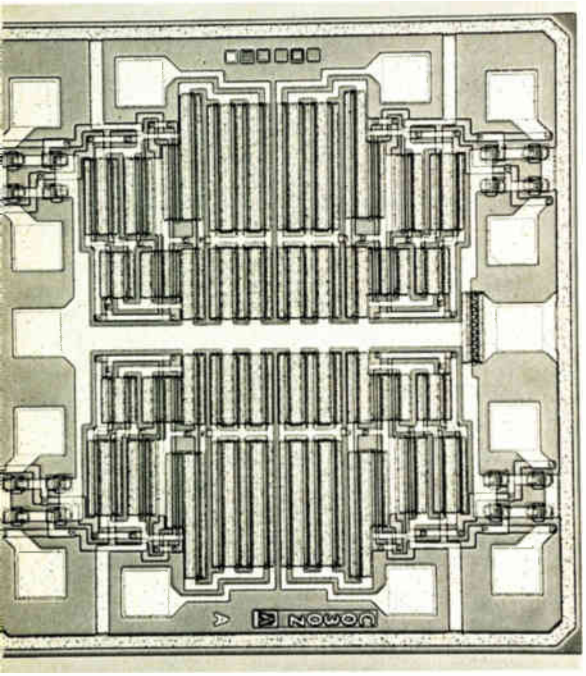
Quirks out. To each output, Fairchild adds two inverter-like buffer stages. Each stage is a complementary pair of p-channel and n-channel transistors. The logic itself, made with very small transistors, drives the intermediate buffer, which then drives an oversized output buffer. This arrangement results in a more powerful, truly complementary output buffer. The change, which takes four extra transistors per output, cures the gremlin-like problems that sometimes crop up in C-MOS systems.

In comparison, the logic stage of a conventional design directly drives the output line. A NAND gate, for example, is simply two p-channel transistors in parallel and two n-channel transistors in series. Since the two pairs are not matched, gate delays and output impedances can vary with input-signal rise times and states.

According to Fairchild engineers, that input pattern sensitivity causes



Size reduction. Because Isoplanar C-MOS reduces capacitance and guard rings, it results in a device about one-third smaller than conventional C-MOS.



Isoplanar C-MOS. Pin-to-pin compatible with standard 4000 series, Isoplanar devices have more stable output impedances.

output-waveform distortions that grow worse with the number of inputs per gate and the number of circuits in series, particularly when the logic is operating slowly at low voltage. The sensitivity, they say, sometimes causes "mysterious" errors in system-logic operation when certain data-word patterns are being processed.

Fairchild says that the signal gains in the buffers also improve noise immunity, make gate delays and output rise times independent of input shapes, and square off the output waveforms.

National Semiconductor Corp. held the previous record with a 360-microampere drive spec for the 74C family, while Fairchild has a 400-microampere family spec. Such high currents make C-MOS more compatible with transistor-transistor logic as well as improving line-driving speed. Output currents of conventional design drop with circuit complexity because the room available on the chip for large output transistors drops with circuit complexity.

Speed in. The extra buffers don't slow down the 34000 chips. On the contrary, Thomas A. Longo vice president, says, the Isoplanar process reduces transistor sidewall capacitances enough to reduce on-chip delays an over-all 20% in gates and more than 20% in complex circuits and the added line-driving current raises that to as high as 50% to 100% in system assemblies.

Although the first parts are 4000 designs, "We may make some 74C parts later," Longo says. He expects Philips of the Netherlands to produce the Isoplanar versions soon. Philips took a license as did TDK Fairchild Corp. in Japan, a joint venture with TDK Electronics. TDK Fairchild is not yet producing MOS, but will do so in about 18 months, Longo says.

Longo believes that before 1980, C-MOS will dominate the industrial and computer peripheral logic mar-

What's next for Isoplanar technology: gigahertz logic and MOS microcomputer

Besides C-MOS, most of Fairchild's upcoming digital designs will be Isoplanar. The gamut will range from logic operating at gigahertz frequencies, through MOS memories, to an n-channel microcomputer, according to Thomas A. Longo, vice president and general manager of the digital products group, and Philip R. Thomas, MOS division manager.

To isoplanar random-access memories already in production, the emitter-coupled logic department will be adding its fast-ECL line introduced last year [*Electronics*, Feb. 15, 1973, p. 41]. The devices will operate at subnanosecond speeds and be fully compensated for variations in power-supply voltages and operating temperatures. Gates will be ready for introduction in a few weeks, Longo says. And within a few months, there will be complex special functions, starting with a gigahertz-frequency prescaler for television tuners and communications systems.

Fairchild made some simple Isoplanar II ECL gates last year to demonstrate the speeds—600 to 650 picoseconds—attainable with oxide-isolated bipolar logic. Compensation was accomplished by putting voltage regulators and thermal resistors on the chips. Longo says that the result is the industry's first ultrafast, compensated logic line—one that should overcome past difficulties in designing with ECL.

A gigahertz prescaler is one of the better ways of automating vhf/uhf television tuners, says Eric G. Breeze, a Fairchild engineer who works with TV manufacturers on new tuner designs. By reducing frequencies, it allows an MOS LSI circuit to handle the more complex control functions. A companion MOS control and channel-display circuit is being designed, along with alternative all-MOS controls.

The MOS division is also preparing an n-channel, microprogramed central processor unit for general-purpose microcomputers and control applications. Thomas expects it to be on the shelf late this year. It is designed to interface directly with bipolar logic and a variety of memories. "We want to produce one CPU," Thomas remarks, "but we will have a number of peripherals to expand the CPU's power."

Later on, the peripherals may include high-density charge-coupled-device memories. Fairchild is developing these to replace conventional rotating peripheral memories in large computer systems. "We can see the advantages of coupling our CCD and microprocessor developments," Thomas says.

Shift registers. Thomas' division is already producing p-channel Isoplanar shift registers and will have an Isoplanar counterpart of Intel Corp's 1103 p-channel dynamic RAM soon [*Electronics*, Dec. 6, 1973, p. 35]. He and Longo won't identify specific future memory products, but they hint that both n-channel RAMs and fifos (first-in, first-out, variable-rate shift registers) will come.

As for fifos, Thomas notes that while conventional shift-register sales are leveling off, fifo sales are growing. They are popular as buffer memories because data can be put in at one rate and taken out at another.

kets now served primarily by TTL. Isoplanar C-MOS, in particular, he says, is fast enough for 75% of industrial applications and speedy enough "to make it uncomfortable now for low-power Schottky TTL."

The difference between Isoplanar C-MOS and low-power Schottky-gate delays is not great—30 to 40 nanoseconds versus 15 to 20 nanoseconds—and the Schottky devices dissipate far more power, he points out. Despite the higher speed of 34000 C-MOS, it uses no more power than standard 4000 C-MOS. □

Mixed process boosts linear action

Combining a standard complementary bipolar process with the various n- and p-channel MOS processes on the same chip has become a hot trend in advanced linear processing. Witness the chopper-stabilized operational amplifier introduced by Harris Semiconductor [*Electronics*, Aug. 16, 1973, p. 125] that combines vertical and horizontal npn and pnp gain structures and an MOS chopper circuit on the same chip.

Now the Melbourne, Fla., firm, adding complementary FET inputs to its process, has built an experimental high-speed inverting-type amplifier that sports a slew rate as high as 320 volts per microsecond, a gain bandwidth of 70 megahertz, an open-loop gain of 2×10^6 and a current output of 50 milliamperes.

According to Jim Beasom, who developed the process at Harris, new levels of system integration could be achieved by combining linear and logic circuits on the same chip. A new line of products, led by the inverting operational amplifier, will be introduced next year by Harris, and Beasom expects a production line dedicated to the process by the end of this year.

The technique is a modification of Harris' polysilicon-dielectric-isolation technique. An n-type slice is selectively etched and filled with p-type epitaxial material. Then diffused n^+ and p^+ buried layers are formed, and a thick—10–20 mils—polycrystalline-silicon layer is deposited. The slice is then polished from the back, using the standard dielectric-isolation method until the polishing plane intersects the p-type epitaxial layer.

Standard device processing is then used to form the devices on the dielectrically isolated n^- on n^+ and p^- on p^+ islands. The finished process includes discrete bipolar devices with breakdown voltages in excess of 50 V and cutoff frequencies over 500 MHz. Beasom feels that using n-channel depletion-mode MOS is advantageous in linear applications because devices can be operated around the zero-voltage-bias level. Early work at Solid State Scientific Corp., Montgomeryville, Pa., emphasized the need for vertical bipolar pnp and npn devices [*Electronics*, Aug. 31, 1970, p. 72].

RCA also has a process for complementary-bipolar and MOS devices. It utilizes enhancement-type devices for MOS and a lateral or substrate pnp structure. This technique tends to degrade performance of the pnp devices. Many companies have npn and C-MOS on a single chip. For example, Motorola Inc., Micropower Systems, and Intersil Inc. have announced devices utilizing this technology. □

Commercial electronics

Aerospace firm turns out fire-hose control

Fire control has taken on a new meaning for the Government-contract-oriented engineers at Grumman Aerospace Corp. They have developed a fire-hose control that adjusts the flow of water electronically.

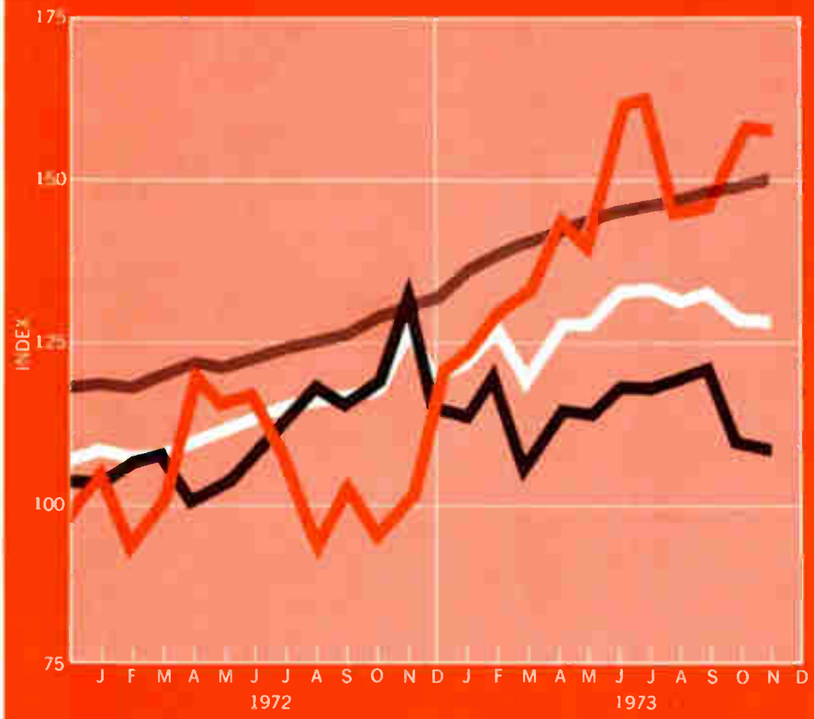
With the control, a fireman directing a water stream at a hose's nozzle can quickly regulate the water flow. Usually, the man at the nozzle must shout directions back to an operator on the pumper truck. Even with walkie-talkies, the confusion and noise at most fires make this a cumbersome routine. And where radios are not used and hose lengths are long, valuable time is wasted just getting a message through to the pumper.

Grumman's engineers, borrowing from the automatic fault-monitoring systems pioneered in the space program, also designed its Nozzle Pump Operator to oversee the operation of the pumper truck. The unit monitors such items as the oil pressure, temperature, and speed of the engine driving the water pumps, and the battery voltage of the unit itself. Grumman points out that its system frees the pumper operator for other fire-fighting chores.

The electronic design of the system, which also includes a specially designed flow-control valve in the pumper-truck, is fairly straightforward, says Joel L. Bernstein, the electronic engineer on the project in Grumman's advanced development department. Between the end of the hose and the nozzle itself is an encoder-transmitter mounted on a 9-inch-long aluminum cylinder

Nozzle control. Using aerospace technology, Grumman developed a fire-hose-control device that regulates water flow.

Electronics Index of Activity



Segment of Industry	Nov. '73	Oct. '73*	Nov. '72
Consumer electronics	158.1	158.6	101.6
Defense electronics	108.2	110.0	115.7
Industrial-commercial electronics	150.7	149.7	132.7
Total industry	129.5	130.2	118.4

The index fell 0.5% in November from October's level, but it remained 9.4% ahead of a year ago. Industrial-commercial electronics was the only major sector that bucked the November downtrend, rising 0.7%. Defense electronics dropped 1.6% and was off 6.5% from November 1972. Consumer electronics, though off by 0.3%, remained 55.6% higher than last November's level.

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

through which the water passes. The encoder circuitry is mounted on the cylinder. Protective nylon housings fit over the circuitry and give the unit—still only in a prototype, hard-wired stage—an outer diameter of 4 inches. It is powered by six nickel-cadmium cells and weighs less than 5 pounds.

The control operates with incremental, rather than absolute, position signals, which are triggered when the fireman turns an outer plastic sleeve on the unit. Seven different flow rates—from 45 to 310 gallons per minute in 45-gpm steps—can be dialed. If water flow can build up gradually, the man at the nozzle is not whipsawed around by the rapidly rising water pressure.

Using frequency-shift keying, a digital encoder in the unit modulates a 1-watt fm transmitter operating at 458.05 megahertz, the special fire-service frequency. A 23-bit message is then sent to the pumper's receiver-decoder. The 23 bits contain the digital addresses of the truck and one of the two hoses these trucks usually carry, an increment or decrement bit, and synchronization and parity bits. Defining truck and hose addresses precludes the possibility of a message being received by any other truck in the vicinity, Bernstein points out.

The pumper truck has a display and control panel for the parameters being monitored, and an alarm sounds if any value falls out of preset limits. In addition, logic networks and solenoid drivers triggered by the decoded commands interface with the flow-control valve.

The Grumman system has been in development for about two years at a cost of about $100,000, says Arthur August, director of the advanced development department. Grumman received advice on fire-fighting needs, he says, from Public Technology Inc., a private, non-profit, Washington-based organization that tries to match urban-area problems with high-technology solutions.

Following additional field trials—environmental conditions are tough, with temperatures, for example, ranging from −22°F to 140°F—Grumman hopes to get the unit into production by the latter half of next year. Plans are to sell the system for somewhere between $10,000 and $12,000. According to one Grumman estimate, there are some 80,000 pumper trucks around the country that could be retrofitted with the system, with another few thousand new pumpers being turned out each year. □

Consumer electronics

TV kit features electronic tuning

With what is billed as the most extensive engineering project in its history, kit-producer Heath Co. is ringing in the New Year with the first commercially available color television that features an on-screen digital clock and channel-number display, as well as completely electronic tuning and volume control.

In planning for more than three

another handful ... with more measurement solutions

THIS 5 MHz PORTABLE ADDS EXPANDED BANDWIDTH TO THE TEKTRONIX LINE OF MINIATURE OSCILLOSCOPES

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In its 3" x 5¼" x 9" package, the 221 has rechargeable batteries. It can be operated and charged from practically any power source from 90 to 250 V, 48 to 62 Hz AC, or 80 to 250 V DC without switching. Double insulation protects the operator while making elevated voltage measurements. Its impact-resistant case absorbs the rough treatment you expect in field maintenance.

221 Portable Oscilloscope, including batteries and probe . . . $745

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Circle 37 on reader service card

years, the model GR-2000 uses a new, Heath-designed LC-type filter in the i-f strip, producing what the Benton Harbor, Mich., company calls an almost ideally shaped bandpass that greatly reduces adjacent-channel interference.

On-screen. The most visible feature of the new set is its on-screen channel display and optional clock. The clock is either 4- or 6-digit with 12- or 24-hour readout. The 1-inch-high channel and clock digits can be positioned by the user anywhere on the 25-in. screen and programed to shut off after 3 to 90 seconds or displayed continuously. Changing channels or tapping the "volume-down" button recalls the display.

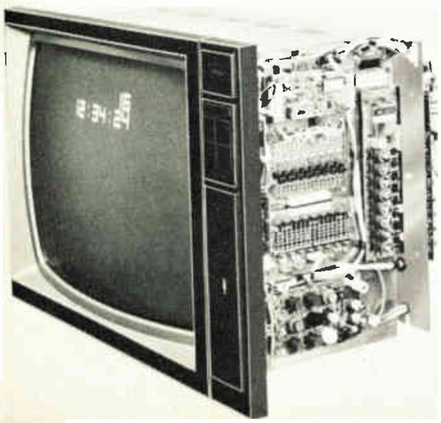
The circuitry for the clock display, which turns on the electron beam for specified time periods to form digits as it scans the tube, is synchronized by the receiver's horizontal and vertical retrace pulses, explains John E. Olson, the Heath engineer who designed the digital system. The position of the display on the screen is determined by adjusting a pair of on-chip monostable multivibrators triggered by the retrace signals, he says.

After positioning, a 4.5-megahertz gated clock-pulse generator is automatically enabled by the vertical retrace signals. Because the display must operate at this 4.5-MHz rate—that is, within 220 nanoseconds—Heath chose C-MOS for the set's faster devices, including the horizontal-scan-line counter and display digital counter, Olson says. Slower devices, such as the vertical counter and its associated logic, were designed using p-channel MOS. National Semiconductor put it all together on a custom character-generator chip.

Self service. Heath engineers designed a new intermediate frequency filter and amplifier so that owners could build and service their own i-f strip. The amplifier also provides an additional half-megahertz in bandwidth, which yields a proportional increase in picture resolution. "Our fundamental goal was to achieve the desired selectivity curve, which in turn eliminates the need for critical trap circuits," says Ivan Mertes, senior design engineer at Heath. "It gives us all the selectivity-curve shaping in one extremely stable package.

Heath has also applied digital techniques to volume control, using a Motorola MC1358 sound i-f amplifier with a built-in electronic attenuator to control volume level with dc voltage. In remote-controlled sets, Heath uses a four-bit up-down counter and feeds its outputs to a 4-to-16-line decoder, providing 16 discrete volume levels. Up-down counters also control remote channel select, color tint and intensity, and on/off.

The basic price for the kit is $649.95. Adding clock, remote control, and cabinetry brings the price to around $900. □



Time and number. New Heath color TV features on-screen channel and clock readout.

Government electronics

Five-year plan goal: improved mechanisms for IC reliability

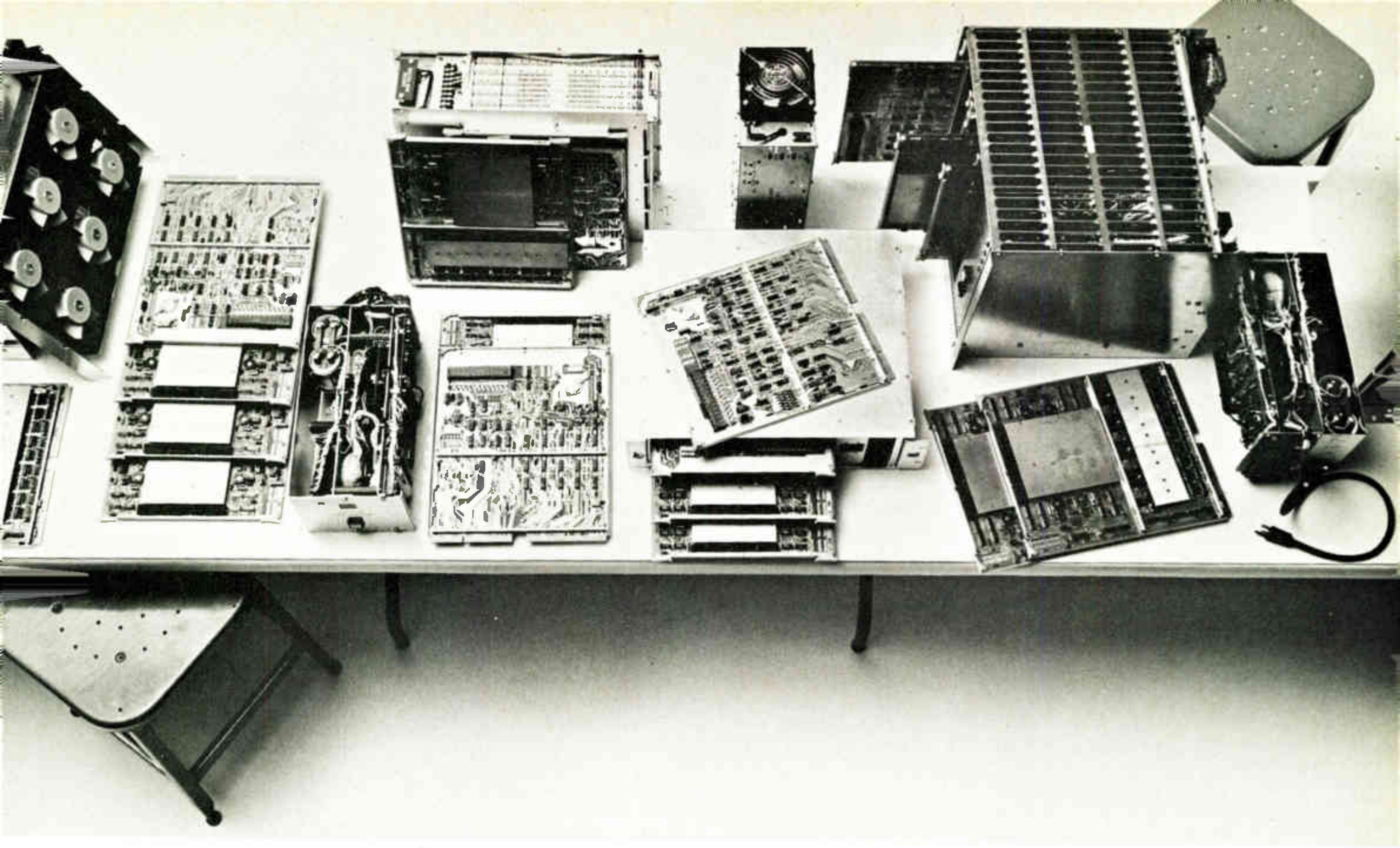
Faced with a $5 billion annual bill for maintenance of electronic equipment, the Defense Department is starting a major five-year effort through the Advanced Research Projects Agency (ARPA) to improve the quality of integrated circuits. The project promises to have a significant impact on the semiconductor industry [*Electronics*, Dec. 20, 1973, p.49].

Plainly unhappy with the performance of the devices it buys, the Pentagon wants to raise yields, lower costs, and improve reliability by developing sets of test procedures for industry—covering steps in production and assembly and ultimately leading to increased use of automated production.

Officials quickly point out that the test methods won't infringe on companies' proprietary production techniques. But application of comprehensive testing methods is bound to have an important impact on production and assembly practices. The program, called the Advancement of Reliability, Processing, and Automation of Integrated Circuits with the National Bureau of Standards, is managed by the bureau and has been announced in an industry briefing. The NBS expects to consult with and contract out to industry, universities, and other Federal laboratories in developing the test methods, according to Judson C. French, chief of the NBS Electronic Technology division.

Focusing initially on digital monolithic MOS and bipolar devices, the program's target will be to produce "a set of well-documented processing practices, controls, and measurements for use on production lines and applicable to the total semiconductor industry," according to C. Martin Stickley, ARPA's director of materials sciences. ARPA plans to test out new processes on new or future defense-system production lines or on Government-owned production lines before encouraging their adoption by industry, he says.

Furthermore, the Pentagon will press for increased use of "hands off" processes to beat down costs of the smaller lots of more specialized large-scale-integrated devices it expects to be buying in the future. "Through this program we also hope to enhance our ability to make perfect devices with the present MOS



Circle 39 on reader service card

technology," Stickley says. "We hope to be able to reduce the number of iterations necessary to develop operating circuits," he says, adding, "this research will move us towards the ultimate of low-cost disposable electronics."

From initial meetings with semiconductor company engineers, industry and program officials have targeted a host of problems, running the gamut from device production to assembly. Among the problem areas are:

- Silicon. Adequate techniques don't exist for measuring the thickness and resistivity of thin expitaxial layers. Other priority areas are methods to determine impurity profiles and rapid means to inspect wafers for contamination.
- Oxides. Defining specific measurement needs in this area are difficult, but concerns seem to center around such things as standardizing stress conditions for the bias-time-temperature stress tests and developing an inspection method that can be used immediately after etching to detect the presence of oxides in contact windows.
- Photolithography. Mask-inspection problems are more of a worry than photoresists, with the primary concern that of inspecting glass masks for defects and dimensional correctness.
- Assembly. Not surprisingly, bonding, packaging, and hermeticity all are problem areas. In wire bonding, a 100% test is needed to eliminate random weak wire bonds. Although DOD wants a high-reliability package, no one yet can define it, let alone tell how to test it. And, in hermeticity, determining leak rate is a big problem.
- Testing. Other problems in process-control measurements include fast production line tests for impurities in acids, solvents, and dopants; ion implantation processes, and surface cleanliness.

The program is starting out at a 30-man-year level in fiscal 1974 and is expected to grow, explains French. A few requests for proposals will be issued early this year, he says. The effort, managed under NBS' semiconductor technology pro-

News briefs

Philips to offer 'miniscopes'

Philips Gloeilampenfabrieken will tackle the "miniscope" market this year with two 5-megahertz oscilloscopes small enough to hold in the palm of the hand. The Dutch company has announced the PM 3000 single-trace and the PM 300 dual-trace scope. At less than 4 pounds, the new Dutch instruments have roughly the same weight and size as Tektronix Inc.'s model 221 single-trace 5-MHz scope introduced last month. Philips has yet to set a firm price, but it is expected that the two-channel instrument will cost $645 plus $80 for a set of rechargeable batteries, compared with $745 for the 221, which comes complete with batteries and charger. Both the Philips scopes, which have a sensitivity of 30 mV/division, and the Tektronix scope, at 5 mV/division, are aimed at the rapidly growing digital and video field-service areas.

Lasers help classify cells

An instrument consisting of two lasers whose beams pass through a jet of liquid containing human cells has been used to classify even rare cells that make up only 0.001% of the body's total cell population. Conventional bulk separators can process large numbers of cells but cannot divide them into many classes. The instrument was developed by researchers at the Stanford School of Medicine, Palo Alto, Calif., and Becton, Dickinson Electronics Laboratory in Mountain View, Calif., with a grant from the National Cancer Institute. The instrument, which Becton will manufacture, is expected to lead to a better understanding of the body's mechanisms of immunity. In turn, that may lead to a means of preventing such diseases as cancer and leukemia.

Trade show aimed at design engineers

A new trade show and exhibition aimed at design engineers has been set for May 1974 in Washington by the Electronic Industries Association's Parts division. To be called the Design Engineers' Electronic Component Show—DEECS for short—the meeting is being touted by EIA as "the first major program where engineers can meet with component people at a single function on a one-to-one basis." Location and exact dates of the show have yet to be set by the EIA division's *ad hoc* committee sponsors. Chairman is Bruce Vinkemulder of Grayhill Inc., and division staff vice president Tyler Nourse will be show director.

Xerox dispatcher cuts response time

By eliminating paperwork required for manual systems, a computer-based vehicle-dispatch system from Xerox Corp. cuts response time to police, fire, and other emergency calls while automatically handling administrative data processing. While the calls are processed, the system accumulates information for reports on daily activity and special management reports, and it eliminates the need for key-punching. In addition, it handles the agency's payroll and other accounting functions.

Hinchman named chief of FCC's Common Carrier Bureau

Walter R. Hinchman, who was made head of the Federal Communications Commission's new Office of Policy and Plans in November 1972, has been named chief of the powerful Common Carrier Bureau. Formerly with the White House Office of Telecommunications Policy, Hinchman will succeed Bernard Strassburg, who is retiring [*Electronics*, Dec. 6, 1973].

First home computer service hangs up

The high cost and small number of Touch Tone telephones has caused the nation's first home computer service in Seattle to go out of business in six months. A Seattle First National Bank official says that the $20 installation fee, $6.50 a month charge, and the few (10% to 15%) area households with Touch Tone phones crippled the bank's In-Touch system, which offered tax-data storage and mathematical services.

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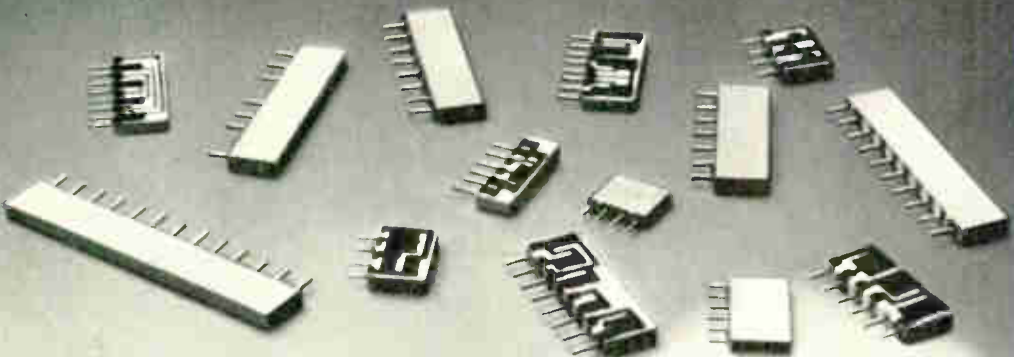

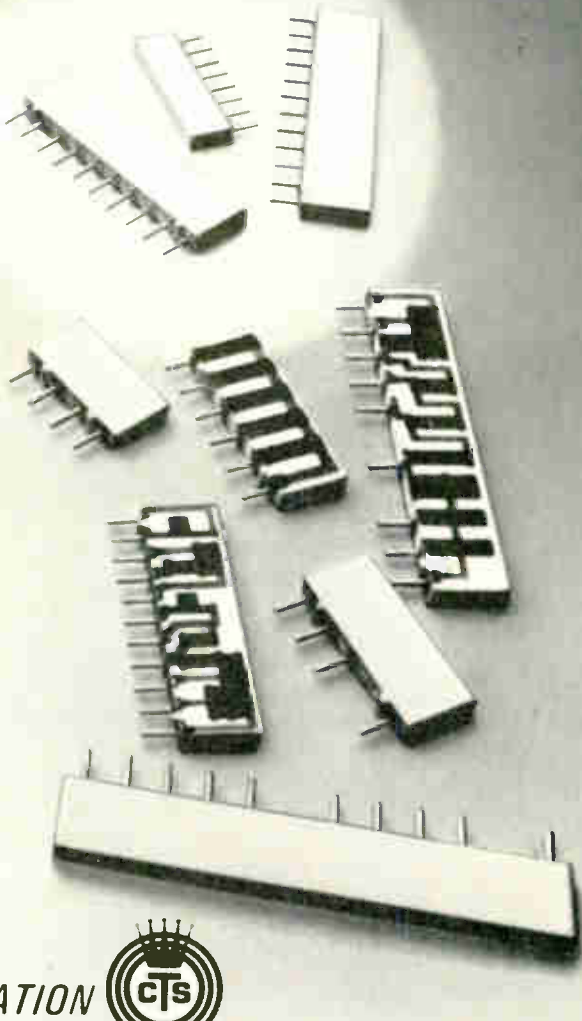

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gram, is being developed with the help of the three services' reliability laboratories. □

Microwaves

L-band filter made by electron beam

Although surface-wave acoustic devices have become valuable components in transversal filtering and chirp radar, these filters have been limited largely to systems operating at frequencies below 200 megahertz. Now Hughes Aircraft Co.—using electron-beam fabricating techniques to greatly reduce the electrode spacing along the filter—has developed a device that operates at the more useful L band. To reach that frequency range, Hughes engineers used an electron beam to cut filter lines with spacing of 1.1 to 1.8 micrometers in a lithium-niobate crystal.

The specifications of the filter are impressive: centered at 1.3 gigahertz, the filter has a bandwidth of 500 MHz, a compression ratio of 250:1, a maximum insertion loss of 40 decibels, and maximum side-lobe level of 24 dB below the central peak. Compressed pulse width varies from 3 nanoseconds with 3 dB of compression to 8 ns with 20 dB. Delay is 500 ns.

The filter was made at Hughes Research Laboratories, Malibu, Calif., from a Y-cut, Z-propagation lithium-niobate crystal to demonstrate that the exotic electron-beam microfabrication technique is practical for very sophisticated surface-wave devices. Lower-frequency acoustic devices have been made with conventional photolithographic processes much like those used to make integrated circuits. Electron-beam fabrication, in which a stream of electrons from a scanning electron microscope replaces a visible-light source plus contact mask, also has been used experimentally to make semiconductor devices.

The fine control and tight line spacings possible with an electron beam are even more vital in microwave surface-wave devices than in semiconductors because of the small dimensions involved. R.D. Weglein, a Hughes engineer who helped develop the filter, says the fabrication of microwave devices is the most demanding application of electron-beam technology: some 650 electrodes are squeezed into only 900 micrometers.

Only 0.5 micrometers wide, an electrode is spaced as little as 2.18 micrometers from its neighbor—a wavelength at the highest frequency. Weglein says that errors are kept to under 500 angstroms—less than 4° of phase. The low error figure is made possible by using self-correcting techniques to control the electron beam; the uncorrected error could be 1,250 angstroms. □

Energy

Electronics firms push conservation

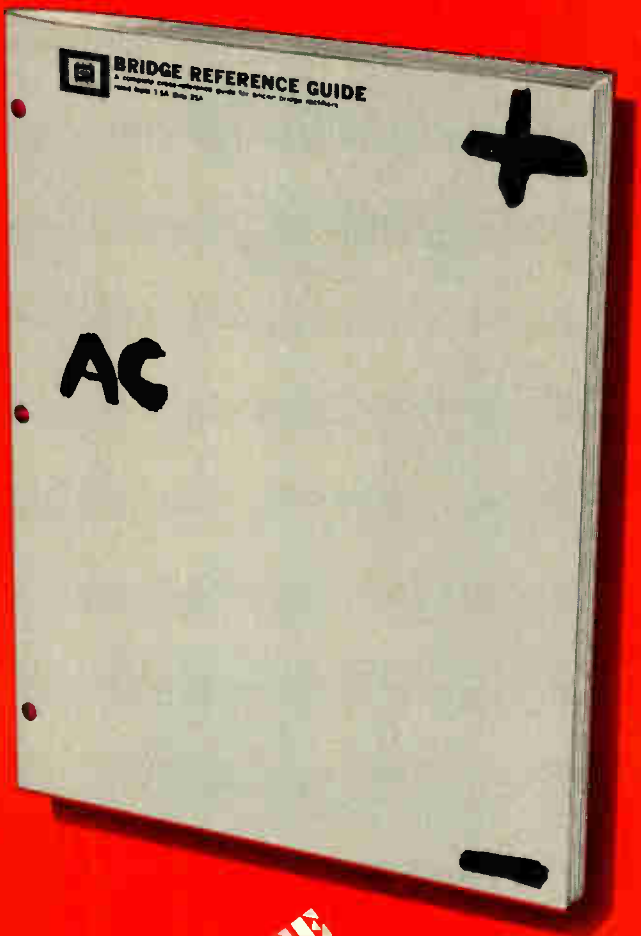
Despite the glimmer of hope in the energy crisis offered by the recent indications that Arab countries would increase their petroleum production, companies in the electronics industries are moving rapidly to reduce their energy consumption.

American Microsystems Inc., Santa Clara, Calif., has a program whereby employees whose written energy-conservation suggestions are adopted receive five shares of AMI stock.

In nearby Mountain View, Fairchild Camera & Instrument has what it calls an "energy-conservation task force," headed by Chuck Smith, director of central services. The group consists of heads of such departments as electricity, air conditioning, lighting, and gas. Already, says a spokesman, the company has cut back electric lighting in offices by about one third. The task force is working informally with the local utility to determine other measures to further reduce the use of electrical energy.

Meanwhile, an official at neigh-

FREE!



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SEMICONDUCTOR COMPONENTS

Circle 43 on reader service card

boring Hewlett-Packard Co. says that consumption of electricity has been cut by 20–25% at its Cupertino plant by shutting off lights. In other areas of the company, heating systems have been changed to reduce the amount of cold air that enters the building.

A company that is spearheading the efforts of several firms in the Chicago area is Motorola's Communications division, which has established a special energy board at its Schaumburg, Ill., headquarters to determine policy and implement fuel-conservation measures for all the division's plants. Initial results are impressive. The Schaumburg plant reduced its consumption of electricity by 20%, with a goal of 25%, and natural-gas consumption is down 16% on the way to a 20% goal, reports Jack Germain, vice president and director of product operations.

For several years, Motorola plants have used a transportation availability console for promoting employee car pools. A large illuminated map marked off in grids is mounted on a table with numbered slots corresponding to the grids. Employees fill out cards indicating rides needed or riders wanted and put them in their home grid slots.

Last month, the use of this console was made available to employees of more than 50 neighboring firms in suburban northwest Chicago. These firms have banded together to form a special energy committee, headed by Motorola vice president and assistant general manager Carl E. Lindholm.

In the East, Lockheed Electronics Co., Plainfield, N.J., organized energy-conservation committees about two years ago to help cope with the electric utility brownouts that strike during hot summer months. Presently, committees are meeting twice a month at the half-dozen or so major Lockheed Electronics facilities to come up with ideas for cutting down on energy use around the company. Minutes of the meetings are exchanged in the hope that action taken at one plant could spark ideas and more action at another. □

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BIPOLAR MEMORIES, 1974 UPDATE.

Basically, what the chart on the right tells you is that Fairchild makes an awful lot of RAMs, ROMs and even PROMs.

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The chart tells you, for example, that Fairchild offers immediate 256-Bit ECL and TTL RAM availability.

What's more, we offer the only 256-Bit and 1024-Bit ECL RAMs available in quantity today. Also our first F10K ECL RAM, the 15ns 128-Bit F10405. Priced lower than many 64-Bit ECL RAMs.

We also offer the only 1024-Bit TTL RAMs available in substantial quantity.

And latest devices from Fairchild include our new full MIL 1024x1 RAM, listed as 93415DM, and our new 256x1 3-state RAM, listed as 93421DC.

In all, Fairchild offers the broadest line of bipolar RAMs available *period*.

And just for the record, we've shipped more RAM bits than all other bipolar RAM makers put together.

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In addition to our existing Planar ROMs we now offer Planar TTL programmable ROMs, listed as 93416DC (open collector) and 93426DC (3-state).

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Device Type ‡	Output †	Max. Read Cycle (ns)	Max. Write Cycle (ns)	100 to 999 Price	Availability
TTL RAMs					
256X1					
93410DC	OC	60	60	13.10	In Stock
93410PC	OC	60	60	11.20	In Stock
93410ADC	OC	45	45	14.60	In Stock
93410DM	OC	70	70	26.20	In Stock
93410FM	OC	70	70	35.00	In Stock
93411DC	OC	55	55	15.00	In Stock
93411DM	OC	75	75	33.00	In Stock
93421DC	3S	50	50	15.00	In Stock
93421DM	3S	70	70	33.00	In Stock
1024X1					
93415DC	OC	90	90	56.00	Contact Fairchild Locally
93415DM	OC	110	110	135.00	Contact Fairchild Locally
ECL RAMs					
128X1					
F10405DC	—	15	15	15.00	In Stock
256X1					
95410DC	—	40	40	21.00	In Stock
1024X1					
95415DC	—	65	65	90.00	Contact Fairchild Locally
TTL PROMs					
256X4					
93416DC	OC	60	—	22.00	In Stock
93426DC	3S	60	—	22.00	Contact Fairchild Locally
TTL ROMs					
32X8					
93434DC	OC	50	—	10.00*	8 wks. ARO (1st. 100 pcs).
256X4					
93406DC	OC	50	—	14.00*	8 wks. ARO (1st. 100 pcs).
93406PC	OC	50	—	13.20*	8 wks. ARO (1st. 100 pcs).

* Plus 600.00 mask charge — Minimum order 100 pcs. per mask.
† OC — Open Collector; 3S — Three State
‡ D — Ceramic DIP; P — Plastic DIP; C — Commercial Grade; M — Military Grade
For more information call your nearest Fairchild Sales Office or Distributor.

What next? Here's your chance to tell us.

If you'd like a sample of our new devices, we'd like to send you one.

All we ask you to do is something you'd probably like to do anyway. Simply write us a note on your company letterhead telling us about your memory needs. And where you think we should go from here.

Future product requirements? More emphasis on RAMs, ROMs or PROMs? TTL or ECL logic? Number of words by bits? Read and write cycle times? New applications under consideration? Quantities required? And anything else you may wish to mention.

In return we will send you a free sample of any one of the following three devices:

93410DC (256x1 TTL RAM)
95410DC (256x1 ECL RAM)
F10405DC (128x1 ECL RAM)

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Along with your sample, we'd like to send you a special portfolio of information on Isoplanar memories.

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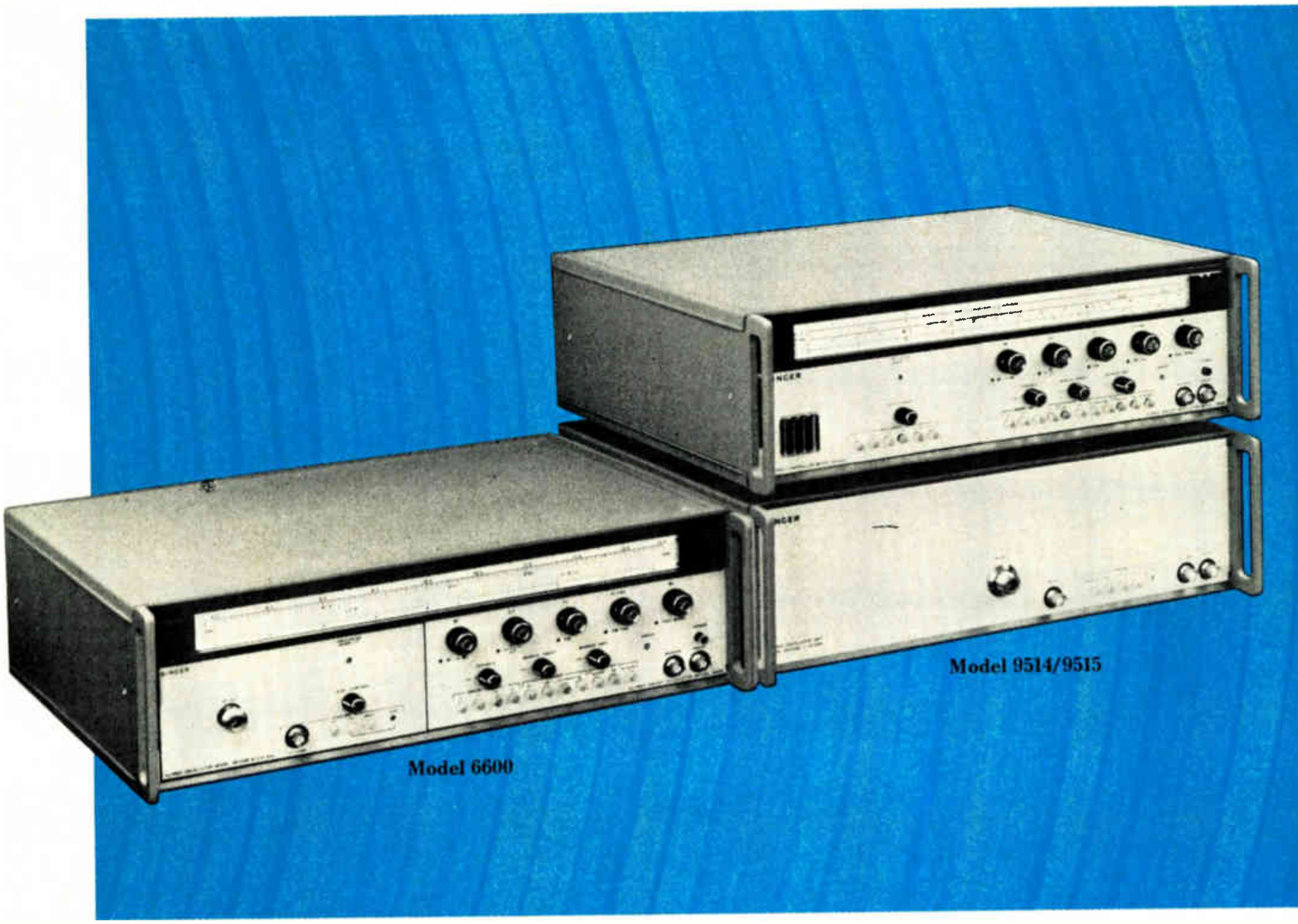
Singer sweeps

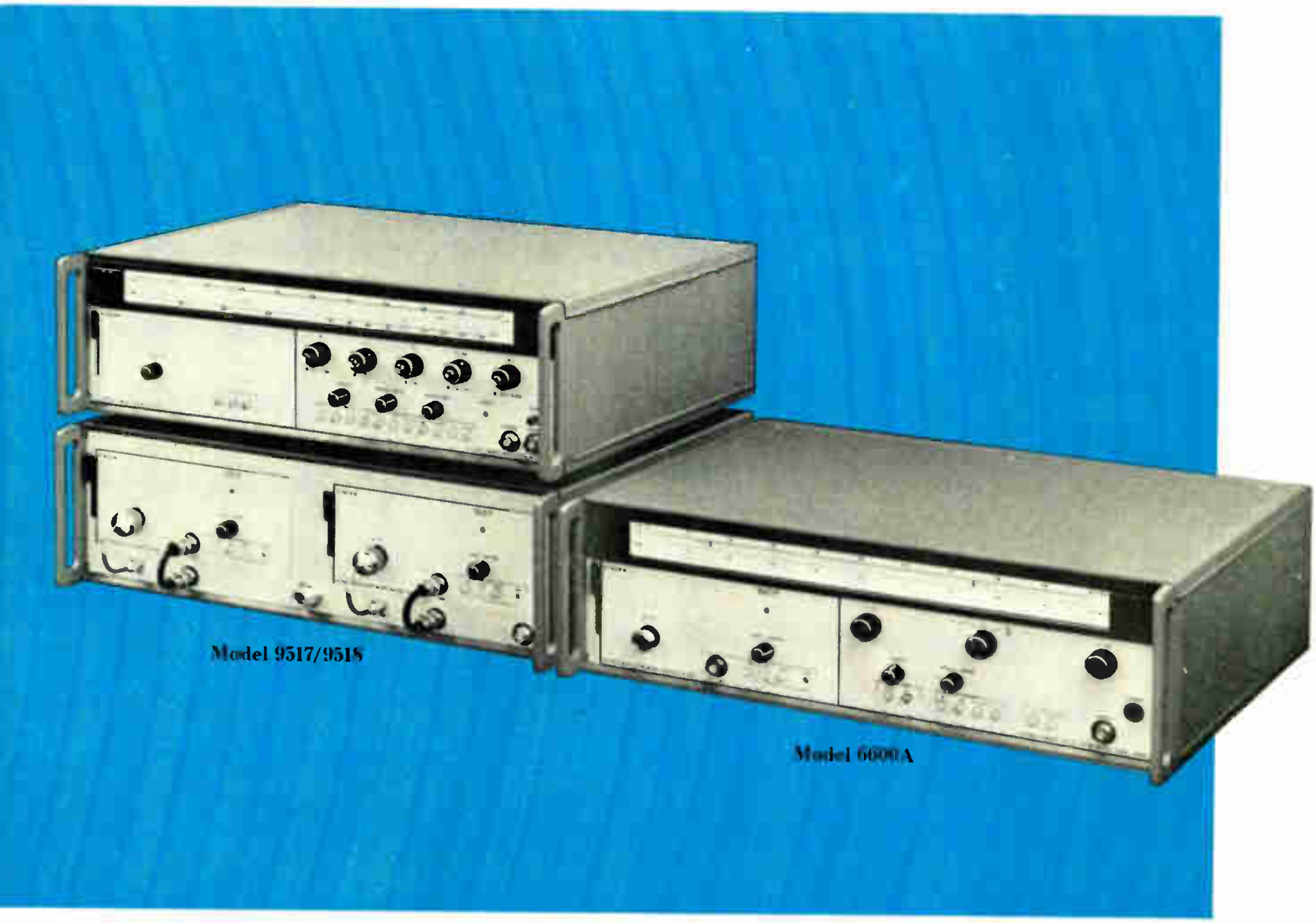


This all-new family of sweep oscillators lets you virtually custom-select a unit to suit exactly your needs. And whatever you pick for your particular range and application, you'll have the best balance of sweep range, accuracy, power, programming and cost—anywhere over the 100 kHz to 18 GHz frequency range. Singer has put its full 20 years of sweeper experience into this new family—so that you don't have to compromise in fitting the right instrumentation to your explicit requirements.

Model 6600. The Singer family starts with this sweep oscillator. Four sweep modes: full-band, marker, manual and ΔF. Stable CW operation with calibrated fine-tuning and low FM. Twenty-one low-cost plug-ins provide octave and multiband coverage from 100 kHz to 18 GHz. And the 6600 is digitally programmable for computer control.

Model 9514/9515. Mate the 6600 with our 9514 Controller and 9515 Oscillator Unit for continuous sweep of 100 MHz to 18 GHz at 10 mw leveled output power. No inconvenience or risk of RF discontinuities or losses resulting from changing and interconnecting plug-ins. For the full beauty of this rugged unit, look inside. All oscillators are mounted on a common cooling duct,

the market!



providing longer life, simpler operation and easy accessibility. To assure drift free operation all oscillators are left on continuously, their signals being switched to the output connector as programmed by your front panel or remote controls.

Model 9517/9518. This system includes the standard 6600 mainframe and any two plug-ins. It delivers multiplexed and leveled output power from a single connector while sweeping individually or continuously across both plug-ins—perfect for straddle band testing anywhere, 100 kHz to 18 GHz.

Model 6600A. Finally there's this simplified, low-cost mainframe compatible with all plug-ins and with both the 9514/9515 and 9517/9518 systems. This inexpensive mainframe performs the same basic sweep functions as the Model 6600 where digital programming, markers, and sweep light are not required.

If RF testing is part of your work, you'll find this exceptional new sweeper family very welcome in your world. For complete specs, use the Reader Service No. or write to The Singer Company, 3176 Porter Drive, Palo Alto, Calif. 94304. Or phone (415) 493-3231.

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With 32K words of our newly designed high-density 980ns memory.

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Plus the ability to run high-level operating systems like RSTS/E and RSX-11D. And ANSI-standard FORTRAN. CAPS 11. BASIC. BATCH. RT 11. And much more, from the world's largest library of minicomputer software.

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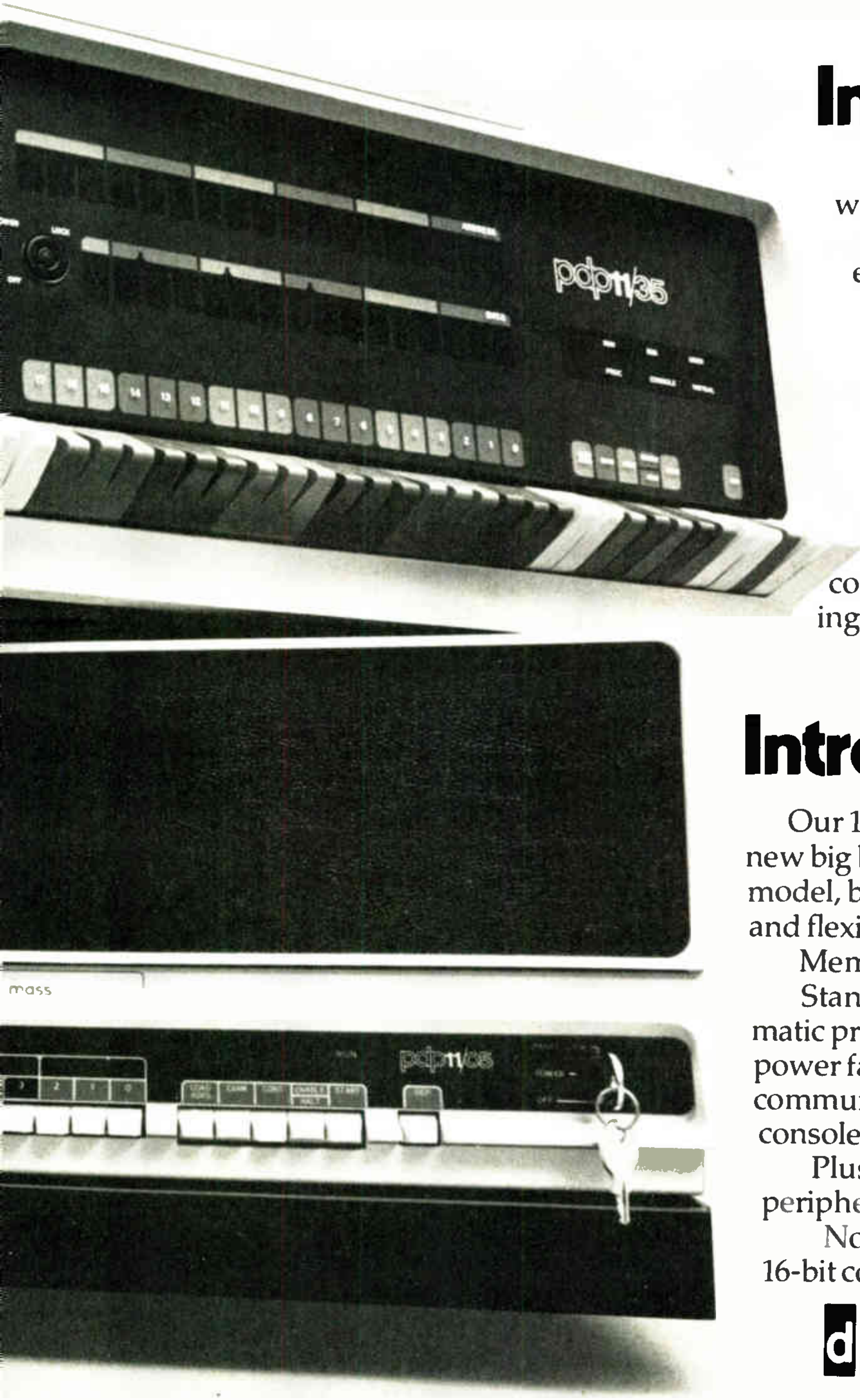

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Our 10½-inch PDP-11/35 minicomputer with 8K of memory.

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Memory expands to 32K within the chassis. And memory management is available.

Plus all those options. And peripherals. And software.

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Plus, again, all those 11-family options, peripherals and software. At only $4,156.*

No wonder the PDP-11 outsells all other 16-bit computers on the market.

digital

Contact your local Digital office. Or write: OEM Products Group, Digital Equipment Corporation, Maynard, Mass. 01754 (617) 897-5111. Ext. 3115. European headquarters: 81 route de l'Aire, 1211 Geneva 26. Tel: 42 79 50. Digital Equipment of Canada Ltd., P.O. Box 11500, Ottawa, Ontario K2H 8K8. (613) 592-5111.

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Circle 52 on reader service card

Washington newsletter

Study by product commission reopens TV safety issue

Capping a lengthy study of accidents related to TV sets, the Consumer Product Safety Commission is planning to call in TV manufacturers in February for a hearing on the safety of TV sets, the results of which **"may very well mandate a Federal safety standard for TV sets,"** says one staffer. The probe is sparked by commission data purporting to show that **916 "home-television-related fires" in the course of a year caused several injuries and one death in a sample population.** While industry had anticipated some changes in quality-control requirements as a result of the study, the commission appears ready to go much further and **will ask set makers to supply their own accident data as well as their plans for design and manufacturing changes and for training service technicians.**

Sets named in the commission data came from RCA, Philco Ford, Admiral, Zenith, Montgomery Ward, Packard Bell, Olympic, Magnavox, Sears, Sharp, Sony, Panasonic, and Heath, most of them color. J. Edward Day, special counsel for the Electronic Industries Association, says that "industry is making maximum efforts" to make safe TV sets, but cautions that "the commission is not in the position to say that TV sets were the cause of the accidents." The industry wants "to see the problem described properly," he says.

Counters of bus passengers, revenue sought by UMTA

The Urban Mass Transportation Administration wants to develop an automatic onboard bus passenger, revenue, and maintenance tabulator so that transit bus operators can plan their fleet schedules better. Moreover, **the agency will qualify the winning design for Federal grants to help municipal bus fleets buy the system.** First stage is planned for the end of January, when UMTA's agent, the Mitre Corp., McLean, Va., will issue requests for proposals for new sensing techniques for an automatic bus-passenger-counting system. After evaluation, feasible approaches will be funded and turned into operational prototype units for further testing.

The solid-state passenger counter—estimated to cost about $1,000 per bus—will be part of a package that will include a plug-in cassette-tape-recorder unit to monitor gas and oil consumption. As UMTA reasons that fleet owners won't want to put the $300 recorders on every bus, the cassettes would be plugged into buses on a selective basis. Separate RFPs for the cassette devices are due later in the development cycle, but the bus-counter contractor should have a competitive edge. UMTA **foresees the combination passenger counter and maintenance recorder as being read during servicing over a connecting cord to a computer, which opens another possible market in computer hardware.**

Bureau of Mines is looking for novel wireless system

A potentially rich vein in the communications equipment market could be tapped if a company can develop a successful wireless communications system in mines for the U.S. Bureau of Mines. The bureau plans to issue a request for proposals for new ideas in January, due back 30 days later, because "there's something wrong with every major means from vhf to uhf," says one staffer. If **the one-year effort is successful, the bureau would like to begin multi-year development leading to Government-backed commercial production of systems,** including portable personal transceivers, repeaters and surface communications.

Managing future shortages

Emilio Q. Daddario, who while in Congress became its acknowledged leader on issues affecting science and technology, is now expected to return to Capitol Hill as director of the new Office of Technology Assessment. While most Government and electronics industries leaders continue to struggle with the immediate problems arising from the petroleum shortage, Daddario is inclined to a longer view. Recently, he considered the long-term impact of shortages at a meeting on National Materials Policy sponsored jointly by the National Academy of Science and the National Academy of Engineering. Excerpts from his comments follow. **—Ray Connolly**

Having lived in the America of abundant land and rich resources, we have long assumed that they were inexhaustible. We have also developed the strong belief that if anything did go wrong, the democratic process and a free market economy would unfailingly lead us to the preferred course. Yet we are beginning to face the fact that our society has become rapidly altered by technical change, and most of us are aware of the critical social maze we, and others of the technically advanced nations, have built for ourselves.

We have come to realize that, like it or not, we must learn to live under different conditions. The great unknown in any such exercise is this, the manner in which Government shall act and if, in so doing, it is to take the prime responsibility.

The two studies [on national materials policy] before us include recommendations that touch on almost every facet of American life, public and private. Without disagreeing with any of the recommendations, I remain overwhelmed by their sheer magnitude. We obviously can't implement them all. So where do we begin? Which have the highest priority? And how is that to be determined?

Too much advice

Moreover, there are many other important commissions which have made recommendations that must also be taken into account. Putting it bluntly: we have more advice than we can handle. What we need now is the kind of systematic decision-making and management to put first things first and get them done. We must develop increased coordination between the agencies and departments of Government so that they can act and interact more efficiently. Clearly, the formal promulgation of a comprehensive materials policy and the organization of Government to implement that policy are of fundamental importance.

