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|---|---|---|---|---|---|---|---|
| Frequency ($f_1$-$f_2$) | 0.9-1.2 GHz | 1.1-1.4 GHz | 1.4-1.7 GHz | 1.7-2.0 GHz | 2.0-2.3 GHz | 3.1-3.5 GHz | 3.7-4.2 GHz |
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| Power Gain ($P_G$) | 9 dB | 9 dB | 7 dB | 7 dB | 6 dB | 5-6 dB | 4-5 dB |
| Efficiency ($\eta_C$) | 60-75% | 55-65% | 50% | 45% | 40-45% | 30-35% | 28-30% |
| Voltage ($V_{CC}$) | 35V | 28V | 28V | 24V | 24V | 28V | 24V |
| Impedance ($Z_{IN}/Z_{CL}$) | 6/10Ω | 25/10Ω | 25/15Ω | 50/25Ω | 50/25Ω | 50/50Ω | 50/50Ω |
| Thermal Resistance ($\theta_{jc}$) | <1.5 C/W | <2.5 C/W | <3.0° C/W | <5.0° C/W | <5.0° C/W | <6.0 C/W | <6.0° CW |

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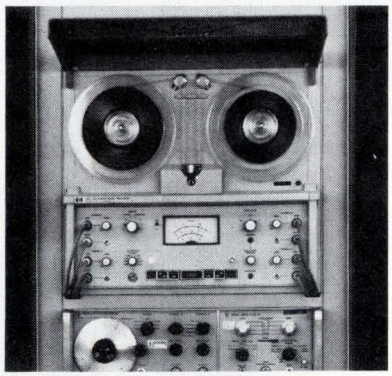

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113-03

## pack it or rack it

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# Electronics

**The International Magazine of Electronics Technology**

**Vol. 46, No. 11•May 24, 1973**




**Highlights**

**The cover: Getting the data through, 89**
In data-communications networks today, data flow between central computer and remote terminals is organized and facilitated by special-purpose processors. Cover by graphic designer Ann Dalton symbolizes how such communications processors sort and concentrate disparate data into orderly sequences for transmission over the communications lines.

**C-MOS sets a new logic standard, 71**
Transistor-transistor logic has a rival in complementary-MOS circuits, and semiconductor manufacturers are jockeying for position in a market that is expected to total $100 million in 1975.

**An a-d converter that does it differently, 97**
The charge-balancing analog-to-digital converter does much the same job for much the same price as the dual-slope converter. But the fact that it requires fewer, less critical components makes it the better option in some applications.

**The first National Computer Conference, 124**
Replacing the spring and fall shows of past years, the first annual computer show takes place next month in New York. Its scope has been greatly enlarged to attract the computer user as well as the computer designer. A preview of products to be exhibited starts on page 129.

**And in the next issue . . .**
Special report on custom hybrid technology . . . a 16-bit computer-on-a-board for less than $1,000 . . . video refresh and two-way television.

# Electronics




## Publisher's letter

**With society's** need for information skyrocketing, it's no wonder that the growth rate of data-communications gear is hefty. To cut the cost of moving the growing volume of data, more and more users are turning to communications processors. These processors, based on small and medium computers, handle the details of transmission, even do some local processing to reduce the data flow, thus freeing the central computer to do its thing—data processing. We think you'll find the eight-page in-depth wrap-up of the state of the art in communication processors (see p. 89) by Communications Editor Lyman Hardeman valuable and timely.

It's especially timely when you consider that in the past decade those processors have zoomed from virtually nothing to several hundred millions of dollars in sales and, currently growing at about 30% a year, may reach $1 billion by 1976. Even in the highly volatile computer and communications segments of electronics, that's some activity.

**In early June,** the first National Computer Conference—which one of its officials calls "a complete department store of computer equipment"—will open its doors in New York. You can just open our pages now to get a preview of what engineers and users alike can expect from the show, which replaces the AFIPS spring and fall meetings.

On page 124, you'll find an article by our New York Bureau Manager, Alfred Rosenblatt, describing what the sponsors have done to tailor the conference to the needs of today's engineers and users. Then, on page 129 starts a detailed run-down on some of the most interesting of the new products to be shown.

**And speaking of computers,** you will find the latest article in our "Minicomputers in Action" series on page 114. It's about San Francisco's attempt to figure out why, when a single rain gage downtown showed only light rainfall, torrents of rain water would flood some local sewage plants and send pollution into San Francisco Bay.

In the quest for a solution, city engineers set up a minicomputer-controlled rain-sensing and sewage-monitoring system. Ultimately, they hope to upgrade the system to give real-time control of the sewers' storage capabilities as a storm moves across the city.

"Significantly," says Computers Editor Wally Riley, "San Francisco's problems are typical of many American cities. And because of the sophistication of the system, delegations from around the country have come to observe it in action."

**Every issue** we pack a wide variety of subjects into our Probing the News department. Take this issue's section as an example. From what's happening in the computer market in Russia to the market for C-MOS devices in the U.S. From an electronics success story in Finland to the down-to-earth uses for satellite data. From medical electronics to pay-TV in hotels and motels.

As its name implies, the section brings you the stories behind the news events, pointing out the trends that add meaning and significance to the spot news.


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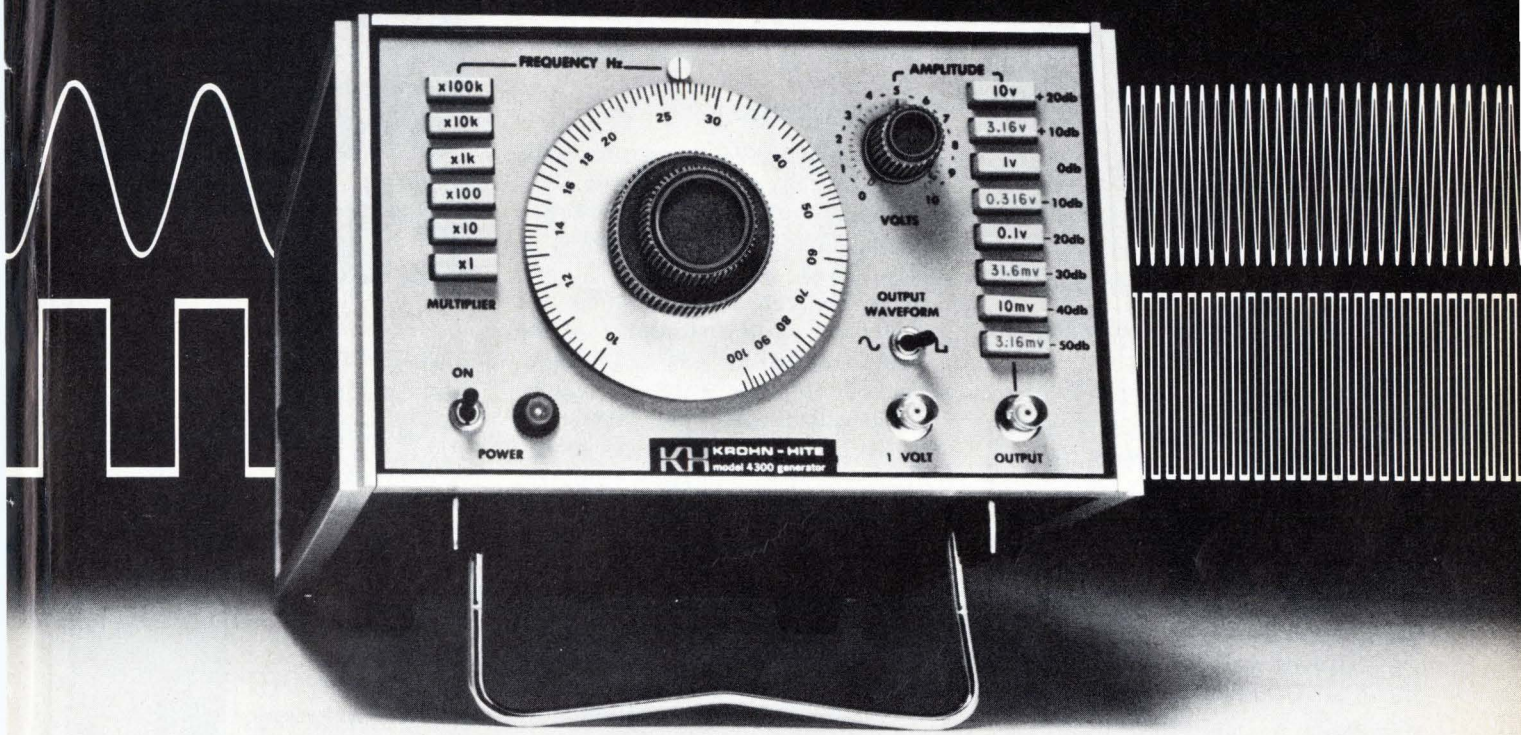


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Circle 5 on reader service card

# Readers comment

### Display corrections

**To the Editor:** I have found two errors in my article "Matching driver circuitry to multidigit numeric displays" (April 26, p.95) that I think merit a correction. Equation (4) should read:

$$C_{eff} = F(L_{on} - L_n)/(L_n + L_aSG) + 1$$

In the chart, the off switching time for thin-film electroluminescent devices should be 1 millisecond rather than 1 microsecond.

Alan Sobel
Zenith Radio Corp.
Chicago, Ill.

### Warping on wrapping

**To the Editor:** My comments on the automatic vs. semi-automatic wire-wrapping machines as published under "Wire Wrapping Takes A New Twist" in the April 12 issue (page 86) were distorted. This was partly due to the semantics of the term "automated." My definition as applied to wire-wrapping equipment encompasses all semiautomatic and fully automatic equipment and excludes hand wrapping.

The comment "Automatics can be changed quickly to handle different types of ICs" should have read "Automated wiring systems. . . ." Either automatic or semi-automatic machines can be changed almost as quickly in the program tapes, but the automatics usually require more extensive tooling and set up.

Semi-automatic systems still offer the advantages of allowing less precise dimensional control of the pin positions, use of twisted pairs and triplets, use of miniature coaxial cable, complex routing patterns, and easy intermingling of different sizes and colors of wires—all of which the automatics cannot accomodate.

The new lower-cost, higher-speed automatic machine should make it more competitive with the semi-automatic, reduce the per-wire cost on longer runs, and make wire wrapping even more competitive with the alternate interconnection methods than it is today.

Jack J. Staller
Techstal Associates
Norwood, Mass.

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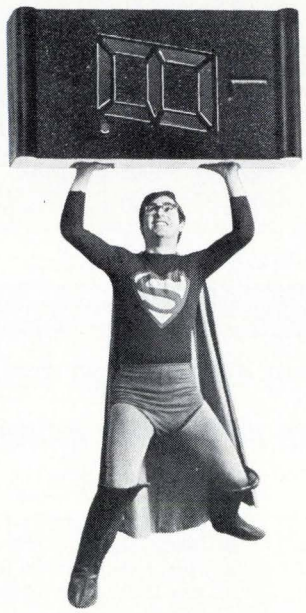

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# 40 years ago

From the pages of Electronics, May 1933

**"Auditory perspective"** by which the sounds of the instruments in a great orchestra seemed to come from different sides of an empty stage, exactly as if the orchestra itself were seated on that stage, instead of being in another city 150 miles away, was the striking feature of the Bell Laboratories transmission of Dr. Stokowski's Philadelphia orchestra to the audience of the National Academy of Sciences, meeting in Washington, April 27.

In addition, new extensions of the frequency band were transmitted, including tones from 40 cycles to 16,000 cycles per second, affording new degrees of utter realism, in the reproduction of wind instruments, bells, snare-drums and other effects.

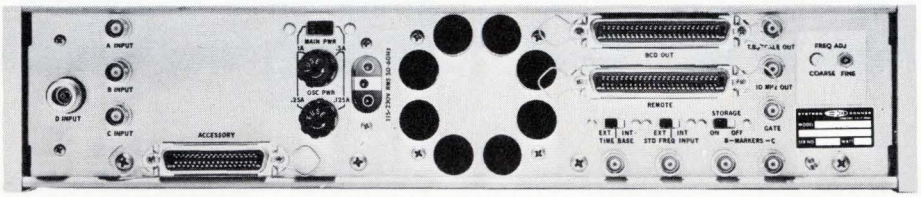
**Dire plans** are apparently underway among the newspaper publishers for the elimination of broadcasting-program material from their reading pages. Unfortunately the newspaper men look upon radio as something competitive, and they are unwilling to give it further support.

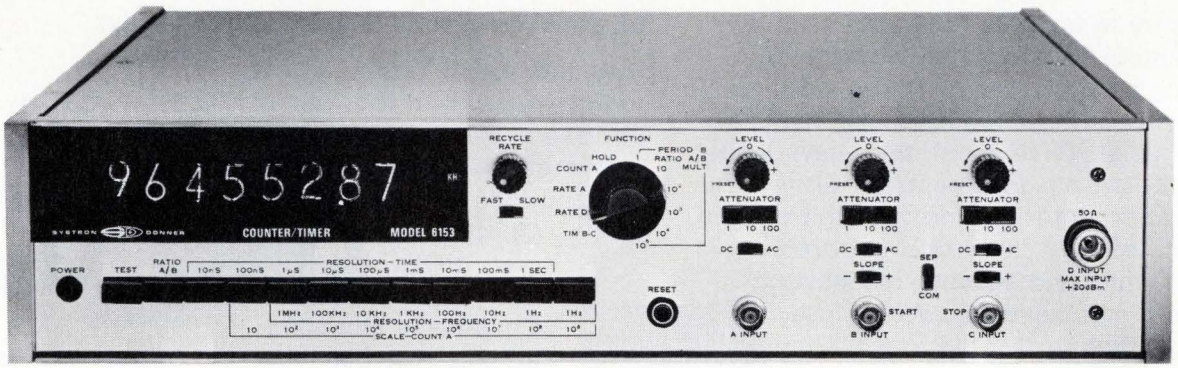
Broadcasting needs advance printed programs to which listeners can refer. Mere oral announcements of program features to come are ineffective, except in the case of single outstanding events.

But the radio industry has its own defensive means all ready, in the shape of facsimile reproduction. The radio listener of the near future, when turning off his receiver on going to bed, might merely switch it over onto "facsimile"; the receiver would then go on recording during the night. And on coming down to breakfast next morning, the listener would find issued from his set his morning tabloid newspaper.

**Following a nationwide** broadcast over the Columbia network, April 17, the infra-red fog-eye developed by Commander Paul H. Macneil of Huntington, Long Island, N.Y., was demonstrated on the Furness liner "Queen of Bermuda" with the aid of British destroyers. A sensitive thermopile has its output amplified so that it is sensitive to one fifty-thousandth of a degree Centigrade.

# interface–ability



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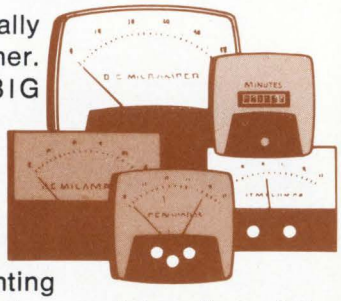
**Once you've installed them, forget 'em.**

GE's famous reliability just doesn't happen, we *build* it in! We designed-out a lot of extra parts that might fail, just to give you extra instrument reliability. To make sure, we added a 20% overload capability to our voltmeters and ammeters. Still not satisfied, we decided to measure instrument quality from parts to finished product in order to screen out anything marginal. Now, it's just too tough for a lemon to squeeze through.

**GE panel meters come from a good family.**



They look good individually and they look good together. Choose the rounded BIG LOOK® design for unique style and wide-eyed readability. Or choose the clean HORIZON LINE® case for its behind-panel mounting flexibility *(without* the usual bezel), and its snap-off mask available in six colors. GE makes panel meters to suit you and to add snap to your application.

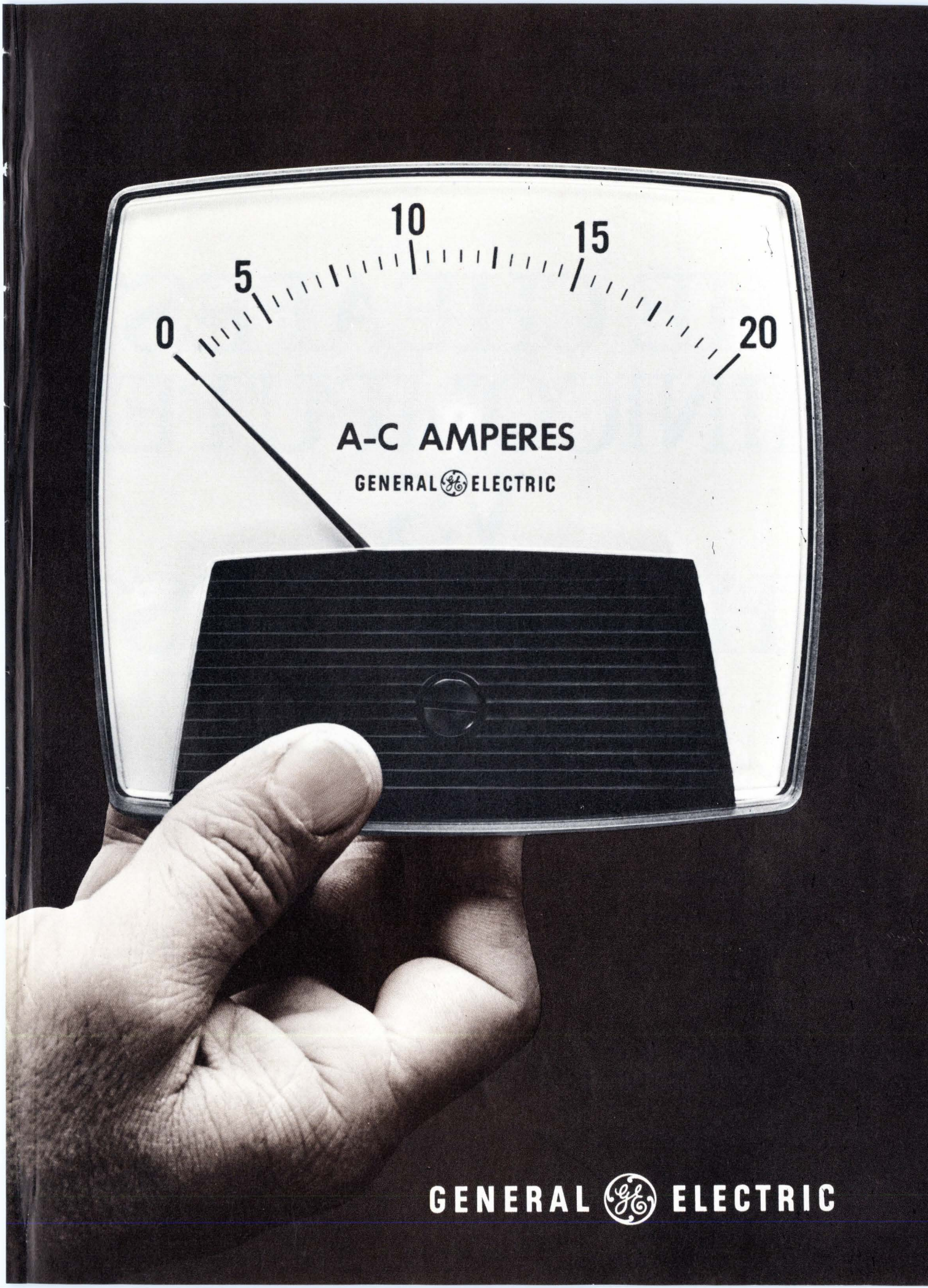
**You can count on General Electric panel meters.**

They're built to help you do a better job. At GE, we're not interested in product equality. We want ours to be *better* than the rest.

*For a complete catalog of competitively priced and readily available GE panel meters, see your nearby authorized GE distributor. Or write to General Electric Company, Section 592-43, One River Road, Schenectady, N. Y. 12345.* 592-43

## Specify General Electric... just for good measure.

Circle 10 on reader service card


0
5
10
15
20
A-C AMPERES
GENERAL ELECTRIC
GENERAL ELECTRIC

# THE CHEAPEST MINICOMPUTER VS. THE CHEAPEST SOLUTION

Before you buy a minicomputer, do yourself a favor. Make a very fundamental decision. Do you want the cheapest machine you can find or the cheapest total solution to your problem?

We think it's the latter.

Because the cheapest machine is just that. It's raw hardware at a rock bottom price. And virtually every minicomputer supplier offers a product like this. Including us.

But your goal should be to get the lowest cost total solution for your problems. And paying less now could cost you more later if the machine you buy has been designed for rock bottom price alone. Be careful. You should look beyond raw iron. You need a computer package that saves you money at both ends. One that's been designed with the total solution in mind. A powerful blend of hardware, systems software, and extensive peripherals.

You also should look for a supplier that has built his business on fulfilling this need. That's us.

## The world's most powerful mini.

We've developed the most effective minicomputer package you can buy: the SPC-16. Six different models to choose from and the *most powerful* instruction set available anywhere.

The SPC-16 does more things in less time with less memory. That's why it can actually save you money on your total system.

And we've recently enhanced the capability of our SPC-16 family with a number of new products including:

Multi-user BASIC, and the real-time, multi-programming capability of our RTOS-16 operating system. And our new extended FORTRAN IV.

New peripherals like a low speed line printer, head per track disk and a floppy disk.

High speed floating point processor, 8K memory board, heavy duty process I/O boards, A/D and D/A converters and digital I/O boards.

And completely new asynchronous communications multiplexer system.

Here's another reason for choosing us:

## We've already had our tryouts.

Today all the big mini manufacturers are announcing that they're "in the systems business."

We've been in it from the start.

And while everybody else was churning out iron, we were building systems and piling up applications know-how.

We got involved with our customers' problems. We listened and we learned. Then we rolled up our sleeves and went to work.

As a result our people don't have to be retrained for this new approach because it isn't new at all. Not to us.

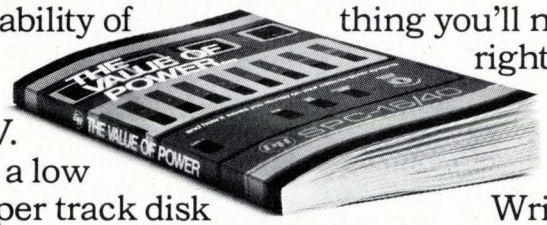
Over the years we've supplied systems to solve some very tough problems in the automotive industry, in production machine control, in electrical testing and communications. And this experience has built a fund of systems expertise no mini manufacturer can match.

There's a good chance we already have a system that fits your needs. If not, we have the know-how to design it for you. Or *with* you.

In fact, we can probably utilize our experience to solve your system problem faster than others can deliver a bid.

## Read all about it.

If you're determined to reduce systems cost, we have a book for you. It's titled "The Value of Power." It covers everything you'll need to know to make the right decisions, for the right reasons, to end up with the right system for your specific needs. It's free. Write for a copy. The address is 1055 South East Street, Anaheim, California 92804. Or phone (714) 778-4800.




# General Automation

# People

## RPI head prepares for technological shifts

As Rensselaer Polytechnic Institute nears its 150th year, its president, Richard J. Grosh, is organizing a five-year plan to maintain academic excellence and prepare its graduates for the technological shifts of the future.

Grosh says the program must consider the technical problems the nation is going to face in the next 40 years, and "we know what these problems are going to be: energy generation and distribution, ecology, information retrieval and distribution." Within these broad categories, he sees the need for continued growth in the areas of computer diagnostics, pattern recognition, materials and materials processing, as well as circuit theory.

Grosh emphasizes engineering. Many students spend their first three years studying chemistry, physics, and mathematics and do not really get involved in engineering until their senior year. "I think we have to make the educational process a little more amenable to their interest," he says, and therefore advocates more engineering courses earlier in students' academic schedules and more laboratory work.

Overall, he stresses that the professional obsolescence faced today by many engineers can only be overcome by the understanding that education is a lifelong experience. Here the universities have an obligation, too. "We tend to focus on men and women between the ages of 18 and 22 years of age, and I think there should be many more opportunities for those later on in life."

Although, according to Grosh, some of the techniques of business can be applied to a university—cost centering, goal setting and programed budgets, "our payoff is difficult to measure. In business there is a P&L statement that can be looked at to help determine if the actions of the past year were reasonably correct. In education, there is no chance to measure the quality of your graduates or their success—if that can be measured."

**RPI president.** Richard J. Grosh sees education as a lifelong experience.

Previously dean of Purdue University's Schools of Engineering, Grosh acts as an adviser to such organizations as Bell Telephone Laboratories and the National Science Foundation, and to other engineering schools besides RPI. While he appears to be a sharp, corporate executive type, he is described by an associate as also a "perennial student," with a serious interest in Greek history, Shakespeare, and classical music. When he's not riding his racing bike, skiing, or sailing his boat, he drives his gray Corvette, which can hardly contain his six children and his wife.

## Silicon General profits from Beck

The route to the top of a semiconductor company rarely starts at an electronics distributor, but Fred Beck feels that his journey along that path has given him an advantage over his counterparts who rose through operations engineering at the IC houses. As president of linear-IC specialist Silicon General Inc., Westminister, Calif., Beck thinks his 13 years at major distributor, Hamilton Avnet, has given him a better insight into customer needs.

# GREAT MOMENTS IN MOS

## ION Implantation Revolutionizes MOS

Mostek's Ion Implantation process is relatively simple, yet its results have literally increased MOS array performance by a factor of 10 and at the same time has yielded smaller size, lower thresholds, and a significant reduction in manufacturing costs. Further, it has made possible the co-existence of digital and linear MOS circuitry on the same chip. Nevertheless, Ion Implantation is a young technology and its full potential is yet to be realized.

AT MOSTEK we were quick to realize the implications of Ion Implantation and we were the first manufacturer to apply it to volume production. The results have been extremely gratifying, both to us and to our many customers who have taken advantage of MOS technology for their products. Unknown just a few years ago, MOS products are now at work in one-chip calculators, multi-function calculator systems, micro clocks and calendar circuitry, organ keyboards and numerous industrial and consumer products. Ion Implantation has made MOS/LSI technology available to virtually all industries no matter how unique their requirements may be. And it's only natural that they turn to a leader to solve their MOS problems. Whether off-the-shelf or customized IC's, Ion Implantation and MOSTEK know-how are both bench marks in Great Moments In MOS.

**REGIONAL SALES OFFICES:**
**Western:** 11222 La Cienega Blvd., Inglewood, Calif. 90304 (213) 649-2888; **Eastern:** 60 Turner Street, Waltham, Mass. 02154 (617) 899-9107; **Central:** 8180 Brecksville Rd., Brecksville, Ohio 44141 (216) 526-6747, **INTERNATIONAL: Europe:** MOSTEK GmbH, 7 Stuttgart 80, Breitwiesenstrasse 19, West Germany (Telex-7255792 MK D) **Japan:** System Marketing Inc., 4 Floor, Mimasu Bldg., 3-14-4 Uchikanda, Chiyoda-ku, Toyko, Japan (Telex-0222-5276 SMITOK) **Far East:** Imai Marketing Assoc., Inc., 525 W. Remington Dr. #108, Sunnyvale, Calif. 94087 (Telex-35-7453) **Hong Kong:** Astec Components Ltd., Golden Crown Court, Flat "C" 5th Floor, 70 Nathan Rd., Kowloom, Hong Kong (Telex-HX4899) **Mid East:** Racom Electronic, 60 Pinkas St., Tel Aviv, Israel (Telex-33-808 RACEL) **Canada:** Cantronics Inc., 4252 Braille Ace., Montreal, Quebec (TWX-610-421-3324)

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And judging by the turnaround in corporate profits, he may have a point. For three years, Silicon General had steadily increasing losses, touching $400,000 in 1971 on sales of $1.5 million. Then Beck took charge. Today the company is fully profitable and reported sales of $3 million in 1972.

Although the strong semiconductor market accounts for part of the turnaround, much of the result stems from changes Beck has made. As a distributor, he learned that what makes the difference among businesses offering the same products is service, and so he modified Silicon's strategy to serve its customers better, by down-playing engineering and emphasizing marketing and distribution.

**Customer-oriented.** Fred Beck solidified corporate strong points to raise sales.

First, he stopped development of new proprietary products, feeling that second-sourcing popular parts made better use of the limited resources available. The firm also started concentrating on the limited military and industrial markets, sidestepping consumer and computer products for the time being.

**Commitment to commitments.** By doing this, and by raising some new capital, Beck says the firm offers fast turnaround and assured delivery. He explains the company won't make commitments it can't keep, and consequently "we turn down more business than we accept."

Beck, a trim 35-year-old, attended the University of Redlands in California. Although he had a 44-ft sloop and expected to enter the 2,000 mile Transpac race from California to Hawaii, business came first. He sold the boat and now won't even go out on the water.

# A tough little competitor.

**AMPSCO. American Power Systems Corporation.**
Maybe you heard of us when we were Armour Electronics. Maybe you didn't. Either way we're a scrappy little powerhouse you *need* to know *now*.

Because when your full time talents are needed in putting out a sophisticated, multi-thousand dollar unit, why waste even a little time designing its power supply? And since a reliable power supply is so critical, why buy it from a big company that spends only *some* of its time making it? Why not find yourself a sharp little outfit that spends *all* its time on power supplies? A company that stakes its entire reputation on *one* kind of product and has to do a mighty good job. For a mighty good price.

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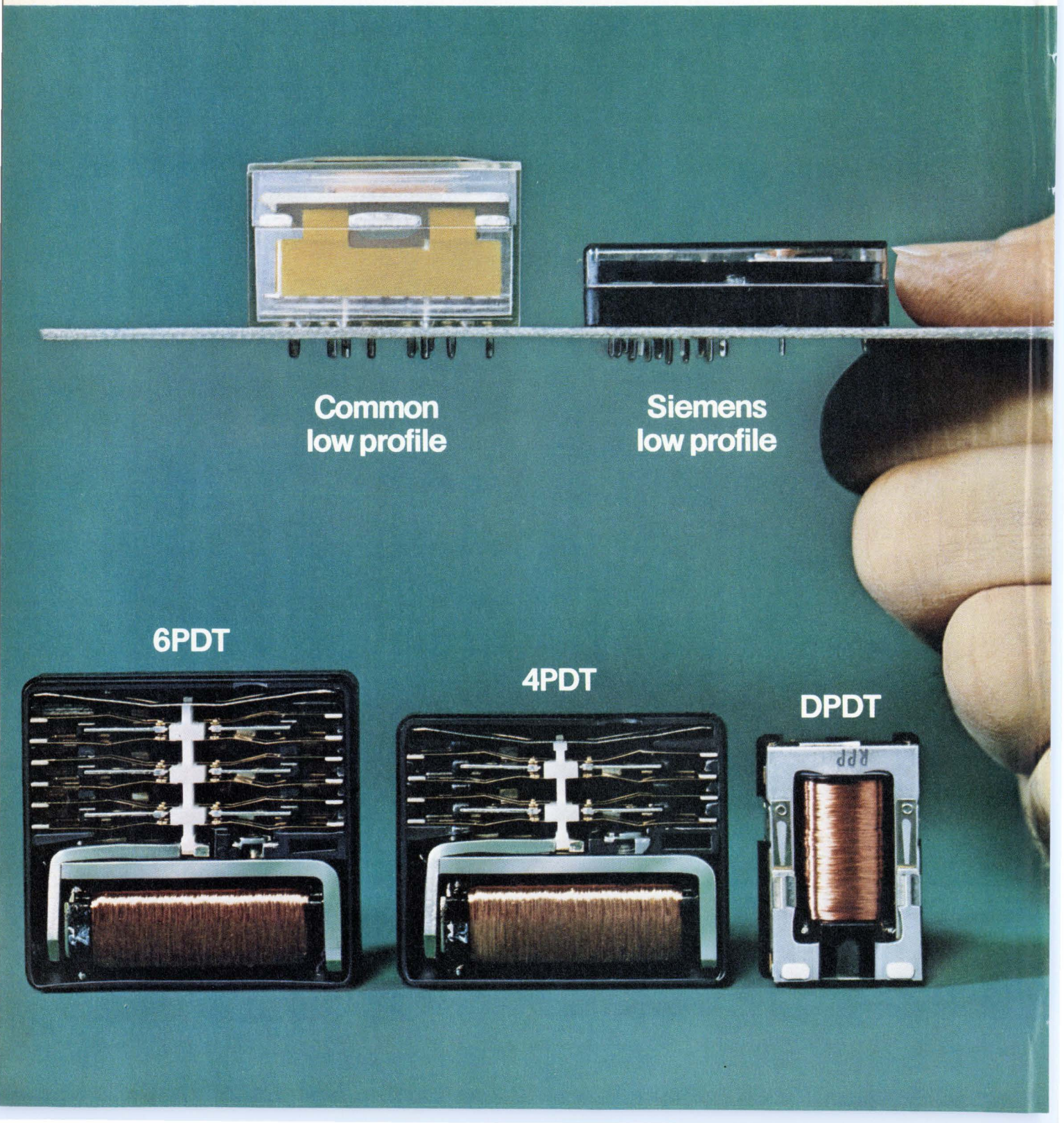
# Siemens introduces the lowest profile in PC-board EMR's.



**SIEMENS**

## These new low profile relays with only 0.4″ height let you put twice as many PC boards in a rack yet give you over twice the current rating.

Siemens, one of the world's leading relay manufacturers, has come up with another major relay innovation. This time it's a complete family of general-purpose Electro-Mechanical Relays with a lower profile combined with higher current rating than has been possible with any available design.

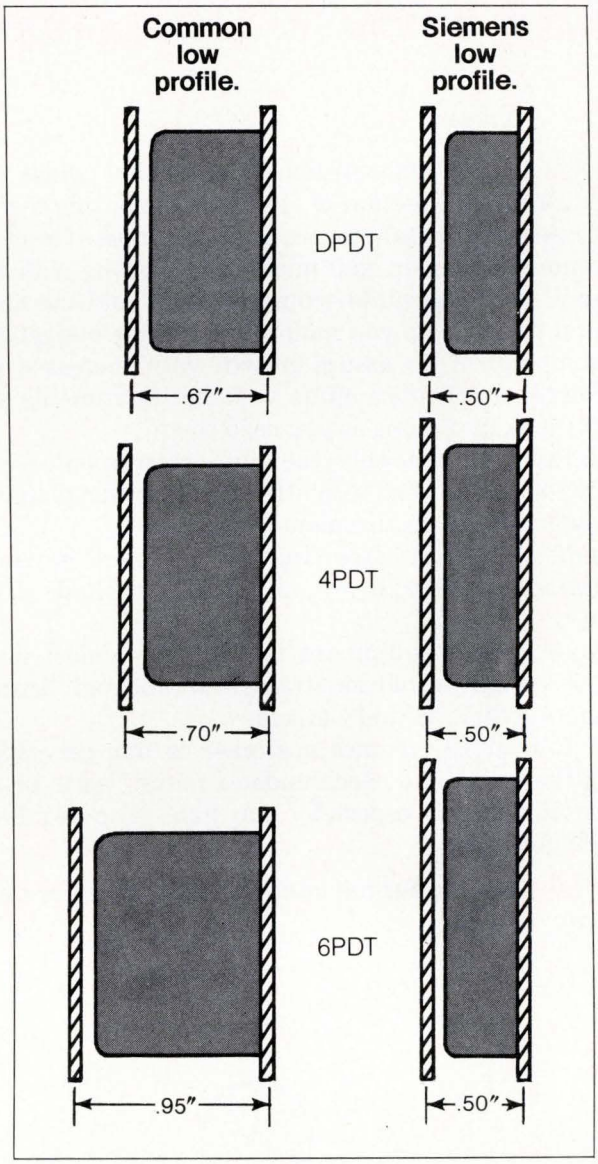
The new Siemens family consists of DPDT, 4PDT, and 6PDT models which have uniformly the same 0.4 inch height above the PC-board face and have contact ratings of 1 A at 24VDC (0.3 A at 115 VAC).

No longer need the relay be a limiting design factor. You can use Siemens low profiles on racks with 0.5″ center-to-center PC-board spacing instead of up to one inch spacing. Thus you can pack up to twice the circuitry in the same space.

It also means you can design to switch twice the current you had been limited to by earlier PC-board relay types. Or if you don't need more current, you have a much higher safety margin.

The new Siemens relays have bifurcated contacts for high reliability, and a sealed base that keeps flux or solder from contaminating the contacts.

Siemens has many additional high-reliability, general-purpose relays. Write or call us for more information on the new low profile line or for relays for other applications.




Siemens low-profile relays are easily mounted in racks with 0.5″ center-to-center PC-board spacing.

Siemens Corporation, Special Components Department, 186 Wood Avenue South, Iselin, New Jersey 08830. (201) 494-1000.

At left, the first complete family of low-profile relays.

Circle 23 on reader service card

## Meetings

**International Microwave Symposium:** IEEE, U. of Colorado, Boulder, June 4–6.

**National Computer Conference and Exposition:** AFIPS, New York Coliseum, June 4–8.

**Consumer Electronics Show:** EIA, McCormick Place, Chicago, June 10–13.

**Chicago Spring Conference on Broadcast and TV Receivers:** IEEE, Marriott, Chicago, June 11–12.

**Power Electronics Specialists Conference:** IEEE, California Institute of Technology, Pasadena, June 11–13.

**International Conference on Communications:** IEEE, Washington Plaza, Seattle, Wash., June 11–13.

**Frequency Control Symposium:** ECOM, Howard Johnson's Motor Lodge, Atlantic City, N.J., June 12–14.

**National Cable TV Association Annual Convention:** NCTA, Convention Center, Anaheim, Calif., June 17–20.

**International Symposium on Electromagnetic Compatibility:** IEEE, New York Hilton, New York, June 20–22.

**International Symposium on Fault-Tolerant Computing:** IEEE, Palo Alto, Calif., June 20–22.

**Design Automation Workshop:** ACM, IEEE, Sheraton, Portland, Ore., June 25–27.

**International Symposium on Information Theory:** IEEE, Ashkelon, Israel, June 25–29.

**International IEEE G/AP Symposium and USNC/URSI Meeting:** IEEE, U. of Colorado, Boulder, Aug. 21–24.

**17th Annual Meeting and Equipment Display:** SPIE, Town and Country, San Diego, Calif., Aug. 27–29.

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If you're looking for on-time delivery of miniature and microminiature High Voltage Silicon Rectifiers, look no further than ERIE. You simply can't beat our zero defect rectifiers since these units were first designed for high reliability night vision, lunar and aerospace applications. Their small size makes ERIE rectifiers ideal for thick film substrates, miniature power supplies, airborne displays, CRT displays, color TV, microwave ovens and other industrial and commercial applications where small size, reliability and superior performance are critical. All ERIE High Voltage Silicon Rectifiers feature conservative voltage ratings, fast recovery time, fast turn-on time, wide operating temperature range, high transient voltage ratings, low reverse leakage and unsurpassed reliability.

ERIE also offers double sealed, miniature Full Wave Bridge Rectifiers . . . perfect for P.C. use, with ratings up to 1000 volts per leg. So think ERIE for your High Voltage Silicon Rectifiers. Write TODAY for our new 24-page catalog . . . High Voltage Components and Devices.


ERIE

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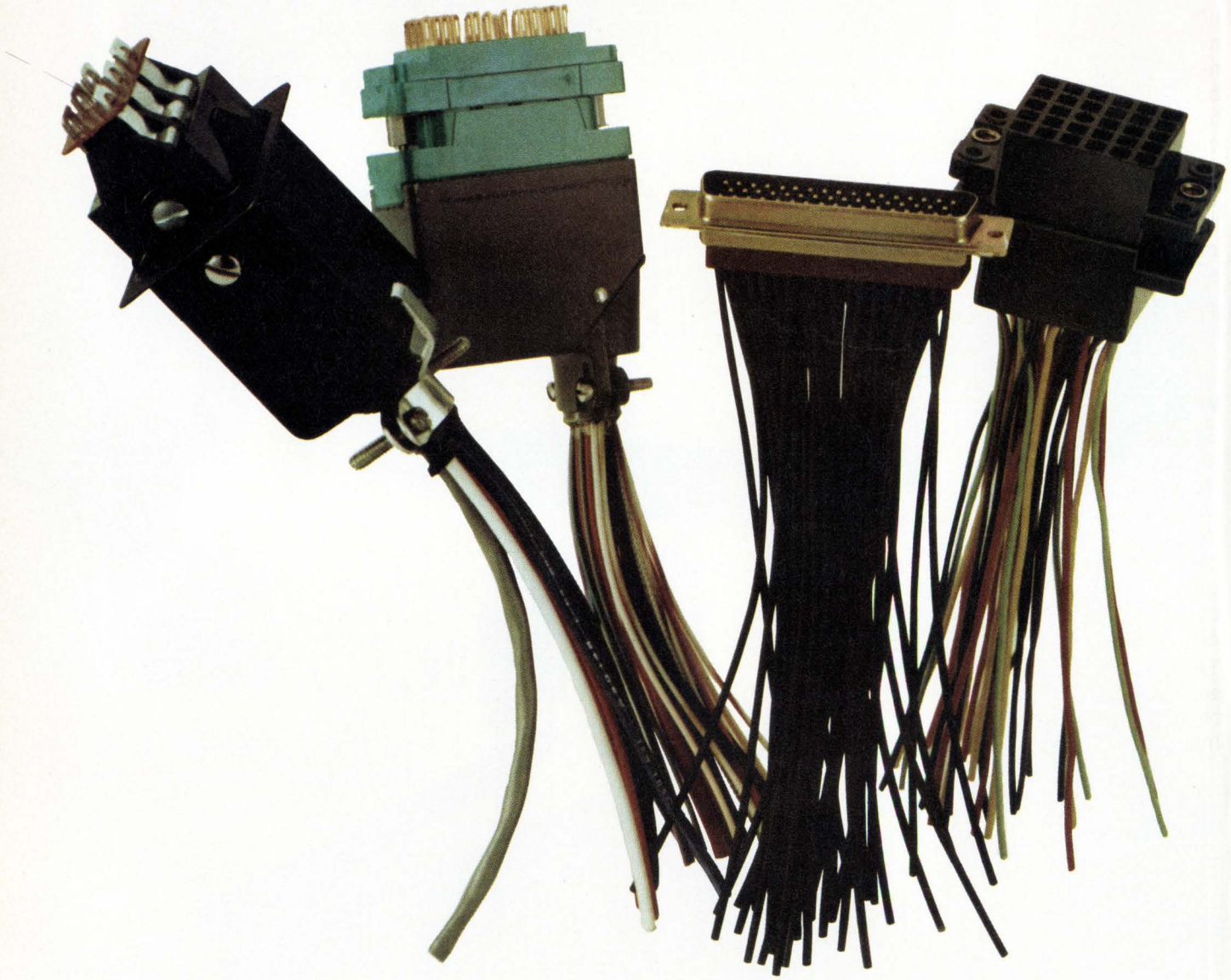
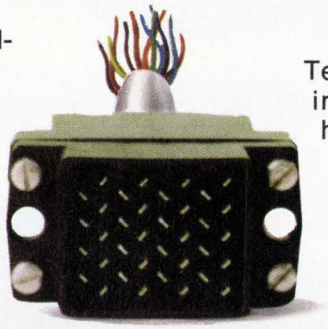
Circle 25 on reader service card

# The world didn't need another darned-good-and-expensive rack and panel connector.



# So we came up with a darned good one that costs you about 25% less.

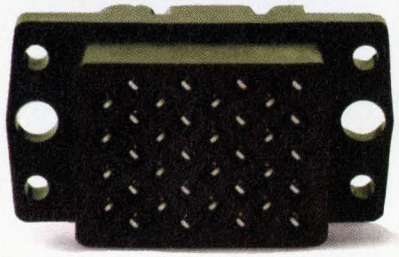
If you still live in a "let's-go-first-class-and-hang-the-expense" kind of world, you may not need us. But if you live in today's world, read on, rejoice and return the coupon below. For several good reasons:



### WE'VE GOT A DARNED GOOD NEW CONNECTOR

It's UL recognized. The glass-filled nylon insulator block is moisture resistant. Contacts are recessed, both in the male and female contact housings. It provides positive cable strain relief.