Either we decide the issues rationally, or they will be decided for us irrationally. Our goals in the management of our national resources of materials, energy, and environment are not easily expressed, nor are they easily reconciled. We cannot wind up our universe like a watch and leave it alone to run by itself. It takes our continued, sustained attention. An orderly and sustained management directed toward this purpose is virtually meaningless in the absence of a stout, well-conceived, well-supported, and well-executed national science policy.

In the development and management of whatever structure is necessary to accomplish these broad objectives, congressional participation is both vital and critical.

The role of our science-based technology in bringing about efficiency and flexibility in our use of resources is clear and unmistakable:

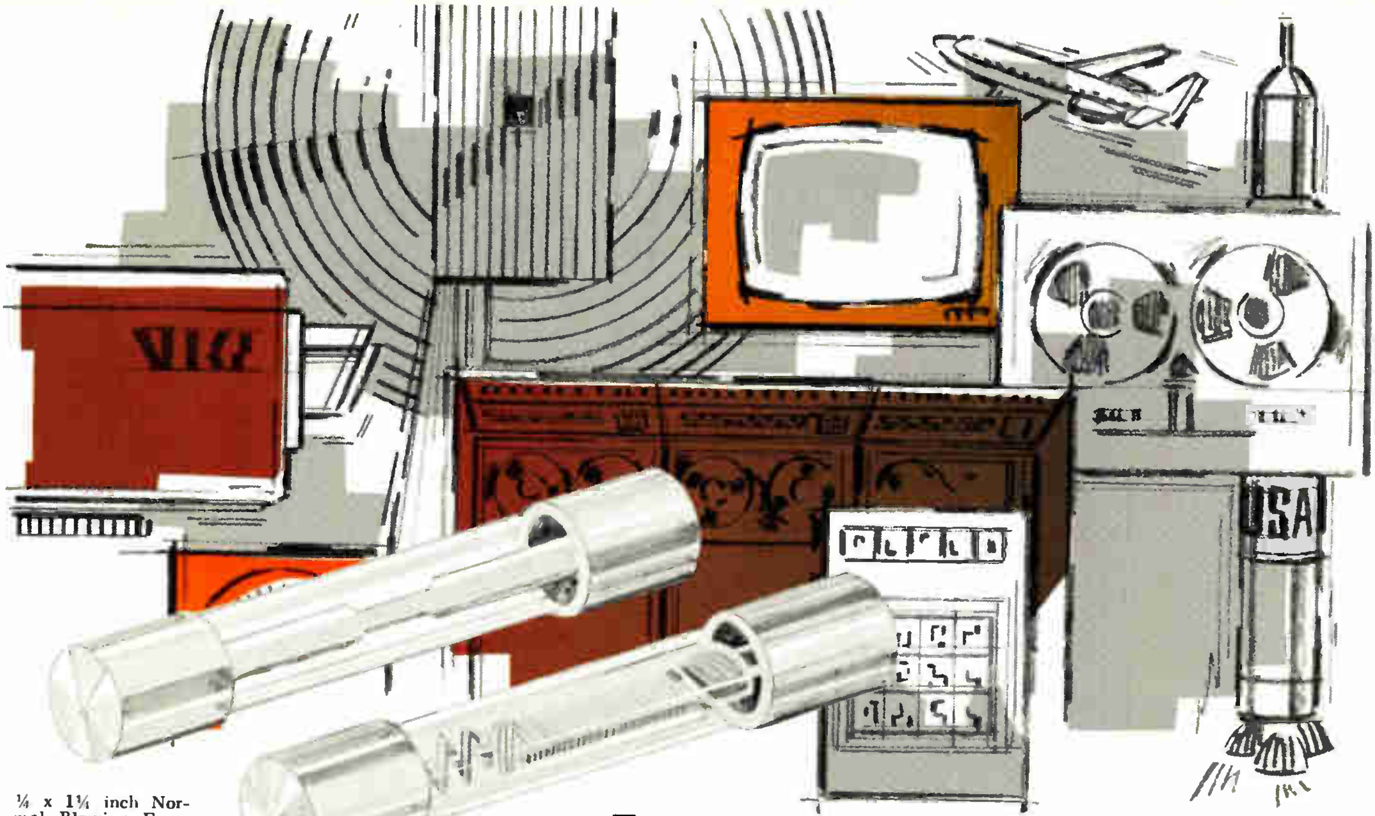
- It improves performance so that we can do more with less.
- It finds new properties for our designs.
- It enhances the efficiency with which we extract metals from the ground.
- It enables us to recapture values from wastes.
- It shows us where to look for substitutes and for new ways of using old materials.

In short: science and technology increase our options, our freedom of choice in the routine management of our resources.

Call for change

As a final point, I must stress the importance of the organization to coordinate the planning and implementation of policy in science, technology, and their application to materials, energy, and environment. [The] responsibility to meet our short- and long-term needs cannot be distributed in an uncoordinated fashion to individual mission-oriented agencies where the competition for funds and attention will lead disastrously to divided public support. To deal with such issues on a piecemeal basis is both wasteful and inefficient. To avoid this calls for a thorough change in Government organization.

In endorsing the concept of a greatly strengthened Department of Natural Resources, presumably based on transfers to the present Department of the Interior, I do not mean to suggest either that reorganization automatically yields beneficial results, or that further pruning and shaping are not needed. But it would be a good starting point, and especially for coming to grips with our needs for a sustained program of resources policy formulation and coordination.



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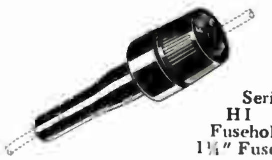

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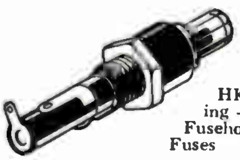

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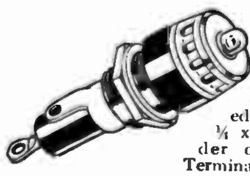

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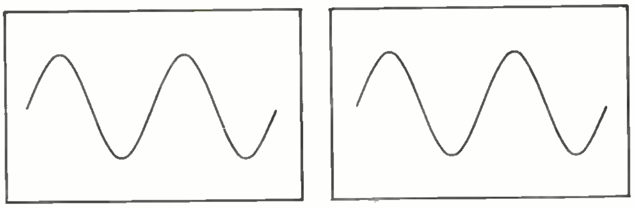


Can your present average-reading DMM tell the difference between these two computer-generated sine waves? Probably not.

But the Weston new model 4445, a low-cost, 3½-digit RMS-responding DMM can. It can seek out and detect the 1% distortion in the third harmonic of the wave on the right. And it could do the same even if the wave were square, triangular or odd-shaped.

So don't depend on just any DMM for those critical AC voltage readings. Stop guessing at those last one or two digits. Get a Weston model 4445 with RMS capability and read every wave to a guaranteed ± 0.5% accuracy ± one digit across ranges from a low 200mV to a full 1000V with 100uV resolution.

For only $450 you get all this, plus 5 DC voltage ranges, 200mV to 1000V; 6 resistance ranges, 200 ohms to 20 megohms; 2 DC current ranges, 200uA to 2mA; plus 2 AC RMS current ranges, 2uA to 2mA—all fully over-load protected.

And you get it all inside a fully portable, shock-resistant case measuring only 2.25″ x 5.45″ x 7″. Weighs only 2.5 lbs. Comes complete with four nickel cadmium batteries for up to 10 hours continuous operation, and AC line converter for bench-work. Fuses, probes, and carrying case are included, of course.

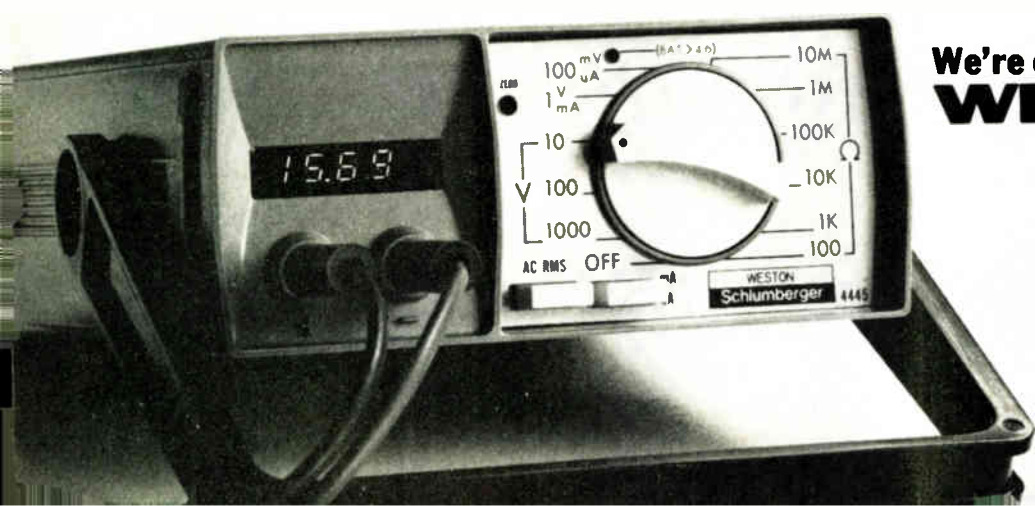
9744 Transducer adds RMS to any one-volt digital instrument.

If you already use a digital voltmeter with 1-volt DC range, you can add RMS with the new Weston 9744 Transducer.

Model 9744 can be ranged to accept AC input from 100mV through 700V. It converts the input to a 1-volt DC output signal for the full-scale RMS value of the AC signal. Will also scale AC current input from 1uA to 1mA. Operates on either 115V or 230V, 50-60 Hz line.

List price only $150 with case.

See both these exciting new examples of WESTON leadership in test equipment at your nearby distributor today. Or, write direct to Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N.J. 07114.



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Circle 56 on reader service card

Electronics makes waves at Europe's boat shows

Sailors within reach of London and Paris don't have to risk chilblains this month to satisfy their passion for boating. A day's hull-thumping and cabin-checking at the big January boat shows in the two cities rates as high as a winter sail except for a hardy few. Amidst the forests of masts, showgoers this year can find some new electronics hardware, much of it within reach of only well-heeled yachtsmen. But there's a noticeable effort by producers to get their prices down.

One way to cut costs is to share common resources. And that's the tack that EMI Marine, a division of EMI Electronics Ltd., has taken. Circuits are shared, as much as possible, in the company's new line of yachting instruments—a log, a depth gauge, and wind and trim indicators. All the circuitry except that necessary for driving the cockpit displays is housed below in a box measuring roughly 6 by 9 by 3 inches. Along with a board for the power supply, this box can take up to three other instrument boards. This gives yachtsmen their choice of up to five instruments—the "wind" board covers three functions.

Add on. Colin Burdick, chief engineer of EMI Marine and the man who devised the new configuration, says that the sailor who intends to stick with just one instrument will pay just as much, probably more, buying it in the new range as he would buying a conventional, self-contained, discrete instrument. However, if he wants two instruments or more—initially or later—he will gain, probably saving about 20% if he wants all five.

In Britain, transducer, electronics, and one instrument for speed and distance measurement will cost about $430. Adding depth indication will cost another $250. All five instruments will cost about $1,200.

Solitary navigators will get a leg up from Oxy Nautica, an affiliate of the Geneva-based Oxy Metal Finishing International. Oxy Nautica has added relatively low-cost acceleration and wind indicators to its line for 1974. But the new instrument that company head Jean-Claude Protta enthuses most about is an autopilot that runs off four flashlight batteries. Hardware powered by non-rechargeable batteries is okay under the rules for single-handed sailing competitions, so Protta expects that deep-water sailors who like to cross oceans alone will be prospects despite the cost—"under $3,000."

In this autopilot, a control tab 50 centimeters high and 15 cm wide is hinged onto the after edge of the rudder. It moves relative to the plane of the rudder through a rack-and-pinion arrangement; a 6-volt motor housed in the tab drives the pinion. The motor is powered by a servo system built around a pair of RCA 3078 operational amplifiers.

Error signals can come from comparison of the ship's desired heading with its actual heading, fed in by an electronic compass, or the autopilot can be set to keep the heading fixed with respect to the wind direction. There's also provision for feeding in control signals manually. "That makes it possible to steer from anywhere on the boat," says Protta. □

Around the world

Radar fits on one car

A pulsed-microwave radar system that does not require special reflectors or transponders on other vehicles has been developed by Frankfurt-based VDO Adolf Schindling GmbH, one of Europe's leading vehicle-instrument makers. Like equipment being developed elsewhere, VDO's system uses pulsed-radar principles because, under bad-weather conditions, it gives better performance than other types of systems, says Guenter Hahlganss, head of VDO's predevelopment section. And "abrupt" targets can be more readily and easily distinguished from "diffuse" ones—for example, water-spray clouds on a wet road.

VDO engineers have built an experimental 9-gigahertz warning system that sounds an alarm when the distance to a moving or stationary object falls below a preset margin. An autonomous pulse system, Hahlganss concedes, needs a narrower beam and a more extensive high-frequency portion than a transponder-based frequency-modulated CW device. However, he considers that its performance under dynamic conditions is superior because analysis of pulse rise times lends itself well to target distinction.

Navigating in deep waters

Once out of sight of land, the most sophisticated and expensive gear can still only give a fix to the nearest 20 yards or so. Now a small French company has come up with a system that can pinpoint a boat's position to less than 10 yards more than 100 miles at sea. At under $10,000, it will be within the reach of some yachtsmen as well as fishermen.

Teleco Radio of Paris is new to the radio-location business, but its hardware is built on the patent base of two French inventors who also had a hand in the development of earlier navigation schemes such as the Omega system. Teleco's design, known as the Rana P.17, uses a concept based on phase measurement of signals transmitted with very narrow bandwidths by a chain of coastal transmitters. Right now, four transmitters are in operation, covering the French Atlantic coast from Brittany south down to the Bay of Biscay. Each has a range of 1,000 kilometers by day and of 400 km at night. Just 20 transmitters, Teleco's president Roger Hadida explains, will cover the whole coast of Western Europe from Ireland to Spain.

Oil cutbacks have yet to hurt industry in Europe and Japan . . .

Electronics companies in Western Europe and Japan face a worrisome winter of uncertainty. **It will be March, at least, before anyone can size up the potential impact of this fall's upheavals in energy supplies and raw-materials prices.** Luckily, most companies went into the new year with heavy order backlogs built up during the 1973 boom. Except in hardest-hit Great Britain, business—paradoxically—figures to continue good for the next few months and perhaps well into the year. As an official at Philips Gloeilampenfabrieken points out, "the supply lines between us as producers and the ultimate consumer are quite long." At components suppliers, backlogs big enough to cover the whole year's output—if cancellations aren't heavy—are not uncommon.

So far, producers on the Continent and in Japan tend to play down direct effects of the Arab-countries' oil cutbacks, which touched off the upheavals. Philips points out that the direct energy "content" of electronics products has been squeezed consistently during the past few years. In France, an initial report by a government agency predicts that a 10% slash in oil supplies would cut growth in the electrical and electronics industries by slightly less than 1%. In Japan, there's a feeling that the crisis is **an escalation of previous raw materials problems.**

As it looks now, price rises in consumer electronics will be the first highly visible effect in Japan. Most companies have had to cut their electricity consumption by 10% but have coped by cutting back on frills like extra lighting and elevators. Higher labor and materials costs this year, though, can't be offset as before by whopping increases in production. For the first time in years, consumer hardware prices are headed up in Japan. Calculator makers, too, figure to reverse the previous trend of lower prices. Test-equipment makers boosted prices during 1973 and talks of another round of increases this year.

. . . but Great Britain is hit by domestic coal shortage

So far, it's been the British companies that have been hardest hit, having in addition a homemade shortage of coal. The country's miners, at odds with the government over pay increases, launched in November a ban on overtime that by yearend had provoked a crisis in electrical power supply, 70% of which comes from coal-fired plants. As the new year started, there was no sign of a settlement and the country went on a three-day work week, as far as electricity goes. Industries that need continuous power—semiconductor producers, because of their diffusion furnaces—though, get 65% of their "normal" kilowatt hours. Most figure they can keep production up between 70% and 90% of normal levels for a few weeks by slashing nonessential consumption.

Until the miners go back to working overtime, then, oil shortages don't mean much. The government figures the economy can handle a shortfall of some 15%. There would be no growth though, and looking forward to that the government has put in effect some credit restrictions that could slash color-TV set sales by some 20% to 40% this year. There will be cuts in public spending, too, which will hurt business in defense electronics, telecommunications, and computers.

TV links in Europe go to digitized audio

The European Broadcasting Union, which organizes European international television distribution, plans to be using the "sound-in-sync" transmission technique invented by the British Broadcasting Corp. for

98% of TV transmission across European frontiers by the spring. Sound-in-sync **dispenses with a separate audio channel by pulse-code-modulating the sound and inserting the digital signals on the video wave in the line synchronization period. EBU is buying coders, decoders, and monitors from Pye TVT Ltd., built under a BBC license.** So far, it has them installed both ways on all international links in Scandinavia, and on outwards legs only from Italy to Greece and Italy to Tunis, from Paris to Spain and then to Portugal and Morocco, from Paris to Algiers, and London to Belfast. Currently, return legs on those routes are being equipped, along with two-way links between all major West European and North African capitals. By the spring, in normal circumstances there should be no separate audio channels in use across frontiers.

CGE looks for foreign partners in telephone switching

In a bid to break down national frontiers in the European telephone-switching market, Compagnie Generale d' Electricite (CGE) is working towards a series of agreements with companies outside its domestic French market. For a start, it is close to signing three separate license agreements for its all-electronic time-division switching technique in three European countries. In addition, CGE hopes to take advantage of its head start in this technology by teaming up with a British partner to supply the U.K. market. It hopes to conclude a deal sometime next year.

French industry sources point out that the British are more heavily committed than their European partners to all-electronic switching systems, but have not yet developed a technique that is as far advanced as French efforts. In fact, the Centre National d' Etudes des Télécommunications, the French government research organization, which has developed the technology, already has 16,000 customers linked up to time-division switching exchanges, plus a further 900 in a PABX system at the new French airport at Roissy, near Paris. CGE as the CNET's industrial partner, is now also busy selling the electronic switching hardware to the Eastern European countries and is battling with ITT for the Russian market, too.

Britain's post office to buy IBM computer for network design

If the government's new economic measures allow it, the British Post Office will buy an IBM 370/168 computer system costing $6 million to help in design and development of the electronically switched trunk network that the BPO expects to start installing late in this decade. Main function of the computer will be system simulation, and the BPO says it **decided on IBM because nothing of adequate size and power for this purpose could be had from a British computer maker—meaning International Computers Ltd.—in the time available.** The machine will be built at IBM's British plant at Havant, Hampshire from elements made mostly at European plants.

Grundig expands in Northern Ireland

Undeterred by the restive political situation in Northern Ireland, Grundig AG continues its expansion in that region of the United Kingdom. As part of a multi-million-pound program heavily supported by the local government, the West German consumer-electronics producer plans to start operations by the end of 1974 in a second manufacturing plant there. The facility, at Newry, about 40 miles south of Belfast, is set aside for cassette recorder production.


4029
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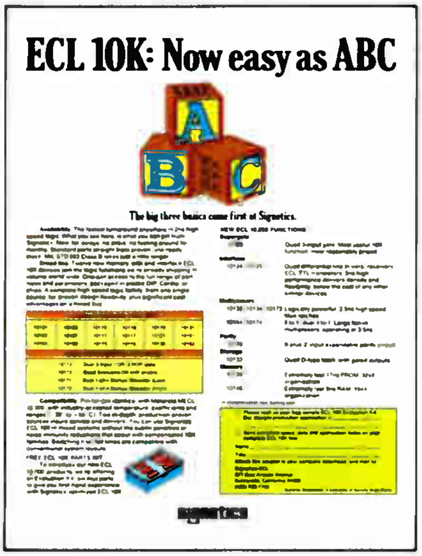
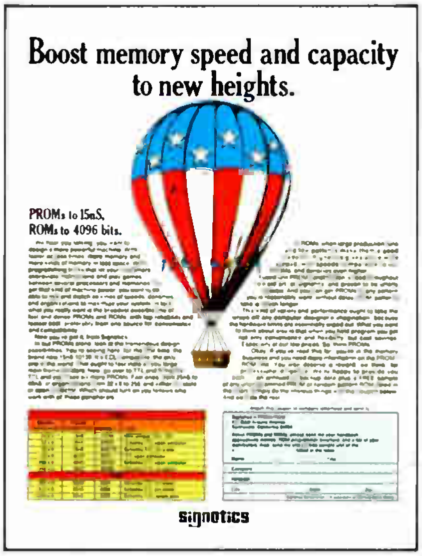
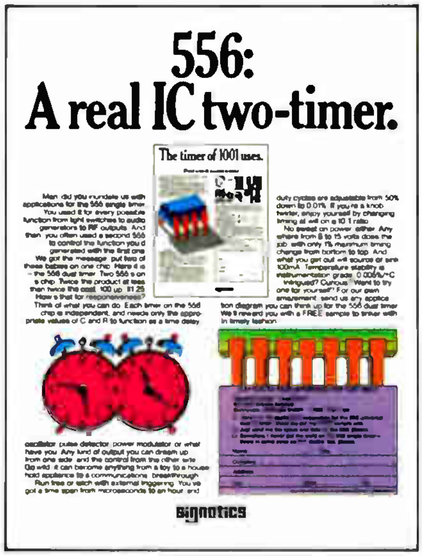
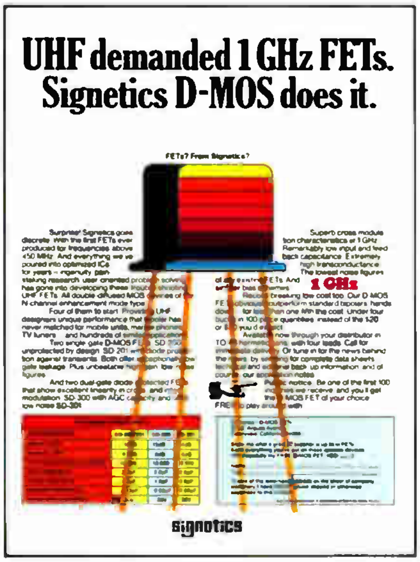
Circle 63 on reader service card

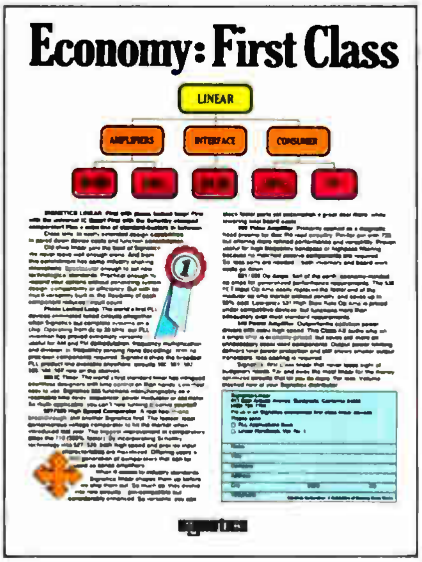
A sample batch of the year's top numbers.

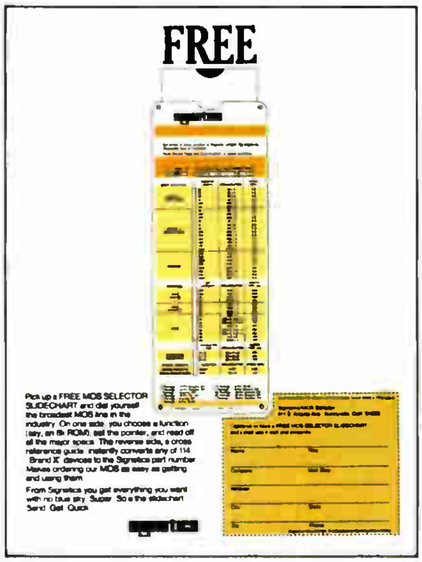












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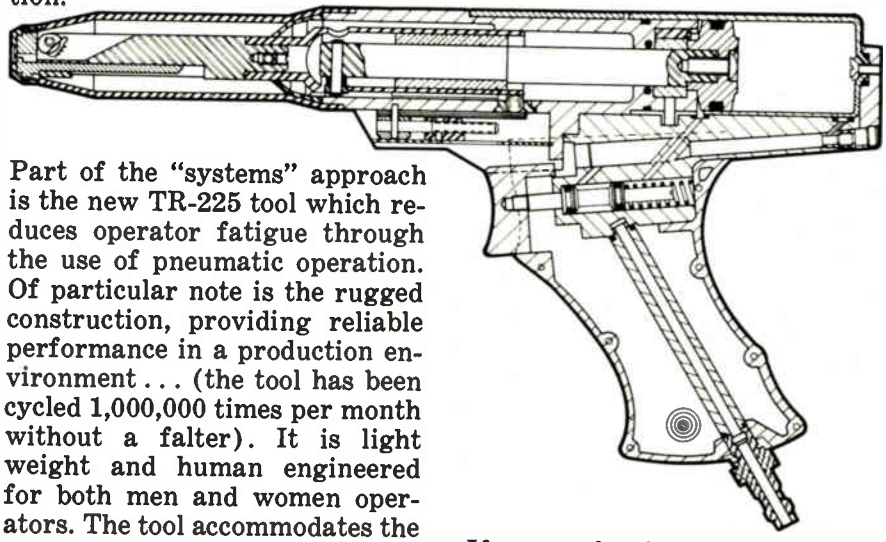
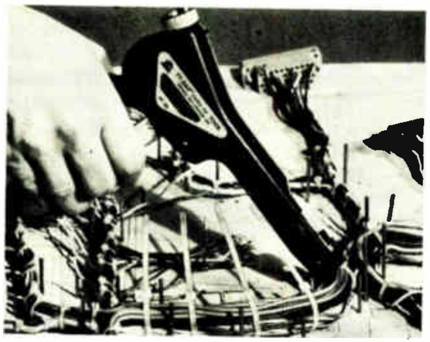
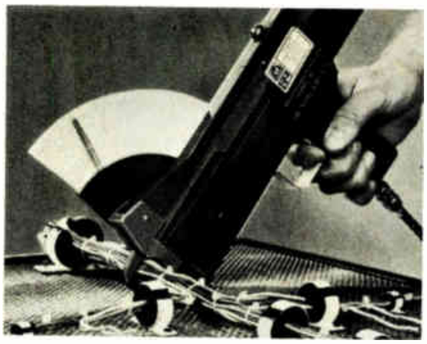


Part of the "systems" approach is the new TR-225 tool which reduces operator fatigue through the use of pneumatic operation. Of particular note is the rugged construction, providing reliable performance in a production environment . . . (the tool has been cycled 1,000,000 times per month without a falter). It is light weight and human engineered for both men and women operators. The tool accommodates the majority of TY-RAP® tie sizes . . . 16 in all . . . with bundle ranges from $\frac{1}{16}$" to 4". A further convenience for the operator is that the long narrow nose gets into confined areas easily. If your production volume is such that it does not require the exclusive use of the TR-225 perhaps the new WT-193 hand tool would supplement your operation.



This tool accommodates the same bundle range as the TR-225. With a similar narrow nose and long barrel, it is well suited for close-up work, breakout points and in tough to reach places. This particular design gives the operator the convenience of a long tying stroke with one squeeze of the trigger . . . the tie is cinched to a preset tension and trimmed flush with the head. The speed of tying is good for smaller volume tying as compared to the pneumatic TR-225.

If an evaluation of your tying requirements reveals a high volume of tying bundles in $\frac{1}{16}$" to $\frac{5}{8}$" diameter, consideration of our new automatic production tool (TR-300) would be wise.



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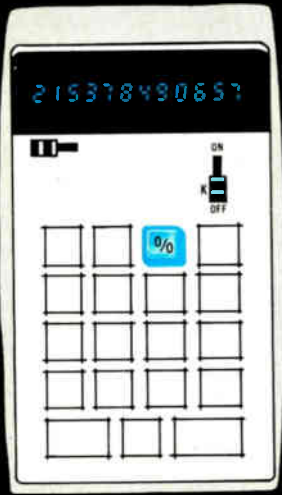
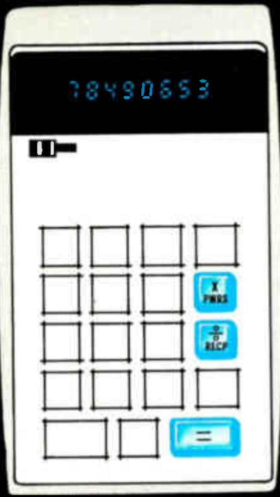
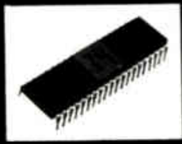






5030

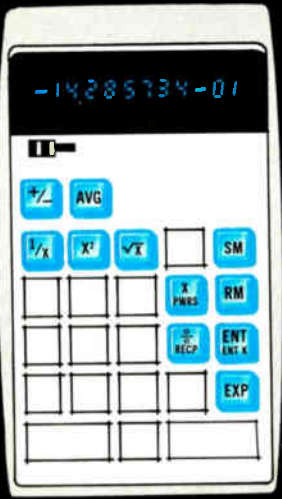
8, 9, 10, 12 digit capacity, constant K, %, add-on & discount operations, floating point, chain & mixed calculations, ≤15ma current drain, self-test.

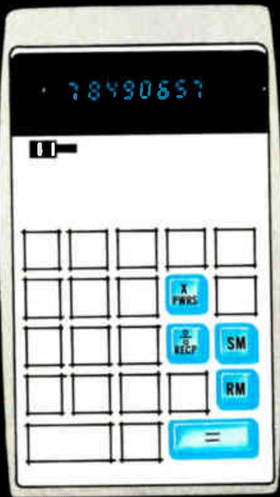
5031

6 or 8 digit capacity, floating point, separate equals key, reciprocals and powers, chain & mixed calculations, 15ma current drain, self-test.

5032

8, 10, 12 digit capacity, accumulating memory, automatic memory totaling, average, %, add-on & discount operations, fixed and floating point, add mode, automatic 4-function constant, sign change, X/Y register exchange, round-off, round-up, truncate, memory indicator light, recriprocals and powers, chain & mixed calculations, 15ma current drain, self-test.





5033

8 digit capacity, plus 2 exponent digits and sign, memory storage register, average, $\sqrt{x}$, 1/x, x^2, exponents, automatic constant, reciprocals and powers, under & overflow, automatic round-off, chain & mixed calculations, 15ma current drain, self-test.

5037

6 or 8 digit capacity, memory, floating point, separate equals key, reciprocals and powers, chain & mixed calculations, 15ma current drain, self-test.

Circle 70 on reader service card

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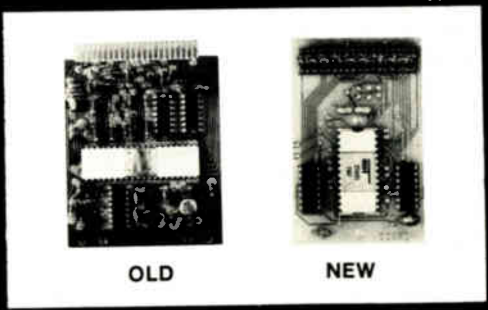

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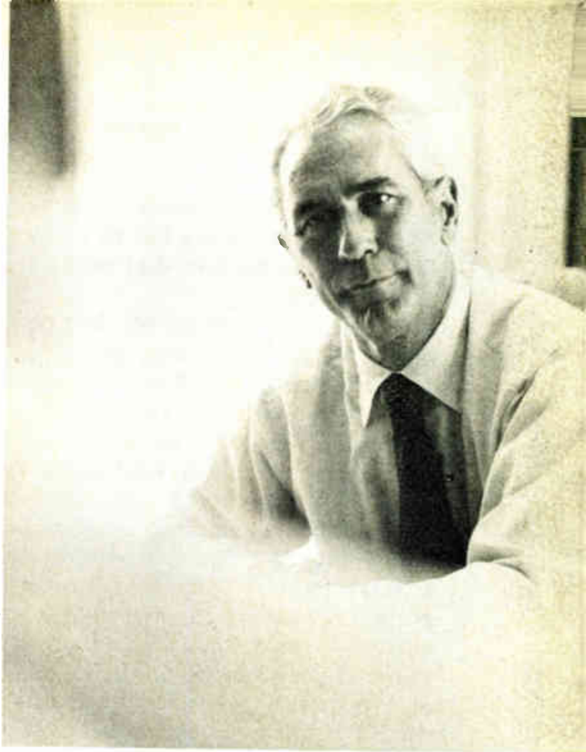


TRW's Webb. "Washington has bungled. . . . We need firm leadership."

Executive views of '74 clouded by energy crisis

Materials shortages and possible dip in growth rate or full-blown recession also arouse concern

Energy may be defined as "power efficiently and forcefully exerted," and its threatened lack in 1974 weighs heavily on those who run many of America's electronics companies. And even as the still-developing energy shortage becomes a major concern, it has to share the top of the list of things to worry about with such familiar threats as the possibility of a recession and increasingly severe shortages of materials.

Those three subjects dominate discussions with chief executives of companies and divisions across the country. But evaluations of their relative significance are almost as varied as the products and services offered by the managers making the predictions.

Perhaps the problems are interdependent, suggests Stanley J. Kukawka, vice president and general manager of Allen-Bradley's Electronics division. Labeling the energy situation as the one with the greatest potential impact on the economy, Kukawka says that an outgrowth is the shortages of parts and materials.

"Continued shortages of raw materials, such as plastics and some metals, will have a definite dampening effect on production, and therefore the economy. Price controls are a factor. Certain raw materials and products in short supply in the United States are being exported because prices are higher abroad." One possible solution advanced by Kukawka is the removal of price controls even though that would add, in the short term, to inflation, he believes.

"We must return to a free economy eventually to alleviate our shortages," he reasons. "Rather than doing it piecemeal as we have done in the last few months, controls should be removed across the board to let supply and demand seek equilibrium."

On the other hand, J. Fred Bucy, executive vice president of Texas Instruments, says, "I think the shock of the energy situation is about at its worst right now; we should be looking for more realistic programs as to what's going to happen, who's going to do what, and how much of a shortage we really have."

"Some people enjoy themselves most when they're prophets of doom," continues Bucy, "and if the doomsayers get the upper hand then they could create a real problem in the minds of the consumers. But I don't think that's going to happen. The U.S. can cut back 15% on energy consumption without any pain—all we have to do is live efficiently. We've been very sloppy in our energy consumption the last decade or more."

Slight drop. As for the economy, Bucy predicts a slight recession. "I think that for the total U.S. economy we'll see a couple of quarters of zero growth" or maybe a very slight downturn. Overall, he expects the total economy to grow by 1% or 2% on the year. Narrowing in on the semiconductor industry, "it's in a most interesting position," says Bucy, "in that it will continue to grow. Right now the industry is capacity—not demand—limited and I don't see any real slackening in demand except for those products that are going into the automotive industry, and in the equipment that is impacted by the auto industry."

The TI executive expects military spending to be up, while consumer spending will increase—but not for autos. The result, in his view, will be simultaneous increases in savings and in spending for personal items that impact the semiconductor industry. In the industrial area, Bucy foresees continued strength due to increasing interest in computers of all sizes.

Tying his forecast to the Arab nations' oil embargo, vice president Robert L. Boniface of Hewlett-Packard Co. says that "before the energy crisis became acute" the growth rate H-P had projected for 1974 had been good and more stable than 1973's. If the embargo is lifted, he says, the economy probably will grow as planned. If, however, the embargo extends beyond February, "it will have a serious effect on the world economy."

Sees solution. But Boniface says he's optimistic that the energy problem will be resolved, an optimism that appears to be the norm among industry leaders. And Boniface believes that the shortages aren't real, merely a case of demand outstripping supply. As long as raw stock is available, he says, the industry will remain healthy, but he does see some "long-term edgy problems" for the economy because of shortages. "The net result," he says, "will be a good thing for all of us. People are aware now that we have to take action."

Robert C. Wilson agrees that action is called for. Wilson, president and chief operating officer of Collins Radio Co., is worried about the effect of the fuel shortage on the aircraft industry, a big Collins customer.

"The aviation industry," he says, "is a matter of primary concern. It is a vital part of our total transportation system, but present fuel-allocation guidelines impact aviation more severely than other forms of transportation. We believe this should be revised, and more equitable treatment afforded the industry." Wilson is also unhappy with the stance of the Government as he sees it. "In general, the Government should adopt a positive supportive role toward industry," he says, "as opposed to the regulatory and even punitive approach that has all too frequently been taken. This is essential to enable American industry to compete on a worldwide basis."

As for the economy in general, Wilson observes, "It seems likely that there will be a recession in the technical sense of the word. That is, there will probably be two or more consecutive quarters in which the gross national product actually declines."

John J. Marino, president of Memory Technology Inc., in Sudbury, Mass., predicts not a recession but a dip in the growth rate that may help ease some of the problems his company, which makes computer memory systems, may encounter.

He reasons that "the electronics industry, and the computer segment in particular, has been under tremendous financial pressure. The terrible political situation in the country breeds tight money, and in this extremely competitive business, lack of capital input means that growth is difficult for most companies." Marino believes that the end result of a dip in the industry's growth will be a healthy, rather than a more stressed, economy.

Another New England computer executive, Robert Howard, president of printer manufacturer Centronics Data Computer Corp. of Hudson, N.H., sees some softening in the industry around March or April "mainly due to shortages, not a lack of business. People just won't be able to fill their demands." However, adds Howard, Centronics won't suffer because the company makes a point of planning production very precisely. "As of this moment we have no changes in our planned schedule and the introduction of new products."

At least one executive believes that the future of the economy depends squarely on the ways industry handles the energy crisis. John M. Fluke Sr., chairman of the John Fluke Manufacturing Co., says, "If the situation is mismanaged or overmanaged, it could put us in a serious downturn. If we're smart and don't panic," a downturn will be less severe. But in any case, says Fluke, there will be a "selective downturn."

There is a school of thought, energy crisis and shortages notwithstanding, that believes there will be no recession in 1974.

J. S. Webb, executive vice president of TRW Inc., and head of electronics operations, says, "I still don't believe that there will be a recession in 1974. I think the gross national product will be level to down 2% or 3%." He points out the energy crisis presents more than one kind of problem. "There is a shortage of energy, but I don't believe that will be a huge problem for the electronics industry. More important will be the shortages of petrochemicals, such as plastics and other parts and materials, due to the crisis. In the electronics industry, it means that we'll have to scramble like heck to keep up, and we're already having to do that." But even if the energy shortage does cause a recession, says Webb, "the electronics industry won't be immune, but it probably won't be as hard hit as some others."

Webb is blunt about where the blame lies. "Washington has bungled this as usual. They've known for years that it was coming even without the Arab boycott. But I believe they will handle it well enough so that the problems won't be too serious." Webb believes that Washington isn't taking enough forceful, forthright steps. "We need firm leadership, and instead they keep sending up trial balloons and making suggestions. The talk about automobile gas rationing, for example. It confuses people. They don't know what to do. They should decide what they're going to do and do it."

Upbeat. Another optimist is Ronald Rosenzweig, president of Microwave Semiconductor Corp., Somerset, N.J. He doesn't believe there will be a recession next year—at most, "a slight, 1% dip in the GNP." And the energy shortage may give electronics sales a strong boost because "much of the new electronics equipment helps the user save energy," Rosenzweig points out. This is true, in his estimation, of things ranging from electronic process control gear to fuel injection systems for automobiles.

He believes the situation won't be

A Wall Street view

Less optimistic than most of the electronics executives is a well informed and respected Wall Street analyst of the semiconductor industry, Benjamin M. Rosen of Coleman & Co. Rosen splits the problems facing the industry in 1974 into two orders of effects. The energy crisis is considered a first-order effect.

"We expect it to turn what we foresaw as a slowdown into a full-blown recession," he says. "The recession will be centered around the first two quarters; beginning with the third quarter most economic indicators will show an upturn that we expect to last into 1975." Also, in Rosen's view the energy crisis will delay a trend that has seen the semiconductor industry becoming independent of world economic ups and downs.

In the second order of effects Rosen places such things as stiffer regulations on offshore value added—"This will only cost some companies with poor documentation some dollars"—and materials shortages, which will not have a major effect on the industry in 1974, says Rosen.

as severe as predicted. Sufficient economies can be made by users, and the shortages will only accelerate the search that has already begun for new energy sources, says Rosenzweig.

Arnold R. Kaufman, senior vice president of Litton Industries and head of the Components group as well as the Industrial Systems and Equipment group, sees no recession. "Backlogs extend six to eight months into 1974, and there are no stretchouts as yet. One barometer that has proved very reliable for us in the past is our Kester Solder division. Since it is a supply item, it will turn down first, and there's no sign of a turndown. In fact, every month they have been setting new records. For the first time in history, major electronics companies—TV, computers, components—are scheduling solder six to twelve months in advance."

In contrast with executives like TRW's Webb, who believe that the Government should take a hand in settling the questions about the economy, energy, and shortages, there is the group that believes the opposite. One such is Edson de Castro, president of Data General Corp., the Southboro, Mass., minicomputer maker.

Loath to predict what will happen to the economy, de Castro is certain about one thing: there is no need for Government intervention. "In fact," he says, "it would be an absolute, tangible unservice." Government intervention, he feels, "dislocates so many areas."

Seconding the motion is Graham Tyson, president of Data Products Corp., a major producer of line printers. "I feel strongly that we should try to get back to supply and demand in the marketplace, and let the economy solve some of our problems. We seem to have more problems caused by Government control than we do solutions. They don't seem to really help. The more we can release the economy, the better."

Maybe the laissez-faire advocates will get their wish. Eben Tisdale, vice president of WEMA, the trade organization, believes the country "will see a rapid de-phasing." He says that the Cost of Living Council has been consulting some member firms for decontrol proposals. "Phase five," he says, "may include fewer controls."

Collins' Wilson. "The Government should adopt a positive, supportive role."

TI's Bucy. "The U.S. can cut back 15% on energy consumption without any pain."

Allen-Bradley's Kukawka. "Continued shortages will have a dampening effect."

The consensus position may be the one set forth by Robert W. Sarnoff, RCA's chairman and chief executive officer, in his 1973 year-end statement. "While the change in the economic climate justifies concern," he writes, "a greater danger lies in emotional overreaction to the new situation as it unfolds. . . . The fact is that the problems facing the economy are manageable. But this will require a full measure of responsible leadership in Government and industry and the willing cooperation of consumers. . . . The national economy is sufficiently strong and resilient to offer the hope for a modest degree of real growth in 1974. While a marked slowdown is in prospect, it need not result in a total halt to further economic expansion, even with the oil shortage and its attendant dislocations. . . ."

Put another way by William Stevenson, president of Lockheed Electronics Co., "There's no sense sitting around wringing our hands." Impressed with the $10 billion figure being bandied about in Washington for research in developing alternate energy sources and ways to conserve energy, Stevenson is looking around to see how his company can get involved in the work. "It could prove a bonanza to some industries," he says.

That type of silver lining also is perceived by John Beukers, president of Beukers Laboratories of Bohemia, N.Y. His company makes meteorological measurement systems that keep tabs on air quality, systems that will be needed as environmental standards are relaxed to permit use of cheaper fuels. □

Integrated electronics

Custom LSI fades into background

Fairchild Semiconductor joins standard trend as potential customers are told that only high-volume orders will qualify

by George Sideris, San Francisco bureau manager

To the list of shortages created by the booming semiconductor market, add one more thing that's becoming harder to find—the MOS producer willing to accept a modest order for a custom large-scale integrated circuit. One after another, the major MOS houses have become mighty picky about accepting LSI-development contracts, preferring to allocate design and production resources to standard products.

Of course, they still compete for high-volume orders from major consumer, automobile, and industrial-equipment manufacturers. But there is little talk nowadays of using computer-aided design and mask-making facilities to cut development costs down to a level that would put LSI within economic reach of the average equipment manufacturer.

While MOS houses willing to accept contracts for 5,000 or 10,000 custom arrays a year are few and far between, that doesn't mean the average equipment manufacturer will be LSI-poor in the future. As the swing accelerates toward standard products, there is general agreement that the need for custom memory and logic is easing up. And most of the requirements for specialized system-control and random-logic functions will be served in the last half of the decade by LSI microprocessors or programed logic arrays, according to some companies.

The last of the giant semiconductor producers to join the standard-MOS parade is Fairchild Camera & Instrument Corp. Last January, the output of Fairchild's MOS division in Mountain View, Calif., was 80% custom and only 20% standard, even though Fairchild's catalog listed some 50 standard MOS designs. After a management shakeup early in 1973, the development emphasis shifted almost entirely to standard products made with high-density, Isoplanar isolation processes (see p. 33).

Shift to standard. Today, the output is about 60% standard, estimates Philip R. Thomas, division manager. "It's not that a profit cannot be made on custom work," he explains, "but standards generally give a better payoff on design and capital-equipment investments."

His boss, Thomas A. Longo, vice president and general manager of the Digital Products group, frankly admits "Fairchild was going the wrong way in MOS." He believes standard MOS will enjoy the same "fantastic success" in the 1970s that bipolar logic had in the 1960s. So, his strategy is to position Fairchild now in the memory, microprocessor, and C-MOS-logic markets. His goal, he says, is to raise the firm from "way down on the list" of MOS producers to the No. 2 spot.

Fairchild still takes "interesting" jobs. Longo defines these as high-volume, long-term production orders—preferably accompanied by agreements that allow future production of adaptable designs as standard products.

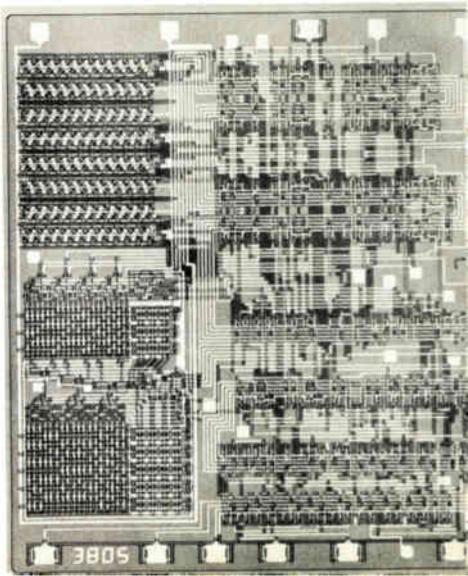
TI backs off. Texas Instruments Inc. backed away from custom LSI two years ago. In 1973, less than 1% of new MOS production was custom, estimates Jerry Moffitt, logic marketing manager for the Houston-based MOS facilities. The percentage will rise in 1974 under the impact of auto and consumer orders.

For custom work, TI follows the expensive "dedicated" layout route to small, high-density chips, rather than the "standard-cell" approach that cuts design cost but increases chip size. First-year production must run around 100,000 to 200,000 units, or 10 to 20 times the cost of designing a dedicated layout.

At Motorola Semiconductor Products division, Phoenix, Ariz., Colin Crook, MOS marketing manager, says, "We try to reserve custom work for where it's really needed, and that usually means quite high volume." For example, automobile orders sometimes run more than 100,000 parts a year.

N-channel trend. Crook says n-channel and C-MOS appear to be going overwhelmingly toward standard products, in contrast to p-channel MOS, which was dominated at first by custom designs. He estimates that custom work accounted for 85% of MOS production in 1970. It has dropped to 60% or less today and will probably shrink below 5% when the big growth in memories and microprocessors begins, he forecasts.

One result of the trend was the quiet demise recently of Motorola's



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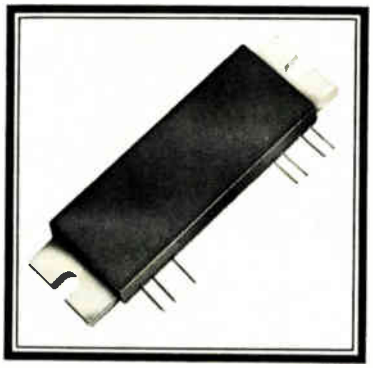

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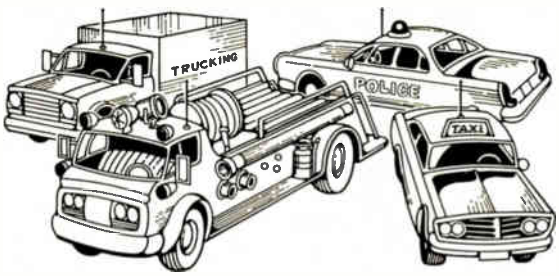

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Power Output, Min. (W)	10	13	15	10	13	15	10	12
Supply Voltage, Nom.	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Power Gain, Min. (dB)	20	20	20	20	20	20	20	20
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customer CAD center in Boston, which was opened less than 18 months ago with much fanfare. "Generating multitudes of small-volume chips isn't compatible with our present goals." says Crook.

National boosts fee. National Semiconductor Corp., Santa Clara, Calif., has no intention of turning off its custom-MOS spigot, but "we have raised the entry fee," says Floyd Kvamme, vice president and director of marketing. By "entry fee," he means the size of the job.

Kvamme claims that National shares industry leadership in custom-MOS production with American Microsystems Inc., of Santa Clara. He ranks General Instrument Corp., Hicksville, N.Y., third in new business. But both AMI and GI are positioning themselves to capture larger shares of the standard-MOS market.

AMI went into a "resources-allocation mode" a year ago. It started refusing orders for chips with uncertain production volume and stressing consumer, business-machine, and standard products.

AMI has almost completed a corporate reorganization designed to concentrate the firm's future growth in memories and other standard products. Bernard Marren, vice president and chief operating officer, forecasts that in 1976, only one-third of AMI's output will be custom, compared with a 90% total output a few years ago.

Although General Instrument is getting set to introduce microprocessors and standard memories, Peter Lesser, vice president of marketing for the Microelectronics division, expects custom LSI to stay a "sizable percentage of GI's business."

Another dissenter is Herb Shannon, MOS marketing manager at RCA Solid State division, Somerville, N.J. He says 75% of RCA's resources are committed at present to standard MOS. But he expects the percentage to begin shifting toward custom around 1976, as RCA's C-MOS logic line "matures" at about 200 types.

Microprocessors or not, he argues, there is still money to be made in such custom work as circuits for autos, organs, telephone, and paging systems.

Dual policy. Shannon says RCA has a dual policy on custom orders. Single-customer designs should reach a volume of 500,000 chips in the first "mature" production years,

Let them eat PLAs

MOS-LSI microprocessors have been called the "first truly universal logic blocks since the gate" by Gordon E. Moore, executive vice president of Intel Corp., the firm that started the trend toward general-purpose microprocessors [*Electronics*, Oct. 25, 1973, p. 98].

However, read-only memories were used to simulate random logic long before microprocessors arrived. And now, the programable logic array, sophisticated offspring of the ROM, is coming on fast as the second type of random-logic block. At that chore, a PLA can replace scores of ROMs. Several manufacturers, including Texas Instruments, Rockwell, and National Semiconductor, now supply them, and they've also been used in custom work by other firms, including Fairchild.

National's bipolar PLA, for example, can simulate as much random logic as 64 2,048-bit ROMs, claims Dale Mrazek, digital applications engineering manager. "It can provide the equivalent of 400 to 16,000 gates," and it averages "between 800 and 1,000 gates," he says. "The discretionary-wiring and cellular approaches to low-cost LSI will die, now that the PLA is here."

Fairchild's Longo has a somewhat different view. He predicts that PLAs, which are very fast at simulating complex logic functions, will take over many of the specialized sections of computer mainframes from custom random-logic arrays.

Intel established a large base of small-volume applications for microprocessors with the first chip sets, Longo says. But the faster, more efficient second-generation n-channel processors coming out in 1974 will spur high-volume applications, he predicts.

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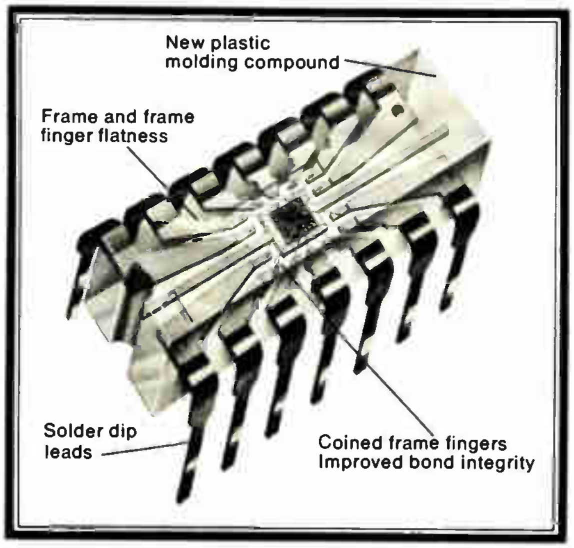

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Circle 77 on reader service card

Probing the news

but that's waived for a design with a 5-to 20-year production life, or for one that could eventually be sold to many customers.

Holdouts. On the other hand, a number of companies are resisting the trend toward catalog standard products. They range from big to small—from Rockwell International's Microelectronic Device division in Anaheim, Calif., to Amador Associates, a company started several months ago in the Sierra-foothills town of Pioneer, Calif.

Rockwell has traditionally catered to high-volume customers. The closest it comes to standard products is mask-programable calculators and microprocessors. Both are seen as ways of broadening the firm's customer base. Competing with Rockwell in both those areas is Western Digital Corp., Newport Beach, Calif., where Al Dall, marketing vice president, agrees that microprocessors can take over many of the small-volume custom jobs.

Micro Power Systems Inc., Santa Clara, Calif., is still interested in orders of 5,000 to 50,000 pieces at a front-end-development and tooling cost of $30,000 to $50,000. But because scores of such jobs are available, there are constraints. John Hall, president, says that the customer's project must fit in with company goals, must need high-density C-MOS or micropower bipolar arrays, and the chips must slash the product's production cost.

Customers wanted. Amador is something of a rarity in the industry—a company looking for customers. It has one circuit in production, a television sync generator, and two are nearing production, a telephone dialer and a fire-and burglar-alarm processor. The TV circuit, though standard in that it generates both American and European TV signals, is being made for the Grass Valley Group Inc., of Grass Valley, Calif.

Richard P. Kunkle, who founded Amador with Grass Valley's backing, also expects the generator to be used in test equipment by Tektronix Inc., which has an interest in the Grass Valley Group. Kunkle says he plans to specialize in communications-related products. □

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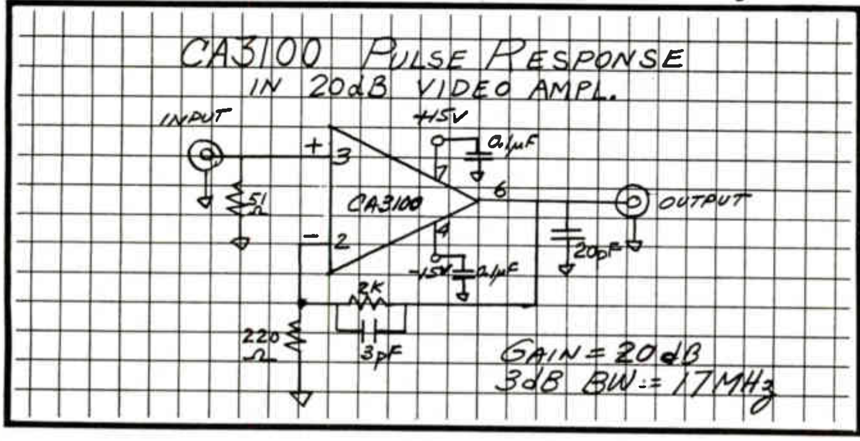

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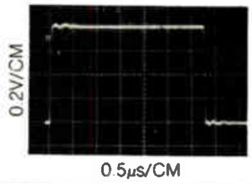

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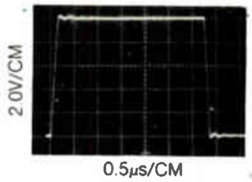

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Circle 79 on reader service card

Communications

U.S. seeks medical-emergency net

Dedicated frequencies linking ambulances, hospitals, and specialists can save thousands of lives; plan creates equipment market

by William F. Arnold, Washington bureau

Early this year, a team of Government agencies will start a new lifesaving service based on communications—emergency medical services for areas and communities. The Department of Health, Education, and Welfare and the Federal Communications Commission, supported by other agencies and a private foundation, will provide the money and the communications frequencies that are needed to help communities create emergency medical-service (EMS) networks.

Coordinated local networks linking various ambulance services, hospitals, and specialists via dedicated communications frequencies are expected to save thousands of lives each year. Through an EMS system, a doctor can give instructions to a paramedical aide at the scene, listen to electrocardiograph data, and continue consultation while the victim is sped to a hospital. And the hospital, having been told the patient is coming, can prepare the emergency room.

A national emergency-medical plan also is expected to create a good market in medical communications and electronic emergency equipment as communities create regional emergency-care systems. The size of the market is difficult to estimate, but HEW figures that an emergency network for a community of 2 million persons, the size of the Baltimore, Md., area, would cost $2 million in communications gear alone.

This month, HEW will help get things rolling by telling communities how they may apply for $185 million in Government grants for systems. The department will begin accepting applications in June and begin making awards in late June, according to current plans. The money comes from a recent act authorizing the department to make grants on a matching basis over three years. And the Robert Wood Johnson Foundation has spent $15 million privately over the past few years to stimulate action along the lines planned for EMS, while the Department of Transportation has poured $11 million into the effort. The National Heart and Lung Institute of the Department of HEW has also spent some money on spade work in the area.

Other resources. Although much of the money will go for new ambulances and manpower training, HEW's regulations will insist that each community offers a well-coordinated systematic plan that includes good communications links, as well. But before cities begin lining up at the door, HEW cautions that they must have exhausted all other possible financing sources and must have had their emergency

Emergency case. Ambulance attendants rush a patient into Chicago's Cook County Hospital. Communications plan would help cut time.

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Probing the news

medical systems approved by an appropriate regional or state health authority.

High on the list. At the FCC, EMS is "a priority item," says George Petrutsas, acting chief of the Industrial and Public Safety Rules division. The commission probably will decide in a few months what frequencies to allocate. At the end of January, the FCC will receive comments from industry, the medical profession, and interested parties about the impending assignments, as well as further study recommendations from Advanced Technology Systems Inc., of Arlington, Va., which is examining the issue for the commission. The FCC already has a Government plan, formulated by the White House Office of Telecommunications Policy, which has HEW's "enthusiastic support," says Dr. Charles C. Edwards, assistant secretary for health [*Electronics*, Dec. 6, 1973, p. 59].

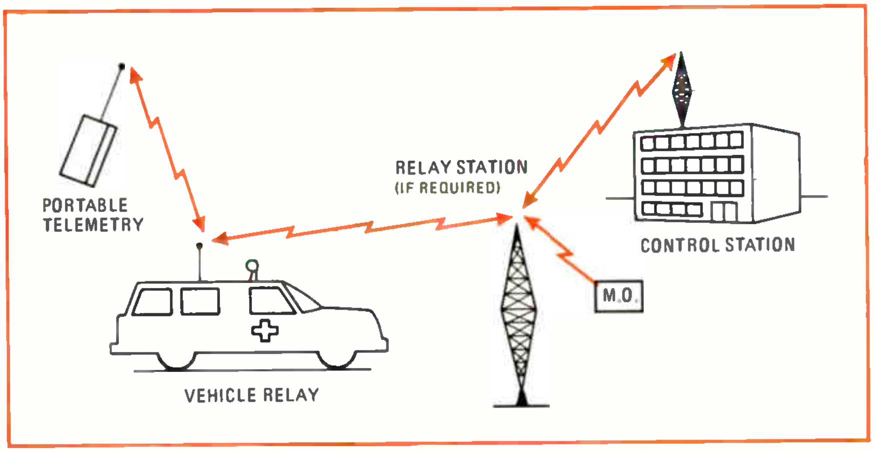
What a national EMS plan might accomplish is illustrated by statistics compiled for OTP by the Government's Interdepartment Radio Advisory Committee. Since action in the first 30 minutes generally determines whether an injury or heart attack victim lives or dies, prompt care, coupled with continuing supervision, is likely to save 20% of the more than 100,000 accident victims and 25% of the more than 700,000 heart-attack victims annually. In addition, based on experience of the successful Illinois state EMS system, IRAC says that 15% of the 56,000 that lose their lives annually on the highways could be saved.

Up to now, EMS has been hamstrung by a lack of dedicated frequencies. The FCC has allocated 32 frequencies for emergency medical radio communications—30 to 50 megahertz and 155.13 to 155.340 MHz—but these must be shared with other uses such as school buses, beach patrols, and the like. Competition for available spectrum—about 362 licenses per available EMS frequency on a national average—plus other restrictions limit the growth of systems.

Moreover, IRAC has found that the present EMS frequency plan does not provide for a host of important functions, such as relaying information, hospital-to-hospital communications, a national calling frequency to allow one jurisdiction to contact another for help, interface with other public agencies like the Coast Guard, data telemetry with commentary at vhf, or for air-ambulance operators.

Time is now. Despite these impediments, EMS, like an idea whose time has come, is catching on. "It's a hot item," declares John J. Renner, president of Advanced Technology Systems. "The medical community has already moved in developing its portion of EMS," he comments. Helping, too, are the successful pilot or operating systems in Illinois, Maryland, Ohio, and Florida.

Consequently, the market looks good also. "The EMS market looks like it's going up," says Glenn R. Petersen, general manager of General Electric's Mobile Radio department, Communications Systems di-



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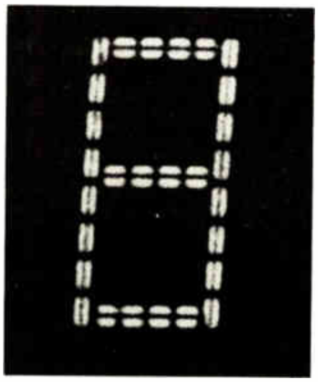

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vision, Lynchburg, Va., which makes mobile and personal-communications equipment. "Federal legislation certainly will stimulate it," he says. Agreeing, Craig A. Castle, marketing manager for biomedical systems at SCI Systems Inc. in Houston, Texas, predicts a lively market in emergency medical communications gear. Mobile-communications giant Motorola also is in the business.

Duplex channels. Since an effective national plan depends on how the FCC will reallocate frequencies, what might the commission do? ATS' Renner, whose company is studying EMS for the commission, hints that the principal emphasis will be on getting about 20 uhf duplex channels from 450 to 470 MHz for ambulance communications and use some vhf for other allied services, such as paging and electrocardiogram telemetry.

A clue might be contained in the Government's OTP-IRAC recommendations, which divide 38 channels this way: national calling frequencies in vhf and uhf bands with designated channels for paging, command and control, telemetry, hospital-to-hospital, and general medical services.

To augment the limited spectrum available, IRAC further proposes to reallocate three military frequencies and three other frequencies now shared by the amateur radio service and the Federal Government for shared government/public medical services use. Also, it wants to allocate to EMS four pairs of radio call-box frequencies now reserved for the local-government radio service, use uhf biomedical-telemetry frequencies for other medical services, and have the FCC add three presently unassigned frequencies to the EMS pool.

Coordination seen. A national EMS plan should change emergency medical care from a "fire-dispatch service" to a coordinated effort where "ambulances participate on a systematic basis," declares Renner. After all, he adds, "it's not that we don't have communications. It's just that we have islands of communications." □

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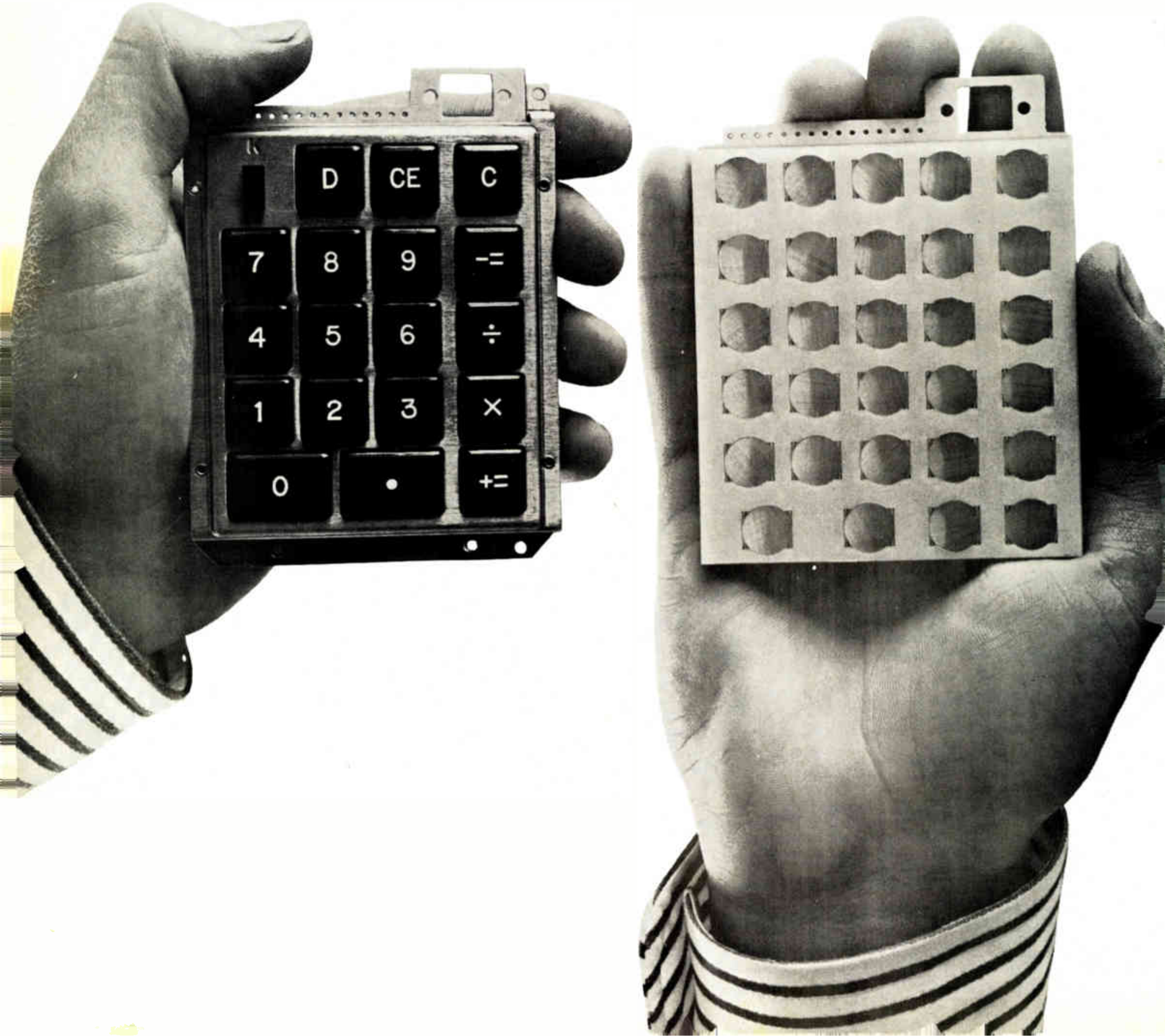

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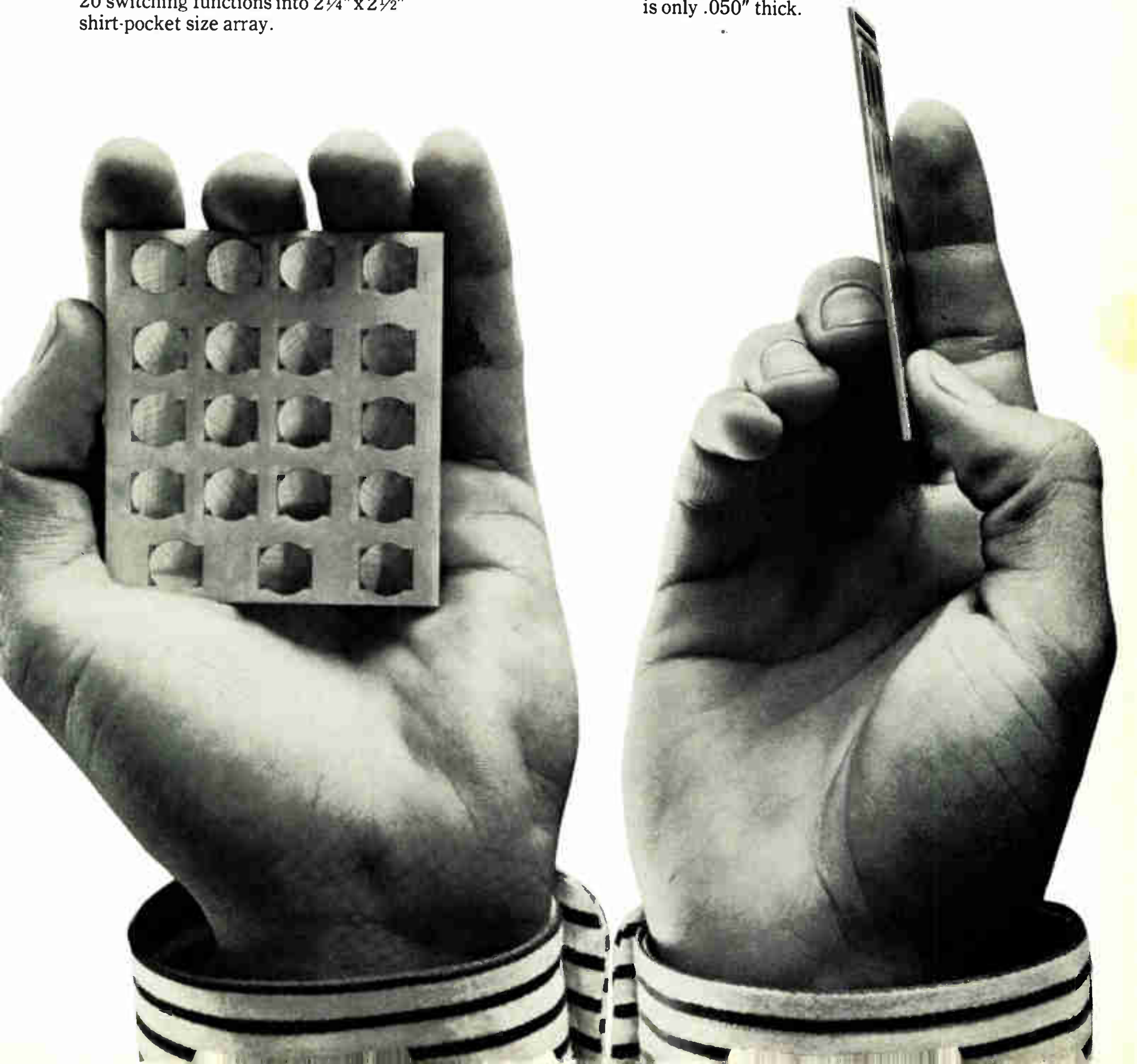

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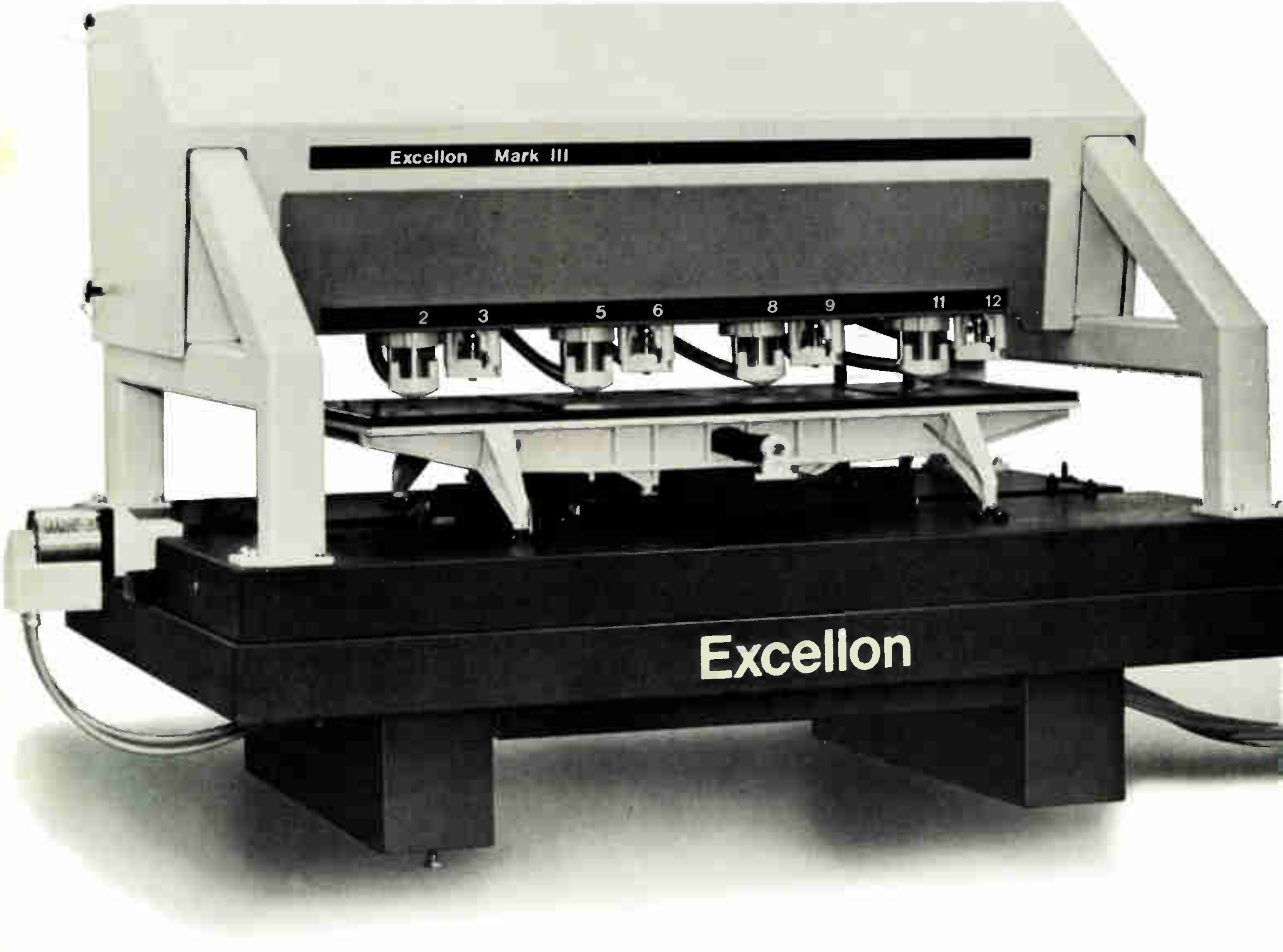

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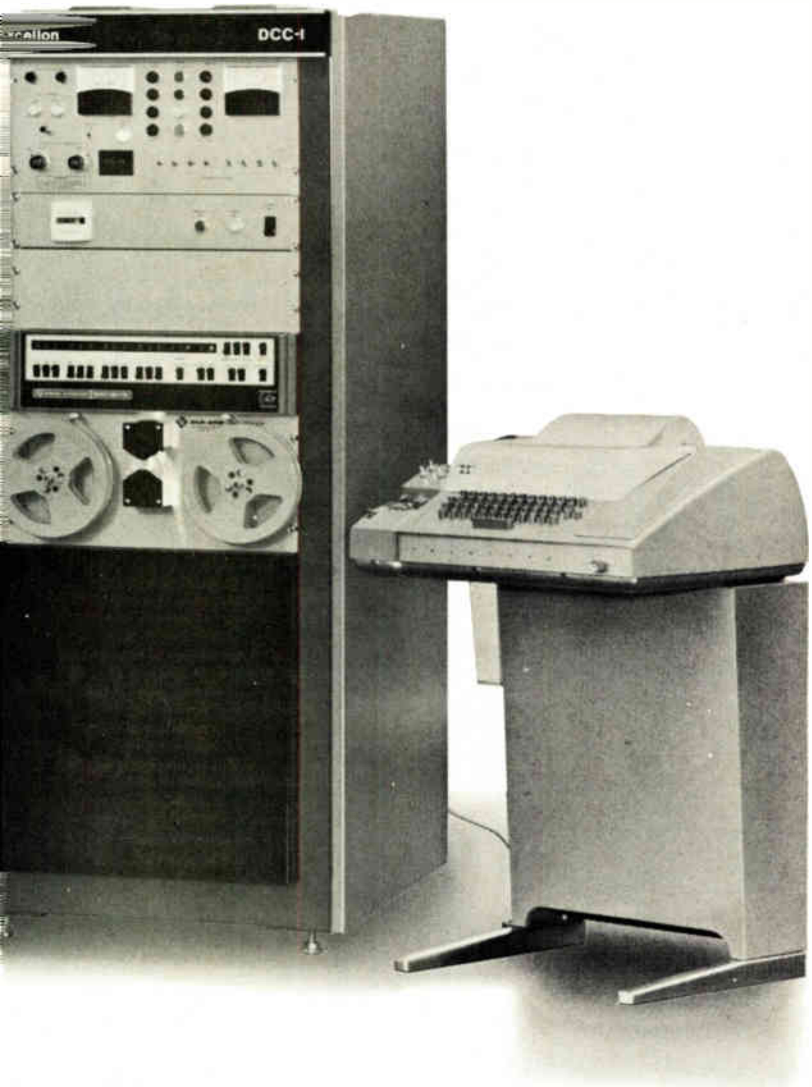

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U.S. MARKETS 1974

ANOTHER GOOD YEAR, DESPITE UNCERTAINTIES

Fortified by a strong showing in computers and components, the U.S. electronics markets will go over $38 billion this year; momentum is strong enough to ride out economic confusion

U.S. MARKETS 1974

☐ The two faces of 1974 (see cover)—one smiling and confident, the other perplexed—reflect the electronics industries' market situation for 1974. On the one side there is considerable bullishness based on the extremely good sales logged in 1973. But on the other, there is uncertainty arising from the nation's scrambled economy.

The statistics tell a story of growth, though at a lower rate than in 1973. Manufacturers tell a story of new markets in untapped industries, indicating a wider base for electronics operations. Yet, as 1973 drew to an end, no one could foretell in detail what the impact of the energy crisis, materials shortages, rising prices, and slowing economy would be on the market this year.

For a time, the only worry in 1973 was how to meet demand, which is a nice worry to have. So many key markets fell into place at once that practically every product sector became production-limited. The industry total, according to *Electronics*' survey, which covers industrial and commercial, consumer, and Federal sectors, exceeded $35 billion last year (see chart) and should reach over $38 billion in 1974 if the economy does not run into trouble. Totals for the components, including semiconductors, going into electronics equipment amounted to $6.7 billion in 1973 and are estimated to increase to $7.2 billion this year.

Right now, the semiconductor and components industries are virtually at 100% capacity, and orders are backed up for almost all commonly used parts. Every equipment manufacturer has been affected by the lengthening lead times. For the first time, large users, particularly the auto and consumer companies, are competing for the same type of parts. As a result, purchasing agents have become important cogs in the design cycle, for they often have to ride herd on components deliveries stretching out for several months. Engineers are forced to design around hard-to-get semiconductors, capacitors, and resistors. Instrument houses and production-equipment manufacturers, to name a couple, find themselves in the agonizing situation of being unable to complete and ship some products for want of a few components.

The momentum generated in 1973 is carrying over into the New Year. Just eliminating the backlogs would be enough to maintain a healthy year. And it appears that for once there's a good balance between sales and capacity even if the pace set last year slows down.

While many equipment producers grumble guardedly about what they consider a mistake by components manufacturers in not adding enough capacity soon enough, the components houses defended their cautious approach on the basis of past experiences. Work shifts have been added, six-day weeks initiated, but facilities expansion has been approached only conservatively. Besides, there's a long wait these days for production equipment because its makers are waiting for parts, too. There has been double ordering to be sure, but it appears that the bulk of the order backlogs is for real this time. If anything, equipment companies might want to add to their inventories this year, rather than live off them as happened during the last recession. The buying last year was for immediate production requirements since inventories were generally reduced to bare bones.

After the fast pace, some panting

All in all, the electronics industries look to be in very good shape—penetration of new markets has continued, established markets are growing, and the panic stage over parts and materials supply has calmed. However, the energy crisis, coupled with an increasingly topsy-turvy economy marked by rising prices and falling demand, rising unemployment and rapid inflation, is a new unknown factor. Planners have never had anything quite like the oil shortage to cope with. For one thing, the econometric models generally used for planning are based on steady-state conditions or slow changes, not sudden impulses like this crisis. For another, the entire free world faces the situation, so there's not much one sagging economy can do to prop up another even in this era of multinational electronics companies.

Some marketing men, looking for a "domino" effect

HOW THE ELECTRONICS INDUSTRIES SHAPE UP

(in millions of dollars)

	1972	1973	1974	1977
Industrial and commercial	14,928.8	17,747.0	20,254.4	23,849.0
Consumer	5,163.8	5,733.5	5,982.7	7,084.0
Federal	11,503.0	11,929.0	12,504.0	14,311.0
Total industry	$31,595.6	35,409.5	38,741.1	45,249.0
Components				
Semiconductors	1,524.1	2,017.7	2,324.5	3,128.0
Other components	4,172.4	4,705.4	4,879.0	5,473.0
Components total	$5,696.5	6,723.1	7,203.5	8,601.0

Good vibes. Here's a summary of this year's market findings calculated from returns in *Electronics*' 16th annual survey of factory sales by U.S. electronics manufacturers. A complete breakdown of individual product categories appears at the end of this report.

triggered by the auto industry, have gone back for a long talk with their computers. Interestingly, not everyone has come back with the same answers. For example, semiconductor marketing managers see opportunities for new growth and have increased their forecasts. Others at instrument companies and data processing firms have lopped arbitrary percentages off growth projections. Still others have decided that the energy crisis will have little effect—provided the measures to ease the shortage do not get any more stringent.

A few have pointed out that a little belt-tightening to conserve energy would be a good thing because there is so much waste in American consumption. Besides, they add, the first 15% in savings is easy. It's after this point that the going gets tougher.

There's also the distinct possibility that the electronics industries could benefit from the energy crisis, in the sense that one man's crisis is another man's market opportunity. Electronics is not one of the large users of electricity, especially for building equipment like computers. An obvious selling point these days is that electronic controls can help conserve energy in industry. The same can be said for all-solid-state consumer products (people will be spending more time at home). Communications equipment can be sold for its energy-saving quality as well as its speed. Test equipment would certainly get a boost from any research projects launched to find and perfect new forms of energy—though the R&D money does not appear to be forthcoming as yet. And data-processing equipment, designed to make business more efficient, can be put to work on the conservation program.

Yet there's the grim possibility that the economy will literally and figuratively run out of gas on which to grow. As the year drew to an end with more confusion than leadership in Washington, it was just too early to tell what would happen. But then again, that's the definition of a crisis—a time when it is impossible to foretell what will happen next. It may be some months before anyone in the industries gets a good handle on this situation. Until then, the two faces of 1974 will remain.

Solid state

Consumers, computers keep semiconductors flying

Orbiting off the strongest boom in recent history, the semiconductor industry should continue to accelerate in 1974. U. S. factory sales of semiconductors are expected to reach $2.3 billion, up 15% from its $2 billion mark in 1973. Although everyone's crystal ball is being clouded by uncertainties in the economic climate—the energy crisis, manpower and supply shortages, order backlogs, and predicted growth slowdown for the gross national product—the strong market momentum developed in 1973 will probably overwhelm any tendency toward reduction in the growth rate, at least for the first half.

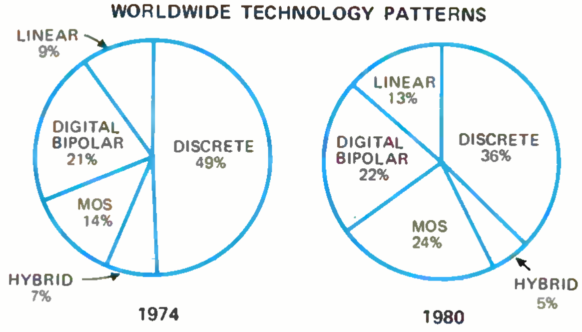
Indeed, 1973 surpassed everyone's expectations. A whopping 32% gain was scored in U. S. semiconductor sales. Strong promises in the consumer market, which was the smallest in 1972, finally paid off handsomely with a remarkable 47% increase over 1972 sales, making it the largest segment in the U. S. semiconductor marketplace (Table 1). This market is expected to increase by 15% this year. Fueled by a 46% growth in entertainment products, 100% gain in automotive sales, a 57% increase in watches and clocks, and an 80% jump in the calculator market, the consumer segment is expected to dominate sales activity this year, as well, and probably for the next five years (Table 2).

Although semiconductors have barely penetrated the mass consumer markets, their growth is expected to accelerate in appliances by 175% to $11 million in 1974, and cameras to $25 million. Microprocessors, which were only beginning in 1973 to show their appeal, are expected to absorb a total chip value of $16 million this year, a growth rate of 100%. And semiconductors are poised for another year of exploitation in personal calculators, automobile-control systems, cheap, dense memories, industrial-process equipment, leisure-time products, home controls, and information-processing equipment.

Technology to develop

Unlike the past two market years, when manufacturers trimmed their technology sails to consolidate and optimize their product lines, this year, many new advances will be registered. In the MOS sector, which will grow by 29%, or $113.1 million, to $501.9 million this year, ion-implanted n-channel and complementary designs will begin to supplant the standard p-channel products of earlier years. MOS sales grew by 79%, or

WORLDWIDE TECHNOLOGY PATTERNS



FREE WORLD CONSUMPTION PATTERN
(Dollars in millions)

Country	1972	1973	1974	1979
United States	$1,524	$2,017	$2,324	$3,333
Europe	655	939	1,097	2,252
Japan	845	1,172	1,333	2,621
Rest of world	95	129	169	381
Totals	$3,119	$4,257	$4,923	$8,587

A solid-state world. Although 1973 was a banner year for U.S. semiconductor manufacturers, other nations in Europe and Japan have been steadily closing the gap on American consumption in the world markets. In the next decade, these countries will draw even.

Components: the waiting game

The component shortage is an old story by now, and its end is still not in sight. Less than a month ago, component manufacturers expected to be able to improve their delivery times by midyear. However, the effect of the worsening energy crisis is uncertain at this time, and those already preposterously long lead times may get even longer.

Although the present shortages are an industrywide problem, there are many components that are in good supply. Even seemingly impossible-to-get devices can often be found by diligent search.

In effect, component availability has become another design parameter. The engineer must be prepared to select suitable substitutes for his first-choice devices from parts that can be obtained within a reasonable amount of time. It may even be necessary to modify a design to accommodate available components.

The table provided here lists component lead times being quoted by manufacturers and distributors across the country as of mid-December. The numbers are generalized figures that apply to entire classes of devices, which accounts for the tremendous spread in the indicated lead-time ranges. For example, some lead times range from stock to a year (two to 52 weeks). Actually, delivery time will depend on the specific device ordered, the quantity, and whether the order is placed with a manufacturer or with a local distributor.

Generally, it is best to place smaller orders (those not for very large production quantities) with a distributor. A small order can get tied up at the factory while thousands of devices are being shipped to the high-volume customer whose order came in first—manufacturers tend to operate on a first-come-first-served basis. Additionally, many distributors are smart buyers who project supply-and-demand component trends and order accordingly ahead of time. This means that even some hard-to-get items might be available off the shelf from distributor stock.

Parts shortages are not characteristic of any one region of the country. For some high-demand products, manufacturers are supplying their customers on an allocation basis so that all customers receive a fair share. Order backlogs, at this time, are considered to be genuine, both by manufacturers and distributors. Either double ordering is not yet a problem, or the time difference between order placement and delivery is so long that false orders cannot be detected now.

Manufacturers, for the most part, are optimistic about shortening lead times by this summer. Factories are operating at full capacity—24 hours a day and sometimes seven days a week. Just this past year, new equipment and new plants came on line, and additional production expansion is being planned for 1974. Ironically though, component production expansion is being delayed because the manufacturers of production equipment are waiting, too—waiting for the parts they need to build the production equipment.

The current level of energy expenditure cutbacks will not appreciably affect component lead times. (The limitation imposed on all petrochemicals this past year has already extended delivery dates for components like switches and relays.) However, it's possible that additional energy restrictions, not yet imposed, may have adverse effects.

Larger fuel cutbacks may mean even slower deliveries. For instance, plants may be forced to shut down completely, and there may also be fewer truck delivery runs. Moreover, a run will be made only when a truck is fully loaded. Overseas shipments may also be curtailed, affecting the delivery of the many components (such as resistors, capacitors, and discrete semiconductors) that are imported. Additionally, many U.S. manufacturers have offshore factory operations.

On the other hand, even greater fuel cutbacks will reduce demand for new aircraft and new automobiles. This, in turn, means cancelled high-volume component orders, giving component manufacturers a chance to catch up on their order backlogs and to speed up deliveries. (Continued order cancellations, of course, are highly undesirable.) Fewer new autos, which require about 150 pounds of plastics per car, will also free some petrochemicals for use in electronic components.

As the table indicates, lead times are naturally longest for high-usage components—these are generally the low-cost, plastic-packaged commercial devices. Color-shading highlights those components that are particularly difficult to obtain.

Brand-new products, semiconductors in particular, also tend to be hard to get. IC manufacturers usually announce a product when it is available in sample quantities. Once these samples are sold out, there may be a substantial wait before the product becomes a volume-production item. But when these same ICs are from six months to one year old, they can sometimes be obtained directly from distributor stock.

Some components are readily available—like displays, light-emitting diodes, emitter-coupled-logic ICs, optical isolators, and monolithic digital-to-analog converters. Military ICs, including mil-spec operational amplifiers, also often have short lead times. Therefore, it may be a better design choice to spend a bit more for available components than to wait around for cheaper components that are not immediately obtainable.

As a rule, discrete semiconductors that do not meet their data-sheet specifications are abundant. And an out-of-spec device is not necessarily one that can't be used at all. Testing and respecifying, say, an out-of-spec transistor could save a beautiful design. In other cases, asking for the right part—the one in good supply—can be the solution. For example, individual rectifier diodes may be hard to get, but rectifier bridge assemblies may not be at all difficult to obtain.

Lead times for assembled components, like connectors and hybrid relays, are long now and growing longer. If only nine of the 10 pieces needed for an assembled component are on hand, the unit simply cannot be put together. Lead times for such components as switches, which depend on plastics, are also lengthening. Petrochemicals are basic to many switch bodies, push buttons, and wire and cable wrappings.

In general, the various shortage difficulties, as well as the heightening energy crisis, are expected to drive component costs up this year. Price increases for some connectors have already been announced.

COMPONENT LEAD TIMES

Component		Lead time	Note
TRANSISTORS	Small-signal, plastic	12 – 26 weeks**	Out-of-data-sheet-specification units can be obtained from stock.
	Small-signal, metal can	6 – 16 weeks**	Same as above. Average delays are about 10 weeks.
	Power	6 – 26 weeks**	Plastic units particularly difficult to obtain. Rf power units are readily available.
	FETs	2 – 26 weeks**	Longer delays for consumer-type units.
DIODES	Rectifier	2 – 32 weeks**	Longer delays for consumer-type units.
	Zener	6 – 52 weeks**	
THYRISTORS	SCRs and triacs	6 – 32 weeks**	
DIGITAL ICs	TTL	2 – 52 weeks*	Lead time depends greatly on device type. Average delivery time is about 26 weeks.
	ECL	2 – 8 weeks**	Most device types in good supply.
	DTL	2 – 52 weeks**	Flat market, mostly replacement units.
MEMORIES	All	2 – 30 weeks**	Lead time depends greatly on device type. Longer delays for larger units.
C-MOS	All	2 – 52 weeks***	Lead time depends greatly on device type. Average delivery time is 12 – 16 weeks.
OP AMPS	Commercial	4 – 40 weeks***	Longer delays for general-purpose units.
	Military	2 – 20 weeks**	
OTHER LINEAR ICs	All	2 – 40 weeks***	Longer delays for consumer-type units. Some data converters in good supply.
RESISTORS	Fixed, carbon-comp	3 – 20 weeks**	Average 4-week delivery for most units, except ¼-W size.
	Fixed, metal-film	8 – 45 weeks***	Longer delays for tight-tolerance units.
	Fixed, wirewound	6 – 20 weeks**	Precision units have longer delays.
	Variable	6 – 20 weeks*	Average delays are less than 10 weeks.
CAPACITORS	Electrolytic	6 – 52 weeks**	Large-value computer-grade units more difficult to obtain.
	Ceramic	6 – 52 weeks**	Longer delays for disk units.
	Mica	4 – 12 weeks**	
	Film and paper	4 – 20 weeks**	Paper units have slightly better deliveries. Average delay is 4 – 8 weeks.
	Tantalum	8 – 52 weeks***	Longer delays for hermetically sealed units.
RELAYS	Most types	5 – 26 weeks**	Average delivery time is about 10 weeks. Longer delays for hybrid and coaxial units.
SWITCHES	Most types	6 – 20 weeks***	Average delivery time is 8 – 14 weeks. Longer delays for snap-action and keyboard units.
CONNECTORS	Most types	4 – 36 weeks***	Longer delays for military units.
TRANSFORMERS	Audio and power	2 – 10 weeks**	
WIRE AND CABLE	Most kinds	8 – 26 weeks***	

Average lead times are generally long.
*Average delays getting shorter.
**No appreciable change expected.
***Average delays getting longer.

$171.8 million, to $388.8 million in 1973.

MOS logic and shift registers will grow by $83.2 million, or 31%, to $378.5 million in 1974. Among the new products expected to emerge this year are 8- and 16-bit microprocessor chips, capable of supplying more and faster (5-nanosecond) logic in smaller spaces for microcomputers and even some minicomputers.

Complementary-MOS logic families that offer complexities of 100 to 500 gates will emerge for industrial timing and control applications. Oxide-isolated MOS memory and logic chips will soon be introduced for fast peripherals and terminals.

Furthermore, the first charge-coupled serial memories will make their debut in 1974—4,096- and 8,192-bit shift registers are already in prototype production for an assortment of disk-memory replacements.

As for bipolar logic, TTL will gain about 23%, or $72.4 million this year to $380.8 million, following a 51% burst, amounting to $104.2 million in 1973, to $308.4 million. The trend is veering sharply away from small-scale integrated TTL products and toward the newer MSI and LSI TTL families. With their capability of providing more and faster logic for less money, the LSI parts will fill the demand for the new minicomputers, big mainframes, and fast but small peripheral memories. Indeed, Schottky MSI TTL, boasting high speed-power-product ratings, is emerging as the fastest-growing segment of the TTL market.

New bipolar logic families—such as the integrated-current and merged-transistor logic—will be launched in 1974. This logic will deliver more than 1,000 gates of high-performance logic on a single chip. I^2L counters and dividers are now being readied for the marketplace.

Mainframe and medium-speed peripheral-memory sales are expected to be dominated this year by 4,096-bit n-channel random-access memories with access time of 200 nanoseconds and power dissipation of only 300 milliwatts.

Bipolar-memory technology, budding in 1972-73, will begin to blossom in 1974. Sales will jump 44.5% to a respectable $86.7 million. Schottky TTL, I^2L, and oxide-isolated bipolar-memory products are expected to share growth in the mainframe and fast-peripheral markets.

Linear products are sporting new technology, as well. Coming to market in 1974 will be precision monolithic amplifiers with digitally trimmed field-effect-transistor inputs, amplifier chips built with a mix of p-MOS, C-MOS, and bipolar processes, integrated power amplifiers capable of 20-watt output, linear control circuits with p-MOS and C-MOS logic on the same chips, C-MOS multiplexers, faster IC counters, and phase-locked loops with increased accuracy.

Technology advances are being made, even in discrete products. FETs with subnanosecond channel lengths are being prepared for the low-noise microwave market. In addition, tuning diodes, FET input devices, and sharp-cut-off zeners will be offered in the consumer market in quantity. Power discretes in ceramic and plastic packages will provide new highs in power output. These devices will lead the power-semiconductor sector in 1974 to its best growth in a decade with a 14% boost. In fact, plastic-packaged power will emerge as a major consumer component.

Discretes to move

The automotive-power market, now $30 million a year, has nearly tripled in three years, and many order deliveries have been strung out for as long as six months. What's more, although automobile production may lag this year, the number of power discretes in each car will be increased.

The discrete optoelectronics market will register another banner year, adding nearly 20% to its 1973 total, to reach nearly $75 million, exclusive of light-emitting-diode displays. Especially strong in 1974 will be opto-isolators for industrial-relay and data-processing systems, as well as discrete LED lamps for control and alarm equipment.

But continued long-term growth in other types of discretes is problematical. Small-signal devices—transistors, diodes, and low-current zeners—are expected to begin a decline as these functions are integrated onto chips. The shortages in small-signal devices that many experienced in 1973 should be slowly dissipated as suppliers build up their stocks.

Digital bipolar logic sales smashed records last year, increasing by 32% to $405.4 million—nearly half of the total IC market. Nevertheless, many observers believe 1973 was the high-water mark for standard TTL. Sales are expected to increase to $380.8 million and then level off. TTL is coming under increasing attack by C-MOS families and is suffering from the growing trend to fabrication of logic systems with read-only memory and programed logic arrays. Worse yet, the use of software microcomputer logic is accelerating the trend away from standard TTL. The software technique enables logic designs to bypass completely the hard-wired logic packages.

The highlight in the sales picture is the trend toward fast low-power TTL circuits. For the first time, more medium-scale circuits of all types will be consumed this year than small-scale circuits—about 55% to 45%, in favor of MSI.

Manufacturers will also increase the number of new standard LSI bipolar-logic products, such as the 125-gate accumulator introduced last year by Texas Instruments and Motorola's TTL-logic products with densities as high as 160 gates. In addition, a swing is expected to the growing family of Schottky TTL products—mostly

TABLE 1: TOTAL U.S. MARKET FOR SEMICONDUCTORS
(Dollars in millions)

Segment	1972	1973	1974
Consumer	$ 230	$ 337	$ 410
Computer	285	335	409
Industrial	270	305	340
Government	275	260	265
Distributor	264	320	375
Export	200	460	525
Totals	$1,524	$2,017	$2,324

MSI—for high-speed applications in minicomputers and peripherals.

The question regarding the future of emitter-coupled logic has changed from "when will the ECL market take off?" to "will it take off at all?" In 1973, sales amounted to $35 million to $40 million—less than the 10% of the digital bipolar market it had maintained since its introduction 10 years ago.

But other industry experts, still bullish on ECL, point to the next generation of fast computers that could begin pouring off the production line at the end of 1975 or early 1976. Their designs for high-speed mainframes may well need the nanosecond-speed logic functions that ECL provides. And there's a growing need for fast logic in instruments and communications systems.

C-MOS awakens

Complementary-MOS, a sleeper in the MOS market, has awakened. U. S. factory sales doubled in 1973 to reach a solid $30 million level, and domestic sales are expected to exceed $65 million this year. Moreover, if a couple of developments pan out, C-MOS may well become a dominant logic family and cut sharply into TTL sales. These developments include the possibility of using oxide-isolating techniques to increase the density of logic and memory circuits and silicon-on-sapphire substrates to increase both speed and density. In any event, C-MOS should score in the vicinity of $200 million a year by 1975.

Pioneered by RCA, Somerville, N. J., in its 4000 series and followed by Motorola, Phoenix, Ariz., C-MOS was practically a two-company marketplace as recently as 1970. Then, suddenly confronted with a vast and diverse market opportunity, most other semiconductor companies jumped aboard with standard 4000-type products. The two conspicuous exceptions, Texas Instruments and Fairchild Semiconductor, will follow suit early this year with commercial-4000 lines.

The largest market potential is in industrial controls where the noise immunity and tolerance of voltage variations shine most. In the industrial environment, instruments must operate at 3 to 30 volts, and control circuits must perform in tough ac, dc, and audio-noise environments. This market, which also includes new vending-machine designs, coin-changers, elevator and building controls, surveillance systems, process logic, and similar applications, will reach $18 million in 1974.

The industrial sector offers the largest C-MOS market potential, but communications sales are growing the fastest. The market doubled in 1973, and it is expected to double again this year to the range of $14 million.

The low power requirements and tolerance of fluctuations that are characteristic of C-MOS will be exploited in such diverse equipment as pocket pagers, modems, and mobile-radio systems. C-MOS is also ideal for the even larger market of telephone-interconnect equipment—telephone sets, voice terminals, and displays.

When all these sales are added to the growing use of C-MOS in frequency synthesizers, digital panel meters and wave-shape analyzers, the total potential communications market will amount to $50 million by 1976.

Consumer equipment, including automotive applications, constitutes the biggest custom-C-MOS potential. Sales are predicted at $15 million this year. And applications in watches will burgeon this year as watch manufacturers realize the capabilities of C-MOS to achieve the tough goal of low power dissipation in LSI configurations. The C-MOS market in personal calculators is turning on as manufacturers bring to market additional liquid-crystal-display units that benefit from the C-MOS capability of supplying the low-power 10-V drive signals.

The major uncertainty now in the C-MOS marketplace concerns automobile production, which had been considered a bonanza until the energy crisis intervened. To make matters worse, cutbacks will likely be in the top-of-the-line gasoline gluttons, which also use the most electronics. On the other hand, any slack in C-MOS sales for automotive applications will probably be taken up by increases in demand for data processing and a steadily growing Government demand.

Microprocessors ahead

Although the first standard central-processing unit on a single chip appeared as recently as 1972, analysts are calling this market one of the best for the future of MOS technology. Many observers are calling the CPU chip the most significant circuit development in semiconductor history, destined to have the heaviest impact on equipment development. Because of its capability to perform any logic-block function with only a simple software change and inexpensive memory, the microprocessor makes possible design of dedicated computers to perform single functions cost-effectively. Sales of microprocessor chips are doubling each year. They reached about $8 million last year and should grow rapidly to about $50 million by 1975. These 8-bit p-channel standard microprocessors have had data rates of 10 nanoseconds, but in 1974, the first n-channel CPUs entering the marketplace will offer 16-bit capacity at higher speeds.

Today, the biggest demand for the microprocessor is in point-of-sale systems and related applications, and this market will register a sharp increase in 1974. Moreover, an explosion of microprocessors is expected in 1975, as system designers learn to use CPU chips in an assortment of smart-terminal applications—telecommunications equipment, schoolroom and library

TABLE 2: U.S. CONSUMER MARKET FOR SEMICONDUCTORS
(Dollars in millions)

Segment	1973	1974 (Est.)	% Growth
Entertainment	$120	$175	46%
Automotive	40	80	100%
Organs	7	10	43%
Watches/clocks	7	18	157%
Cameras	21	25	32%
Appliances	4	11	175%
Calculators	40	72	80%
Total	$239	$391	64%

processors and displays, automotive testing gear, and the like.

The other major MOS LSI market boom will be in calculator chips. The number of chips sold in 1973 tripled over the number for the previous year—from 2.5 million units to 7.5 million, and 6 million of these were for the hand-held units. The number is expected to double each year to reach a total of 30 million units by 1975. Dollar growth in calculator chips, which will not climb nearly as fast as units sold, should reach $150 million to $200 million by 1975.

Memories get bigger

A drop in the market bucket only two years ago, semiconductor memories have suddenly become a worthwhile business—jumping from $92.1 million in 1972 to $179 million in 1973. This year, semiconductor memories should reach the $240.1 million mark, to become one of the biggest sellers in the IC marketplace, and by 1976, the total semiconductor-memory market should be in excess of $330 million.

Although the workhorse of the semiconductor-memory market remains the venerable p-channel 1103, that chip is expected to come under increasing pressure against its hold on 50% of the market. The challengers are the n-channel products, which boast higher performance and are easier to use—the fast (50 to 80 ns) 1,024-bit RAMs and the big 4,096-bit RAMs.

Nearly all semiconductor manufacturers are set to introduce 4,096-bit n-MOS products in 1974 as design alternates to the 1103. The 4,096-bit RAM has a single clock and access time of 300 ns and faster. The potential for low cost per bit makes this product commercially as explosive a force in the market as the 1103 itself for mainframe and medium-speed peripherals. How many will be sold depends only on manufacturers' ability to produce at acceptable yields, but the consensus estimate is roughly 100,000 units in 1974. Other serious 1103 competitors in 1974 will be the new, fast, and easier-to-use single-clock 1,024-bit p-channel and n-channel RAMs. These new RAMs, which will account for only about 5% of total memory-market sales in 1974, could well grow to 15% to 25% of the market by 1975, or $50 million worth of new MOS memories.

Another factor in the MOS-memory market will be the strong growth of static RAMs, which may reach $10 million in sales in 1974. Since static RAMs need no refresh, they can be operated from a single power supply, require less power, and are compatible with TTL at inputs and outputs. The drawbacks of statics in the past has been their slow speed, which meant limiting them to slow-terminal applications. Now, manufacturers have turned to faster n-channel ion-implanted designs to boost speed, and they are delivering statics as fast as the 1103s, making them the runaway choice for display and buffer-terminal applications.

TABLE 3: RANDOM-ACCESS MEMORY MARKET FOR SEMICONDUCTORS
(Dollars in millions)

	1972	1973	1974	1975	1976
MOS	$24.2	$69.0	$95.8	$135.0	$225.0
Bipolar	11.7	37.8	57.0	67.0	89.0
Emerging technologies CCD	—	—	2.0	8.0	17.0
Total	$35.9	$106.8	$154.8	$210.0	$331.0

Bipolars to thrive

Sales of bipolar memories, both random-access and read-only, should jump by 35% in 1974, while sales of bipolar shift registers are expected to increase by 20%. The bipolar RAM, for example, has virtually captured the cache and special-purpose semiconductor-memory market on the basis of its 35-ns access time. As for the fast-mainframe market, bipolars have become universally established as standards for the new ECL add-on memories.

Competing for this portion of the memory market are both the 256-bit bipolar RAMs, many boasting access times of less than 20 ns, and their big brothers, the 1,024-bit bipolars. Although the 1,024-bit RAMs are expected to gain in the memory market share to about 10% for 1974, only Fairchild has been able to ship in quantity; consequently, many computer manufacturers are waiting for other supplies to come on stream.

The bipolar ROMs, both the field- and mask-programable, continue to be strong in 1974. The trend to using ROMs for logic applications has stimulated user demand so much that almost half of all ROMs sold today are for logic applications. Sales of field-programable ROMs, which now range from the 1,024-bit units to a new 4,096-bit PROMs introduced last year, are the fastest growing of the read-only products. Because PROMs allow users to reduce their stocks of different memory types, they have largely by-passed the long stretch-outs in delivery times that have plagued users of custom parts.

Linear ICs get a little help

Like the digital segment, the 1973 market in linear integrated circuits was gratifying, as sales grew by 31% to reach $166 million. And this year, as last, the consumer segment is expected to account for a major fraction of the new gains, but at a lower rate, as TV and audio consumption cool off after their 1973 records. Nevertheless, linear ICs this year will remain strong, growing 16% to $193 million, as sales in communications and industrial ICs take up some of the slack in consumer parts.

Although the demand for increased integration of TV sets remains a strong incentive for manufacturers of linear ICs to develop more complex circuits, the question remains: how quickly can the TV-set manufacturers incorporate them into new sets? Some manufacturers feel that 1974 will be too soon. Partitioning of color sets has stabilized around four to six ICs, supplied by several manufacturers who are struggling to meet scheduled programs. To expand TV sales, IC manufacturers will require, not new technology, but more capacity. But they are reluctant to expand for fear of a TV-market slowdown in 1974-75.

In the industrial market, the emphasis on process and plant modernization in 1973 will continue this year, stimulating sales of operational amplifiers and comparators.

An increase in the demand for the standard 741 has already materialized, and backlogs have been growing weekly, as has the demand for the new three-terminal regulators. Moreoever, industrial-equipment manufacturers are now discovering the new high-performance FET op amps, introduced last year for precision data-acquisition systems. These, together with the strong converter-IC demand, could spell a $30 million data-acquisition market for linear ICs this year.

The standard-hybrid market segment remains steady at about 12% annual growth. The military, about the only customer able to pay the price, still commands most attention. Converters and high-performance op amps will continue strong in 1974, but the ever-increasing shadow of monolithic devices capable of matching hybrids' performance dims their long-term appeal.

However, the new thick-film consumer hybrids may well turn the market around, boosting sales, as well as broadening the customer base. Thick-film-hybrid packages already dominate the mobile-radio market, and increases in the market are expected as new designs capable of supplying 30 watts and more of uhf power become available.

Computers

New memories will make the most profits this year

The computer industry is alive and well and looking forward to a good year in 1974, despite the components shortages and the implications of the energy crisis.

The high shipping rate of the past year, reaching a total of $12.4 billion on the *Electronics* consensus chart, will continue. But it will be tempered by the at present substantial return rate on old computers, so that the total installed base will remain nearly flat. The dramatic rise in installed memory, however, will be an outstanding feature this year.

Among other trends that will continue to be felt in 1974 are the growth of virtual storage, the increasing importance of data communications to computer manufacturers, the continued fanning out of computers into new applications, and the demand from users, particularly from minicomputer customers, for more and more manufacturer support.

Another important and growing area of the market will be computer networks—collections of terminals linked to a central computer. Because the terminals are becoming more capable and powerful, the role of the central computer has been decreasing. But this has made it possible to design economical, special-purpose networks and enter new markets, such as department stores and banks.

The market for minicomputers also continues to expand as customers find new applications for these machines. Minis, as defined by *Electronics*, totaled some $420 million in 1973, and the consensus forecast predicts it will hit $513 million this year, an increase of 22%. At the same time, prices have continued to fall, opening the way for more customers. But because many of the new users are relatively unsophisticated in minicomputer operation, they are demanding software and maintenance backup similar to that obtained by medium-scale-computer users.

These minicomputer systems require large memory capacities to enable them to carry out the extra functions that users now request. Accordingly, several manufacturers have brought out ferrite-core modules that hold over 32,000 bytes on one printed-circuit board.

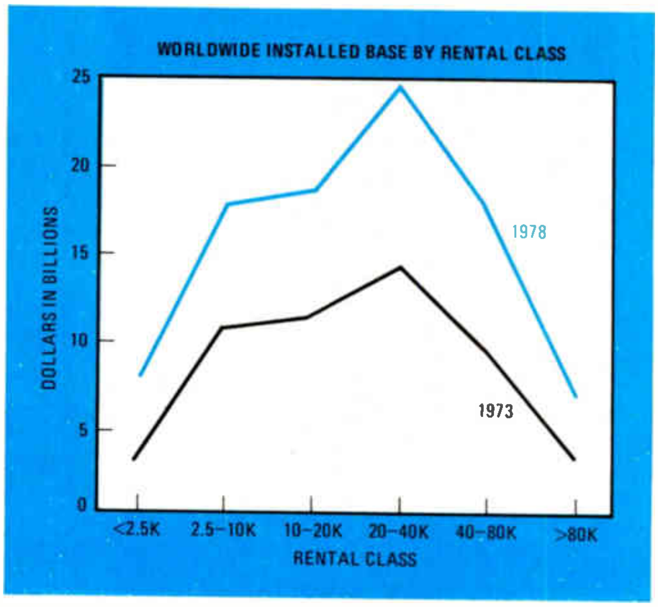
The availability of fast, economical memory is an important factor for both the virtual-memory technology and data-communications applications. As virtual-storage software and applications are developed, the need rises for a large and very fast backup to the main memory to supply data upon demand from the program. For data communications, large memories are needed to contain enormous data bases and hold the software to maintain these data bases, as well as permit interactive computing and other sophisticated operations that data networks make possible.

These factors, together with the growth of minicomputers, have generated during the past 18 months a greater increase in total installed memory capacity than ever before, according to one estimate.

So what about the economy?

The computer industry's mixed-up relationship to the general economy prompts many in the industry to ignore the import of usual year-end indicators. For, in a sense, computer companies can find solace in whatever turn the wheel of fortune, or misfortune, takes.

On the one hand, 55% of computers in dollar value are leased, so if capital spending were to decline, contrary to forecast, it wouldn't shake up the industry. Moreover, because computers are supposed to increase



Saddle effect. Large central computers and networks of satellites, smart terminals, and small local computers may eventually squeeze the medium-scale computer out of the market; however, its demise is not likely for many years. In fact, it may never completely die.

productivity and reduce certain costs, they have appeal during downturns.

On the other hand, when business is good, customers are also inclined to install computers to assist in rapid expansion. It seems that this industry is highly resilient, but not entirely immune to disaster, as was shown in the 1970-71 recession. But conditions are different this year. Manufacturers may very well take any slowdown as an opportunity to modernize and upgrade computer installations. In addition, the computer industry now has a larger user base than in '70—particularly data communications, which is itself somewhat recession-proof.

At any rate, the consensus among computer company officials is that a slowdown may indeed occur in 1974, but a genuine recession is unlikely. An executive of Honeywell Information Systems Inc., Waltham, Mass., told a group of security analysts recently that, in all of the six other countries where Honeywell did the bulk of its business, the growth rate was greater than in the U.S., whether in real or inflationary terms, and that the same was true of the installed base of computers in those countries. He concluded that these factors did not presage a slowdown for worldwide computer business.

Touching on what could be an important psychological factor in this period of uncertainty, Avery F. Blake, marketing vice president for Iomec Inc., Santa Clara, Calif., chides, "The computer industry will see a recession in 1974 if enough people talk about the possibility. We convinced ourselves we should be in a recession once before, and surely we can do it again if we try."

Microprocessors start something big

The great prospects for microprocessors—those 4- to 8-bit "one-chip computers"—are one of the technological and marketing marvels of our time. They represent a happy compromise between hard-wired logic and a general-purpose minicomputer—more flexible (easier to alter) than the former, because they're programable, and much less expensive than the latter.

Microprocessors are showing up in a growing number of applications—for example, in process control, in traffic control, in remotely controlled machines of all kinds, and in communication devices.

Today, there is one major source, Intel Corp., Santa Clara, Calif., with two chips in production, while other companies have announced their own versions and are getting them into production. In 1974 several more entries can be expected, and meanwhile the number of applications is expected to snowball. Signetics Corp., Sunnyvale, Calif., one of the later entries, goes so far as to call the microprocessor the most significant circuit development in 40 to 50 years, in terms of its impact on equipment development, while originator Intel predicts a 100% annual increase in sales through 1975.

Does the microprocessor represent a threat to conventional minicomputer markets? No; on the contrary, the micros serve a whole range of new markets that lie below the minimum economical point of application for minicomputers. Their only impact is in the "bare chassis" mini area.

Ferrite-core memories live

A new computer with semiconductor memory seems to come down the pike almost every day, giving the impression that ferrite-core memories are a thing of the past. But that's not true yet.

For example, minicomputers are still very largely core-based machines: Varian says 80% of its production uses cores, Interdata admits to 90%, and Data General—one of the first companies to announce the availability of a semiconductor main memory, back in 1970—still uses "almost all" core.

Data General president Edson D. deCastro explains that dramatic improvements in core-manufacturing techniques, using more precise, easier-to-maintain equipment, have resulted in better yield and more consistent control of core characteristics. Meanwhile, neighboring Digital Equipment Corp. recently punched out half a billion cores in a single month—nearly 200 cores per second, around the clock—for shipment to its overseas stringing plants.

Furthermore, a recent rash of announcements of 32,768-byte modules will keep the high-end minis in the core camp for some time. One of these new modules, on a single printed-circuit card, costs about the same as the older standard module of a quarter the capacity; its cost per bit, therefore, is reduced by a factor of four. But low-end minicomputers, needing only about 1,000 to 4,000 bytes of main memory, cannot use the new modules, so they have been the first to change to semiconductors, with further defections expected in 1974.

One supplier of add-on memories, which use both cores and semiconductors, says that shipments of core memories are still 60% of its total and there should not be much tapering off until 1975. A major mainframe company has cores in 70% of its machines.

On the other hand, while IBM is still heavily core-oriented, it is swinging around rapidly to the semiconductor side. All of its most recently announced computers have semiconductor memories.

In general, core memories are hanging on in the larger minicomputers and in a substantial fraction of general-purpose computers, while semiconductor memories seem to be taking over in smaller minicomputers and in most of IBM's large and small machines. Today 1,024-bit p-channel MOS chips have about half the semiconductor memory market; they'll hang onto it while 4,096-bit production and yield build up. When that happens, semiconductor memories will make an even greater impact on cores. Optimists in the semiconductor industry see this impact coming in 1974,

On the air. The reduced cost of minicomputers has opened up many new applications areas. For example, in this Boston radio-broadcasting station, a minicomputer system, based on a DEC PDP-8, verifies program schedules and controls music and voice inputs.

Antitrust suits churn the waters

As part of its attempt to anticipate the 1974 market, the computer industry is evaluating the possible impact of the antitrust suits involving IBM. The bizarre outcome of the Telex case got the headlines last year.

In brief, Telex Corp. early in 1972 sued IBM under the Sherman Antitrust Act, charging it with monopolistic practices aimed at destroying its competition in plug-compatible peripherals. IBM, in turn, countersued Telex, accusing it of the theft of trade secrets and the infringement of IBM copyrighted manuals.

In September 1973, both lost. IBM was found guilty, was ordered to pay Telex treble damages of $352.5 million, and was enjoined from certain practices. Telex, too, was found guilty and ordered to pay IBM $21.9 million. Later, the judge admitted to having miscalculated the damages and reduced IBM's payments to $259.5 million plus softening of the injunctions.

IBM is appealing; the first stage is likely to be concluded by the end of the summer, after which the case may go to the Supreme Court. If the ruling holds, manufacturers of plug-compatible equipment will be able to thank the injunctions for making competition somewhat easier, but the third-party leasing companies will not be so fortunate. They have already lost their past advantage of offering free overtime and reduced-rate, long-term rentals, thanks to changes in IBM policies; one of the injunctions takes away their only remaining ace, penalty-free cancellation.

Another antitrust case involving IBM was brought nearly five years ago by the U.S. Justice Department on the last day of President Johnson's administration. This case asks, in part, that the company be broken up into a number of independent entities.

It's not scheduled for trial until October, but both parties have been admonished that they must meet this date. Yet the Justice case may not actually come to trial. At the end of last October, four of IBM's competitors jointly proposed early interim relief from IBM's alleged predatory practices, asking for a change in the course previously mapped by the Justice Department. Later it was disclosed that Justice had solicited this joint proposal, potentially damaging its own case and conceivably forcing its dismissal before trial.