Our Tuning-Fork type contact has two important things going for it: low electrical resistance and little change in contact pressure over the specified contact life.



### WE'VE GOT WHAT IT TAKES

Technical experience. True, we're new in multi-pin connectors. But we're old hat at making other types. We make JCM miniature coaxial connectors, for example — which are a lot more demanding and sophisticated from both an engineering and production point of view.

### WE'RE AS GOOD BUT LESS EXPENSIVE

Of course, we want you to check it all out for yourself. So ask us about a free sample along with all its specifications.

Specs such as:

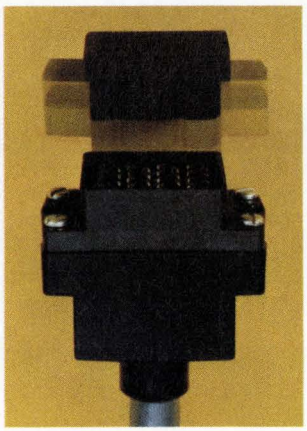
Voltage Rating (adjacent contacts) . . . . 250 VRMS
Flashover Voltage . . . . . 1000 VDC
Current Rating (con't max/ckt) . . . . . 3 amp
Contact Resistance (typical) . . . . . 0.003 ohms
Insulation Resistance . . . . . 5000 megohms
Insertion Force* . . . . . 6 oz. min./12 oz. max.
Withdrawal Force* . . . . . 5 oz. min./10 oz. max.
Cycle Life . . . . . 500 min.

*Per contact

### WE'VE GOT PROOF

Excellent contact alignment was maintained through 500 insertion-withdrawal cycles and no "scooping" action took place. The forces show a gradual increase over 500 cycles caused by plating abrasion.

Take a look at these results computed from more than 100 hours on our Instron testing machine:



CONTACT INSERTION AND WITHDRAWAL
(Cadmium Plating)

| | First Cycle | | 100 Cycles | | 500 Cycles | |
|---|---|---|---|---|---|---|
| Contact No. | Insertion (oz.) | Withdrawal (oz.) | Insertion (oz.) | Withdrawal (oz.) | Insertion (oz.) | Withdrawal (oz.) |
| 1 | 6.9 | 5.3 | 8.1 | 6.4 | 9.2 | 6.5 |
| 2 | 7.2 | 4.5 | 7.8 | 6.0 | 8.9 | 6.6 |
| 3 | 7.1 | 5.1 | 8.0 | 5.4 | 9.2 | 6.0 |
| 4 | 6.5 | 4.7 | 7.8 | 5.4 | 8.6 | 5.3 |
| 5 | 7.4 | 5.4 | 7.9 | 5.9 | 8.9 | 6.5 |
| Averages | 7.0 | 5.0 | 7.9 | 5.8 | 9.0 | 6.2 |

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☐ Please send literature, price and test data.
☐ Yes, I'm interested in evaluating a test sample.
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# If you're really serious about cost, be serious about quality.

That could be money in your pocket. Allen-Bradley's exclusive hot molding process offers physical consistency that can reduce your installation costs. Bodies are a uniform size with clean squared ends, free from coatings which adversely affect automatic handling equipment. Lead lengths and diameters are precise. Resistors with uniform physical characteristics, accurately placed on tape reels, eliminate insertion machine jam-ups. And trouble free assembly means less production down-time; lower cost. That's A-B quality. Consistent shipment after shipment. If you think all resistors are the same, send for our free booklet, "7 ways to tell the difference in fixed resistors." Allen-Bradley Electronics Div., 1201 S. 2nd St., Milwaukee, WI 53204. Export: Bloomfield, NJ 07003. Canada: Allen-Bradley Canada Ltd., Cambridge, Ont. U. K.: Jarrow, Co. Durham NE32 3EN.

A-B QUALITY

**Allen-Bradley**
Milwaukee, Wisconsin 53204

Circle 28 on reader service card

# Electronics newsletter

**Tiny tape head ups disk density by seven times**

VRC California, Los Angeles, has developed 0.4-mil flying tape heads for disk drives. **The prototype units permit disk densities of about 1,500 tracks per inch, over seven times that of present IBM 3330 disks with their 4.3-mil heads.** VRC California, a subsidiary of Vermont Research Company, is also using slightly larger 1-mil heads, plus a special locating system earlier developed for amorphous laser memories, to produce disk drives the size of a small drawer-type OEM disk but with 3330-type storage. The 600 track-per-inch density permits a 60-megabyte memory in one IBM System-3-type cartridge using a 3330 disk; other small systems typically store 10 megabytes.

**Tektronix starts OEM design and sales program**

After a 25-year tradition of catalog sales, Tektronix Inc. has started up an original-equipment-manufacturer design and sales program in its Information Display Products division. Under the new policy, the division will disclose new developments to systems manufacturers months before they would normally be introduced and will also design special versions for OEMs. **Among the first developments being offered are a video scan converter for computer-graphics and analog-instrumentation systems, a hard-copy printer for computer-display terminals, and a 19-in.-diagonal storage CRT for computer-terminal applications.** The tube can display more than 8,000 characters, compared with some 2,500 for today's most advanced unit.

**West Coast gets fully automated stock system**

What appears to be the first fully automated stock-transaction system has gone on line at the Pacific Stock Exchange. Its Comex system **should particularly benefit the small investor who buys up to 199 shares.** An earlier version of the system, useful for odd lots (under 100 shares) helped eliminate odd-lot charges at PSE since it reduces the cost of handling the small orders for the brokers. **The system uses displays and keyboards from Quotron Systems, Inc., two IBM 370/145 computers, and two DEC computers as communications processors.** It ties together the exchange's San Francisco and Los Angeles branches.

**Gold bumps offer beam-lead reliability, flip-chip strength**

A new process for preparing integrated circuits for automated packaging is being developed by the Solid-State Electronics Center of Honeywell Inc., Plymouth, Minn. **Gold bumps, which offer the reliability of beam leads and the ruggedness of conventional solder-bump flip-chip techniques, are plated onto an evaporated, intermediate, multilayered base of chrome, copper, and gold.** The contact resistance between the bump and the chip is typically 30 milliohms, while the pull strength is as high as 20 to 50 grams. **Because a plating process is used, gold costs are kept to a minimum.** The gold bumps can be bonded to tin-plated-copper lead frames. The technique is compatible with most semiconductor manufacturing processes.

**MECL 10,000 moves to peripherals**

Officials at Motorola's Semiconductor Products division think they have a bonus on their hands **because of the apparent acceptance of the MECL 10,000 emitter-coupled logic line by computer-peripheral-equip-**

**ment manufacturers.** MECL 10,000 was intended for computer mainframes. But the move to peripherals surprised them, because they expected peripherals makers to stay with slower TTL or Schottky TTL devices. Doug Powell, manager of computer industry marketing at the Phoeniz division, says a number of perhipherals manufacturers are turning to ECL because of their need for greater speed, triggered by the burgeoning growth in data communications.

### Italian firm enters U.S. hi-fi market with high-power IC

SGS-Ates, Italian-based semiconductor company, has pushed integrated-circuit technology into the high-fidelity realm with their development of a 10–15-watt audio amplifier chip—**two to three times more powerful than previously available single chips**—which will be available by the end of the year. Pietro Fox, U.S. marketing manager of SGS-Ates, estimates there are one million hi-fi amplifier sockets in the U.S. that this product could fill. And unlike audio amplifier ICs now available, this chip will have the high power and low distortion—1% at 15 W—that is required for hi-fi service. Also, SGS-Ates, which has been marketing complementary MOS in Europe on a limited basis, is **planning to bring its C-MOS products to this country late this year.** SGS-Ates has a licensing agreement with RCA to build the 400 series COS/MOS line.

### Chopper-stabilized op amp is packaged in standard DIP

Texas Instruments has built the first chopper-stabilized op amp to be marketed in a standard 14-pin DIP. Previously, the low offset, low drift, and high gain of chopper-stabilized devices were available only in bulkier module packages. **The two-chip op amp has a differential capability and fast slew rate (25 volts per micro-second) that in most cases are found only in modules.** Sample quantities of the SN62/72088 are available at $70 for the device specified over 0° to 70°C and $120 for the –25°-to-85°C version.

### Boston visitors try domestic-satellite communications

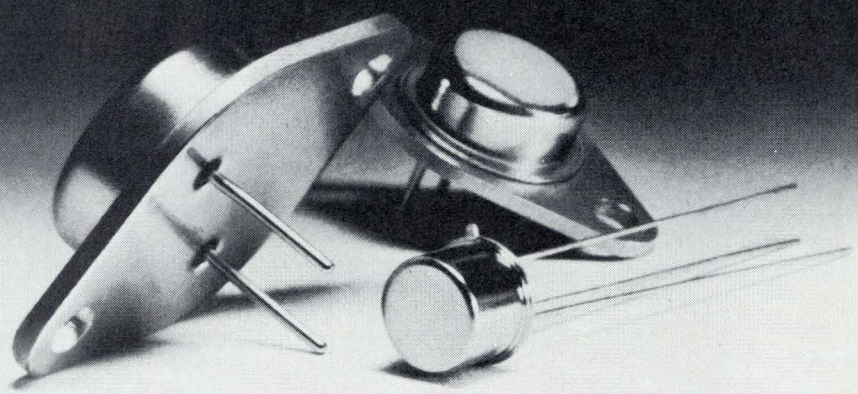
People attending the International Communications Association's annual meeting in Boston early this month were among the first in the nation to communicate via domestic satellite. The link was set up by RCA Global Communications Inc., using Telesat Canada's Anik II satellite. **By September of this year, public voice-grade circuits should be operating between New York City and Los Angeles or San Francisco at a monthly charge of $1,400, roughly 40% less than terrestrial circuits.** The initial system is an interim arrangement, the forerunner of a more extensive domestic-satellite communications system that will serve all 50 states and Puerto Rico when RCA Global Communications completes it in two years' time.

### Addendum

A third-party leasing agreement has been reached between Memory Technology Inc., Sudbury, Mass., and Alanthus Corp., White Plains, N. Y. for **$16 million worth of MTI's add-on memories for the IBM 370 Models 155 and 165.** The MTI semiconductor memories have up to four megabytes on one port, twice IBM's core-memory capacity in less than half the space.

# ¢-LINE POWER SWITCHING TRANSISTORS

## 100 WAYS TO GET MORE INDUSTRIAL SWITCHING PERFORMANCE FOR YOUR MONEY



Unitrode's UPT Power Switching Transistor series offers the optimum combinations of price and performance from 0.5A to 20A, and up to 400V in 3 package types. Choose from 100 different transistor types for more efficient and simplified circuit design in power supplies, switching regulators, inverters, converters, solenoids, stepper motors and other inductive load driving applications. They're available off-the-shelf from your local Unitrode distributor or representative. For the one closest to you, dial (800) 645-9200 toll free, or in N.Y. State (516) 294-0990 collect.

For immediate action on any specific problem, call Sales Engineering collect at (617) 926-0404, Unitrode Corporation, Department 6Y, 580 Pleasant Street, Watertown, Massachusetts 02172.

For specific data sheets containing full characterization of devices check the table/coupon below.

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| ☐ | | up to 400V | UPT311 -T05<br>UPT321 -T066 | 200ns | 800ns | 1.25 to 2.73 |
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| ☐ | 15ADC | up to 150V | UPT1021-T066<br>UPT1031-T03 | 450ns | 350ns | 3.69 to 5.93 |
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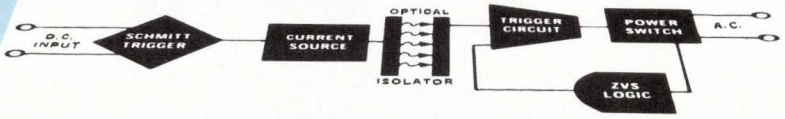


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**GENERAL ELECTRIC**

# Optical-fiber communications spurred by new waveguide and low transmission losses

Bell Labs and Corning Glass take the lead in innovating light pipes for communication systems

**Fiber-optic waveguides** for communication systems look more practical now that Bell Laboratories has developed single-material fibers with losses as low as 5 decibels per kilometer and Corning Glass has reported more conventional core-cladding fibers with losses of 2 dB per kilometer. In mid-1971, the best fibers had losses of about 20 dB [*Electronics,* July 5, 1971, p. 46] and even today 20 dB loss is considered very good [*Electronics,* April 26, p. 53].

While much work remains to be done, scientists at Bell Labs now consider glass fibers as practical replacements, or more likely, additions to copper wire, particularly in cities where conduit space below ground and the communication capacity is becoming limited. Hair-thin glass fibers packed together to form a cable a quarter of an inch in diameter could carry as many communication signals as thousands of ordinary telephone cables, according to Bell Labs.

**Modulation.** A working system could use semiconductor lasers, modulated at rates between a few megahertz and a few gigahertz, to generate the light signals. Avalanche photodiodes could be used as detectors at the receiving end. Research thus far has shown that optical fibers can carry signals modulated at rates up to 6 MHz— equal to about 3,000 telephone calls.

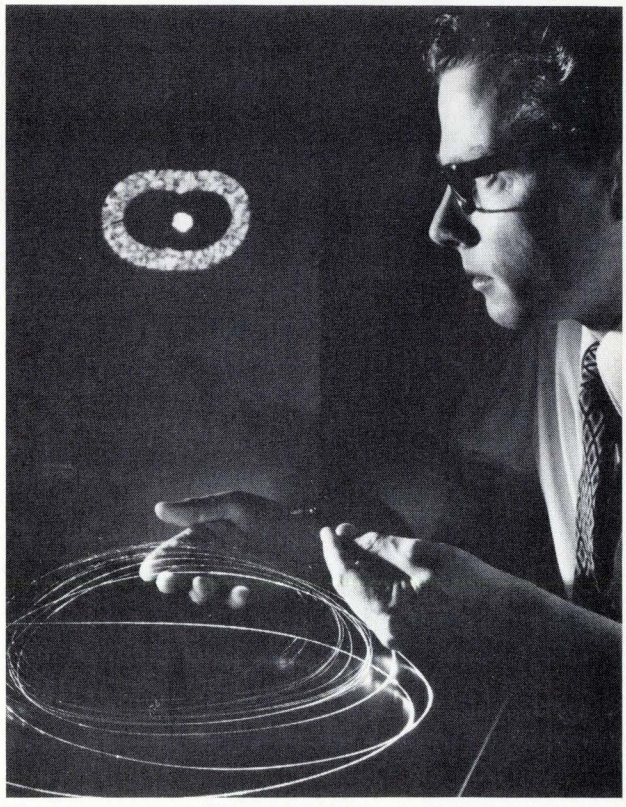
The Corning research was reported last month in a paper at the American Ceramic Society meeting in Cincinatti, Ohio, by Peter C. Schultz, senior ceramicist. Schultz ran his experiments at wavelengths of 1,050 nanometers with a glass fiber 1.2 km long. The fiber, made of two high silica glasses, had a core with an index of refraction somewhat higher than the cladding. Although this is an experimental fiber, scientists at the Corning, N. Y., firm believe that its relatively simple configuration will ease production.

**Three in one.** Three Bell Labs scientists—Stewart E. Miller, Enrique A. J. Marcatili, and Peter Kaiser—devised a glass-fiber structure with three elements, all made of the same low-loss glass. Fibers made with differing glass materials, according to Bell Labs, contain undesired impurities that interfere with the passage of light and cause transmission losses in the fiber.

The Bell Labs' design consists of a tube, a solid inner rod, and a supporting plate for the rod. The technique of centering the light involves wave, rather than geometric, optics. Marcatili says that the changing height between the rod and the supporting plate is equivalent to a change in refractive index. The tube serves as a protection for the fiber assembly.

The preformed waveguide consists of a tube, 1 centimeter in diameter, with the interior plate supporting a rod a few millimeters in diameter. As this is heated and pulled, all the elements retain their scale and the external dimension is reduced to only a few mils in diameter.

**Stronger than steel.** The tensile strength of newly drawn fibers varies from several thousand to several million pounds per square inch, depending on the specific fiber and



**New fiber.** Bell Labs' Peter Kaiser helped with design.

the conditions under which it is used. This is considerably greater than copper and even better than steel.

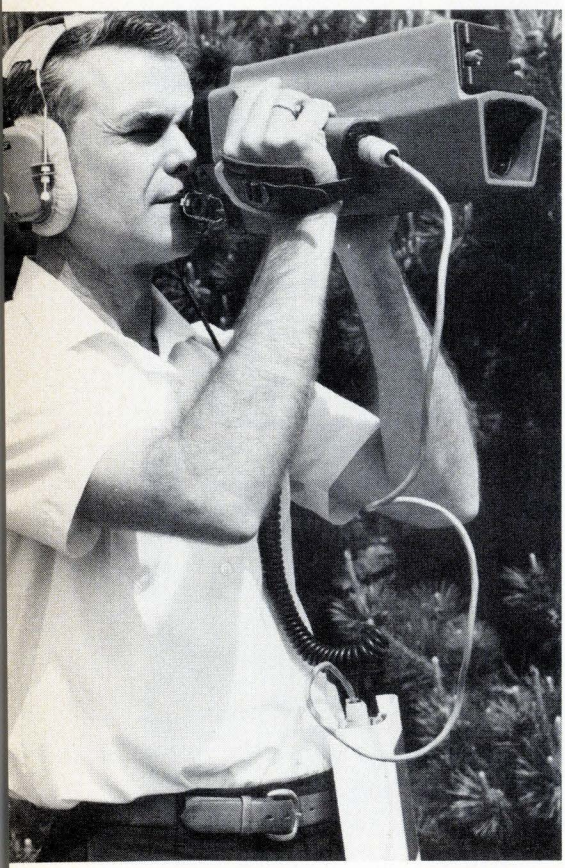
Thus there should be little difficulty in drawing such fiber cables through conduits. The strength of optical fibers will, however, degrade with time, but this is not considered to be a problem since the fibers will be in bundles and will also gain strength from a sheathing.

**Needed: laser reliability.** While the work in low-loss glass fibers has proceeded at a rapid rate, long-range optical systems require long-life semiconductor/lasers, and these light sources have not had the reliability required for communication systems. □

## Communications

# Stabilized laser communicator operates from moving vehicle

Laser beams offer hope for secure communications, but the major problem has been keeping the two ends of the circuit aligned. A new development from American Laser Systems, Santa Barbara, Calif., may change that, and both military and police organizations are interested [*Electronics*, May 10, p. 26]. The system permits 15- to 20-mile two-way communications between moving land vehicles, ships, or helicopters.



**Land, sea or air.** New laser communicator can be used on trucks, ships or planes.

The laser communicator combines infrared-laser transceivers with stabilized optics, which are modifications of binoculars made by Stabilized Optics Corp., Cupertino, Calif. The binoculars, which permit the use of highpower, 20× magnification on moving ships and vehicles, are already in use by police and naval forces. Conventional binoculars are limited to 10× or less in these situations.

The stabilized communications system uses a simple but patented physical principle that cancels the effects of magnification of movement with opposite-phase reflected light. A small gyroscope is also included, but serves only to overcome the friction of bearings at very low vibration frequencies.

**Avalanche detector used.** In the communicator, the optical path to one eyepiece in the binocular is replaced by a sensitive silicon avalanche detector. The stabilized system permits the sensitive but sharply focused detector to give a 100× system gain over conventional laser systems. The transmitter in the system is a small semiconductor laser diode with a peak output of 2 watts and an average output of 1 milliwatt.

The range of the unit is 16 to 20 miles, but, of course, is dependent on the visibility of the receiver. The communicator does not have to be aimed accurately—the bridge of a ship or a whole automobile is adequate. The American Laser Systems unit operates from flashlight-size cells, giving 5 to 7 hours of operation. Power drain is about a third that of a flashlight bulb.

**Computer transmission.** According to Duncan Campbell, president of American Laser Systems, the receiver and transmitter are basically digital in nature. The U.S. Navy has shown interest in data communications between ships using the technique, and Campbell also sees a future in the individual transmitter and receiver modules in the context of computer transmission between fixed points. □

## Auto electronics

# Solid-state sensor monitors car fumes

A new type of diffused semiconductor pressure sensor for automotive emission control has been developed by Bell and Howell. The device is expected to meet the long-term environmental requirements of cars while also surviving the tests of the legendary sharp pencils of Detroit's automotive economists.

The reliability required of semiconductors used in automobiles is actually higher than in the aerospace industry. For instance, conventional wire and tape strain gages for aerospace are not good for monitoring pressures in emission control, whether by fuel injection, exhaust gas recirculation or ignition control. According to Robert L. Cheney, project engineer at Bell and Howell's electronics and instruments group, Pasadena, Calif., the basic problem is that an aerospace transducer may be subjected to several temperature cycles and hundreds of pressure cycles, but a transducer in a car traveling 50,000 miles will be subjected to hundreds of temperature cycles and thousands of pressure cycles.

The Bell and Howell device is not

the first strain gage to use the piezoresistivity of a semiconductor, but earlier ones used a whole piece of silicon as a sensor, with separate support. The new diffused device uses a silicon slice as support and pressure diaphragm as well, with only small areas actually serving as sensors. This eliminates the mounting interface problem between the sensor and support, a vital consideration in view of the tiny displacements involved.

Unlike conventional gages, also, the technique seems well adapted to low-cost automated assembly and checkout, for manufacturers can use the proven photochemical methods used in making integrated circuits and transistors.

**Tolerance.** One area in which semiconductor gages are basically inferior to conventional ones is temperature tolerance. However, this temperature dependence is virtually eliminated in the Bell and Howell device, since it combines two or more sensors in a bridge configuration. As the sensors are simply small areas in a silicon slide, they cost no more than a single sensor. The usual automatic-adjustment techniques of laser-trimmed thick-film resistors and temperature-sensitive resistance elements permit this unit to respond to a change of less than 0.002% of full scale per degree fahrenheit. This is five times better than typical aerospace standards.

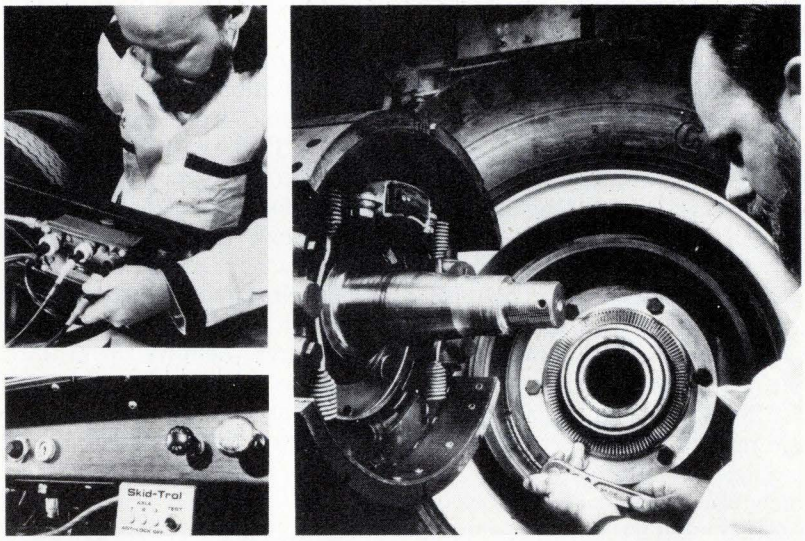
An unusual feature of the gage is the bond between the silicon diaphragm-sensor and the glass tube that supports it. The bond was developed by P. R. Mallory Co., Indianapolis, Ind., and it produces a stable, pressure-tight joint. The stability of the semiconductor devices also eliminates the need for periodic calibration, which is prohibited in automotive uses.

Tests of transducers over a million cycles from -65° to 250°F while being pressure-cycled from full vacuum to ambient pressure indicate stability of better than 0.5% of full scale. Conventional transducers subjected to the same cycling have shown an order of magnitude greater change, says Cheney. Robert W. Meyers, product manager at Bell and Howell, feels that the new device can beat both performance and price requirements of the auto industry and expects to see such sensors will be picked for use on 1975 model year cars, at least those sold in California. □

## Anti-skid unit is digital

At the first public showing of its SKID-TROL anti-wheel-lock braking systems for heavy trucks, Rockwell International Corp. said it hopes to capture at least 30% of the $100 million market [*Electronics*, May 10, p. 70.] The electronics for SKID-TROL's digital computer comes from Rockwell's Microelectronics Division, Anaheim, Calif. The firm's Rockwell Standard division is handling the system integration.

The computer is the heart of the only fully digital system for the function that will be required by new Federal safety regulations. It uses an MOS LSI calculator-type chip programed for this special function. Other manufacturers of anti-skid systems are expected to adopt the digital approach in the future.




## VW uses ICs in seat-belt system

With about a quarter of its production going to the United States, Volkswagenwerk AG is moving ahead of other German car makers in complying with U.S. motor vehicle safety legislation. The company is now installing the first production versions of a seat belt interlock system in VW passenger models destined for U.S. exports later this year.

The electronics firm that helped with the system is Intermetall GmbH, the German member of the ITT Semiconductor Group and developer of the integrated circuit around which the equipment is built. Intermetall calls its IC the first made in Europe for interlock units. Designated the SAJ 280, the device will be marketed in the U.S. through the ITT group's American facilities.

With its new equipment, Volkswagen is complying with U.S. regulation MVSS 208, the motor vehicle safety standard that requires seat-belt interlock systems on all 1974 passenger models [*Electronics*, March 1, p.70]. Such systems prevent the driver from starting his vehicle unless he and his front-seat companions have fastened their lap and shoulder straps.

**Signs and alarms.** Like any seat-belt interlock system, VW's equip-

ment lights a "fasten seat belts" sign and sounds an acoustical warning when a set of conditions is not satisfied. Monitoring the proper sequence of events from seat occupancy and belt fastening to handbrake loosening and engine turn-on are electronic circuits. Using inputs from sensors at the seats, in the seat belts, the oil pressure system, and at the handbrakes, the circuits regulate an interlock solenoid so that the engine can be started only when the sequence is correctly followed. The solenoid blocks the starter when, for example, the belts are fastened before the seat is occupied.

In addition to performing the basic functions spelled out in the U.S. regulation, the German system has a few refinements. One is a time delay that allows an engine restart before three minutes have elapsed, regardless of whether seat belts are fastened or not. This feature will be welcomed by a driver who, for example, turns off the engine and gets out of his car to open a garage door. The time delay lets the driver put his vehicle into the garage without the need for him to fasten his belts.

Another feature is a 10-second delay that prevents the starter from becoming blocked when a passenger, whose seat belts are already fastened, temporarily lifts himself from his seat in trying to find a comfortable position. Without this delay, the driver would have to go through the whole sequence of getting into the car, fastening his belt and loosening the brakes every time he pulls himself slightly off the seat.

While other German electronics and car-accessory makers have chosen simple discrete solutions for the interlock circuitry, the Intermetall/Volkswagen designers have opted for an IC approach. "Although more difficult to realize, it makes for a more reliable and relatively inexpensive system when produced in volume," says Alfred P. Prillmann, sales manager for professional products at Intermetall.

"The price of the system," Prillmann says, "is about the same as that of a discrete-transistor version." Now that it has delivered a limited number of ICs for the car maker's first production versions of the system, Intermetall will start mass producing them at its Freiburg plant next month.

**Picked bipolar.** The 280 circuit packs onto a 3.5-millimeter-square chip roughly 100 transistors in addition to a number of diodes and resistors. The company has picked bipolar instead of MOS technology to insure circuit operation even when, as a result of cold weather, the supply drops to 6 volts, half of the normal 12-V supply. A bipolar design also makes it easier to get up to the current levels needed for driving the output stages and for relay operation, Prillmann says. The trend in U. S. seatbelt interlock systems is to use C-MOS, which operates from as low as 3 V and is more tolerant of power-supply variations than bipolar.

The Intermetall circuit, which comes in a 14-pin dual in-line plastic package, handles up to 25 milliamperes. Its current consumption under engine-off conditions is less than 5 mA, and leakage current is less than 1 microampere. □

## Commercial electronics

# Highway call box moves to corner

The highway aid box is a familiar sight along major thoroughfares across the country, but these hard-wired telephone devices are not vandal-resistant and are prone to destruction in severe weather conditions. Now, hard-wired systems are being replaced by radio call boxes, which overcome these problems, and many have been set up on interstate highways.

The first installation, on a 43-mile stretch on Florida Interstate 75, was put up by the ADT Corp., New York. It was followed by a string of boxes from Motorola along 20 miles of roadway between Fort Lauderdale and Miami, Florida [*Electronics*, March 1, p. 32]. Further, ADT is currently installing 248 help boxes


**Radio call.** Opening radio box energizes magneto that powers signal to a console.

along the 60 miles of Massachusetts I-495 and in various locations along interstate highways in southern Illinois. Moreover, the company, moving its system onto the street-corner, is set to install 40 radio boxes in the small industrial-residential town of Weehawken, N.J., at a cost of $400,000. Motorola's installation of 90 boxes cost $328,000.

The ADT box, unlike Motorola's, uses no voice communications or batteries. Instead, the user activates a magneto when opening the door of the box, which in turn provides power to send a radio signal to a computer-type console.

When the signal reaches the console, the type of assistance requested and the location of the box flashes on a digital counter and is permanently recorded on paper tape. An operator returns a signal that the message has been received. The console can handle as many as 9,999 remote call boxes. In the event that a pole holding the help box is knocked over, a tilt alarm is activated on the console.

Components for the system are manufactured by Solid State Technology Inc., Wilmington, Mass. □

## Computers

# Systems house in microcomputer race

The ever-growing commercial microcomputer derby has a new and seemingly unlikely entry: Teledyne Systems Co., historically best known

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Also available are rackmount versions of both the 465 and 475.

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for its military equipment. Taking advantage of the availability of chip sets from several semiconductor makers [*Electronics*, March 1, p. 63], Teledyne has come up with a family of microcomputers that are 2.5 in. in diameter, 0.10 in. high, and cost $1,000 in small lots.

The Northridge, California firm developed the microcomputers for a Government program and is now attempting to develop commercial customers. The company has several varieties in its line, from a basic, all-in-one package unit with about four to five times the capability of the Intel MCS-4 microprocessor set, up to one that requires two packages and has close to the capability of a minicomputer, according to Earl Kanter, vice president of advanced systems. Typical add times for this level are 10 microseconds for 16 bits. The price is about $1,000 per package independent of the specific circuitry, although memory is less expensive than logic.

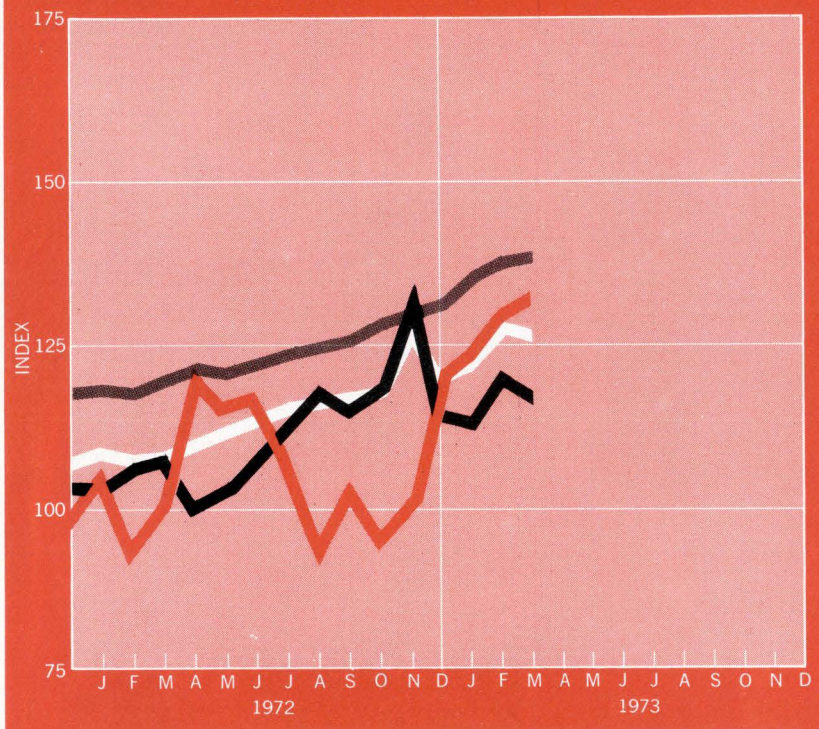
**P-MOS now, n-MOS later.** The basic technology in the computers is p-MOS. It makes use of available components from Intel, National and Rockwell, but with architecture and other components different from standard sets. Kanter expects to use n-channel sets when they become available. Teledyne buys the parts in wafer form, then separates, tests, and applies them with hybrid techniques.

**Handful.** Teledyne Systems' microcomputer is 2.5 in. in diameter and sells for $1,000.

Kanter says that the most popular package is the 2.5-in. round one, but other, rectangular units are available. The sealed unit requires no maintenance, calibration or service, and can easily be replaced in the field. The compactness of the microcomputer, its ease of replacement and projected high reliability (mean time between failure is 25 years) make it especially attractive for the automotive, process control, chemical, and petroleum industries. It requires about 7 watts.

In addition to the unique packaging, Teledyne is also offering a comprehensive set of software, and in fact, Kanter feels that this is the unit's major advantage over the capabilities of the stock chip sets. □

## Electronics Index of Activity




| Segment of Industry | March '73 | Feb. '73* | March '72 |
|---|---|---|---|
| Consumer electronics | 133.4 | 130.9 | 101.8 |
| Defense electronics | 118.2 | 121.6 | 102.3 |
| Industrial-commercial electronics | 139.8 | 138.3 | 122.1 |
| Total industry | 127.4 | 128.3 | 108.1 |

The Electronics index fell in March, but it still remained a healthy 17.9% above March 1972's level. Defense Electronics dragged the total index down, falling 2.8%, but it, too, was still 15.5% above March 1972. Consumer electronics climbed 1.9%. The other gainer, industrial-commercial-electronics, climbed 1.1%, 14.5% higher than it was a year ago.

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.

## Production

# Ribbon wire virtues don't move users

Bonding with round wire has been a headache for IC and hybrid manufacturers, but a switch from round wire to flat ribbon wire could provide a cure. Alvin H. Sher and Herbert K. Kessler of the National Bureau of Standards have recently completed studies showing that an ultrasonic bonding tool can operate over a much broader time-amplitude range yet still provide a given pull-strength value when the wire used is ribbon-shaped.

Potential users also believe it is the way to go, but not right now.

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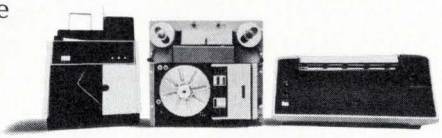

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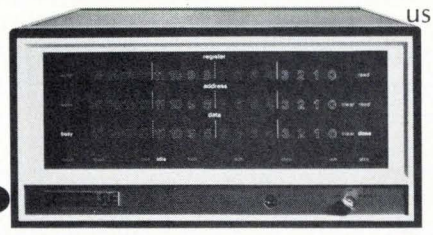

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Circle 39 on reader service card

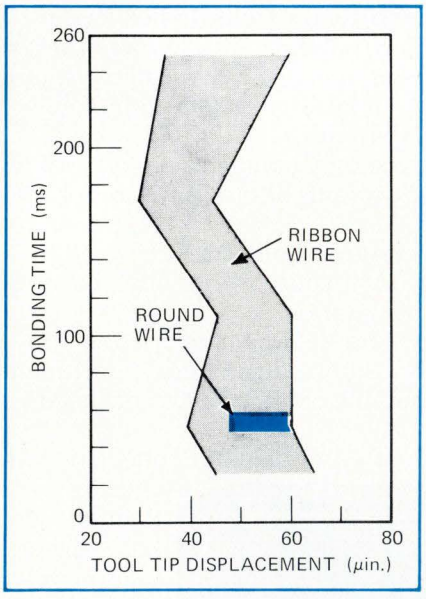
Leo W. Czarnecki, manager for equipment engineering at Fairchild Camera & Instrument, Mountain View, Calif., says Fairchild tried ribbon bonding and found its strength to be its most outstanding characteristic. He says it takes current surge better and its assembly is easier. Czarnecki believes the greatest demand for ribbon bonding will be in power devices. But for now, Fairchild is staying with round wire for economic reasons.

Frank Stevens, general manager of Sigmund Cohn Manufacturing Co. Inc., Mount Vernon, N.Y., which supplies bonding wire to the industry, says that ribbon wire is just "a few days after birth," and few are using the technique in volume.

In one series of tests, Sher and Kessler learned that tool displacement amplitude can be varied over wide margins and could still meet a 10-gram pull-test. But the margin of adjustment is much tighter for bonding round wire.

A second advantage for ribbon wire is that bonds can be stacked. This gives the device maker greater flexibility in point-to-point wiring and should be particularly attractive to hybrid users.

But this technique has been around for more than two years and so the puzzling question is: why have so few users adopted it? One answer may be that IC device makers are in a boom period, and are only just now beginning to recover from 1970 and 1971 and are too busy to innovate.




**Relaxed tooling.** Shaded area indicates the broad region over which an ultrasonic wire bonder will bond ribbon wire with a minimum 10-gram full strength.

**Does ribbon wire cost more?** Cost depends on the tolerance requirements of the user. If tolerances are relaxed, as Stevens feels they should be, then the price for ribbon wire would probably rise no more than 10%. However, if the user sticks with ±3% tolerance on the cross-section dimensions, as is often the case with round wire, then the price might jump as much as 25%. But either way, going to ribbon wire shouldn't impact the IC fabrication cost much, since the value of the wire is no more than 3% of the material costs in the IC. □

## Components

# Military holds out against plastic packs

Intermittent or open bonds continue to plague plastic-packaged semiconductors tested by the U.S. Army for military applications, despite acknowledged gains in bond reliability and device moisture-resistance. This, coupled with the Army's view that "vendors are not interested in supplying plastic devices to 'hi-rel' specifications," have led the military to hold fast to its restrictions against general usage of plastic discrete and microcircuit semiconductors, the 1973 Electronic Components Conference was told in Washington.

The steadily increasing preference of semiconductor makers for plastic packages could pose a future procurement problem for military users seeking hermetically sealed glass, metal, or ceramic packages, says Edward B. Hakim of the Army Electronics Command's Electronics Technology and Devices Laboratory, Ft. Monmouth, N.J. Citing Electronic Industries Association estimates that plastic packages accounted for about 70% of U.S. transistor production and approximately 55% of monolithic-integrated-circuit output in 1972, Hakim told the symposium that growth rates for plastic packages in these two market categories approximate 2% and 4% a year. Compared to hermetic packages, prices for plastic devices continue to decline. In 1972, transistors averaged 59 cents for hermetics compared to 13 cents for plastics, while hermetic ICs cost $1.56 compared to 63 cents for plastics.

**Volume.** Following the symposium session on interconnection, where he outlined Army data on tests of interconnection reliability of plastic devices in a paper authored jointly with ECOM's Bernard Reich, Hakim identified the potential problem for military semiconductor users this way: vendors "can sell a million plastic devices a month to the computer industry. We may not buy more than a million a year." Moreover, the industrial customer's test requirements are much less rigid than the military's, making the market more appealing to semiconductor makers.

Vendor disinterest in supplying plastic packages to 'hi-rel' specifications, he said, stems primarily from lot testing costs relative to the cost of the devices themselves. "Plastic device vendors would rather rely on short-term indicators than be confronted with the rigors of the normal 'hi-rel' specifications," Hakim explained to the ECC meeting. The three-day May meeting was sponsored jointly by the EIA and the IEEE.

The Army semiconductor specialist was not prepared to write off military use of plastic devices indefinitely, however, noting that surveillance of device developments and performance should continue because their future use—"possibly within this decade"—may be justified.

**Defects down.** Bonding defects, for example, are about 0.15% based on 1972 experience, he noted, "down significantly from the period when the bond problems first began getting visibility." Hakim forecast that this figure could drop to 0.01%

# 16 channels


## PROGRAMMABLE MULTI-CHANNEL ANALOG FILTER SYSTEM 816

- **UP TO 16 FILTER CHANNELS (THROUGH PLUG-IN CARDS) IN 5¼" PANEL HEIGHT**
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by 1975 with present technology. However, if beam-lead devices or devices employing bump technology are generally applied, the rate of improvement could be significantly increased.

Fort Monmouth, he said, is considering the use of "a liquid-to-liquid, -60°-to-+150°C thermal shock screen to cope with the bonding problem," but added "there is a great reluctance on the part of vendors" to accept it on the ground that such a test "is potentially destructive and capable of creating latent defects." Preliminary results at ECOM show the test is not destructive.

Noncontrolled field reliability performance of plastic and hermetic transistors by ECOM indicates dramatic improvements and suggests their performance should approach those of hermetics by 1974–75. □

## Space electronics

# FCC okays Marsat, but questions remain

When the Communications Satellite Corp. announced that it planned to use the interim Navy navigation satellite as a civilian maritime satellite as well [*Electronics,* March 15, p. 36], it brought a storm of protest from the international record (message) carriers and potential equipment builders. They complained to the Federal Communications Commission that the deal was too quick, could give Comsat dominance in international maritime-satellite communications, and effectively freeze them out of the system.

Now, after much discussion, the FCC decided this month that Comsat could proceed "at its own risk" to contract with Hughes Aircraft Co. for three Anik-like satellites to start the $70 million program. But it left some touchy issues undecided—how to achieve workable joint ownership among competing companies and how those parties would choose a system manager. To find out who's really interested, the FCC ordered U.S. common carriers now providing maritime service and known as wanting to join—AT&T, ITT, RCA, TRT Communications Inc., and Western Union International—to sign up with the commission by June.

**Comsat comeback.** Naturally preferring to keep its lead, Comsat argues that the commission's decision to let the participating companies select the system manager could breed disruptive discontinuity.

By piggybacking a commercial maritime satellite system on the Navy's two-ocean interim satellite requirement, Comsat and the participating carriers could engineer a lucrative combination. Satellite costs, including spare parts and development, would equal $39 million, launch costs would come to $26.5 million, and system development and filing fees would take up the rest, the company says.

Moreover, participating in such a system would give companies entrée into a bigger market beyond—a projected global ship-shore-satellite navigation and communications system that maritime interests are seeking [*Electronics,* Feb. 1, p. 50]. □

## News briefs

**Wescon gains ERA as co-sponsor**

The Western Electronic Show and Convention (Wescon), to be held Sept. 11–14 in San Francisco's Brooks Hall, will have a new co-sponsor with IEEE—the Electronic Representatives Association. WEMA withdrew as a co-sponsor earlier [*Electronics*, March 15, p. 25], but ERA's presence "guarantees some management and marketing flavor to the Wescon board," says a Wescon spokesman. All the exhibits will be contained in Brooks Hall this year, which means the show will be limited to about 500 booths. One new feature planned for the show this year is a two-day manufacturing seminar to be held at the San Francisco Hilton.

**Bendix in $1 million deal with Argentina**

Bendix International, New York, has received a $1 million contract from the Argentine Ministry of Agriculture and Cattle to supply an airborne remote-sensing and ground data-processing system for conducting surveys of the country's agricultural lands. Data will be gathered and stored on high-density magnetic tape and will be processed by a general-purpose computer provided by the Argentinian government.

**Color sets have built-in cable converter**

RCA Corp. says it is the first color-TV manufacturer to build into its sets the capability of receiving 24 cable channels in addition to conventional vhf and uhf signals. The new feature is going into RCA's top-of-the-line XL-100 solid-state units and will eliminate the need for a separate converter or selector device to obtain cable TV reception.

**Analog Devices starts C-MOS line**

Believing that "C-MOS is on the upswing and ready to replace TTL in many applications," Analog Devices' microcircuits operation in Santa Clara, Calif., announced its entry into the C-MOS field with three new products (see p. 71). These include a differential four-channel multiplexer, a single eight-channel analog multiplexer, and an uncommitted quad analog switch. All are compatible with TTL, DTL, and C-MOS logic. The new devices are aimed at applications in analog-to-digital and d-a converters, digital amplifiers, frequency multipliers, and digital filters. Analog Devices says part of the move was in anticipation of growth in the minicomputer and IC markets.

**E-Systems wins airborne command post job**

The Air Force Electronics Systems Division, Hanscom Field, Mass., has awarded a $20.5 million fixed-price-incentive contract to E-Systems Inc., Greenville, Texas, to equip two 747-200B Advanced Airborne Command Post (AACP) aircraft with electronics.

# WORLD'S FIRST PRODUCTION CCD



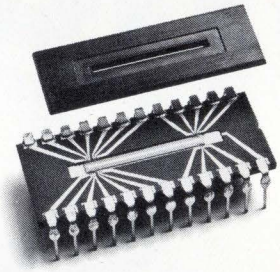
 

# Our 500-Element Linear Image Sensor: World's First Production CCD.

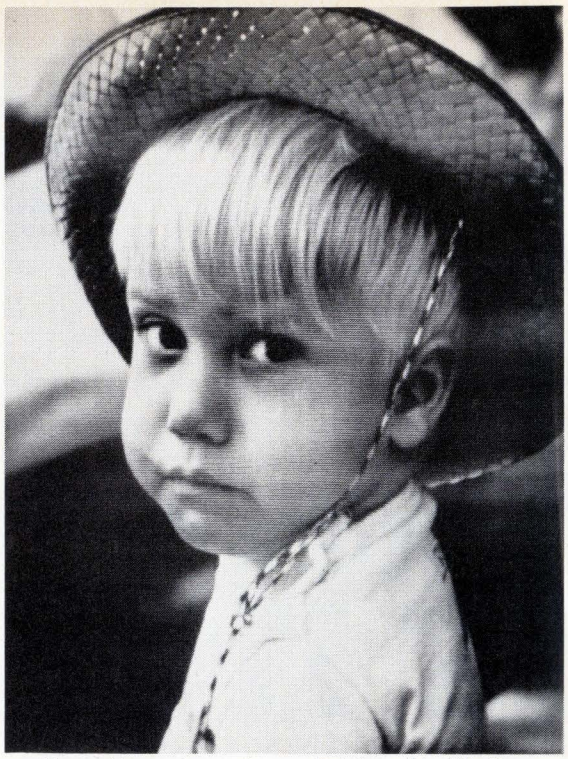
**New CCD101. High sensitivity, wide dynamic range, self-scanning device. Available now for prototyping at $1200.**

The CCD101 Linear Image Sensor uses charge-coupled technology and a buried-channel structure to create a rugged, monolithic, self-scanned, 500-element sensor designed for high sensitivity conversion of images to analog signals. For slow-scan TV, facsimile, and other high-resolution linear imaging applications.

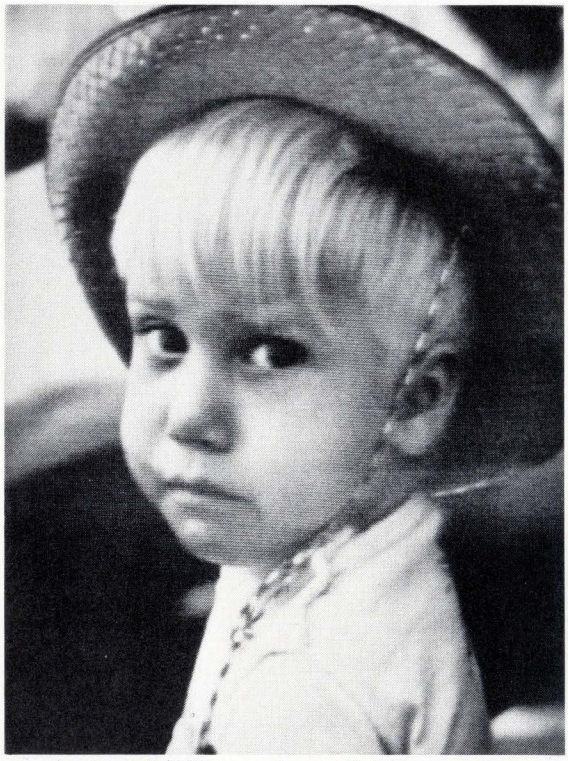
The impact of CCD on imaging is analogous to that of the transistor on vacuum tubes. It has been called by one high level government scientist "the most important breakthrough in semiconductors since the development of MOS."



**CCD101 Linear Image Sensor**
The array is a 500-element photo-sensing chip, 60 x 635 mils. It includes, in addition, charge transfer gates, two 250-element CCD analog shift registers, a 2-element output register, and a preamplifier. The device allows sequential reading of the 500 imaging elements with a typical dynamic range of 1000:1 at 1 MHz. Sensitivity is typically $15 \times 10^{-6}$ footcandle-seconds. Operating voltages are under 20V. On-chip preamplifier allows a low-impedance interface. The 24-lead dual in-line ceramic package—1¼" long x ½" wide x 5/16" high—has a sealed anti-reflectance glass window and non-reflective interior.



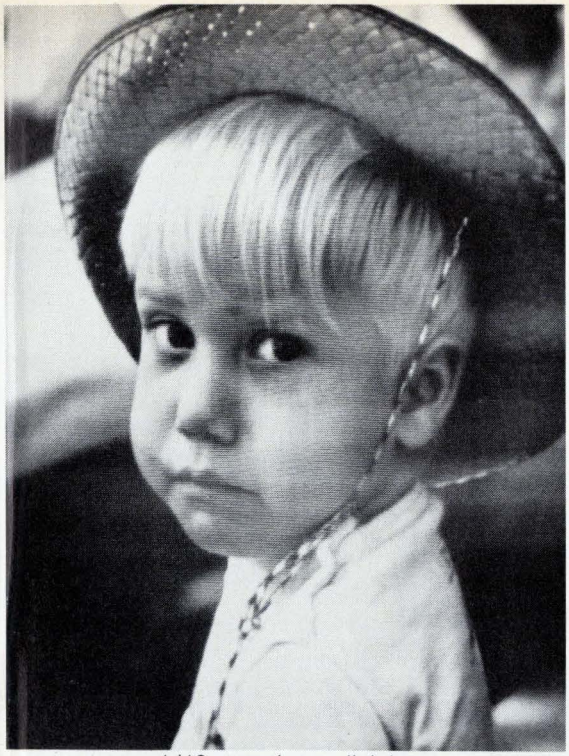
Normal incandescent room lighting. (No filtration. Peak incident illumination around 30 footcandles.)



1/100 normal room lighting.

**99.999% Transfer Efficiency**
Key to CCD101 high sensitivity imaging is the buried channel structure which reduces charge-transfer loss, thus permitting greater image element density. The result is demonstrated above.

The 4 photos illustrate the device's capacity for generating a clear video picture *of a single frame* at



1/10 normal room lighting.

1/1000 normal room lighting.

widely varying levels of illumination. The photos show the face of a CRT displaying the output of a CCD101 sensor clocked at 1 MHz scanning a black-and-white photo on a rotating drum. Increasingly dense filters were inserted between the sensor and the scanned photo. The intensity dropped, but the image remained usable.

**CCD Imaging Advantages**

CCD technology provides the first high-performance method for solid state imaging. The CCD101 is the first CCD product, and thus the first to clearly demonstrate its high performance advantages, high reliability and dimensional accuracy, with lower noise video, low-voltage operation and self-scanning that eliminates much external control circuitry. All made possible by our CCD buried N-channel technology.

CCD advantages over other types of imaging devices are manifest:

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| • Long Life | • No pattern noise |
| • Lower power | • Low, uniform dark current |
| • Lower operating voltages (none greater than 20V) | • Better detectivity |
| • Solid state ruggedness | • On-chip preamp |
| • Inherent metric accuracy | • Lower power |
| • Low impedance interface | |
| • Greater dynamic range | |

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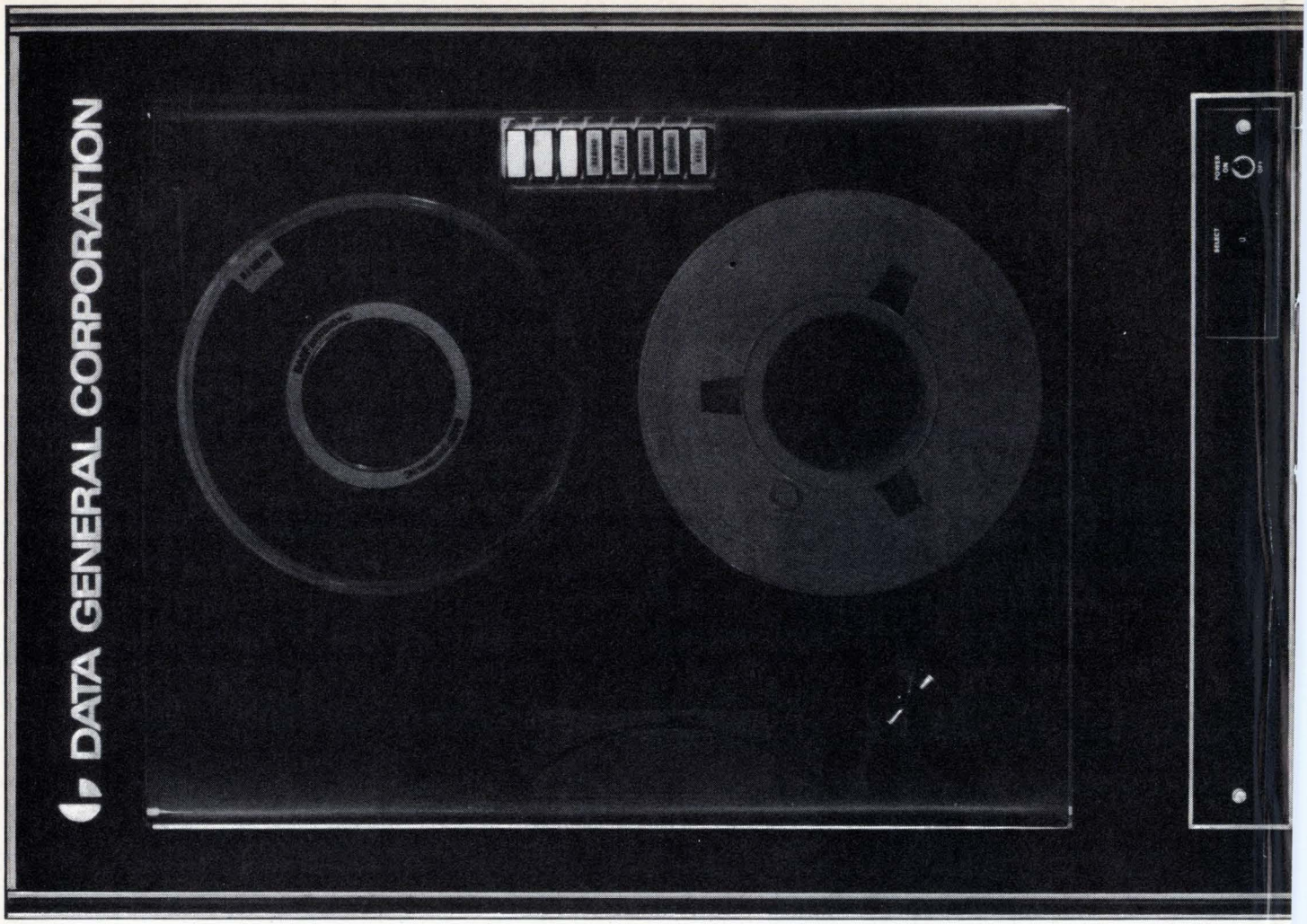


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The loaded Nova is the new Nova 840 and the most comprehensive set of software/hardware capabilities ever available with a Data General computer.

It comes with a built-in Memory Management and Protection Unit that lets you expand main memory to 128K 16-bit words. Base price with 16K of memory is $16,530.

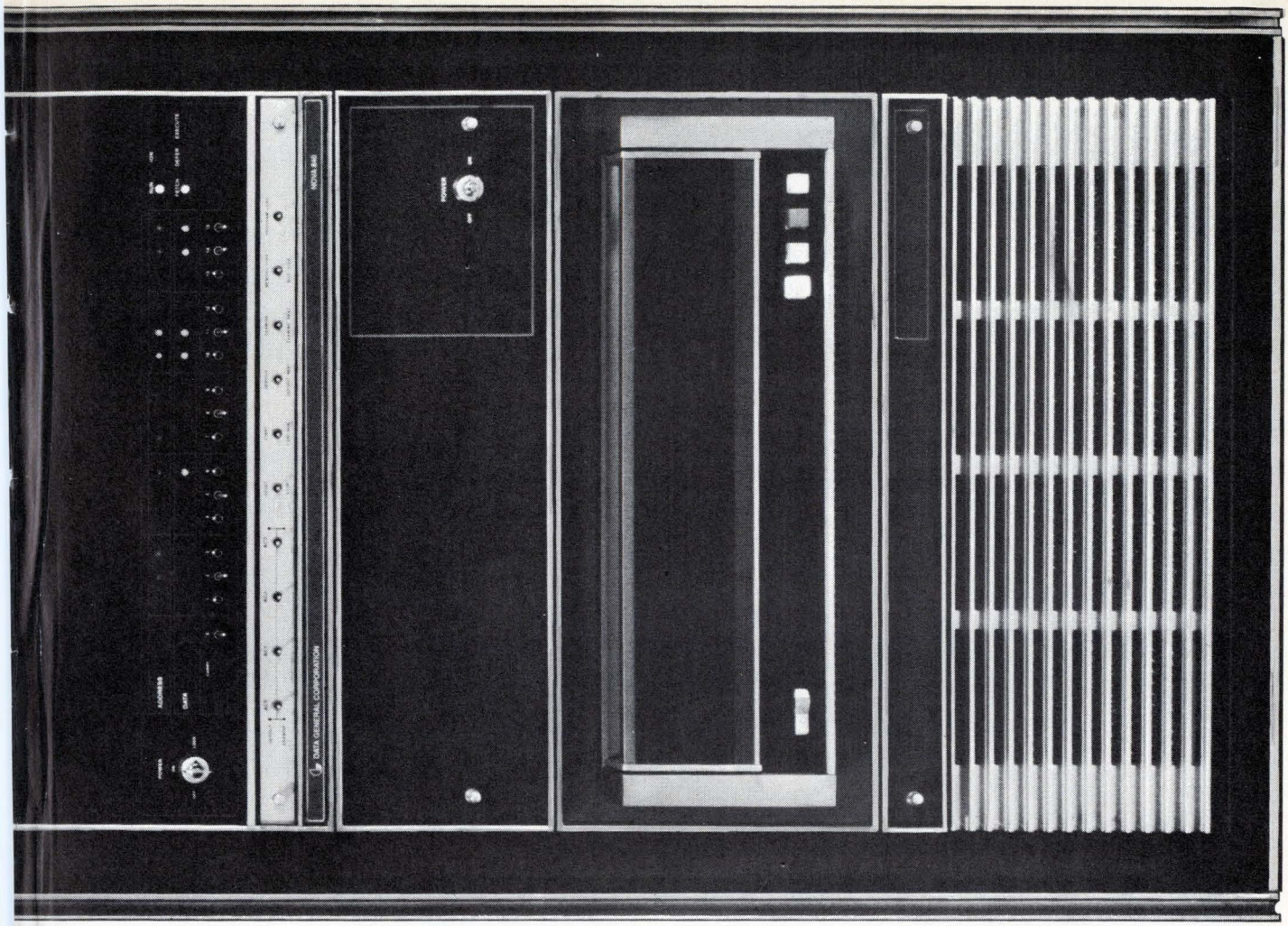
Nova 840 runs a comprehensive Real-time Disc Operating System (RDOS) for dual programming operations.

A new BATCH executive lets you pick your I/O devices, load your jobs, and walk away.

It has our new Fortran 5, Extended ALGOL, Extended Timesharing BASIC, and a whole library of proven Data General software; proven software that we can deliver now.

And our Remote Job Entry software can let the 840 double as a high-powered terminal to a big computer someplace else.

With the right kind of configuration (like the one shown), all that software is available free.



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The Nova 840 in the picture has a central processor with 32 to 64K of main memory, a high-speed Floating Point Processor, hardware Multiply/Divide unit, fast-access disc storage, and 9-track mag tape.

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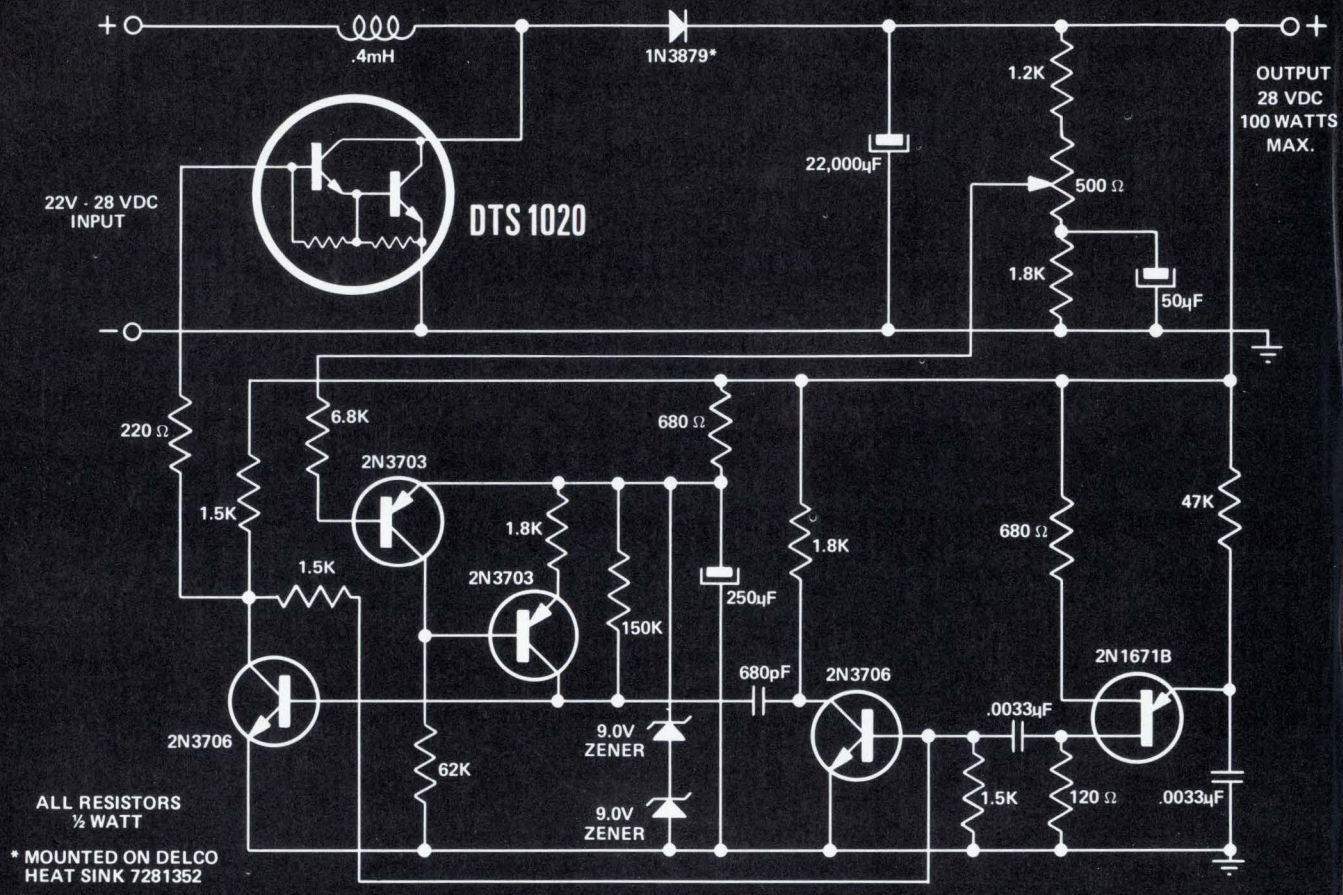


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|---|---|---|---|---|---|---|---|---|
| DTS-1010 | 120V | 7V | 80V | 12 | 200 | 1.8V | 10A | 100W* |
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*100 percent tested at 2.5A, 40V.

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For details on the switching regulator circuit, ask for Application Note 49.

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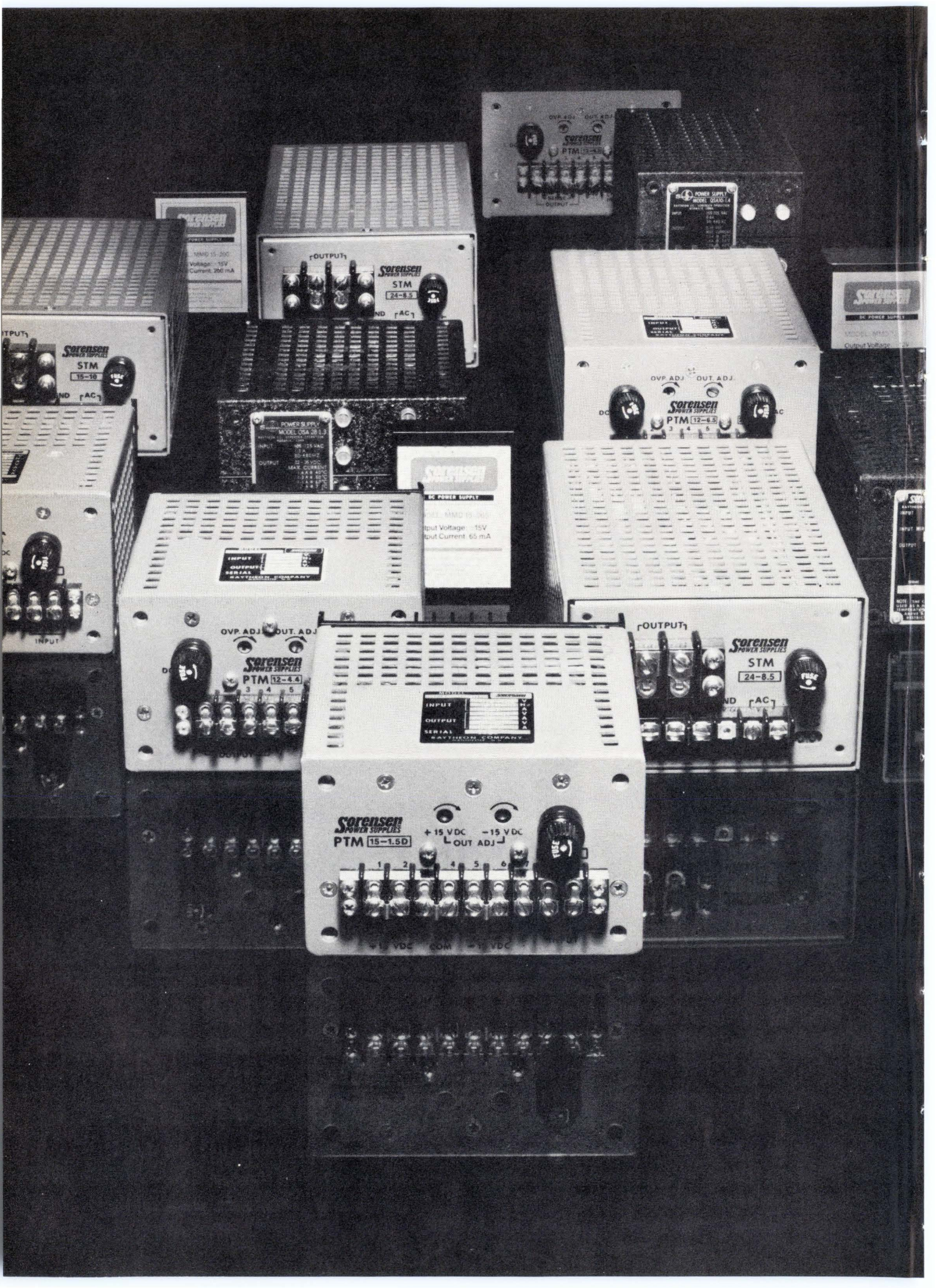
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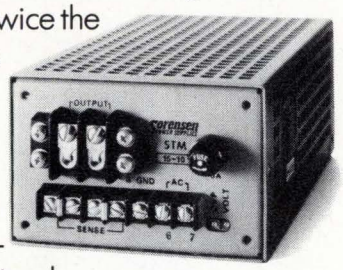
**STM Series** — 40 models. Switching-transistor modulars that provide twice the efficiency of series-pass competitors in half the space — and eliminate need for external cooling. STMs feature built-in overvoltage protection; computer-optimized filtering; 0.05% voltage regulation; output voltages range from 3.0 (min.) to 56 (max.) Vdc.



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**MM Series** — MMS (single) MMD (dual) MMT (triple) — 15 models, 4 package sizes. Designed for maximum reliability in microminiature electronic applications. All MM encapsulated modulars feature built-in overvoltage protection; excellent voltage regulation; single outputs from 5 to 28 Vdc; dual outputs of ±12 or ±15 Vdc.

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# Washington newsletter

**International components standards come nearer . . .**

American component manufacturers believe they have won **a significant victory in the development of a voluntary international components certification system** under the International Electrotechnical Commission. This is the message just delivered by Leon Podolsky, chief negotiator for the U.S. IEC committee, to the Electronic Industries Association, following a round of meetings in Geneva last month. EIA, as well as a number of U.S. officials, have long regarded the proposed multipartite standards pact as a nontariff barrier to trade, since the pact initially involved only European manufacturers [*Electronics*, March 30, 1970, p. 69].

Podolsky's report spelled out **progress in getting "a generally satisfactory compromise" by most of the 13 member nations on two key U.S. points.** The first is a provision that an "inspectorate in the country in which the product is released is responsible for the supervision of all testing and inspection necessary," thereby covering multinational manufacturing operations. The second provides for use of other than IEC specifications when there are none covering a given product.

**. . . but await decision in June; domestic reaction**

Following the Geneva round, which Podolsky dubbed "unexpectedly difficult" because some national delegates altered earlier positions, **the IEC Council will vote at Munich in June on whether to accept the draft statutes for the new certification system.** Odds on acceptance are put by Podolsky at "about 5 to 1." Participating nations are Australia, Belgium, Brazil, Canada, France, Germany, Israel, Italy, Japan, the Netherlands, the UK, U.S.A., and USSR.

Domestically, **the EIA says it is exploring a means of developing a national supervising inspectorate** through existing Government or industry inspection organizations, "or some brand-new organization." **It is also determining how much U.S. participation will cost manufacturers**—and how much more a components user will be willing to pay for certified parts. A preliminary EIA estimate of a 3% increase in component costs has been criticized by some members as too high. In any event, the earliest the new system could be operational is late 1974.

**Phone tariffs may thwart GSA plan for own phone centers**

Bad news may be in store for those suppliers of interconnection and switching equipment who have been eyeing **the General Services Administration's plans to install and operate telephone centers for Federal use.** Following its cancellation of the publicized Middle River, Md., project to install its own Centrex-type system, GSA is re-evaluating projects at Erie, Pa., Winston-Salem, N.C., and Denver, Colo., as well as others as yet only on the drawing boards, to see whether the total telephone tariffs permit economical operation of its own equipment. **"We may have to make modifications in the program,"** says one source, indicating that some cutbacks may be in order.

GSA dropped the small, 200-line Maryland project after **the Chesapeake and Potomac Telephone Co. produced a new tariff which the agency thought was too high** to allow it to run its own equipment. Observers view that tariff as a way of stifling GSA's idea and discouraging large users from buying non-Bell equipment. Winston-Salem is planned to use 600–800 lines, while Denver has about 3,000.

# Washington commentary

## Trade reform and the impact of Watergate

"When Nixon's trade bill makes it through this Congress . . . perhaps I should say if Nixon's trade bill makes it through this Congress, you won't be calling it 'the Trade Reform Act of 1973' anymore. You will be calling it 'the Mills bill.' "

Thus, with a deft bow to Rep. Wilbur Mills—the Arkansas Democrat invariably described in the press as "the powerful Chairman of the House Ways and Means Committee"—one Administration trade specialist summarized the view of many in the capital following the opening round of congressional hearings on the President's proposal. The fact that even some Nixon Administration loyalists seem uncertain about the bill's fate is one of the less heralded consequences of the Watergate affair.

Apart from all its other national and international implications, Watergate is expected to severely handicap the President's request for new and extraordinary powers to deal with the nation's mounting balance of payments and trade problems. "The Administration's bill would give unprecedented powers to the President" to deal with trade problems, explains one congressional economic specialist, "and there are a lot of members up here having second thoughts about that, considering the way the White House has been handling itself lately." The electronics and aerospace industries, anxious to see the legislation passed, would do well to listen closely to the views of Chairman Mills, whose committee will shape the bill.

### Another crisis

While the President is confronted by a personal crisis of substantial proportions, the nation's trade problems present a national crisis of far greater significance for the long term. This was made plain by the mid-May disclosure by the Department of Commerce that the $10.2 billion balance of payments deficit in the first three months of 1973 was only $100 million less than that recorded during all 12 months of 1972. The red ink for the quarter was more than three times the $3.22 billion deficit shown in the first quarter of 1972.

What is intriguing to anyone taking a closer look at the new Government figures is that this massive increase in the payments deficit came despite a significant improvement in the U. S. trade balance for the same period. Commerce blames it largely on a $5.9 billion flow of liquid private capital out of the country in the quarter, reflecting a lack of confidence in the dollar by those seeking to capitalize on the relative stability of European currencies. All of this presents two significant complications for industries such as electronics and aerospace that have heavy multinational interests.

The first and most obvious of these is that action to turn the payments balance around cannot wait on the passage of new trade legislation later this year. If all the mounting signs of economic crisis are not dealt with swiftly and comprehensively, then the combination of payments deficits, inflation, and international monetary controls could easily snowball, taking a shaky securities market down with it. The Mills committee, among many others in Washington, is cognizant of this, of course.

The second complication is that congressional and other Government fiscal leaders are also suspicious that a disproportionate share of the liquid capital outflow out of the country is the responsibility of the multinational corporations, protest as some of them might to the contrary. Thus are the multinational technologists likely to find in the Congress a diminishing sympathy and a more intense questioning of the motives behind their pleas to eliminate suspension of Items 806.30 and 807.00 of the U. S. Tariff Schedules from the Nixon trade package [*Electronics*, April 26, p. 29].

### Shifting power

Mills at one point questioned the wisdom of giving the President power to grant relief to industries threatened by imports by imposing temporary tariff surcharges or quotas. But such suspicions do not carry over to the White House request for power to suspend Items 806.30 and 807.00 under which products assembled abroad using U.S. components enter the country duty-free except for the value added, despite the strong opposition of such groups as the Electronic Industries Association and the Aerospace Industries Association of America. As AIAA president Karl G. Harr, Jr., put it strongly in early testimony before the Mills committee, "If the manufacturing is not done in this manner, it either will not be done at all or the components will be produced locally instead of in the United States. This would mean a real loss in American jobs—those of an estimated 37,000 workers" for AIAA's membership. Despite their persuasive ring, such arguments do not seem to have much influenced Mr. Mills or many of his colleagues, who are being subjected to just as intensive lobbying by organized labor and its opposite view.

**—Ray Connolly**

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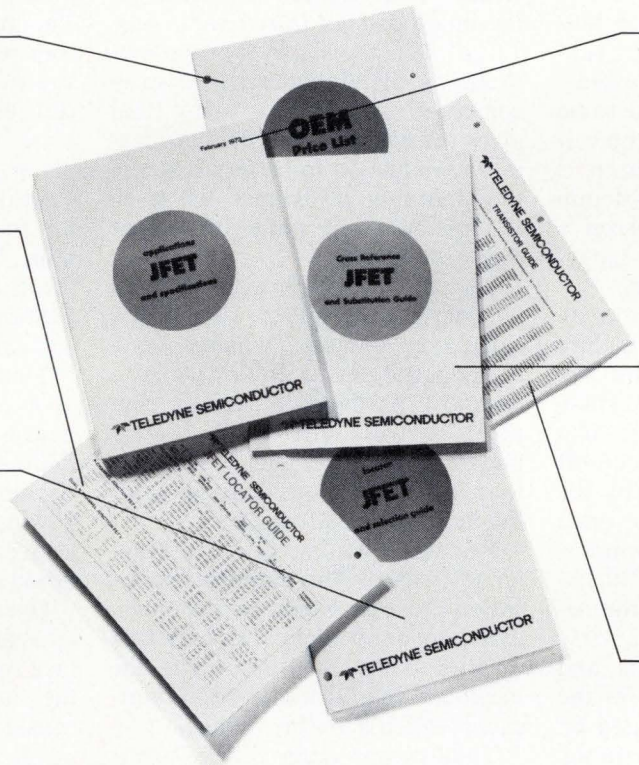


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## Calculator has drive and display on a single substrate

**Circuits of a new** low-power calculator developed at Sharp Corp. are on the same glass panel as the liquid-crystal display, making it a calculator on a single substrate.

Even the key-switch interdigitated contacts—which are shorted by conductive rubber buttons embedded in an insulating rubber mat when the key is depressed—are on the opposite side of the same substrate. The only part of the calculator not on the same substrate is the direct-current voltage-stepup converter, which is mounted on a small substrate of its own—piggybacked onto the main substrate.

**In one.** Liquid-crystal displays are made by Sharp itself and feature dynamic drive. The optimum oblique viewing angle for best display contrast is assured by the use of a snap-up hood coupled to the on-off switch. Light to be reflected by the display enters from both the open front and from a plastic window toward rear of hood. The black-matte hood makes all but the selected segments appear black.

Both the display segments and the two-layer printed wiring for the electronic circuits are fabricated on the lower surface of the substrate, while the key-switch contacts are fabricated on the upper surface. Connections between the printed circuits and the switch contacts are made around the edge of the substrate to simplify fabrication.

The low power drain of both the liquid-crystal display and the C-MOS circuits enables the calculator to run for about 100 hours on a single penlite-size dry cell. What's more, the unit is complete in itself. "With this combination of long battery life and low-cost replacement, it didn't seem worthwhile to build an ac adapter," says Atsushi Asada, general manager, business machine division.

Although the new calculator represents a far greater developmental effort than other recent units introduced by the company, a significant portion of it is not new at all. The C-MOS LSI calculator chip and clock generator and register MSI chip are the same units used in an earlier calculator that featured a light-emitting-diode display [*Electronics*, Aug. 14, p. 8E]. It is the lower power drain of the liquid-crystal display compared with LED display that gives the almost two orders of magnitude reduction in battery cost and the doubling of battery life even though only one rather than four cells are required.

Two new ICs, both manufactured by Sharp, are required for the new calculator, though. Dynamic drive of the liquid-crystal display uses two identical packages of C-MOS segment drivers. The 28-lead maximum for the packages used rather than the size of the chips dictated the decision to use two chips.

For the backplate driver, a bipolar IC is used. This simplifies fabrication processing because it is much easier to build bipolar circuits that operate at the 28 V applied to the backplate than it would be to fabricate C-MOS ICs for this voltage.

Total power drain is only about 12 milliwatts during standard operating conditions. The dc-to-dc converter, which has an efficiency in the range of 60–70%, ups the power drain from the battery to the nominal value of 20 mW.

**Display.** The liquid-crystal display, which makes possible the low-power and single-substrate features of the calculator, differs a bit from other dynamic-scattering displays. The front-panel glass carrying the transparent segments is the substrate on which the calculator circuits are fabricated. A smaller glass plate carries the mirrored backplates. The transparent segment electrodes are indium oxide, while the mirrored backplates are aluminum. Sharp went to indium oxide for its longer life and its ease of fabrication to the required precision, compared with the usual tin oxide.

Two coatings cover both the front and rear electrodes. The coating nearest the electrodes insulates them from the liquid-crystal material, preventing direct current from flowing between the electrodes and also electrolytic breakdown of the liquid crystal at the electrodes.

Overlying the insulation layer is an activation layer, which has a surface roughness similar to the size of the liquid-crystal molecules, that causes the molecules to line up perpendicularly to the panel when the display is undriven. The layer also acts to speed up the random orientation of the molecules when the display is driven. □

**West Germany**

## Solar cells charge the batteries in table-top cigarette lighters

If two West German companies are right, solar cells may turn up on coffee tables. Rowenta-Werke GmbH and Braun AG, majority-owned by Gillette Co, Boston, Mass., are putting the space-age products into prototype table-model cigarette lighters and are looking into the possibilities of solar-cell-powered pocket lighters.

Because patents are still pending, neither company is willing to give

all technical details on their new lighters. Rowenta volunteers enough information, though, to give a rough idea on how its units work. Called the Solartronic, its lighter uses four 2-centimeter-square cells mounted on top of the case. There, the cell's bluish color imparts something of a decorative effect.

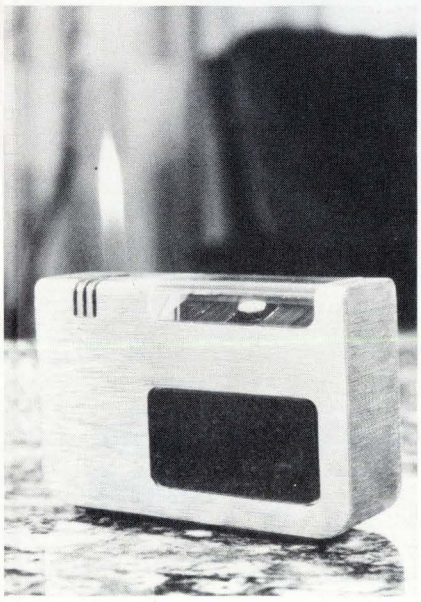
**Capacity.** Rowenta says that it manages with only an 8-cm$^2$ cell area "thanks to special circuit-design measures". The photocurrent charges a small nickel-cadmium battery with a capacity in excess of 100,000 milliwatt-seconds. The battery supplies the energy for a high-voltage ignition system which ignites the gas.

A full battery lasts for at least 1,500 ignitions. That means the Solartronic can be used to light up an average of 50 cigarettes a day for a full month without the battery having to be recharged by exposing the solar cells to a light source. Since a lighter on a living-room table is exposed to some form of light every now and then, the Solartronic stays charged much longer than that. Lighter operation then depends only on the amount of gas inside.

Wildred Grosch, marketing manager at Rowenta, is convinced that solar-cell-powered lighters are here to stay and that more companies will follow suit in making them. Braun, which does not yet share Rowenta's optimisim, is still cautious on the prospects of solar-cell lighters and wants to see if demand justifies full-scale entry into the market.

Whatever their prospects, solar-cell lighters will be initially a prestige product. Grosch points out that, when they hit the market in September, the least expensive of the company's new lighters will retail for "between 500 and 600 marks, probably closer to 600." At the current exchange rate, the price tag comes to between $175 and $210. Braun, which does not yet have any marketing plans, is tight-lipped on price but says they will be high. Both companies believe, however, that prices will come down eventually. They are pinning their hopes on electronic firms being able to supply less-expensive cells. □

**Light-powered lighter.** Solar cell on top of Rowenta unit keeps battery charged.



**Sweden**

## Paging system would cover nation

Sweden, the fourth largest nation in Europe, is about the size of California, and it's half covered with forests. But no matter where any of the 8 million Swedes happens to be, he will never be out of touch if he's carrying a new pocket pager.