Besides these two suits, California Computer Corp., Transamerica Corp., Hudson General Corp. and Memorex Corp. have also begun actions against IBM for unfair practices, and IBM has once again countersued Calcomp on much the same grounds that it sued Telex. These five suits, which are in the discovery stage, may not come to trial in 1974.

with 8,192-bit and larger chips to follow. More cautious observers think the impact won't come until about 1976.

While many exciting new developments, like bubble memories and charge-coupled-device memories, will make an impact on the computer industry in good time, 1974 won't be the year for it. Rather, it will be the year of consolidating today's state of the art, with emphasis on manufacturing and packaging.

High-density magnetic-tape systems were announced by IBM and several other manufacturers during 1973. Eventually the new density may become an industry standard, along with the current and historical standards of 200, 556, 800, and 1,600 bits per inch.

Much effort will be expended in 1974 on improved system software and file security, especially for minicomputers. Interdata, in fact, plans to spend more on software than on hardware in 1974, for the first time in its history. But the really novel advances in this area are still years in the future.

Consumer

Color-TV sales to simmer down; other products will sell if . . .

All will be well in the consumer sector this year, *if* economic uncertainty does not clamp pocketbooks shut. And that's a big if, what with the energy crisis, and an expected economic cooling off.

The worst thing that could happen is that long lead times of components and shortages of wood and plastics continue, prices are forced up, unemployment soars, and demand declines. The best thing that could happen is that the energy crisis is short-lived—next best, that consumers, forced to stay at home, decide to invest in a new TV set or audio equipment with which to wait out the fuel shortage.

Chances are the true 1974 will fall somewhere between these extremes for most consumer electronic products. The amazing pace set by color-TV manufacturers through 1972 and 1973 will definitely slow. Audio components manufacturers, almost recession-proof in the past, should make out well in 1974 as four-channel sound gains wider acceptance. Radio and tape companies will probably feel a pinch in the middle-priced products but should profit on sales at the high and low ends of their catalogs.

Calculators, hitting new price lows, will open new sources of sales, though manufacturers are concerned about shortages of plastic and batteries, especially rechargeable types. Microwave ovens, coming out of a safety squabble, will heat up. And look out for watches—this is the year electronic timepieces with digital displays will tick up sales to rival the pace first set by calculators.

Color TV—how good it was/will be

Last year 9.2 million to 9.5 million color television sets were sold at the dealer level, setting yet another record. About 60% were table or portable models. The biggest selling point was the all-solid-state chassis.

According to one estimate, approximately 40% to 50% of total dealer sales were all-solid-state models, and next year it should be 75%, though list prices will still be higher than those of the dwindling number of hybrids.

Through the first half everything was coming up roses. Not only were domestic sales growing, but imports from Japan took a nose dive because yen revaluations, favored American manufacturers. In addition, exports increased, mainly to Canada, and a U.S. company, Motorola Consumer Products division, Chicago, even arranged to sell color consoles in Japan.

The pace began to slacken, however, toward the end of the year as some companies faced profitless prosperity in the third quarter. Shortages and increasing concern over the energy crisis started to hurt. The Federal Consumer Product Safety Commission once again raised the issue of fire and electric shock hazards in color receivers, which may force costly design and inspection changes.

The slowdown is expected to continue this year with sales of 8.8 million to 9 million sets expected. Since color saturation is only 65% to 70% of American homes, most sales will continue to be first sets. However, second-set and replacement sales are gaining. Last year around 25% of sales were replacements, either for monochrome or older color receivers, and 10% went to second-set homes. This year, approximately 28% will be replacements and 12%, second sets—unless the energy crisis causes high unemployment, curtailing sales.

Black-and-white receivers survived, despite the domination of color TV. Some 6.5 million to 7 million monochrome units were sold at dealer level last year. And with a downturn in the economy, and the drive to save electricity, the low prices of black-and-white sets, plus low power consumption, could maintain this level.

Technically, TV receiver designers continued to concentrate on picture quality and tuning. More ICs were used, though long lead times probably inhibited greater application of color-processing ICs and acceptance of digital ICs for tuning. GTE Sylvania, Batavia, N.Y., one-upped the field with a lock and key on the tuning knobs to impress consumers with its factory-set tuning. And once again remote tuning failed to live up to manufacturers' expectations.

Pleasing sounds for audio companies

Shortages of materials, particularly wood, and lack of enough clout with semiconductor and components suppliers to insure parts deliveries have hindered the hi-fi equipment companies. But despite the need to alter production schedules or design around certain critical parts, these firms increased sales about 9% last year and could do it again this year if the economy does not literally run out of gas. Another shortage hurting hi-fi companies is cash. While bookings are up, payments are down, prompting one industry observer to quip that the best part of the audio business this year will be in factoring services.

V-less TV. General Electric Co. has had good response to its new TV-band radios mated with a-m/fm portable units. They appeal to people whose attention is diverted from the television screen, but who still want to hear what's going on at televised events.

Four-channel sound is still the talk of the industry. In fact, at times there appears to be more talk than sales as audiophiles, manufacturers, recording companies, performers, and dealers haggle over the merits of quadrophonics. Nevertheless, development, first of a matrix decoder IC and more recently of a discrete decoder IC, has permitted hardware manufacturers to design four-channel amplifiers capable of playing all of the competing disk types. In addition, turntable tone-arm cartridges designed for four channel came along last year. Finally, new speaker configurations were marketed to make it easier to put four in a room for quadrophonics. Later this year, one company plans to bring out a glass cone speaker already being hailed by audiophiles as the first really new speaker designed in 20 years.

In the meantime, disk makers are crying about plastic shortages, which might indicate a good opportunity for pre-recorded tape companies—except that there, too, plastic is in short supply for cartridges and cassettes.

Of the other segments of the audio market, the companies most likely to be hit by the energy crisis and/or recession are the auto radio manufacturers. After a unit increase of well over 20% for the year in a-m and a-m/fm units, auto radio sales will track car sales' expected decline this year.

But things won't be as bad for other radios. Last year sales at the dealer level increased from $490 million in 1972 to $550 million, although, as with TV, sales began to taper off in the fourth quarter. As always, clever packaging was a major factor in keeping radios moving. Among the newcomers was General Electric's television band radio which permits consumers to listen to a television program even when they cannot view the screen. According to GE, sales of the fm/a-m/TV units were "fantastic," indicating that housewives and football fans spend a fair amount of time with their attention diverted from the TV picture tube.

Calculators—an opiate of the people?

Makers of consumer calculators have already noted that once people start to use one of these machines, they never want to be without one. So narcotic is the effect that at each new price break a whole new surge of sales is rung up. At the same time, machines at all higher prices points continue to sell.

As Charles Krakauer, general manager of Bowmar/Ali Inc., Acton, Mass., marvels, "We keep selling them and we wonder where they all go."

Well, something like seven million consumer calculators went out U.S. manufacturers' doors last year. This year, 12–13 million more could follow, though, because of the energy crisis and uncertainties in the marketplace, 10 million units is a good hedged bet. The new low price is $30, first announced by National Semiconductor late last year. By next year it should be $20.

The next consumer boom, now that the calculator boom is getting to be old hat, will be in electronic watches. Digital display models with liquid crystals or light-emitting diodes are hovering around $100, and standard motor-driven versions sell for $20 to $25 less.

According to Quantum Science Corp., Palo Alto, Calif., digital electronic watch sales worldwide, at the consumer level, will rise to as much as $880 million in 1978, at an average annual growth rate of 110%. Units will grow from 180,000 last year to over 18 million by 1978, while prices decline to less than $50. Dollar share of the world watch market in this time will go from less than 1% to 15.6%.

This year semiconductor companies will begin a serious push into the watch market and collide with established watchmakers who have been developing their own electronic timepieces. In addition, like the calculator business of a couple of years ago, newcomers will be lured into the market because of the ease with which these watches can be assembled.

Microwave ovens last year proved their staying power on the U.S. market. With a total penetration of only 0.7%, electronic ranges received a bad blow from the prestigious Consumers Union, which gave all home ovens tested an unsatisfactory rating based on what it felt was dangerous microwave radiation emission. In fact, the report released last spring concluded that any amount of radiation could be hazardous.

But U.S. microwave-oven manufacturers counterattacked, pointing out that Federal safety standards had been rigorously established and met. After a period of stagnation, sales picked up again. According to Litton's Microwave Cooking Products division, Minneapolis, Minn., 500,000 units were sold in 1973 as projected, and 750,000 more will be sold this year. (This includes consumer and institutional sales.) The company expects microwave ovens to reach 8% to 10% market penetration in five years, and by then, four out of five conventional ranges will have some type of microwave oven built in.

Consumer electronics companies generally expect to maintain the momentum gained in the boom of 1973. But a number of questions cloud the future, prime among them the uncertain state of the economy. Perhaps Donald E. Perry, general manager of GE's Home Entertainment Business division Syracuse, N.Y., and chairman of EIA's Consumer Electronics Group, spoke for all when he stated, "Business has been gratifying overall, but 1974 is critical. Of 26 years in consumer marketing, six of them in consumer electronics, this is the most difficult year I've had to forecast of them all."

Components

After 1973's backlogs, a letup this year wouldn't be so bad

Growth in 1973 sales for components manufacturers ranged from 10% to 50%, and most manufacturers closed out the year with large order backlogs, which may require months to bring under control. For one thing, customers' inventories were low when the boom began, and their orders were for immediate product needs. The energy crisis and materials shortages put large question marks on this year's outlook. However, the secure-looking order backlog at the beginning of 1974 should cushion the impact of whatever general economic slowdown may develop.

Since many components manufacturers are working a six-day week now, a cooling off might merely move them back to a normal five-day week. Total sales are projected at $4.9 billion. Based upon last year's 13% increase in factory sales, even zero growth in 1974 would provide a profitable environment.

One cloud on the profit horizon is a cost-price squeeze, which could lead to profitless prosperity. The costs of labor and raw materials rose sharply during the past year, while competitive pressures and Government price controls in 1973 held price rises to a minimum, despite the seller's market. Price rises are almost inevitable, even without the strain of the energy crisis, and the psychology of shortages has led to a market atmosphere in which these rises will probably be accepted.

One long-term trend is a rising influx from foreign sources, especially Japan, for higher-quality components, such as capacitors and resistors. The high-quality, high-price market was previously the exclusive domain of domestic manufacturers. However, the Japanese have come on quickly, spurred by initial domestic demand for these products.

Now, Japanese manufacturers are looking outside for markets, and they have found one here. Some domestic manufacturers confide concern over this trend. They feel that with enough R&D money, new technical ideas can be brought to fruition to recapture lost customers. The foreign threat could revive technical innovations in both capacitors and resistors.

Manufacturers go offshore

Components makers here are combatting this competition however, by adding more offshore plants and foreign subsidiaries, another industry trend that will carry over in 1974. Juarez, Mexico, and Taiwan, for example, are two active locations, but Europe is also receiving attention. Allen-Bradley Co., Milwaukee, has recently set up plants in England and Juarez to manufacture resistors.

On the other side of the coin, large foreign manufacturers like Piher of Spain are building plants in the U.S. to take advantage of the rapidly expanding market here. For the next year, at least, market expansion should maintain this country's role as the major consumer of electronic components. And certain electromechanical relays, variable resistors, and some capacitor types may be technologically superseded by other devices, but they are still being used in consumer and industrial products because of reliability, availability, and cost considerations. Their over-all share of the total electronic-components market may decline, but their dollar level can remain the same or rise.

Perhaps the brightest spot in the components market is the capacitor industry, which grew by 23% last year. By late fall, lead times for some capacitors were stretching out past a year, Aluminum electrolytics, with 25%

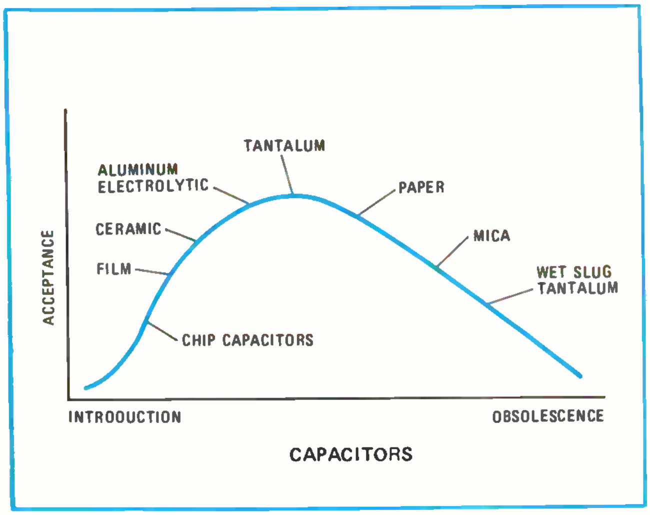
growth to $109 million, were strong, as were ceramics. Chip tantalum capacitors are expected to take off this year, but they still haven't become a high-volume item. Tantalum electrolytics, on the other hand, are expected to reach $125 million in factory sales this year. Improvements in capacitance per unit volume of ceramic chips has pushed into an area formerly held by tantalums. There generally is little overlap between the two chip types, although the ceramic is generally less expensive.

The energy curtailment may put a glitch in the burgeoning aluminum electrolytic market because aluminum requires a lot of electrical power during fabrication. Companies like Sprague Electric, North Adams, Mass., prepare their own aluminum foil. But others could face supply problems, should utility cutbacks worsen. The larger manufacturers like P.R. Mallory Corp., Indianapolis, Ind., feel that they are well stocked for the short run.

Prior to the petrochemical shortage, there was a trend toward use of polypropylene, metalized polypropylene, and polysulfoan films, a threat to nylon and paper capacitors. However, if the plastics shortage gets worse, this move could be stalled. In addition, production and field experience is still sparse, by industry standards, so these films are a couple of years from wide acceptance.

No slack for resistors

A similar market prognosis may be made for the resistor market. Sales, pegged by the *Electronics* consensus at $404.7 million last year, should increase to $418.6 million in 1974. This segment of the components industry would thereby enjoy growth years back to back at a time when integrated circuits have been challenging. For the long term, resistors will, in all likelihood, get a smaller slice of the over-all electronics pie. But, since the pie is getting larger, these component markets should have a healthy growth rate this year.



Age curves. Items on the left-hand portion of the curve should see expanded growth; those on the right should occupy a decreasing percentage of the market, although their sales in absolute dollar volume may not decline. Thus chip and film capacitors should experience continued technical development and increasing market share in the next few years.

The major growth areas will be for thick- and thin-film resistors and resistor networks, plus metal-film types. Their growth was accelerated by long lead times for other resistors. Customers who couldn't obtain standard products ordered the more expensive film resistors because they were available. Consequently, volume production has led to economics of scale, making these higher-priced products more competitive. And this year, thick-film 0.5- and 0.25-watt resistors will be introduced to compete with standard carbon-composition devices.

Wirewound-resistor sales should remain steady—$11.5 million in 1973 and 1974 for variable non-precision and $18.1 million to $17.5 million from 1973 to 1974 for variable precision types. Ultimately, thick- and thin-film networks in DIP packages will replace them as outboard components on pc boards that combine many IC packages. Networks should be worth $43 million this year. Metal-film resistors, set to hit $58 million in 1974, will impinge on wirewounds because of reduced size and comparable noise performance. With few exceptions, other segments of the components industry should do well in 1974. These categories include:

- **Networks.** Filters, networks, and delay lines should grow about 7% to $146.2 million. The Bell System, with its use of thin-film RC networks, the military use of RFI/EMI filters, and the acceptance of active filters have created a momentum that is almost insensitive to economic fluctuations, at least this year. Passive and crystal filters at $37.4 million and $33.5 million, respectively, will continue to enjoy good sales, largely because they are not threatened by other more-expensive types.
- **Connectors.** Major growth is expected by device sockets, printed-circuit connectors, and nonstandard special-purpose types. Any over-all slowdown could affect the general growth expected in the standard-size coaxial and cylindrical connectors, while device sockets will track the burgeoning sales of ICs and passive networks. Shortages will hasten the search for substitutes for hard-to-get materials like gold and, more recently, certain plastics. A major candidate is beryllium-copper, since connectors made from it can be smaller, yet achieve the same resistance and strength, and require less gold-plating.

The general electronics boom opened opportunities for connector innovations in 1973, and these fruits will be harvested in the first half of 1974. Examples of these developments include leadless IC sockets, mass-termination units, and low-cost card-edge connectors.

- **Relays.** Relays had a good year in 1973; growth in some segments reached 10% to 25%. The major growth areas in 1974 will be solid-state, high-sensitivity, and time-delay relay types, for modest totals of $18 to $20 million each. In particular, solid-state relays are expected to grow significantly in the next few years and become a major market factor near the end of the decade. Production experience has led to price reductions so that market acceptance has been steadily growing. The *Electronics* forecast predicts that this category will hit $35 million by 1977.
- **Readout devices.** This group should safely ride out economic fluctuations. Calculators, point-of-sale registers, clocks and watches, and digital equipment of all

kinds will provide a generally sound market base.

Particularly strong futures are predicted for the light-emitting-diode and liquid-crystal markets. At $31 million for discrete readouts and $75 million for multidigit readouts, LEDs this year represent two-thirds of the readout market. Liquid crystals have just been launched, but sales will more than double this year. Recent improvements in plasma panels will make them attractive for many display applications, especially complex alphanumeric displays and large digital displays.

■ **Magnetic and microwave.** Transformers and coils seem to roll on, despite predictions of decline. As they are designed out of one application, they enter another, rather than fading away. Next year should also find them healthy, if not exactly explosive. Transformers and chokes, except for TV applications, are pegged at $214.5 million this year, compared to $200.5 million in 1973. The weak prospect, core memory, is beginning to give way to semiconductor memories, although cores should be around for some years—even after semiconductors pass them in dollar value.

■ **Tubes.** No doubt, this is a declining market, but tubes are still worth over a billion dollars, primarily because of the growth and dollar value of color-television tubes. Elsewhere, the trend is downhill for receiving tubes, power, and special-purpose tubes, and gas and vapor tubes, as well as monochrome-TV picture tubes. Image-sensing tubes and CRTs should show a little pep this year, as will TWTs, which are expected to reach $73 million this year, compared to $72 million in 1973.

■ **Transducers.** The advent of applications like solid-state keyboards and the development of biomedical and automotive transducers will keep this market growing to $83.3 million this year. Pressure, position, and acceleration transducers all have relatively bright futures, although a reduction in automotive production could mar their growth. Of the three, pressure transducers will chalk up the largest increase this year, from $26.5 million to $29.2 million.

■ **Switches.** Common to all equipment, switches should follow a steady gain to $281.6 million this year, compared to $254.7 million in 1973. Solid-state switches represent the latest in technology, although keyboard assemblies will experience the largest dollar boost in this category.

Communications

Interconnect gear, satellites, land-mobile radio to do well

Just about every part of the communications business should grow this year, and some may even do better than expected because of the limitations put on travel by the fuel shortage. The *Electronics* consensus table pegs this market at $2.4 billion for 1974 after $2.1 billion last year.

Perhaps the most promising growth area to communications equipment suppliers is interconnection—or the tie-in of customer-owned equipment to the telephone network. Leading the way with about half of the total interconnect sales are private automatic branch exchanges (PABXs) which sold at a 1973 level of $150 million. Other interconnect products include modems, with better-than-expected $45 million sales in 1973, multiplexers at about $34 million, and such other terminals as decorator phones, automatic answering units, and repertory dialers at $40 million. The 1974 total of greater than $300 million has grown from a market that did not exist only five years ago. And since the landmark Carterfone decision by the Federal Communications Commission in mid-1968, virtually all of this terminal equipment business, worth over $1 billion annually, has been taken from under the protective cover of telephone company monopoly and put up for competitive grabs.

Critical links. Recent passage of the Emergency Medical Service Systems Act will provide funding of up to $185 million over the next three years. Much of this is expected to go into the development of emergency communications networks, both mobile and wire.

Being still in its infancy, the interconnect business is only now beginning to organize effectively in order to educate the telephone user to the advantages that non-telephone-company equipment can offer. This fall, the North American Telephone Association, which is considered the voice of the interconnect industry, announced its approval of a $1-million-plus budget to launch a nationwide public awareness program in 1974.

While the sheer size of potential business to interconnect suppliers is impressive, several obstacles to their complete success remain. First, the Bell System is now organizing to do battle with its new competition, introducing new equipment and announcing an assortment of pricing plans for its services. Also, since interconnect equipment was not allowed in the U.S. until five years ago, foreign manufacturers in Japan, Germany, Sweden and elsewhere, who have been building PABXs for many years, have had a technological head start in the U.S. market. Finally, there are still many unsettled regulatory issues concerning industry standards for interface units between interconnect equipment and the public telephone network.

Rocky road for specialized carriers

The regulatory future seems just as uncertain for the specialized common-carriers, who are competing head on with the telephone company to provide leased private-line service. These regulatory issues stem from actions taken by the Bell System.

For example, in response to the FCC's decision in 1971 to give specialized carriers permission to operate microwave transmission links between states, AT&T applied for lower tariffs for those of its own interstate links that compete most directly with the new independents. In addition, AT&T has been slow in providing local loop service as directed by the FCC and is now attempting to move its regulatory battlefield from the Federal level to that of the commissions of each individual state. Both of these issues, the interstate tariffs and the local-loop hassle, will notably influence the fortunes this year of the new carriers and their equipment suppliers.

Meanwhile, to compete effectively with the ubiquitous Bell System, these new carriers are pressing to get nationwide links into operation. In some recent cases, this has required the merger of smaller regional carriers. In other instances, the specialized carriers are working together to provide services that compete effectively with the common carriers.

Data communications upward bound

From the simplest modems to the most complex communications processors, every type of equipment used in data communications systems will continue to enjoy a healthy growth in dollar volume in 1974 and beyond. Market growth aside, though, 1974 will be noted for its emphasis on second-generation technology: the new products and services that have been talked about for the past few years will finally start coming on line. As a result, data-communications networks will be less costly to operate because equipment prices will drop and transmission links will be used more efficiently.

Among the second-generation prospects are:

- High-speed modems, operating at 4,800 and 9,600 bits per second and using LSI circuits, will come on the market. In end-user configuration, including remote diagnostics, they will sell for about $3,000 compared with about $7,000 for similar present units.
- Programability—perhaps even adaptability—will be added as a hardware feature to time-division multiplexers, making it easy for the user, or the TDM itself, to set the time slot required by terminals of different data rates. This kind of TDM will therefore have some of the flexibility of remote data concentrators but without suffering the penalty of software development.
- Transmission links operating inherently in the digital mode and with a number of low- and high-speed offerings will finally become available—but only in certain regions. AT&T plans to introduce the first leg of its digital data services from Boston to New York early this year and then expand to three other cities in the Northeast, growing over a number of years into a nationwide digital network. And Datran, Vienna, Va., the only specialized carrier building a private-line digital transmission system, will extend its operation beyond its present Dallas-to-Houston link.

With the launching of the first U.S. domestic communications satellites in early 1974 comes a renewed market opportunity for suppliers of ground-terminal equipment. Unlike the past, in which there have been only one or two biggish earth stations to a country, many of the applications now being considered require a much wider network of rather smaller terminals. These applications promise volume-production opportunities for small and medium-sized companies.

The handful of multi-terminal domestic satellite systems now going into operation is only the beginning of a trend toward higher-volume markets for terminal equipment. For satellite applications involving mobile terminals, such as the U.S. Maritime Administration's Marisat programs, and for one-way services like the distribution of network television and CATV signals, hundreds and even thousands of earth stations of all sizes will be required.

In addition, two key advances in satellite technology should encourage future satellite systems to continue to grow. First, the development systems operating at frequencies over 10 gigahertz will overcome many of the limits in spectrum shortage now experienced below 10 GHz. Also, digital multiplexing techniques will allow the efficient use of a single satellite rf transponder channel over many earth terminals.

While the energy crisis has stalled many vehicles, it could easily accelerate mobile communications equipment sales. Land-mobile dispatch radio systems, already economically justifiable because they reduce the size of a fleet by increasing its efficiency, are now even more easily justified because they also conserve fuel.

Mobile radio growth to accelerate

An equally important stimulant to land mobile's sales in 1974 is last September's passage of the Emergency Medical Service Systems Act. This act provides funding of $185 million over the next three years, much of which is expected to go into developing emergency communications networks. Taken together, these two factors are expected by land-mobile equipment producers to boost market growth in two-way radios a little beyond the 9% to 10% experienced in recent years. It will be at least another year or so, however, before new frequencies for land-mobile use will be released in the 900 megahertz band and the resulting volume production of 900-MHz equipment will get started.

Although the fuel shortage should nudge the sales of land-mobile radio equipment upward, it will unquestionably stunt growth in marine-radio sales. Much of the marine mobile market comprises radios for pleasure craft, which will be beached by the shortage.

Commercial

All systems are go, but the going's getting tough

Manufacturers in commercial electronics are choosing to look at the bright side of the energy crisis—or, since lights are being turned off around the nation, perhaps it should be called the happy side. Their reasoning is that if businesses and offices are forced to cut down operations, money-saving equipment like calculators, point-of-sale systems, and word-processing equipment will become more attractive to profit-pressed managers.

There's a certain amount of whistling in the cemetery in this thinking, because cuts in spending usually hit office capital equipment early. But the argument has some merit, particularly for 1974, because of the tremendous momentum these electronics products built up in 1973.

Office calculators last year set new records in sales and profits the world over. U.S. sales neared $400 million, while technical programable and nonprogramable machines hit over $100 million. Prices held up, too, unlike those of the volatile consumer machines. Desktop models remained at $400 to $500, and technical scientific types, which are hardly distinguishable from minicomputers, kept at $1,000 to $7,000 levels.

In between these two price points is what may be the fastest-growing segment of the business-calculator market in 1974—the specialized units for financial, statistical, and design-engineering applications. This group consists both of nonprogramable tailor-made units intended for such vertical markets as loan calculations, stocks and bonds, and engineering calculations, and of programable machines for horizontal markets, including warehouses, factories, hospitals, schools, and construction firms.

Supply problems have plagued calculator manufacturers. At the beginning of 1973 light-emitting-diode displays were hard to get. This situation was cleared up with added capacity, but then the plastics shortage took its place. MOS-LSI circuit deliveries also lengthened.

As for this year, says James Sheridan, president of Monroe division of Litton Industries, Orange, N.J., "If some economic projections come to pass, we could overproduce. With a hot new device like the electronic calculator, overproduction in the industry is almost inevitable, but this year it won't be a disaster. We'll have a stable market, though it can't support all of the 50-plus companies worldwide now making calculators."

POS industry begins consolidation

Competitors in the burgeoning point-of-sale business are set for growth and profits this year, but as of this writing, it's difficult to tell if the economy will cooperate. Manufacturers hope that at least partial immunity to the fallout from the energy crisis will be provided by the systems already ordered for new retail stores. Generally, new construction proceeds as planned, despite the state of the economy, so POS systems destined for these customers look safe. However, many replacement orders may be canceled if retailers decide to hang on to their electromechanical cash registers for one more year as a hedge on their own profits. Fortunately, replacements represent less than a third of retail-POS-equipment sales at present.

Supermarkets have been slower to install electronic systems than department stores, but the Universal Product Code adopted last year will speed machine-reading at checkout counters, and equipment sales should pick up accordingly.

If no major recession occurs, retail POS registers and systems could pass $250 million this year, most of it in department and general-merchandise stores. At about $15 million in sales anticipated this year, the supermarket end of the business will just be getting off the ground.

The POS cast of players has been altered during the last year. IBM officially entered both the retail and supermarket arenas with large-scale systems tied to System/370 computers. IBM claims that its 3650 retail-store system has gained wide response and its 3660 supermarket system has received interest "beyond our expectations." At least two major retail chains already dealing with other POS companies have indicated interest in IBM's equipment when it becomes available later this year.

At the same time, the POS market underwent a degree of consolidation when third-ranked Pitney Bowes-Alpex, Danbury, Conn., bowed out and General Instruments, New York, which has Unitote, began negotiating to acquire American Regitel, San Carlos, Calif., a Motorola subsidiary. The shakeout will continue this year, particularly as IBM finally begins to make its presence felt.

Will auto electronics run out of gas?

Nineteen-seventy-three was the year electronics hitched a ride on the automobile market and got a trip worth over $150 million, according to *Electronics'* survey. In fact, electronics suppliers were strained to keep up with auto company demands for the 1974 seat-belt-interlock system required by Federal mandate. With wide acceptance of electronic ignition and alternator voltage regulators and a splurge in car-entertainment products, returns anticipated in this estimated 11-million-car year were quite high.

But that was before the fuel crisis. As of now, it appears that this will not after all be an 11-million-car year, and expectation of 40% growth in automotive electronics will go the way of Sunday gas stations. Most probably, auto sales will wind up with better than a recession year, but worse than just a cooling off.

Even though motorists may turn to small cars to save gas, the basic electronic content—at least the seat belt, entertainment, and ignition system—should remain the

Do it yourself. As a hedge against the long lead times experienced in 1973, National Cash Register Co. has set up its own Microelectronics division in Dayton, Ohio, to manufacture about a third of the company's IC requirements for point-of-sale terminals.

same. What will suffer are extras like digital clocks, temperature controls, anti-theft alarms and cruise controls. The future for diagnostic electronics and electronic fuel injection still looks good because the former has a cost-savings appeal and the latter fits into emission-control requirements now postponed to the 1978-model cars.

Word-processing equipment, which had been having an identity problem, has begun to round into an identifiable industry covering automatic typewriters, dictation gear, and office copying and printing equipment.

Last year word-processing passed the $900 million mark and should grow at something like 15% to 20% a year up to 1980. This segment of commercial electronics is more likely to suffer from business curtailment than calculators or POS equipment, because it comes under capital equipment budgets that are more susceptible to the ax. The long-term outlook is good, however, particularly for dictation systems, which will become more and more important as businessmen learn to live with less traveling and more letter writing. Now in development for the word-processing industry are laser-erasure typewriters, ink-jet typewriters, buffer-display typewriters, and magnetic-disk voice recorders to replace tape belts in dictation machines.

Cable in a quandary

The big movement in cable television these days is pay-CATV, currently at the heart of a verbal battle between cable operators and commercial broadcasters. The Federal Communications Commission is supposed to referee the match, and all signs point to inevitable growth of some subscription programing, despite the howls of broadcasters.

While the squabbling was going on about the future of pay-TV, CATV hardware manufacturers were enjoying a good year in 1973. But things turned sour about the time that the largest U.S. cable operator, TelePrompTer, New York, ran into financial difficulties, stopped trading on the stock market, and cut back personnel and new construction.

At that point, a subtle but important change came over the entire industry. Until then, cable operators had been eager to bid for franchises everywhere, and municipalities large and small held the power. States, too, began to chime in with regulations on top of the FCC's controls, and winning a construction bid became increasingly drawn out. Now operators are taking a close look at their commitments and are beginning to pick and choose their franchise bids. To hardware manufacturers, these changes mean a flat sales year in 1974.

But the bright spot is the steady move of two-way systems. Although one-way pay-cable has been getting all of the attention, work has proceeded on developing two-way systems. This year, there will be more large-scale experimental installations and some nonexperimental, on-going operations set up in Ohio, Arizona, California, and Florida. Gone are the visions of all the TV wonders promised in the Wired Nation dream, but still alive is the belief that two-way CATV has a future, once operators learn what viewers want.

Instruments

Shortages hit some gear, but not automatic test systems

Component shortages retarded the growth of instrument sales in 1973 by an estimated 8% to 15% from the 18% to 30% that some manufacturers think the market was capable of supporting. With fuel and raw-materials now added to components on the shortage list, the big question for 1974 is what effect will supply problems have on the instrument market during the next 12 months.

Actually, the question has two parts: what will be the effect on demand, and what will be the effect on manufacturers' ability to meet the demand? The relative importance of these two questions varies greatly among the four major categories of test and measuring equipment, which are:

- Big, expensive, automatic test systems.
- Stand-alone digital instruments, often provided with either digital outputs or both digital outputs and programing inputs for use in systems.
- Traditional benchtop laboratory instruments.
- Low-cost, often portable, test equipment.

Come what may, automatic test systems seem to be the center of action in 1974. After a growth of over 20% last year, the automatic test market is first beginning to develop. Because automatic test equipment (ATE) is expensive—"small" systems cost around $25,000; large ones go for $100,000 to perhaps $300,000; and a few big versions have gone beyond $1 million—there tends to be a long lag between the initial preaching of the automatic-testing gospel by the ATE manufacturers, and the final conversion of potential buyers into true believers, at least for the first purchase.

Automatic testing leads the way

Once the ice is broken, however, and ATE has a chance to prove its worth within a given company or within a given industry, the deluge follows. Suddenly people who never used ATE before discover that they can't survive without it. In the main, the increasing complexity of today's new products makes more extensive testing necessary, and testing by manual methods would make the costs of this testing unacceptable. At the same time companies that used to be able to get by with a modest program of spot checking are finding it necessary to do 100% testing on many classes of incoming components because of their concern over quality. Poor seals, insufficient attention to cleanliness and other production details, and use of inferior raw materials have been cited by some users as the reasons components that were formerly regarded as highly reliable must now often be carefully inspected.

As far as ATE manufacturers are concerned, all of this adds up to a demand situation that will exceed their production capabilities, no matter how badly the rest of the industry is hit. What worries some ATE makers, however, is that shortages may affect their ability to produce. Since the selling price of ATE is not as dependent upon IC costs as the prices of less expensive test gear, the ATE manufacturers can afford to pay a little extra to ensure themselves an adequate supply of ICs, thus giving every indication that 1974 will be their best year yet.

The fastest-growing part of the digital-meter market is low-cost portables, which are expected to jump by perhaps 35% to 45% in 1974. Unfortunately, low-cost instruments (which may roughly be defined as those selling for less than $500) are extremely susceptible to IC price increases and to other problems that shortages can generate. For example, one way to beat a shortage of a particular component is to design it out of the instrument. This, of course, means that engineering money that might have been spent on potentially profitable new products must, instead, be pumped into an old product simply to keep the old product on the market.

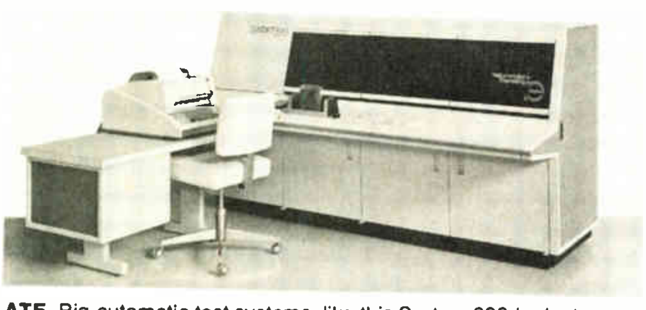
Furthermore, shortages can hurt the maker of low-cost instruments by slowing down his manufacturing reflexes. Long lead times make it tough to respond to unanticipated increases in sales of old products, and difficult to respond to innovations made by competitors.

The outlook for low-cost instruments in 1974, therefore, is extremely dependent on the availability of components. At the very least, the shortages will reduce the number of new products that can be introduced. In addition, manufacturers face a severe cost/price squeeze this year. This is really the big worry of 1974. Sales of low-cost instruments will, in all likelihood, grow at a very healthy clip. What profits will do is another story.

Systems-oriented instruments

In contrast to the low-cost field, the higher-priced digital instrument market looks much less risky because, like the ATE, it is much less sensitive to modest increases in the costs of components. Demand is great for these instruments because they can serve two functions: they are excellent stand-alone benchtop tools in the laboratory, and they can be put to work, either temporarily or permanently, as part of medium-scale automatic test systems.

What's more, the advent of calculators, rather than minicomputers, as controllers of programable instruments makes possible much cheaper automatic test systems. A typical minicomputer-controlled system might cost anywhere from $20,000 to $200,000, but a calculator-based system runs from about $15,000 to $30,000 and the result is the opening up of new market areas to penetration by automated instrumentation. To some extent, of course, the calculators' gain will be the minicomputers' loss, but most marketing managers feel that the calculator-based systems will bring automation to areas that otherwise would do without it.



ATE. Big automatic test systems, like this System 390 by Instrumentation Engineering, typically sell for hundreds of kilobucks. What makes them worth those prices is their ability to test many production items, like this circuit board (right of chair) in a short time.

What could hurt systems equipment is the fact that the larger digital units represent fairly sizable capital investments. And if the energy crisis should worsen to the point of a general downturn in business, spending for capital equipment, expected to rise, might instead decline, and with it, the sale of these instruments.

Old reliables get a new twist

Finally, the slowest-growing, but largest, segment of the instrument market—the traditional R&D type of bench instrument—will probably grow less than 10% this year. But since it comprises perhaps half of the total instrument marketplace and includes many instruments whose engineering costs have already been paid for, this non-glamorous area is still the most important profit category for many instrument makers.

An exception to the slow-growth outlook in standard bench instruments is the new category of logic scopes [*Electronics*, Dec. 20, p. 125]. This class of instruments, which was started last spring with the introduction of Hewlett-Packard's 5000A logic analyzer, now includes three more products: the 5000A, H-P's 1601L logic-state analyzer, Biomation's 810D digital logic recorder, and E-H Research Labs.' AMC 1320 Digiscope.

Because logic scopes are new, estimates of the present size of the market or its potential for growth are difficult to come by. Most instrument makers agree, however, that it's "a sizable field," "a big field," and "the only bright prospect in R&D bench instruments." The speculation is that sales of the new logic scopes will be $2 million to $3 million in 1974, with growth then proceeding at a rate of at least 40% for the years immediately following.

Another problem caused by the newness of logic scopes is that there's no field experience. Such questions as what features it must have, what features might better be offered as options, and how much are people willing to pay for these instruments will only be answered as user feedback becomes available. So far, at least three points are already quite clear:

- To be successful in the marketplace, a logic scope must be able to look back in time—that is, it must be able to display the succession of events leading up to the trigger condition.
- It must be able to work with nonrepetitive signals since many logic-circuit problems are caused by anomalous events that occur at irregular intervals.
- As implied by the preceding points, the scope must have a storage capability.

Other details will be determined by the success or failure of new products that will undoubtedly be introduced over the next several months. But regardless of these details, the expansion of computers, computer peripherals, and other equipment made up essentially of digital logic circuitry would seem to guarantee a very bright future for any instrument that is capable of easing the complicated jobs of designing, servicing, or simply analyzing the operation of digital logic circuits.

One aspect of the energy crisis that may stimulate sales of the old reliables is the demand created by increased oil exploration. Today's geologists use a good number of chart recorders, magnetic-tape recorders, instrumentation amplifiers, storage scopes, minicomputers, and other test equipment for the recording and analysis of seismographic data. Because of the enormous potential profits in oil exploration, it is unlikely that any reasonable increase in instrument prices will deter an oil company from buying the equipment it needs to search for new fields.

Industrial

Automation in new markets may gain because of fuel crisis

The McGraw-Hill economics survey predicts that U.S. industry will extend capital equipment expenditures about 14% this year, the same as last year (see "The U.S. economy in 1974"). And once again, electronics sales will grow right along with this expansion.

As for the energy crisis and the predictions of a slowdown in the growth rate of the gross national product, manufacturers are apparently proceeding on faith: first, that somehow the oil and its derivatives needed to keep industry's wheels turning will flow again, and second, that back orders reflect enough demand to justify plant expansion, even in this uncertain time. In addition, some demand for industrial electronics is keyed to Federal and local requirements for pollution control and safety, regardless of how the economy performs.

Paradoxically, many builders of digitally controlled process and manufacturing systems expect they'll do well, no matter how the energy picture shapes up. The reason: digital control, like the computer in business data processing, is regarded as an efficiency tool. It helps turn out more products faster, desirable when demand is up, and it cuts waste to a minimum through monitoring and control when raw materials and fuel are in short supply. In both instances, costs are reduced.

Plants are being modernized and expanded across a broad spectrum of industries, including petrochemicals, automotive, pulp, paper, electric utilities, and textiles. Even as big-car sales go down, Detroit's feverish switch to turning out more small cars that consume less fuel will probably increase the installation of electronic controls. These controls perform such tasks as checking emission levels of automobiles coming off the assembly lines, testing the performance of individual components such as carburetors, controlling and monitoring machines and transfer lines, counting production pieces, reporting defects, and controlling storage and distribution of materials.

Use of minicomputer controls has zoomed to such an extent that an engineer at General Motors Corp., Warren, Mich., observes: "Asking us how many we're using is like asking us how many electric motors we have in the assembly plants. We just don't know."

The U.S. economy in 1974

With a gain of about $103 billion, the gross national product this year will top $1.39 trillion. This marks the third year in a row that GNP will increase by more than $100 billion, though of course that figure is in inflated dollars.

But 1974 will be a different kind of year—an energy shortage, high rates of inflation and unemployment, and rising prices, all at once. Prices will go up about 6%, and real growth will slow to about 2%.

Business expenditures for new plants and equipment will provide the major upward thrust. According to the McGraw-Hill survey, reported in November, capital expenditures should rise about 14% this year, on top of a similar growth in 1973.

The industrial operating rate at year's end was about 85%, which is quite high. With industrial output leveling or even declining and new capacity coming on stream, the operating rate will dip. Inventory building will be a modest plus factor in GNP growth in 1974. It's unlikely any major inventory correction this year will be caused by the energy shortages. Companies have wanted higher inventory levels, but could not achieve them because of capacity limitations and shortages in raw materials. Consequently, the rate of inventory accumulation in 1974 will add up to $7 billion, compared with $5 billion last year.

Net foreign trade will also provide a lift to the U.S. economy this year. In 1973, exports topped imports for the first time since 1970, thanks in part to monetary changes favoring American products. There should be a $9 billion surplus of exports over imports this year.

Consumer spending is a mixed bag. Outlays for soft goods and services continue to be a positive factor, but spending for durables and investment in new housing are negative. The forecast calls for rises of 10% in soft goods spending and 9% for services this year, but for drops of about 1% in durables and 10% in residential construction.

Actually the declines in durables and housing are interrelated, since, as fewer new houses are built, spending for appliances and home electronics to go in them also drops.

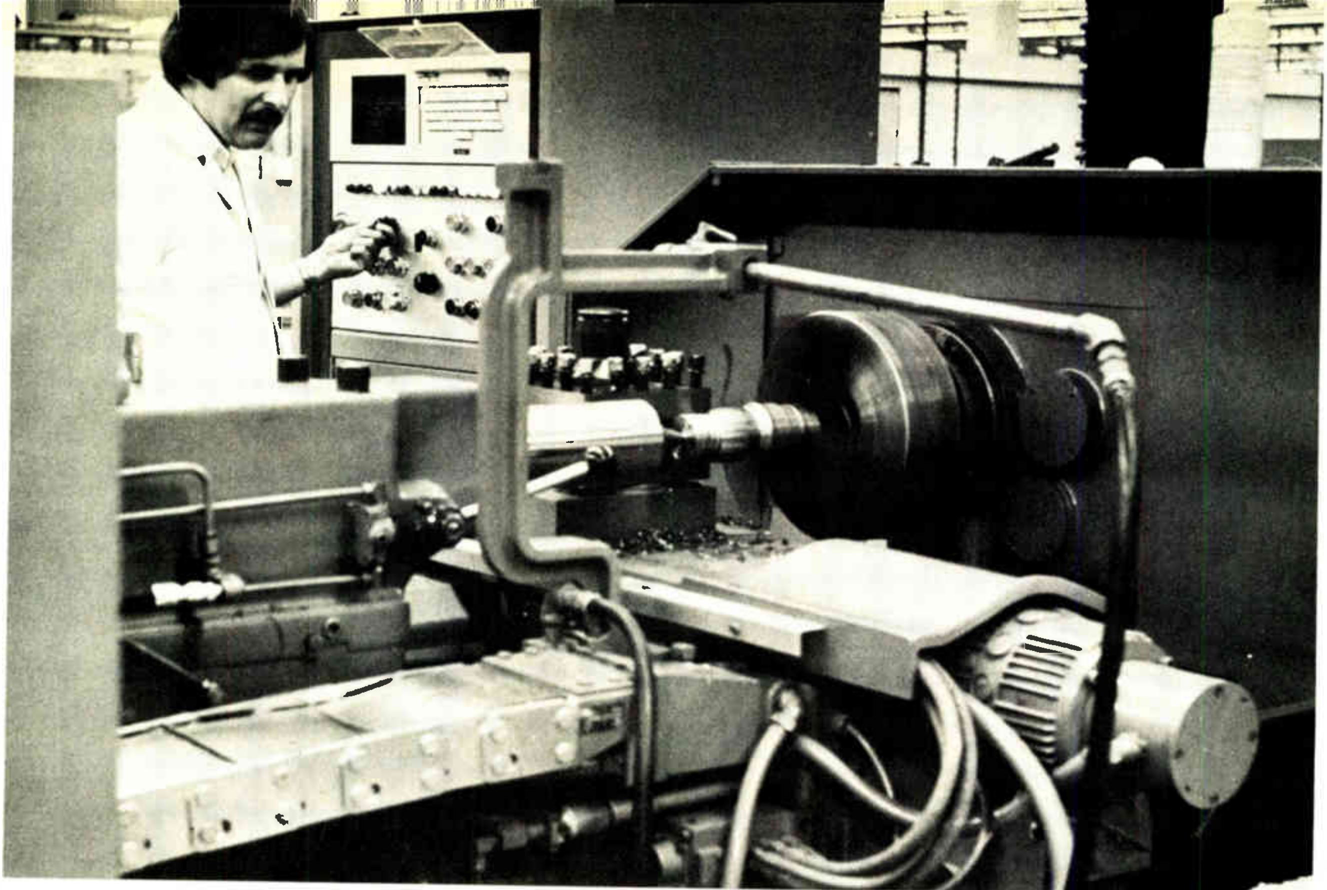
Consumer income, after taxes, will be up more than 8% in 1974, but that's two percentage points below last year's mark. A small increase in disposable income is expected.

To sum up, we do not believe, that, even with energy shortages this winter, 1974 will turn out to be a recession year. It will be a slow growth year.

—Douglas Greenwald, Chief Economist, McGraw-Hill

Machine-tool controls

Shipment of electronics for machine-tool controls climbed precipitously during 1973—roughly 50% ahead of the total for the year before, according to the National Machine Tool Builders Association, Washington. Orders were also strong. The total for the first 10 months of 1973 exceeded the previous peak order year of 1966, and these orders are expected to be shipped during 1974. For manufacturers of numerical control-



Mini NC. Computer-numerical-control systems, in which one minicomputer controls one or two machine tools, made good gains in 1973 and should do well in 1974. The capability to edit programs on the factory floor is perhaps the biggest reason for CNC's success to date.

lers, 1973 was a fine year, despite the fear today that materials shortages and declining consumer demand may cause a holdback on orders.

Sales of computer numerical control (CNC) equipment, boosted by desirable features such as self-diagnosis of faults, began to skyrocket last year. Programable controllers, digitally programable semiconductor replacements for hard-wired electromechanical relay banks, are also doing exceptionally well. The market amounted to $20 million in 1973, according to an estimate by Digital Equipment Corp., Maynard, Mass., and until the uncertainties arose this autumn, sales were expected to double in 1974.

Not only are the first users coming back for more equipment, but the word that machines are being operated reliably with less down-time than with the relay-bank approach is spreading to other newcomers. OEMs and end users are making long-term commitments for units, and order values are getting quite large. For example, Reliance Electric Co., Cleveland, Ohio, reports it's closing one deal with a nationally known manufacturer of consumer goods for some $2.5 million worth of programable controllers.

Breaking into new markets—at last

Electronics is also making inroads into industrial areas that had heretofore shown little interest. Builders of textile machinery are becoming increasingly enamored of electronics. In 1973, for example, a minicomputer-controlled pattern-designing machine for double-knit goods received a lot of publicity. Now, electronic-control elements are expected to find their way into other types of textile machines, as well—even though in this industry, some equipment dates back to the early 1900s. Eventually, electronics will be involved in the entire textile process—from the making of the fibers to the weaving of the fabric, to the sewing of the final products. However, manufacturers are not expected to be converted to the electronics faith overnight, as this is a conservative industry in capital investment.

Another area attracting electronics, particularly numerical-control systems, is general manufacturing, a catch-all phrase covering all kinds of customers producing goods from machinery parts to consumer products. A spokesman of the Bendix Corp. Industrial Controls division, Detroit, Mich., says this area is finally taking up the slack caused by the slump in aerospace manufacturing, which spawned NC and provided its initial impetus in the early 1960s.

Monitoring pollution

Computer-direction of materials-handling systems is also a growing market for electronics, and pollution control is creating new markets. Systems for monitoring wastes at both industrial plants and municipal sewage-treatment facilities are acquiring a hefty complement of electronics equipment. Industrial plants, for example, are being forced to limit the amount of dangerous wastes they put into adjacent waterways. They'll have to measure their effluents. While they do so, they may also feed back the information into their plants to control their processes, thereby closing the loop. The result: less waste and less cost. Computer-based systems are also being used increasingly in sewage-treatment plants for better monitoring of the treatment process.

Air-pollution-monitoring systems are coming into prominence, not only within municipalities, but at industrial plants, as well. Impetus to industry for these systems will come from the need to document proof that facilities are meeting pollution standards. Electric utilities are particularly interested in this data, prompting demand for combination stations to monitor weather and air pollution for plants still on the drawing boards.

This demand is based on the reasoning that a utility doesn't want to get blamed for pollution that may already abound over the area in which it hopes to build a power plant. With an eye on the U.S. market, the giant Dutch firm, Philips Gloeilampenfabrieken NV, late last year introduced in the U.S. air-pollution-monitoring equipment originally developed for use in Europe.

Pollution-monitoring is not the only opening for electronics in electric utilities. "The industry is no longer afraid of computers," says a utility-industry consultant, pointing out that the application of computer-based systems to new and modernized generating plants, as well as to distribution and transmission facilities, is "overwhelming." And it's all aimed, he adds, "at giving the utility better control over its facilities, and the ability to find faults and diagnose troubles quicker than ever."

Still another market keyed to the energy crisis in 1974 involves environmental-monitoring systems for office buildings and factories. Monitoring systems based on microprocessors to balance heating and air-conditioning against outside temperature and sunlight conditions may quickly pay for themselves by reductions in fuel consumption. In addition, it would be possible to program such extras as fire and burglar alarms and a means for checking employee badges.

In the year to come, the new breed of single- and multiple-chip microprocessors will proliferate. Programable controllers are a prime target for the new devices, which will bring additional arithmetic capability to programable logic. Reliance Electric Co, for one, is reported to have already introduced this capability into its line of controllers, and others are working to apply it. General Automation, Anaheim, Calif., cites some potential applications for its unit [*Electronics*, Dec. 6, p. 39]: controllers for four-axis positioning systems using stepper motors, two-axis closed-loop servo systems, intelligent controllers for automated test systems, set-point controllers in the process industries, environmental controllers, remote data-entry sources, and controllers for fire and burglar alarm systems. What's more, a broad range of applications still lies ahead.

Packaging and production

Future is healthy, so long as semiconductors are healthy

Despite the threat of scarcities, manufacturers of both packaging hardware and production equipment swung into 1974 optimistic about the year ahead. A good many makers of semiconductor production equipment expect to double sales in 1974, and even companies in so-called mature technologies such as printed circuits expect growth rates of 25% this year. Automation is rapidly capturing a larger portion of electronics manufacturing. Some spokesmen predict that this market in the electronics industries will double annually for some years.

As for 1973, several firms that had barely survived the sales drought of the early seventies were not far into the second quarter of the year before they became capacity-limited and had to turn away business. At least one semiconductor equipment manufacturer reported that orders kept climbing right through the close of 1973, though in the past it has seen sales trail off toward the end of the year as companies depleted their capital expenditure budgets.

A real gainer in the semiconductor equipment area in 1973 was ion implantation equipment. Sales swept past the $7 million mark and will probably double in 1974. Ion implantation is a precision doping technique, which is now catching on across the board in MOS and bipolar processing. Robert Muspliger, marketing manager for ion implantation equipment at GCA Corp., Sunnyvale, Calif., says that the market is brisk both here and in Japan, but somewhat lagging in Europe.

Epoxy die attach—an adhesive technique for attaching a silicon chip to a package—came on strong as a method for mounting LSI, MOS, and LED devices. It lends itself well to automation, boosting die attach rates to as high as 4,000 per hour, while traditional eutectic bonding delivers only 1,000 bonds per hour, at best. As a consequence 90% of all die attach will be done with epoxy adhesives within five years, says Laurier A. Wood, president of Laurier Associates, Littleton, Mass. Thus, just by replacing the tens of thousands of eutectic die bonders now in use, the semiconductor equipment manufacturers could create a potential market for the epoxy die bonders of upwards of $100 million.

Packaging hitched to semi's star

LSI ceramic-package deliveries should top 62 million pieces and bring in $45 million this year—a 28% increase in dollars over 1973— whereas premolded plastic packages are estimated at about 13 million pieces, the majority being made in-house by companies such as Rockwell International, Anaheim, Calif. and Western Digital Corp., Newport Beach, Calif. The upturn in 1973 was so dramatic that one ceramic package house, Metalized Ceramics, Providence, R.I., increased its employee count by 30%, added a third shift to meet the demand, and doubled its annual sales.

MetCeram anticipates an even larger growth of 40% in the coming year—understandable in view of the sharp increase in demand by memory manufacturers, who favor ceramic for its reliability record.

The printed-circuit industry entered 1974 with firm backlogs through 1974. The value of laminates sold in 1973 was about $100 million with a slight drop expected this year thanks to shortage-inspired orders placed in 1973 to cover 1974 requirements. The dollar value of the entire printed-circuit market has climbed above $500 million and is exhibiting a growth rate of about 8% per year. Captive operations account for about 65% of production and will increase to about 75% in 1974.

Additive plating—heralded for a decade as an economical and pollution-free method to process printed-circuit boards—is breaking free of the doldrums and is setting sail in new industries such as hand-held calculators and automotive electronics. It is currently used in about 5% of printed-circuit production, but A.J. Siegmund, product manager for MacDermid Inc., Waterbury, Conn., estimates that the figure will jump to 25% by 1975. Both McDermid and Kollmorgen Corp.'s Photocircuits division, Glen Cove, N.Y., are carrying the banner for additive plating processes and claim that the technique offers users 25% to 30% savings over traditional subtractive techniques. So far, large companies with in-house additive capabilities include RCA, Texas Instruments, Univac, and General Electric. Significantly, overseas acceptance of additive plating is a step ahead of the U.S. with some 10% of printed-circuit technology in Japan already committed to this process.

Why has additive technology been so slow coming on? One veteran packaging engineer sums it up this way: "In the early years it was like witchcraft. That is, maybe it worked in my pc house, but not in yours across the street. But recent refinements have changed the additive process to a controlled, predictable technology."

Packaging companies learned last year that plastics suppliers with tight supplies were leary about taking on new customers who they assume are trying to circumvent the shortage with substitutes. As an example, if a user of polystyrene—suddenly seeks easier-to-get nylon, the nylon supplier may not want to add a new customer into his already-tight allocation system if he expects the customer to revert to polystyrene, once the shortage abates. The nylons and the acetals have been less short than polystyrene.

Another factor aggravating domestic scarcity was the freeze on prices, which caused materials to command premium prices overseas. Copper can yield 36 cents a pound more, polyvinyl chloride twice its domestic price of about 13 cents a pound. And unless the Government exempts raw materials from price control and/or clamps down on exports, the condition can only worsen.

Additive. These printed-circuit boards, undergoing final inspection at Kollmorgen Photocircuit's Glen Cove, N.Y., plant, are made by the additive process—a plating technique which accounts for about 5% of U.S. production now but is expected to reach 25% by 1975.

Federal

Confusion reigns in capital on how to prime industry pump

Despite their dispute about the real direction of the U.S. economy in 1974, the diverse economic factions in Washington do have a consensus of sorts on the Government's role as an electronics industries' customer: it will get bigger rather than smaller.

A survey by *Electronics* shows the Federal Government plunking down more than $12.5 billion for electronics hardware, research, and development during the next 12 months—a 4.8% increase over 1973. As in the past, most of the money will be spent by the military, whose forecast outlays of just $11 billion represents a 5.4% cent increase over the last year (see table).

Precisely how much new business those dollar increases will mean for the electronics industries is another matter. While there are big gains proposed in the area of military R&D, for example, most of the increases represent little more than inflated dollars.

Certainly the biggest question mark for Federal budget and economic specialists is the impact of the energy shortage and its potential ripple effect throughout the nation. The Government can do little directly to counter those effects, although it stands ready to prime the national economic pump with more Federal spending. Hence part of the rationale behind the proposed increases in military R&D outlays is that such money can be moved quickly into the economy, maintaining high-technology jobs even if it's not buying much hardware. "We have never before faced a slowdown because of shortages of resources," explains one perplexed budget planner, "so we can't learn a thing from history. There are no prior patterns."

Two views dominate among the many Federal economic factions forecasting the 1974 national economy. While both anticipate dollar increases in Government support of the electronics industries, the reasons behind their forecasts are substantially different.

On one side, there is a faction, typified by Treasury Secretary George Shultz and the Council of Economic Advisors, who see an over-all slowdown producing a "no-growth" economy, increased unemployment of 6% or more, plus an inflation that is the direct result of shortages. In their opinion, that inflation, coupled with a highly selective system of Federal pump-priming, will require increased Federal outlays, including some deficit spending.

On the other side are a number of private-sector economists and many Democratic congressional leaders, who project an economic crisis more serious than a simple "mini-recession" in the first half—one that will require quick congressional action to force-feed the economy with Government money in the second half if the White House fails to move. But, as one Republican congressional leader opined near the close of last year, "The White House cannot afford not to act." Thus the dispute centers less around how much Federal money will be spent for electronics than about the timing.

The Defense Department electronics budgeteers and project officials are little affected by economic forecasts. Though their own counterparts in operations and maintenance express serious concern about keeping ships steaming and aircraft flying, DOD's technology planners are moving unswervingly ahead with plans to rebuild and strengthen defense capabilities during an expected period of peace. Defense Secretary James Schlesinger is still pursuing the concept of a "hi-low force mix" introduced by his predecessors over a year ago. This calls for a small, elite force of high-performance strategic weapons, such as the Rockwell International B-1 bomber and the Navy's 24-missile Trident submarine, plus a larger proportion of relatively lower-cost strategic and tactical forces that will include updating some older weapons systems by retrofitting them with new high-performance guidance, radar, and communications subsystems.

Defense R&D gets high rank

In pursuing an expanded R&D effort, the Pentagon is broadening its planning cycle to look five to 15 years ahead, rather than three to five. Beyond R&D, however, other spending increases are forecast only for aircraft procurement. These will generate little new business, but merely reflect increased outlays proposed for commitments already made to the Air Force's F-15, the B-1, and the A-10, as well as the Navy's F-14. All other categories of electronics procurement will decline in varying degrees with some holding close to 1973's level, as cutbacks occur in numbers of systems to be bought in order to compensate for inflation of unit costs. The sole bright spot in these areas of reduced spending is the fact that new business may evolve as electronics planners propose modifications to a number of systems as a result of lessons learned from the October Mid-East war.