The Swedish telecommunications authority has been given half a green light for a nationwide personal paging system, which engineers here say is unique in the world. The system has been under development and field test for almost four years.

The half green light means that all that's left is to work out a deal with the Swedish Broadcasting Corp. to share their fm bands. Engineers at the telecommunications authority are optimistic that the broadcasting company will be willing to work out a deal—and this will mean that commercial launching of the system could be in 1975.

The system involves providing each pocket-paging receiver with a special 3-tone-code signal receiver. These tones range from 52–75 kilohertz. When a caller wants to page a person, he uses a ordinary telephone, dials a special code number to get into the automatic-paging transmitter, and then dials the personal page number of the person he is seeking. With each person in Sweden already assigned a personal number for tax and census purposes, he already has a personal number that could be used.

The caller hears a confirmation signal that the paging message has been sent out. Before hanging up, he dials his own phone number, which is recorded. When the person being paged hears the beep on his pocket receiver, he telephones to a central exchange. The number of the caller is given to him automatically over a voice device that has transformed the telephone number into a vocal message.

Today, the Swedish Broadcasting Corp. has three programs broadcast on the fm band. Program 1 is educational shows and news, 2 is classic music, and 3 is light music. Broadcasting in stereo is done on a test basis on program 2. Since fm transmitters now cover the nation, this means that the telecommunications authority would be able to use these transmitters for broadcasting the paging tones.

**Seeker.** One nuance that the engineers would work into production receivers would be automatic transmission-seeking, a capability which would tune the receiver to the most powerful transmitter.

By using high-speed transmission, engineers figure that the present fm network (using 87–100 megahertz) could handle up to 400,000 customers—and they certainly don't expect this kind of business. However, they plan on a first production run of 5,000 receivers, which the authority would market and lease, just to get the ball rolling. After that, any manufacturer could offer pocket pagers, which the authority estimates would be able to be sold for between $100 and $200. Users would pay a regular fee for the service—which is estimated to run about $50 for a full year. □

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# International newsletter

## French avionics producers look abroad . . .

Ambitious armaments and aerospace programs that spawn new technology are noticeably lacking in France these days so the country's avionics producers won't have much in the way of brand-new technology to unveil at the upcoming Paris Air Show. All the same, they'll have some considerable commercial achievements to talk about.

**The supersonic Concorde transport and the medium-range, wide-body Airbus projects don't look like they'll turn into major outlets for hardware as once hoped.** But French electronics companies are compensating for this setback at home by aggressive marketing around the world. Thomson-CSF, the biggest company in French avionics, did some 1 billion francs ($220 million) in aerospace business last year. This year the company's general manager, Jean-Pierre Bouyssonnie, expects aerospace sales will climb 15%. About 55% comes from outside France.

**Where Thomson-CSF has scored best on the ground is in its export push.** Its big order at the moment is a nationwide air-traffic control system for Brazil, a project worth 350 million francs (roughly $77 million). Thomson-CSF radars also are on tap for U.S. airports. General Dynamics has an FAA contract to build 37 ASR-8 airport radars, developed in France. Texas Instruments has sold 135 sets of instrument-landing system hardware built under license from Thomson-CSF.

## . . . but nation's telecommunications makers thrive at home

French telecommunications equipment producers will have full order books through 1974 at least. In an effort to meet a fast-rising demand for telephones, the postal ministry **plans to spend $2.3 billion next year for telecommunications.** That's a hefty 25% more than the ministry has earmarked for this year. **The goal now, promised by Prime Minister Pierre Messmer during the election campaign this spring, is 12 million lines in service by 1978.** The current five-year economic plan calls for only 9.6 million lines by 1975.

## Plasma etches and cleans ICs in Japanese process

Plasma gas ions replace chemical etchants and organic solvents in a new integrated-circuit fabrication process developed by Mitsubishi Electric Corp.—and quietly put into operation in the company's production facilities in the second half of last year. **The company claims the process is superior to the ones it replaces by every yardstick applicable to production.** Yield and uniformity of MOS threshold voltage are improved and finer line widths can be obtained. The number of processing operations and processing time are decreased, and the labor content of processing operations is cut. **What's more, since the gas ions react to form harmless gases and water, the problems of disposal of spent acids and organic solvents can be forgotten.**

The plasma approach can automatically perform masked etching of silicon nitride layers or polycrystaline silicon layers and the removal of photoresist after the etching process is completed. Mitsubishi is now using these processes in the production of LSI chips for calculators, silicon-gate LSI memories, and linear bipolar circuits.

## German firm studies "wired nation"

Now that the Wired City has become a household word, a new one, the Wired Nation, is cropping up in European electronic circles. In a study prepared by Siemens AG, communications experts at that company are

proposing a scheme whereby cable television, which has thus far been limited to population centers, would be extended to the whole of West Germany. **To wire up the country—which is about the size of Oregon—the company estimates that $7–14 billion would be needed.** The Siemens Wired-Nation scheme would be based on a broad-band communications concept in which not only the functions of present-day cable-TV networks would be handled, but also services like viewer participation during program transmissions, question-and-answer educational programs, and various information services. In successive steps of service expansion, remote shopping, conference television, and video-phone transmissions would also be handled.

### Surface regrowth improves material for magnetic-bubble use

Scientists at the Philips Research Labs in Eindhoven, the Netherlands, have found a way of **producing a near-perfect bubble material—which is needed for practical memories.** In the new Philips method, the thin magnetic monocrystalline layers needed for high bubble density are grown from a liquid phase on a nonmagnetic monocrystalline substrate, which has previously been subjected to a predipping process. The surface of the treated substrate shows considerably fewer crystal imperfections than bubble materials produced thus far. This, in turn, enhances bubble displacement in the magnetic layers on the substrate.

In conventional bubble materials, imperfections in the crystal structure at or near the substrate surface greatly impede bubble displacement. In the Philips method, **faults in crystal structure are minimized by first dipping the substrate in a bath containing the substrate constituents and heated to a temperature at which a thin layer of the substrate dissolves.** Next, the temperature of the bath is allowed to drop slightly. This causes a new and more nearly perfect layer of substrate material to form on the substrate surface. Finally, the magnetic layer, from 3 to 5 micrometers thick, is epitaxially grown.

### Activity surges in green LEDs

Look for an upswing in sales of light-emitting diodes in coming months. Following Siemens new production line [*Electronics*, May 10, p. 56], **Ferranti Ltd. has halved prices for its gallium-phosphide green-emitting dice to 15 cents each** in quantities of 100,000, or about 20% more than similar red gallium-arsenide-phosphide dice. Similarly, a new line in small green monolithic seven-segment numerics is priced at $1.50 each for 100,000, not much more than comparable red numerics. **And Monsanto is making proportionately similar cuts on its reflective-mode green numerics,** which aren't as bright as monolithics.

### Addenda

Motorola has received advanced notice of permission from the Japanese government to form a 50-50 joint venture with Alps Electric Co. Ltd. to produce semiconductors in Japan. . . . West Germany's Grundig AG is readying the country's first portable color-TV set. The unit, which will debut at the International Radio Show in West Berlin this August. Since no German—or European—component houses are yet producing picture tubes for color portables, Grundig had to turn to a Japanese supplier, Tokyo Shibaura Electric Co., and its shadow mask tube with vertical slots and three in-line electron guns.

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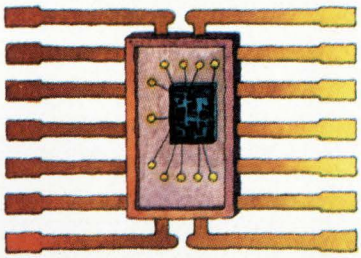

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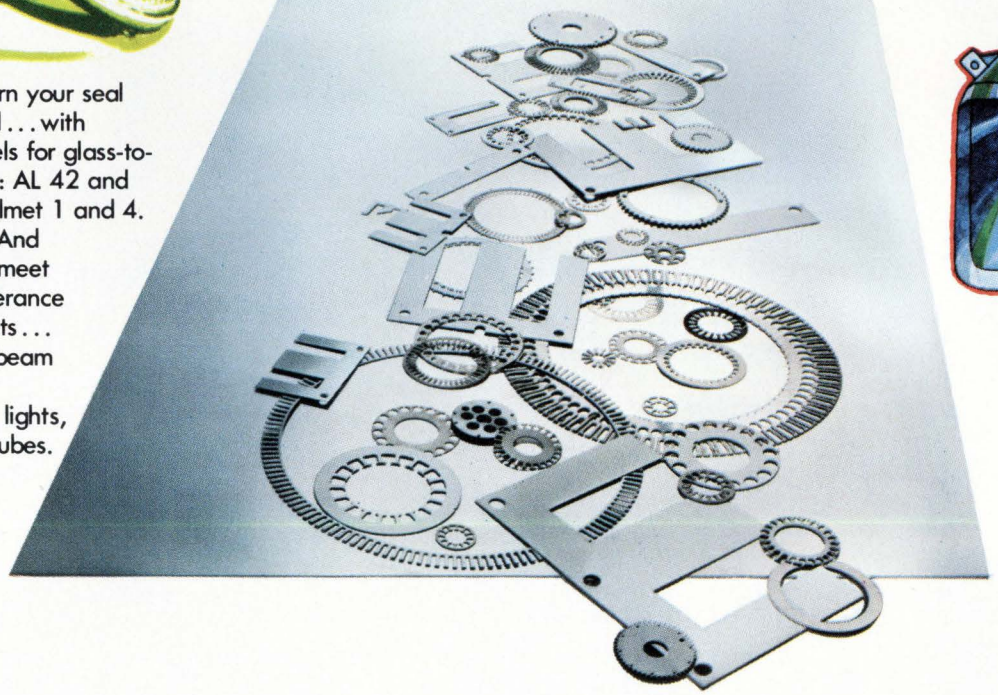

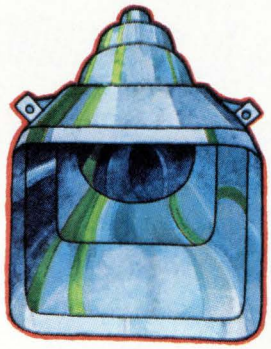

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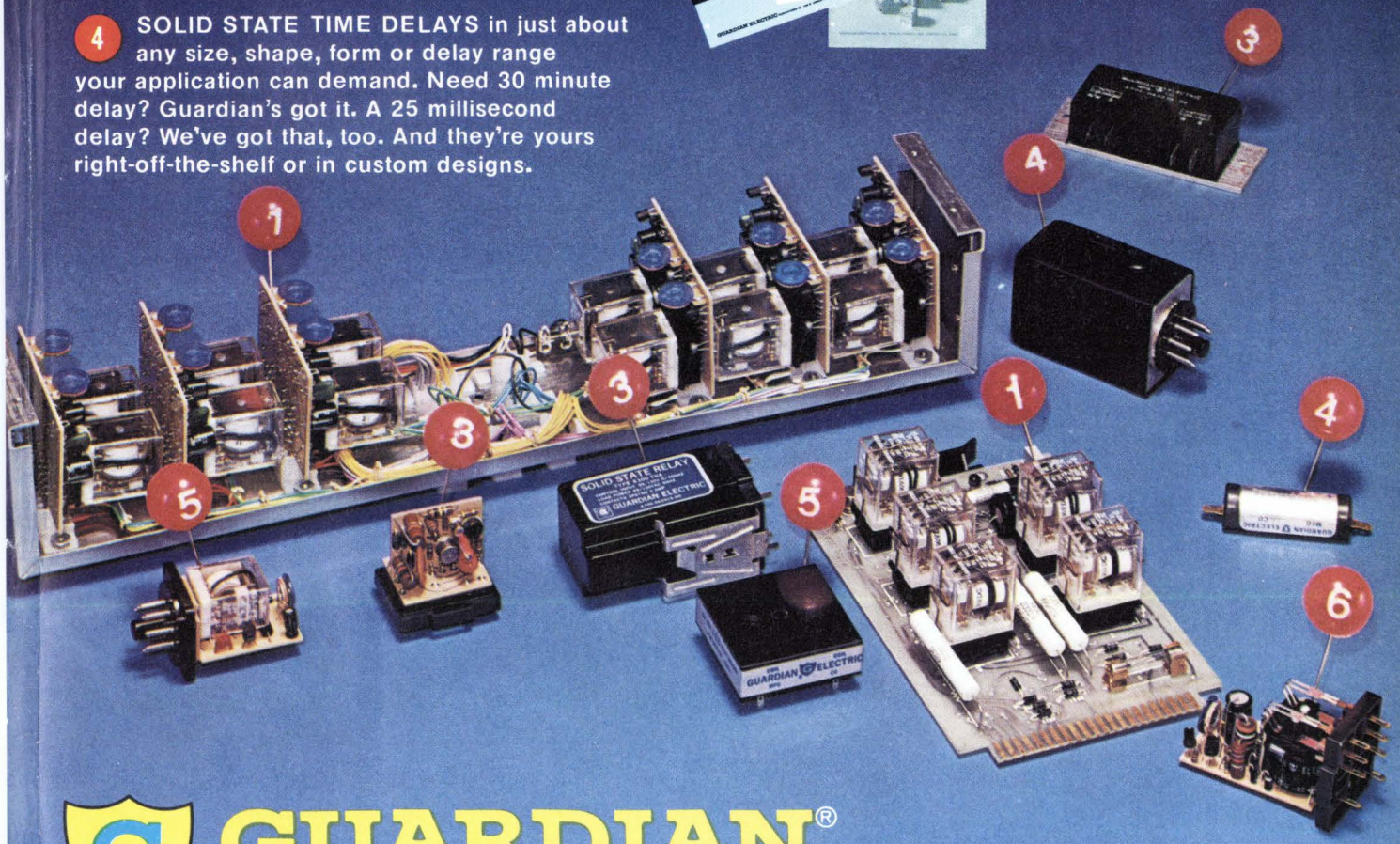


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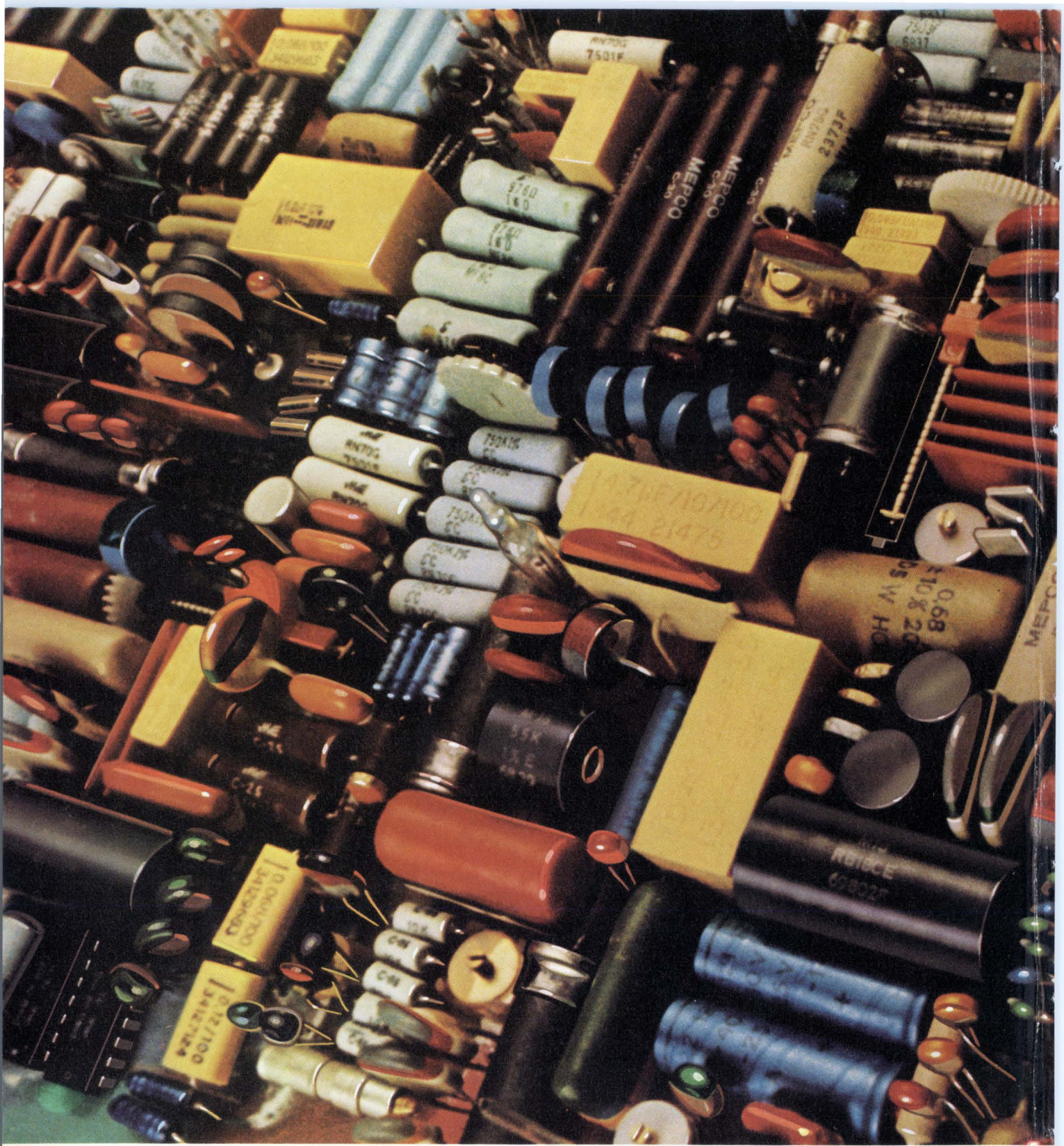


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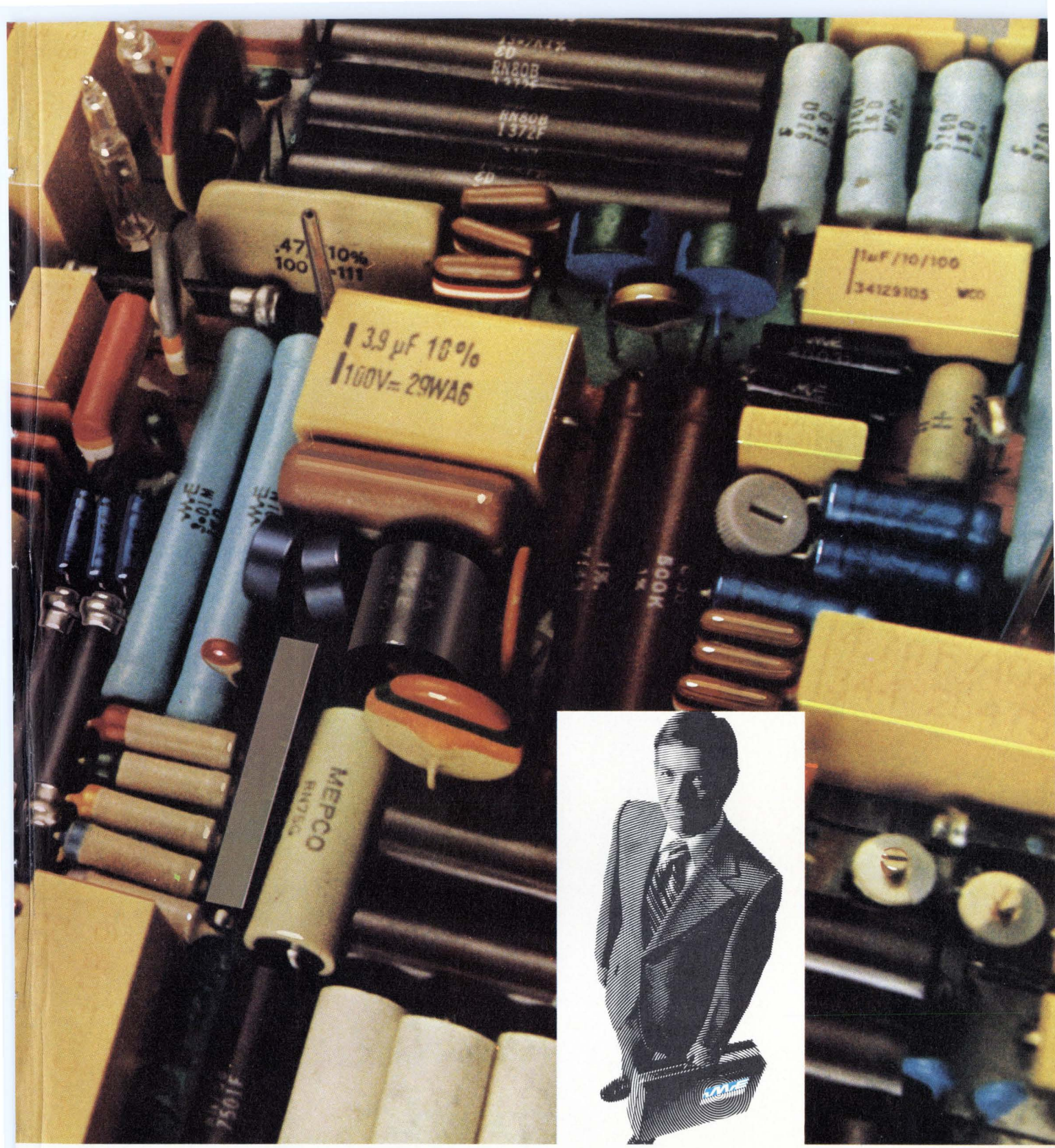


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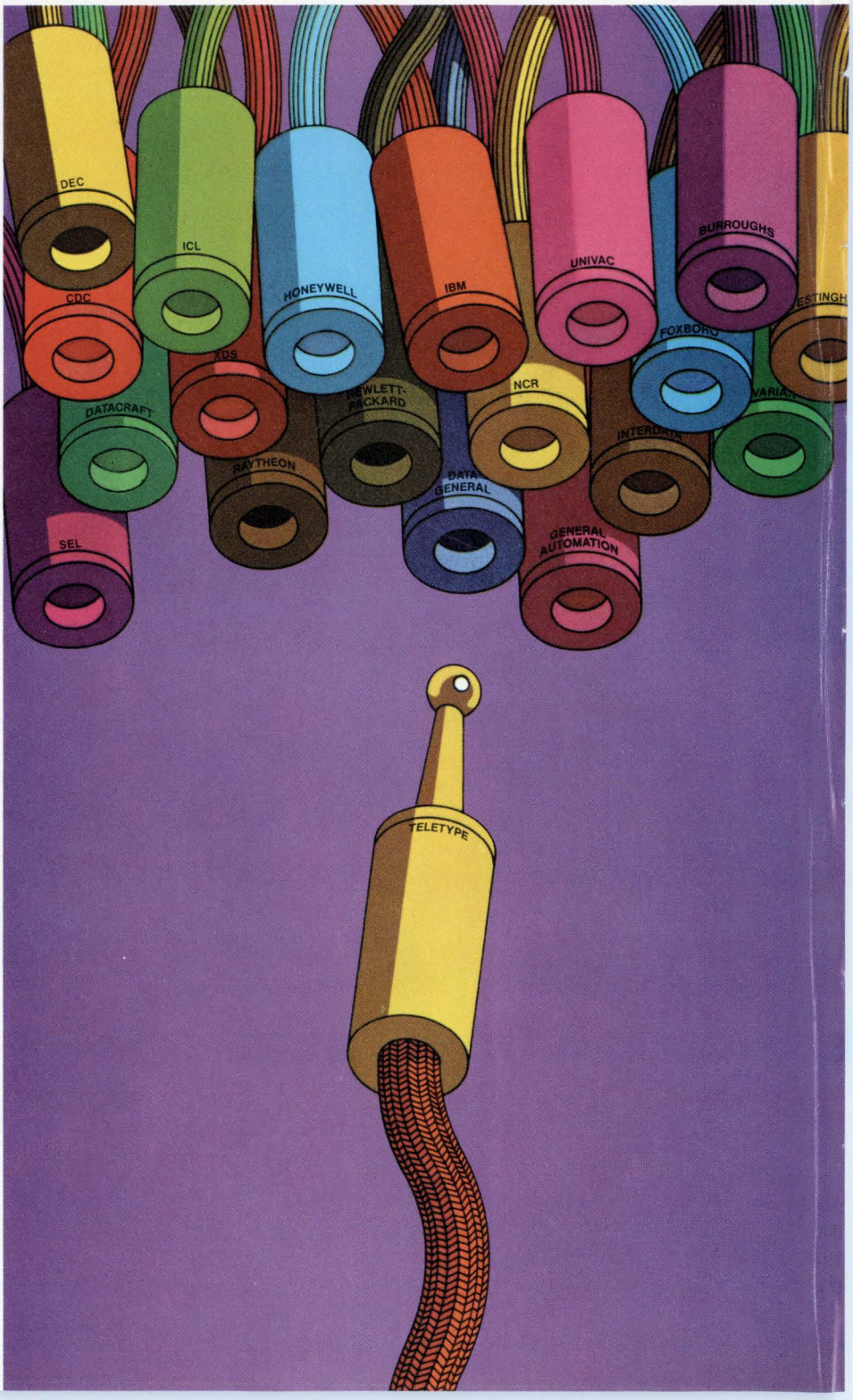

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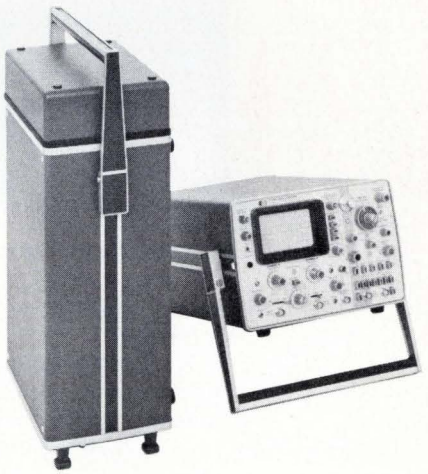

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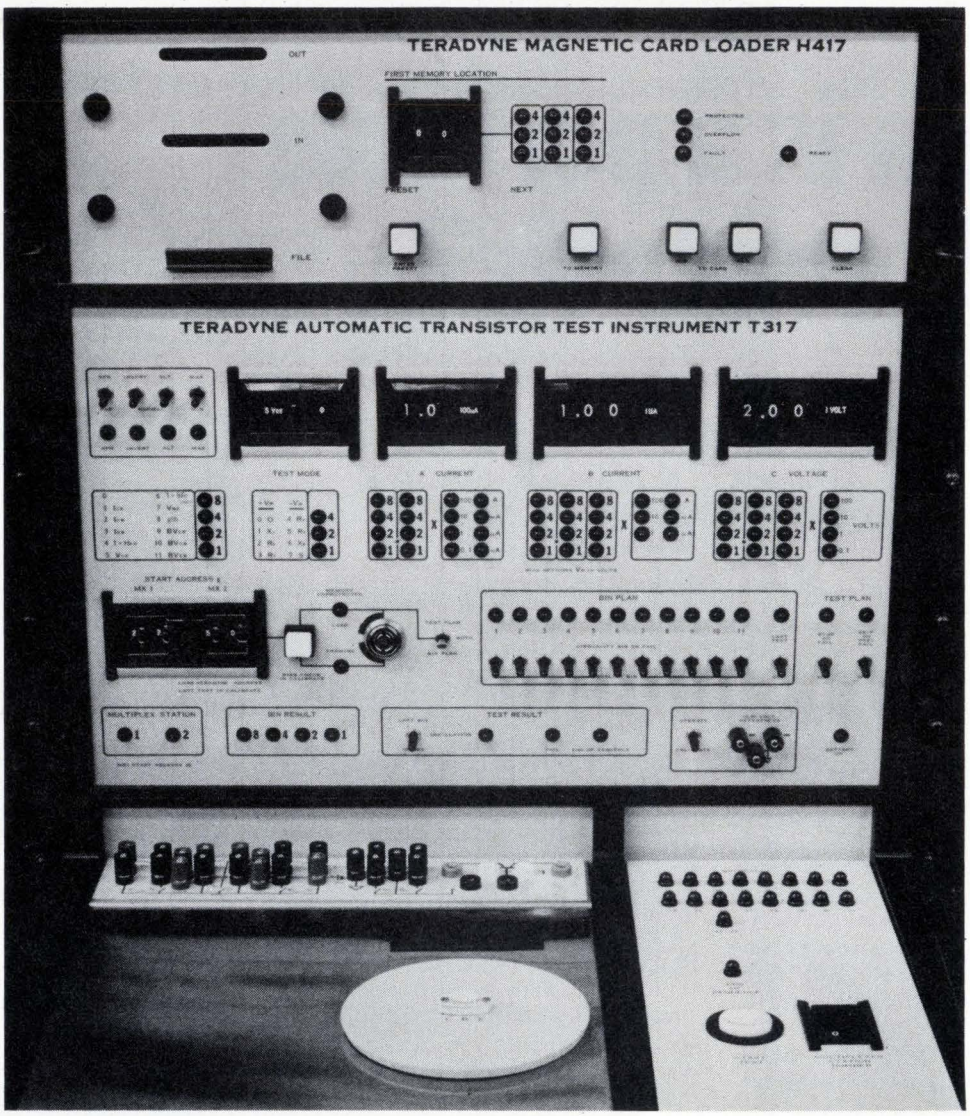


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# IC makers are betting on C-MOS

They expect it to replace TTL as the standard logic line, with sales soaring to $100 million in 1975

*by Howard Wolff, Associate Editor*

**With complementary MOS** building muscle as a standard logic technology, integrated-circuit makers are getting their production lines ready for a plunge into the market. And that market is a dazzling one: from $8 million to $10 million last year, total sales are expected to grow to $100 million in 1975 [*Electronics*, Jan. 4, p. 77].

Robert Mason, sales manager at Solid State Scientific of Montgomeryville, Pa., sums it up best, saying: "We're obviously not replacing transistor-transistor logic at this stage of the game, but I certainly believe C-MOS eventually will be its successor—except maybe where high speed is needed." Adds RCA's Harry Weisberg, manager of MOS IC product lines: "Standard C-MOS can go beyond TTL's capability, with one C-MOS circuit often equivalent to up to 30 TTL parts."

**Pick a number.** There are two major C-MOS families. RCA's 4000 series has the advantage of being older and established, with a choice of second sources. National Semiconductor's 54C/74C has the advantage of being pin-to-pin compatible with TTL; however, its only second source at present is in Japan. As a result, more companies are putting their money on the 4000 parts [see "Choosing sides," ].

However, National says it's sailing along. Robert Bennett, C-MOS marketing manager, claims that sales have doubled every four weeks since 74C was introduced last August and now surpass National's sales of 4000 types. The company started second-sourcing the 4000s last June to "support our diffusion furnaces" while the 74C line was developed.

But whichever family dominates, everyone agrees that C-MOS is the standard logic of the future. RCA's Weisberg expects it to break in at two main points in the market. One is where TTL is already used but where designers are interested in the improved noise immunity and stingier power consumption of C-MOS. Here RCA sees increasing application of C-MOS in industrial and numerical-control circuits, point-of-sale equipment, line printers, peripherals, and medical electronics.

The other market is where p-channel MOS circuits, mostly cus-

## Choosing sides

More and more IC manufacturers eager to get into the standard C-MOS logic business are choosing the older, established RCA 4000 family with its wide choice of parts over the 54C/74C line introduced nine months ago by National Semiconductor.

Fairchild Semiconductor, which expects to be in production by the end of the year, will go initially with 4000 parts because of their popularity. It might also second-source some Motorola proprietary parts, besides building some of its own. There has been no decision yet on whether Fairchild eventually will also second-source 74C.

Texas Instruments has said it is planning some 4000 parts—including a high-reliability 4000A line in a ceramic dual in-line package [*Electronics*, April 12, p. 82]. And one industry observer says that TI will announce 30 parts next month: 19 RCA and 11 Motorola types.

Motorola makes the RCA line, which it calls MCI4000, as well as its proprietary line, MCI4500. John Ekiss, group MOS operation manager, is so certain that his company has taken the right route that he says flatly: "54C MOS is dead." Also in the 4000 camp are Solid State Scientific, Solitron Devices—which had been National's sole domestic second source—Signetics, and General Instrument. Signetics MOS marketing manager Robert Dwyer says 74C was considered because of its compatibility with TTL functions. But 4000 won out since, among other reasons, Dwyer says it's more thoroughly debugged.

However, no one at National is ready to roll out the hearse. C-MOS marketing manager Robert Bennett says that 74C is "coming on so fast" that the bulk of his development support is going to the new line. By the end of this month, he says, National will be second-sourcing 17 RCA designs and prime-sourcing 27 of the 74C designs. About 20 more 74C parts, including a 256-bit tri-state random-access memory, a four-bit adder, and other complex devices, are on the "future" list, compared with only two 4000-series designs. Among the characteristics of 74C that make National so optimistic:

- The same logic configurations as standard TTL, making it unnecessary for designers already familiar with bipolar logic to learn how to design with C-MOS.
- Higher speed, current drive, and noise immunity. National says the first two are a 50% improvement over the 4000 series, and specifies noise immunity in volts similar to TTL specs.
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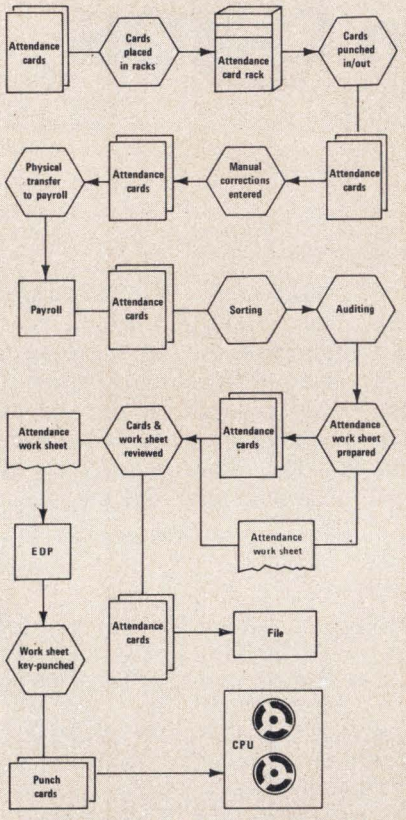


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tom, have held sway. Now engineers find they can rely on a standard logic family, accomplishing medium- and even large-scale integrated functions with TTL compatibility and lower power dissipation.

Another important area, says Weisberg, involves equipment that wouldn't have been feasible with either TTL or p-channel MOS technologies. This includes such items as pocket paging systems using digital C-MOS addressing circuitry, satellite and airborne computers, and telephone dial-tone generators and coin changers.

**New standard.** At Motorola Semiconductor, which second-sources 4000 and also builds proprietary parts, MOS development and planning manager Ronald Komatz expects C-MOS to replace TTL. "On new designs, I think C-MOS will become standard. Where it can't be used because it's not fast enough, users will go 74S [Schottky] or ECL," he said. C-MOS is about 5 megahertz at 5 volts, 10 MHz at 10 to 15 V. Standard TTL is 25 MHz at 5 V.

Komatz thinks the TTL shortage may have helped accelerate early redesigns to C-MOS from TTL, "but now they can't get C-MOS either." He says Motorola's production has doubled since the first of the year, "but orders have tripled." Komatz concedes that backlogs are building, with wafer fabrication the real crunch.

One of RCA's first C-MOS second sources, Solid State Scientific, put together a pair of $1 million-plus deals earlier this year. The rapidly growing company signed contracts with the Philco-Ford division of the Ford Motor Co. and the Chrysler Corp. for custom C-MOS circuits for auto seat-belt interlock systems.

As for standard logic, sales manager Mason believes that there will be no problem with designers learning a new set of logic rules. If they've used TTL they're accustomed to a system concept of gates, flip-flops, MSI, and building blocks, he says, and "even though the logic family may be different, conceptually it's the same."

This year will be a dramatic one for C-MOS, he continues. "It will be the first year of real production." He estimates that C-MOS sales should hit $35 million by the end of the year.

Solid State Scientific has been increasing production facilities "dramatically" since last fall, according to Mason. But sales are booming to such an extent that "the faster we go, the behinder we get," Mason says, paraphrasing an old saying from the nearby Pennsylvania Dutch country.

**Cheers.** "We're very excited about the C-MOS market," declares William Maxwell, digital products marketing manager at the Harris Semiconductor division of Harris Intertype Corp., Melbourne, Fla. By the end of 1973, Harris plans to have 39 circuits on the market, up from 15 so far. "60% of them will be 4000-series parts, while only a few will be Motorola types," Maxwell says. The rest will be proprietary designs, relying on a dielectric isolation process that results in a circuit roughly two to three times as fast as the 4000 series and with quiescent power dissipation an order of magnitude lower. Right now, commercial units with temperature ranges of from −40° to +85°C sell at a premium of 25% to 30% over conventional 4000-series units. However, the full-temperature-range devices are competitive.

Maxwell says that improvement in yields, which Harris is already seeing as production builds up, and the introduction of a plastic package (to go with the ceramic dual in-line packages) should bring this price premium down to only about 10%.

Like its fellow IC makers, Solitron Devices Inc. in San Diego, Calif., is betting heavily on C-MOS. The company has 32 of the 4000 parts, with 13 to be added by June. It also has three proprietary parts, with two more due next month. And while Solitron is second-sourcing only RCA, after dropping its 74C parts [*Electronics*, May 10, p. 25], MOS applications engineer James Everett says that it is also interested in Motorola's seven-segment driver with bipolar output.

**Going east.** Back on the East Coast, General Instrument Corp. also has its eye on the end of the C-MOS rainbow. One of the product marketing managers in the company's Semiconductor Components division in Hicksville, N.Y., says it will announce eight 4000-type products by the end of the year, with the first—a quad bilateral switch—to be available this month.

As C-MOS invades more and more of what is now TTL territory, production facilities are showing the strain. Solid State Scientific has already increased capacity; Motorola is building a new plant in Austin, Texas, dedicated to MOS. And demand in Europe has been so heavy that Motorola has decided to begin making C-MOS in Scotland. □

Reporting for this article was provided by George Sideris in San Francisco, Paul Franson in Los Angeles, and Alfred Rosenblatt in New York.

## The difference

All complementary-MOS logic families are based on the inverter concept of circuit functions. The circuits consist of two types of MOS enhancement-mode transistors—a p-MOS type and an n-MOS type—in various parallel and series combinations on a single chip. The 74C logic family from National Semiconductor differs from the basic 4000 family because its pin arrangements are identical with those of standard bipolar logic (TTL, low-power TTL, DTL, and so on), so in some cases it can be used as a direct pin-for-pin replacement in standard logic configurations. This is not true of the other C-MOS types, which have been uniquely partitioned to be used specifically for C-MOS applications.

The compatibility of 74C with standard bipolar logic circuits is one of its strongest selling points. National says that the 74C series can be driven directly from TTL, low-power TTL, and DTL over the commercial temperature range without external pull-up resistors, but the 4000 series cannot be driven directly by bipolar logic because that family does not guarantee a direct interface with no pull-up resistors. As for the other question, whether 74C can drive bipolar logic, the answer in many cases is "yes"—but is also more complicated.—**Laurence Altman**

Commercial electronics

# Hotels like what they see in pay TV

1973 shapes up as boom year for private delivery systems enabling guests to watch first-run movies in their rooms

*by Alfred Rosenblatt, New York bureau manager*

**The average audience** is not likely to be as numerous or as husky as the 22 football players who crowded into a single Atlanta hotel room one Friday night last fall to see the movie "Deliverance." In town for a big college football game, the players were viewing the first-run show over a pay television system that had just been installed at the Regency Hyatt House by Trans-World Communications division of Columbia Pictures Industries Inc. The charge: a flat $3 for "unlocking" the room's TV set so the movie could be seen, or little less than 14 cents per footballer.

Most often, the personal economics will not be this attractive. But for travelers finding themselves in strange cities with little to do, pay TV systems may prove to be a cheap and convenient entertainment boon—so much so that 1973 is shaping up as a boom year in the number of pay systems installed in hotels and motels across the country.

Trans-World's Tele/Theatre movie system, for instance, in the past 15 months has gone into 29,210 hotel rooms in 27 hotels in seven cities. The company expects this figure to double by the end of the year. Another company in the field, Computer Television Inc.'s Computer Cinema division, New York, reports it has just signed on with the Hilton Hotel chain with a potential 40,000 rooms across the country. Players Cinema Systems Inc., Englewood Cliffs, N.J., boasts some 14,500 hotel rooms with more "signing up like crazy," according to a company spokesman.

And a newcomer to the field, Telebeam Corp., has signed on the Americana Hotel in New York.

The designs of the various systems differ markedly. In any given city, Trans-World may distribute its programs—sport and theatrical events as well as movies may be offered—from a central studio to its hotel clients over specially installed coaxial cables. Or, with the FCC approval it has received in at least four cities, it may beam the signal from the studio to the hotels over a private microwave link.

**Riding a LED.** Telebeam, however, since the installation of either a coax or microwave link is expensive, encodes its programs on the beam from a 20-milliwatt light-emitting diode, and then transmits them to a receiver at the hotel. From one location, then, the company can transmit to any hotel within a range of a half mile. Eschewing a distribution net from a central studio is Players Cinema Systems. It actually sets up video tape players with program tapes in each hotel subscribing to its service.

Other elements in the pay TV system include the central control station in a hotel through which the room units can be unlocked to unscramble the picture for a paying guest, plus maybe a control unit in a hotel room for selecting one of several pay TV channels.

The central control station, often directed by a minicomputer, is used to keep track of the programs ordered by guests so that they can be billed later. It usually distributes the programs to the individual rooms over the master antenna network that is already installed.

Computer Cinema, however, does not believe the master antenna systems are generally in good enough shape to provide a suitable signal for a customer paying for a program. This company, therefore, installs its own coaxial network in the hotel, connecting each room to a "switching nest" that may pick up all the rooms on a floor, or all the rooms in a vertical line through the building.

The switch itself, specially built for the company by Data Architects Inc., Waltham, Mass., is "one of the most sophisticated rf switching units in the business," says executive vice president Paul von Schreiber. The company's three pay channels are transmitted in a 50- to 100-megahertz band. The fact that, instead of an elaborate control unit, only a very simple switch is needed in the hotel room at the TV set compensates somewhat for the expense of wiring the hotel with the dedicated coax. Von Schreiber estimates he can fit up a hotel for about $100 per room, plus the cost of the studio origination equipment. Others find the costs as high as $150 per room.

Most of the systems, however, do not have any provision in the individual rooms for ordering a program. Rather, the guest is expected to telephone down to the control station and request the program he wants to see. An operator at the station then switches the program to the room.

**Payment plans.** Most of the systems, too, operate with the customer paying a flat rate—$3 is a usual figure—for each program he wants. Others, such as Players Cinema Systems II, are "subscription" services in which the hotel pays the fees and the guests can then see whatever programs are being sent into the system. Critics of this system assert that the payments to motion picture

producers would not be attractive enough for them to furnish popular, first-run motion pictures. This is because they would receive a flat rate rather than a payment based on the number of viewers.

Players Cinema also has another pay-as-you see system that does not employ a scrambled picture which must be decoded. Rather, a hotel guest will receive a clear, unimpeded picture. But his viewing is monitored by a central station in the hotel. If he's tuned into the program for, say, longer than 10 minutes, he's billed.

**Two-way control.** Perhaps the most sophisticated system in terms of the number of services offered is Telebeam's. It provides five channels of pay TV, relying on an interactive, two-way control unit in the room that allows a guest to do such things as dial up various information services, such as restaurant menus or airline and train schedules, or keep track of whether the door to the room is opened without authorization. Both Trans-World and Computer Cinema, among others, are also developing similar expanded services around their pay TV system. The latter company plans to upgrade one of its Hilton hotel systems to a two-way system by next summer.

In the Telebeam system, the information is displayed on the TV set using a frame grabber device manufactured by Systems Resources Corp., Plainview, N.Y. [*Electronics,* March 17, 1972, p. 30]. In addition, Telebeam provides a terminal, to be deployed beside the hotel's various point-of-sale terminals, that immediately bills a guest when he presents a check at, for example, a hotel coffee shop or restaurant. Employing a 7-inch TV set, the terminal displays the guest's original registration card with his signature; it's designed to eliminate the "charges after departures" that are the bane of the hotel manager. Telebeam also has a room-status terminal for the front desk that keeps track of rooms as they are sold, vacated, or cleaned by the maids.

But the security provision should be of greatest interest to hotel keepers. In this mode, the central computer station can monitor through the hotel's master antenna system as many as 2,000 doors per second. An unauthorized entrance made, for example, without the proper key, or when a room guest has checked out, immediately triggers an alarm.

As the pay TV systems prove successful in hotels they will undoubtedly be applied to large apartment houses and hospitals, as well as being introduced to already installed community-antenna TV systems. In fact, this latter type of system is already operating in many parts of the country. For many companies, hotels are a proving ground for their system. "They're simpler systems to do, more controllable, and they can be adjusted more thoroughly," says Marvin Korman of Trans-World. Comments Computer Cinema's von Schreiber: "Hotels are a natural learning environment for both the economics and technology for pay TV." The environment is relatively easy to set up and service, he continues, and "you don't have to worry about upgrading 300 miles of outside cable plant." □


**Headquarters.** Trans-World's originating studio pipes first-run movies to hotel pay-TV systems. Charge is usually $3.

Computers

# Moscow strides into the marketplace

Westerners at first showing of the East Bloc's Unified System agree it will be strong competitor, even as they press sales efforts

*by Axel Krause, World News*

**The Soviet Union's** four-year effort to make the Comecon nations a force in the European computer marketplace has been successful. That's the virtually unanimous conclusion of Western computer experts who traveled to Moscow this month for their first look at the line of computers, software, and peripherals produced by the Soviet-led Eastern European bloc. However, even though they were impressed by the display, the Western marketers have no intention of easing up on their Eastern Europe sales efforts.

The series, formerly RJAD but now officially called ES (from the Russian for Unified System) [*Electronics*, Sept. 25, 1972, p.72] is on display until June 10 in Moscow. It demonstrates that "concretely, [the Soviets] now will be able to handle all their routine, commercial data-processing needs on their own," said a senior marketing executive of Britain's International Computers Ltd. after an inspection tour of the exhibit. And, as though to underscore that, a top Soviet computer official, pointing toward the equipment—ranging from the small, Hungarian-made ES-1010 to the powerful, Soviet-made ES-1050—flatly declared: "What you see here either is being mass-produced already, or will be by the end of 1973."

**Consequences.** While Western computer experts questioned how fast or in what quantities the series actually would be manufactured and installed, Soviet officials provided a glimpse into some of the inner workings and implications of the joint project, which initially included the Soviet Union, Bulgaria, Czechoslovakia, East Germany, Hungary, and Poland. Soviet officials disclosed:

- An ES-series intergovernmental coordinating agency will be in charge of all future development and design work. Moreover, the agency will, for the first time, include Rumania, which had decided to stay out of the ES effort but from now on will participate in all future work, including design and possibly software development. "Eventually, we hope to go beyond the ES-1060," said a Soviet official, referring to the most powerful computer in the series, which is still under development by the Soviet Union. The 1060 will be a 2,048,000-byte machine.
- Experience, knowhow, and equipment from Western computer firms will be welcomed in complementing the ES-series development.
- Soviet planners have no serious ambitions now to export substantial amounts of equipment from the present ES series.

Western computer experts viewed the developments with mixed feelings. A seasoned executive of a U.S. electronics firm, with long experience in East European countries, said that "as with others in this league, our technology is so far advanced that we aren't worried in the slightest—but some large computer firms should be." As the executive sees it, the market for computers in the range of the IBM 360/50 and below will be "gradually squeezed and eventually eliminated."

He predicts that Western computer and electronics companies increasingly will be competing against ES-series equipment as it becomes available. For the immediate future anyway, there should be some consolation for marketers in develop-

**Looking it over.** Technician at the exhibit of the new ES computer series in Moscow works a terminal scanner under the gaze of a portrait of Soviet party chief Leonid Brezhnev.

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## Probing the news

ment gaps noted in the series by Western experts. These include advanced disk systems, memory storage units, communications equipment, and high-speed printers.

**IC problems.** Soviet and Bulgarian officials, jointly developing the ES-1020 computer—with its 256,000-byte main memory roughly equivalent to an IBM 360/40—admitted to visiting Westerners that they were still encountering difficulties with the production and installation of integrated circuits. Commented a Western computer engineer after seeing the unit, "The kinds of circuitry problems they described were exactly the same as those besetting us six or seven years ago." But he added that they seem to be finding solutions.

While Soviet ambivalence is not making the marketing tasks of companies any easier, there are some clear-cut signs that several leading U.S. computer companies are pressing ahead to expand their business in the Soviet Union. With Washington's continuing embargo on sale of computers above the range of the IBM 360/50, any of these deals that materialize into sales and deliveries would represent breakthroughs.

At the center of things is IBM, which last month signed a contract to supply a large computer system to the Soviet travel company Intourist. It is described by Moscow sources as a 370/155 with enough memory to make it totally unacceptable to Washington under existing embargo rules. Western diplomats in Moscow are convinced, however, that IBM would not have signed the contract unless it had some strong indication that the Nixon Administration would reverse current restrictive policy. The June 18–26 visit of Soviet party leader Leonid Brezhnev to the U.S. could result in relaxation of the embargo.

If the embargo were lifted, several other pending major computer projects could be consummated, according to Western diplomats in Moscow. These include an estimated $25 million data-processing system for the $2 billion heavy-duty truck plant the Russians plan to build on the Kama River, east of Moscow. Though ICL, IBM, and Honeywell-Bull have been mentioned as among those interested, some trade sources in Moscow report that IBM already has signed or is about to sign a contract.

Soviet officials also have requested bids for an estimated $15 million computer network for Aeroflot, the Soviet airline. But this deal, too, is running up against Washington's embargo, since the equipment involved calls for extensive memory storage capacity.

**CDC deal.** Control Data Corp. is continuing negotiations with Soviet organizations for a range of projects. Among them is the possible sale of several computers, ranging from the Cyber 70 up to the Cyber 76, as well as cooperation in developing large-scale, advanced, computer-manufacturing potential.

Several U.S. companies are bidding on a Soviet proposal to build a plant specializing in manufacturing disk packs and magnetic tapes. While the investment called for is believed to be in the range of $10 million, progress was described by Moscow sources as slow, pending approvals by Washington. □

### The waiting game

Not only are Western computer and peripheral makers busily knocking at Russian doors, but large components firms, among them Texas Instruments, have been actively canvassing the Soviet market. Again, for what the Soviets want most—the latest, highly sophisticated IC equipment, technology, and knowhow—the embargo remains in force.

"Unless Kissinger, Nixon, and Brezhnev have come to some kind of new understanding on the embargo we don't know about yet, I would say that the chances of anything happening soon are about nil," says a highly knowledgeable U.S. electronics executive. He notes that easing of restrictions on sale of electronic products announced last year has not yet been implemented by U.S. Government agencies. "We are still waiting," he says.

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Companies

# Many pennies from heaven

By interpreting satellite data on the earth's natural resources, Earth Satellite Corp. benefits both itself and clients the world over

*by William F. Arnold, Aerospace Editor*

**The Federal Government** develops a new technology—and the private sector, in exploiting it, opens up a whole new market. The latest version of that script starts from the NASA-derived technology of electronic remote sensing using meteorological and earth resources satellites and stars a small Washington-based company named Earth Satellite Corp., known as Earthsat.

Earthsat specializes in integrating satellite remote-sensing data and aerial photographs with electronic and computer techniques to produce resource analysis tailored to the special needs of its clients. The result is a growing clientèle among Federal agencies, state and foreign governments, and private companies that need to survey an area or to inventory resources.

What a company like Earthsat offers is the speedy and precise inventory of an area's resources, thanks to satellite sensing and computer-based analysis. For example, Iran, concerned about increasing the amount of protein in its citizens' diet, wants to know the extent of its grazing land so it can plan cattle production. Conventional surveying techniques could take decades, but satellite technology will let Earthsat give the Iranian government an exact inventory of its approximtely 100 million hectares of potential grazing land in 120 days.

**Jersey, too** The uses and users are varied. Besides Iran, Earthsat has contracts with the state of New Jersey to map the wetlands; with the Brazilian government to chart the Amazon River basin; with the state of New York to identify danger zones in strip mining areas as a preliminary to better control of land use; and with the states of Maryland and Arizona, and the governments of Argentina, Ecuador, Greece, and Venezuela for various land-use inventories.

Applying satellite data to commercial and public needs is successful for a variety of reasons. It responds to an urgent demand for resource planning in a shrinking world. A factor, too, is that the company's president, J. Robert Porter Jr., was chief of NASA's earth resources technology program until he quit four years ago to form Earthsat. His vice president, Arch B. Park, succeeded Porter at NASA until he left last March to join the company.

Whether by performing the surveys itself, by consulting, or by training a client's cadre to perform analysis, Earthsat applies satellite technology to social and economic uses.

Refined ERTS technology gives analysts a lot to work with. A multispectral scanner onboard the craft picks up images simultaneously in four spectral bands of green, red and two infrared, stores them, and dumps the pictures digitally as it passes over U.S. receiving stations, explains Charles Sheffield, Earthsat's computer applications manager and president of Image Processing Inc., of which Earthsat is majority owner. Each ERTS picture covers an area 115 miles on a side with a high resolution of 70 meters, he says. Iran can be covered in 107 pictures, of which 42 have to be studied for grazing land and only 10 of those intensively, Parks adds.

Since ERTS passes over the same area many times during its journeys, an agriculturalist, for example, can chart the maturation of a wheat field or the cancerous growth of corn blight by studying the frequency distributions and changes in the images.

Earthsat's IBM 360/50 computer helps handle the voluminous data. One image from one of the four bands contains 7.6 million eight-bit bytes, each of which corresponds to one grey element in the picture (the computer processes in black and white), explains Sheffield. Each ERTS picture element equals about one acre of land.

But it isn't quite as simple as that, Sheffield goes on. On the data collection side, the ERTS pictures have to be "underpinned" with ground or aircraft surveys to establish reference points. According to Park, however, only a millionth of the sample area is needed, instead of the 10% sampled in other survey methods. On the processing side, Earthsat uses a highly interactive process employing optical, analog, and digital techniques with "the human operator very much in the

loop," Sheffield says. A biologist trained to use the computerized processing can employ his special and sometimes intuitive knowledge to get the most out of the data. This way, "we avoid the problem of trying to encode into the computer what's in a person's head," Sheffield says.

Armed with the computer and equipment such as additive color viewers and a Digicol unit (which translates grey tones into color) made by International Imaging Systems, Mountain View, Calif., Earthsat personnel prefer to work with the unprocessed computer-compatible ERTS tape. The data can be "squeezed" using a variety of picture-enhancing techniques, such as frequency histograms, Fourier transforms, scale changes, and edge enhancement. A current project is development of an automatic crop-classification system, Sheffield says. With the technology it's possible to completely classify an agricultural area by vegetation codes, even before a team goes over to find out what plants go into the classifications, he adds.

Porter had two lean years before Earthsat began to take off. Now, fattened by the New Jersey wetlands survey at $800,000 and the $1 million Interior Department contract among others, the company is looking up. Current backlog is more than $2 million, and assets equal $1 million plus. □

**Earthsat brass.** J. Robert Porter Jr. left, is president, and S. Benedict Levin is executive vice president.

Medical electronics

# 'Olli' is taking giant steps

Small Finnish company entered medical market in 1969; to log $2.5 million in '73 with monitor, lab systems

*by Martin Schultz, World News; Arthur Erikson, Managing Editor, International*

**You don't judge** a book by its cover, and you don't judge a company simply by its size. And even by Finnish standards, Ollituote Oy is small. Only some 150 workers report for work each day at the company's modern but modest plant in the wooded outskirts of Helsinki. Nonetheless, Ollituote has compiled a track record many a larger corporation would envy: in 1973, a scant three and a half years after it plunged into medical electronics, the company has a line of hospital hardware that's selling strongly in export markets as well as in Finland.

And largely as a result, Ollituote's sales are spurting. For 1972, the firm logged roughly $1.65 million in sales, about half in medical and half in "conventional" electronics. This year, Ollituote figures its sales will jump more than 50% to reach $2.58 million. Some two thirds of sales will come from items like the Olli 3000 automated chemical analyzer, cardioscopes, defibrillators, and arterial pressure meters. The other third will come from Ollituote's former bread-and-butter hardware—warning flashers, electronic controls for electric fences, and subassemblies for elevator controls.

**Diagnosis.** When Ollituote got into the hospital field, says Harry Timonen, managing director, "there was no domestic production at all. It was all imported." Further, the company realized that Finland has a reservoir of medical technologists eager to cooperate with a Finnish company in the design and domestic production of hospital electronics. And there was adequate electronics expertise in the country's technical universities.

Ollituote plunged into the world of hospital electronics in 1969 in a joint project with the huge state-run engineering corporation, Valmet Instrument Works. The pair developed a 12-patient coronary-care unit and by 1970 had the first one installed in the hospital at Tampere, Finland's second largest city. Timonen maintains that the Ollituote intensive-care system costs about 20% less than imported systems. To be sure, the Ollituote equipment doesn't provide the diagnostic capacities—not really needed usually, Timonen insists—of most other hardware. But the company has managed to sell several hundred.

This first success in medical electronics obviously made Timonen eager to try again, and he soon had a team looking into operations at several general hospitals. One thing the team found was that hospital labs tended to be overloaded in the morning and that pointed to a market for an automated chemical analyzer. After three years of development work and an outlay of more

than $500,000, the company had its Olli 3000 system ready. The first went into operation in August 1972, and two others have gone on stream since. During the next couple of years, Ollituote expects to deliver another 10 or so of the $77,000 systems to Finnish customers.

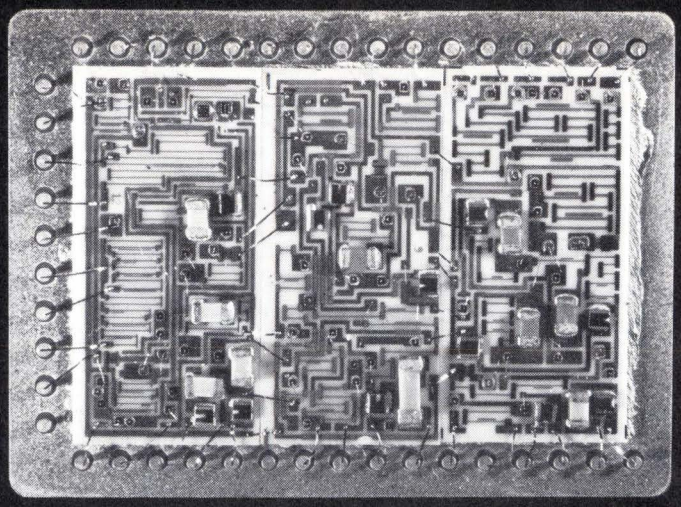
These estimates back up Timonen's belief that Ollituote is among the first to get onto the market with hardware for automating a wide range of clinical tests. The Olli 3000 can easily handle 1,000 analyses an hour, using up to 20 different wavelengths. The analyses are made by a photometer, and the readout comes from a data processor built around a Data General Nova 1200.

**Mass production.** Actually, Ollituote's big stride forward has not been in the chemical analysis itself, for the photometer performs no better and no worse than many others now on the market. But Ollituote grouped 24 of them in one block, vastly improving the handling of the blood samples, the identification of sample and patient, and the processing of the photometer results.

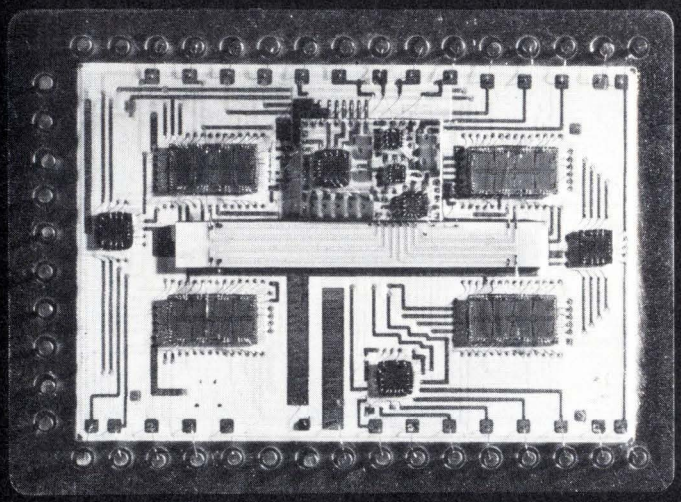
When a patient enters the laboratory, an identification tag is made up in binary code and attached to his wrist. Then the blood sample is taken and identified by the code, and the syringe tube is put into the 24-tube carrier. This carrier, after passing under a dispenser that drops test reagent into the tubes, is manually put into the photometer, which has 24 channels. Because the samples are coded, the computer has no problem matching test results with the right patient. (In manual systems, there's always a chance of error here.)

Having drawn blood with its Olli 3000, the Finnish firm plans to expand its operations in hospital electronics. The next product will be a terminal for computer analysis of electrocardiograms. The terminal records patients' EKG, digitizes the records, and then feeds the data to a remote computer. The computer, backed up by a diagnostic specialist, analyzes the EKGs and then sends the results back to the terminal where the doctor can see them. □

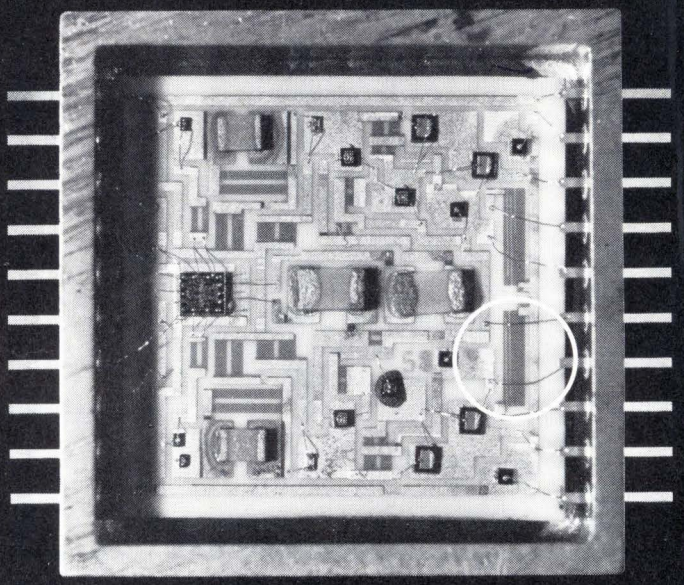
**Automated tester.** Engineer checks out Olli 3000. It can handle 1,000 analyses an hour, using up to 20 different wavelengths.



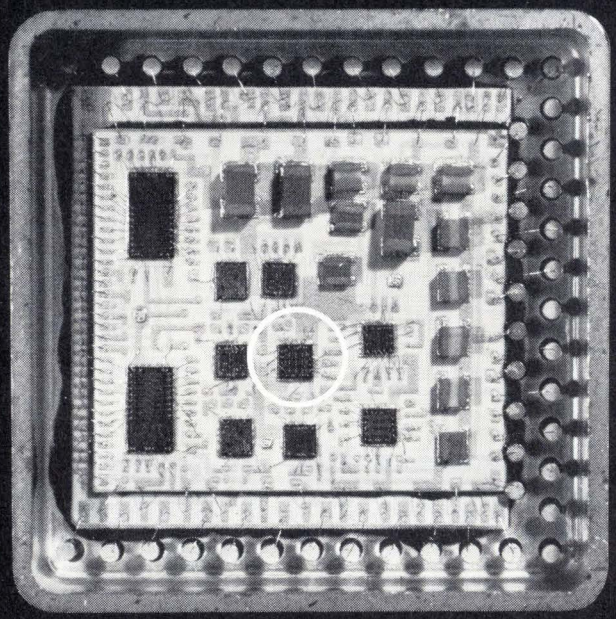
**1.** Is this circuit a thick film or thin film hybrid?
■ Thick ■ Thin



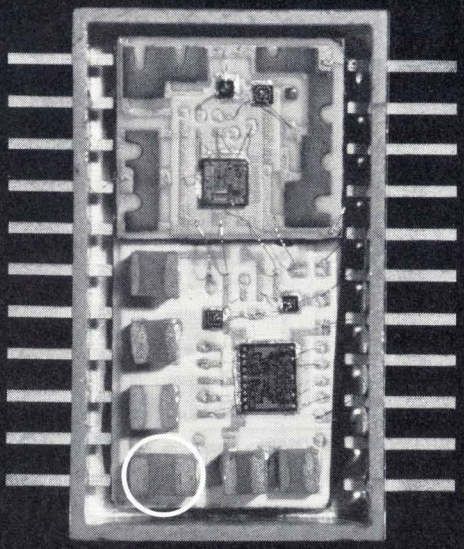
**2.** Is this hybrid's package designed for a hermetic seal?
■ Yes ■ No



**3.** Has this resistor been abrasive or laser trimmed?
■ Abrasive ■ Laser



**4.** Is this semiconductor chip an integrated circuit or transistor chip?
■ IC ■ Transistor



**5.** Is this passive chip a resistor or capacitor chip?
■ Resistor ■ Capacitor

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**1. Thin Film.** This is a digital logic circuit being used in a military guidance and control system.

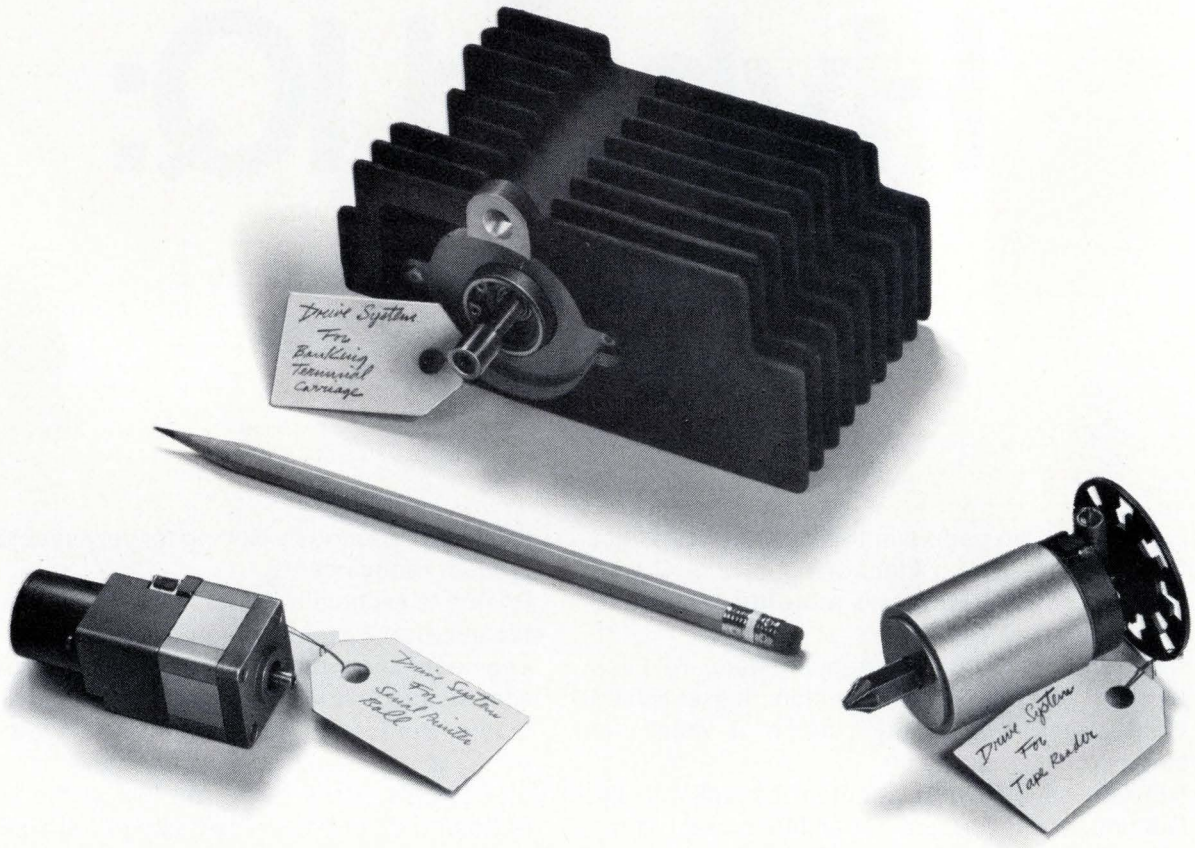
**2. Yes.** This is a 4096 bit random access memory circuit for a digital computer.

**3. Laser.** This hybrid dual current switch circuit handles .4 amps per switch in an airborne computer.

**4. IC.** This 16-channel multiplexer hybrid is used in an aircraft on-board maintenance and test system.

**5. Capacitor.** This circuit is an accelerometer restoring amplifier used with a gyro in a guidance and control system.

# Computer builders get more than a motor from TRW/Globe

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# Communications processors pace growth in data-network traffic

## Based on small and medium computers, programable front-end processors, message switchers, remote concentrators, and remote-terminal controllers coordinate communications among many widely dispersed data terminals

by Lyman J. Hardeman, *Communications Editor*

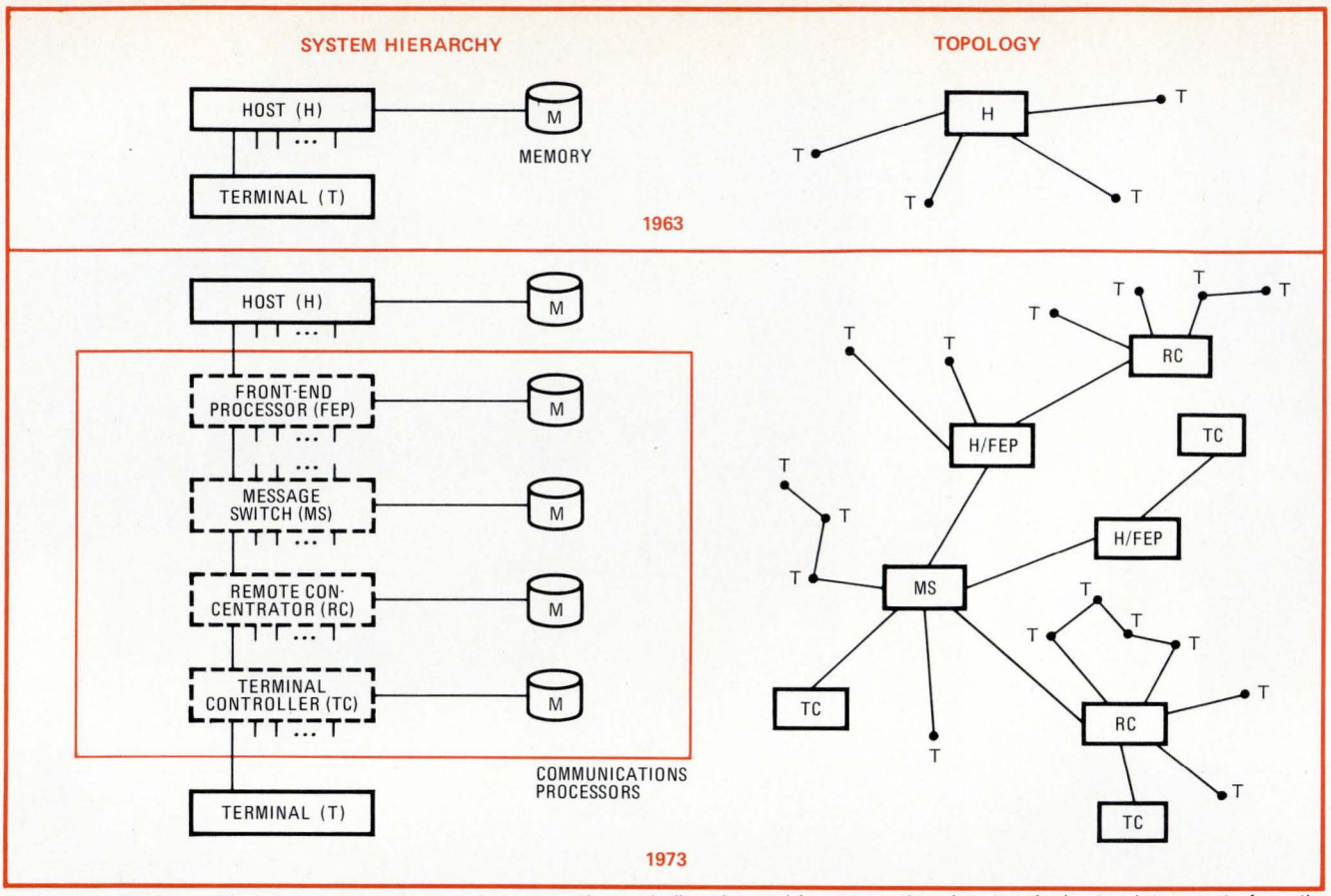
☐ The current explosion in central processing of data for widely dispersed terminals has created a tidal wave of demand for equipment to cut down the expenses of data communications. In order to slash the heavy expenses of transmitting data among an ever increasing number of terminals, manufacturers over the past few years have developed a new class of equipment known collectively as communications processors.

The amount of data transmitted is substantially reduced by partial processing at the terminal sites and at intermediate locations. And the built-in processing power of this equipment also relieves the host computer of the burden of having to perform line-control and other communications functions, thus leaving the host more time and resources for the higher-level information processing for which it is designed.

In the span of about 10 years, the market for communications processors has skyrocketed from virtually zero to a present annual level of several hundred million dollars. Sales for communications processors are expected to grow at a rate of approximately 30% per year for the next several years to a volume that has been estimated as high as $1 billion by 1976. This growth and market size easily places communications processors among the most active segments of both the computer and the communications industries.

### Processors classified

It is convenient and instructive to categorize programable communications processors into four classes




**1. Teleprocessing added.** In the span of only a few years, the exploding demand for connecting data terminals at points remote from the host computer has complicated the requirements of communications networks. To simplify network coordination, several levels of communications processors have been inserted into the network in order to enhance over-all teleprocessing efficiency.

of equipment. These classes, shown in Fig. 1, are:

- Front-end processor, which serves as the communications controller interface between the host computer and the communications network.
- Message switcher, which receives data messages in a distributed communications network, analyzes the messages to determine their proper routing, then forwards them to other points in the network.
- Data concentrator, which receives a number of low-speed transmission lines, multiplexes them, and transmits on one line at a higher data rate.
- Remote-terminal controller, which coordinates a cluster of peripheral units at a location remote from the host computer, and often performs limited local processing.

Functions within each of these classes of communications processors overlap substantially, and a single processor may, in fact, serve multiple functions. A message switcher, for example, while switching messages in and out of a network node, may function as a data concentrator. Similarly, a front-end processor may perform additionally as a message switcher or a local terminal controller.

A detailed description of design trends and system applications for each of the four types of communications processors will be more meaningful if the typical communications-network tasks that must be performed are examined first. These include network control, code and data-speed conversion, buffering for character and message assembly, error control, compilation of system statistics, message validation, and record keeping.

Network-control functions are usually performed by a front-end processor or a message switcher in conjunction with remote terminals. The communications processor must decide when each terminal is to be connected to the system. Connection is accomplished by a well-defined protocol and signaling procedure called handshaking. Also, the processor must determine priorities for connection of the various peripherals, and set up message queues.

## Network control

Line discipline must be established to identify and distinguish between the data itself and the control information that coordinates transmissions within the communications network. Several factors must be considered.

First, unlike peripheral devices local to the host computer, a remote terminal is often not continuously connected to the system. Therefore, means must be provided for a terminal to establish contact with the computer to supply an input message, or conversely, the computer must contact the terminal (via an automatic dialing unit in the dial-up telephone network, for example) prior to transmitting output data.

Also, since several terminals may be attached to a common private or leased line to reduce communications costs, it becomes necessary to provide a proce-

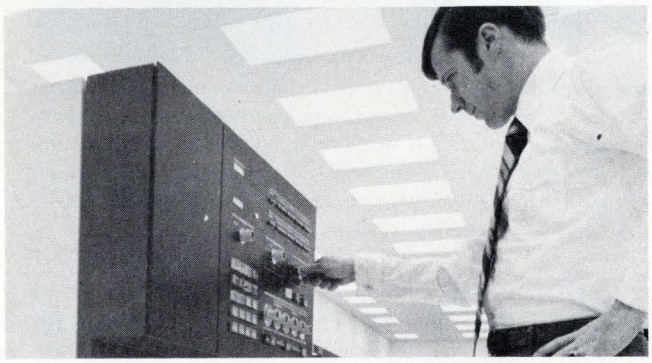
## IBM's blessing—at last

IBM entered the communications-processor business in March of last year with the announcement of its model 3705 front-end processor, which coordinates data transmissions between a host computer and as many as 352 voice-grade communications lines. A more recent unit, model 3704, can accommodate a maximum of 32 lines. It is intended for use mainly as a remote data concentrator. The announcement of both models significantly impacted the communications processor field.

Because IBM System/360 and 370 computers represent about 65% of the host computers that either actually or potentially interface with data-communications networks, that company has been the market target of the communications-processor industry. But until last year, IBM's products in data communications consisted of a line of hardwired controllers to interface data-communications lines with the input-output ports of mainframe computers. These controllers, however, depend on the processing powers of the host computers and therefore cannot be classified as stand-alone communications processors.

Thus, IBM's approach to data communications before last year had been to let the host computer handle the communications tasks. In effect, IBM was saying that there was no need to add processing capability external to the host computer. This network philosophy, propagated by the company with the dominant role in data processing, made it difficult for other companies to sell the stand-alone-communications-processor concept to their customers.

IBM's belated endorsement of the need for communications processors, therefore, has generally been considered a blessing by competing equipment vendors. But this IBM blessing, of course, brings with it the formidable competition of the computer giant in the communications-processor field.



dure to determine which of the terminals is to send or receive data at a given time. On these multipoint lines, the network controller addresses, or polls, each terminal periodically to invite the terminals to send messages.

An alternative to such terminal polling is the interrupt technique, whereby a terminal, without waiting to be polled, transmits data to a communications processor at another network rode. Such contention methods eliminate unnecessary polling and system overhead in systems with a large number of normally inactive terminals, but they place stronger demands on the communications processors, which must be designed to be always prepared to accept incoming data.

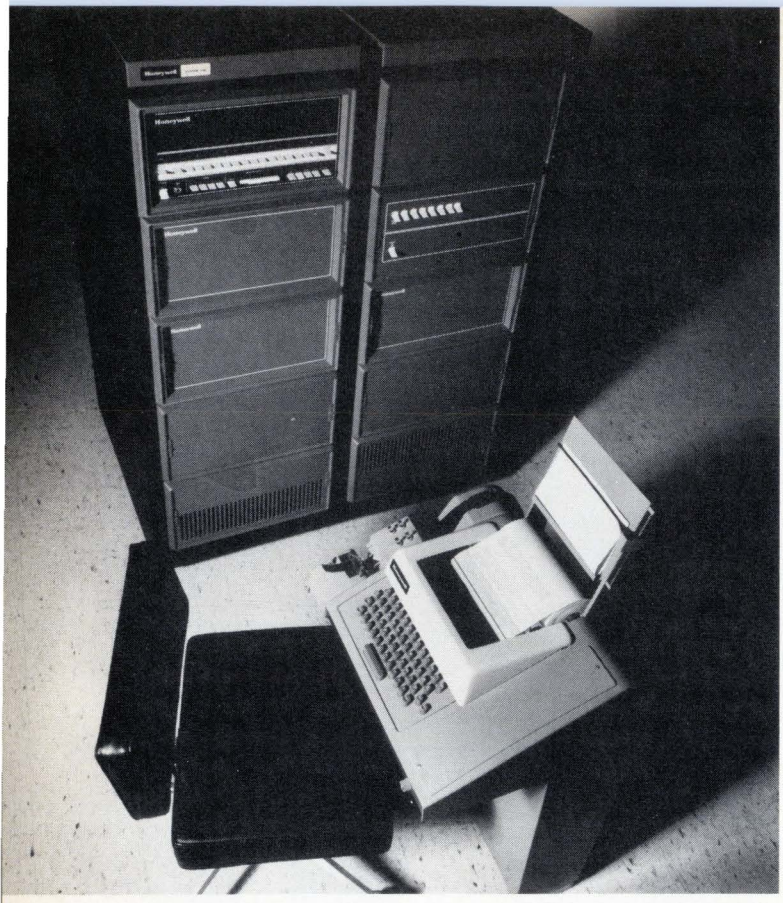
### Code conversion and other tasks

In increasingly complex communications networks, a multitude of "standard" communications codes is used to represent alphanumeric and control characters, ranging from the 5-bit-per-character Baudot code often used by teletypewriter terminals, to the 8-bit-per-character EBCDIC code that has gained wide acceptance for computer-to-computer communications. These codes must be converted to the code used by the host computer.

Similarly, data from terminals is transmitted over communications lines at "standard" rates ranging from 50 baud to more than 9,600 baud, and the processor must be able to accept these different speeds and merge them into a fixed higher speed to the host computer.

As binary data is received by a communications processor, it is assembled into characters, blocks, or complete message texts before being forwarded to the host computer or another network node. Thus, sufficient storage must be provided to buffer these messages for further routing. This message-buffering is one of the most important tasks of the front-end processor or message-switcher. It reduces high-speed-line costs. In addition, message blocks can often be edited to remove unneeded address information. Stripping messages of unneeded characters at the earliest points in a network decreases communications-line requirements and reduces the load on the host computer.

Another important function of the communications processor is that of controlling errors introduced by noise on the communications lines. Although highly sophisticated techniques are available for correcting errors introduced in a one-way communications lines (for-



**Message switch.** In complex communications networks, the message switch analyzes data messages to determine their proper routing, then forwards them to other points in the network. The medium-size switch shown is based on Honeywell's H-716 minicomputer. Other panels in the rack contain line adapters, automatic calling units, and an interface to the teleprinter control unit.

ward-error correction), practical error-control techniques simply use another channel to request retransmission of characters or messages when errors are detected. In all error-control methods, however, redundant "parity" bits or characters for checking errors are transmitted along with information bits, and the communications processor codes and decodes messages containing such check bits.

The communications processor, with its built-in storage capability, can also keep a running record of all message traffic, including such statistics as the total number of messages processed, number of line errors, overflow information, and lengths of time messages are in queues. These statistics, which can also be used to analyze future communications requirements, can be printed at periodic intervals in the processing cycle.

With this general outline of the tasks that must be performed by the communications-processing system, it is now convenient to look more closely at each of the four classes of processors. Since the front-end processor often serves as the principal node in a network, it will be discussed first.

As communications networks came into being, hard-wired line-controllers (such as IBM models 2701, 2702, and 2703) were provided to interface the computer with the communications system. The problem with hard-wired controllers, however, is that they cannot easily adjust to the almost unending changes in network configurations and terminal types that characterize a large system. Also, a network using the hard-wired line-controller totally depends on the processing ability of the host computer to perform such important communications functions as network control and message-storage.

The programable front-end processor, however, keeps most communications tasks outside of the host computer. This separation of communications-processing from information-processing functions is justified in terms of over-all system cost and efficiency. The host computer, including its associated software, is generally optimized for arithmetic operations at extremely high speeds. Therefore, when communications processing must be handled intermittently and at relatively slow speeds, the effectiveness of the host is decreased.

Without a front-end processor, the large communications-oriented mainframe computer typically dedicates from 15% to over 30% of its time to communications processing. This overhead can be reduced to 1–4% by adding a separate front-end processor. In addition to savings in host processing time, a front-end processor may reduce memory requirements for communications functions in a typical host computer from a level of 24 to 64 kilobytes to only 1 or 2 kilobytes. And there are corresponding decreases in the traffic loading at the host computer's input-output ports.

### Line-controller emulators

Even when used as direct plug-for-plug replacements for IBM 270X hard-wired line controllers, minicomputer-based front-end processors generally offer as much as 30% lower equipment costs than the line controllers they replace. While such line-control emulators do not remove the communications-processing functions from the host, they can be installed without its being necessary to rewrite existing user applications programs for the host computer. And the processing capability external to the host computer serves as a base for future expansion to a true stand-alone front end.

As a stepping stone from the line-control emulator to the full front-end processor, several companies have developed the intelligent emulator, or the "emulator-plus." In a typical application, the intelligent 270X emulator may be used with the IBM System/360 or 370 mainframe to support terminals that are not IBM-compatible. It may also provide limited network control functions when the host processor fails, alerting remote terminals not to send new messages.

### Message-switching systems

Unlike front-end processors, which usually funnel data into a large-scale computer for information processing, the message switch generally serves as a central clearinghouse for messages between all points in a communications network. Large stand-alone message-switching systems actually existed before the computer terminal began to leave the data-processing center. Military switching systems, such as Autodin, and, more recently, public message networks, such as the Western Union Corp.'s TWX and Telex, are typical systems that are dedicated solely to message switching.