Aerospace may be grounded

The 1974 spending formula for the Government's two big civilian aerospace agencies—the National Aeronautics and Space Administration and the Federal Aviation Administration—is uncertain at best. The dim picture is the result of an already tight procurement posture complicated by the economic rippling of the energy shortage throughout the planning department of the Government. At both NASA and FAA, it looks, in sum, like slim pickings for electronics companies seeking big new contracts. The impact of aircraft fuel shortages and the resultant cutbacks in commercial and general-aviation traffic, for example, leaves the FAA with less justification for upgrading the nation's automated air-traffic-control system—and that obvious conclusion could severely handicap the efforts of an agency already constrained in its spending by the budget impoundments of the Office of Management and Budget.

On paper, the aviation agency probably will stay at about the same funding level, approximately $1.7 billion, with R&D funds totaling $130 million. Most of this money is fueled by the airport trust fund designed to upgrade the nation's airfields. But in practice, the OMB hasn't let the agency spend a dime on new programs.

In near and outer space, NASA will lose a little altitude this year. It appears likely that its fiscal 1975 budget will drop below $3 billion, perhaps significantly, for the first time since the Apollo program was cranked up. The $5 billion space shuttle program, which was to have neared peak funding levels, will probably be nicked in the budget cutting and be stretched out again to hold down annual costs. The 1975 Apollo-Soyuz docking by the U.S. and Russia, the other manned program, appears safe for diplomatic reasons.

The big victim looks to be NASA's Planetary and Space Science programs, whose total funding may drop significantly from fiscal 1974's $584 million. While finishing the 1975 Viking-Mars missions, the agency hasn't much left over, but would like to start a $187 million Pioneer-Venus probe if OMB and Congress approve [*Electronics*, July 5, p. 29]. A bright spot could be the popular Earth Resources Technology Satellite series—ERTS B could be moved forward from its 1976 launch data, and the Interior Department might just get its wish for a C model.

Civil agencies raise hopes

Among the civilian agencies, one of the most powerful is the Federal Communications Commission, which, in allocating frequencies instead of funds, creates or shapes electronics marketplaces. Soon, the commission is expected to decide two issues that probably will spur two markets.

First, it is likely to assert its jurisdiction over interconnection equipment, in response to a challenge by North Carolina and others [*Electronics*, Sept. 27, p. 74]. Second, it will rule on how the 900-megahertz land-mobile spectrum will be divided among competing interests [*Electronics*, May 10, p. 29]. Also important will be how the thrust to create services competitive to AT&T will be continued under the successor to retired Common Carrier Bureau chief Bernard Strassburg [*Electronics*, Dec. 6, p. 60].

Under congressional mandates, three agencies have billions of dollars to spend: the Federal Highway Administration and Urban Mass Transportation Administration in the Department of Transportation, and the Law Enforcement Assistance Administration in the Justice Department. While most of the money will go for nonelectronic goods, the three agencies' R&D programs can fuel new uses for electronics in supporting roles. The big funding question will be how much the energy crisis and gasoline shortages will cause a shift to mass transit systems and their automated command and control systems. A potential electronics market in marine-navigation systems could be created this year if Congress, Defense Department, and the White House Office of Telecommunications Policy can thresh out what will be the techniques for riverine, coastal and ocean uses among Loran A and C, Omega, and satellites. □

Note: *Electronics* will treat specific weapons system plans and other Federal Electronics outlays in greater detail in its regular annual report on the Federal Budget, to follow the President's delivery of his fiscal 1975 request to the Congress later this month.

U.S. MARKETS FORECAST 1974

Market estimates represent total value (at the factory level) of goods shipped by U.S.-based manufacturers. Some product categories have been added, deleted or redefined; therefore, these totals are not directly comparable to those of previous years.

FEDERAL ELECTRONICS

(millions of dollars)	1972	1973	1974	1977
FEDERAL ELECTRONICS, TOTAL	11,503	11,929	12,504	14,311
Defense Department, total	10,058	10,390	10,955	12,418
Procurement, total	5,126	5,181	5,472	6,676
Communications and intelligence	962	997	981	1,550
Aircraft and related ground equipment	1,091	1,200	1,550	1,740
Missiles and space systems	2,205	2,101	2,083	2,361
Mobile and ordnance	265	238	233	290
Ships and conversions	603	645	625	735
Research and development, test and engineering	2,692	2,848	3,020	3,085
Operations and maintenance	2,240	2,361	2,463	2,657
NASA, total	948	825	800	920
Transportation Department, total	188	399	419	600
FAA procurement	–	159	162	185
FAA research and development	–	123	130	153
Highway and transit systems	41	80	95	172
Health, Education, and Welfare Department, total	309	315	330	393
Education systems	135	133	130	163
Health-care electronics	174	182	200	230

CONSUMER ELECTRONICS

(millions of dollars)	1972	1973	1974	1977
CONSUMER ELECTRONICS, TOTAL*	5,163.8	5,733.5	5,982.7	7,089
Television receivers, total	3,156.0	3,263.0	3,212.0	3,462
Black-and-white	563.0	495.0	475.0	429
Color	2,593.0	2,768.0	2,737.0	3,033
Audio equipment, total	1,503.5	1,650.0	1,810.7	2,154
Radios, total	451.0	457.0	465.0	479
Table, clock, and portable radios, a-m and fm	138.0	140.0	145.0	153
Automobile radios, a-m and fm	313.0	317.0	320.0	326
Phonographs and radio-phonograph combinations	345.0	350.0	370.0	385
Tape recorders and players, total	357.5	463.0	555.7	810
Automobile cassette and cartridge players	145.0	200.0	235.0	375
Cassette and cartridge player/recorders (including four-channel)	112.5	131.0	146.7	200
Reel-to-reel players/recorders	50.0	47.0	44.0	35
Tape player-radio combination	50.0	85.0	130.0	200
Hi-fi audio components (amplifiers, receivers, speakers, tuners, pickups, compacts, and headphones)	350.0	380.0	420.0	480
Other consumer products, total	504.3	820.5	960.0	1,473
Video players/recorders	2.0	3.0	5.0	45
Electronic organs and other electronic musical instruments	100.0	110.5	120.0	150
Intrusion alarms and fire-monitoring devices	132.0	140.0	142.0	160
Electronic assembly kits, all kinds	65.3	72.0	80.0	98
Microwave ovens	100.0	165.0	253.0	600
Calculators, personal and four-function	105.0	260.0	270.0	300
Electronic watches	–	70.0	90.0	120

*Includes domestic manufactured and domestic-label imports, but does not include foreign-label imports.

COMPONENTS

(millions of dollars)	1972	1973	1974	1977
COMPONENTS, TOTAL	4,172.4	4,705.4	4,879.0	5,473
Capacitors, total	483.0	593.7	627.5	679
Paper	54.1	65.2	69.0	68
Film	90.0	97.0	102.8	114
Electrolytic, total	178.5	229.0	238.9	237
Aluminum	87.5	109.0	113.9	110
Tantalum	91.0	120.0	125.0	127
Mica	21.7	26.5	26.8	25
Glass and vitreous enamel	7.0	6.9	6.6	5
Ceramic	98.9	129.2	140.5	177
Variable	11.8	12.2	12.6	14
Chip	10.0	13.8	15.5	22
Other	11.0	13.9	14.8	17
Connectors, total	403.6	463.3	488.5	592
Coaxial, standard size	30.8	34.9	43.3	55
Coaxial, miniature	13.0	15.0	15.6	21
Cylindrical	119.2	133.8	136.2	153
Rack and panel	90.0	103.8	107.0	129
Fused	8.5	9.0	9.5	11
Printed-circuit, total	86.8	88.5	102.1	130
Card-insertion	51.2	58.0	62.0	74
Two-piece (metal-to-metal)	18.5	21.0	21.1	28
Plate-module	17.1	19.5	19.0	28
Special-purpose	46.3	51.8	53.0	60
Device sockets	9.0	16.5	21.8	33
Electron tubes, total	872.1	1,147.3	1,115.9	1,097
Receiving	226.5	191.5	166.4	120
Power and special-purpose, total	293.4	289.8	289.5	278
High-vacuum	61.5	60.0	63.5	48
Gas and vapor	19.0	16.9	15.6	13
Klystrons	34.9	34.0	31.7	30
Magnetrons	34.3	34.0	30.0	32
TWTs, (including backward-wave)	74.3	72.0	73.0	73
Light-sensing	9.5	10.0	10.5	12
Image-sensing (including TV camera and image-intensifier)	28.0	30.7	32.0	34
Storage	15.1	15.2	16.0	17
Cathode-ray, except TV	16.8	17.0	17.2	19
TV picture, black-and-white	49.0	40.0	33.0	21
TV picture, color	575.0	626.0	627.0	678
Filters, networks and delay lines, total	124.4	136.8	146.2	164
Delay lines	14.9	15.0	14.8	13
Passive electric-wave filters (LC)	32.5	36.0	37.4	38
RC networks	8.0	8.6	8.9	11
Crystal filters	22.7	29.0	33.5	39
Rfi and emi filters	36.8	38.0	40.0	46
Active filters	9.5	10.2	11.6	17
Magnetic components, total	269.5	302.1	318.7	357
Computer memory cores	32.0	30.0	31.5	23
Transformers and chokes (except TV), total	170.3	200.5	214.5	258
Laminated	110.0	128.0	136.9	163
Toroidal	37.0	43.5	46.0	55
Pulse transformers	23.3	29.0	31.6	40
TV magnetic components (including yokes and flybacks)	52.0	56.0	57.0	59
Rf coils	15.2	15.6	15.7	17
Microwave components and hardware (except tubes, antennas and semiconductors), total	76.6	82.0	86.5	97
Mixers	10.1	10.2	11.0	13
Detectors	3.3	3.4	3.6	4
Passive components (filters, couplers, terminations, attenuators, etc.), total	30.0	33.7	36.2	39
Waveguide	8.0	8.5	9.0	10
Coaxial and stripline	22.0	25.2	27.2	29
Switches, total	8.7	8.9	9.5	12
Waveguide	2.7	2.7	2.7	3
Coaxial and stripline	6.0	6.2	6.8	9
Ferrite devices, total	20.3	21.4	21.4	23
Isolators	4.8	4.9	4.9	5
Circulators	11.1	11.5	11.5	12
YIG devices	4.4	5.0	5.0	6
Power limiters	4.2	4.4	4.8	6

(millions of dollars)	1972	1973	1974	1977
Printed-circuit boards, total	155.5	199.5	214.5	254
Single-layer	16.5	16.0	14.0	10
Two-layer	95.0	122.5	130.0	136
Multilayer	35.0	50.0	58.5	87
Flexible	9.0	11.0	12.0	21
Quartz crystals (including mounts and ovens), total	42.6	48.6	52.3	62
Readout devices, total	75.3	133.2	159.8	316
Discrete, total	30.3	39.2	45.3	68
Gas-discharge	–	2.0	2.0	1
Incandescent	9.0	10.0	11.0	16
Fluorescent	1.0	1.2	1.3	2
Light-emitting diodes	20.3	26.0	31.0	49
Multidigit, total	45.0	94.0	114.5	248
Gas-discharge	–	25.0	32.0	55
Light-emitting-diode	45.0	65.0	75.0	165
Liquid-crystal	–	1.0	2.5	17
Plasma panel	–	3.0	5.0	11
Relays, total	328.2	418.3	417.9	457
General-purpose	120.0	180.0	150.0	130
Telephone-type	29.2	34.0	38.0	40
Crystal-can	24.5	26.0	31.0	32
High-sensitivity	13.0	15.0	18.0	22
Reed	25.5	28.1	30.9	38
Stepping and impulse	12.0	12.2	10.0	10
Time-delay	10.0	15.0	20.0	30
Solid-state	9.0	13.0	18.0	35
Other	85.0	95.0	102.0	120
Resistors, total	382.0	404.7	418.6	435
Fixed, total	191.1	198.6	203.0	204
Composition	70.0	74.7	73.0	62
Deposited-carbon	13.8	12.0	12.0	12
Metal-film	54.8	55.9	58.0	67
Wirewound	52.5	56.0	60.0	63
Variable resistors, total	139.5	147.9	152.6	159
Wirewound, precision	18.6	18.1	17.5	16
Wirewound, nonprecision	10.0	11.5	11.5	12
Wirewound, trimmers	22.0	21.8	21.8	22
Non-wirewound, precision	9.0	10.5	10.5	11
Non-wirewound, nonprecision	52.9	58.0	60.3	63
Non-wirewound, trimmers	27.0	28.0	31.0	35
Other resistors (including varistors and thermistors)	18.9	19.2	20.0	22
Resistive networks, thin- and thick-film	32.5	39.0	43.0	50
Switches, total	216.2	254.7	281.6	339
Small-movement snap-action	38.0	42.0	44.0	50
Lighted	30.0	33.8	37.0	46
Push-button	17.0	25.0	27.5	33
Toggle	28.0	30.0	33.0	35
Slide	10.0	14.5	15.1	18
Rotary	32.7	33.2	33.2	33
Coaxial	10.0	10.2	10.8	13
Thumbwheel	11.5	12.5	13.5	16
Keyboard, single-key	10.0	12.5	14.8	17
Keyboard, assemblies	29.0	41.0	52.7	78
Transducers, total	70.2	77.2	83.3	101
Pressure	23.0	26.5	29.2	36
Position	9.5	10.7	11.8	16
Strain	17.9	18.3	19.0	20
Acceleration	8.5	8.9	9.7	13
Other	11.3	12.8	13.8	16
Wire and cable, total	401.4	444.0	467.5	523
Coaxial cable	99.5	113.0	119.8	124
Flat and flexible cable	14.9	18.5	19.6	29
Hook-up wire	99.0	103.5	107.6	118
Magnet wire	85.0	90.0	94.0	99
Multiconductor, shielded	49.0	59.0	60.5	68
Multiconductor, unshielded	54.0	60.0	66.0	85

(millions of dollars)	1972	1973	1974	1977
SEMICONDUCTORS, TOTAL	1,524.1	2,017.7	2,324.5	3,128
Discrete, conventional devices, total	557.9	616.0	626.4	625
Transistors, total	353.8	415.2	428.7	437
Silicon bipolar, total	293.8	353.2	364.2	372
Small-signal (< 1-W dissipation)	167.4	191.8	186.9	127
Power (≥ 1-W dissipation)	126.4	161.4	177.3	245
Germanium bipolar, total	34.5	30.0	28.0	16
Small-signal (< 1-W dissipation)	12.5	10.0	9.0	5
Power (≥1-W dissipation)	22.0	20.0	19.0	11
Field-effect	25.5	32.0	36.5	49
Diodes and rectifiers, total	204.1	200.8	197.7	188
Signal, total	53.1	48.3	43.8	31
Germanium	5.1	4.3	3.8	1
Silicon	48.0	44.0	40.0	30
Zener, total	44.5	45.5	46.5	51
Voltage regulator	36.0	36.5	37.0	39
Reference	8.5	9.0	9.5	12
Rectifiers, total	106.5	107.0	107.4	106
Silicon	79.6	82.0	84.4	90
Selenium, copper-oxide	10.9	11.0	10.0	7
Rectifier assemblies	16.0	14.0	13.0	9
Discrete, special devices, total	121.0	136.3	146.1	168
Thyristors (SCRs, 4-layer diodes, etc.)	58.6	70.0	75.6	83
Tunnel diodes	4.0	4.0	3.6	2
Microwave diodes, total	16.3	17.4	19.1	27
Avalanche	0.5	0.5	0.6	3
P-i-n	4.5	5.0	5.5	7
Gunn	0.8	0.8	1.3	3
Varactor	6.8	7.3	7.7	9
Mixer and detector	3.7	3.8	4.0	5
Microwave transistors	9.5	11.9	14.8	22
Tuner varactors (< 1 GHz)	8.0	8.0	8.0	8
Multiple devices (duals, diode arrays, Darlingtons, etc.)	19.6	20.0	20.0	21
Other special devices (temperature-sensing, strain-gage, etc.)	5.0	5.0	5.0	5
Integrated circuits, total	699.6	1,080.6	1,332.0	1,969
Digital logic, total	460.8	675.4	818.9	1,148
RTL	5.0	4.0	3.5	2
DTL	64.0	55.0	47.5	31
TTL	204.2	308.4	380.8	397
ECL	33.0	38.0	39.6	80
C-MOS and other MOS	154.6	270.0	347.5	638
Semiconductor memory, total	92.1	179.0	240.1	468
Read-only (incl. programable), total	36.1	46.4	56.3	102
Bipolar	18.0	21.9	28.7	65
MOS	18.1	24.5	27.6	37
Random-access, total	35.9	106.8	152.8	327
Bipolar	11.7	37.8	57.0	126
MOS	24.2	69.0	95.8	201
Shift registers, total	20.1	25.8	31.0	39
Bipolar	0.1	0.8	1.0	3
MOS	20.0	25.0	30.0	36
Other digital functions (calculator, decoder, etc.)	19.6	60.0	80.0	100
Analog ICs, total	127.1	166.2	193.0	253
Op amps	40.0	47.6	51.3	68
All other, total	87.1	118.6	141.7	185
Industrial types	27.5	35.6	37.0	48
Communication types	15.0	25.0	31.0	40
Consumer types	21.0	29.0	38.0	42
Interface types	23.6	29.0	35.7	55
Optoelectronic devices, total	39.8	59.8	72.0	112
Photovoltaic (solar) cells	7.0	7.2	7.4	9
Photoconductive cells	5.0	4.5	4.4	4
Light-emitting diodes	8.0	18.0	25.0	37
Photodiodes (including arrays)	3.5	4.5	5.5	10
Phototransistors (including arrays)	7.5	10.0	10.8	14
Couplers and isolators	5.3	11.6	13.5	25
Silicon targets	3.5	4.0	5.4	13
Multicomponent or hybrid circuits, total	105.8	125.0	148.0	254

A McGraw-Hill Publication
Electronics

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)

	1972	1973	1974	1977
INDUSTRIAL AND COMMERCIAL, TOTAL	14,928.8	17,747.0	20,254.4	23,849
Test and measuring instruments, total	1,178.9	1,315.6	1,456.0	1,876
Non-microwave instruments, total	725.2	806.1	890.5	1,137
Spectrum analyzers	19.0	21.0	22.0	30
Frequency synthesizers	20.3	22.7	24.6	32
Function generators	8.3	9.2	10.4	14
Signal generators	26.0	27.7	28.0	30
Sweep generators	7.9	9.0	10.0	13
Pulse generators	10.1	11.5	12.9	17
Oscillators	2.8	3.1	3.5	4
Waveform analyzers and distortion meters	9.0	10.0	12.0	15
Counters, time and frequency	27.8	32.1	32.6	39
Panel meters, total	29.5	31.0	35.0	42
Analog	20.0	19.0	19.5	17
Digital	9.5	12.0	15.5	25
Noise-measuring equipment	2.7	3.0	3.1	4
Analog voltmeters, ammeters and multimeters	16.8	17.0	17.5	17
Digital multimeters, total	37.0	40.8	46.2	56
≤3 ½ digit	11.9	14.4	17.1	22
≥4 ½ digit	25.1	26.4	29.1	34
Calibrators and standards, active and passive	8.0	10.1	10.6	14
Oscilloscopes, total	158.0	174.7	188.7	238
Oscilloscopes, non-plug-in	80.3	92.5	99.9	126
Oscilloscopes, plug-in, main frame only	59.5	62.3	66.7	82
Oscilloscope accessories and plug-ins	18.2	19.9	22.1	30
Recording instruments, total	115.0	122.6	128.5	146
Magnetic-tape	51.8	55.3	57.0	63
Strip-chart	47.2	49.8	52.0	58
X-Y	16.0	17.5	19.5	25
Automatic test equipment, total	108.5	133.3	167.3	265
IC testers	59.5	76.3	97.0	138
Component testers	4.0	4.5	5.3	7
Pc-board testers	45.0	52.5	65.0	120
Manual component-test equipment	3.9	4.0	4.2	5
Power supplies, lab and industrial type	75.5	80.5	86.0	95
Amplifiers, total	31.1	33.8	37.4	45
Lab type	7.0	9.0	10.1	12
Signal conditioners	24.1	24.8	27.3	33
Phase-measuring equipment	8.0	9.0	10.0	16
Microwave instruments, total	108.5	118.7	129.3	164
Phase-measuring	14.8	16.0	18.0	23
Impedance-measuring	9.5	10.5	11.5	15
Power-measuring	4.3	4.7	5.2	7
Computerized automatic microwave-measuring	5.5	7.0	8.5	15
Spectrum analyzers	17.1	18.7	20.4	26
Wavemeters	1.1	1.0	0.9	1
Frequency counters	7.0	7.9	8.9	12
Noise-measuring	1.6	1.8	1.8	2
Signal generators	12.4	12.8	13.1	15
Sweep generators	16.5	19.0	20.8	26
Microwave modulators	1.0	1.0	1.0	1
Field intensity meters and test receivers	6.0	6.3	6.8	8
Antenna-pattern-measuring	5.5	5.7	5.9	6
Oscillators	6.2	6.3	6.5	7

	1972	1973	1974	1977
Analytical instruments, total	345.2	390.8	436.2	575
Chromatographs, total	48.2	55.1	63.1	87
Gas	38.8	42.0	45.5	55
Liquid	9.4	13.1	17.6	32
Spectrophotometers, total	121.5	135.8	148.6	201
Infrared	37.0	38.5	40.6	46
Ultraviolet—visible	54.5	58.3	62.0	73
Atomic absorption	20.0	24.0	26.0	54
Others	10.0	15.0	20.0	28
Mass spectrometers	19.5	21.8	26.0	32
Nuclear magnetic resonance spectrometers	24.0	27.0	30.0	38
Electron microscopes	14.0	15.5	17.0	22
pH meters and ion-selective electrodes	14.0	15.2	16.5	20
Spectrofluometers	9.0	12.0	14.0	17
Spectropolarimeters	4.0	5.0	5.9	8
Thermal analyzers, total	6.0	8.4	10.1	15
Differential thermal analyzers	2.0	4.0	5.0	8
Thermogravimetric analyzers	0.8	0.9	1.1	1
Differential scanning calorimeters	3.2	3.5	4.0	6
X-ray analysis equipment	25.0	30.0	35.0	50
Other, analyzers, colorimeters, photometers	60.0	65.0	70.0	85

(millions of dollars)

	1972	1973	1974	1977
Data-processing systems, peripherals, office equipment, total	10,463.2	12,445.0	14,181.1	18,447
Data-processing systems, total	5,575.0	6,605.0	6,938.0	8,120
Mini (< $50K)	350.0	420.0	513.0	925
Small ($50K–$420K)	620.0	685.0	710.0	1,120
Medium ($420K–$840K)	675.0	1,600.0	1,400.0	1,200
Medium/communication ($840K–$1,680K)	1,980.0	1,390.0	1,410.0	1,000
Large ($1,680K–$3,360K)	1,000.0	1,500.0	1,700.0	2,200
Giant (> $3,360K)	950.0	1,010.0	1,200.0	1,675
Add-on memory, total	275.0	325.0	415.0	800
Core systems	190.0	175.0	165.0	125
Semiconductor systems	85.0	150.0	250.0	675
Data-storage devices, total	1,817.0	2,149.0	2,752.0	3,880
Disk	875.0	1,000.0	1,160.0	1,810
Drum	90.0	103.0	119.0	80
Magnetic tape	800.0	985.0	1,400.0	1,900
Magnetic tape and disk cassettes	52.0	61.0	73.0	90
Input/output peripherals, total (shipped independently of systems)	945.0	1,133.0	1,312.0	1,902
Card read/punch	165.0	230.0	260.0	380
Line printers, impact	409.0	460.0	524.0	786
Line printers, non-impact	11.0	10.0	21.0	48
Computer input/output microfilm	28.0	35.0	40.0	50
Optical character readers	238.0	285.0	350.0	525
Magnetic-ink character readers	35.0	37.0	38.0	20
Electromechanical plotters	42.0	48.0	50.0	48
Paper-tape devices	17.0	22.0	29.0	45
Key entry, total	514.0	518.0	550.0	436
Key punch/verify	325.0	295.0	265.0	138
Key-to-tape	110.0	108.0	95.0	58
Key-to-disk	59.0	75.0	110.0	90
Keyboard-to-cassette/cartridge	20.0	40.0	80.0	150
Data terminals, total	626.0	805.0	966.0	1,374
Keyboard printers	220.0	275.0	268.0	275
Video terminals	165.0	225.0	245.0	260
Remote batch/intelligent terminals	200.0	255.0	375.0	650
Interactive graphic terminals	35.0	42.0	68.0	175
Audio-response	6.0	8.0	10.0	14
Source data collection equipment, total	160.0	230.0	420.0	820
Point-of-sale systems	100.0	130.0	265.0	510
Industrial data collection systems (badge readers, portable units)	50.0	65.0	70.0	85
Other	10.0	35.0	85.0	225
Office equipment, total	551.2	680.0	828.1	1,175
Calculators, total	330.5	383.0	438.0	595
Programable	155.5	188.0	228.0	330
Non-programable	175.0	195.0	210.0	265
Dictation equipment	82.0	90.0	98.0	130
Facsimile	53.7	64.0	74.1	125
Electronic typesetting	80.0	125.0	176.0	205
Other	5.0	18.0	42.0	60

	1972	1973	1974	1977
Industrial electronic equipment, total	889.5	1,079.5	1,271.2	1,712
Motor controls (speed, torque)	90.3	100.5	106.5	127
Numerical controls, total	39.2	49.0	59.8	90
Point-to-point systems	11.3	13.9	15.6	25
Contouring systems	27.9	35.1	44.2	65
Inspection systems, total	23.2	24.6	26.7	37
Ultrasonic test equipment	9.0	9.7	10.0	12
X-ray test equipment	14.2	14.9	16.7	25
Thickness gages and controls, total	45.4	58.0	62.3	102
Photoelectric gages and control	33.0	43.0	44.2	75
Radiation-based	12.4	15.0	18.1	27
Data-acquisition systems	56.0	92.3	140.0	172
Electronic process controllers (temperature, pressure, flow, etc.)	30.6	35.6	40.3	49
Electronic process recorders and indicators (temperature, pressure, flow, etc.)	58.2	60.0	62.0	64
Program sequence controllers	13.0	21.3	31.8	76
Ultrasonic cleaning equipment	11.6	13.1	14.6	20
Pollution-monitoring equipment	14.0	17.0	19.9	28
Power supplies, complete equipment	100.0	150.0	185.0	210
Power supplies, OEM type	90.0	98.5	108.0	135
Induction and dielectric heating and sealing equipment	25.5	27.6	28.3	34
Industrial process-control computer systems, total	292.5	331.5	386.0	568
Digital	250.0	290.0	343.0	516
Analog	42.5	41.5	43.0	52

(millions of dollars)

	1972	1973	1974	1977
Communications equipment, total	1,743.7	2,068.2	2,380.5	3,076
Radio, total	623.5	680.2	718.4	801
Aviation mobile (including ground support systems)	113.0	115.0	115.0	120
Marine mobile (including shore stations)	19.2	24.1	20.0	23
Land mobile (including base stations)	300.2	324.3	360.0	405
Microwave relay (including cable systems, both specialized and common carriers)	170.0	194.8	200.0	225
Amateur	11.2	11.5	11.9	13
Citizens' band	9.9	10.5	11.5	15
Navigation systems	131.0	136.2	140.4	158
A-m and fm station equipment	19.2	19.6	19.0	22
TV-station equipment (except CATV)	150.3	155.6	160.0	167
Telemetry (industrial only)	47.1	50.0	55.5	64
Switching systems (including PABX)	180.0	225.0	260.0	350
Voice terminals (autodialers, autorecorders, etc.)	2.0	4.0	6.0	20
Paging systems	20.4	22.0	25.0	30
Intercoms	120.0	130.0	138.0	150
Nonbroadcast TV equipment, total	144.2	184.3	225.6	368
CATV, total	108.2	144.4	181.5	310
Studio and head-end	21.3	26.0	31.3	57
Distribution	55.2	69.8	89.0	151
Transmission lines and fittings	22.2	31.3	38.8	60
Converters	9.5	17.3	22.4	42
CCTV, total	36.0	39.9	44.1	58
Cameras	20.2	22.6	25.3	36
Monitors	6.8	7.3	7.8	9
Auxiliary	9.0	10.0	11.0	13
Video recorders and playback units (non-consumer)	15.2	16.3	18.6	21
Data-communications equipment, total	290.8	445.0	614.0	925
Modems	40.0	45.0	49.0	57
Remote concentrators	45.3	65.0	110.0	240
Message-switching systems	60.0	85.0	135.0	220
Front-end communications processors	115.0	210.0	270.0	328
Multiplexers	30.5	40.0	50.0	80

	1972	1973	1974	1977
Medical equipment, total	524.6	607.3	673.9	871
Diagnostic equipment, total	380.7	427.5	468.7	571
X-ray equipment	245.0	279.5	307.5	382
Electroencephalographs	8.5	9.3	10.3	13
Electrocardiographs	16.3	17.6	19.0	24
Ultrasonic scanners	3.4	3.8	4.3	7
Automated blood analyzers	65.5	70.8	76.5	85
Scintillation cameras and counters	32.0	34.5	36.6	42
Audiometers	10.0	12.0	14.5	18
Prosthetic equipment, total	94.7	122.1	140.5	209
Hearing aids	50.8	61.8	65.8	74
Pacemakers	43.0	58.5	72.5	130
Motorized limbs	0.9	1.8	2.2	5
Therapeutic equipment, total	35.3	45.4	47.3	66
X-ray equipment	17.0	22.0	24.6	34
Diathermy, shortwave and microwave	5.4	5.9	6.4	9
Ultrasonic generators	7.0	7.7	8.5	11
Defibrillators	5.9	6.8	7.8	12
Surgical support equipment	13.9	15.3	17.4	25

	1972	1973	1974	1977
Nuclear instruments and equipment, total	28.9	33.4	37.7	57
Nuclear spectrometers	11.3	12.2	12.6	15
Reactor controls	9.3	11.1	13.3	23
Radiation-detection and-monitoring equipment, total	8.3	10.1	11.8	19
Detectors (including ion equipment)	4.6	5.5	6.2	9
Monitors, portable and fixed	1.3	1.6	2.1	5
Personal dosimeters	2.4	3.0	3.5	5

	1972	1973	1974	1977
Lasers and equipment, total	34.8	41.3	49.3	75
Gas lasers	13.5	15.8	18.5	34
Semiconductor lasers	1.7	2.1	2.7	6
Other (including ruby, neodymium-doped, etc.)	12.0	15.0	18.5	20
Laser power supplies	5.8	6.4	7.2	10
Modulators	1.8	2.0	2.4	5

	1972	1973	1974	1977
Automotive electronics, total	65.2	154.2	204.7	617
Voltage regulators	42.0	44.1	44.8	45
Anti-pollution systems	10.0	20.0	35.0	98
Electronic ignition systems	12.2	28.0	48.0	90
Fuel-injection systems	1.0	1.5	3.0	80
Safety systems, total	—	60.6	73.9	304
Anti-skid controls	—	5.0	25.0	148
Air-bag sensors and controls	—	0.6	5.9	100
Seat-belt interlocks	—	55.0	42.0	16
Radar collision-avoidance systems	—	—	1.0	40

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EI-1

Ac-coupled gas-discharge display multiplexes digits with message blocks

Elaborate multiplexing and addressing circuitry normally needed to combine elements of very different sizes in one display panel is unnecessary with gas-filled cells that are capacitively coupled

by W. E. Coleman, *National Electronics Inc., a Varian division, Geneva, Ill.*

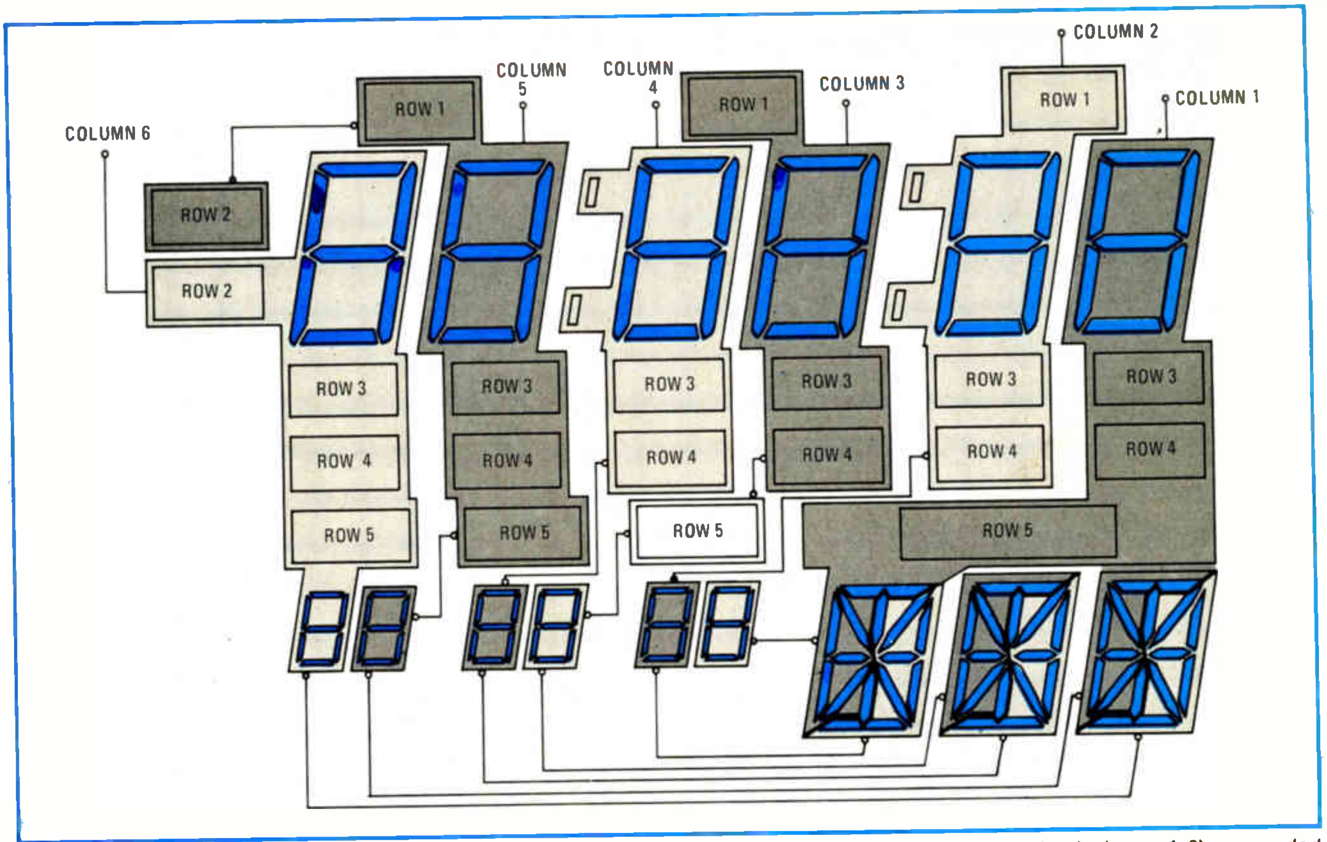
☐ Displays requiring mixtures of numerics, alphanumerics, and fixed messages, though increasingly to be found in automobiles, point-of-sale equipment, and other applications, have been hard to build simply and therefore inexpensively. But a newly developed ac-coupled gas-discharge panel has fewer design complications than arise in designing multiformat displays with the other options available—dc discharge panels, liquid crystals, or panels based on two or more technologies (see "Three multiformat alternatives," p. 125).

The new panel, called "Plasmac," can be as large as 8 by 15 inches or as small as 1 by 3 in. It is uniformly bright over large and small areas alike, so that segmented numeric and alphanumeric characters anywhere from 0.4 to 5 in. high can be displayed alongside large blocks, typically 1 by 0.375 in., for backlighting filmstrip fixed messages (Fig. 1).

The ac coupling is achieved by lining the front and back of each gas-filled display element with a dielectric. When voltage is applied across the element, almost all of it appears across the gas since its capacitance is much smaller than the dielectric capacitance. Any tendency for a few display elements to hog current and for the whole display therefore to light nonuniformly is prevented since the current-limiting element—the dielectric layers functioning as series capacitors—is internal to the display element itself. Consequently, elements of very different sizes appear uniformly bright and can also be driven in parallel. This keeps the addressing and drive circuitry simple (Fig. 2).

Other advantages of the display include: a choice of colors, depending on the gas used; relatively high power-conversion efficiency—on average about 0.5 lumen per watt—as well as considerable temperature insensitivity and long life, because the electrodes are protected by the dielectric layers from degradation by

1. Uncomplicated. A single ac-coupled gas-discharge panel for a digital calendar clock incorporates elements of different sizes—numerals 0.5 and 1.25 in. high, 1 in.-high letters, and various blocks that backlight such messages as AM, PM, etc. Note uniform brightness of display.



2. Simple addressing. Diagram of internal bussing of panel in Fig. 1 shows that only six front-plate electrodes (columns 1-6) are needed, each of which links two digits, a letter, and several fixed messages. Rear-plate electrodes link similarly labelled display elements (R_1, R_2, etc.) in rows. (For the sake of simplicity, those row lines necessary for linking identical segments of numerals and letters are omitted.)

direct contact with the gas (again, see "Three multiformat alternatives," p. 125).

In construction, the display panel is a sandwich of the two coated glass plates, separated by gas-filled gaps (Fig. 3). On the inner surface of each plate is a conductor pattern, transparent on the front plate, achieved by etching away a conductive coating. Overlaying the conductor pattern is an intact dielectric layer—transparent for the front plate so as to be seen through, and black for the back plate, to enhance contrast. And overlaying each intact dielectric layer is another dielectric layer, black and with portions removed to define display areas (segments, symbols, and so on). These two innermost dielectric layers actually mate with each other, turning each display element into a separate cell and acting as shim spacers between the plates.

Electrically, each cell or display element functions as three capacitors in series—the transparent front dielectric layer, the gas-filled cavity, and the intact black dielectric layer on the back glass plate. The capacitance of each solid dielectric is typically 100 times greater than the capacitance of the gas—generally in the range of 5,000-8,000 picofarads per square inch as against 10-20 pF/in.^{2}

Voltage applied across the cell at first appears almost entirely across the gas. As it increases, the gas becomes ionized, light is emitted, and current flows across the cavity, charging the dielectric layers on either side. At this point, the voltage drop across two layers begins to increase at the expense of the drop across the cavity, until the field across the gas is no longer enough to keep it ionized. The voltage at which the gas starts ionizing is called the firing voltage, and the one at which ionization stops is called the extinguishing voltage.

The voltage pulses applied to light such a display element may be either unipolar or bipolar. Each have advantages that prove useful for different applications (see "Types of firing voltage," p. 127).

When an ac-coupled panel is intended for multiplexing and therefore has the display elements wired up in rows and columns, short sequences of voltage pulses are applied to each column in turn. The columns are scanned fast enough for any lit element to appear continuously lit to the eye.

Easy addressing

Since each row or column in a multiplexed ac-coupled panel consists of capacitively-coupled elements operated in parallel, current divides among them as among capacitors in parallel—that is, according to area. As a result, large message blocks and tiny digit segments achieve the same average current density and hence the same brightness, and they can be bussed together in whatever groupings make for simplest and most economical addressing circuitry.

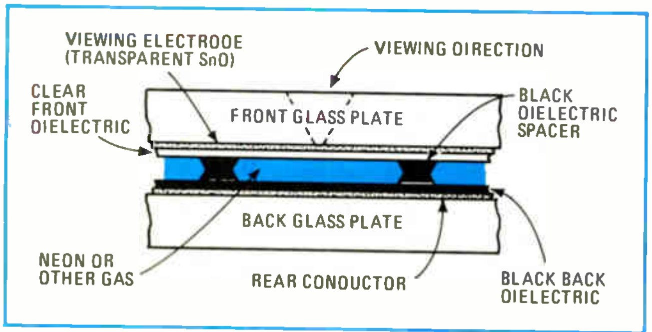
Take, for example, a display consisting of 10 numeric and 40 message blocks. Each digit is composed of eight segments and has its own address line. Identical segments in each digit are bussed together. If the digits are strobed in sequence at a 1/10th duty cycle rate, only 18 lines are needed for 10 digits. The 40 message blocks are arranged in a matrix of four rows and 10 columns.

Now, since the same driver can scan a digit and a column, only 22 address lines need come out of the panel—10 lines for columns and digits and 12 lines for the eight segments and the four rows of message blocks.

Other bussing arrangements are easily achieved. The above example could take the form of an eight-by-15 matrix and be scanned at a 1/15th duty cycle—an arrangement that requires 23 address lines. Although an additional driver is required, economies could result in the logic organization of the display system.

This type of arrangement would not be practical in a dc panel, because there the message blocks and segments would be of significantly different brightnesses. This occurs because the same external current-limiting resistor would have to be used for both a segment that was small in area and a message block with a large area. Other problems would be current hogging in a large message block or between two display elements in parallel, rising out of nonuniform emission from the cathode surface. Consequently, the message blocks in a dc panel would have to be handled separately from the digit segments, and the display would require many more address lines.

The simple addressing of the ac panel goes hand in hand with straightforward multiplexing. For simplicity's sake, consider a two-by-two array of four display elements (Fig. 4). In this array, the top left and bottom right elements are lit and are called full-select elements; the other two are unlit but because they are on the same driver as full-selected elements, they have some voltage across them and are called half-select elements.



3. Construction. Each display element is a gas-filled cavity defined by dielectric spacers that separate the front and back plates of a display panel. Generally, the front electrodes link elements into columns, whereas the rear conductors link them into rows. Different gases can be used to give different colors.

Easy multiplexing

During a first short period of time, voltage pulses are applied simultaneously to the lefthand column and upper row and are combined at the toggle frequency from φ_A. As a result, the top lefthand display element sees a sequence of bipolar voltage pulses and will ignite for each pulse, so long as the applied voltage exceeds the firing voltage. During this same period of time, the half-select elements ignite once, as long as the half-select voltage is less than the unidirectional firing voltage, and not again. This single firing of the half-select elements is too short to be visible to an observer. Many firings are necessary before the element appears lit.

During the second short time period, voltage pulses are applied to the righthand column and the bottom row, so that the bottom right element is full-select and the same two elements as before are half-select. However, this time they do not fire, since the voltage pulse they see has the same polarity as the unipolar pulse that caused their first ignition. Even when the righthand column is scanned again, the half-select elements will not fire since they always see the same-direction unipolar pulse.

For proper operation, the applied-voltage input (+V in Fig. 4) must be set so that it is above the highest firing voltage required by any element in the panel and below the lowest unidirectional firing voltage of any panel element. Typically, the first is 130 v and the second is 190 v. This gives an operating range of about 60v.

There are other multiplexed schemes where the row half-select pulses and the column half-select pulses are in opposite directions. In these schemes, the half-select

Three multiformat alternatives

Although complex displays often look attractive and are growing in popularity, designers pay a heavy premium for using them. Up till now, there have been three main commercially useful options.

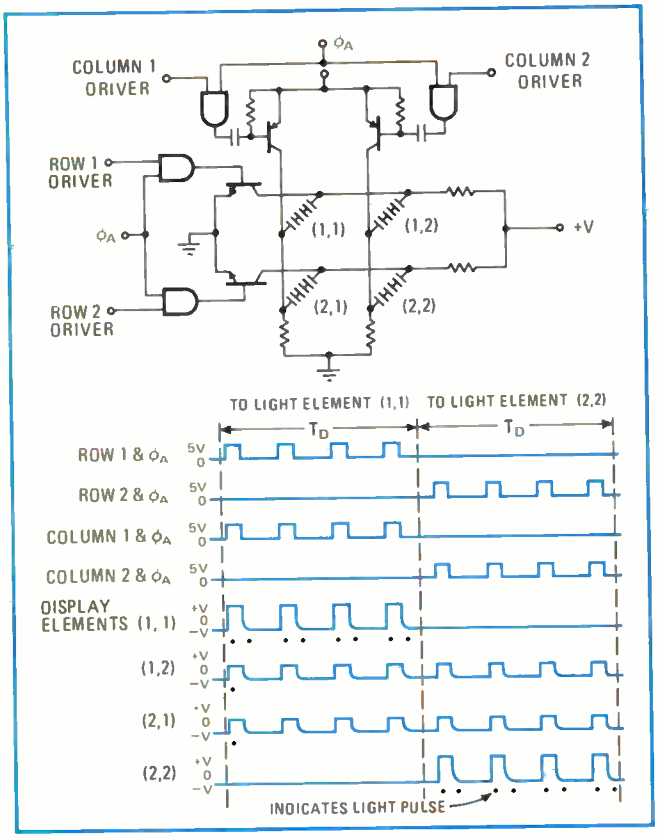
A panel may combine a number of different technologies—for example, it may combine LED digits, dc discharge alphanumerics, and backlit incandescent fixed messages. Such a display, however, requires three separate sets of multiplexing, addressing, and power-supply circuitry, as against the ac-coupled gas-discharge panel's single set, so that reliability rapidly falls and cost rises.

Multiformat liquid-crystal displays, on the other hand, turn on and off so slowly that they require elaborate multiplexing. They also have memory effect that, in multiplexed units, leads to character "blooming" or smearing.

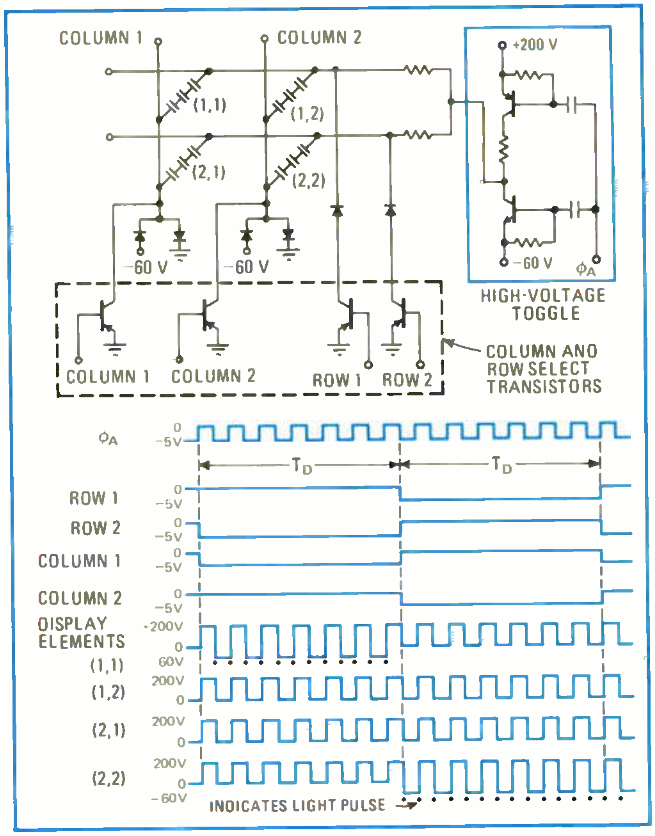
Finally, unlike a discharge device, they tend to be vulnerable to disturbances in a half-select voltage (the voltage that should not be capable of firing a display element except when it is combined with a second half-select voltage).

In multiformat dc discharge displays, the variations in cathode surfaces and electrode spacing would give rise to current hogging and hot spots if these problems were not circumvented by complex drive and address circuitry. Multiplexing is more complex and has to include blanking since dc discharges have to be switched off as well as on—in other words, they are not self-limiting in the way ac discharges are.

Also in dc-discharge displays, the gas is in direct contact with the electrodes. Eventually, the gas discharge may begin sputtering off the cathode and the display begins to fail. This is especially liable to happen at temperature below 0°C, where sputter inhibitors stop working, and is the main reason why dc-discharge displays are not to be found in automobiles.



4. Simple multiplexing. In the drive scheme for two-by-two matrix, input from the same clock (ϕ_A) is used for both row drivers and column drivers. Dots under waveform indicate when element fires and emits light. Since columns are strobed alternately, for a period called column dwell time (T_D), this scheme has a 50% duty cycle.



5. Unidirectional drive scheme. In this scheme low-voltage transistors (0- to −60 V) are used to address the row and column lines. However, one high-voltage toggle driver (−60 V to 200 V) is required for the entire matrix regardless of size. Also, circuit requires input from clock ϕ_A at only one point, instead of two.

elements will ignite twice each time a column is completely scanned.

Brightness is controlled by a clock or toggle frequency as well as the duty cycle. Suppose the brightness of a display element to be 40 foot-lamberts at 10 kilohertz and 100% duty cycle with an applied voltage of 170 v. Then if the clock frequency is 100 kHz across 10 columns (that is, the duty cycle is 1/10), the display element sees an equivalent frequency of 10 kHz and has a brightness of 40 fL.

Although resistive pullups and pulldowns are shown in Fig. 4, they are impractical for large display elements, which require high peak current. Instead, for digits more than 0.5 in. high, active pullups and pulldowns should be used. In one common active pullup and pulldown scheme, diodes replace resistors, and there is one common pull-up transistor for the rows and one common pulldown transistor for the columns. This provides a low-impedance path to ground or to supply voltage.

A unidrive scheme

In the drive schemes described above, the column and the row lines go from a positive voltage to 0 v and back, where the positive voltage is 130 to 180 v. In addition, a means of combining or ANDing the toggle frequencies on each row and column intersection had to be developed.

Overcoming these difficulties is a unidirectional firing-voltage drive scheme (the unidrive scheme). Shown in Fig. 5, the unidrive scheme allows low-voltage transistors to address the row and column lines and requires the toggle frequency to enter at one point only. It also requires only two high-voltage drive transistors for any size of array. (In Fig. 5, the same elements as before are full-select and half-select.)

To select a row, the row-select transistor is turned off, allowing that row to swing between −60 v and 200 v in phase with the toggling frequency. An unselected row has its transistor turned on, clamping it on the low side to ground instead of −60 v and making it swing between 0 and 200 v in phase with the toggling frequency. Conversely, to select a column, the column-select transistor turns on and clamps the line to ground, but an unselected column has its transistor turned off and swings between −60 v and 0 v.

The display element at the intersection of a selected row and selected column swings between −60 v and 200 v also in phase with toggling frequency. However, a half-select element sees only 200 v left after the −60 v in-phase swing of the row and column together. Thus, the unselected column subtracts −60 v from the −60-to-200-v swing of a selected row, so that the element sees 0-to-200-v swing from both the selected column and as unselected row.

For this setup, the minimum unidirectional firing voltage is 200 v, and the maximum is 260 v.

However, the resistor in series with each row limits the peak current across the gas during an element's discharge. But for maximum brightness the element needs a low-impedance path when it ignites. Here, too, therefore, the resistor can be replaced by a transistor. Such a unidrive scheme is used in the system diagramed in Fig. 6. The drive chip employed is produced by Electronic Arrays. The panel is the National Electronics 1253-12, which displays 12 0.4-in.-high digits.

When not to multiplex

Brightness of up to 400 fL can be achieved with nonscanned operation of the ac-coupled gas-discharge display. Such a display is readable in direct sunlight and can be used even on gas pumps and in cockpits.

A nonscanned display requires individual pinouts for each element area in the display. The drive configuration is very similar to the unidrive circuit. The common front electrode is connected to a high-voltage toggle driver, which swings it between -60 V and 200 V in phase with the toggle frequency. The element lines are held between -60 V and ground by diodes. To select a display element, an open-collector or open-drain transistor, with its collector or drain tied to the element's line, is turned on. An unselected element has its transistor turned off, allowing its line to swing between -60 V and ground in phase with the high-voltage toggle. In this manner, any selected element sees a swing of -60 V to 200 V while any unselected element sees a swing of only 0 to 200 V. Since the addressing pulse duty cycle is 100%, a brightness of 300–400 fL may be achieved with

Types of firing voltage

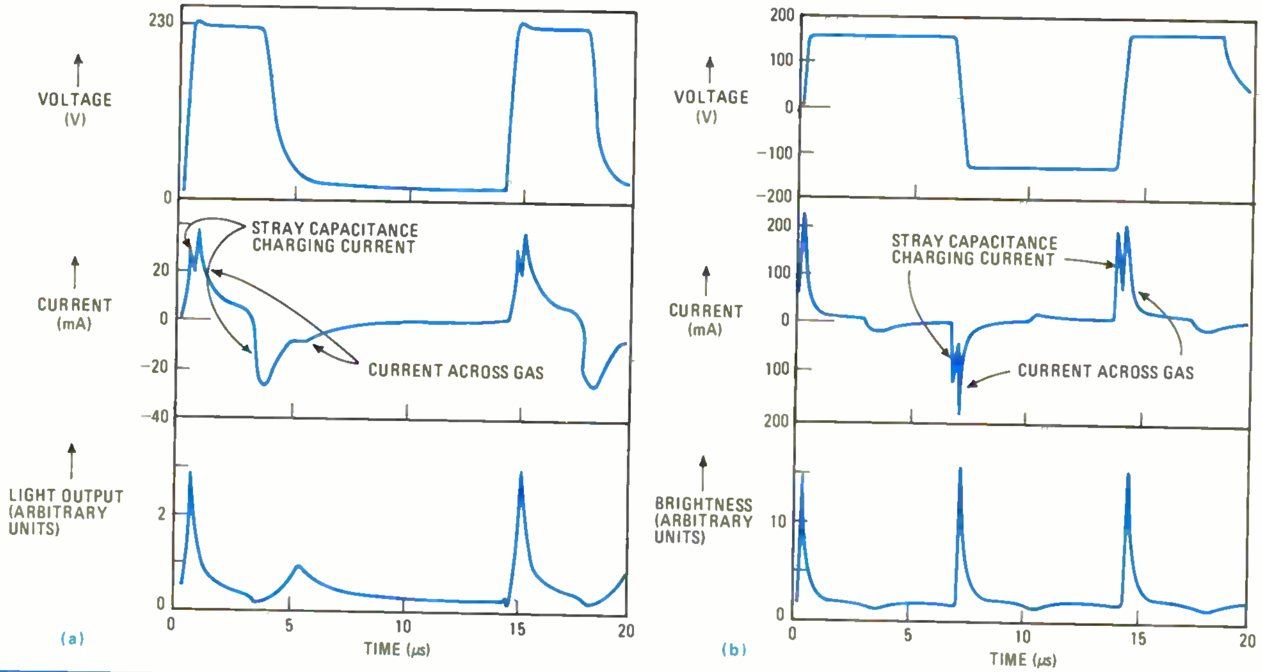
Understanding the ways in which the display elements in the ac-coupled gas-discharge panel can be fired will help the user in optimizing the multiplexing scheme for a particular application. Basically, each element can ignite in response to either a unipolar or a bipolar voltage pulse. The current and light responses to each are shown in Figs. A and B.

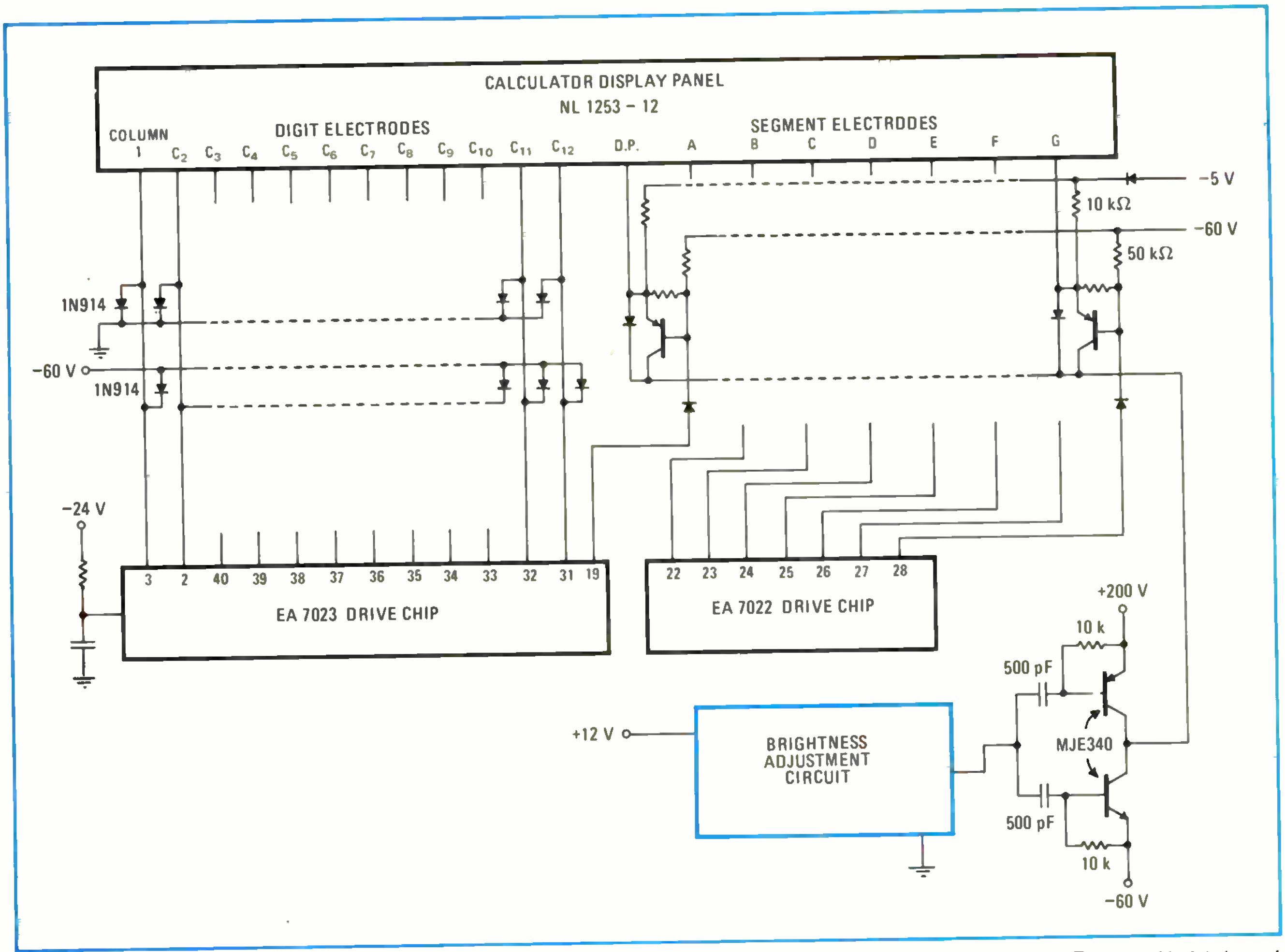
When a large enough unipolar pulse is applied, the element fires twice, the second discharge occurring because the charge stored in the dielectric capacitors gives rise to a field sufficient to ionize the gas when the applied voltage level returns to zero (Fig. A). The unidirectional firing voltage is in fact defined as the lowest voltage level at which the element fires twice per cycle—about 230 volts here. Since the stored charge supplies less current than the power supply, its output pulse current is lower.

When a bipolar pulse is used, however, the firing voltage can be lower—in the region of 130 V in Fig. B, when the pulse makes a direct transition from a minus to a plus value. Thus the voltage on either side of the gas capacitor swings from +130 to -130 volts. Peak current and peak brightness is higher because bipolar pulses force a more rapid charging and discharge of the dielectric layers than do unipolar pulses of the same voltage so that the field across the gas-filled cavity is stronger, the ionization is greater, and the light emitted at a given voltage level above the firing voltage is also brighter.

Also possible are indirect-transition bipolar pulses, which are alternately plus and minus in value but return to 0 V in the interval between pulses. Consequently, there is only an indirect transition from a minus to a plus voltage, with a slower over-all risetime (dv/dt) than that of the direct transition. Therefore, ionization is less, and the firing voltage is about 10–20 V more than for a direct-transition pulse. Also, less light is emitted at a given voltage level above the firing voltage.

Note that, in order to light a display element using the unidirectional method, the applied-voltage level is twice that required using the bipolar method. The voltage swing across the cell remains the same. For example, if a bipolar pulse swings between +130 V and -130 V as in Fig. B, the voltage seen by the element is 260 V, or roughly the same as the 230 V provided by the unipolar pulse swinging from 0 to 230 V in Fig. A.





6. Actuality. Calculator display system employs a unidirectional drive scheme and drive chip from Electronic Arrays. The panel is fabricated by National Electronics and displays 12 digits that are 0.4 in. high. Brightness is adjustable.

a toggle frequency of about 100 kHz. By adjusting this frequency, the brightness may be controlled over a wide range.

This may be seen by noting that the brightness is directly proportional to the number of pulses per second times the brightness per pulse. The brightness per pulse is in turn proportional to the charge flowing through the cell per discharge cycle, which for the bipolar firing scheme is given by:

$$Q = C_t(V_{app} - V_e)$$

where $C_t = C_fC_b/(C_f + C_b)$ and is the series capacitance of the front (f) and back (b) dielectric layers, V_{app} is the applied voltage, and V_e is the extinguishing voltage which remains across the cell after the discharge ceases.

If one light quantum is emitted by each charge, and the cell is fired F times per second, then the average brightness, B, equals

$$B = C_t(V_{app} - V_e)F$$

The energy supplied to the plasma cell per discharge, E_d, equals the applied voltage multiplied by the charge flowing, or

$$E_d = V_{app}I\Delta t$$

where I is the average current flowing through the plasma cell during time Δt. Taking this summation over a number of time increments and plasma cells, the average power conversion efficiency was found to be about 0.5 lumen/watt.

It should be pointed out that the ac-coupled gas-discharge technique is certainly not a panacea for all types of display requirements. It does require high voltage to operate. For purely numeric displays under 0.5 in. high, LEDs or dc panels will prove more cost-effective because of drive considerations. Where low voltage and low power are crucial, liquid-crystal displays, which do not generate any light of their own but merely vary the way in which they reflect ambient light, clearly will be the choice.

However, for complex displays, the ac-coupled gas-discharge technique has an edge because virtually the same circuitry needed to multiplex the numeric section can also be used to simultaneously drive the alphanumeric and fixed message sections. □

Closing the loop

Readers who are interested in finding out more about the Plasmac display may call author W. E. Coleman at (312) 232-4300 in the week of Jan. 14.

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GENERAL INSTRUMENT MICROELECTRONICS

Designer's casebook

Automatic gain control quells amplifier thump

by Paul Brokaw
Analog Devices Inc., Semiconductor Division, Wilmington, Mass.

If an audio amplifier with automatic gain control makes a thumping noise when the input signal level changes quickly, the cause may be unwanted feedthrough of the gain control signal to the amplifier output. A simple solution is the addition of a resistor to prevent variations in the control voltage from being fed through to the output.

In the "thumpless" agc circuit of (a), transistors Q_1 and Q_2 form a differential amplifier that has a gain determined by the emitter current of the pair, I_E. This emitter current varies the transconductance and therefore the gain of transistors Q_1 and Q_2. But if gain changes too quickly, a thump may be heard. Inserting resistor R_1 in the emitter-current control circuit eliminates the thump.

Emitter current I_E is made nearly equal to the current (I_2) flowing through resistor R_2 by using identical same-substrate transistors for Q_3 and Q_4. When the base-emitter voltages of these two devices are equal, their collector currents (I_E and I_2) are also equal.

Since the base and collector of transistor Q_4 are shorted together, this device's base-emitter voltage will rise until its collector current becomes equal to $(1 - 2/\beta)I_2$, where β is the common-emitter current transfer ratio. Since transistor Q_3 is identical to transistor Q_4, Q_3's collector current will also rise to the same value. If current transfer ratio β is large and the reverse voltage feedback ratio of the transistor is small, Q_3's collector current (I_E) will nearly equal resistor current I_2. The value of current I_2 is:

$$I_2 = (E_{control} - V_{B4})/R_2$$

where V_{B4} is the voltage at the base of transistor Q_4.

Because the collector currents of transistors Q_3 and Q_4 are approximately equal, the transconductance of the differential pair (transistors Q_1 and Q_2) will vary in direct proportion to the control voltage. If Q_1 and Q_2 are identical, emitter current I_E will divide equally between them. Each transistor will have a collector current of $\alpha I_E/2$, where α is the common-base current gain.

If α is approximately equal to 1 and I_E is approximately equal to I_2, the collector currents of transistors Q_1 and Q_2 become:

$$I_{C1} = I_{C2} \approx I_2/2$$
$$I_{C1} = I_{C2} \approx (E_{control} - V_{B4})/2R_2$$

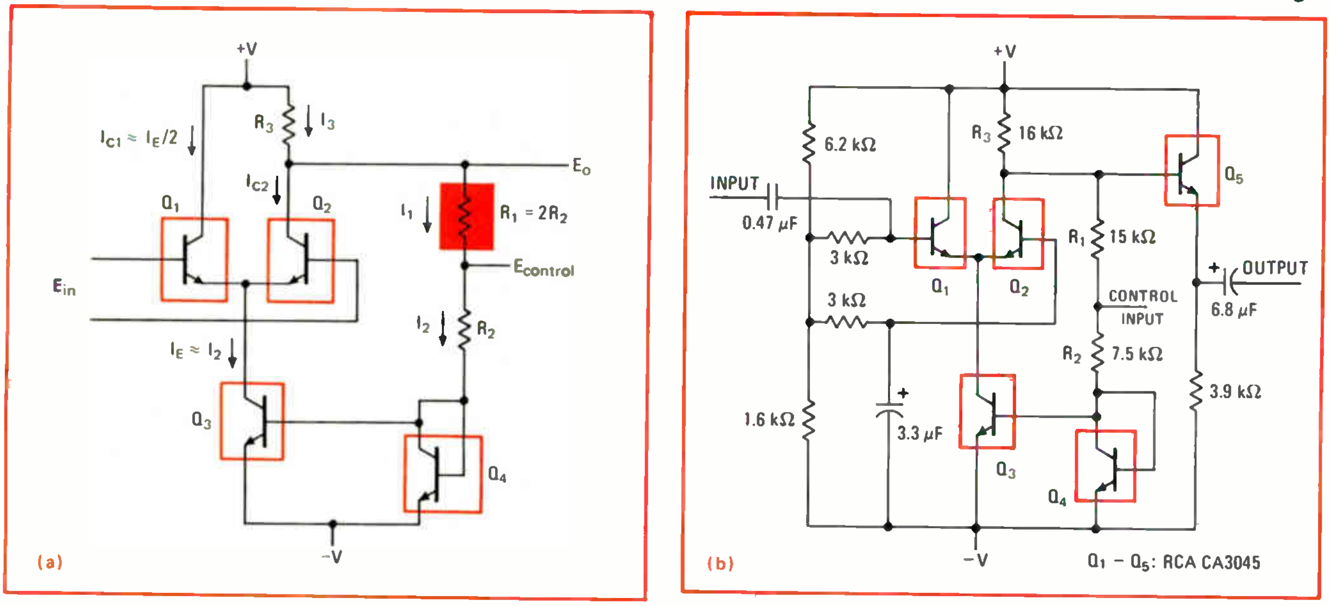
where I_{C1} is the collector current of transistor Q_1 and I_{C2} the collector current of transistor Q_2. The current (I_3) through resistor R_3 is due to both resistor current I_1 and collector current I_{C2}. Current I_1, which flows through resistor R_1, is given by:

$$I_1 = (E_o - E_{control})/R_1$$

Resistor current I_3 is the sum of collector current I_{C2} and resistor current I_1:

$$I_3 = I_{C2} + I_1$$
$$I_3 = \frac{E_o}{R_1} - \frac{V_{B4}}{2R_2} + \left(\frac{1}{2R_2} - \frac{1}{R_1}\right)E_{control}$$

If $R_1 = 2R_2$, the last term in this equation drops out, making current I_3 independent of the control voltage,



Improved agc. Automatic-gain-control circuit (a) for audio amplifier applications eliminates unwanted thumping that may be heard when the input-signal level changes abruptly. Resistor R_1 prevents sudden variations in the control voltage from reaching the output as an audible thumping. An audio amplifier using this agc scheme is shown in (b); amplifier gain is 30 for a control voltage of 15 volts.

except for a small contribution caused by the dependence of V_{B4} on $E_{control}$. Since the output voltage is proportional to resistor current I_3, and not to the control voltage, variations in the control voltage will not be fed through to the output.

To implement a complete audio amplifier (b) with agc requires only a single monolithic array of five matched transistors. Two transistor pairs are used as indicated in (a), while the fifth remaining transistor is used as an output signal buffer.

The base current error introduced by transistor Q_4 can be reduced by making resistor R_2 slightly less than what the half-value approximation calls for. If resistors R_1 and R_2 are made variable, the performance of the circuit can be optimized by adjusting them for minimum feedthrough. For the component values indicated, the amplifier's voltage gain is about 30 when the control voltage is 15 volts. Circuit gain is directly proportional to the control voltage minus V_{B4}. (Voltage V_{B4} can be approximated as 0.55 v.)

Naturally, amplifier performance is limited by component tolerances. With components having 5% tolerances, the feedthrough signal can typically be suppressed by 20 to 30 decibels. Tighter tolerances will, of course, improve feedthrough suppression, but at some point, the various approximations made (like neglecting the transistor base current error) will limit performance. For a large control voltage, amplifier gain becomes inversely proportional to absolute temperature. At room temperature, this variation in amplifier gain amounts to about 0.03 dB/°C, which is not objectionable for most automatic-gain-control applications. □

Transistor array cuts cost of algebraic inversion

by Pavel Ghelfan
M.G. Electronics Ltd., Rehovot, Israel

Monolithic operators for algebraic inversion are convenient, but a reliable algebraic inverter can be built quite simply and at less cost from an integrated five-transistor array and two operational amplifiers. The circuit first converts the input signal to a logarithmic equivalent and then takes the antilog of this.

The output voltage (V_L) of amplifier A_1 is a logarithmic function of the input current (I_{in}) and the current (I_R) that the transistor array sinks at pin 13:

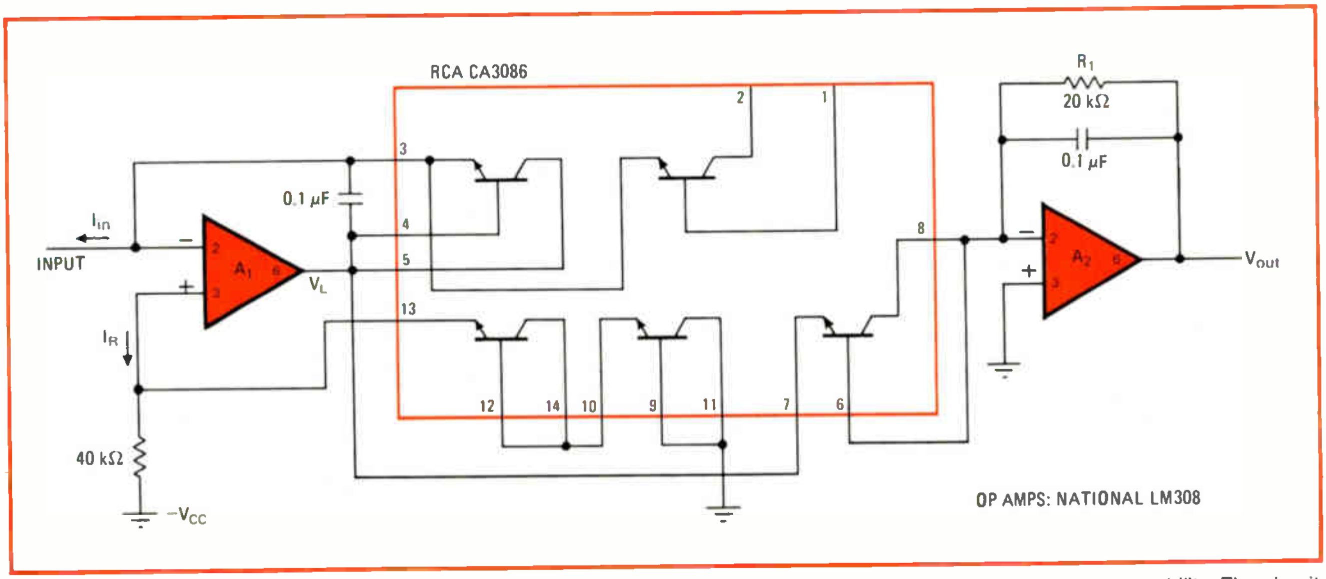
$$V_L = \frac{2kT}{q} ln\left(\frac{I_R}{I_{ES}}\right) - \frac{kT}{q} ln\left(\frac{I_{in}}{I_{ES}}\right) = \frac{kT}{q} ln\left(\frac{I_R^2}{I_{in} I_{ES}}\right)$$

where I_{ES} is the emitter saturation current (with collector shorted to base) of the array's transistors, k is Boltzman's constant, q is the charge of an electron, and T is absolute temperature. The antilogarithmic operation is performed by amplifier A_2. The circuit's output signal can be expressed as:

$$V_{out} = I_{ES} R_1 exp(qV_L/kT) = I_R^2 R_1 / I_{in}$$

Trimming the value of constant current I_{IR} will adjust the numerator of this equation so that the output voltage of the circuit is brought to the desired value and kept there.

This inversion operator maintains good stability over a 50°C temperature range, as well as over three decades of signal amplitude variation. Its amplitude range can be significantly broadened by using low-bias-current operational amplifiers. □



Taking the reciprocal. Algebraic inverter employs IC transistor array to keep costs low and to provide good temperature stability. The circuit converts the input signal to a logarithmic voltage and then takes the antilogarithm of this voltage to develop the output signal. The output, of course, is indirectly proportional to the input and can be brought to the desired value by adjusting resistor R_1.

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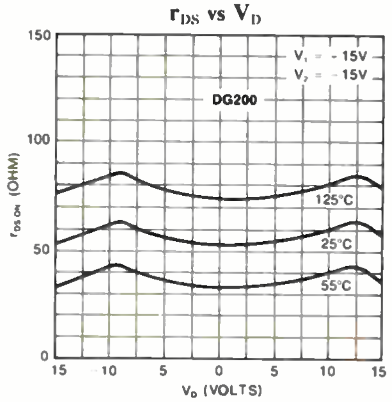

With supply voltage levels less than ±15V, the maximum analog signal always equals supply voltage.

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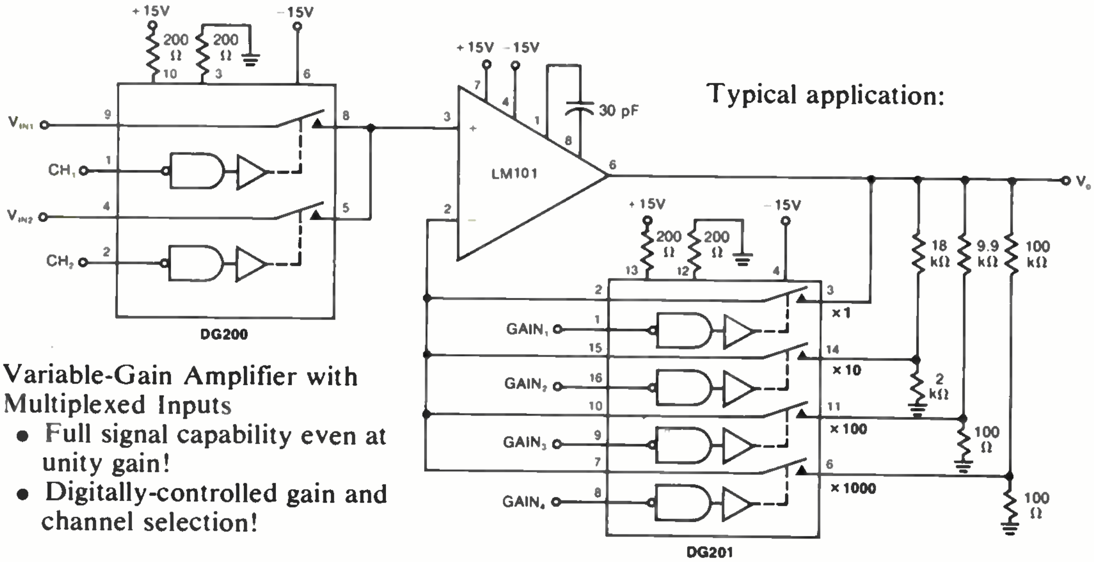

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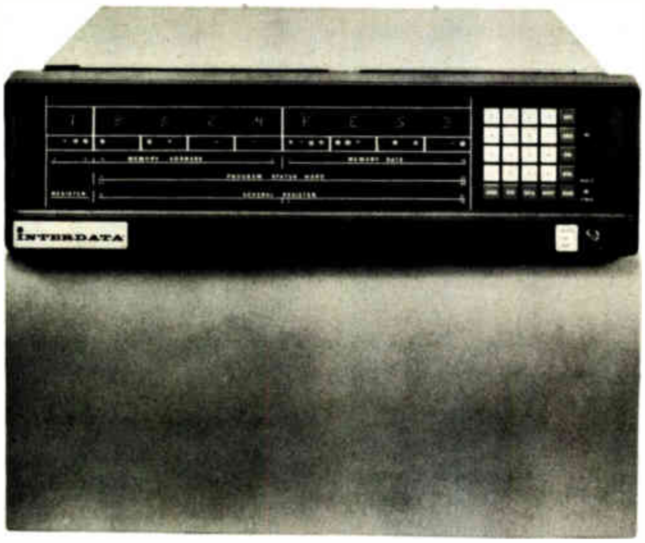

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Memory speed (nanoseconds)	750	800	900
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Addressing range (bytes)			
Direct	1,048,576	512	65,536
Relative	±16,384	±256	±32,768
Indexed	1,048,576	65,536	65,536
Double indexed	1,048,576	No	No
General-purpose registers	32 32-bit	4 16-bit	8 16-bit
Index registers	30 32-bit	2 16-bit	8 16-bit
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1 Megabyte processor	171,650	Not available	Not available

Source: Data General Price List, 5/15/73. DEC PDP-11/40 Price List, 6/73. DEC OEM & Product Services Catalog, 1972. Auerbach Minicomputer Characteristic Digest, June, 1973. "How to use Nova Computers", 1973.

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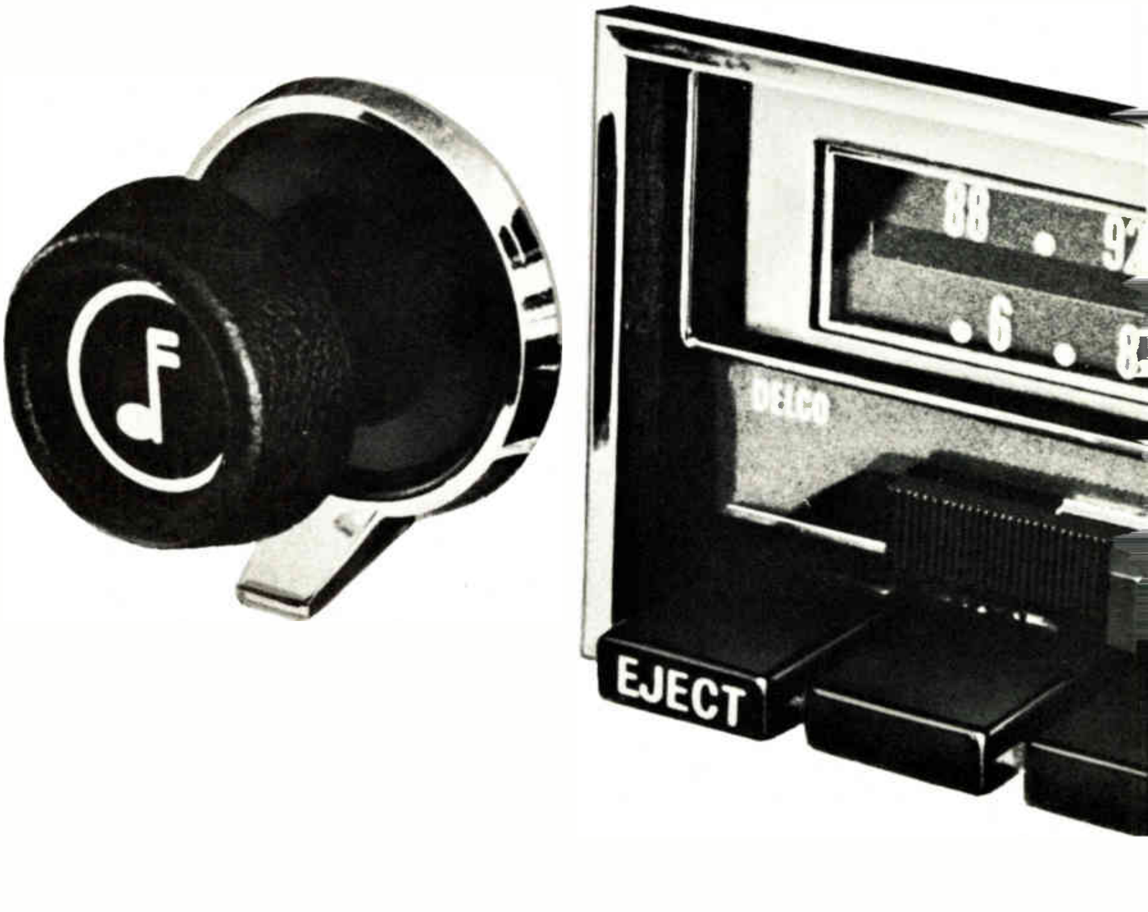

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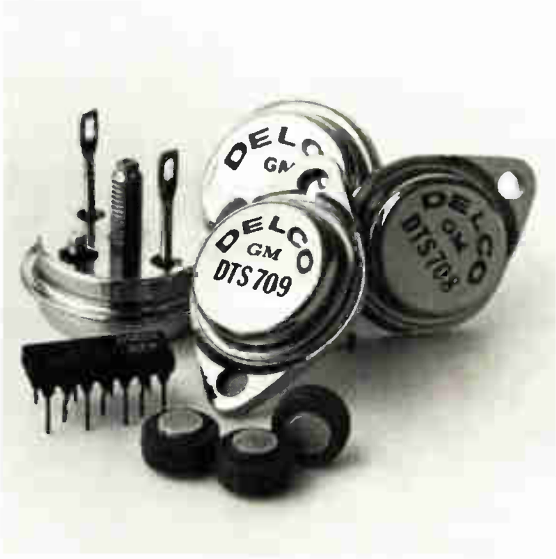

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Light-emitting diodes

Simultaneously a junction diode and a pilot light, the versatile light-emitting diode is not only sensitive to the direction of current flow—it also has a definite conduction threshold voltage, and its brightness varies with current level. Some ways of exploiting this unique combination of optical and electronic properties are suggested in this selection of LED applications.

Lucinda Mattera, Circuit Design Editor

LED test circuit checks power-supply connections

by Harrel J. Tanner
Bellflower, Calif.

Before a circuit board is installed in new equipment, each pin should be checked to be sure that its power connections are in good order. Since this means checking the connections to both the supply voltage and ground lines, at least two measurements must be made for each pin. These continuity checks are uncomplicated but can become exceedingly time-consuming for a large system.

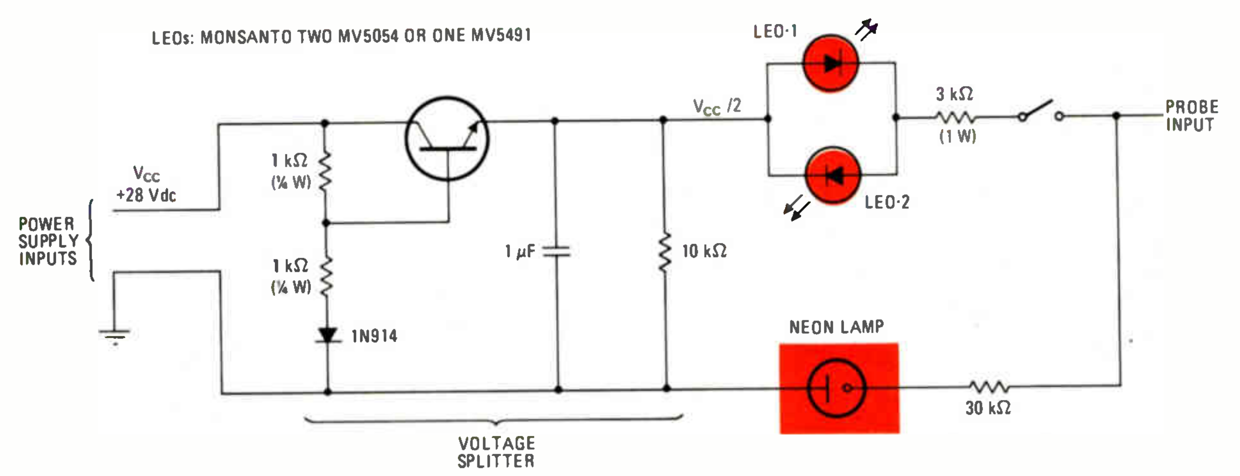
However, a simple test circuit based on light-emitting diodes lets you see whether voltage and ground connections exist after making only one measurement. The circuit, which is drawn in the diagram, operates from the same power supply as the circuit board it is monitoring.

The inputs for the test circuit are connected directly to the voltage-source and ground-return lines to be checked. The test probe is then touched to each pin on the circuit board. If only LED-1 glows, the pin is connected to the ground line. If only LED-2 glows, the pin is connected to the dc V_{CC} supply line. If both LEDs glow, an ac V_{CC} supply voltage exists at the pin.

There is a switch at the probe input to the test circuit. When this switch is open, the neon lamp lights if any line voltage is present. If the neon lamp remains dark, the switch can be closed and the circuit-board pin safely checked for dc power connections.

The power-supply input voltage to the test circuit is split so that only half the supply voltage ($V_{CC}/2$) reaches the LEDs. With the switch closed, if the pin voltage at the probe is zero (connected to ground), LED-1 is forward-biased as long as $V_{CC}/2$ is greater than the forward voltage of the LED. If supply voltage V_{CC} is present at the pin, LED-2 becomes forward-biased.

With the component values shown, this monitoring circuit checks for supply voltages of 28 V ac or dc and a line voltage of 115 V ac. Simply changing the resistor values permits other voltage levels to be monitored. A type 2N2107 transistor works well. □



Power supply checker. Test circuit uses light-emitting diodes to check voltage and ground connections for circuit boards in one measurement. Here, with the switch closed, LED-1 lights if the probe voltage is at ground; LED-2 lights if the probe is at 28 V dc; and both LEDs light if the probe is at 28 V ac. With the switch open, the neon lamp lights if there is line voltage (115 V ac) present at the probe input.

LEDs help tune FSK demodulators

by C. Clay Laster
Kelly Air Force Base, San Antonio, Texas

Light-emitting diodes make excellent tuning aids for frequency-shift-keyed (FSK) demodulators. They can replace cathode-ray tubes or meters in both single-frequency-shift-keyed demodulators and dual-frequency-shift-keyed (DFS) demodulators. The LED display can be easily incorporated in existing demodulators or in yet-to-be-designed demodulators.

Many conventional FSK and DFS demodulators use CRTs to provide vector-like displays of the teleprinter mark (binary 1) and space (binary 0) signals. FSK and DFS modulation techniques normally make use of frequency shifts on the order of 200 to 800 hertz. One popular standard is to use a frequency shift of 850 Hz, with the space centered at 2,125 Hz and the mark centered at 2,975 Hz. The FSK demodulator, therefore, will have selective filters of 2,125 and 2,975 Hz to detect the respective space and mark signals.

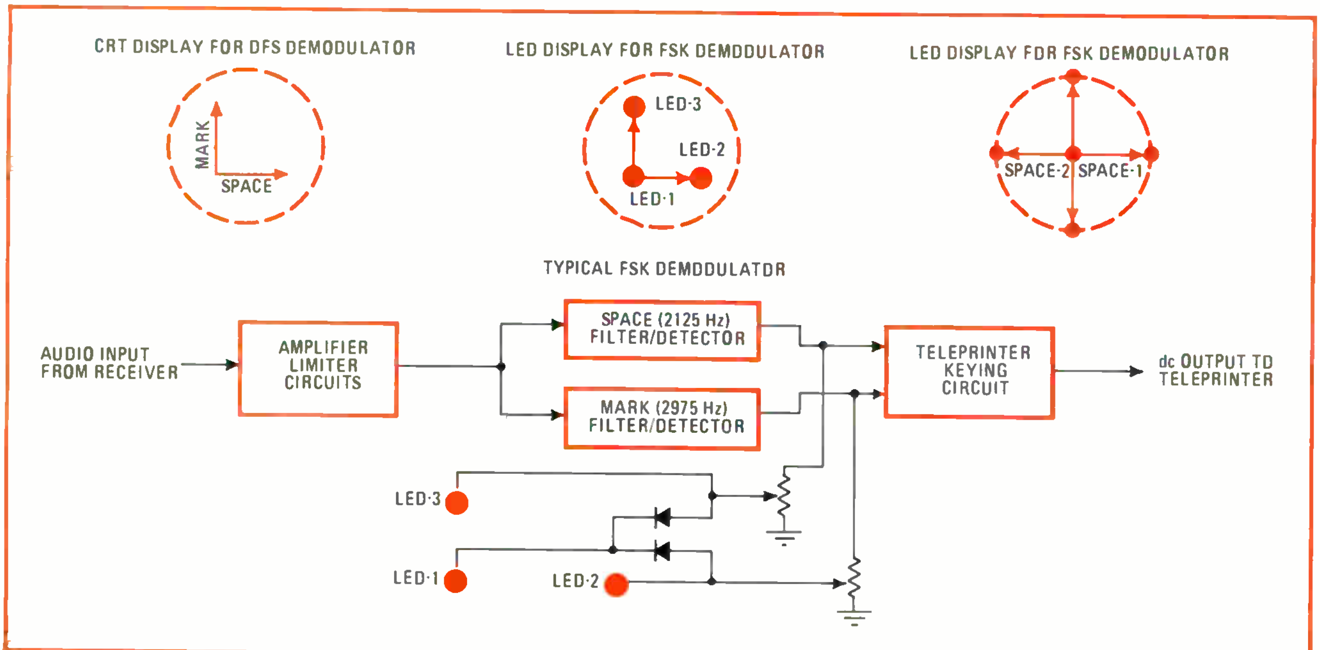
In radio-communications circuits, the mark and space signals are transmitted as individual signals that shift below and above the transmitter's center frequency. Thus, if a radioteletype signal is transmitted at a center frequency of 7,100 kilohertz with a total frequency shift of 850 Hz, the space signal will be transmitted 425 Hz below the center frequency (at 7,099.575 kHz), and the mark signal will be transmitted 425 Hz above the center frequency (at 7,100.425 kHz). For proper signal reception, the receiver must be tuned so that the space and mark signals are centered at 2,125 and 2,975 Hz.

With a CRT vector-like tuning monitor, the space signals are displayed horizontally, while the mark signals are displayed vertically. When the receiver is tuned to the teleprinter signal and the receiver's beat-frequency oscillator is adjusted so that the space and mark signals are centered, the CRT will display the space and mark vectors.

Light-emitting diodes, along with the appropriate logic-interface circuitry, can be substituted for this more expensive and less reliable CRT tuning aid. Three LEDs, when arranged as indicated for the FSK demodulator, provide a display for the tuning function. (Other arrangements may be more desirable in some instances.) When the receiver is tuned to the signal center frequency, LED-1 lights; when it is below the center frequency, LED-2 lights; and when it is above the center frequency, LED-3 lights.

The block diagram shows how this simple LED tuning aid can be added to a conventional FSK demodulator. The dc outputs from both filter/detector stages are applied to a resistive divider network that acts as a threshold detector for the LEDs. The isolating diodes are connected as an OR gate to allow these dc signals to be applied to LED-1 when the demodulator is tuned to the signal's center frequency. If the output level from either filter/detector stage is not sufficient to drive the LEDs, appropriate transistor switches or digital logic ICs may be used as interface devices.

The same sort of LED tuning aid can be devised for DFS demodulators. In this case, five LEDs are required to replace the CRT display. Most DFS demodulators use switchable filters and have individual outputs for each teleprinter channel. They also sometimes have combining circuits (different antennas) for use with space and frequency-diversity schemes. In any case, the LED interface circuitry can be connected to the individual detector outputs, and the display can be arranged to show the space-space, space-mark, mark-space, and mark-mark combinations. □



LED tuning aid. Light-emitting diodes can replace the vector-like CRT display commonly used for tuning a receiver to the signal center frequency. Three LEDs do the job for a single-frequency (FSK) demodulator, while five are needed for a dual-frequency (DFS) demodulator.

LEDs regulate voltage for C-MOS applications

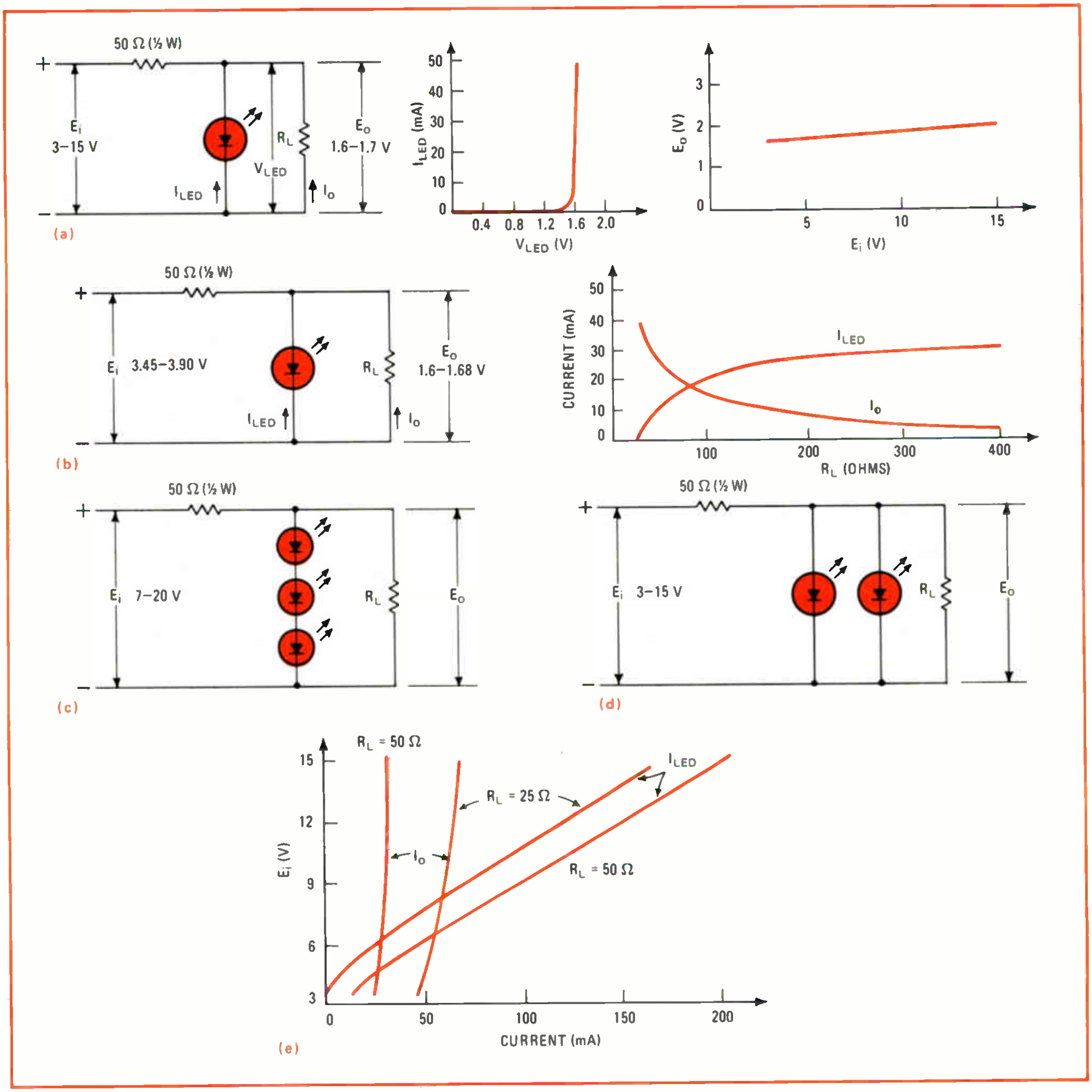
by Calvin R. Graf
Kelly Air Force Base, San Antonio, Texas

As a voltage regulator, the useful light-emitting diode is particularly suited to complementary-MOS circuit designs, especially in automotive applications. The large current surges caused by widely varying input-voltage levels are easily handled by a LED regulator.

In circuit (a), an LED operates in parallel with load resistance R_L. (A series-dropping resistor is placed between these two devices and the power supply.) The voltage drop across the LED (V_{LED}) remains rather constant, ranging from about 1.6 to 1.7 volts, over a large current (I_{LED}) variation from approximately 5 to 50 milliamperes. It is this characteristic constant forward voltage that can be used for regulating the voltage in low-power, low-current circuits.

The voltage across the LED also remains fairly con-

Regulating voltage with LEDs. Single-LED voltage regulator (a) maintains output voltage level at 1.6 to 1.7 volts, in spite of an input voltage variation from 3 to 15 V. The graph in (b) shows that regulation is "lost" only when the load resistance drops below 37.5 ohms. To increase the regulated output-voltage level, the LEDs are connected in series (c); to increase the output current, the LEDs are wired in parallel (d). The graph in (e) illustrates how LED current changes with a varying input-voltage level, but output current remains fairly constant.



stant for a large swing in input voltage, as illustrated by the graph of E_o versus E_i in (a). LED voltage increases by only approximately 0.4 v as the input voltage goes from 3.5 to 15 v.

In (b), the influence of the load resistance on both the current drawn by the LED and the output current is plotted for an input voltage variation of 3.45 to 3.90 v. When the load resistance drops below approximately 37.5 ohms (and the series resistor is 50 ohms), LED voltage decreases to less than 1.6 v, and the output-voltage level is determined entirely by the load resistance, and not the LED.

To increase the level of the regulated output voltage, several LEDs can be connected in series, as is done in (c). This configuration produces a regulated output voltage as long as the input voltage to the LEDs does not drop below 1.6 v times the number of LEDs being used. Higher load currents can be achieved by connecting a number of LEDs in parallel, as is done in (d). Or, to raise the output voltage, as well as the current level, the LEDs can be connected in a series/parallel manner to get the desired results.

The value of the series-dropping resistor determines the input voltage level at which the LED starts to control the output voltage. The higher the value of this resistor (above 50 ohms nominal), the higher the input voltage must be to make the LED conduct.

How brightly the LED glows depends on the input-voltage level. The LED gets brighter as input voltage increases (for a fixed value of load resistance), but the load current remains almost constant, as illustrated by the graph in (e).

Usually, the luminous intensity of a LED is established at a given current level, which generally ranges from 5 to 30 mA, and at a nominal LED voltage of 1.6 to 1.7 v. Although a LED can still operate properly at continuous current levels as high as 50 mA, continuous current levels of 200 mA or so should be avoided. They cause the LED to exceed its safe operating temperature, reducing its average 20-year half-life.

Additionally, since a LED is a visual current-indicating device, it makes a handy front-panel circuit monitor. For example, it can indicate when circuit power is on, (LED lit), when the circuit input voltage is too high (LED bright), when the load current is too heavy (LED dim), and when the circuit is turned off (LED dark). □

Light-emitting diodes

LEDs watch for overvoltages

by Don DeKold
Santa Fe Community College, Gainesville, Fla.

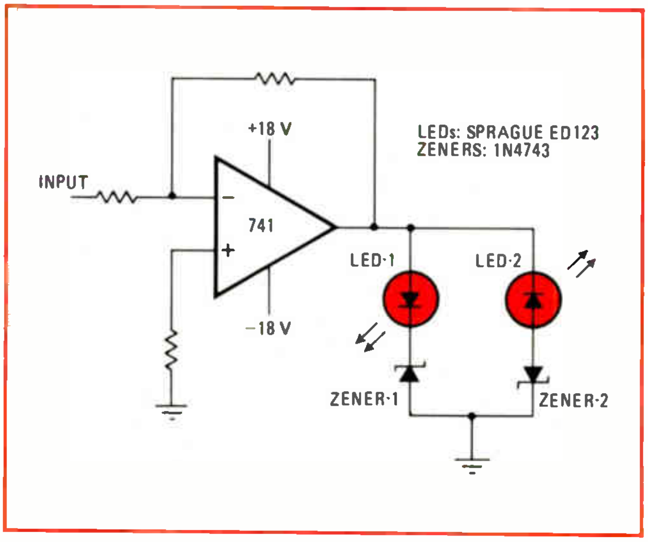
A pair of light-emitting diodes, along with a pair of zener diodes, can serve as a simple visual voltage monitor. For instance, if the two LED/zener combinations are placed at the output of an operational amplifier, they will indicate when the magnitude of the op amp's voltage exceeds a certain maximum, and whether this overvoltage is positive or negative.

For the circuit shown, LED-1 lights if the op amp's output is greater than +15.5 volts dc; about 13.9 v is dropped across zener-1 and about 1.65 v across forward-biased LED-1. In this case, LED-2 is back-biased, and no current flows through it or through zener-2. LED-2 lights for an op amp output of −15.5 v dc, while LED-1 is back-biased and remains dark.

The internal short-circuit current limiting of the op amp prevents the current flow through either forward-biased LED from exceeding 18 to 20 milliamperes. This current level allows the LEDs to glow brightly enough for you to see them easily in a well-lit room.

For an ac output signal, both LEDs will light on alternate half cycles when the signal level is more than 31 v peak-to-peak. If the signal frequency is fast enough, each LED will appear to be lighted continuously. When a pair of well-matched zener diodes is used, this feature lets you detect the op amp's output offset voltage without a voltmeter. By noting which LED lights first when the level of the amplified signal is increased, you can deduce the presence of an offset voltage as well as its polarity.

The diode loading across the op amp's output also serves to limit voltage to the maximum 15.5-v level, but it does not affect signal voltages that are less than this amplitude. □



Voltage monitor. Light-emitting diodes glow when op amp output voltage exceeds a maximum level, 15.5 volts dc in this case. For a positive overvoltage, LED-1 lights; for a negative overvoltage, LED-2 lights. Both LEDs light for an ac output of more than 31 V pk-pk.

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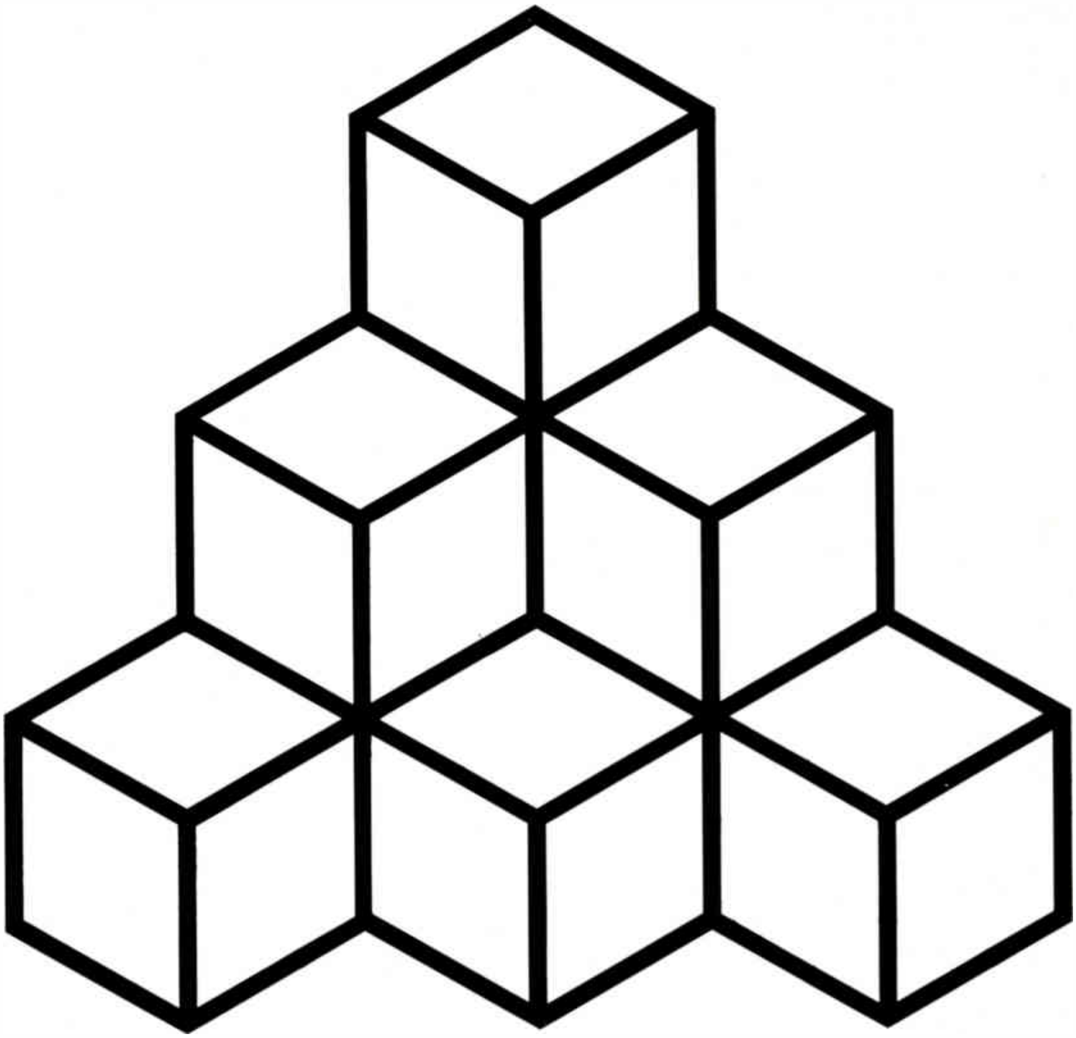

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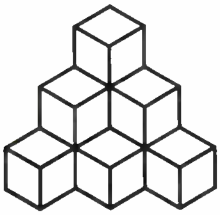

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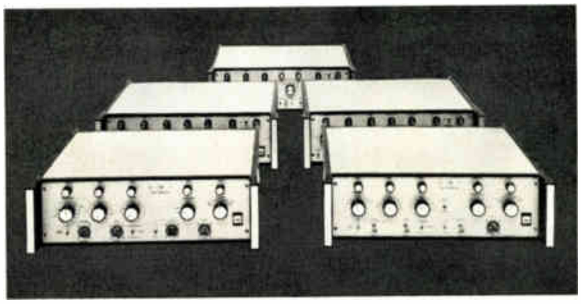

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(415) 834-3030

Engineer's newsletter

Microwave devices become more interchangeable

Because of recent advances in high-frequency technology, you should **revise the tradeoffs you've been making between microwave devices.** Bipolars, what with better metalization and tighter electron-beam photolithography, now have an f_t as high as 8 gigahertz, a region traditionally reserved for FETs. On the other hand, ion-implanted gate structures and better alignment techniques have made **high-impedance FETs an alternate both to bipolars in the 1- to 6-GHz region and to Impatts at 10 GHz and above.** At the same time, Impatt and avalanche diodes are now contenders for power applications at frequencies as low as 6 GHz, as well as on their home ground of X band and up.

How to match a scope to a pulse

Here's a rule of thumb for determining how much bandwidth (f) a scope must have to be capable of handling a pulse of specified rise time (t). Let ft = 0.35, where f is in hertz, and t is in seconds. This means that, to see a pulse with a rise time of 10 nanoseconds, you need a scope with a bandwidth of at least 35 MHz.

How to run your calculator from a rechargeable battery

Although most handheld electronic calculators are battery-operated, they use ordinary carbon-zinc batteries and not rechargeable alkaline units. But it's easy to modify your calculator so that it accepts long-life rechargeable batteries and gives you the benefit of their lower operating costs. A small ⅛-watt resistor is all that you need, says John R. Nelson of Marion, Iowa. Simply **install the resistor across the calculator's ac power adapter jack, between the wire going to the computing circuitry and the wire going to the battery supply.** The resistor allows the batteries to trickle-charge whenever the calculator's ac adapter is plugged in. **The charging current is typically 15 to 20 milliamperes for a resistor value of 100 ohms.**

This resistor value can be computed more precisely from this equation: $R = (E_C - E_B)/I_C$, where R is the resistor value, E_C is the charging voltage (the ac adapter output voltage under a light load), E_B is the battery voltage (the open-circuit voltage at the beginning of the charging period), and I_C is the desired charging current.

A different breadboard

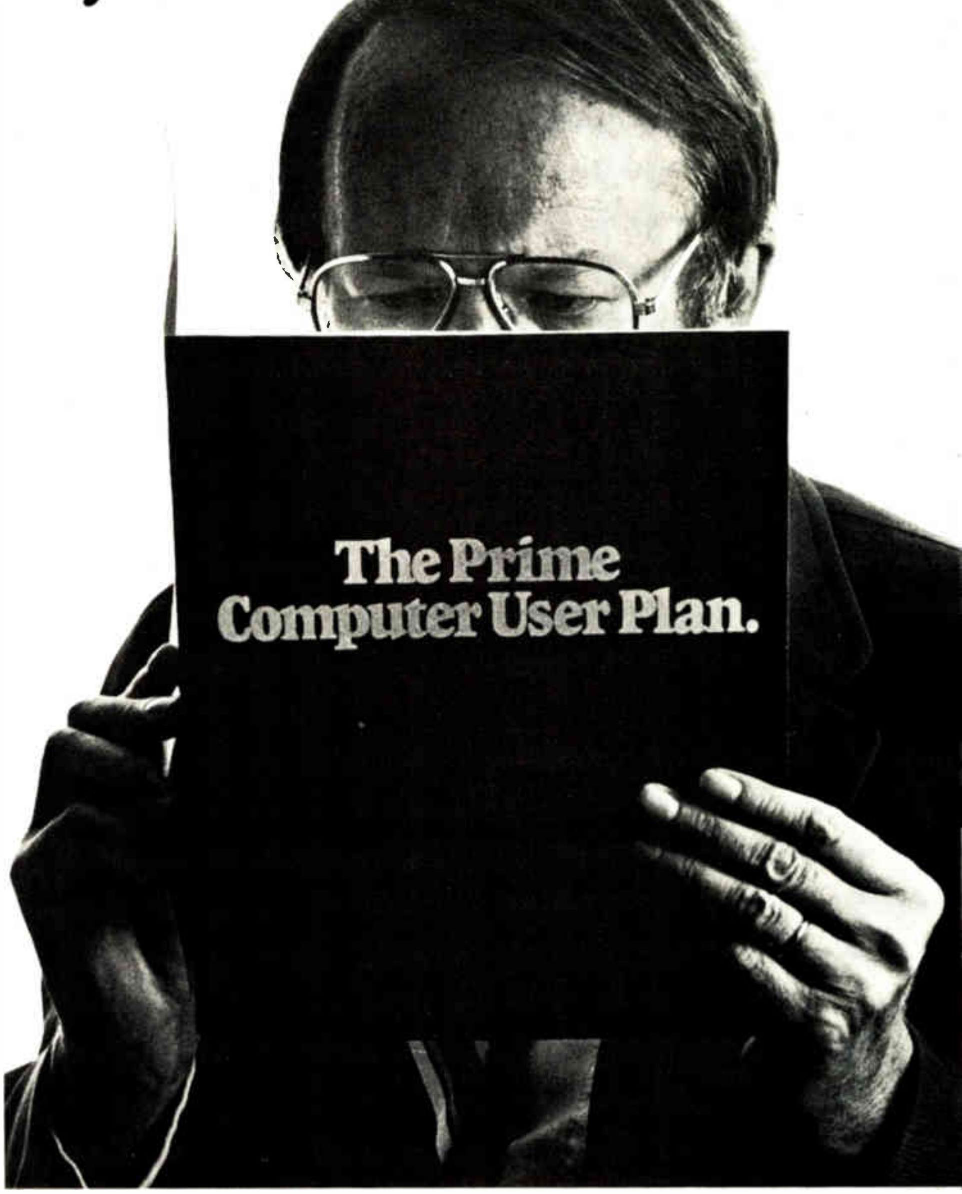
Prepunched breadboards, called bridgeboards, have orthogonal conductor patterns already in place, and make it easy to wire up and test a circuit and then change the components if necessary. **After a component is inserted, the conductor pattern is simply bridged over with a soldering iron.** Available from Pico Inc., 1001 Vine St., Liverpool, N.Y., 13088, these boards have conductor patterns in a variety of spacings and can handle both discrete and IC packages.

Standards listed from A to X

The latest IEEE Standards Catalog, an old standby for EEs, is now available. **The new 32-page 1974 edition lists more than 350 standards publications** by their subject—from accelerometers to X rays—as well as by their numbers. You can get a single copy free from the IEEE Standards Department, 345 E. 47th St., N.Y., N.Y. 10017.

The Prime Computer

A totally new way to buy, use and upgrade computer systems.



The Plan introduces the first two-year guaranteed trade-in schedule. This program fully protects your computer investment when it's time to expand. Grow as much and as fast as you wish. The Plan will back you all the way.

The Plan protects your budget by eliminating arbitrary system packaging. You only buy what you need. With 3 discount schedules, you need pay as little as possible.

The Plan also protects your software investment. Only Prime offers upward *and* downward system compatibility. Without modification.

The Plan offers a whole new maintenance procedure, too. Built-in integrity checks can isolate a fault to a circuit board and maintenance is as simple as replacing the board.

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Everything we offer at Prime, hardware, software and support, works together as a logical system, be it large or small. You can put together a powerful, reliable, easy-to-use computer system at a better total system price than ever before possible. The Plan shows you how.

Read on.

Plan on a guaranteed trade-in

You can start your system with any Prime Computer. If, for any reason it isn't the best one to handle expanding applications, trade it in. Trade all of it or parts of it. Trade whatever is standing between you and better performance.

For instance, to upgrade from a Prime 200 to a 300 processor, simply trade in the original processor board. You can then plug in a fully equipped* Prime 300 for $5000 (less a 50% trade-in credit for certain optional features on the original processor).

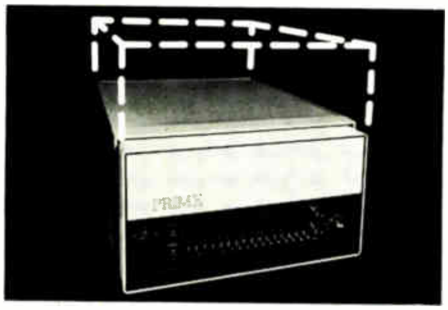
You can also elect to keep the original processor as a spare. The cost is only $1000. Keep your original power supply, memory and chassis, too. Or selectively upgrade any of them under similar trade-in arrangements.

Of course, all the software written on the original system

*Standard features include: virtual memory, restricted execution mode, memory protection, byte parity, extended direct addressing, integer multiply/divide, direct memory access system, automatic program loaders and microverification

User Plan.

will run on the new one without modification. Only Prime makes this possible. Only the Prime Plan guarantees it.



		PROCESSOR 100		PROCESSOR 200		300	
Memory	First Increment	4K	8K	4K	8K	8K	8K
	Cycle Time	1 µsec	1 µsec	750 nsec	750 nsec	750 nsec	600 nsec
	Parity	no	no	yes	yes	yes	yes
Chassis	5 Slot	x	x	x	x		
	10 Slot	x	x	x	x	x	x
	17 Slot	x	x	x	x	x	x
Features	Battery Backup	x		x		x	
	Automatic Prog. Load	x		x		x	
	Direct Mem. Access	x		x		x	
	Integer MUL/DIV	x		x		x	
	Extended Direct Addressing			x		x	
	Microverification			x		x	
	Single Precision Floating Point Arith.			x		x	
	Double Precision Floating Point Arith.			x		x	
	Writeable Control Store					x	
	Virtual Memory					x	

Plan on unheard of compatibility

You can write real-time and time-independent programs on any Prime processor, in any language, under Disk Operating System control, or as stand alone programs, using a common set of support packages. You can then execute the developed programs on the same or any other Prime processor under Disk or Real Time Operating System control, or as stand alone programs—without modification. Furthermore, the Prime 300 supports a multi-user, virtual memory version of the Disk Operating System (DOS VM) and a foreground/background version of the Real Time Operating System (RTOS VM).

Choose Any Processor	Choose Any Development System	Choose From Support Packages
100 200 300	DOS Stand-Alone	File Systems Libraries Utilities IOCS Drivers

Choose Any Language	Choose Any Operating System
Macro Assembler FORTRAN BASIC	DOS RTOS Stand-Alone

Plan it right, right off

The right combination of computer resources are all here and they're yours to select.

Pick a processor. Enhance it with options if you wish. Select memory size and speed. Add peripherals and controller. Then package the electronics in the right size chassis and you're done. We'll provide the right power supply to handle whatever you put together.

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Plan on running full time

Prime service is every bit as sound as its technology. It's just as inventive, too. For instance, you can pick a full service contract or choose to use our services only when required. In either case we maintain a nationwide network of service and customer service representatives. They're ready to help.

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Read more about it in the Plan.

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The Prime Computer User Plan is a unique and remarkably logical document. You've just been treated to a sampling here. For the first time you'll know everything to expect in a computer system. Read the Plan. Send for it today.

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☐ Send the Plan
☐ Send Planner (He'll call for an appointment.)

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PR1ME

Caught in the le

At MEPCO/ELECTRA, we're taking action on three fronts...

Everyone figures the lead-time crunch will pass. At MEPCO/ELECTRA, we're not waiting for it to pass. We're taking immediate action in the form of a **3-pronged committment** to our customers. We're building for increased capacity. We're broadening our product base and we're organized for action.

We're building for increased capacity.

Our five divisions are running multiple shifts, giving us maximum production activity from every square foot. In addition, we are adding new facilities at three of these locations. Six new metal film production lines will be coming on stream in the next 12 months. In the last three years we've tripled our volume and within two more we'll have doubled it again; with all facilities highly automated, computer-monitored and programmed.

We're broadening our product base.

Part two of our committment to action is the development and addition of new products that complement our existing lines. This expansion will come via our Product Research and Development organization and selected acquisitions.

And we're organized for action.

Each product line operation is treated as an independent business with its own Product Operations Manager, Customer Service Representative and Manufacturing team. Each Product Operations Manager has total responsibility for all operating aspects of his product line which means, each customer order moves faster because of greater control. A problem can be identified and eliminated **before** it becomes a crisis.

ad-time crunch?