Today, however, there are new and expanding re-

quirements by companies with geographically dispersed computing facilities (as well as terminal locations) for efficient means of exchanging messages. Companies in the banking, transportation, and retailing businesses are perhaps the best examples, but large multilocation manufacturing operations, law-enforcement agencies, and others can benefit by the use of message switches.

Although the concept of store-and-forward message-switching is readily understood, it is usually the most difficult class of communications processor to implement. This is because of the seemingly unlimited number of alternatives of routing, queueing, assigning of priorities, recording, and other control actions that must be taken for any given message.

A look at the requirements for a typical corporate data switching center will help in determining the requirements for a stand-alone message switcher. The example that follows is also representative of the requirements for a small to medium-size front-end-processor.

Consider a message-switching system supporting a peak load of 30 terminals actively sending data into the message switch (a much larger number of inactive terminals may actually be connected, or have access, to the network, but only 30 are assumed to be sending data at any one instant). With an average message length of 150 characters and an average store-and-forward buffering of two messages per input line, a quick-access buffer storage capacity of 9 kilobytes is required. For a system of this size, another 6 to 9 kilobytes of memory would typically be required to store the necessary software programing, which would result in a total quick-access storage requirement of about 18 kilobytes.

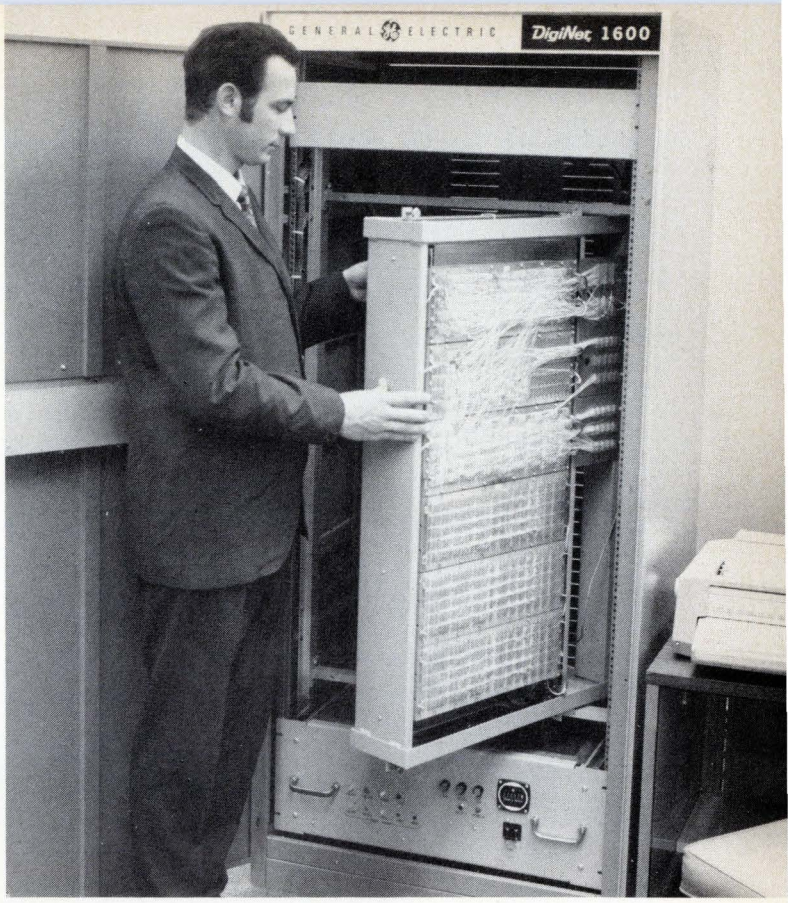
In addition, assuming that 3,500 such messages are switched through the system each day and that all messages must be kept on record for six months, this switcher system would require up to 100 million bytes of peripheral magnetic-tape storage.

### Remote data concentrators

Compared with front-end processors and message switchers, the design requirements for remote data concentrators and intelligent terminals are generally much less demanding. The basic function of the data concentrator is to reduce telecommunications line costs by concentrating data from multiple input lines onto, generally, one high-speed line.

The data concentrator is generally more efficient than the simpler hard-wired data multiplexer, which competes with the concentrator for similar network applications. With its built-in processor and memory, however, the concentrator can smooth the intermittent traffic loads that occur in data systems. This reduces the peak loading of the high-speed output of the concentrator, often by a factor of 3 or 4, allowing a corresponding decrease in line costs.

The remote concentrator based on the minicomputer can also be expanded into a local message-switcher to help reduce the load on switchers located at more central nodes in a network. However, the objective of remote concentration is to reduce system communications costs. Therefore, the cost of added processing functions must constantly be weighed against resulting savings in line costs.



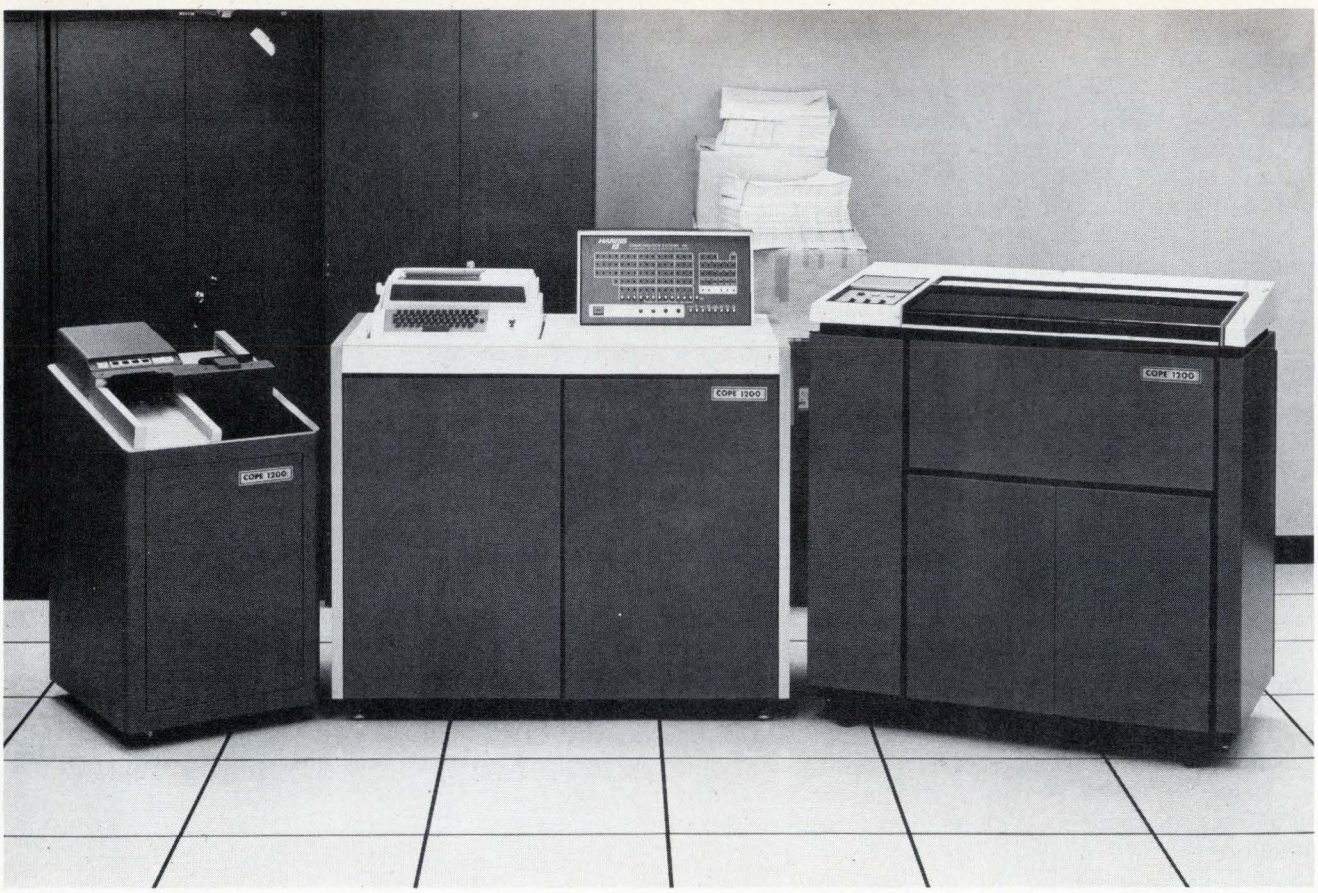

**Data concentrator.** To reduce communications line costs, a data concentrator terminates a number of low-speed transmission lines and multiplexes them into fewer high-speed lines. In the unit shown, a processor and a maximum of 32,000 16-bit words of memory allows such additional functions as code conversion, message assembly, and terminal-usage accounting.

The intelligent terminal can be thought of simply as a remote data concentrator that controls one or more local peripherals. However, there seem to be two diverging trends in technologies and markets for intelligent terminals. Along one path, more and more use is being made of the processing powers of remote minicomputers, which form the heart of most of these terminals. Small data files have even been attached to local computers to avoid unnecessarily having to use communications lines and central computers for simple data-processing functions.

Taking an entirely different approach to intelligent-terminal design, some terminal vendors are using the sophistication of LSI technology to produce specialized communications controllers at prices that cannot be approached by even the least expensive communications processor. And since many relatively simple communications functions required of the intelligent terminal can be handled with only a few LSI packages, the trend toward use of such technology is sure to gain momentum.

### Communications processor components

The essential modules for each of the four general classes of communications processors are identified in Fig. 2. The six functional modules identified are building blocks for the communications-systems designer. In many practical systems, each of these building blocks is




**Intelligent terminal.** Minicomputer-based terminal controller (center) provides code conversion, error correction, and even limited local processing for a cluster of terminals remote from the host computer. Any of a number of terminal units can be attached to the controller, such as the 300-card-per-minute card reader (left) and the 600-line-per-minute printer (right) marketed by Harris Communications Systems.

on an individual printed-circuit board or group of boards. These same modules serve as the basis for programing into functionally divided software packages. It is therefore helpful to take a closer look at what hardware (and software) goes into each of these modules.

For all but the largest data-communications networks, minicomputers (both general-purpose and, in some case, custom-designed units) often serve the central processor and memory functions in the communications processors. Software in conjunction with the associated line and host computer interface hardware, adapt the minicomputer to communications applications.

### Built-in ROMs

In several recent designs, microprogramable read-only memories have been incorporated into the processors of some communications-oriented minicomputers, following the trend that exists in other segments of the computer industry. The use of such microprogramable circuits shortens the processing time associated with commonly recurring communications functions, such as code-conversion, by reducing the number of times in the conversion process that main memories must be accessed to obtain software instructions.

An example of one of these modified minicomputers is a microprogramable design used in Interdata's model 50 communications processor to handle the numerous repetitive tasks. "By making use of ROMs," Jon Gould, director of data communications at the Oceanport, N.J., company, says, "throughput in a moderately sized communications processor is increased from 10,000 to over 30,000 characters per second." In addition, claims Gould, "the amount of memory required to store software programs is typically reduced by a factor of 75."

Taking a similar approach to design of the minicomputer processor, Teleswitcher Corp., a Dallas-based vendor of turn-key data communications systems, has designed an array of 32 field-programable plug-in ROMs onto its latest custom-designed processor board. In addition to requiring less software and allowing greater throughput than could be achieved by implementing the same functions with software, the use of such microprograming reduces the over-all processor hardware costs, reports Wayne Pratt, manager of hardware design at Teleswitcher.

To supplement these basic processing and memory functions, both minicomputer manufacturers and others have developed the necessary special-purpose hardware and software to interface the minicomputers with communications lines, terminals, and host computers.

### Line adapters

The line-adapter units shown in Fig. 2 bring data on the communications line into the communications processor following three basic techniques—bit-by-bit, character-buffered, and by direct memory access.

The simplest line interface unit looks at a message bit

by bit, transferring it through the processor and into memory one bit at a time. Such a "bit-banging" technique requires little hardware, but it requires substantial software and is therefore usually wasteful of processor time.

A much more efficient line adapter converts serial bits into characters, then transfers complete (parallel-bit) characters into the processor and memory. In addition to reducing processor overhead, a character-converter interface is capable of handling much higher data rates—up to about 9,600 bits per second.

A line adapter that works with characters instead of bits also can perform such tasks as code conversion and simple error correction without depending on the computing powers of the processor, thus further increasing over-all system efficiency.

The most efficient method of interfacing high-speed data with the communications processor is through the computer's direct-memory-access channel. Here, data rates of 50 kilobits per second and higher can be loaded directly into memory without having to be processed character by character by the central processing unit.

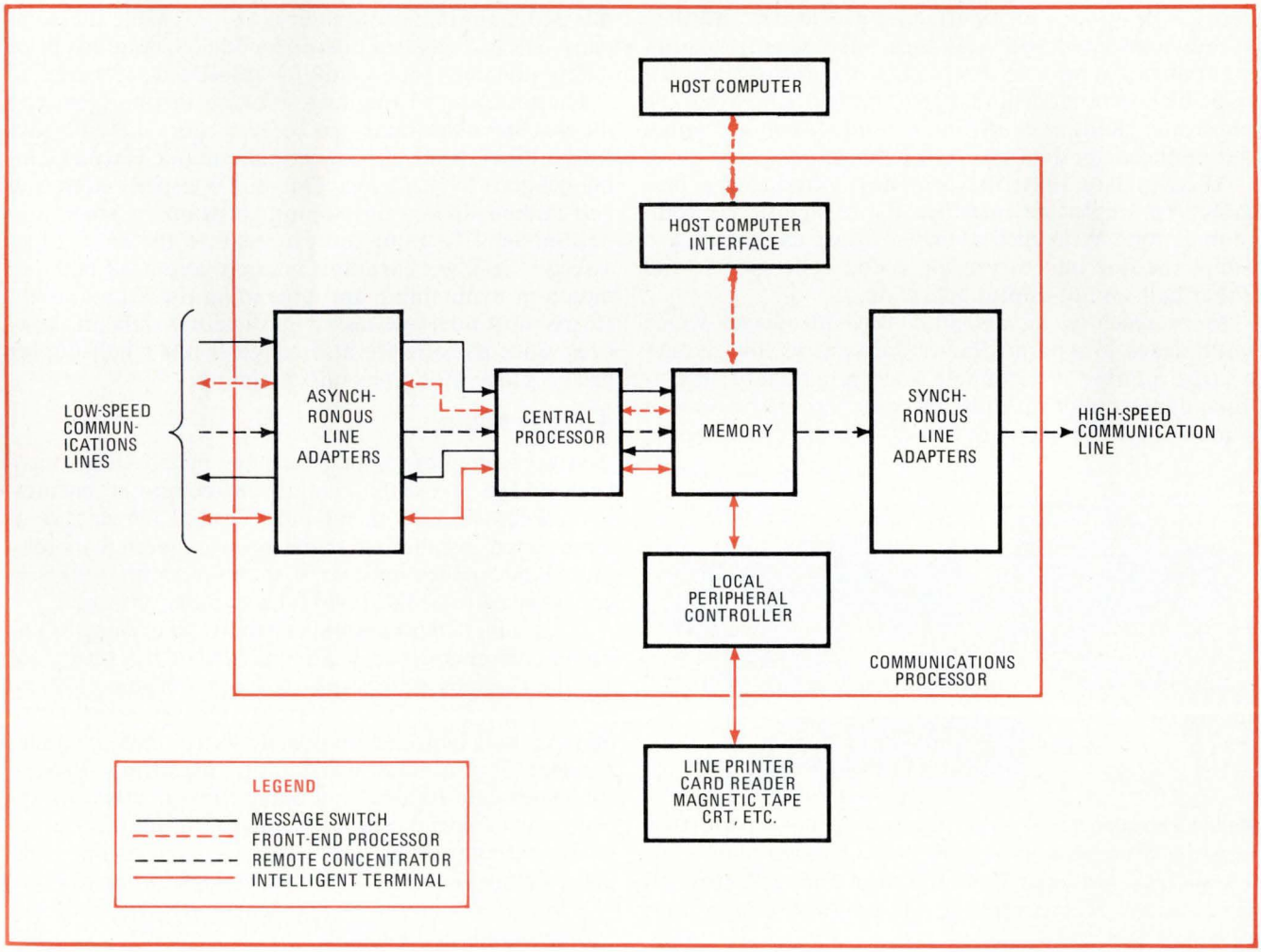
As might be expected, choices between the three techniques used in line adapters are governed by tradeoffs in price and performance. Bit-by-bit adapters are adequate only for small systems where the burden on the processor is light. The use of character-conversion techniques in the line adapter satisfies all but the most rigorous high-speed-network requirements, where direct-memory-access methods can be used.

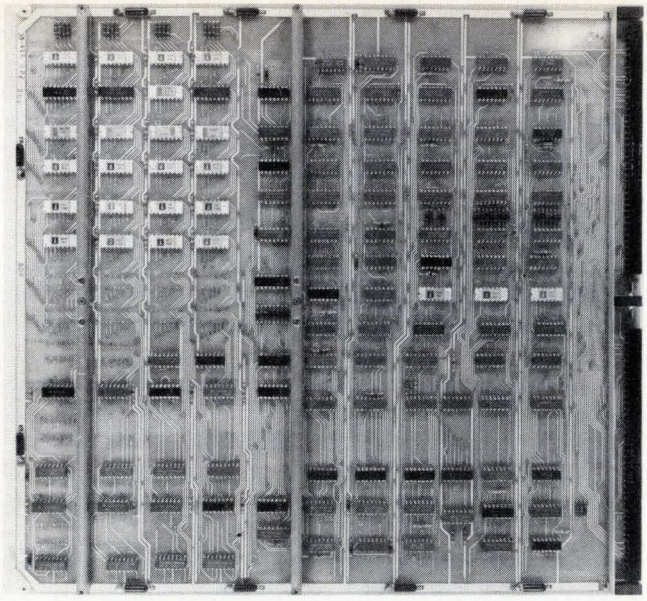
## Cost tradeoffs

The price for line adapters, however, increases substantially as performance level is increased. According to John Chyzik, data-communications specialist at Data General Corp., Southboro, Mass., a minicomputer maker that also supplies communications-processor accessories, "the system using bit-banger-type line-adapters might average $130 per line, while the character-converter hardware for high-speed lines can cost between $200 and $600 per line, not counting the cost of the minicomputer and other communications-processor functions." On the high end, adds Chyzik, the complex hardware in the line adapter with direct memory access brings its price up to about $2,500 per line.

Typical of the classes of line-adapter hardware developed in the last couple of years are the plug-in printed-circuit cards produced by Digital Equipment Corp.,

**2. Building blocks.** Both hardware and software needed to implement the tasks of a communications network are often separated into six functional blocks. Two of the blocks—the central processor and memory—are often general-purpose minicomputers. The manner in which the six blocks are configured defines each of the four fundamental classifications of communications processors.





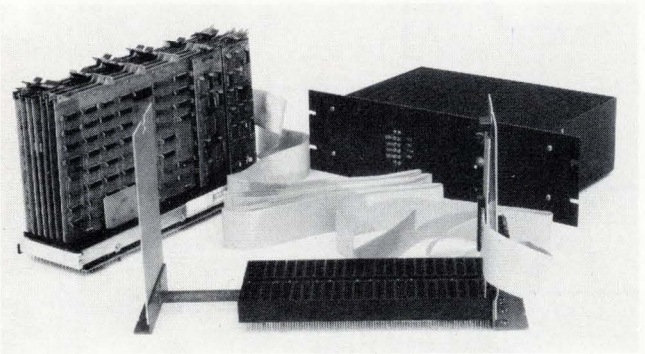
**Microprogramed.** Microprogramable read-only memories have been designed into some minicomputers in order to shorten the processing time that is associated with commonly recurring communications functions. The read-only-memory board shown here is part of Interdata's model 50 communications processor.

Maynard, Mass., for use with communications processors employing that company's minicomputers.

At first, DEC announced a line of nonprogramable cards with options for interfacing with codes and data speeds associated with standard teletypewriter equipment or CRT terminals. These plug-in cards operate in a basic bit-by-bit mode and, being hard-wired, have to be physically changed every time a remote terminal with a different code or data speed is changed.

Then in late 1971, the company introduced a programable single-line interface for asynchronous communications. With such a unit, software can be used to adapt the line unit to varying codes, code speeds, and either half- or full-duplex operation.

More recently, an assembly was introduced which multiplexes 16 separate lines. "For systems that require a large number of terminals, such programable multiline adapters offer much lower costs per line because of shared logic for all lines," says Dimitri Dimancesco, senior market development specialist.



**Multiline adapter.** For a system that includes a large number of terminals, programable multiline interfaces, such as this 16-line interface assembly produced by Digital Equipment Corp., offer a flexibility and a reduction in costs that could not be achieved in earlier hard-wired single-line units.

Product evolution in other companies has followed similar patterns. Some of the latest extras that add flexibility to programable line adapters include automatic dialing options, provisions to allow direct memory access between the line unit and the communications processor's memory, and logic to fully control modems through EIA RS-232 interfaces.

### Host-computer interface

If there is one thing that vendors agree on, it's that the interface between the communications processor and the host computer is the most difficult of all the communications processor functions to build. To make the front-end processor appear to the computer as another peripheral at one of its input-output ports is no mean feat.

As in the communications-line adapter, the host-computer adapter must be made to interface with signal levels and operating procedures over which the maker of the communications processor has little control. The adapter therefore must be designed around existing systems, and it must be flexible enough to easily adjust to future changes, in both hardware and software, dictated by the mainframe manufacturer.

As a result, the host-computer interface modules are often more expensive and more complex than the central-processing unit in the front-end processor. For example, the price for Interdata's interface adapter for the IBM 360 mainframe computer is $8,180, while the company sells its processor boards for $6,800. And this price differential does not account for associated software.

The problem of adapting software to interface with the IBM 360 mainframe can be even more difficult, says Royce Pipes, head of product planning at Harris Communications Systems Inc., Dallas. "We spent close to a half-million dollars developing software to adapt our new model 4705 front-end processor to the 360," Pipes asserts, "and we currently commit about $5,000 per month in maintaining and upgrading these programs." Harris' host interface task is particularly difficult, however, since its software also converts IBM's half-duplex protocol to a full-duplex line discipline.

### A strong future

Most communications-processor installations have been added to existing mainframe-computer installations. Even so, this means only a small percentage of these batch installations have been converted to teleprocessing applications, so that this retrofit market is not expected to be saturated for a number of years.

But adding teleprocessing capability to existing mainframe computers is only a small part of the future for communications processors. A large portion of these processors will, as they do today, go into stand-alone message-switched information networks that are independent of, or at least incidental to, mainframe processors. Such data-transfer and data-retrieval networks appear now to have the strongest long-term future. And as data communications and two-way television technologies advance, the communications processor will eventually be central to consumer-oriented networks with terminals in the home. □

# The charge-balancing a-d converter: an alternative to dual-slope integration

Like dual-slope analog-to-digital conversion, the new technique basically is an integration scheme; but simple design and relaxed tolerances on components may give it an economic edge in some applications

by Robert C. Kime, Jr., *Keithley Instruments Inc., Cleveland, Ohio*

☐ Given the problem of designing a cheap, simple, reliable analog-to-digital converter that exhibits high accuracy and low power consumption, most engineers will probably first think of the dual-slope converter. Recently, however, the charge-balancing converter was developed for pretty much the same purpose.

The two circuits have much in common. Both center on charging and discharging a capacitor, both are integrating circuits, both are quite economical, and neither will ever set a conversion speed record.

But the techniques are not identical, and one or the other may prove superior in any given application. The dual-slope unit can be designed to have outstanding normal-mode rejection at one particular frequency, so that line rejection is very easy, while the charge-balancing converter can generally be implemented with fewer parts and with looser component specs.

Basically the dual-slope converter works by applying the unknown input signal to an uncharged capacitor for a fixed length of time, and then measuring the time needed to discharge the capacitor at a constant rate. In the charge-balancing converter, however, there is no fixed charging period, and the charging continues for as long as necessary to get the capacitor voltage to cross a fixed threshold level; then a reference current is subtracted from the input current, and the capacitor discharges until the threshold level is crossed again. The process repeats itself until the conversion period is over. At that time, a counter, which only accumulates clock pulses when both the input signal and the reference current are applied to the capacitor, contains a number of counts proportional to the input voltage.

### One conversion cycle

The charge-balancing unit got its name from the fact that the net charge put into an integrator over one integration cycle is zero. The converter (Fig. 1), which accepts only positive input voltages, operates as follows. Initially the current switch is open, and only the input voltage is applied to the integrator. Since the integrator contains an inverting operational amplifier and a capacitor, the output voltage, $V_o$, is a negative-going ramp that has a slope proportional to $V_{in}$.

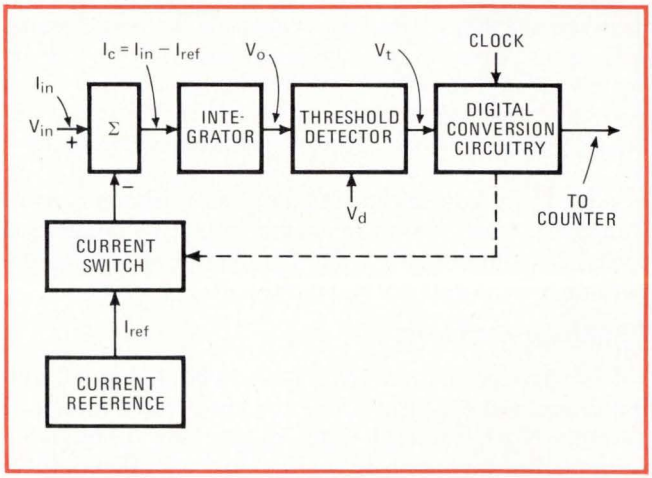
As $V_o$ passes the threshold level, $V_d$, of the threshold detector, the detector's output voltage, $V_t$, switches to a logic 1 state which, among other things, opens a gate that allows the counter to start accumulating clock pulses. It also makes a flip-flop close the current switch on the next clock pulse. Closing this switch causes the known, constant reference current to be subtracted from the input current. The difference current is applied to the integrator as before.

The reference current is chosen to be greater than the input current for all allowable input voltages, so that subtracting the reference current, $I_{ref}$, from the input current, $I_{in}$, is guaranteed both to change the polarity of the input to the integrator and to start $V_o$ on a positive-going ramp.

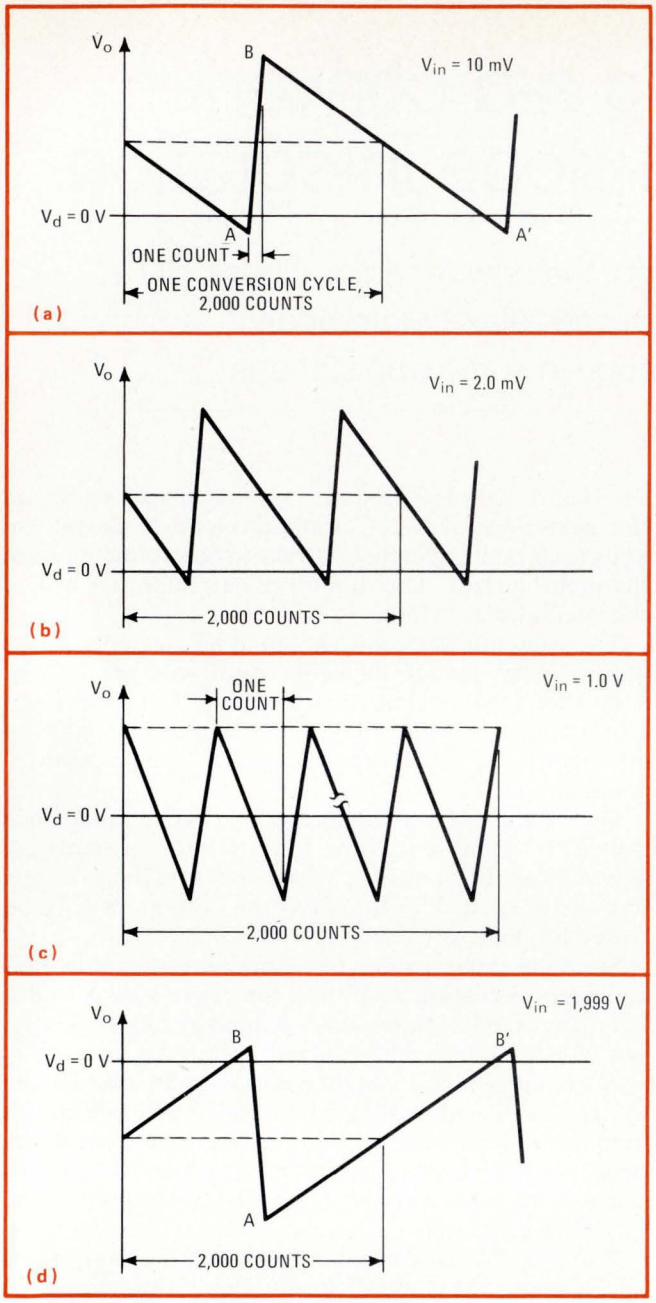
During this part of the integration cycle, gated clock pulses are being fed to the counter and accumulated. When $V_o$ again passes $V_d$, $V_t$ switches to a logic 0 state, and the next clock pulse opens the current switch and closes the clock gate.

Since the converter is a free-running system, this process keeps repeating itself until the conversion period is over. The conversion period is defined as a certain number of clock pulses, $N_t$, received by the digital conversion circuitry. $N_t$ is a system constant and is fixed when the converter is designed. The number of clock pulses accumulated by the counter during one conversion cycle, $N_f$, is a variable quantity that is directly proportional to the input voltage. $N_f$, in fact, is the digital output of the converter.

Probably the most unusual feature of the charge-balancing converter is the diversity among the waveforms




**1. Balanced.** By switching reference current on and off, a-d converter puts zero net charge into integrator over full integration cycle.




**2. Timing.** Number of integration cycles in one conversion cycle depends upon input voltage. When voltage is very small, negative ramp is very slow, and converter makes only one integration per conversion (a). Doubling input voltage doubles number of integration cycles (b). After half-way point (c), trend reverses and at top of measurement range unit is back at one integration per conversion (d).

observed at the output of the integrator. In one conversion cycle, there can be anywhere from zero integration cycles to approximately $N_t/2$ integration cycles, depending on the value of the input voltage.

### Changing waveform

For instance, assume that $N_t = 2{,}000$, $I_{ref} = 1.0$ milliampere, and $R_{in}$—the converter input resistance—is 2 kilohms. Now, if a small input voltage, say 1.0 millivolt, is applied to the input, $I_{in}$ will be only 0.5 microampere and $V_o$ will move very slowly in the negative direction until it crosses zero (Fig. 2a). Then, at the next clock pulse, $I_{ref}$ is connected to the integrator (point A), causing it to climb steeply in the positive direction. A zero crossing occurs almost immediately, and the next clock pulse disconnects $I_{ref}$, leaving $V_o$ at point B. From here on the process repeats itself, with $V_o$ dropping slowly toward point A′.

Since this is a charge-balancing converter, the charge removed from the integrator between points A and B must equal the charge applied between points B and A′. Because $I_{ref}$ is 1.0 mA and $I_{in}$ is 0.5 μA, the reference current must be off for about 2,000 times as long as it is on. Thus, if $I_{ref}$ is on for the minimum duration of one clock pulse, it will be off the 2,000 clock pulses and there will be only one integration cycle in the conversion cycle.

But if $V_{in}$ is twice as large—2.0 mV—$I_{in}$ becomes 1.0 μA, and there are two integrations per conversion (Fig. 2b). The negative-going ramp is twice as steep as in the preceding case, while the positive-going portion has practically the same slope. (To be exact, the charging current, $I_c = I_{in} - I_{ref}$, is 0.9995 mA in the first case and 0.9990 mA in the second.) As the input voltage increases further, the slope of $V_o$ from B to A′ becomes steeper because $I_{in}$ increases, while the slope from A to B becomes less steep because $I_c$ decreases.

Again, when the input voltage is 1,000 volts, $I_{in}$ = 0.5 mA, and $I_c$ = 0.5 mA too. Thus the two slopes of the $V_o$ waveform are equal and opposite, and the wave shape is a triangular wave centered about zero (Fig. 2c). Also, the peak amplitude of $V_o$ is half of what it was when $V_{in}$ was 0.001 V, and there are 1,000 integration cycles in one conversion cycle.

Finally, when the input voltage is 1.999 V, $I_{in}$ is 0.9995 mA and the waveform picture is an inverted version of the situation pertaining to the 1-mV input (Fig. 2d). The segment of the $V_o$ waveform from B to A in Fig. 2d corresponds to the segment from A to B in Fig. 2a. The reference current is connected for all but one count during a conversion cycle, so there is one integration per conversion again. If the input voltage is 2,000 V or greater, $V_o$ never gets back to zero, and the counting is continuous.

### How it works

An implementation of the converter block diagram (Fig. 3) shows one of the advantages of the charge-balancing converter—its simplicity. The integrator, for example, consists of only an op amp, a capacitor, and a resistor. Since the high open-loop gain of the op amp keeps node A at ground potential, the resistor in the input lead determines the input resistance of the converter. Note that the system is designed to work properly only with positive inputs.

The threshold detector is even simpler. Although two different threshold levels could have been used—one for when $V_o$ is moving in the positive direction, and one for the negative direction—this is not necessary. For the implementation shown here, it was sufficient to choose $V_d^+ = V_d^- = 0$. The only further requirement is that the threshold voltages remain stable for at least one conversion cycle (about 200 milliseconds in this case).

Usually, a threshold detector contains a positive feedback that, by setting up a hysteresis voltage at the

switching levels, assures positive switching when the input is moving slowly nearly the threshold level and also prevents the detector from oscillating under the influence of input noise, input bias voltage shifts, and so on. But in the charge-balancing a-d converter, the detector requires only an open-loop operational amplifier, and the hysteresis is provided instead by the digital portion of the circuitry.

The digital section consists of J-K flip-flop, an inverter, an AND gate, and a few diodes. The circuitry works as follows: first, assume that Q is low, $\bar{Q}$ is high, and $V_t$ is low. Since Q is low, there are no pulses coming through the AND gate. Since $\bar{Q}$ is high, it supplies the current $I_{ref}$ through $D_2$, and $D_1$ is back-biased so that $I_{ref}$ is not connected to node A of the integrator. Under these conditions $V_o$ ramps negatively and eventually passes zero—the threshold voltage—causing $V_t$ to go high. This puts a high level on J and a low level on K.

At the next clock pulse, Q goes high and $\bar{Q}$ goes low. The AND gate now starts to pass clock pulses which go to a counter. At the same time $I_{ref}$ is switched to node A because $D_2$ is reverse-biased, and reference current is drawn from the integrator.

When the integrator output $V_o$ again passes $V_d$, $V_t$ again goes negative, putting a low level on J and a high level on K. At the next clock pulse, Q goes low and $\bar{Q}$ goes high, which stops clock pulses from passing through the AND gate and disconnects $I_{ref}$ from the integrator. A known current has now been removed from the integrator over a measured integral number of clock cycles and thus a known amount of charge has been removed. This process continues as long as $V_{in}$ is positive.

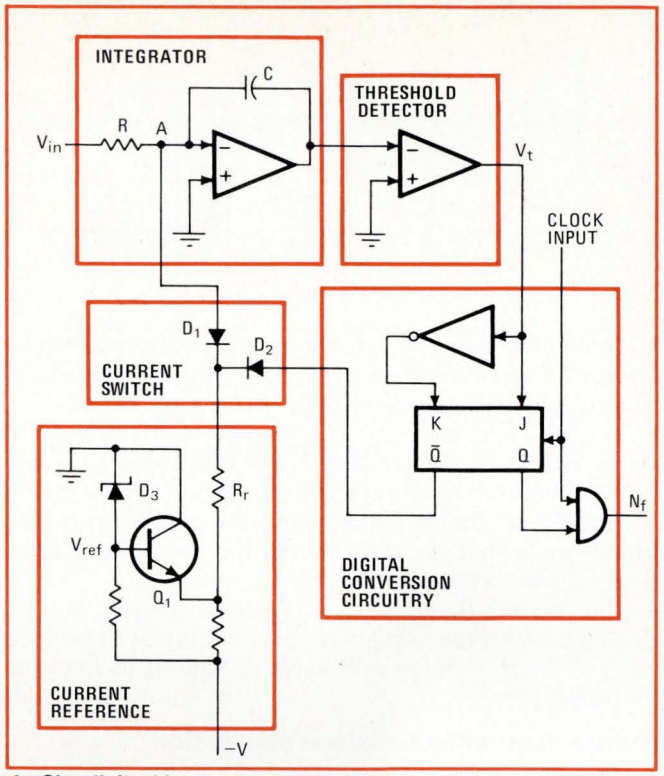
The variable time period between when $V_t$ changes state and when the clock pulse changes the state of the J-K flip-flop is the digitally generated hysteresis of the system. This time can vary from zero to one clock cycle. After a period of time, under the application of a constant input voltage $V_{in}$, the output of the integrator establishes an average voltage. For this to occur, the average voltage on the integrating capacitor must be constant. Consequently the charge removed must equal—or balance—the charge applied.

The current reference is really a voltage reference and a resistor. It makes use of the fact that the integrator summing junction (node A) is at 0 v which makes $I_{ref} = V_{ref}/R_r$ (see Fig. 3). Since diode $D_1$ is also in the circuit when $I_{ref}$ is connected to node A, transistor $Q_1$ is used to buck out and temperature-compensate $D_1$. $D_3$ is a temperature-compensated zener diode.

## Fixing the variables

Since the same capacitor is used for both the applied and removed charge, the charge-balancing equations can be written in terms of currents. Over any conversion cycle, the average input current, $I_{in} = V_{in}/R$ must equal the average current removed from the integrator, $I_o = I_{ref}N_f/N_t$. Here, $N_f$ is the number of clock pulses over which current was removed from the integrator, and $N_t$ is the total number of clock pulses in one conversion cycle. Thus, $V_{in}/R = I_{ref}N_f/N_t$, or $V_{in} = RI_{ref}N_f/N_t$.

The only variable on the right-hand side of this equation is $N_f$. Thus, by proper selection of R, $I_{ref}$, and $N_t$, the converter can easily be scaled to cover any desired voltage range. For example, choosing R = 2 kilohms, $I_{ref}$ = 1.0 mA, and $N_t$ = 2,048 counts provides a 3½-digit converter that can measure up to 2.000 v with 1.0-mv resolution.




**3. Simplicity.** Major advantages of charge-balancing converter are its few parts and the loose tolerances of most parts. Threshold detector, for example, is simply an op amp operated at full open-loop gain. Current switch consists of only two diodes.

Actually, only 2,000 counts are needed for a 3½-digit machine; the extra 48 clock pulses are used for such housekeeping chores as transferring the contents of the counter into some type of memory (so that the count can be displayed during the next conversion cycle) and resetting the counter to zero.

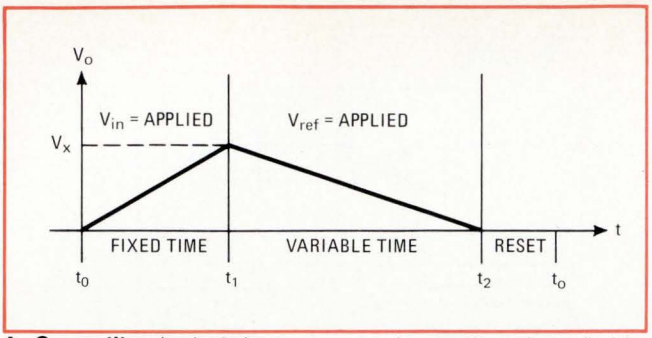
## Limitations

The major disadvantage of the charge-balancing converter is its speed. It requires at least as many clock pulses as the maximum count to complete a conversion cycle. As an example, a 3½-digit (13-bit) converter requires more than 2,000 clock pulses to effect a conversion. A successive-approximation converter could probably do the job in 14 to 16 clock cycles.

Inexpensive linear ICs have sufficient gain-bandwidth product and slew rate for satisfactory operation at clock frequencies of 10 to 20 kilohertz, which allow a conversion cycle time of 0.1 second. If 10-ms conversion times were required, faster devices would be needed.

As for sensitivity, the 3½-digit system described here can resolve 1 mv. To achieve 100-microvolt resolution would require either an integrator amplifier with less than 30 $\mu v/°C$ of drift, or an autozero circuit.

Precision, too, must be considered. The present system is free-running—each conversion cycle does not necessarily start with the same initial integrator condi-




**4. Competitor.** In dual-slope converter, input voltage is applied for fixed period, and time needed to return integrator voltage to zero at constant discharge rate provides measure of applied input voltage.

tions. This leads to a ±1-digit error. The converter could be synchronized to remove this source of imprecision.

Finally, as already mentioned, this a-d convertor is unipolar, so that an input must be preconditioned before a-d conversion can take place.

Still, despite these disadvantages, all of which can be overcome with the exception of speed, the performance of this system is quite impressive in light of its low cost and simplicity.

### Comparison with dual-slope conversion

The speed limitation of the charge-balancing converter is shared by the dual-slope converter, so it should prove worthwhile to compare these two approaches in some detail. Different versions of the dual-slope converter can be made to handle bipolar inputs, to be auto-zeroed, to reject power-line interference, and to be insensitive to variations in the values of some of its components. But for purposes of comparison with the charge-balancing circuit, a unipolar system with the same input configuration will be used. (Actually, many of the input-circuit variations used with the dual-slope technique can also be applied to the charge-balancing converter.)

A dual-slope converter has basically the same parts complement and block diagram as the charge-balancing unit. Of course, the digital conversion circuitry would have to be different.

For the dual-slope circuit in Fig. 4, input voltage $V_{in}$ is converted to a current and applied to the integrator for a fixed period of time, which allows the integrator to ramp to some arbitrary voltage, $V_x$. Then a reference current of opposite polarity is connected to the integrator until the integrator crosses zero. Once $V_{ref}$ is connected to the integrator, the counter starts, and clock pulses are counted until the zero crossing occurs. Since the voltage on the integrating capacitor is again zero, the charge applied equals the charge removed, and a digital conversion has been performed. A small reset time is needed to strobe the latches and reset the counter.