We're keeping a weather eye on the future.

Speed isn't everything. You also demand quality over the long haul. That's why you buy MEPCO/ ELECTRA products, and that's why, in the whirl of our expansion activities, we're watching out for your needs today, tomorrow and keeping an eye on your long term requirements.

It's working!

That's our program. Plan, design, build or buy—to get ourselves and our customers safely and successfully through the lead-time crunch. While we keep our pricing sharply competitive, and continue as your best single source for resistors, capacitors and resistor networks. Whether you're into EDP, consumer electronics, communications, industrial control, or military programs, MEPCO/ ELECTRA can supply your total passive components needs—faster and better every day.

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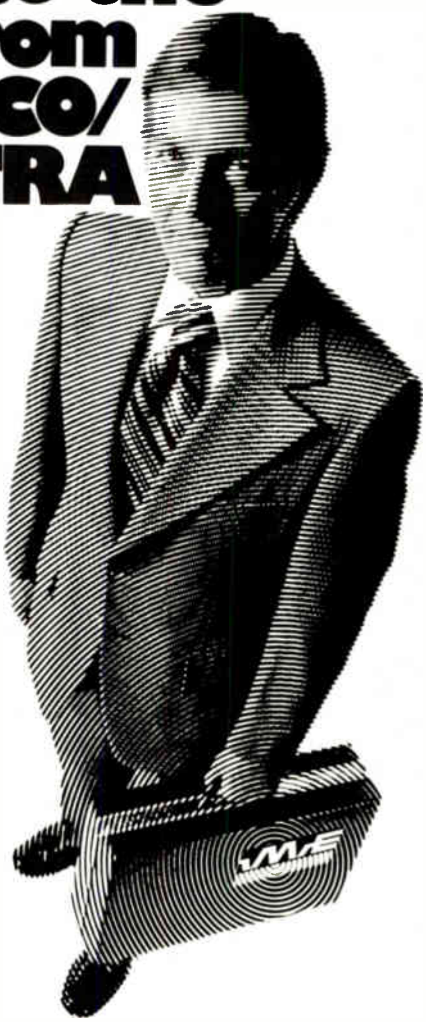

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DEC's disk-based systems will run you about $60,000.

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You get faster program generation because we give you both scientific and commercial languages.

While other systems are confined to either interactive or batch operation, DBOS-II offers a combination of both. Plus a comprehensive file management system, text editors, interactive debug routines, mathematical functions and commercial libraries. That explains our faster program implementation.

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RTOS-II has all the advantages of DBOS-II in background, with a very responsive foreground for handling events that occur in real time.

And compared to DEC's RSX-11D, we pack more power and features in far less memory.

You can tailor our system to fit your application starting with as little as 16K memory, expandable to 128K.

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The reasons we can give you price/performance advantages are all spelled out in "The Value of Power." For a free copy, or for more information on RTOS-II or DBOS-II, write General Automation, 1055 South East Street, Anaheim, Calif. 92805. If you're in a hurry, call (714) 778-4800.

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IC simulates power transistor

Fast-switching, three-terminal monolithic circuit includes 'self-defense' against destructive current, voltages, and heat

By George Sideris, San Francisco bureau manager

A **"power transistor"** that protects itself—and anything connected to it—from shorts and overloads is seen by its designer, Robert Dobkin of National Semiconductor Corp., as the start of a new trend in power-device technology. He also expects the LM195 to rewrite the economic rules that apply to control circuits.

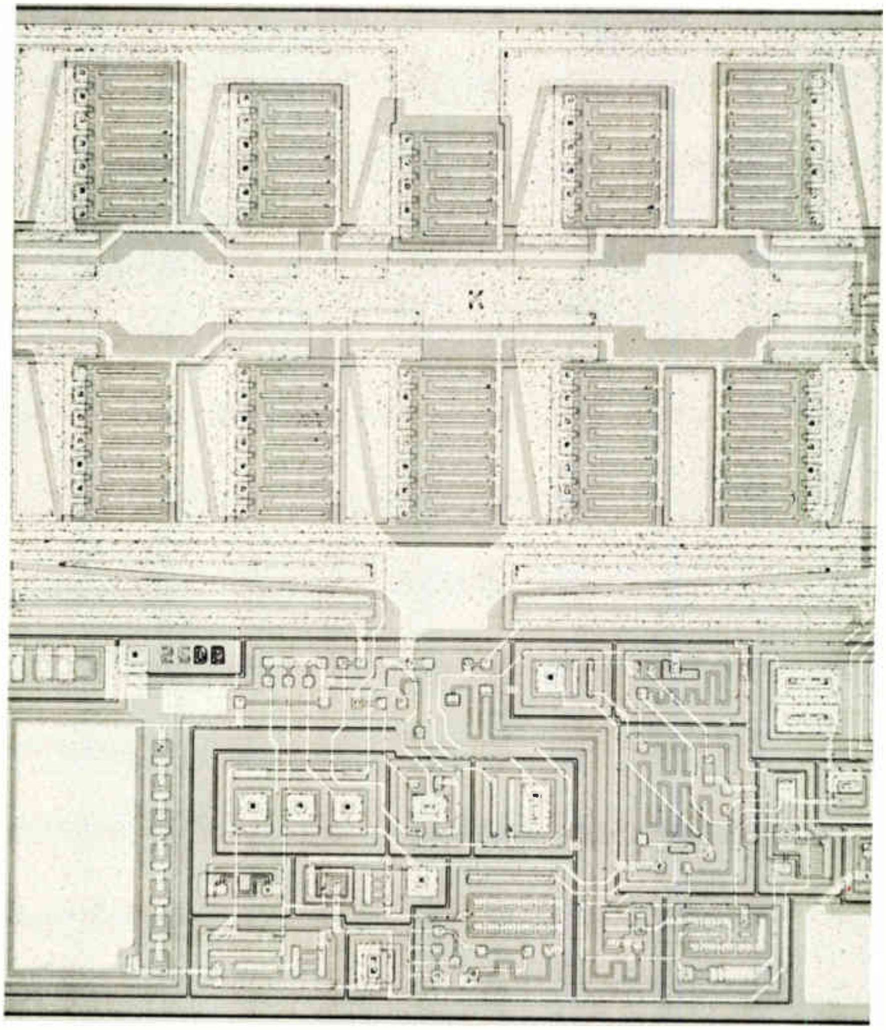
The LM195 is a three-terminal monolithic circuit that simulates a 40-watt transistor with unusually high switching speed. Worked into the chip are some 50 components that drive and protect a large, multi-base, multi-emitting npn power transistor that gives the device a gain over 1 million. The protective circuitry makes the chip blowout-proof at output currents to 2 amperes and at input and output operating voltages to 40 volts. Current-limiting and thermal-shutdown circuits on the chip disconnect the power stage if output current exceeds 2 A or if the chip gets hotter than 165°C.

Even if the chip itself is destroyed by highly excessive operating voltages, it continues protecting. Instead of becoming a short, as does a conventional power transistor, a blown-out LM195 becomes an open that causes the load to be shut down. Thus, says Dobkin, the devices provides "absolutely reliable protection under any kind of overload." The devices are tested to 42 v, but can withstand higher transients.

However, the LM195 costs five times as much as conventional power transistors in hermetically sealed cans. Dobkin maintains that is really a bargain when one considers the cost of replacing relays, solenoids, logic cards and other destructible loads, or the cost of buying and assembling discrete protective components, bulky heat sinks, and such short-proof accessories as armored, waterproof cables for industrial control lines.

As a power transistor, the LM195 has no discrete counterpart. A simplified schematic looks like a pnp driving an npn Darlington. The three terminals represent the base, emitter, and collector of an npn transistor. There the similarity ends, because high powers can be switched by the LM195 at high speeds with very low input signals. Furthermore, current-limiting al-

Power chip. Upper section is the output-power transistor—10 small transistors connected in parallel with a common collector. At bottom is input, protective, and control circuitry.



lows any number to be driven in parallel to multiply output current, regardless of the matching of the parameters from device to device. The switching threshold is only 2 volts, and the switching time is only about 500 nanoseconds from off to saturated on, or vice-versa. Input base current is 3 microamperes or less throughout the input voltage range of 0 to 42 V. Thus, there is an ideal interface between low-power control circuits and loads—a single C-MOS gate, for example, could drive more than 100 LM195s.

Though current-limiting starts at 2 A of output current, thermal shutdown normally limits the practical operating current to from about 2 A at 20 V to about 1 A at 40 V. A full 40 W can be handled in switched-driver applications, since the short transition times (during which the transistor is resistive) help reduce power dissipation and heating on the chip. In comparison, Dobkin points out, conventional transistors with a 120-W maximum rating are normally restricted to 40-W operation by the unavailability of infinite heat sinks.

He does recommend the LM195 be put on a heat sink at the higher power levels, such as when 30 W or more must be switched. But the heat sink can be relatively small, and there is no need to add a thermal-cutoff switch to prevent overheating, he says.

Power dissipation is package-limited, as usual. Dobkin recommends air-cooling at the normal driver power range of 10 to 15 W.

Dobkin is already planning still larger transistors. Meanwhile, National Semiconductor will have the device in stock this month in three versions: LM195, with a maximum operating voltage of 42 V from −55 to +150°C and LM295, 42 V from −25 to +150°C, and LM395, 36 V from 0 to +125°C. They are available in TO-3 cans at 100-up prices of $17, $10 and $5, respectively. The devices will also be made available in solid-Kovar TO-5 packages, the company says.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [338]

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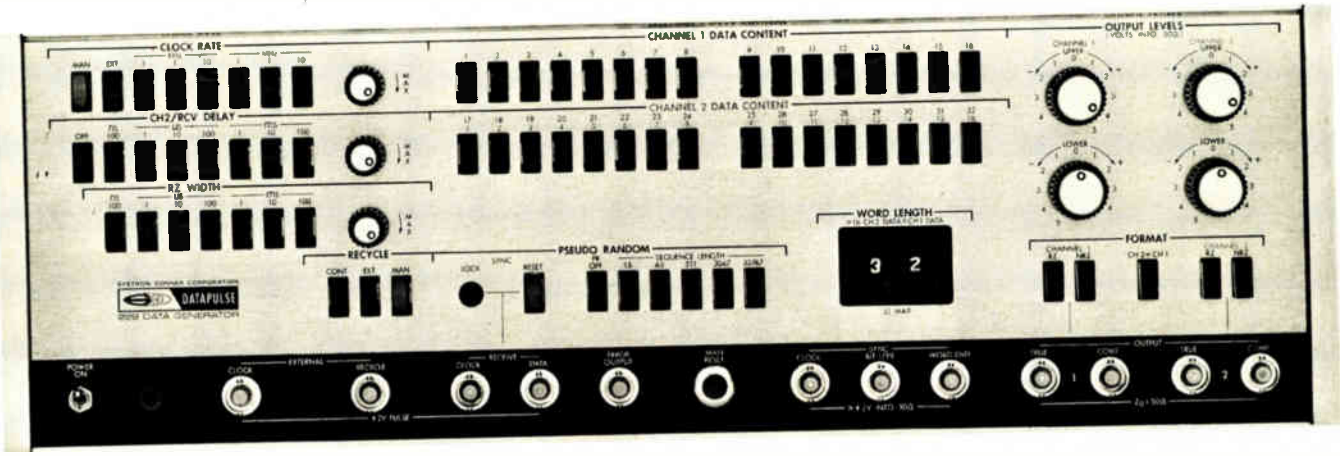
Circle 153 on reader service card

Some data generators can do only one thing.



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For details or a demo, contact your Scientific Devices office or Systron-Donner, Datapulse Division, 10150 W. Jefferson Blvd., Culver City, CA 90230. Phone (213) 871-0410.

SYSTRON DONNER

Components

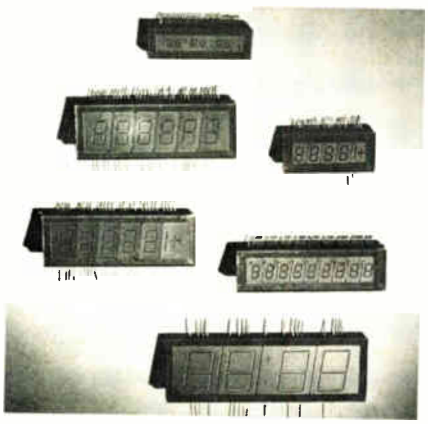
Gas-discharge display is simple

Multidigit readout uses low-cost materials and assembly technique

Promising to help fill the expanding market for gas-discharge displays, a new type offers broad versatility and low production cost. Diacon's DiaDigit display, using low-cost materials and assembly, is aimed at what the company says is a prospective $50 million market, now only half served by gas-discharge displays because of product shortage. The Diacon display is now priced at $1 per digit, but lower in quantity purchases.

The $50 million, Diacon says, is the market that neon-discharge displays could capture if supplies of the readouts were adequate.

The new multidigit gas-discharge display is used or will be used shortly in such applications as electronic instrumentation—digital voltmeters, multimeters, and panel meters; business equipment such as copiers, computers, calculators, cash registers, point-of-sale and other computer terminals; and in consumer items, including clocks, stopwatches, appliances, radio and TV receivers, and automobiles. Duane Manning, manager of displays at Diacon, says, "We are equipped even now for extremely high-volume runs." He also feels that the process will lead to substantial reduction in manufacturing cost by 1976. The product requires relatively little labor.



Diacon's display is similar in principle and operation to the Sperry and Burroughs seven-segment displays, but it is mechanically different. The Diacon display uses a dual in-line package, assembled much like an integrated-circuit package, with the leads emanating from the sides for easy circuit-board use without a special socket. The multidigit displays will be offered as standard parts in heights of 0.16, 0.30, 0.5 and 1 inch, with varying numbers of digits and symbols. A special attraction of the displays to users, however, is the simplicity of custom variations. Manning says that the company was able to prepare a special stop-watch display for only $7,000 in special tooling.

Because of its simple construction, only four parts are used in the display. All are inexpensive and readily available. Two are simple window glass, and the others are nickel/iron alloy lead frames etched or stamped to form the package leads, plus the masks and segments that form the image. One lead frame is attached to each glass with a glass-slurry mixture, then the whole assembly is fastened together by means of a hot cap sealer. Then the package is evacuated, charged with a standard neon gas mixture, and sealed. Patented processes are used by Diacon for its glass-ceramic IC packages, and both materials and techniques contrast strongly with those other displays. One competing display, for example, uses a special glass-filled ceramic base, and the segments are welded to metal terminal pins. Eight welds are needed for each digit. Likewise, the glass in this display has a relatively expensive thin-film tin-oxide coating on its face to form the anode, and this, Diacon says, results in a significant addition to production costs.

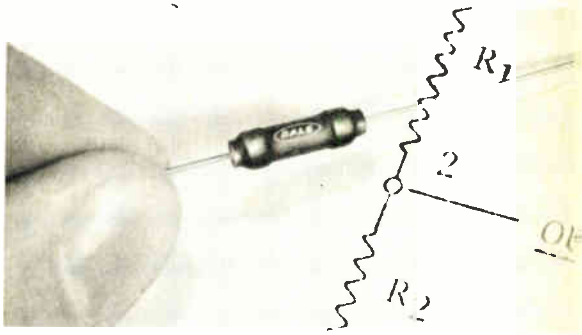
Diacon claims a projected cost of only 30 to 50 cents per digit. In addition to simple construction, the use of a metal frame with slots for the discharge results in an especially sharp, high-contrast orange display that has the segments defined by the mask.

Like other gas-discharge displays, the DiaDigit requires a high-voltage (about 170-volt) drive, and this is its principal disadvantage. However, MOS circuits are now available for this application. Power requirements are relatively low.

Diacon, Inc., 4812 Kearny Mesa Road, San Diego, Calif. 92111 [341]

Voltage-divider networks aimed at precision tasks

Special-purpose voltage-divider networks use combinations of discrete film resistors to meet the voltage-division needs of precision power supplies. The units can also be used in



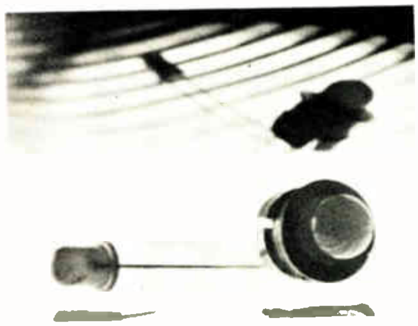
applications that require precision tracking of ratio and stability of ratio in high-voltage equipment. Resistors within the network can be provided with up to these maximum specifications: 167 megohms resistance, 7 kilovolts, and ½-watt power at 70°C.

Dale Electronics Inc., Box 609 Columbus, Neb. 68601 [345]

Orange LEDs cost the same as red readouts

A series of orange gallium-arsenide-phosphide light-emitting diodes are priced the same as equivalent red LEDs. The Orange-Lit 30 is priced at 65 cents in 1,000-lots, and the model 31 is a miniature LED priced at 42 cents in the same quantity. Radiating area of the model 30 is 0.2

New products

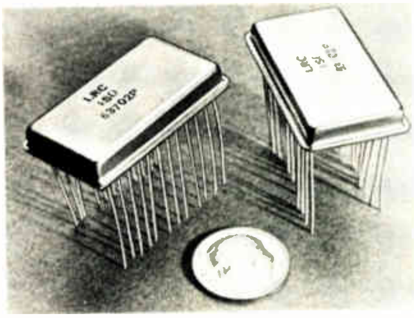


inch and the viewing area extends 0.140 inch beyond the face of the mounting clip; brightness is 0.8 millicandela. The model 31 is intended for large-volume applications and is rated at 0.3 millicandela.

Litronix Inc. 19000 Homestead Rd., Cupertino, Calif. 95014 [346]

Integrated switch-drivers operate from 10 to 200 MHz

A series of integrated switches and drivers is designed to provide rf control from 10 to 200 megahertz. The



units, which are housed in 24-pin DIPS, require no bias connections or dc blocks in the rf lines. The driver inputs are TTL-compatible and have built-in fail-safe provisions. If the input-gate level is open-circuited, the switch goes to an isolation state.

LRC Inc., 11 Hazelwood Rd., Hudson, N.H. 03051 [347]

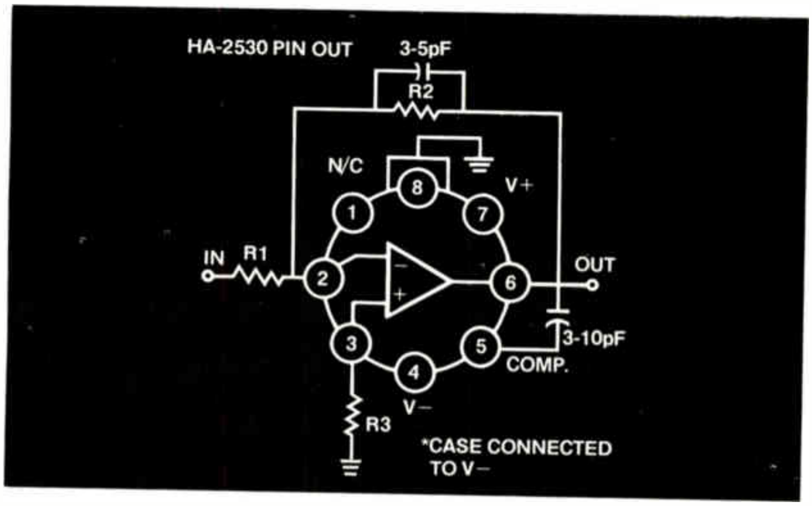
Wire connector eliminates insulation stripping

A device called a screw wire connector is designed so that wires can be connected without stripping insula-

Fastest:

This new wide band inverting op amp is so fast no other monolithic device can match its speed.

Until now the only way you could obtain the performance speed of our new HA-2530 wide band inverting op amp was with expensive discrete modules. Say at around $50 each. Now, for far less money you can have it all on one cost-saving chip. For example, typical slew rate at + 25°C is 320V/μS, settling time (0.1%) is 550nS. No other monolithic op amp can match these speeds. Application range is excellent, too. Among applications are video summations, high speed integrators, wave form generators, coaxial line drivers, and fast D/A outputs. For details see your Harris distributor or representative.



Features:

Offset voltage	0.8mV
Average offset voltage drift	5μV/°C
Slew rate	±320 V/μS
Power bandwidth	5 MHz
Gain bandwidth	70 MHz
Settling time	550nS
Open loop voltage gain	140db
Power consumption	100mW
Supplied	TO-99 pin out
	100-999 units
HA-2535 0°C to +70°C	$14.30
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"You've gotta be kidding. A battery-powered design like that would need a dense, static CMOS RAM with a 200 nanosecond access time and around 2 microwatt stand-by power.

"No way you're going to find an outfit that can hack that."

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Our new S2222 512x1 CMOS RAM does it all. It combines the highest density and performance with the lowest power requirements on the market —three more firsts from Number One. For complete information, write AMI, 3800 Homestead Road, Santa Clara, CA 95051. Phone: (408) 246-0330. Or call your distributor.

AMI
AMERICAN MICROSYSTEMS, INC

Circle 158 on reader service card

Here's that dense, static CMOS RAM.

Our S2222 is a 512 word by one-bit RAM, constructed with silicon gate CMOS devices integrated on a monolithic array. Fully decoded on the chip, this memory uses DC stable (static) storage elements and needs no refresh to operate. The memory matrix is organized as 32 rows by 16 columns. High-speed operation and micropower supply requirements make our new RAM ideal for applications where you have to conserve electricity or use a battery.

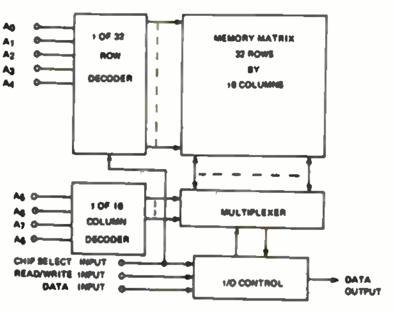
You can't beat its performance, either. It has a 200 ns access time and 420 ns cycle time, with power dissipation of less than 5 μw/bit and typical stand-by power of just 4 nw/bit. Since it is static, the data can be read without interruption. Maximum power dissipates only when the inputs change.

The unique circuit design lets the chip select precharge the internal nodes which minimize the power dissipation and maximize the performance. And for greater density, it is designed with five transistors per cell. All in all, it's the densest, lowest powered CMOS RAM ever produced.

S2222 Specifications

Access time: 200 ns at room temperature.
300 ns at military temperature range.
Cycle time: 420 ns
Power dissipation: typically less than 5 μw/bit.
Stand-by power: 4 nw/bit.
Power supply: single + 10 volt.
Current sink output with "OR" tie capability.

BLOCK DIAGRAM

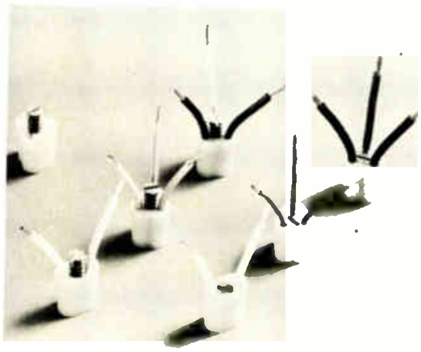


AMI

Circle 159 on reader service card

New products

tion. Two steps are required to make the connection: the first is inserting the wires into the holes without stripping; then during step two,



a special spiral screw is inserted to full depth. This eliminates wire twining, twisting, crimping, soldering, and taping. No special tools are necessary—only a screwdriver. Benefits of the new method are: no exposed wires, no frayed or straying wires, and no loss of current-carrying capacity. A free sample of the screw wire connector is available upon request.

The Sloan Co., Box 367, Sun Valley, Calif. 91352 [343]

Solid-state plug-ins replace industrial rectifier tubes

A line of solid-state plug-in tubes is designed to replace industrial rectifier tubes. The silicon units replace most gaseous and vacuum rectifier types with ratings up to 1,750 milliamperes and 60 kilovolts. Higher voltages and currents are available as special options. The new tubes

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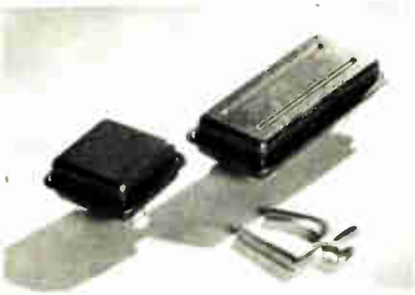
need no filament transformers and provide constant output and fast warmup.

Electronic Devices Inc., 21 Gray Oaks Ave., Yonkers, N.Y. [348]

Crystal filters are made as single networks

A series of crystal filters in coldweld flatpacks are said to differ from most filters in that they are fabricated as single networks and are housed in hermetic cans, rather than being composed of collections of crystals in individual cans or coils, wired together and housed in larger



cans. This new method provides lighter, smaller packages that cost less than other types. Models available include two- three- and four-pole units covering the range from 350 to 525 kilohertz and bandwidth from 0.005% to 0.02% of selected center frequency.

Electronic division, Bulova Watch Co. Inc., 61-20 Woodside Ave., Woodside, N.Y. [349]

Optical sensor controls recorder's tape tension

An optical sensor is designed to control the tape tension on recorders. The series RS-10 is completely encapsulated and has a light-emitting diode that transmits infrared light, which is received by a phototransistor. The sensor converts rotational or linear mechanical motion into a usable voltage, compatible with TTL or DTL levels. Price is $35 each in 100-lots.

Controlled Energy, 3296 Call Dr., Riverside, Calif. 92503 [350]

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Drum plotters. We're the world's leading supplier of both hardware and software.

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Microfilm plotters. Here, we got bigger by getting smaller. With microfilm. Our 1675 COM plotter/printer and our 2100 COM printer deliver the best price/performance in the industry.

Disk memory equipment. This was our second area of concentration. In a remarkably short time, we have become the leading independent supplier.

Tape systems. We've recently begun to concentrate on tape. The result is that our new 1040 Tape Drive combines the features of others with our own experience. We intend to be a leader in this field.

The point is we have not grown by accident. Thirteen years after our beginning, we have become a leader in computer peripherals.

For information on peripheral products, call your local CalComp office, or contact California Computer Products, Inc., EM-M1-74, 2411 West La Palma Avenue, Anaheim, California 92801. (714) 821-2011.

CALCOMP

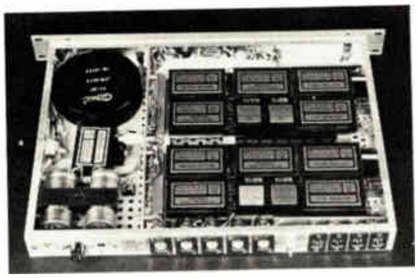
Circle 161 on reader service card

Instruments

Audio unit makes tape range wider

110-dB dynamic range can be recorded, while noise is reduced by up to 50 dB

Similar techniques to those used in the well-known Dolby system for noise reduction in commercial tape recording and fm broadcasting can also reduce noise and distortion in, and increase the dynamic range, of instrumentation tape recorders.



The Burwen Laboratories model 2000 Perfectly Clear Audio Processor is a two-channel instrument that can increase the dynamic range of tape recordings to as much as 110 decibels, at a recording speed of 15 inches per second. Normally, a tape's dynamic range is limited to about 65 dB at 15 inches per second.

To get the increased dynamic range, the Audio Processor compresses the input signal so that, above a certain threshold level, a 3-dB change in the input results in only a 1-dB change in the signal applied to the tape. Below the threshold, the level applied to the tape is directly proportional to the input signal. As a result of this compression, an input signal with a dynamic range of 110 dB is recorded on the tape with only a 55-dB dynamic range. Because the compression is accomplished by high-end gain reduction, rather than low-end boost, distortion due to tape overloading is greatly reduced.

Reducing the recorded dynamic range ensures that the signal on the tape is almost always at a fairly high level. In particular, it is almost always much stronger than the tape noise. On playback, therefore, when the instrument expands the signal to its original dynamic range, tape noise is much less than in conventional "straight" recording systems. Depending upon the particular system, improvements of as much as 50 dB can be achieved.

The model 2000 is designed to cover the audio frequency spectrum, and has a response of ±0.2 dB from 20 hertz to 20 kHz. The response falls off sharply outside this band, so the unit is not suitable for use when low-frequency or dc signals must be recorded.

Price of the standard two-channel system is $6,500. A one-channel version is also available at $3,800. The purchaser of a one-channel system is not penalized if he wants to upgrade his system to two channels, since all chassis are wired for two channels, and a plug-in second channel costs only $2,700. Delivery time is stock to 60 days.

Burwen Laboratories Inc., 209 Middlesex Turnpike, Burlington, Mass. 01803 [351]

Microwave sweeper modules deliver added power

Power modules for the Hewlett-Packard 8620 series microwave sweep oscillators are solid-state devices able to deliver power levels typical of backward-wave oscillators at frequencies above 2 gigahertz. Equipped with one of these modules (model 86330B), an H-P sweeper puts out a guaranteed minimum of 40 milliwatts leveled, from 1.8 to 4.2 GHz. A second module, the 86331B, extends that range 100 MHz.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [352]

4½-digit multimeter offers BCD output

Providing 20,000 counts (4½ digits), the model 41 multimeter provides binary-coded-decimal output for

Think AVX NiGuard™

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AVX

THE CERAMIC CAPACITOR MANUFACTURER

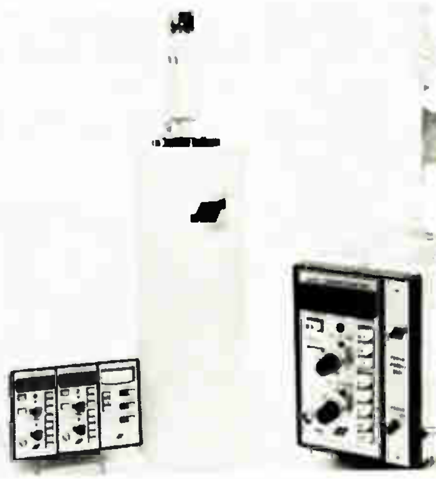
Circle 163 on reader service card

systems applications. The 24-range instrument has four ac voltage ranges with 100-microvolt resolution, five dc voltage ranges with 10-μV resolution, five resistance ranges with 100-milliohm resolution, and five ac and dc current ranges with 10-nanoampere resolution. Power consumption of the multimeter is 8.5 watts. Price is $595, and delivery is from stock.

Data Technology Corp., 2700 S. Fairview Rd., Santa Ana, Calif. 92704 [355]

Sensitive magnetometer measures weak fields

A superconducting magnetometer has a sensitivity of 10^{-9} to 10^{-11} gauss, enabling it to measure weak fields. Coupled with a dynamic range of 100 decibels and low noise, this sensitivity enables the instrument to provide data in a wide range of tests. Applications include measurement of the magnetic field of the heart and magnetization of solid-state physics samples. The in-



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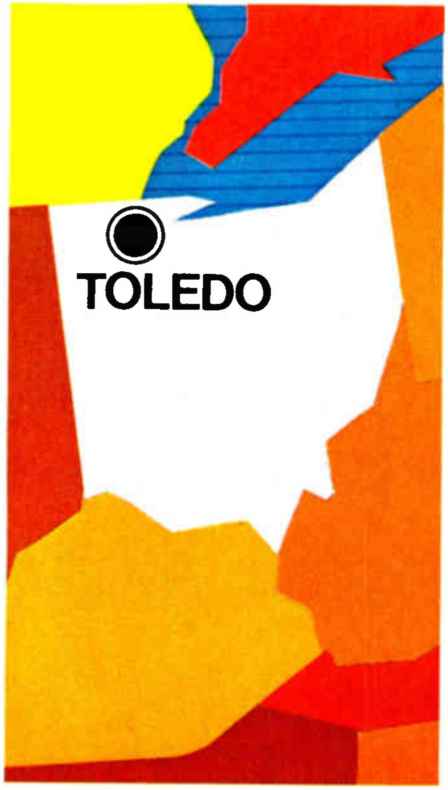

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Circle 165 on reader service card

strument can also be used as a nanoammeter or inductance-bridge null detector. Price is $2,725.

Superconducting Technology Inc., 1166 Independence Ave., Mountain View, Calif. [356]

Microwave synthesizers use octave-bandwidth sources

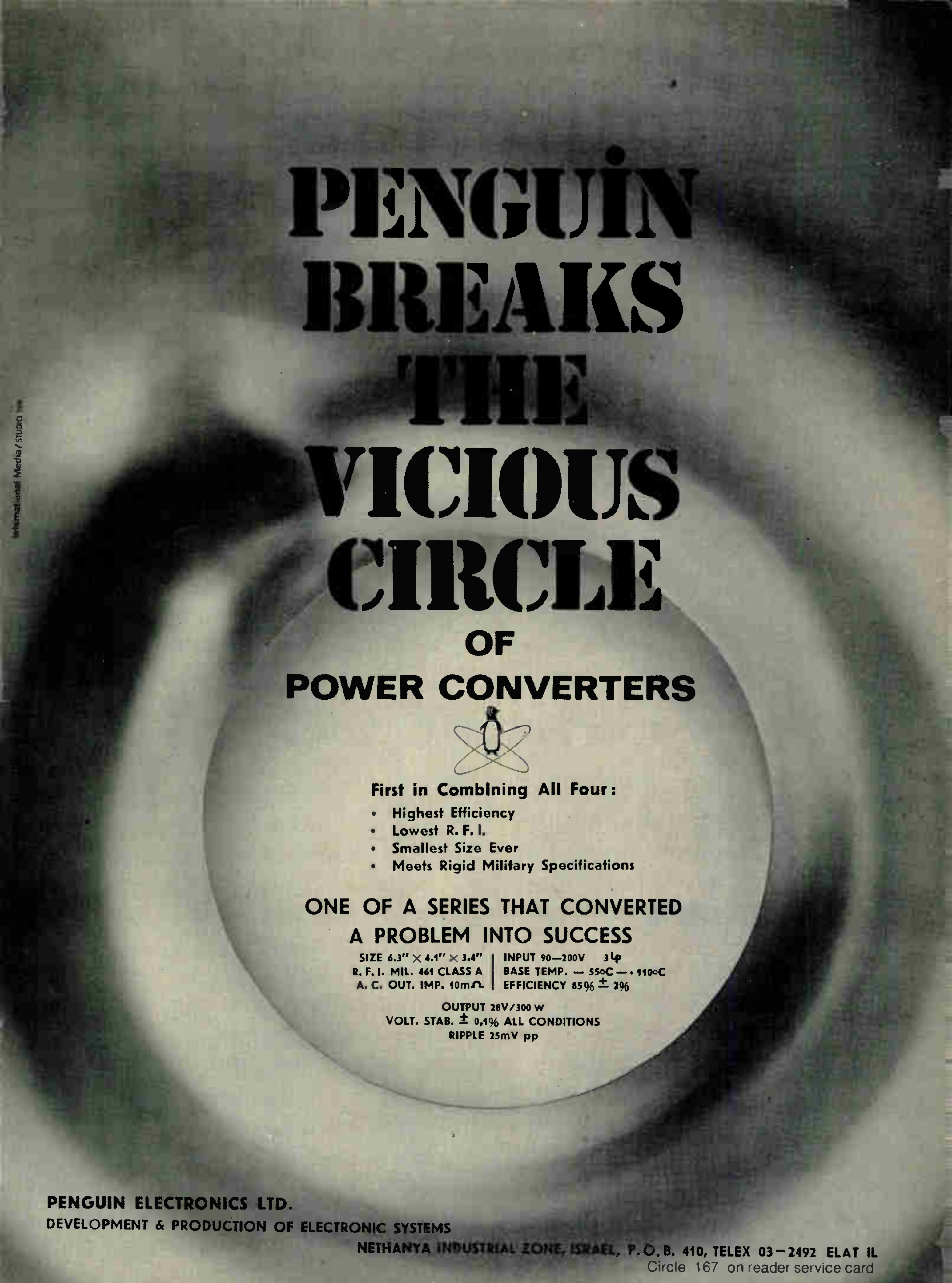
A family of microwave frequency synthesizers uses octave-bandwidth signal sources to achieve good special purity. This method is used instead of external multipliers. The signal sources in the series 1600 have leveled outputs over the range of 500 megahertz to 12.4 gigahertz. All models are based on phase-locking techniques. The model 1603 programable synthesizer, for example, covers 2 to 4 GHz, and is specified with a phase-noise figure of −85 dB at 1 kilohertz from carrier in a 1-hertz bandwidth. Prices range from $12,000 to $18,000.

Systron-Donner, 10 Systron Dr., Concord, Calif. 94518 [353]

Ground-fault simulator tests safety devices

A test set evaluates the effectiveness of ground-fault interrupters and other safety devices in swimming

pools, hospital operating rooms, and in a variety of applications where current leakage is a hazard to human life. The tester, a ground-fault simulator, allows a variable fault condition to be placed on the circuit. The time that is required to shut off the power in the device is measured and held on the display so that the lapsed time can be logged by the

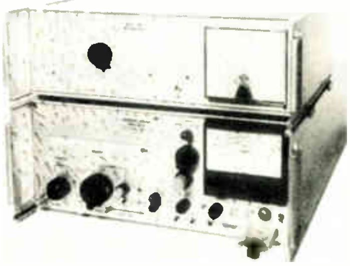


Circle 167 on reader service card

operator of the test system.
Canadian Research Institute, 85 Curlew Dr., Don Mills, Ont., Canada [354]

Metering module checks conformity to standards

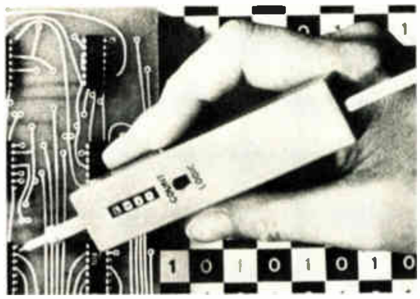
A quasi-peak adapter for the model EMC-25 interference analyzer is designated the model CMM-25. With this addition, the EMC-25 is



capable of making measurements for conformance to 11 widely used electromagnetic-testing standards. Peak readings from the module can be noted on the front panel of the analyzer simultaneously with quasi-peak readings on the adapter.
Electro-Metrics, 100 Church St., Amsterdam, N.Y. 12010 [358]

Logic probe is combined with pulse counter

Said to simplify the testing of digital systems, a logic probe not only displays logic states, but can also function as a fast pulse counter. The model DP-6000, when switched to the counting mode, detects multiple clock and trigger pulses, and requires no accessories or options. It



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can also indicate the presence of spurious oscillations; the three-bit counter is reset by a push button. Price is $66.

Zi-Tech division, Aikenwood Co., 223 Forest Ave., Palo Alto, Calif. 94301 [357]

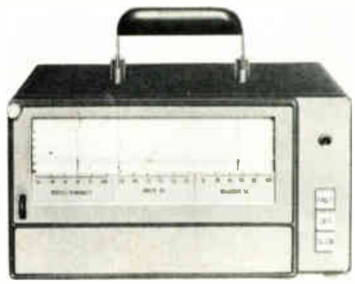
Module provides gaussian white noise to ±1.5 dB

The model NSM 4501 module provides gaussian random white noise to ±1.5 decibels over the range of 20 hertz to 300 kilohertz. Output levels are 20 microvolts per root hertz and 200 µV per root hertz within ±5% from a 600-ohm source impedance. Direct noise amplification from the noise source ensures that the output is free of periodic components inherent in mixer, pseudorandom, and thermionic-generation methods. Price is $171.50.

Advanced Circuit Systems Ltd., Box 11185 Station H, Ottawa, Canada [359]

Miniature servo recorder accepts 100 plug-ins

The model 4300 is a miniature servo recorder that accepts more than 100 plug-in preamplifiers. It records ac and dc volts and amperes, temperature, and various industrial and process-control functions. Accuracy is within ±1% of full scale, sensitivity is 100 millivolts full scale, and response is 2 seconds full-scale deflection. The recorder writes on pressure-sensitive chart paper and requires neither ink nor cartridges.



Gulton Industries Inc., Recorder Systems division, Gulton Industrial Park, E. Greenwich, R.I. 02818 [360]

SCHOTTKY

Every milliwatt counts.

Low-power Schottky lets you design at 2mW per gate without sacrificing speed.

Today's new TTL system designer must look carefully at any option that cuts power consumption.

And low-power Schottky is getting a long look. Here's why.

Low-power Schottky offers more than just 2 milliwatts power dissipation per gate. You also get TTL speed—10 nanoseconds. This reduces your power requirement as much as 80% when compared with standard TTL logic. Low-power Schottky also offers high stability over a broad temperature range.

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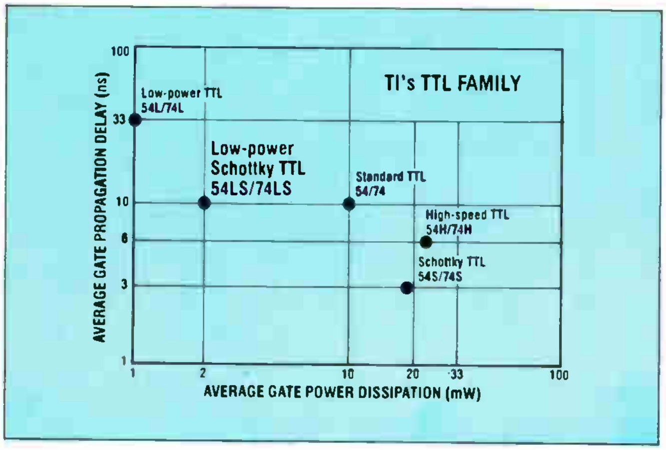

And there's a broad choice of 60 functions—35 SSI and 25 MSI: Decoders/demultiplexers. Data selectors/multiplexers. Shift registers. Arithmetic elements. Dual flip-flops. Latches. Counters. NAND/NOR/AND/OR gates, inverters and buffers. An even larger assortment will be ready later this year.

Availability is excellent—right off the shelf.

For prices and information on the wide selection of 60 low-power Schottky functions, contact your nearest Texas Instruments sales office or your local authorized TI distributor.

TEXAS INSTRUMENTS
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84162

Semiconductors

Impatts pulse at up to 12 W

New diodes promise to replace TWTs in airborne and manpack applications

A new Impatt diode structure—a ring-shaped, double-drift, silicon mesa diode—is expected to lead to the development of low-cost, completely solid-state airborne and battery-powered manpack microwave systems operating at pulse-power and frequency ranges normally covered by small traveling-wave tubes. The new structure, which is suitable for both oscillator and amplifier circuits, also boosts diode efficiency and lowers noise and capacitance, according to the HPA division of Hewlett-Packard Co.

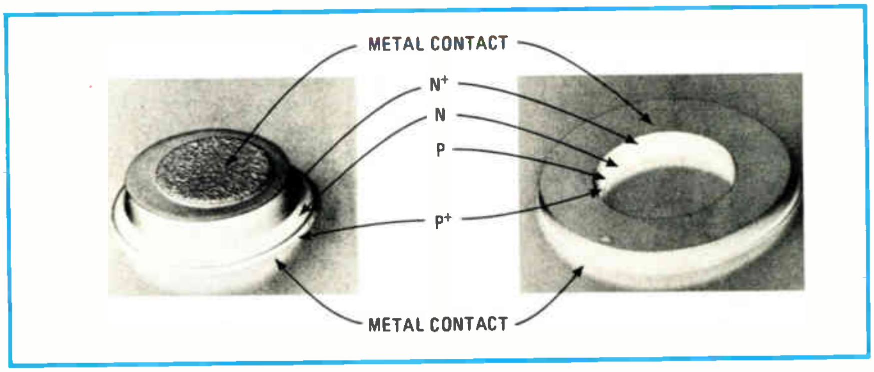
HPA has begun producing four types of diodes numbered 5082-X001 through 5082-X004. The first has an average power output of 3 watts and peak pulse power of 12 W with 11% efficiency when operating at a 25% duty cycle in X band (10 GHz). The second puts out 2.5 W average and 10 W peak at 11% efficiency at a 25% duty cycle in Ku band (16.5 GHz). The last two types are designed for continuous-wave operation, providing 1.3 W and 2.3 W, respectively, at 10% efficiency at 11.2 GHz. Diodes of the same type may also be combined for higher-power outputs (the 2.3 W cw diode, in fact, is two Impatt chips in one package).

Package capacitances are all 0.45 picofarad. Junction capacitances range from 1.3 to 0.35 pF, depending on type. Operating voltages range from 100 to 143 V and operating currents from 900 down to 125 milliamperes—again, depending on type.

The power ratings compare with about 1 W cw at X band, with 6 or 7% efficiency, for conventional single-drift Impatts, points out Bert Berson, R&D section manager responsible for the diodes. His group is now experimenting with higher-power types. Goal is 25 W of pulse and 5 W of cw in production devices. Berson sees the immediate applications of the diodes as small doppler radars and small manpack communications and radar sets. Other probabilities are tiny battery-powered countermeasures transmitters and phased-array systems. The diodes may be operated as narrowband fm-signal sources or as very broadband noise sources. In fm operation, the noise is much less than that of single-drift Impatts (at left, below), though it is not as low as the noise of transferred-electron devices.

"Our pulse diodes may take the place of magnetrons as well as TWTs," Berson says. "We can start thinking of using pulse compression to achieve very high effective powers in airborne systems."

The double-drift diodes (at right, below) are effectively two complementary single-drift diodes fabricated back to back on the same silicon chip. That is, an extra epitaxial layer is fabricated to provide drift regions for holes, as well as electrons. The extra drift increases the diode's efficiency, while the added



Even when it was only $35 an ounce, gold was expensive. That's why we started long ago to reduce the amount of gold in our contacts to a minimum.

In 1958 we developed a really reliable gold dot contact. And no matter what anyone else says, only silver and copper are better electrical conductors than gold (but gold doesn't oxidize or corrode).

Over the years we've been able to reduce the cost because we reduced the gold.

And we've been reducing the amount over the years without reducing the mechanical or electrical quality of our connectors.

Now, after all these years, we find out that we not only reduced cost but we've been making our own small contribution to solving our country's gold problem.

And all because we wanted to design a more economical, more reliable gold-contact connector.

GTE SYLVANIA

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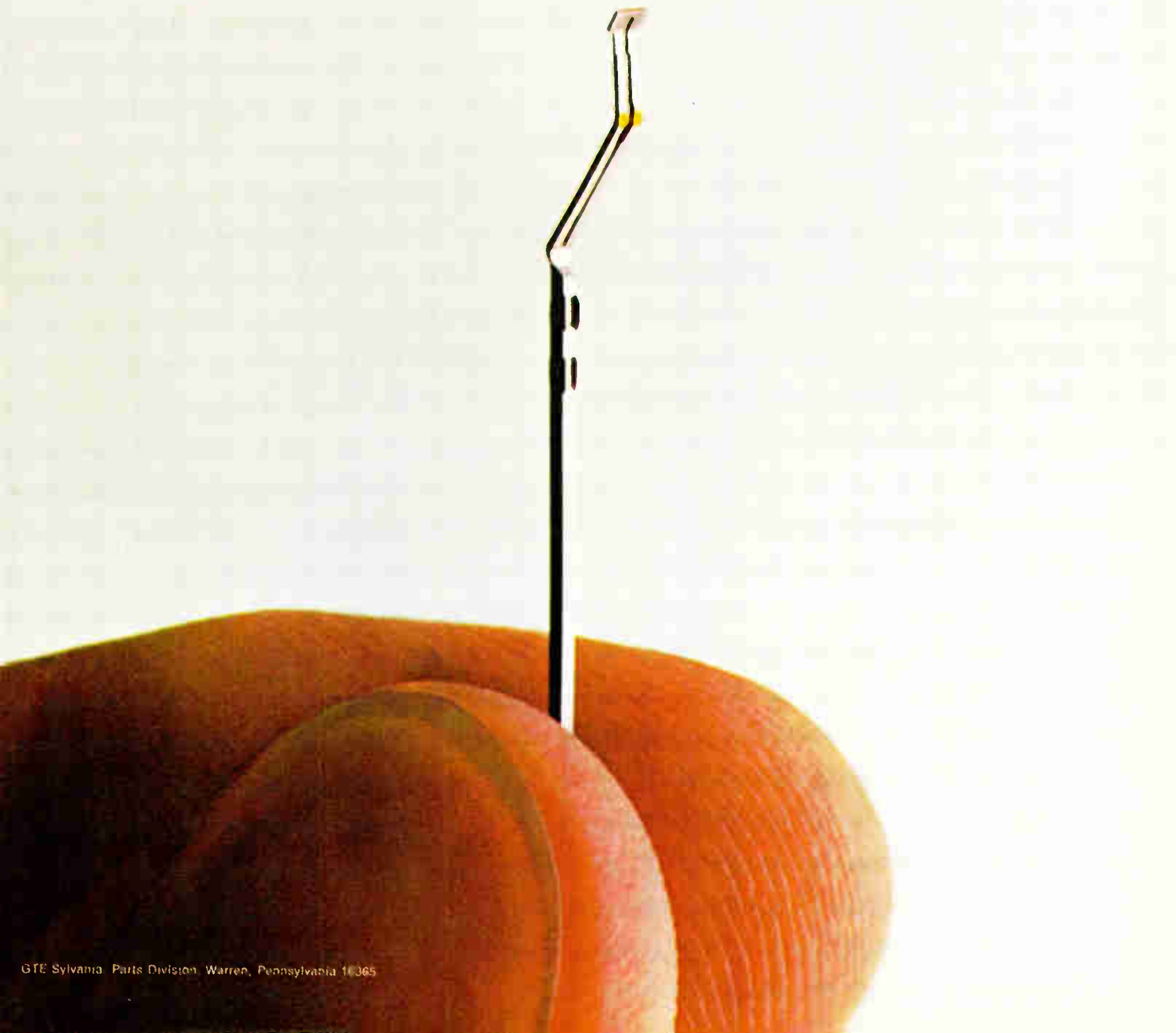
Our small contribution to solving the gold problem.



thickness reduces capacitance.

Cw types look like conventional mesa diodes. But the pulse types have holes etched in the center of each mesa. The shape reduces thermal resistance and makes current density at the central junction more uniform, thus permitting the diodes to operate at higher power densities.

Berson expects the silicon double-drift configuration to become an industry standard, since it could be produced by any company with a well controlled, multilayer silicon epitaxial process. He notes that Bell Telephone Laboratories researchers are also working on double-drift Impatts. In the past, he says, it was necessary to use a much more difficult gallium-arsenide process to achieve powers of several watts. (Raytheon Co. has made 6-w gallium-arsenide diodes, for example). The two pulsed diodes and the 1.3-w cw diode are priced at $200 each in quantities of one through nine and $175 each for 10 or more. The 2.3-w 5082-X004 costs $50 more than the others. All are supplied in type 46 coaxial packages.

HPA Division, Hewlett-Packard Company, 640 Page Mill Road, Palo Alto, Calif. 94304 [411]

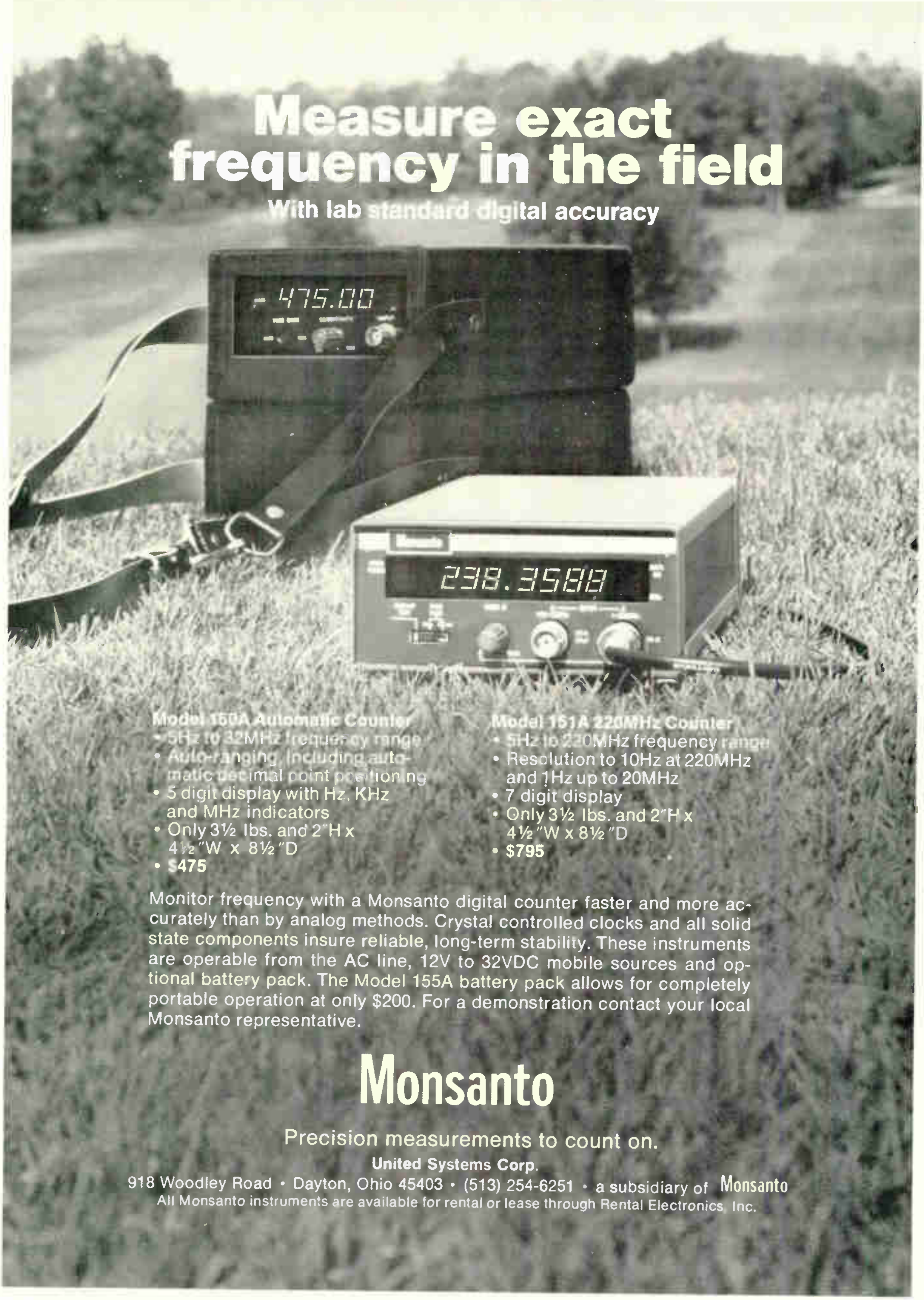
Rf power transistors offer 'true overlay'

Model 1001, with 5 watts output at 400 MHz, and model 1002, 3 w, are rf power transistors providing "true overlay." This structure, using two-level metal processing, eliminates narrow emitting fingers and lossy diffused-base conducting grids. Prices start at $7.45.

Transistor Power Technology Inc., Bee Hill Rd., Williamstown, Mass. 01267 [420]

10-bit converter offers multiplication, low drain

Two achievements of the first C-MOS digital-to-analog converter from Analog Devices Inc. are monotonicity across the operating temperature range and two-quadrant or four-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Monitor frequency with a Monsanto digital counter faster and more accurately than by analog methods. Crystal controlled clocks and all solid state components insure reliable, long-term stability. These instruments are operable from the AC line, 12V to 32VDC mobile sources and optional battery pack. The Model 155A battery pack allows for completely portable operation at only $200. For a demonstration contact your local Monsanto representative.
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quadrant multiplication with 10-bit accuracy, resolution, and linearity. The firm says the converter also sets new lows in price and power dissipation and is compatible with TTL, DTL, and C-MOS logic.

The AD 7520 10-bit d-a converter is basically an R-2R thin-film ladder network with a C-MOS switch in each 2R leg. For unipolar binary operation (two-quadrant multiplication), one operational amplifier such as the AD741K is connected between a feedback terminal and one of the converter's current outputs. The feedback resistor is on the chip. For offset binary bipolar operation, two op amps and the second amplifier's feedback network are connected. That mode provides four-quadrant multiplication.

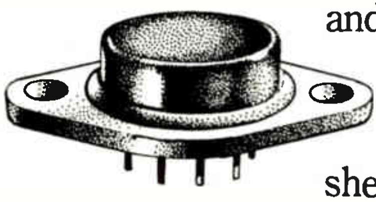
The resistors on the chip are silicon-chromium films deposited with a value of 2 kilohms per square ±30%. Unlike the diffused resistors of conventional bipolar d-a converters, the network resistors need not be closely matched because C-MOS devices do not require current inputs. And, although the temperature coefficient of the resistors is 150 parts per million/°C, the co-deposited feedback resistor cuts gain-error drift to less than 5 ppm typically (maximum is 10 ppm of full-scale range/°C).

Moreover, C-MOS power dissipation is so low—only 30 milliwatts maximum, including resistor dissipation and power-supply drain—that self-heating drift drops to the point where monotonicity can be guaranteed, even over the military temperature range. This is because maximum temperature coefficients of linearity and gain are only 2 and 10 ppm of full-scale range/°C, respectively. Typical drifts are half the maximums.

Other key specifications include: linearity of 0.05% to 0.2%, depending on device type; gain linearity of 0.05% with 100% modulation; and settling time to 0.05% of less than 1 microsecond, including a delay time of 500 nanoseconds. Again, those are maximum percentages of the full-scale range.

This simple, yet stable, network and the small size of the C-MOS chip,

HOW TO TRANSMIT THERMOCOUPLE, STRAIN GAGE AND PRESSURE GAGE SIGNALS WITHOUT A LOT OF SWEAT, HOURS, DOLLARS, INCHES AND OUNCES.

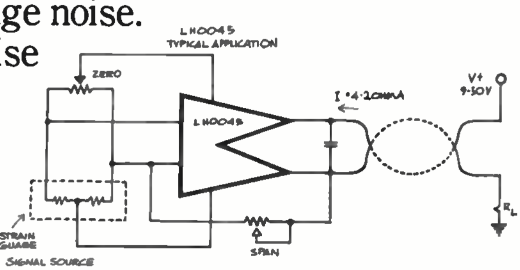


Introducing National's new 2-Wire Transmitter. It converts the voltage from a sensor to current, and sends it through a receiver, utilizing the same simple twisted pair as the supply voltage.

No sweat. You buy it off the shelf, instead of having to juryrig your own transmitters.

So naturally you save a lot of size, weight, effort, time, and since time is money — money.

Goodbye noise. But the 2-Wire Transmitter eliminates more than juryrigging hassles. It also eliminates line drops and voltage noise.



Line drops and voltage noise can only happen when your signal is being transmitted in the voltage mode. But we transmit in current mode...which is impervious to either resistance in the wire or voltage noise spiking. So you get fewer bugaboos all the way around.

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For the full story call our nearest office or write National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051.

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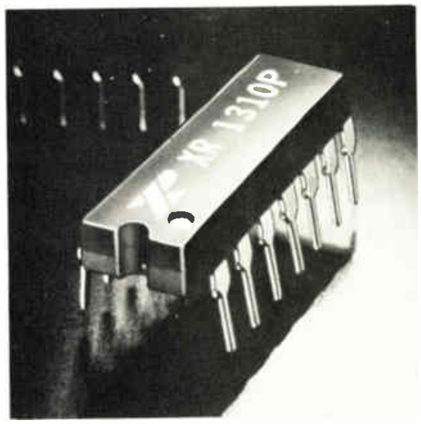
National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051; Scottsdale, Ariz. (602) 945-8473; Mountain View, Calif. (415) 961-4740; Sherman Oaks, Calif. (213) 783-8272; Tustin, Calif. (714) 832-8113; Miami, Fla. (305) 446-8309; Chicago, Ill. (312) 693-2660; Indianapolis, Ind. (317) 255-5822; Lenexa, Ka. (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, Texas (214) 233-6801.

which measures 74 by 96 mils, account for the prices, lower than those of hybrid devices. Prices in quantities of 100 and higher are $17 for commercial-grade units with linearity within 0.2% up to $65 for military-grade devices with linearity to 0.05%. Nine grades are available from stock in 16-pin DIPs.

Analog Devices Inc., Rte. 1 Industrial Park, P.O. Box 280, Norwood, Mass. 02062 [412]

Phase-locked loop is for stereo demodulator

An fm-stereo demodulator uses a phase-locked-loop technique to derive the right and left audio signals from the composite audio signal. As a result, the model XR-1310 needs no external LC tuning tanks, and instead is aligned with a noncritical potentiometer adjustment. In addition, the stereo/monaural switch is inside the unit, which has a 100-milliampere direct lamp-drive capability. These features help minimize the number of external parts needed, besides saving on cost and



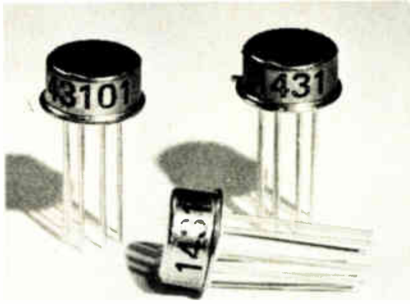
package count. Price is $3.30 each in 100-lots.

Exar Integrated Systems Inc., 750 Palomar, Sunnyvale, Calif. 94086 [413]

FET op amps have 100-MHz gain-bandwidth product

The models 1431 and 143101 FET operational amplifiers are recommended for high-impedance, high-

Circle 180 on reader service card



frequency applications such as sample-hold amplifiers, buffer amplifiers for data-acquisition systems, and wideband interrogators. The units feature a full 100-megahertz gain-bandwidth product measured at a closed-loop gain of 10 and a slew rate of 35 volts per microsecond. They offer an open-loop gain of 150,000 and input impedance of 10^{12} ohms, also bias currents of 1 picoampere, to virtually eliminate source-loading and bias-current errors, while the output circuit provides an output current of ±18 milliamperes. Model 1431, rated for operation from 0 to 75°C, is priced at $13.50 each for 100 to 999, and the 143101, rated for -55° to +125°C, $18.60 each.

Teledyne Philbrick, Allied Dr. at Rte. 128, Dedham, Mass. 02026 [415]

Schottky TTL counters are presettable and fast

Two presettable, high-speed Schottky TTL counters, the model 82S90 decade counter and the model 82S91 binary counter, provide a wide variety of counter and storage-register applications. The binary counter may be connected as a divide-by-two, -four, -eight or -16 counter. Both devices have strobed parallel-entry so that the counter may be set to any desired output state. A 1 or 0 at the input is transferred to the associated output when the strobe input is at the 0 level. Both units are also provided with a reset input that is common to all 4 bits. Clock frequency is 100 megahertz. Price is $3.15 in 100-lots.

Signetics, 811 East Arques Ave., Sunnyvale, Calif. 94086

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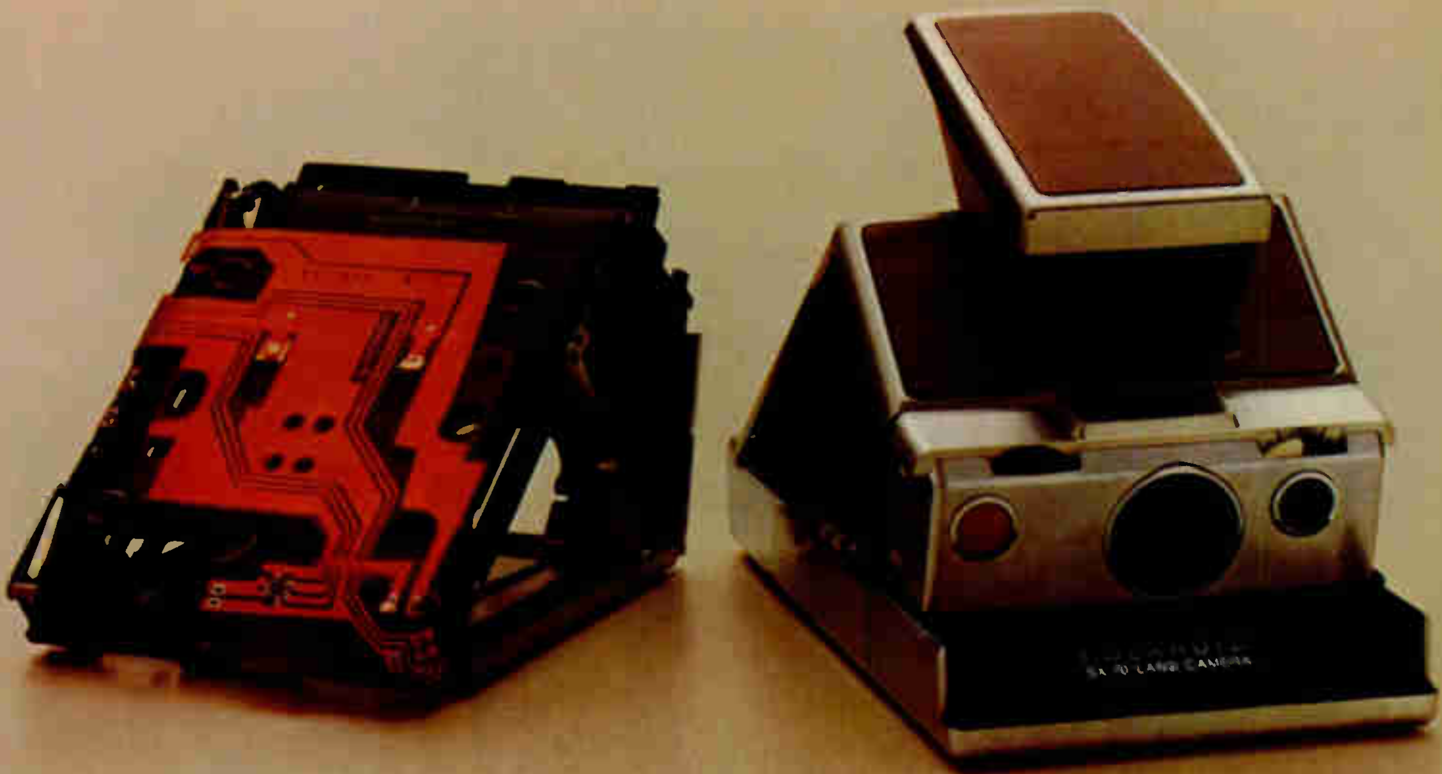

And we can do it for you.

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Circle 181 on reader service card

New products

Data handling

Disks include safety features

Minicomputer peripherals are protected against dirt, heat, and erasure

"People are now doing the same thing—payroll, accounting, for example—on small systems that they have been doing with large ones, so they need [minicomputer peripherals with] the reliability and safety interlocks that didn't seem so vital in the past," says Donald A. Savitt, director of engineering at Microdata.

That's why the company's new series 8000 disks incorporate many safety features previously found only in larger units for use with larger computers, even though they are being sold at the price standard for the IBM 5440 type cartridge with one fixed and one removable disk. The new units replace disks that have been sold by Microdata but made by another company.

In making its own peripheral devices, Microdata resembles other minicomputer companies that also want an increasing share of a growing systems business as well as more control over the products they make. The disks follow a tape driver series, Microdata's first venture into the manufacture of peripherals, and will be followed by vacuum-column tape drives and cathode-ray-tube terminals.

A major effort in the design of the series 8000 went into protecting the disk drives against dust and other particles. Instead of simply depending on the rotation of the disk spindle, an extensive pressurized filter system that uses a separate blower is employed. This provides a flow from the disk surface of about 35 cubic feet per minute rather than about 5 ft^3/min. The blower also helps cool the unit, an important consideration in view of the high heat dissipation that results from the disk's high speed and density.

The drives also incorporate several electrical and mechanical safety measures and interlocks. An electrical cutoff in case of power failure—an ever-increasing problem—assures that a swath of the disk won't be erased. Other circuits protect against multiple head select, erase failure, sector erase lock out, overvelocity on the linear motor, and incorrect disk speed.

The linear motor is a radial-field version in which the coil never leaves the field of the magnets, resulting in lower mass and potentially higher speed. The magnets are ceramic rather than alnico. The positioning is optical.

The disk drive is mounted on a single large aluminum casting with integral airflow. It is designed for easy servicing, with six LED fault-indicator lamps, modular electrical and mechanical units, and plug-in circuit boards.

Basic price for a 5-megabyte unit is $3,900 in single quantity, and various models offer 2½, 5 and 10 megabytes, 100 to 200 tracks per inch, and 1,500 and 2,400 rpm. The company offers the drives plug-for-plug-compatible with units made by various suppliers. Units measure 8.75 inches high, 19 in. wide, and 28 in. deep.

Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92705 [361]

Speech-recognition system responds to specific words

An automatic speech-recognition system is designed to respond to individual spoken words—in fact, unlike a sound-actuated switch, only to that word or group of words programed into it. Simply pressing an access button and speaking the specified words into a microphone is enough to operate the unit.

Part of the system consists of an analog-to-digital converter, which changes the applied speech waveforms into digital formats. In turn, this information is applied to a memory-logic system, which identifies the speech pattern and stores it;

New products

additional modules permit a number of the words to be stored. Applications include industrial process control, security, materials handling, and physical therapy.

Shields Products Inc., 1104 Prospect Ave., Cleveland, Ohio 44115 [363]

Teletypewriter modem is Bell-compatible

An automatic answer-originate data modem is designed for teletypewriter and TWX users and is called the model TTY-10C. It is fully compatible with the Bell System's 101C and 103 series datasets and provides several switch-selectable operating modes, including answer-originate, voice-data, half or full duplex, on-line-local, normal-test, and out of service. The modem also features echo-back, framed break signal, automatic answer, call-abort timing, and several optional capabilities.

Penril Data Communications Inc., 5520 Randolph Rd., Rockville, Md. 20852 [365]

Control store upgrades minicomputer in the field

The Interdata model 80 minicomputer is now field-upgradable to the model 85 with the addition of a dynamic control store module. The unit is intended for users who foresee an eventual need for user-alterable microprograming but who want to initiate development software immediately. The model 85 is identical to the model 80, except for the addition of the 60-nanosecond, 4,096-byte bipolar-LSI dynamic con-

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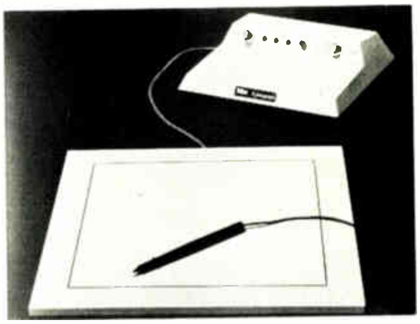
After three years, Matrix is still the industry standard.

Circle 185 on reader service card

trol store in the model 85. Price of the module is $8,900.
Interdata Inc., 2 Crescent Place, Oceanport, N.J. 07757 [366]

Tablet converts writing into digital formats

Designated the Cybergraphic tablet, a new system digitizes hand-drawn or marked data for input to a computer or communications system. The unit senses and tracks pen position on its surface and translates this position information into analog or digital signals. The process is based



on an all-electronic writing servo principle, and the tablet itself is only 0.3 inch thick. Moreover, unlike many other tablets of this nature, the Cybergraphic tablet has a drawing surface that is completely flat, flush with the tablet's frame. Price is $1,000 to $2,500.
Talos Systems Inc., 7311 E. Evans Rd., Scottsdale, Ariz. 85260 [364]

Modem's filter eliminates foldover distortion

The model 202 modem features a digital filter system that eliminates data distortion caused by modu-

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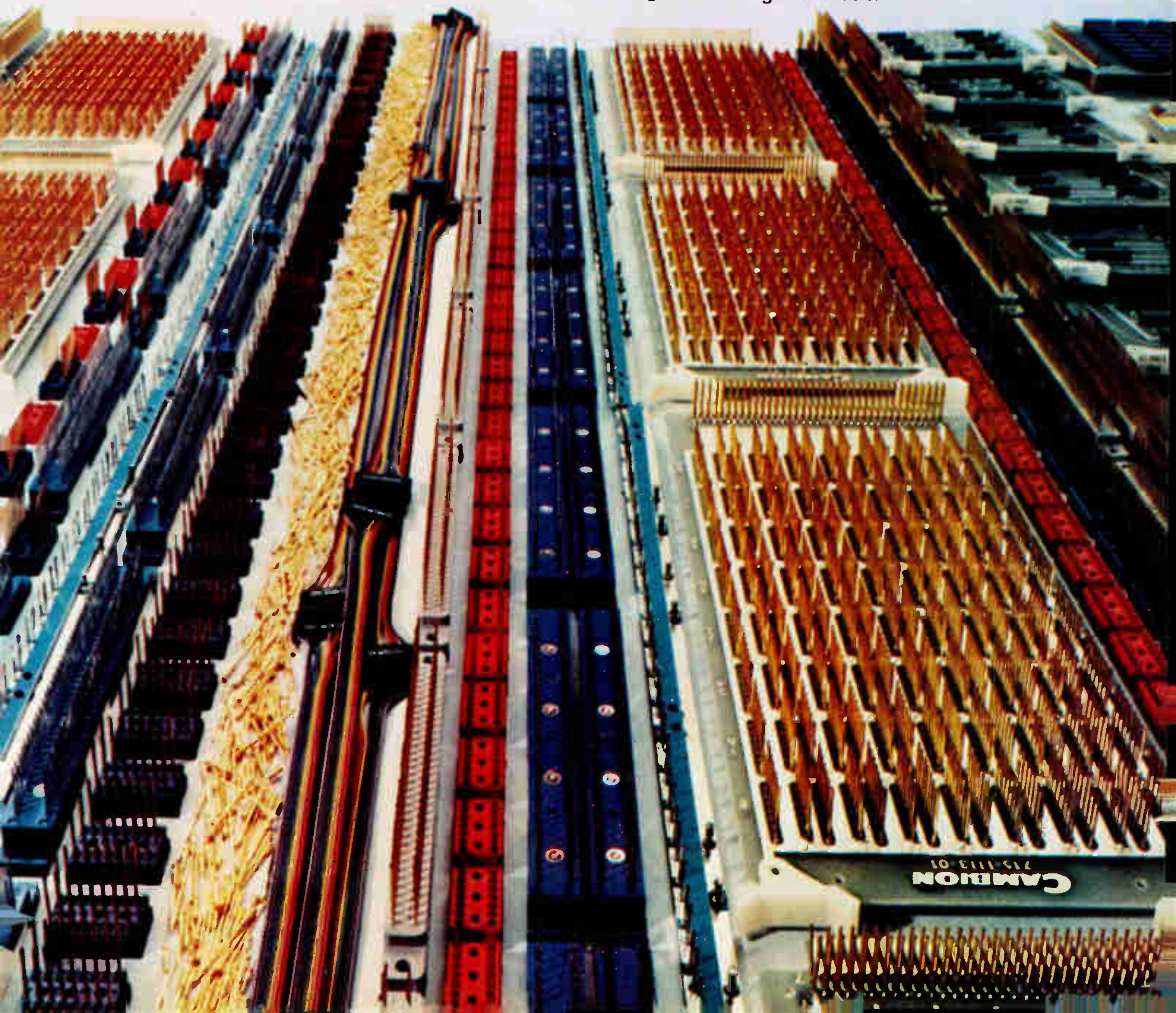


lation-product foldover. It is claimed that the digital technique improves performance at the rates of 600 and 1,200 bits per seconds and also permits communications between the model 202 at 1,800 bits per second over unconditioned or switched network telephone lines and at 2,000 bits per second over C2-conditioned private lines. The unit uses crystal-controlled digital transmitters and receivers to achieve stability, and it is unaffected by temperature or supply voltage drifts. Price starts at $205, and delivery is from stock.

Timeplex Inc., Norwood, N.J. [367]

Tape subsystems are for Univac computers

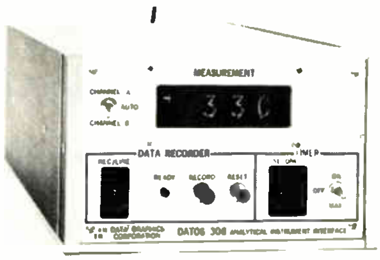
The 3400-3820 series of tape subsystems from Storage Technology Corp. are designed for Univac central processors. These units, which are plug-to-plug- and program-compatible with the Univac 418, 494, 1106, 1108, 1110, will replace the Uniservo 6C, 8C, 12, 16, and 20 tape subsystems. The 3400 series tape drives are the company's standard units, while the 3820 control unit is the company's 3800-III redesigned for correct connection to the word-parallel interface of the Univac units. A Univac multiple subsystem adapter is not required for this connection. Two-year lease for a typical subsystem is $4,570 per month, a price that includes maintenance, and the purchase price for the same subsystem is $189,600.

Storage Technology Corp., 2270 S. 88th St., Louisville, Colo. 80027 [368]

Data-acquisition unit links with instruments

The Datos 308 is a two-channel miniature data-acquisition system designed for users of such instruments as spectrophotometers, colorimeters and gas chromatographs. The 308 is connected in parallel with the instrument's strip chart recorder or directly on the output of

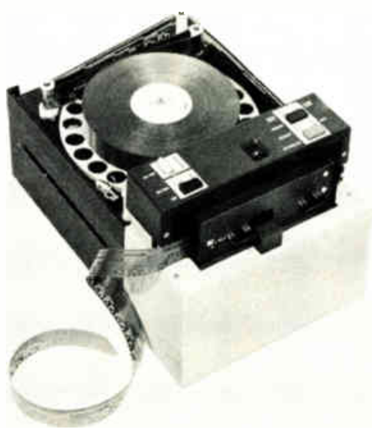
the sensor or its amplifier. The signals are then digitized at 60 times per second, formatted, and sent to a teletypewriter, programable calculator, magnetic-tape unit or paper-tape punch, or a computer. Price is $2,145.



Data Graphics Corp., 8402 Speedway Dr., San Antonio, Texas 78230 [369]

Paper-tape reader uses LED source

Eliminating problems caused by variations of light and temperature, the model 4020 paper-tape reader uses a light-dispersion reading method in which light-emitting diodes are the light source. As a result, the machine can read tapes that are up to 80% transparent. The tape reader tolerates 6% spacing errors and operates at speeds up to 300 characters per second. It is easily adaptable to existing systems and has applications in data transmission, typesetting, numerical control, and data processing.



Facit-Addo Inc., 501 Winsor Dr., Secaucus, N.J. 07094 [370]

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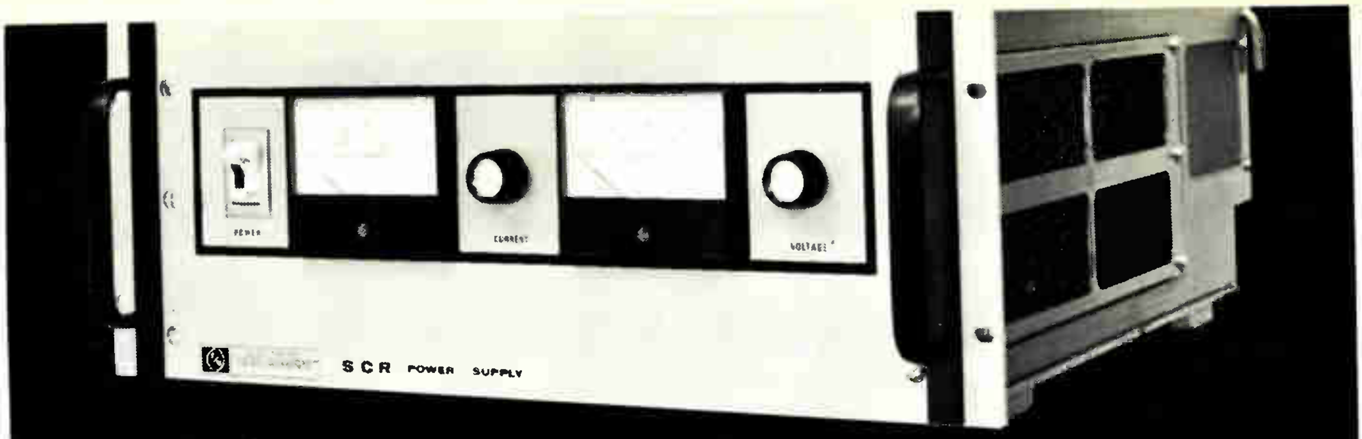

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	Price	
Rating	EM	SCR
6V-600A	$1,600	$2,000
7.5V-300A	1,200	1,400
10V-250A	1,200	1,400
10V-500A	1,600	2,000
20V-125A	1,050	1,200
20V-250A	1,275	1,500
20V-500A	2,050	2,650
30V-100A	1,050	1,200
30V-200A	1,450	1,800
40V-60A	950	1,100

	Price	
Rating	EM	SCR
40V-125A	$1,300	$1,600
40V-250A	1,975	2,500
50V-200A	1,975	2,500
80V-30A	950	1,110
80V-60A	1,200	1,500
100V-100A	1,975	2,500
120V-20A	975	1,300
120V-40A	1,200	1,500

	Price	
Rating	EM	SCR
160V-15A	$ 950	$1,100
160V-30A	1,300	1,600
160V-60A	1,975	2,500
250V-10A	950	1,100
250V-20A	1,300	1,600
250V-40A	1,975	2,500
500V-5A	1,300	1,500
500V-10A	1,600	2,000

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See EEM Vol. 1, Pages 791, 792, 793 for additional product information.

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Communications

Tester isolates network faults

Checkouts of lines, modems, terminals achieved without assistance of remote site

Troubleshooting multipoint polled communications networks has always been a problem. In order to test the lines, operator intervention at remote sites is required, and communications must be interrupted. It

can also be difficult to isolate faults to specific lines, drops, or network elements. Now, Intertel Inc., has taken a systems approach to network diagnosis with its MPT 500 multipoint tester, which can test and isolate faults in modems, telephone lines, and terminals in a network with up to 12 multipoint lines and as many as 40 drops per line, the company says.

Tests are run on a full-duplex, 75-baud, asynchronous, out-of-band test channel between the MPT 500 and a remote-site module, the MP 750, mounted on a printed-circuit card 13.64 by 7.50 inches, that plugs into each Intertel modem on the network. This bandwidth is narrow enough to go through lines, no matter how bad they are, even when the data channel cannot operate, Intertel claims.

The MPT 500 runs three varieties of tests, none of which requires assistance at the remote sites. After the operator's switch selects the line and drop to be tested, he runs a series of six on-line diagnostic tests for remote terminals, including modem power, line continuity, terminal disabled, terminal power, modem test, and monitoring of the EIA connector pins. All these tests can be run automatically in less than a minute. Special-function tests can also be run on-line by the test system.

The network must be taken offline to test the transmitter, receiver, and error-detect capability of the central-site modem, to check line quality in line loopback, transmit/receive quality, and to insert transmit and receive errors. Line-error rates on transmit/receive line-quality tests are digitally displayed by the system.

Transmission is over a 600-hertz frequency-shift-keyed carrier. A speaker mounted behind the front panel enables audio-signal monitoring. Speaker straps allow the user to hear input to both data and test channels, or only the data channel. And an LED display on the front panel displays line and drop numbers, name of current test, and test status. Channels not being tested are switched through the MPT 500 with relays.

The instrument, mounted in a standard 19-inch rack, includes one transmitter and one receiver, two channel selectors, modulator and demodulator, TTL logic for tests and display, and factory-programable bipolar ROMs for display memory.

The MP 750 acts as a modulator and demodulator, receives and decodes commands, controls tests at remote sites, and transmits back test results. Because it often must communicate under adverse conditions, a valid command must conform to a format check on two successive transmissions before the 750 will go into the test mode. A battery-powered 300-hertz oscillator transmits an alarm to the central site when ac power is lost at a remote modem. Self-test hardware is also included.

The units, which are compatible with all Intertel modems, test at speeds from 1,200 to 9,600 bits per second. The MPT 500 will lease for $225 a month on two-year leases, and each MP 750 will lease for $16

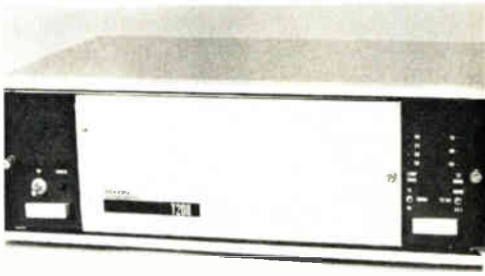
a month. Purchase prices are $7,500 and $450 respectively.
Intertel Inc., 6 Vine Brook Park, Burlington, Mass. 01803 [401]

Full-duplex modem has high insensitivity to noise

Wherever simultaneous two-way transmission of data on two wires is required, multiplexing has to be used. And wherever data has to be transmitted over bandwidth-limited or noise-corrupted links, a sophisticated modulation scheme is needed. Both requirements are said to be met by the HG-1010 modem developed by Girsberger, of Eglisau, Switzerland. The full-duplex unit—except for the filters and a limiter—is fully digital and needs no tuning or readjustment. The modem operates with differential-phase-shift-keying modulation, which the company says assures a high insensitivity against noise on the transmission channel. A digital phase-locked loop is included to assure the regeneration of the necessary clock signals at the receiving side. In order to keep the modem simple, easy to maintain, and independent of any supplier of integrated circuits, no large-scale or custom-designed ICs have been used in the unit's design.
Girsberger Elektronik, CH-8193 Eglisau, Switzerland [402]

Data set offers rate of 4,800 bits a second

Offering a 4,800-bit-per-second rate, the model T208A dataset operates in a synchronous full-duplex config-



New products

uration on dedicated, unconditioned voice-grade lines. It is end-to-end compatible with the Western Electric 208A set. An automatic equalizer continuously adapts the T208A to changing line characteristics so that operator attention is not necessary. Turnaround time is 50 milliseconds, and a synchronous capability allows for use in polling applications. Price is $3,750.

Rixon Inc., 2120 Industrial Parkway, Silver Spring, Md. [405]

Miniature laser system puts out 6-watt pulses

A miniature laser system for sensing and communications is designed to replace cables and conduits. The injection lasers and receivers can be operated with rechargeable batteries at a range exceeding one mile. Short, high-energy light pulses of 6 watts peak power and pulse width of 15 nanoseconds separate the signals from the background. Laser repetition rate is controllable up to 20,000 pulses per second for pulse-position-modulation communications, and rise time is 600 × 10^{-12} seconds. Price of a system is less than $1,000, including modulator and power supply.

Electronic Products for Industry, 1241 Birchwood Dr., Sunnyvale, Calif. [403]

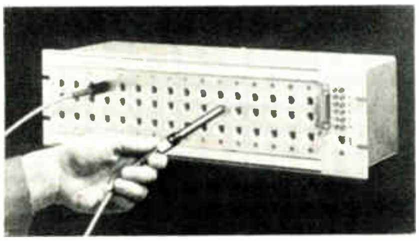
Interface allows 16 Novas to communicate directly

A 1-megaword-per-second multicomputer interface is designed specifically for Nova computers and is called the MCI-10. The device per-

mits as many as 16 Novas to communicate directly from memory to memory at a 1-megahertz 16-bit word rate. Computers can be separated by as much as 250 feet. Price is $3,800 per computer.
Elsytec Inc., Syosset, N.Y. [404]

Patching system transfers data with one patchcord

An EIA standard RS-232 interfacing and patching system, called the Dyna-Patch, is designed to transfer an entire EIA duplex data circuit, together with clock and control signals, by means of a single patchcord, thus permitting flexibility in rearranging interconnections in a data system. The unit's jacks provide normal through-circuits without the use of any patchcords. Alternate circuit connections are made by inserting a single 12-conductor shielded patchcord. Circuits may be monitored or tested without interruption by patching to a monitor jack, where signals appear at individual test points through an EIA standard 25-pin connector.

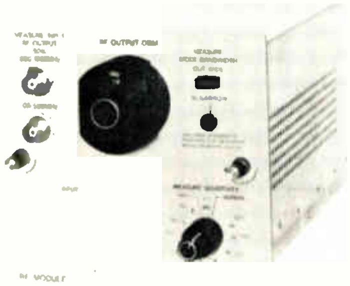


Cooke Engineering Co., 900 Slaters La., Alexandria, Va. 22314 [406]

Plug-in module doubles monitor's frequency range

Called the RFM 11-A, a plug-in module increases the maximum capability of the Singer FM-10C communications-service monitor from 512 megahertz to 1.3 gigahertz. This equips the monitor to service transmitters and receivers in the following band assignments: common carrier, Tacan/DME, air-traffic-control radar beacons, and the proposed

New products



new 900-megahertz assignments for land-mobile radio. Price is $1,295.
Singer Instrumentation, 3211 S. La Cienega Blvd., Los Angeles, Calif. 90016 [407]

All-electronic PABX handles up to 600 lines

An all-electronic private automatic branch exchange is made with large-scale integrated circuits so tiny that 64 switching crosspoints fit into an area the size of a pencil point. The system handles up to 600 lines and is of modular construction. The LSI chips, only 0.03-inch square, in the model 600 also contain the logic needed to set up and maintain telephone connections. Similar-size chips are used for control functions. The result is a system that is said to be 1/10th the size of most electromechanical switches in current use.
RCA Government and Commercial Systems, Moorestown, N.J. [408]

Data compressor, modem system cuts line costs

A data compressor and modem system, called the FacDac, can connect to most popular facsimile transceiver-telecopiers and is said to be able to reduce long-distance telephone costs by at least 80%. The unit works on unconditioned dial-up lines and offers a transmission time of about 30 seconds for a typical business letter. Four operational modes are provided: record, transmit, receive, and print.
Karr Data Communications, Box 1287, 9601 Sunset Blvd., Beverly Hills, Calif. 90213 [409]

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Circle 249 on reader service card

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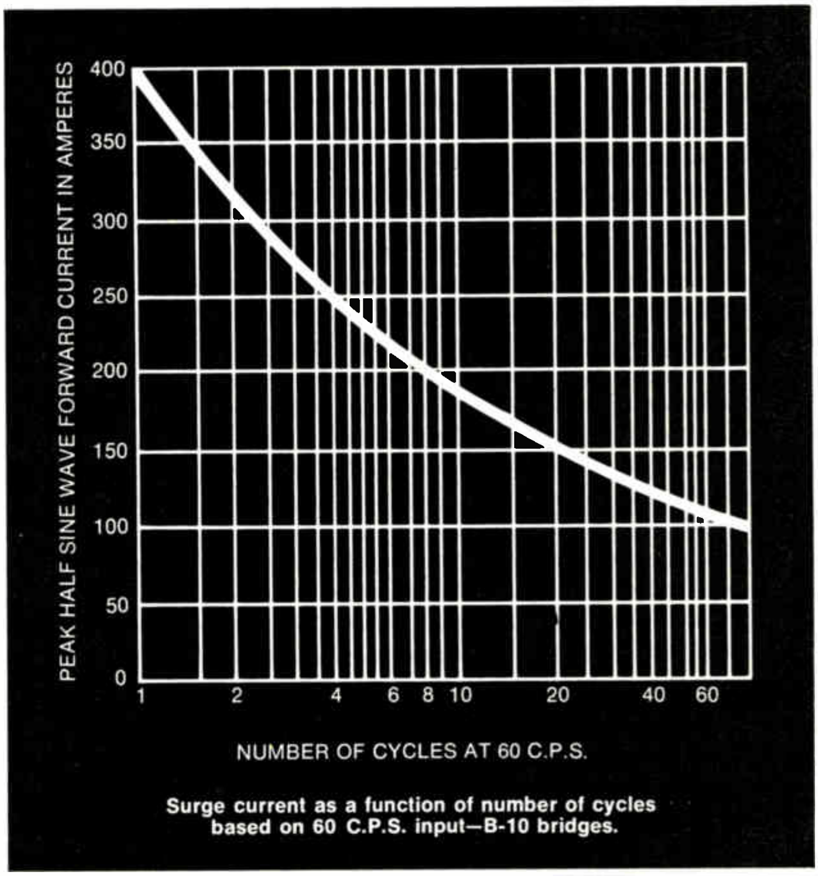
We bridged the forward surge gap. For extra protection.

Our bridge rectifier ratings for DC output and forward surge capacities are substantially greater than those of competitive devices. Even though our physical dimensions are the same.

So, our single phase and three phase bridge rectifiers provide important added safety at normal operating levels.

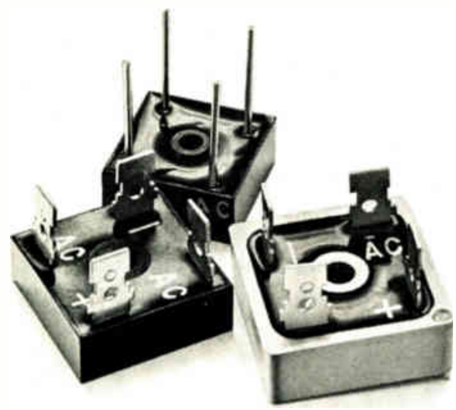
You no longer have to take the chance of using a marginally rated bridge rectifier and running the chance of expensive down time and replacement costs.

Wagner single and three phase bridge rectifiers as well as center tap rectifiers come in standard size packages. Only our current ratings and forward surge ratings are higher.



Surge current as a function of number of cycles based on 60 C.P.S. input—B-10 bridges.

B-10 Series. DC rating-30A@75°C Case. Forward Surge rating-400A@ *rated load.* B-10 Series replaces look-alike bridges rated up to 25A and from 50 to 1,000 PRV per leg.



B-40 Series. DC rating-15A@75°C Case. Forward surge rating-300A@ *rated load.*

B-50 Series. DC rating-10A@75°C Case. Forward surge rating-300A@ *rated load.*

For additional information on Tung-Sol® bridge rectifiers, write to: Tung-Sol Division, Wagner Electric Corporation, 630 West Mt. Pleasant Avenue, Livingston, New Jersey 07039.

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LFE Digital Panel Meters, Digital Control Meters, and Digital Temperature Indicators are available in models ranging from 2½ digits to 4¾ digits. For complete specifications and for applications assistance on LFE's Digital Panel Meters, Digital Temperature Indicators, and Digital Control Meters, call or write LFE Corporation, 1601 Trapelo Road, Waltham, Massachusetts 02154, telephone (617) 890-2000.

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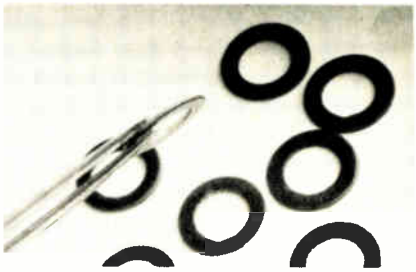

Ceramic wear parts, claimed to have the hardness of tool steel, are made to print in fully fired Aremcolox Grade 502-1100 ceramic. After curing, the material exhibits a hardness of 6 on the Moh's scale. The material can also be polished to a 6-microinch finish. Applications for the parts are in computer tape guides and resistance-welding jigs.
Aremco Products Inc., Box 429, Ossining, N.Y. 10562 [476]

An RA-type flux is said to offer greater soldering capabilities than military R- and RMA-type fluxes. Known as Lonco resin flux 106-A, the material has good wetting, capillarity, and solder-flow characteristics, especially on single-sided or through-hole solder-plated circuits. Corrosion potential is 60,000 ohms-per-centimeter resistivity.
London Chemical Co. Inc., 240 Foster Ave., Bensenville, Ill. 60106 [477]

A thermosetting resin, called Dienite, for use in circuitry and molded components, provides good insulation, along with heat resistance for intermittent exposures of up to 500°F. The material also cures rapidly, can be made soft or flexible, and exhibits low moisture absorption and long storage stability. It can also be made flame-resistant or self-extinguishing.
The Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron, Ohio 44317 [478]

A modified lithia-alumina-silicate ceramic is a refractory material that is primarily used in the brazing of ceramic-to-metal subassemblies, such as semiconductor rectifiers, diodes, transistors, and flatpacks. The material exhibits virtually zero coefficient of linear expansion.
Krohn Ceramics Corp., 211 Seventh Ave., Hawthorne, N.J. 07507 [479]

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36 DIFFERENT CONVERSIONS

LENGTH
IN. ⟷ CM. YD. ⟷ M.
FT. ⟷ M. MI. ⟷ KM.

AREA
IN.^{2} ⟷ CM.^{2} YD.^{2} ⟷ M.^{2}
FT.^{2} ⟷ M.^{2} MI.^{2} ⟷ KM.^{2}

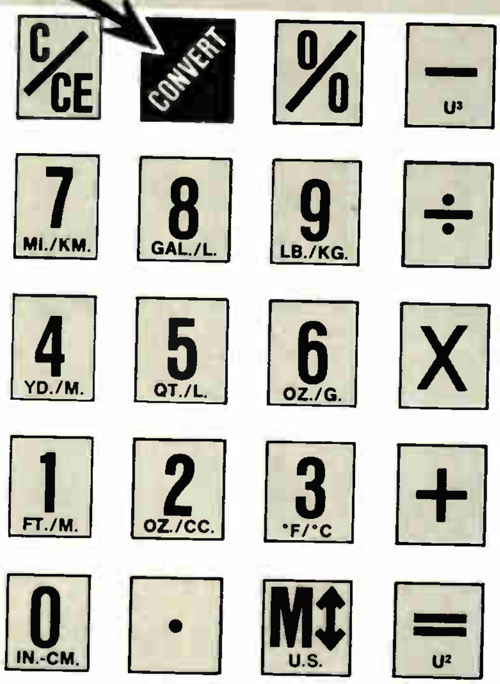
VOLUME
IN.^{3} ⟷ CM.^{3} YD.^{3} ⟷ M.^{3}
FT.^{2} ⟷ M.^{3} MI.^{3} ⟷ KM.^{3}

LIQUID
OZ. ⟷ CC. QT. ⟷ L.
GAL. ⟷ L.

MASS
OZ. ⟷ G.
LB. ⟷ KG.

TEMPERATURE
°F ⟷ °C

FIVE FUNCTION CALCULATION WITH MEMORY



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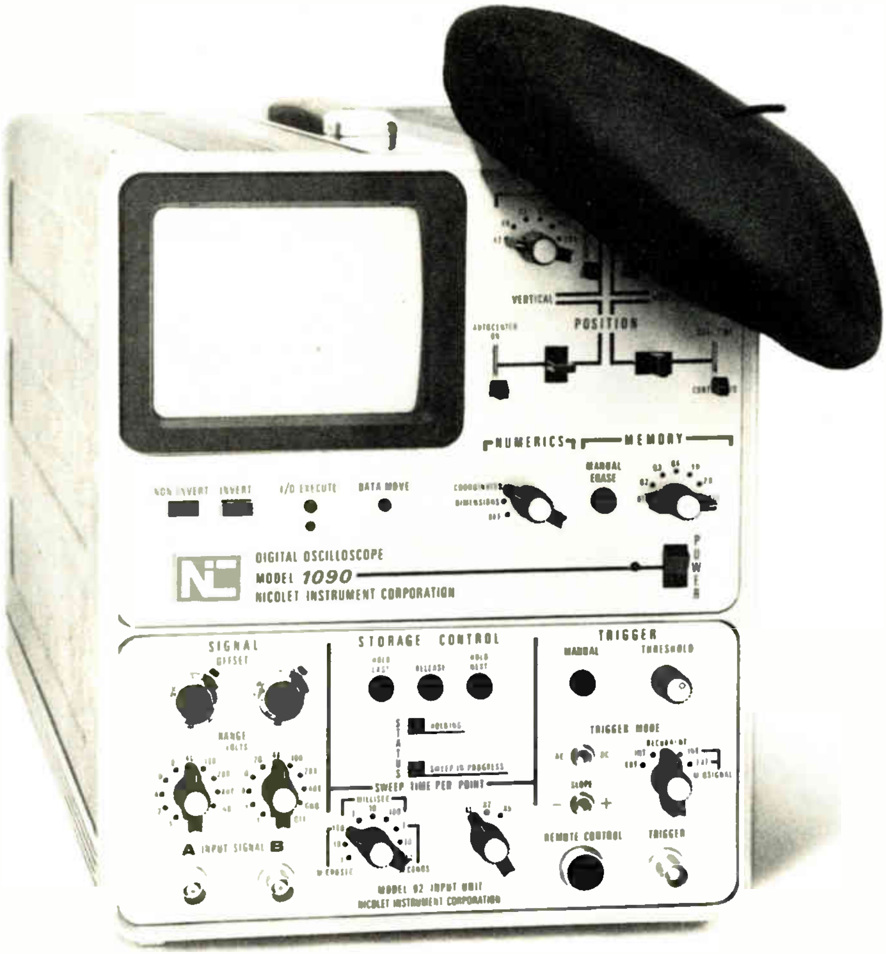

VIVE LA DIFFÉRENCE!

Storage is more than phosphor deep in the Nicolet 1090 Digital Storage Oscilloscope

At first glance the 1090 may look like a typical storage oscilloscope, but practically the only similarity is the presence of a CRT. The differences run the gamut from higher accuracy and resolution to much easier operation and the ability to look backward in time from the trigger.

The 1090 stores so much information about a waveform that it would take an analog storage oscilloscope with an enormous screen to show similar detail. Yet the 1090 does this by expanding any selected portion of the display on its screen up to 64 times, providing a display that is effectively 16 by 20 feet in size.

Moveable electronic crosshairs permit the selection of any data point on the waveform for normalized numerical readout of time and voltage values. There's no conversion to do, thus no mental calculations.

If you wish, you can *look backwards* in time from the sweep trigger to observe conditions leading up to the trigger. This means, for example, that you can investigate the change in the air's electrical potential just prior to and just after a lightning bolt. Or you can record equal amounts of time on either side of nearly any *unpredictable trigger* and display the waveform with the trigger centered. Since the 1090's Model 92 plug-in unit has two inputs, you can also *compare cause-and-effect* relationships in great detail.

Ease of use is incomparable. Screen erasure is automatic. There's no mode switching and no need for intensity or enhancement adjustments. To capture a signal, just touch a button. To release it and see each signal as it occurs, touch another button. You can choose to capture and hold the next signal, the previous signal, or the present one. Remote control is available for these functions.

Every captured signal may be inspected in ultra-fine detail for as long as you wish. You can even retain an older waveform for future comparison while you use the remaining ½ or ¾ of 1090 memory for other measurements.

Write or phone for more details on use of a 1090 in your laboratory.

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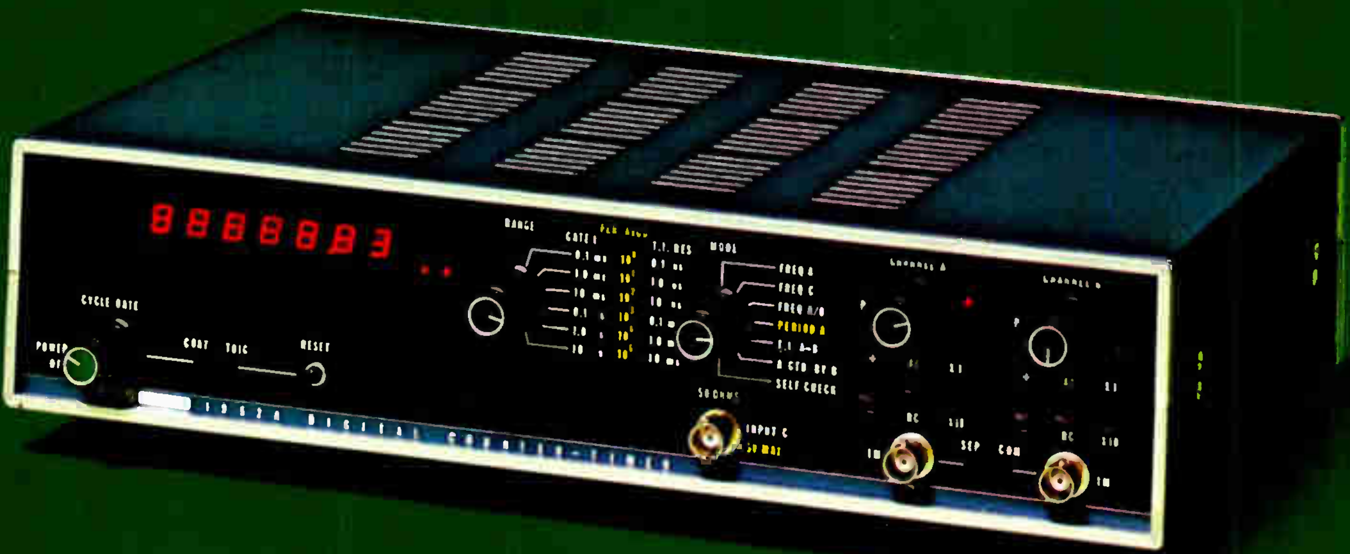

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For instance, if you are planning to purchase a new counter/timer, we invite you to take a flinty eyed look at the new Flukes. Nowhere in the entire market place are there better buys. Nowhere will you find a counter line where owner benefits are constantly raised and at the same time owner costs are being lowered.

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Or look at our Model 1980A VHF/UHF Telecommunications Frequency Counter. Here's the precision instrument to service mobile land, sea, and air communications systems quickly, accurately. Measure frequencies in the field or in the lab from 5 Hz to 515 MHz with a sensitivity of 50 mV over the entire range. Read frequency from a 6-digit LED display. For total portability, add a snap-on battery pack for completely portable operation with up to 5 hours continuous use. And the cost of this little gem is only $795. Add all of the options and you're still under $1200.

Then there's our blue plate special, the full five function Model 1950A. Measure frequency, frequency ratios, single periods, multiple period averages, or totals. Features include 6-digit LED display with automatic annunciation, variable trigger level control with status lamps and a switch selectable input attenuator. For field use, remember the instrument weighs only 5 pounds and will operate from 12 vdc.

Optional features include BCD output and TCXO for super stability as well as full accuracy. Price of the basic unit is just $445. All the options are less than $300 more.

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FLUKE®

Circle 209 on reader service card

New literature

Tape recorder. A two-page information sheet is available from Ampex Corp., 401 Broadway, M/S 11-12, Redwood City, Calif., describing the model PR-2200 portable instrumentation-type tape recorder. The illustrated data sheet, No. D-218, gives major features and specifications of the recorder. Circle 421 on reader service card.

Test system. Teradyne Inc., 183 Essex St., Boston, Mass. 02111. A 15-page brochure provides information on the model J384 computer-operated test system for semiconductor memories. The unit can perform functional and parametric tests on static and dynamic MOS and fast bipolar memories with capacities up to 4,096 4-bit words. [422]

Diffusion boats. Electronic Slicing and Dicing Inc., 45 Osgood St., Methuen, Mass. 01844, has issued a 12-page catalog on quartz-diffusion boats. The catalog contains drawings, descriptions, and price information. [423]

Standards. IEEE, Standards Department, 345 E. 47th St., New York, N.Y. 10017. The 32-page 1974 standards catalog lists more than 350 standards publications by subject, as well as in numerical sequence. Standards listed in the catalog cover test methods, graphic symbols, definitions, and applications methods, for example. [424]

Function generators. Ailtech, City of Industry, Calif. 91748. A brochure describes in detail the company's 5-, 10-, and 20-megahertz function generators with built-on sawtooth generators. [425]

Rectifiers. General Instrument Corp., 600 W. John St., Hicksville, N.Y. 11802, has issued a 12-page cross-reference guide to silicon bridge rectifiers that are rated at from 1 to 25 amperes. [426]

Keyboard switches. A line of keyboard switches, designed for such applications as data terminals, calculators, and business machines, is described in an eight-page brochure

New literature

from Oak Industries Inc., Switch division, Crystal Lake, Ill. 60024 [427]

Signal conditioner. A two-page bulletin from Vishay Intertechnology Inc., 64 Lincoln Highway, Malvern, Pa. 19355, describes the model BA-4 signal conditioner, an instrumentation package consisting of a seven-stage dc amplifier, plus and minus shunt calibration network, and bridge completion. [428]

Load cells. A short-form catalog gives information on a line of load cells. Provided with charts and descriptions, the brochure is available from Interface Inc., 7210 E. Acoma Dr., Scottsdale, Ariz. 85260 [429]

Data conversion. Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604. An eight-page catalog describes 50 data-conversion products and contains electrical and mechanical specifications. [430]

Connectors. A handbook from Microtech Inc., 777 Henderson Blvd., Folcroft, Pa. 19032, describes the use of ultraminiature connectors and cables for high-density packaging. [431]

Process effects. Institute of Printed Circuits, 1717 Howard St., Evanston, Ill., has published a report prepared jointly by the Process Effects and Assembly and the Joining Techniques Committees. The report consists of a check list of causes and recommended corrective actions for various problems encountered in wave-soldering printed-circuit boards and assemblies. [432]

Card cases. Vector Electronic Co., 12460 Gladstone Ave., Sylmar, Calif. 91342, has issued an eight-page pocket catalog describing the line of assembled card and module cases intended for both prototype and production use. [433]

Power units. Induction Process Equipment Corp., 32251 N. Avis Dr., Madison Heights, Mich. 48071. A technical bulletin describes the line of solid-state induction-heating inverter power units called Statipo-

New Literature

wer IV, which convert low-frequency ac line current to high-frequency ac current for heat-treating applications. [434]

Connectors. A line of connectors, available in a miniature series compatible with military specifications, and a line of hermetic connectors are described in bulletin 124 from The Deutsch Co., Municipal Airport, Banning, Calif. 92220. [435]

Rf semiconductors. KSW Electronics Inc., S. Bedford St., Burlington, Mass. 01803. A 16-page catalog and selection guide provides information on the Implion series of ion-implanted semiconductors. [436]

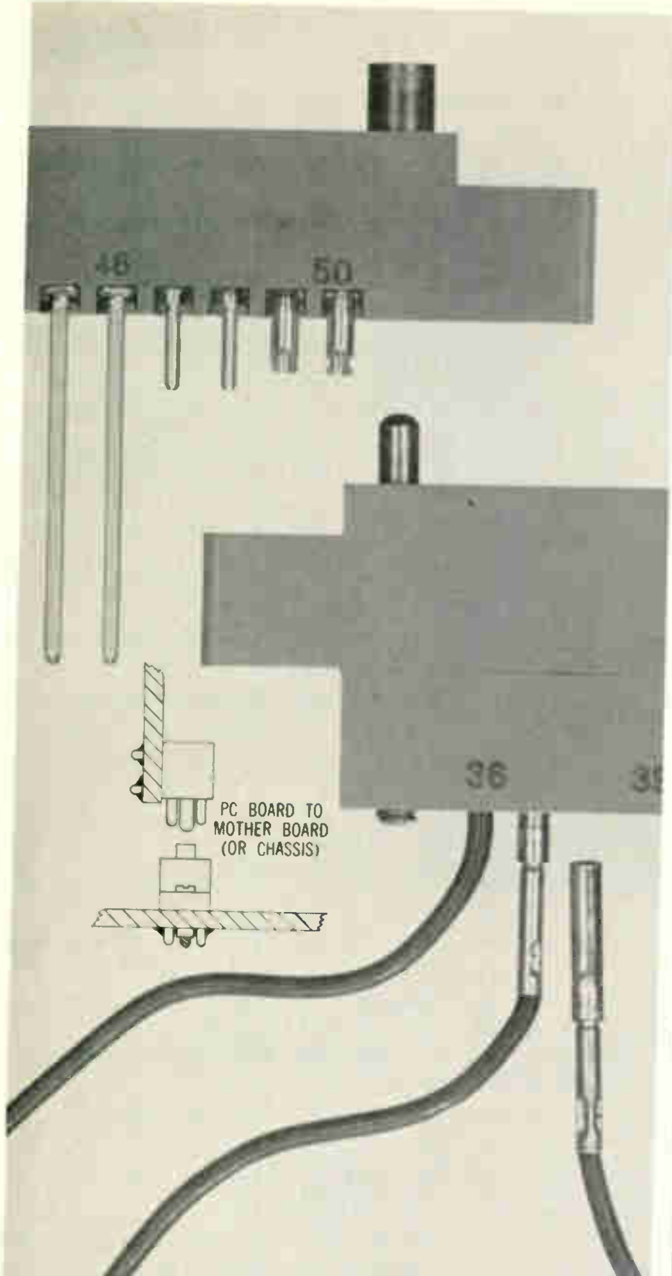
SCR power controller. A four-page condensed product bulletin covering the Red-Pac family of SCR power controllers is available from Vectrol Inc., 1010 Westmore Ave., Rockville, Md. 20850. This reference guide is intended to assist the designer in selecting the proper device for specific applications [437]

Recorders. Soltec Corp., 10747 Chandler Blvd., N. Hollywood, Calif. 91601, has issued a brochure providing information on four low-cost strip-chart recorders. [438]

Rf transistors. A four-page catalog from Amperex Electronic Corp., Slatersville, R.I. 02876, presents technical and applications information on high-performance rf transistors for CATV, MATV, communications, and instrumentation. [439]

Card readers. A family of card readers is described in a 12-page brochure available from Bridge Data Products/Okita Corp., 738 S. 42nd St., Philadelphia, Pa. 19104. The brochure provides specifications and gives modes of operation, as well as data on capabilities. [440]

Waveguide isolators. E&M Laboratories, 5388 Sterling Center Dr., Westlake Village, Calif., has issued product bulletin 107 describing low-loss broad-bandwidth waveguide isolators for Ku-band applications. [391]



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On most all AirBorn subminiature connectors for printed circuit board or conventional interconnection applications, you can choose soldercup, dip terminal, Wire-Wrap* post, or crimp barrel terminations. For information on AirBorn's entire subminiature line, call 214/ 233-2000 or write our Dallas plant at 4321 AirBorn Drive, Addison, Texas 75001.

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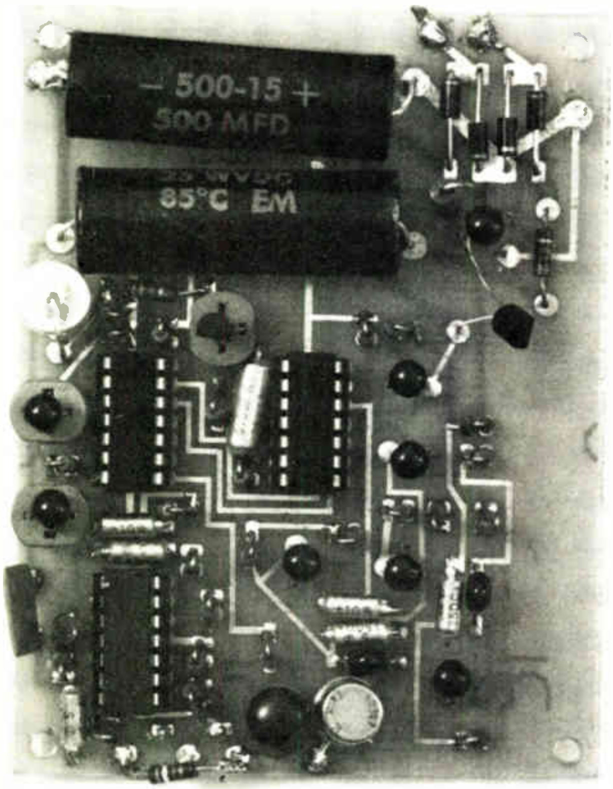

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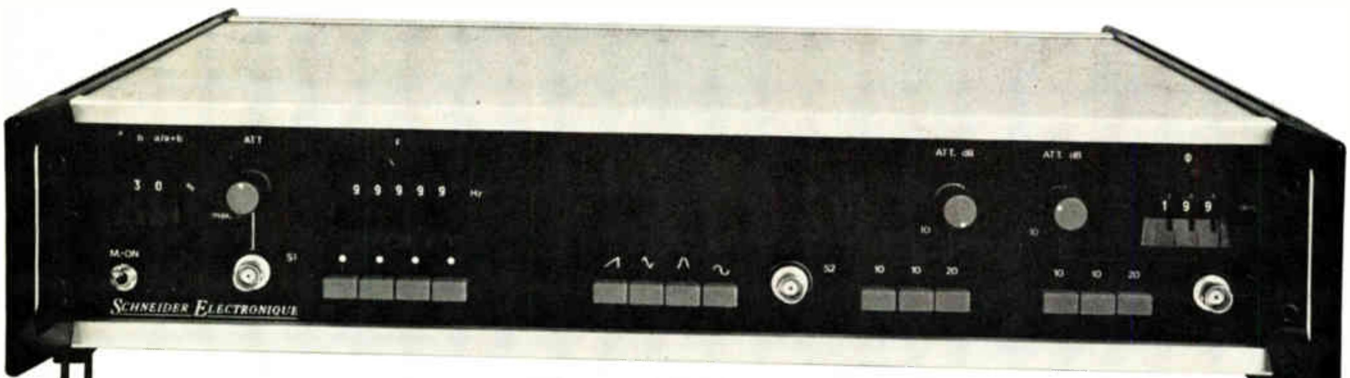

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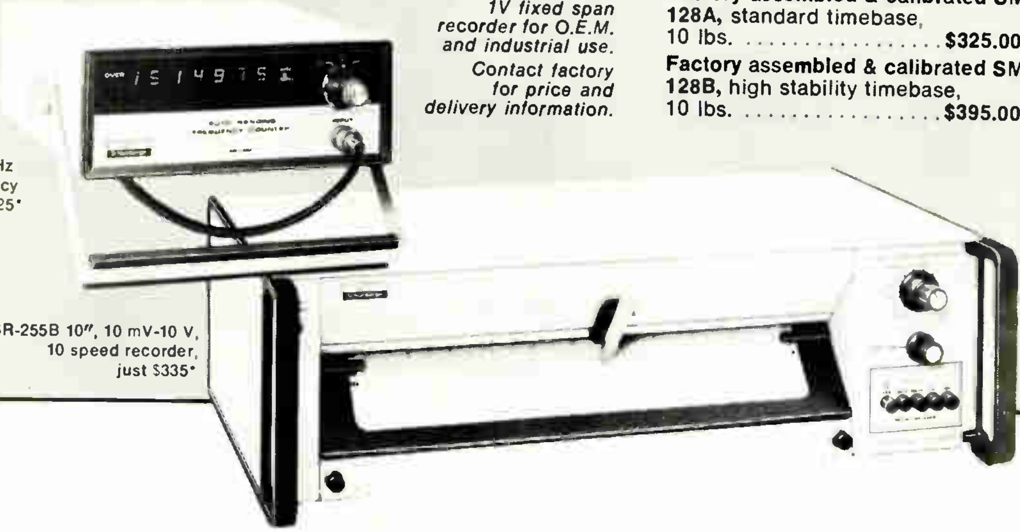

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