From the standpoint of a circuit complexity, the digital sections of the dual-slope and charge-balancing converters would be about the same complexity with slightly different timing. The dual-slope circuit would need more counts for the conversion cycle for the period that $V_{in}$ alone is applied, which would increase the size of the required ripple counter.

The analog sections would also be about the same with two exceptions: the threshold detector and the switching devices. In the dual-slope circuit, the threshold detector must have good long-term zero stability; in the charge-balancing circuit, good zero stability for one conversion cycle is all that's required. For both converter types the integrating capacitance and the system clock frequency must be stable for one conversion cycle.

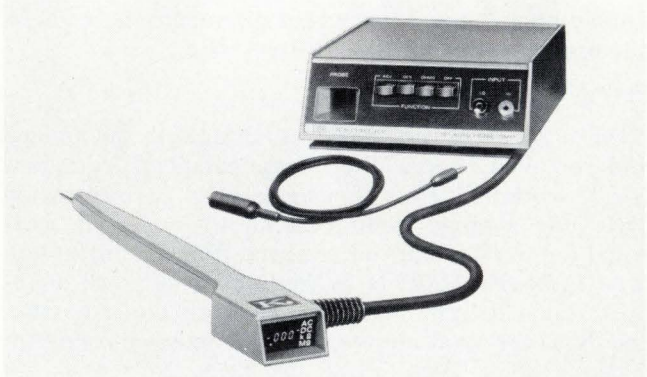
To connect the reference, the same diode switching could be used in the dual-slope as in the charge-balancing technique, but for reset, additional switching devices would be required for the former. The integrator in the dual-slope circuit must be initialized before the start of a conversion cycle because its starting level determines the accuracy of a conversion.

Consequently, the charge-balancing approach winds up using fewer components, which are less critical, than does an equivalent dual-slope circuit.

Dual-slope converters can be made bipolar—by adding an opposite-polarity reference, another high-quality threshold detector, and polarity-sensing circuitry to determine which reference and which threshold detector to use. To give the charge-balancing converter bipolar capability, an absolute-value detector can be used in front of it. In this case, over-all complexity and cost of each system are about equal. Even so, the charge-balancing circuit still enjoys an advantage over the dual-slope circuit because the absolute-value detector doubles as an ac-dc converter, which adds ac measurement capability at no extra cost.

The dual-slope converter has one distinct advantage over the charge-balancing converter. By proper selection of the period for which the input is applied, the dual-slope converter can be made to reject a specific frequency (such as line frequency) and its harmonics. This is impossible to do with the charge-balancing convertor. Ac rejection must be accomplished with input filtering techniques.

The operation of the charge-balancing converter has been proven by over a year of use in the Keithley 167 Autoprobe Digital Multimeter (Fig. 5). This instrument is fully auto-ranging, measures ac and dc voltage and resistance, and is battery-operated. In fact, the charge-balancing converter seems to have met the meter's over-all design objectives as well as or better than any other a-d conversion system. □



**5. Proven performance.** Charge-balancing converter is heart of this portable multimeter. Extensive field experience proves that new conversion technique is worth considering for new system designs.

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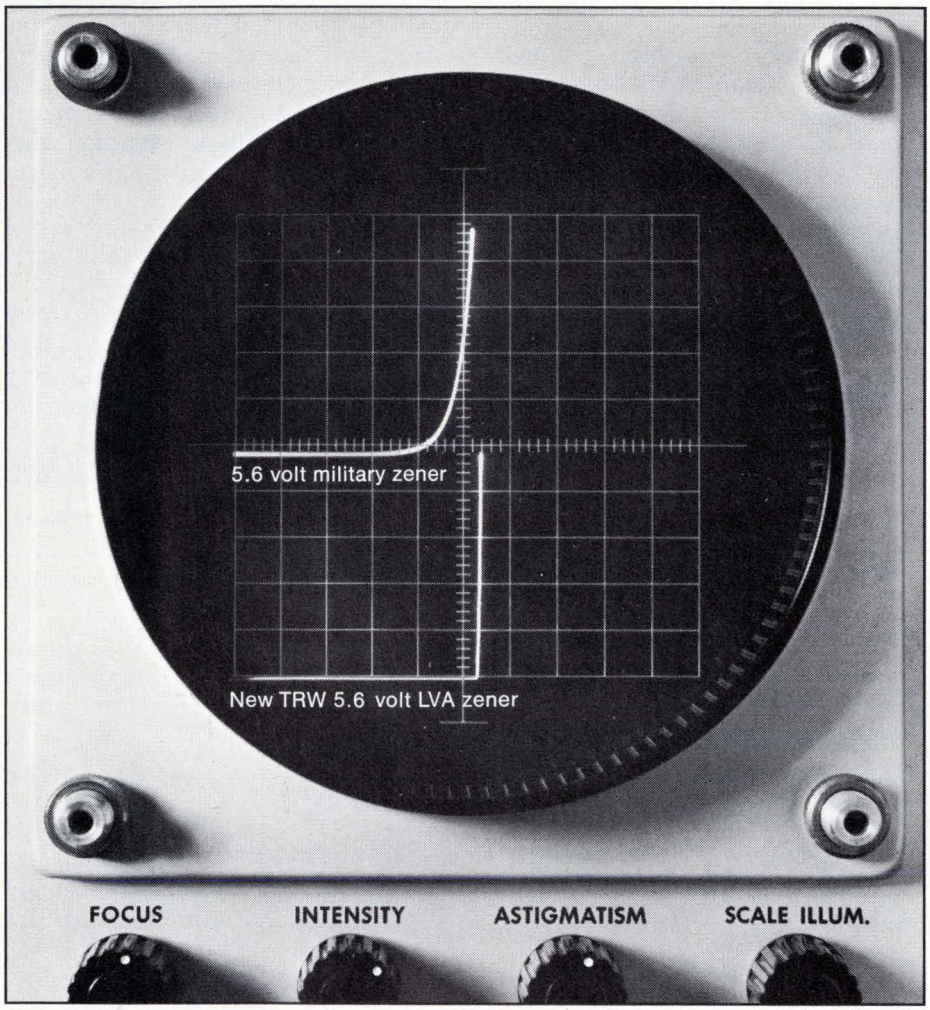


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# Temperature compensation for high-frequency transistors

by Bert K. Erickson
*General Electric Co., Syracuse, N.Y.*

If the operating temperature of a high-frequency grounded-emitter power transistor varies widely, the collector resistance of a second transistor can provide temperature compensation, without causing excessive power dissipation in the stage's bias circuit. The technique is suitable for operating frequencies of 300 to 3,000 megahertz, if the power levels are at least 200 milliwatts and ambient temperature variations range from 0°C to 70°C. For this broad a temperature range, the quiescent collector current of a class-A transistor amplifier will change enough to cause noticeable gain variation and waveform distortion.

Conventionally, a current-feedback approach is employed to obtain temperature stability. The resistance in the transistor's emitter circuit is maximized, while the resistance in the base circuit is minimized. But this technique presents assembly problems because of the very high operating frequencies involved. The emitter of these transistors is usually connected to ground with very short wire bonds to eliminate the series resonance of the bypass capacitor. And, although the transistor's emitter is grounded, temperature stability cannot be obtained with a voltage-feedback approach since this would reduce power-conversion efficiency.

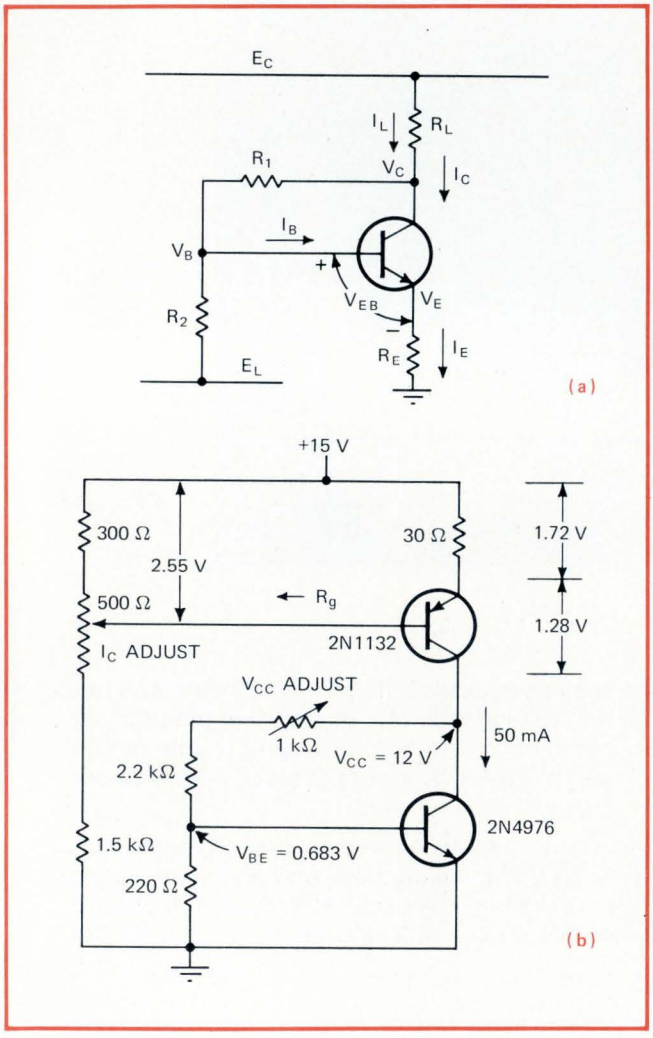
The typical grounded-emitter transistor stage of (a), which is drawn without isolating, coupling, and tuning components for simplicity, has a current stability factor of:[1]

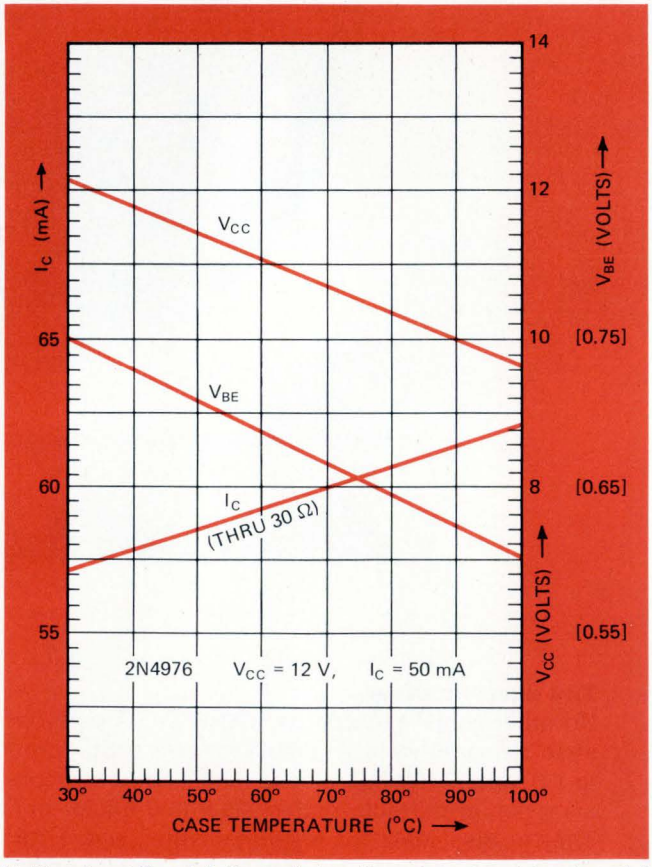
$$S_i = \Delta I_C/\Delta I_{CO} = [R_L+R_1+R_E(1+(R_1+R_L)/R_2)]/[R_L+R_1(1-\alpha)+R_E(1+(R_1+R_L)/R_2)]$$

And the voltage stability factor is:[1]

$$S_v = \Delta I_C/\Delta V_{EB} = -\alpha[1+(R_1+R_L)/R_2]/[R_L+R_1(1-\alpha)+R_E(1+(R_1+R_L)/R_2)]$$

Voltage stability is the preferred sensitivity parameter for a power transistor because the emitter-base voltage,




**Nailing down Q point.** Grounded-emitter power transistor stage (a) can be compensated for a 70°C temperature range by employing a second transistor as the load resistance (b). The collector resistance of upper transistor improves the voltage and current stability of lower transistor without causing an efficiency-robbing voltage drop. The graph depicts the stage's temperature performance.

$V_{EB}$, is easily measured and is often used to find the temperature of the collector depletion layer.[2] The voltage stability factor is negative because collector current $I_C$ increases as junction voltage $V_{EB}$ decreases.

Since the term, $R_1(1-\alpha)$, is very small, one way to diminish $S_v$ is to make the load resistance, $R_L$, as large as possible. Unfortunately, $I_C$ flows through $R_L$, and the stage's conversion efficiency will be reduced substantially. However, a large $R_L$ can be obtained without the usual voltage drop degradation by using the collector resistance of a second transistor, as in (b).

With the T-model equivalent circuit for the common-emitter transistor, the output resistance of this configuration can be expressed as:

$$r_o = r_c(1-\alpha) + r_e(r_b + \alpha r_c + R_g)/(r_b + r_e + R_g)$$

For this equation:

$$1/r_c(1-\alpha) = \Delta i_c/\Delta v_{ce}|_{i_b}$$

$$\beta = \Delta i_c/\Delta i_b|_{v_{ce}}$$

$$\alpha = \beta/(\beta+1)$$

All of these quantities can be readily obtained from the transistor's collector characteristics.[3]

The upper transistor in (b) provides an output resistance of 1,200 ohms, which yields a predicted voltage stability factor of $14.9 \times 10^{-3}$ amperes per volt. If a fixed resistor of 1,200 ohms were used, it would have an IR drop of 60 v across it. But the voltage drop across both the transistor and its emitter resistor is only 3 v.

The graph shows the actual characteristics of the transistor stage as temperature rises from 30°C to 100°C. As temperature increases by 70°C, the base-emitter voltage drops by only 0.15 v and the collector current rises only 5 milliamperes. Without temperature compensation, the collector current would be 32 mA higher. □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2. R.L. Pritchard, "Electrical Characteristics of Transistors," McGraw-Hill, 1967, p. 613.
3. R.P. Nanavati, "An Introduction to Semiconductor Electronics," McGraw-Hill, 1963, p. 163.


# Simple gating circuit monitors real-time inputs


by David F. Hood
*Bell-Northern Research, Ottawa, Canada*

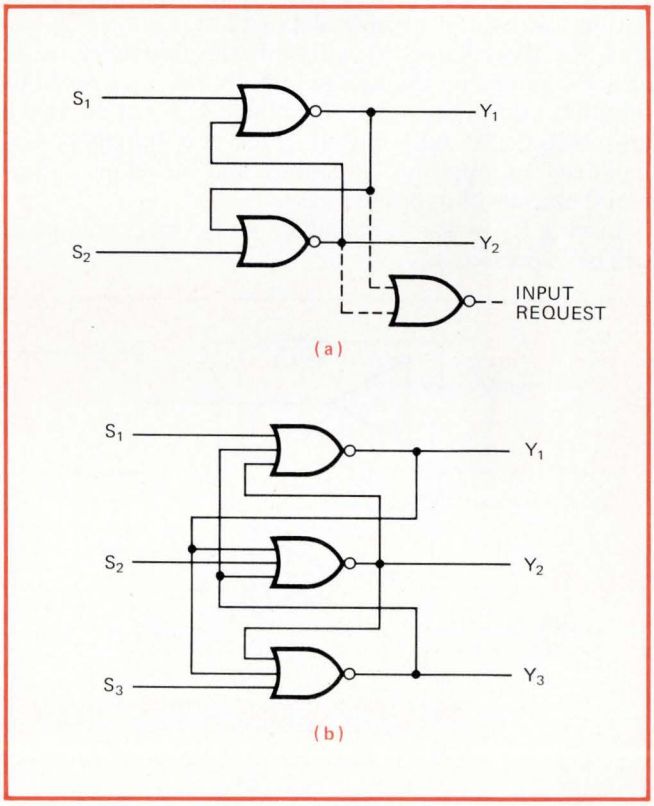

In normal operation, the set and reset inputs of the simple flip-flop circuit are not allowed to become active simultaneously, although both can remain at logic 0. But if this elementary rule is violated, a new gating function that can arbitrate real-time inputs is realized.

The circuit is particularly useful in signal-processing applications where interrupt requests may arrive asynchronously to be processed by a simple sequencer, rather than by a computing-type device. In such applications, the simplicity of the circuit also makes possible considerable cost savings.

When circuit (a) is used as a flip-flop, its $S_1$ and $S_2$ inputs are both low in the quiescent operating state. If the $S_1$ and $S_2$ inputs are both high instead, outputs $Y_1$ and $Y_2$ are low (in the quiescent mode). Now, when $S_1$ goes low, $Y_1$ goes high, and $Y_2$ does not change. But if $S_2$ then goes low, neither $Y_1$ nor $Y_2$ changes. And since the circuit is symmetrical, if $S_2$ goes low while $S_1$ is high, $Y_2$ will go high and lock out $S_1$. The signal paths of $S_1$-$Y_1$ and $S_2$-$Y_2$ may be regarded as inverters with real-time priority arbitration. The addition of a third gate to the circuit provides an INPUT REQUEST lead.

With a third gate, the circuit can also be extended to accept three inputs, as shown in (b). Further extension is done in a similar manner. As with circuit (a), the first input that goes to logic 0 inhibits all the other inputs, while producing an output itself. Two or more inputs going to logic 0 simultaneously will produce a race condition that, nevertheless, can have only a single victor. One input can be handicapped relative to another by using RC delay networks at the input or output of the handicapped gate.

The same operating description and circuit configurations apply if all the logic levels are inverted, and if NAND gates are substituted for the NOR gates. □




**Lock-out gate.** Both set and reset ($S_1$ and $S_2$) inputs to flip-flop (a) are kept high in quiescent state. When either $S_1$ or $S_2$ goes low, its output ($Y_1$ or $Y_2$, respectively) will go high, but the other output stays low even if its input goes low. Since only one signal can pass to the output at a time, this gate can arbitrate asynchronous interrupt signals. An additional gate (b) accommodates another input.

# Audio amplitude leveler minimizes signal distortion

by Edward E. Pearson
*Burr-Brown Research Corp., Tucson, Ariz.*

An ac current-controlled bridge in the feedback loop of an operational amplifier can provide very close control of signal amplitude, while contributing negligible distortion at or near a predetermined optimum input signal level. The resulting circuit is well suited for amplitude leveling in test oscillators, communications equipment, and telemetry systems. It can be built for around $4 and offers extremely close amplitude control over the entire audio spectrum.

Unlike conventional circuits that apply increasing amounts of feedback along the entire span of input voltage range, this amplitude leveler applies zero feedback (and, therefore, zero distortion) at an optimum input level and produces positive or negative feedback above and below this level. The differential output from a bridge is used to get the desired feedback.

The bridge, which is outlined in color, employs two devices, $T_1$ and $T_2$, whose resistance varies with current. Such components as incandescent lamps, thermistors, or even active devices can be used. Here, $T_1$ and $T_2$ are incandescent lamps. Resistors $R_1$ and $R_2$ are chosen to be within the resistance range of $T_1$ and $T_2$.

A specific voltage, V, will shift the resistance of $T_1$ and $T_2$, balancing the bridge and producing a zero differential output ($e_1 - e_2$). As voltage V is varied above and below the zero output level, the bridge is unbalanced in opposite directions and develops differential outputs of opposite phase.

Letting $R_1 = R_2 = R$ and $T_1 = T_2, = T$, voltage $e_1$ can be expressed as:

$$e_1 = TV/(T+R)$$

and voltage $e_2$ is:

$$e_2 = RV/(T+R)$$

so that the differential voltage becomes:

$$e_1 - e_2 = (T-R)V/(T+R)$$

When T is greater than R, $e_1 - e_2$ is more than zero; when $T = R$, $e_1 - e_2 = 0$; and when T is less than R, $e_1 - e_2$ is smaller than zero.

Depending on the input signal level present at amplifier $A_1$, the network formed by the bridge and amplifiers $A_2$ and $A_3$ produces positive, negative, or zero feedback. For the component values indicated, an input voltage of approximately 0.4 volt is just sufficient to drive the bridge to a balanced condition (zero feedback).

At this input level, the components in the feedback network cannot contribute to distortion in the output. If the input voltage varies from the optimum 0.4-V level, the inputs to amplifier $A_3$ will become unbalanced, and an amplified differential voltage (from the bridge) will produce gain compensation at amplifier. $A_1$. The table indicates the range and degree of amplitude control obtained.

The circuit's output voltage can be made higher by increasing the value of resistors $R_1$ and $R_2$; the higher resistance values increase the voltage needed to balance the bridge. Or, the output voltage can be made smaller by increasing the gain of amplifier $A_2$. To lower the optimum input voltage level, the gain of amplifier $A_1$ is made higher.

Because increasing amounts of positive feedback are present at the input to amplifier $A_1$, the circuit becomes unstable at very low or zero input levels. The table shows the minimum permissible input levels; the circuit must be modified to accommodate input signal dropouts. □

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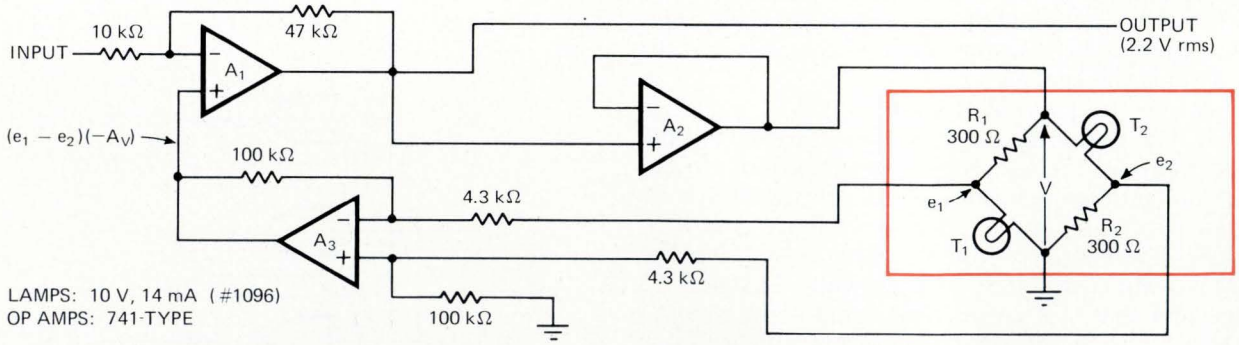
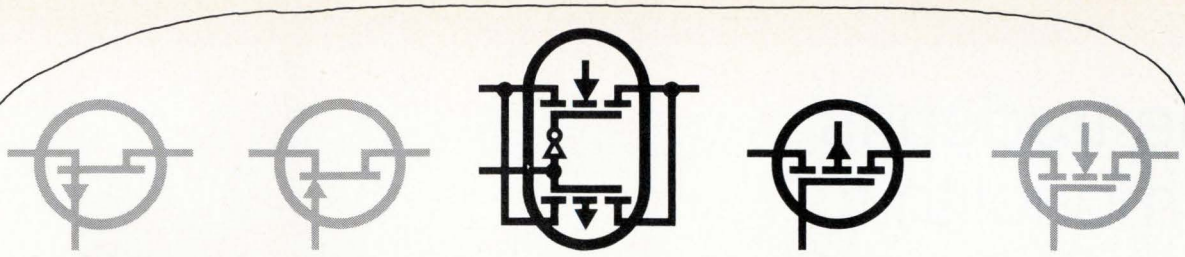



| INPUT | | | | | OUTPUT |
|---|---|---|---|---|---|
| Frequency (Hz) | Minimum (V) | Maximum (V) | Zero feedback (V) | Input swing (dB) | Voltage level |
| 20 | 0.06 | 2 | 0.38 | ≈30 | 2.2 V ± ¼ dB |
| 100 – 15,000 | 0.02 | 2 | 0.38 | 40 | 2.2 V ± ¼ dB |
| 20,000 | 0.23 | 2 | 0.42 | ≈20 | 2.2 V ± ½ dB |

**Leveling audio signals.** Rather than increasing feedback with increasing input voltage, audio amplitude leveler operates at zero feedback for an optimum input voltage. Current-controlled bridge in feedback loop of amplifier $A_1$ develops the differential voltage needed to keep the output level steady. The incandescent lamps act as current-variable resistors that balance the bridge when input voltage is 0.4 volt.



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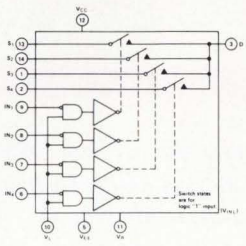

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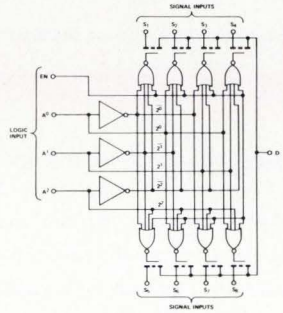

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# The tradeoffs in monolithic image sensors: MOS vs CCD

With two kinds of solid-state imaging devices now available, designers have a choice in systems that will replace image tubes, especially in low-light-level applications

by Roger Melen, *Stanford Electronics Laboratories, Stanford, Calif.*

*Designers of information-display and recording systems have long dreamed of the coming of solid-state imaging devices that are small and fast, operate at low power without high voltages, and work at wide dynamic ranges of ambient light. Those dreams are becoming a reality as the charge-coupled device comes to the marketplace to join the older MOS photodiode image sensor.*

*Both types of monolithic image sensors offer fundamental improvements over earlier imaging methods, especially for optical character recognition, facsimile systems, and video communications, where high-voltage devices often requiring high light levels are being used. But the capabilities of the two types of devices overlap, and designers are evaluating the strong points of each.*

*Preliminary experiences indicate that both the MOS diode array and the CCD imaging array are suitable for OCR and facsimile displays that require only small arrays, while the CCD display appears to be the only one of the two suitable for television applications, both at high and unusually low light levels.*

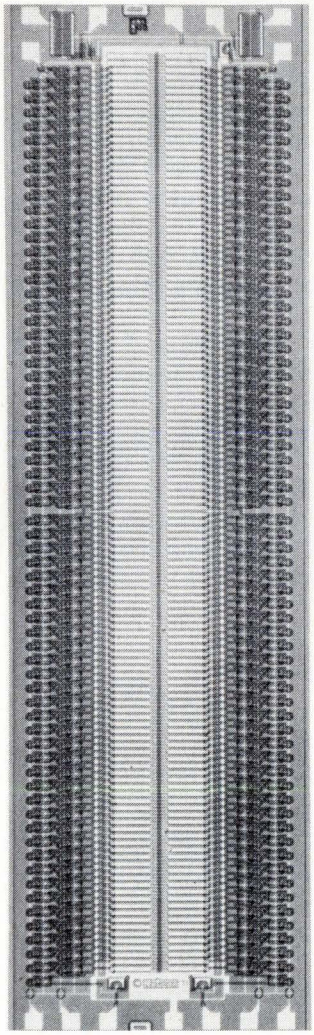
*MOS diode linear arrays ranging in size from 64 to 1,000 diode elements (photograph, right, from Reticon Corp.) have been available for some time from several manufacturers. These devices are capable of imaging rates higher than 5 megahertz, and they offer real-time facsimile-quality performance.*

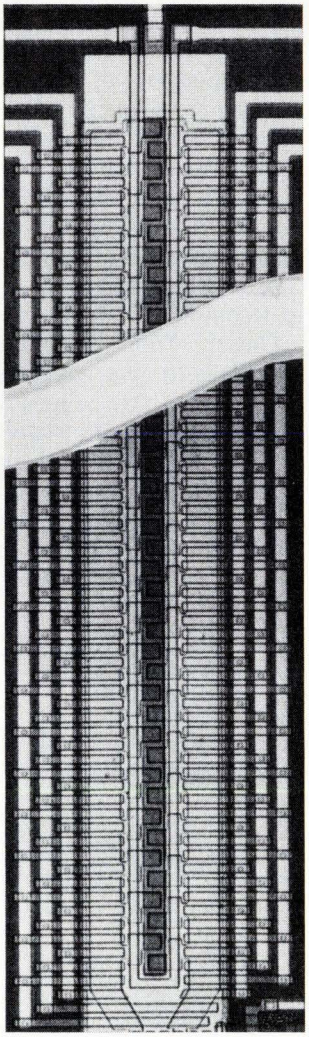
*The MOS diode array also is useful for small-area imaging applications where resolution need not be of television quality. In these applications, the MOS diode array is an excellent replacement for low-resolution image tubes because of its capability of operating at low light levels with self-contained power supply, drive circuitry, and displays. Complete camera systems with 50-by-50 diode arrays are already on the market and are being used for surveillance, OCR, and defect-detection systems.*

*The value of the CCD must be considered as lying mainly in its potential for supplying full video-quality imaging at both high and low light levels, a performance which is beyond the capability of present MOS diode technology and costs. Moving from concept to marketplace in less than three years, the CCD is already available in linear device with 500 elements (photograph, far right, from Fairchild), an incredible achievement when compared to the earliest, 64-element MOS image sensors.*

*CCD technology already offers products with a dynamic range of 1,000 to 1, making it possible to image objects having widely different intensities. The sensor can detect light levels as low as 15 microfootcandles. Full-scale CCD area imaging devices that are expected within the next year include video cameras with resolution of 250 lines, which is adequate for most data-communications systems. Line-imagers with 1,500 elements for page readers are on their way, and not far behind is the ultimate imaging goal—well within the immediate developmental capabilities of CCDs—full-video-quality cameras that have 550-line resolution and that operate at ordinary ambient-light levels.*

*The article that follows compares the two competitive types of monolithic image sensors from the standpoint of important performance criteria—dynamic range, sensitivity, noise, and image clarity. But it is emphasized that the comparison must be based on MOS arrays that have a product history of three to four years, while the CCDs are only now entering production.* —*Laurence Altman*





☐ Monolithic image sensors provide a major new dimension in the fabrication of information system displays—be they video cameras, facsimile equipment, or process control instrumentation for optical character-recognition systems. Both MOS photodiode arrays, now three or four years old, and charge-coupled devices, which are now entering the marketplace, offer the user a new standard in small size, high speed, high reliability, and ease of use.

But because of subtle differences in structure and readout, each has its unique performance characteristics. The design engineer should clearly understand the operation and performance limitations of each device before committing it to an expensive, complex system design.

Superficially, both types of arrays appear to be similar in operation. Both are fabricated with basically the same integrated-circuit technology. Images formed on the face of semiconductors are scanned off in conventional shift-register fashion. However, their performance differs because of different methods of projecting the image on the chip and reading out the signals.

The MOS image sensor (Fig. 1a) is essentially a high-performance diode scanning circuit built with standard photodiode and either metal- or silicon-gate technology [*Electronics,* Nov. 8, 1971]. The scanning circuit is made up of MOS transistors that are embedded in the same monolithic structure containing the array of photodiodes. After an object is imaged onto the surface of the photodiode array, the MOS scanning circuit shifts the signals off the chip by accessing the diodes sequentially through an analog switch to a common bus line.

A simple CCD (Fig. 1b) is essentially an analog-signal shift register (a delay line) fabricated from a closely spaced array of MOS capacitors [*Electronics,* March 29, p.25]. It also is usually built with some sort of silicon-gate buried-layer technology. The input signal takes the form of minority carriers generated in the semiconductor beneath the capacitor plates by the absorption of incident light.

The signal charge, consisting of minority carriers, is stored in packets in the semiconductor beneath the capacitor plates. Since the signals are stored in packets, they appear at the output as sampled signals, with each sample representing a packet of charge.

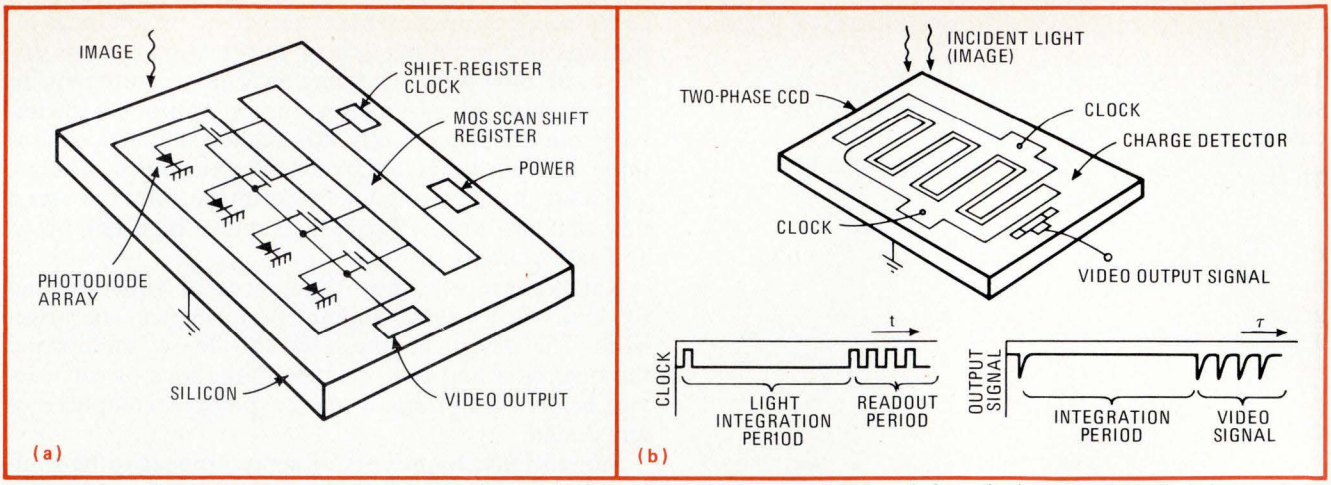
In operation, the signal charge may be transferred from capacitor to capacitor throughout the array by application of a sequence of biasing pulses. The charge-transfer efficiency is typically greater than 99.9% because of the close spacing of the capacitors in the arrays. Recent devices have efficiencies as high as 99.999%.

### Differences in devices

Despite the similarities in fabrication technologies, the performance of the MOS and CCD image sensors are different because they have different methods of imaging the light and different techniques of reading out sig-

## Closing the loop

Readers who are interested in discussing this article with the author may call Roger Melen during business hours on June 7 and 8 at (415) 321-2300 ext. 2642.




**1. Structures.** Two image-sensor types operate differently. MOS sensor (a) passes charge directly from the imaging photodiode into an MOS shift register, which then carries the charge to a detection circuit. CCD sensor (b) uses the imaging array itself as the transfer mechanism.

nal charges. In the CCD image sensor, the signal charge is collected by a field-induced junction beneath an MOS capacitor electrode, and readout is accomplished by multiple transfers of charge through the array of induced junctions to the output circuitry. But in the MOS image sensor, the charge is collected by a diffused junction in the photodiode, and readout is accomplished by a single charge transfer from the diffused junction to the video-out circuitry.

These rather subtle differences in structure and readout result in wide differences in performances at high and low light levels, in image clarity, and in device complexity. At low light levels, the minimum light that can be resolved by the image sensor depends on the efficiency with which the image sensor can collect the light incident on it, as well as noise introduced by the sensor and its associated circuitry.

The MOS sensor converts light to signals more efficiently than does the CCD, a property that results from the differences in the amount of light reflected from the imaging surface of each device and from the differences in the site at which the signal charge (generated by the incident light) is collected.

### Illumination: front vs. back

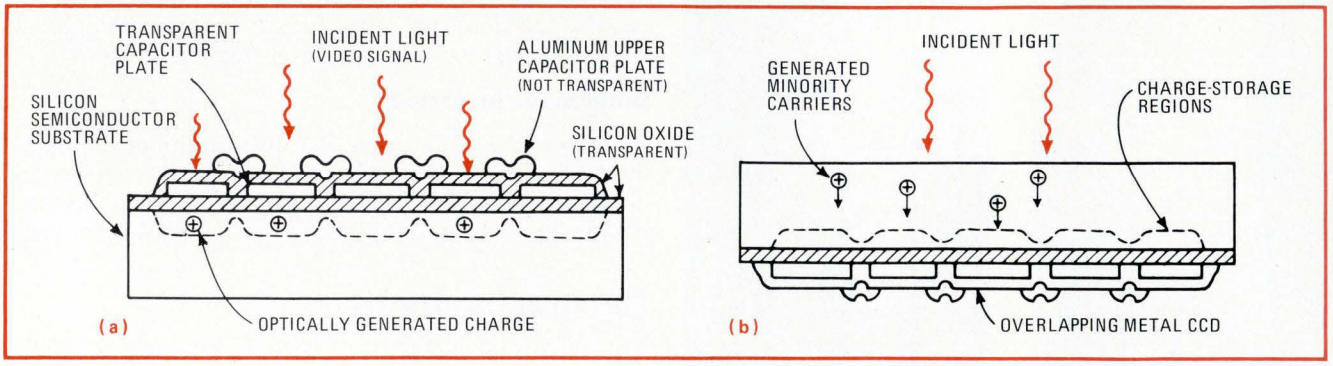
Two common techniques (Fig. 2) are used to illuminate the semiconductor substrate in monolithic image sensors—front and back illumination. Although either technique could be used with either CCD or MOS image sensors, only back illumination is used for CCDs because most CCD structures have electrodes on the front that are opaque.

Unfortunately, back lighting introduces fabrication problems and performance limitations. The substrate die must be made very thin so that the light-generated carriers, which are generated within 4 micrometers of the semiconductor surface for visible light, may be efficiently collected and stored in the depletion layer beneath the capacitor electrodes on the front side.

About the thinnest substrate that can be fabricated has a thickness of about 25 micrometers. This means that device elements cannot be spaced less than 25 $\mu$m apart—thicker substrates would cause charges to spread from one electrode to another—a restriction that limits the potential resolution of back-illuminated CCDs. This limitation on element spacing is especially damaging for image sensors containing large numbers of elements because it means that a great deal of silicon must be used to accommodate the density.

Clearly, front illumination is desirable for simple structures to give good resolution. MOS image sensors, fortunately, have silicon oxide covering the semiconductor substrate. Not only is this oxide transparent, but it also acts as an optical coating that matches the optical impedance of the silicon to the impedance of air.

Some CCD sensors also have been built with polycrystalline electrodes that can be illuminated from the front, but these polycrystalline structures, unfortunately, pro-




**2. Backlighting.** Monolithic image sensors can be imaged either on the back or the front of the substrate. Most CCDs, on the other hand, have front metalization that is opaque to light and therefore requires the imaging to be done from the back.

vide poor impedance matches with the oxide beneath, which causes reflection at the poly-oxide interface. These mismatches create interference patterns in the surface reflections, resulting in a decrease in the photocurrent output.

### That villain, noise

But whether the array is illuminated from the front or the back, noise introduced into the video signal by the image sensors and associated circuitry is probably the greatest factor that limits operation at low light levels. The noise, which masks small photosignals in both types of arrays, comes from mismatches in parasitic capacitances and thermally generated carriers. Moreover, CCDs suffer noise from transfer losses.

In MOS image sensors, capacitor noise results from mismatches between parasitic gate-source and gate-drain MOS capacitance of transistors in the scanning circuit and photodiodes and video output port, with which these capacitances are in series. These MOS transistors are analog switches that address the individual photoelements in the array.

When these transistors are turned on or off, there is a corresponding voltage spike on the analog photosignal line being switched. Although these spikes may be reduced by filtering, because they occur at twice the maximum video frequency, they can not be eliminated completely.

The variation in the magnitude of these spikes throughout the MOS photoarray gives rise to fixed-pattern noise (FPN) in the video passband—noise that cannot be filtered. Fortunately, the variation in the noise is small compared to the absolute magnitude of the spikes. Indeed, with no incident illumination, a low-level noise image resulting from FPN may be observed at the output of the image sensor.

Spike noise, indicated in Fig. 3 as observed at the sensor output, is referenced to an equivalent noise voltage across the capacitance of the photosensing element in a

## Night vision

Monolithic image sensors may be operated at incident light levels below those found in the average office, a capability that has resulted in their being used in monitoring and surveillance applications. For this kind of work, exposure range is the important parameter for evaluating the sensor's ability to perform at low light levels.

The exposure range is the ratio of the maximum to minimum intensity that can be resolved by the image sensor. The exposure range is often expressed in f stops (factors of two in light intensity).

Exposure range may be calculated by:

$ER = 0.301 \log_{10} I_{max}/I_{min}$

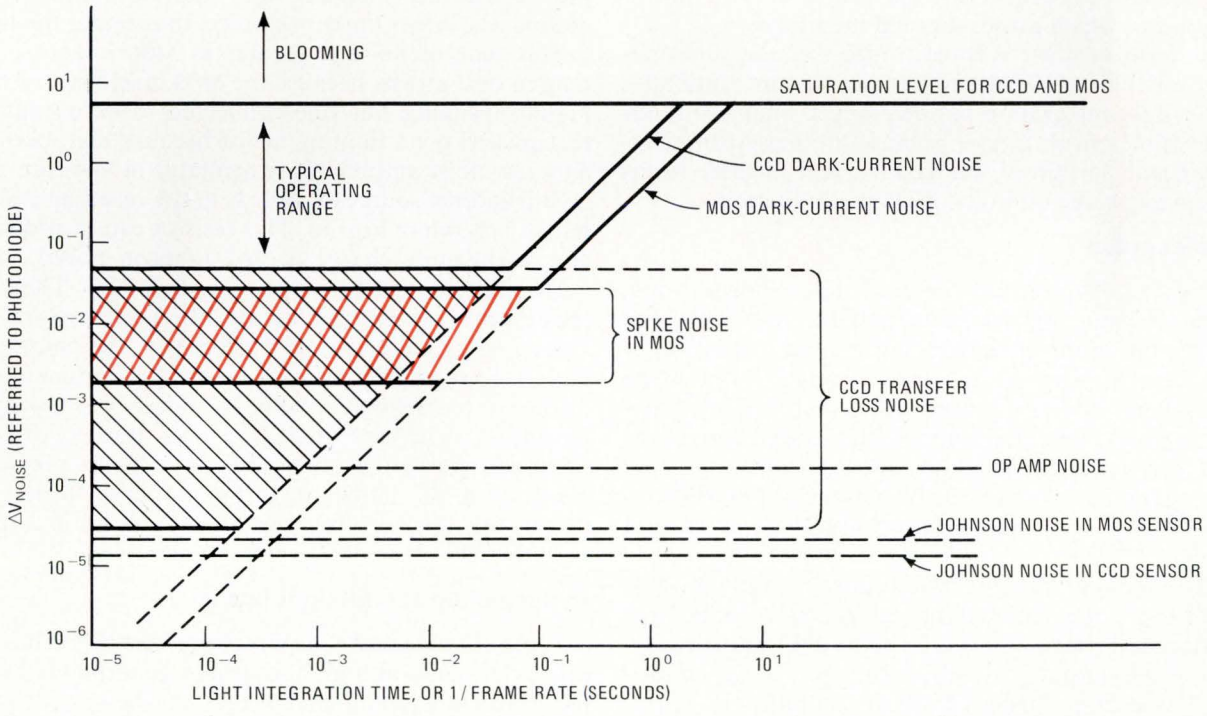
where:

ER = exposure range in f stops

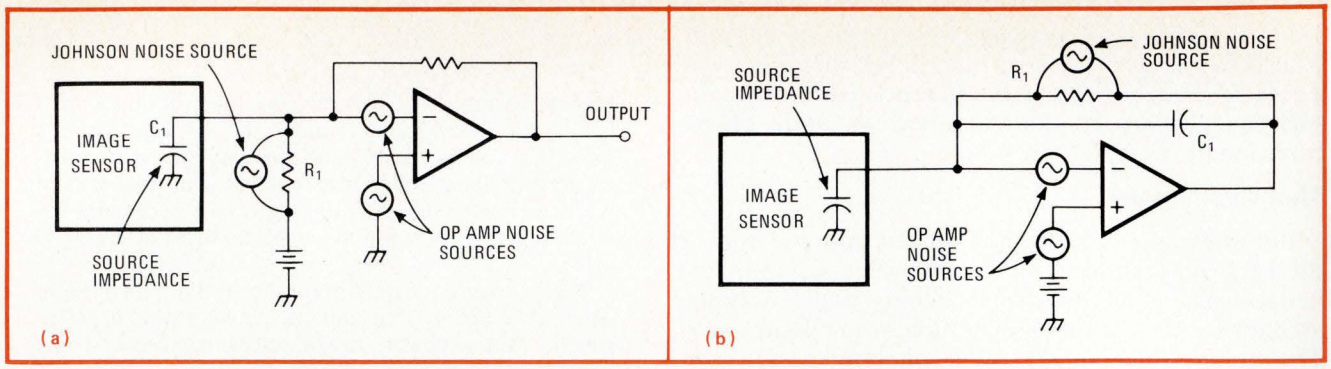
$I_{max}$ = maximum resolved light intensity

$I_{min}$ = minimum resolved light intensity

Maximum resolved light intensity can be limited by either the brightness range of the scene or the saturation level of the image sensor. At the low illumination levels being considered, the exposure range is often limited by the brightness range of the scene. Typical values of exposure range for MOS image sensors are six to 10 f stops, which translates into a dynamic range of 20 to 1. Experimental MOS image sensors and some recent CCD products have already been built with dynamic ranges as high as 1,000 to 1.




**3. The limit.** Noise is the limiting factor in the level of light that can be detected by a monolithic image sensor. In MOS imagers, spike noise in the range of $0.5 \times 10^{-2}$ volt is low enough to allow use in poorly lit rooms. In CCDs, charge transfer noise can be as low as $10^{-5}$ V.




**4. Noise.** Low-light-level detection is limited by noise in the detection amplifier and reset resistor (a). Noise from the latter ($R_1$) is more prevalent in MOS images and dictates the use of low-noise amplifiers, such as the charge amplifier shown in (b).

representative 512-element device. Values of noise range from $10^{-3}$ to $0.5 \times 10^{-2}$ volts, well within practical operating levels. The saturated output signal referred to the diode is typically 5 volts, resulting in dynamic ranges of 100 to 1 and more.

While CCDs are not affected by FPN from the spikes in switching transistors, they have fixed-pattern noise resulting from capacitance between clock lines and the output lines. Luckily, these noise pulses are all the same height and can be filtered out by low-pass filters, but the filters consume power and occupy space.

A better method of reducing this parasitically coupled noise is to fabricate video preamplifiers on the same image-sensor chips. The noise is thereby reduced because the magnitude of the parasitic coupling capacitance may be made smaller for amplifiers on the same chips than for off-the-chip amplifiers.

Fixed-pattern noise in both MOS sensors and CCDs can also come from thermal effects. CCD image sensors, however are more susceptible to thermal effects than are MOS sensors because the surface of CCDs is not in equilibrium, which causes thermal imbalance.

This form of noise is most troublesome at illumination levels below 10 microwatts per square centimeter and for light-integration periods longer than 100 milliseconds for typical devices because the noise comprises a significant portion of the dark current at these levels and represents the ultimate operating limitation.

### Transfer noise

But with CCDs, transfer-loss noise (also shown in Fig. 3) is more damaging than fixed-pattern noise. This type of noise, the result of charges left behind after transfer operations, appears in the sensed image as a white smear to one side of a sensed white spot. It is most noticeable when large quantities of charge are being transferred, corresponding to a high-intensity spot.

For example, a loss of $10^{-5}$ per transfer (99.999% efficient) will in a 512-element array (1,024 transfers for a two-phase device) result in a total loss of one part in 100. Three-phase clocking would increase the total loss of charge for the same charge efficiency. A white spot transferred through the entire array will appear as a smear at the output port with the biggest smear coming from dots starting farthest from the output port. Transfer-loss noise also reduces a CCD's exposure range, and it basically decreases the contrast the sensor can detect.

One method of reducing transfer noise is to bury the transfer channels about 1 micrometer beneath the surface of the substrate by ion implantation. Charges transferred in the buried channels are not subjected to transfer inefficiencies caused by charges trapped in surface states at the semiconductor-oxide interface. A 500-element buried-channel device just appearing on the market has a transfer efficiency of 99.999%.

### Fighting noise

However, some noise sources cannot be readily overcome, such as thermally generated noise, which will always be present. This limits sensor performance at low light levels. All amplifiers and all resistors are subject to thermal noise; in an imaging system, the circuitry connected to the output of the image sensor (Fig. 4a) generates this noise.

In this example, the thermal noise signal appearing at the amplifier output is a function of the source impedance and the noise parameters of the amplifier. In monolithic image sensors, since the source impedance is the capacitance between the output terminal and ground, the larger the capacitance, the greater the noise.

This type of noise is greater in MOS image sensors than in CCD arrays, because the MOS image sensor has a high-capacitance bus line connected to its output, but this noise is not a limiting factor because high-performance low-noise amplifiers are available at low cost.

Still another source of noise is in the resetting resistor, $R_1$, also shown in Fig. 4a. This resistor can introduce an equivalent noise charge (called Johnson noise) on the video signal of magnitude $q_{noise} = KTC_1$. Thus, the greater the capacitance across the reset resistor, the greater is the noise charge. Fortunately, the charge amplifier shown in Fig. 4b may be used to reduce the influence of this fundamental noise source by allowing capacitor $C_1$ to be very small. The magnitude of Johnson noise relative to the other sources of noise previously discussed is also shown in this generalized noise structure of Fig. 3, where Johnson noise is found in a representative 512-element MOS line-image sensor.

### Performance at high light levels

Saturation exposure, a parameter that describes sensor performance at high light levels, generally is a function of the maximum charge that can be stored during the light-integration period of the sensing elements in the photoarray. The light-integration period is the time used by the photoelements to collect charges represent-


**5. Image systems.** Both MOS and CCD imaging arrays can be used in area imaging systems. CCD cameras potentially are capable of TV-quality resolution. MOS arrays, like this one from Reticon, are useful for lower-resolution systems.

ing the illuminated image. Typically, the light-integration period corresponds to the frame period.

For MOS image sensors, the maximum signal charge that can be stored depends on the bias applied to the photodiodes. For CCDs, it depends on the potential of the storage surface. Because the photoelements of CCDs and MOS image sensors have similar geometries and similar storage potentials, the saturation-light levels of both devices are similar.

The high-light-level capability of both sensors can be maximized by increasing the storage capacitance of the photoelements while masking the other regions from incident light. This type of structure, called a monolithic aperture, allows the light-handling capability of line-scanning arrays to be significantly increased, while keeping noise in the unexposed areas small. Area-sensing monolithic arrays do not benefit as much from this technique because of the loss of spatial resolution resulting from the large area required to achieve increased capacitance

MOS image sensors benefit most from this technique because a pn junction is the photoelement, and it can be read out quickly. In a CCD, on the other hand, an adjacent-capacitor photoarray technique would increase the size of the photoelements, and, in turn, the time required to transfer the signal charge from the adjacent photo capacitor to the analog CCD shift register.

CCDs, which have a low charge-transfer efficiency, are subject to blurring where the charges that are left behind during transfer between electrodes may appear later at the device's output terminal. Unfortunately, the transfer losses that cause blurring in CCDs increase not only with the number of transfers but also with lower light levels. However, the MOS imager does not blur because there is only one transfer. The signal flows only through a single analog switch before reaching the output.

## Large-area imaging

There is nearly universal agreement that CCD image sensors, larger because of their smaller cell size, are more likely than MOS sensors to achieve television quality of 525 lines in a two-dimensional scanned-area image sensor. The highest-density MOS area image sensor available has a cell size of 2 mils by 2 mils, whereas CCD area image sensors have already been built in the laboratory with cell sizes on the order of 1 mil by 1 mil—4 times denser. Indeed, a CCD area image sensor with half the resolution of that required for data-transmission systems, such as Picturephone, has already been built on today's LSI-size silicon dice. Industry observers are hopeful that a sensor with full TV-resolution can be built in the next couple of years by using larger 500-by-500-mil dice.

However this device won't have the simple structure that was first conceived for the CCD scanner. It will probably incorporate diffusions for low-noise charge-detection, blooming control, and high charge-transfer efficiency. The fabrication process will most likely include ion implantation, two layers of metal, special annealing steps, and multiple diffusions to obtain the necessary high performance. The elegance and simplicity of the original device may have to be sacrificed to attain the high level of technology required to mass-produce a competitive CCD device having television-quality resolution.

On the other hand, TV-quality systems can be constructed with existing 512-bit MOS line-image sensors by adding a rotating mirror to optically scan the images. However, the mechanical scanning mirror necessitates adding volume in the camera. But less silicon real estate, which is expensive, is required for the mirror-scanned line-image sensor than for a corresponding area image sensor, which results in a correspondingly lower component cost. But the 512-element MOS line scanner requires higher light levels because less time is available for integration of each scanned element than in area sensing devices.

These tradeoffs make it clear that the system designer must evaluate carefully the relative merits and disadvantages of both technologies. CCD image sensors, which are free of spike noise, are more likely to be built in high-density arrays, whereas MOS image sensors tend to be less susceptible to image degradation.

In any case, since both types of sensors are fabricated with silicon semiconductor technologies and offer similar performance, the interchange of the two types of device should be straightforward. □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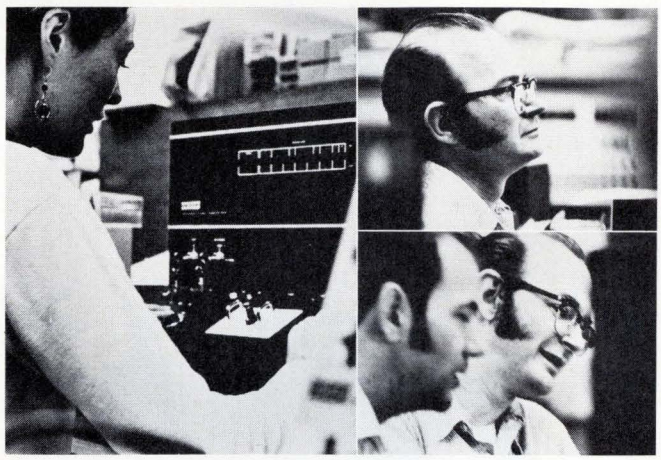

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# Minicomputer points the way to sewer-system improvements

By tracking rainfall variations and sewage flow rates, a data acquisition system in San Francisco shows why and where sewage overflows, and how deficiencies in the sewer system can be corrected economically

by W. R. Giessner, F. H. Moss, and R. T. Cockburn,
*Division of Sanitary Engineering, San Francisco, Calif.*

☐ According to limited data on rainfall available—from a single rain gage downtown—San Francisco's sewer system should have been functioning satisfactorily. Yet sewage overflowed into the bay and ocean in just about every heavy rainstorm. Evidently, a broader data base was a very necessary first step in up-grading the system.

Over a year ago, therefore, a minicomputer began collecting data from a city-wide network of rain gages and sewage-level monitors in order to define the precise link between the rain and the overflows. Ultimately, the project is expected to lead to a real-time control capability for deciding, on a minute-by-minute basis, whether to store or treat sewage from all 30 subdistricts in the city, in response to storm movements.

For the electronics engineer, the challenge in developing either the data acquisition system or the eventual control system lies largely in interfacing the central minicomputer to the gages and monitors that collect data and to the valves, blowers, and pumps that will control the mixtures of rain runoff and sewage flow. There is also the need to design a data acquisition system capable of being expanded into a fully integrated on-line control system.

## Storms and sewers

San Francisco resembles many long-established United States communities in having a combined sewer system—that is, one that carries domestic and industrial

waste water as well as the runoff from rainfall in one set of pipes. In dry weather, waste water flows from its sources, as shown in Fig. 1, into collector sewers, and thence through interceptor sewers to three sewage treatment plants, which normally handle about 39 billion gallons of such dry-weather waste water per year. Because this dry-weather flow fluctuates, the plants have been designed to handle up to three times the average daily flow without being overloaded.

But during a rainstorm, the flow of sewage may for a short period increase to as much as 100 times its average daily flow—causing a massive overflow of untreated sewage into San Francisco Bay and the Pacific Ocean. Over a period of years such overflows occurred on an average of 82 times per year during 46 rainstorms, mostly during the winter months.

Part of the problem seemed likely to lie in an assumption made by designers of conventional storm sewer systems like San Francisco's. Most designs are based on a determination of how heavily rain falls, how long it falls, and how often particular combinations of these rainfall intensities and durations occur. By statistical methods these combinations are converted into pipe sizes and other specifications of a sewer system—but the conversion usually assumes that rain falls uniformly over the entire area drained by the sewers. Moreover, the rainfall data on which the conversion was based in San Francisco's case is obtained from a single gage atop the Federal Office Building, from which measurements had been taken for 62 years.

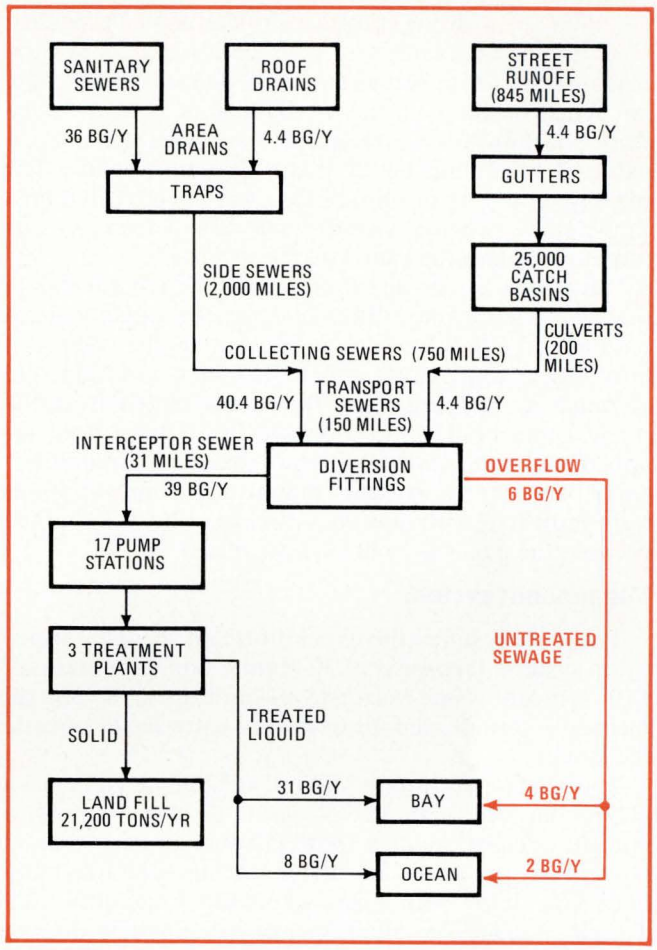
## The preliminaries

When the city's sanitary planning and studies engineers undertook the difficult task of correcting the overflows, they first had to determine what kinds of waste flow were involved and when and in what quantities they occurred.

At this point a computer enters the picture—not the minicomputer in the data acquisition system, but a larger system used by several municipal agencies. On this computer the planning and studies staff developed a historical analysis of actual rainfall over that 62-year period, from 1906 to 1968, using the only data available—that from the solitary rain gage. But instead of looking for combinations of intensity and duration, as in the conventional method, they worked with the actual rain occurrences and the time between rains. The result of this analysis appears in Fig. 2: the scale of inches against hours—rainfall intensity—turned out less important than the relation of the volume of storage to treatment capacity in a given period of time.

As the diagram of the analysis shows, when the cumulative rainfall volume exceeds the treatment capacity, the system overflows. To control this overflow, three avenues are open.

The first is to increase the treatment rate to match the rainfall rate plus the daily rate of sanitary sewage flow, with hourly variations. This is impractical because it would require a large treatment plant with an undefined capacity that could respond almost instantaneously to large fluctuations in rate.




**1. San Francisco sewer system.** Ordinary waste and the runoff from rainfall both pass through the same pipes, to be treated and turned into landfill or to be discharged into San Francisco Bay or the Pacific Ocean. Normally 39 billion gallons per year (BG/Y) are processed. Runoff from rain can rise to 100 times the average daily sewage flow and cause massive overflows (color).

A second, more feasible, approach is to provide storage for the excess flow. Then the excess can be treated as capacity becomes available.

The third, and most sophisticated, approach is to allocate the total treatment capacity to different segments of the city at different times, taking into account the way rainfall varies with time at any given point and from point to point at any given time during a storm. For example, if a third of the city had relatively intense rain and the rest had little or none at that time, then devoting the total treatment capacity to that area of the city that needs it effectively triples the available treatment capacity.

However, the temporal and spatial variations in rainfall upon which the third approach depends assume that the rainfall extrapolated from a single gage is not representative of rainfall in San Francisco. Further measurement was necessary to establish whether such variations occurred, and if so, where and when.

For the initial evaluation, 17 rain gages were installed by staff members on the roofs of their houses at various places in the city. Each of these 17 gages recorded rain-

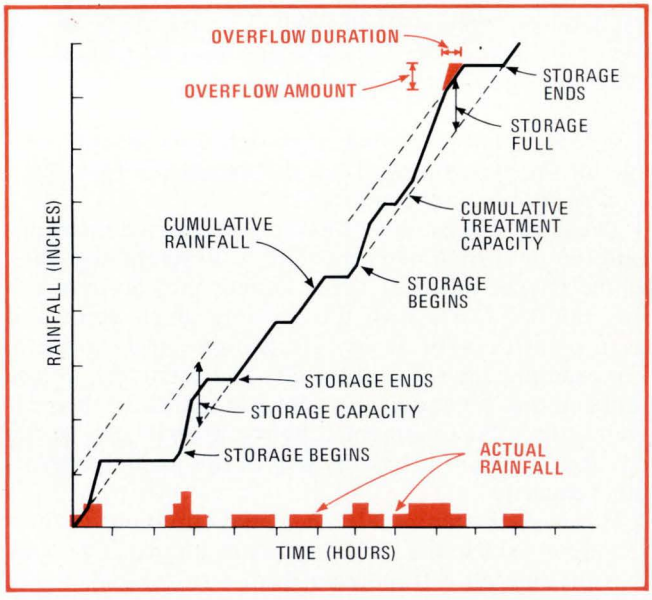
fall data on a drum recorder for the 1969–70 season. They provided a relatively poor data base, for several reasons: the drum recorders on the various gages were not synchronized, and the mechanical or battery-driven clock mechanisms were neither very accurate nor capable of resolution better than five minutes. In a few cases several days of rainfall data were overwritten on a single sheet because a staffer was out of town, or just forgot to replace the charts on the recorders.

Nevertheless, the distributed network recorded data that was significantly different from the single gage at the Federal Office Building. For example, the volume of rainfall was consistently at least 15% less, and ranged to as much as 25% less, than that extrapolated from the single gage—pointing to a drastically reduced need for added treatment and/or storage capacity. Spatial differences were quite evident. Significant time variations were indicated, although they could not be well defined because the gages were not synchronized.

### The present system

This data justified the expenditure on the data acquisition system. It consists of 30 remote rain-gage stations, 120 remote waste-water-level monitors, a central recording station, and all necessary software to operate the system.

The central recording station includes a Honeywell H316 computer with 16,384 words of core memory, a real-time clock, and a power-failure detection and power-restarting unit. Its peripherals include two magnetic tape drives with a controller, and a teletypewriter. The data collection requirements of the system are not severe—almost any minicomputer that was available at the time the specifications were drawn up could have done the job. Even heavy rainstorms keep the computer busy only about 10% of the time.




**2. Rainfall analysis.** Colored steps show rainfall recorded at intervals during a typical storm. The heavy dark line plots the accumulated rainfall when this line rises above the lower dotted line, which represents the volume of sewage treated at a constant rate, some of the sewage is stored. When storage capacity (upper dotted line) is exceeded, sewage overflows.

Software supplied with the system includes the manufacturer's basic package plus application programs: a data communications interface, processors for accepting data from the remote stations, a timer routine, loggers for printed output, formatters and recorders for storing processed data on magnetic tape, and a routine for calculating the five-minute interval of maximum rainfall intensity for each hour of the day. An executive program sequences these other programs in response to timing and interrupt signals.

Leased telephone lines connect the remote stations to the central recording facility. Whenever any of the 150 circuits changes state (from off to on, or from on to off), a corresponding relay in a telephone equipment rack is activated, interrupting the computer; the computer then services the line, identifying it and adding the data that the state change signifies to the accumulated base.

Each rain gage consists of a beam with two indented buckets balanced on a central pivot in such a way that each bucket alternately receives and discharges rainfall collected by a funnel at the top of the gage. When the equivalent of 0.01 inch of rain has accumulated in the bucket, it overturns and empties out the water; this brings the other bucket into position to catch more rain. As a bucket tips, a normally closed mercury switch opens momentarily to signal the tipping; the normally closed position permits the line to be checked for continuity. These gages are identical to the 17 used in the initial evaluation except for the absence of drum recorders.

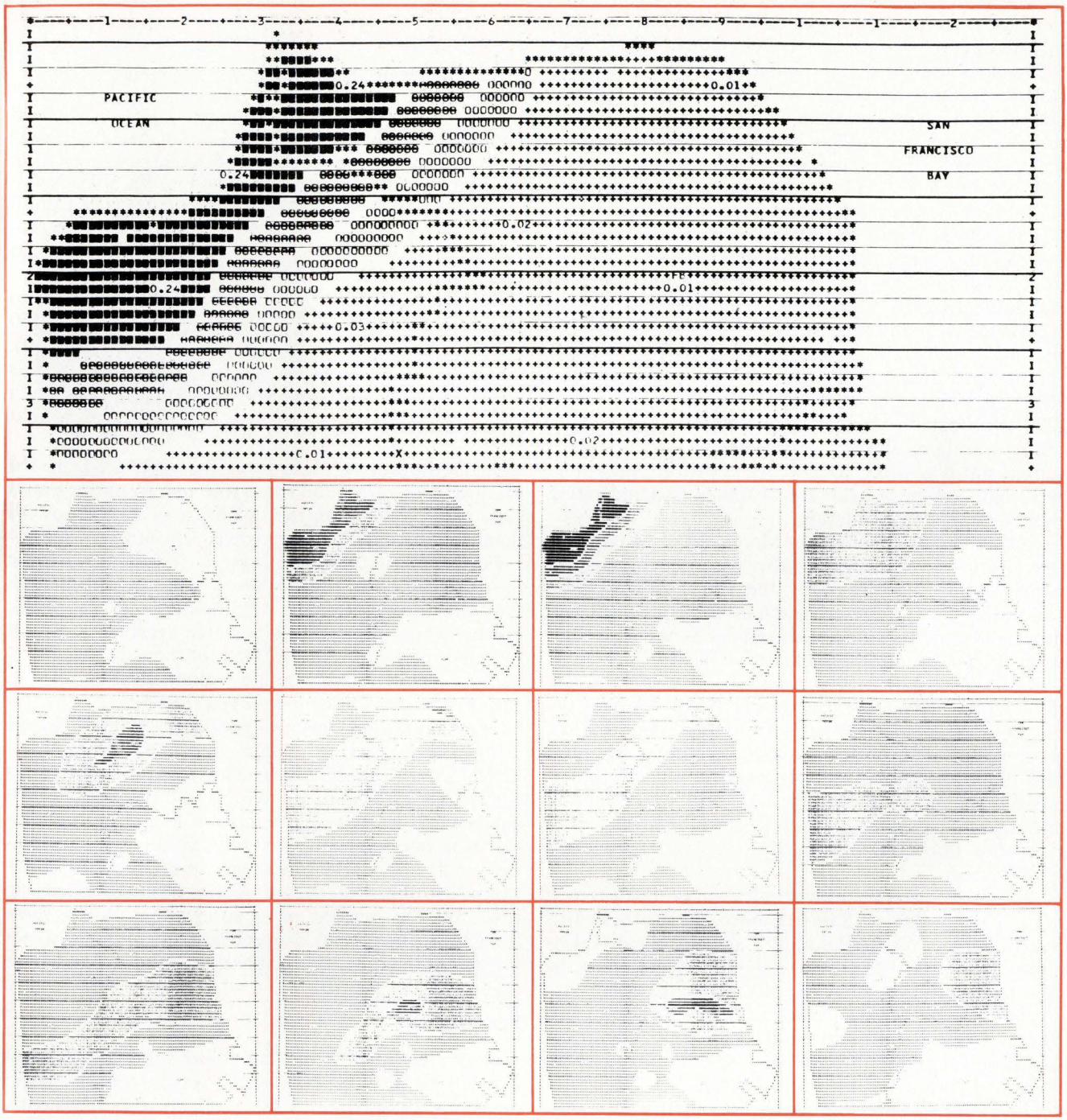
Each remote waste-water-level monitor contains an electrically driven air compressor and regulatory equipment that produces a constant flow of air out of the reservoir at 1½ standard cubic feet per hour and 28 pounds per square inch. The air bubbles up through the water in the sewer pipe, and as it bubbles, it overcomes the back pressure created by the depth of the water. This back pressure is measured by a bellows that sets the position of a cam lever. As the cam rotates, once every 15 seconds, it lifts the lever; this action closes a mercury switch for a length of time that is proportional to the back pressure and thus to the depth of water in the sewer pipe. The switch closure completes the circuit in the telephone line and is detected at the central recording facility.

### Raw measurement cycle

The 15-second cycle of the remote monitors establishes the raw data-recording cycle. From the 120 monitors thus come 480 measurements each minute; these are recorded on magnetic tape in one-minute blocks, followed by accumulated rainfall data. The tape also records summaries every five minutes, and maximum sewer levels, accumulated rainfall, and peak rainfall intensities every hour.

As a whole, the system is modular and flexible, and makes provision for its eventual expansion into a real-time control system.

Installation of the system began in 1970. The remote




**3. Storm front.** Computer-generated maps of San Francisco showing rainstorm moving across the city definitely invalidate the previous assumption that rain fell uniformly on all sections. Degree of shading shows the amount of rain. The 12 small maps represent three-minute accumulations between 11:49 a.m. and 12:25 p.m. on March 12, 1971, while the large map shows part of the printout for the period ending at 11:58 a.m., with accumulations registered at individual rain gages. Asterisks represent the shoreline and boundaries between districts within the city. Each dot represents about 3¾ acres.

stations turned out to be more difficult to set up than had been anticipated, because telephone lines and other facilities that were presumed to exist often did not, and because locations that required new telephone lines to be installed had to await the utility company's engineering and construction schedule.

Other problems and weaknesses appeared during the 1971–72 rainfall season—the system's first full season in operation. For example, noise in the telephone lines and contact "bounce"—or more precisely "slosh"—in the mercury switches were sometimes recorded as tips of the rain gages. Though the "bounce" was more a matter of alignment than a basic fault in the equipment, it did cause the extra data to be recorded, and this extra data overflowed the buffers in the computer's memory and was written in the memory area reserved for the real-

time clock. As a result, the clock indication was thrown off, and one week's data was without value.

The clock itself was quite inaccurate at first. Its specifications indicated accuracy within 2%—which meant it drifted by almost 30 minutes within 24 hours. It had to be modified to synchronize with the ac line frequency, which is much more accurate.

Other problems arose because the computer is considerably more precise than the instrumentation, which is subject to drift and requires the software to be modified to reject spurious data. Algorithms had to be devised to distinguish between significant and insignificant indications of malfunction. The staff had had no experience with any system such as this—nor had anyone else, since the rainfall monitoring system is unique—and therefore had no basis for deciding when they had sufficiently valid data. Attempting to insure 100% valid data was obviously not feasible.

But in spite of all these problems, the system's operational status is being continually improved, providing data that previously was not available and indicating many new aspects of rainfall.

The system was baptized in March, 1971, when fairly heavy rain fell. By this time, also, a computer program called Symap, developed by the Harvard University Laboratory for Computer Graphics and Illustrated Design, had been purchased and modified to produce computer-drawn contour maps of rainfall patterns.

Figure 3 shows several printouts from the March, 1971, storm. They reveal a frontal storm entering the city from the northwest, with a front about a mile wide, progressing southeasterly at about eight miles per hour. This depiction of a storm's shape, size and the rate of travel is the most outstanding and useful benefit of the computerized data acquisition system, because it provides the information needed to upgrade the city's sewer system.

This was the first definitive indication of the degree of rainfall variability in San Francisco. It also indicated clearly the storm's frontal nature and the brevity of its highest intensity—which was evidently dissipated by the high hills in the center of the city. Since these hills are just under 1,000 feet high, they were not expected to affect the storms significantly. But they were evidently responsible for preventing all but a very light rain from reaching the southeastern part of the city.

The rapid response of sewer flow to the course of storm was equally noteworthy. One of the level monitors showed a depth in three successive 15-second intervals of 44, 86, and over 120 inches. That 120 inches represents a substantial surcharge, because the sewer pipe in question is only 72 inches in diameter. No such rapid fluctuation had even been taken into consideration when the sewers were being designed.

More data became available during the 1971–72 rainfall season, providing much information about storms and sewer flow. For example, the degree of variability of rainfall over San Francisco is vividly illustrated by a study of 27 rainstorms recorded during that season. Of these 27, which occurred between November 1971 and April 1972, one entered the city from the north, nine from the northwest, eight from the west, six from the southwest, two from the south and one from the southeast. None came from the northeast or east. Thus the dominant direction of storm travel is from west to east.

Further analysis of 24 of these 27 storms showed that the western part of the city received more rain than either the northeastern or southeastern section in 12 storms, while the northeastern area received the least rain in a different set of 12. Nine of these 12 coincided, and the excess rainfall in the western over the northeastern sector in those nine ranged from 6% to 112%.

These same 24 storms also provide a data base for the primary analysis effort to date—to define the runoff following a rain. In a relatively small drainage subdistrict, with a modified Symap program, the incident rainfall has been quantified and compared to the runoff measured by one level monitor. Initially the emphasis has been to determine the consistency in the runoff between storms traveling in the same direction—primarily to check on the method of quantification. When these techniques have been proven, and the significant parameters identified, the analysis will be expanded to cover other subdistricts.

### The forecast

Eventually a predictive capability for real-time control will be developed. Once the response of the sewer system to rainfall inputs can be reliably and consistently predicted, then the control logic can be developed. This control logic will be tested on physical scale models of actual storage basins in the laboratory, using real data input obtained from recorded storms. Control mechanisms and new computer hardware and software will also be tested with these models, and later with full-size prototypes. Speed will probably be a much more important factor in the real-time control computer than in the present data acquisition computer.

While most of the elements incorporated in the San Francisco plan are not new, nowhere else have they been integrated into a single system. And in helping to make the plan a reality, minicomputers will play a crucial role. □

## No dearth of data

The season just ending has been San Francisco's wettest since 1890, with a total of over 34 inches since July 1, 1972 (the normal is about 20). As a result, staffers in planning and studies have lots of data available for comparing the runoffs in different areas on a storm-by-storm basis, as described in this article. In fact, they have too much—it's coming in faster than they can analyze it, and every new storm puts them even farther behind.

The storms this year have confirmed the earlier finding that some parts of the city get substantially more rain than others. No startling discoveries—like the one about the surcharged sewers, which was found by accident—have been made. But staffers are writing a program to search the data base for anomalies that may show other unsuspected effects of heavy rain.

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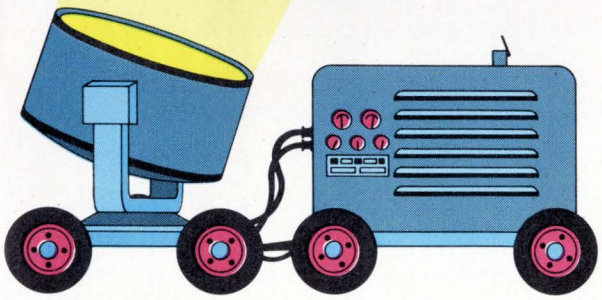

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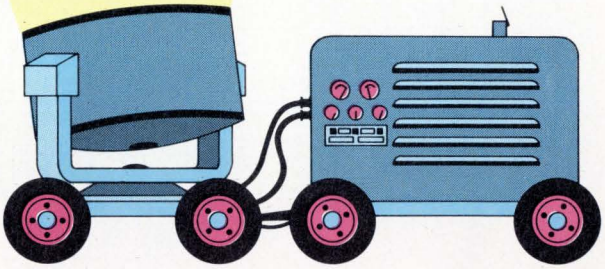

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# Ac power considerations in capacitor selection

by John Kropp
*Mepco/Electra, Inc., a North American Philips Co., Morristown, N.J.*

There are as many different ways of calculating power dissipation in a capacitor as there are ways to use a capacitor. The dissipation due to an impressed ac voltage is often overlooked or considered negligible, resulting in capacitor degradation, excessive heating, and early failure. The ac voltage capability of a capacitor is quite different from its dc rating and is a function of its construction. Fortunately, dissipation due to dc leakage adds to dissipation due to ac components, permitting them to be calculated separately and superimposed.

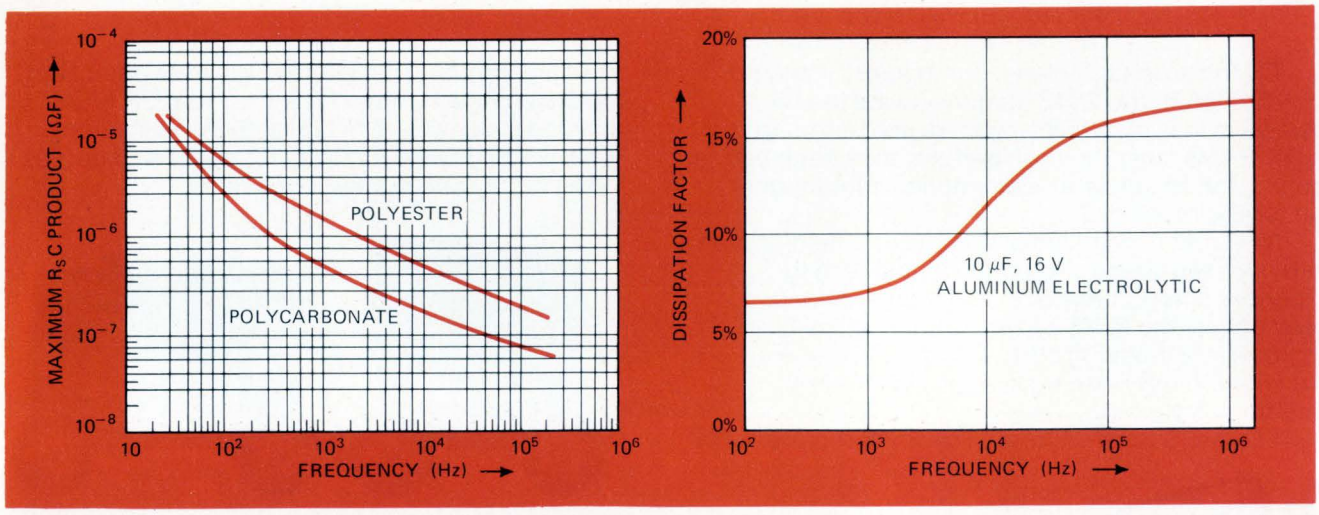
Film capacitors are rated in terms of a frequency-dependent equivalent series RC product, which is labeled the $R_SC$ product. And since nonsinusoidal waveforms can be broken down into their harmonic components, the dissipation of each significant component can then be calculated separately and added arithmetically to obtain a conservative estimate of power dissipation.

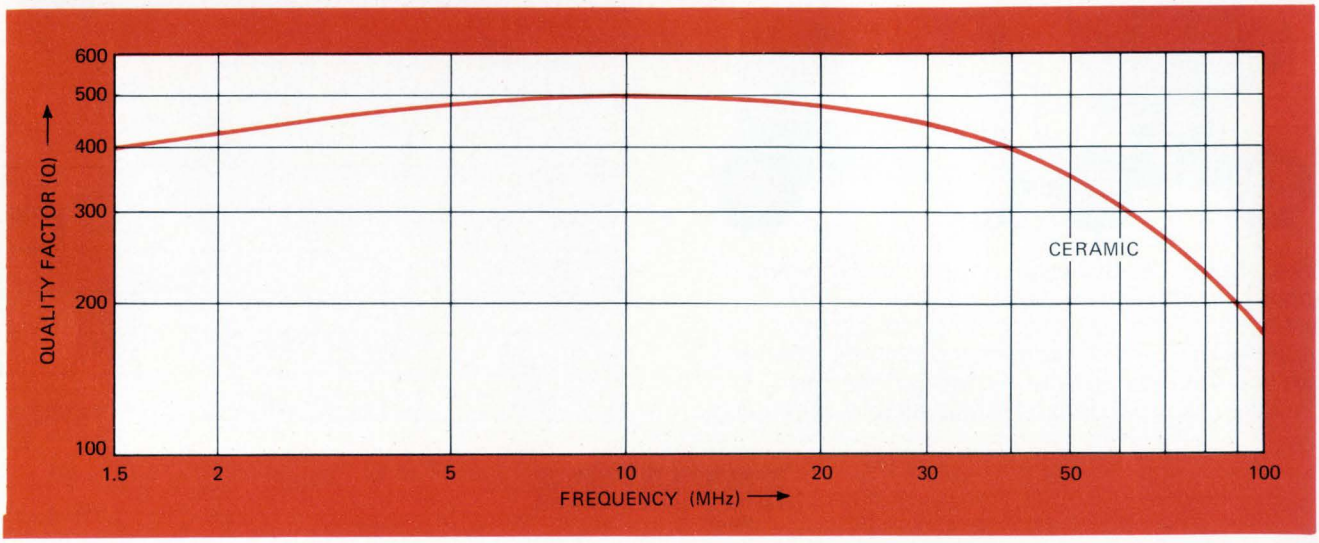
Ceramic capacitors are rated in terms of Q (quality factor) or its inverse, the dissipation factor, from which the $R_SC$ product can be computed. The equivalent series resistance of electrolytic capacitors can be found similarly, but this is rarely necessary since ripple current ratings for electrolytics are generally specified.

The limitation on power dissipation is, of course, the maximum temperature the capacitor can tolerate. This is, in turn, a function of the internal structure and case size, which determines the surface area available for dissipating the power. The approximate relationship (assuming free-air convection around the entire surface) between surface area and temperature rise above ambient is:

$T_{rise} = 133(P/A)^{\circ}C$

where P is the dissipation expressed in watts, and A is



the surface area of the case expressed in square inches.

The typical frequency curves show how the maximum $R_SC$ product varies with frequency for polycarbonate and polyester film capacitors, how Q varies with frequency for ceramic capacitors, and how dissipation factor varies with frequency for electrolytic capacitors. For film capacitors, the temperature curves illustrate how the maximum permissible power dissipation is related to ambient temperature for various capacitor sizes. The table associated with each temperature graph gives approximate capacitor dimensions. The Group A plots are representative of Mepco/Electra series C280A/C280M units, Group B plots represent series C280M units, and Group C plots represent series C281 units.

A sample power computation will show how to use the graphs. Suppose a polycarbonate capacitor of 0.33 microfarad must handle an impressed voltage ($V_{ac}$) of 180 volts at a frequency ($\omega$) of 1 kilohertz in an ambient temperature of 50°C. Since the power dissipated is:

$$P = I^2R_S$$

and:

$$I = V_{ac}\omega C$$

then:

$$P = R_S V_{ac}^2 \omega^2 C^2$$

or:

$$P = (R_SC)V_{ac}^2\omega^2C$$

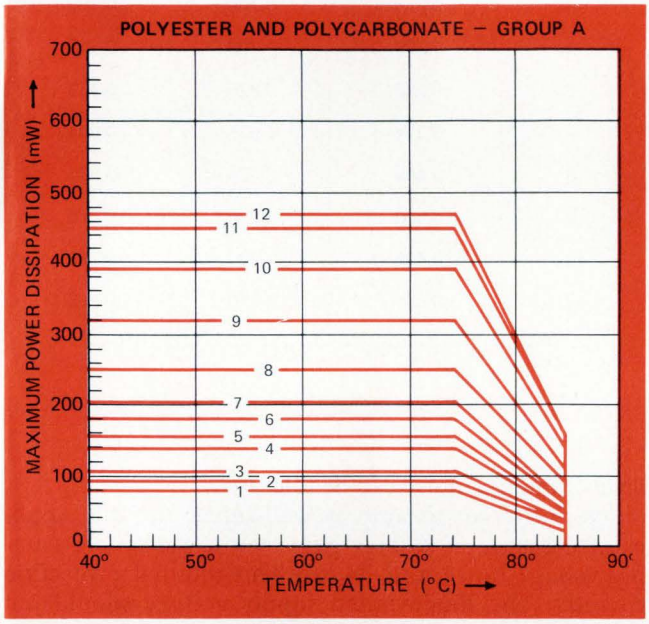
The film capacitor frequency curves indicate that the $R_SC$ product is $5 \times 10^{-7}$ ΩF. Substituting for this product and for the capacitor's operating conditions in the last equation yields:

$$P = (5 \times 10^{-7})(0.33 \times 10^{-6})(2\pi \times 1{,}000)(180)^2$$

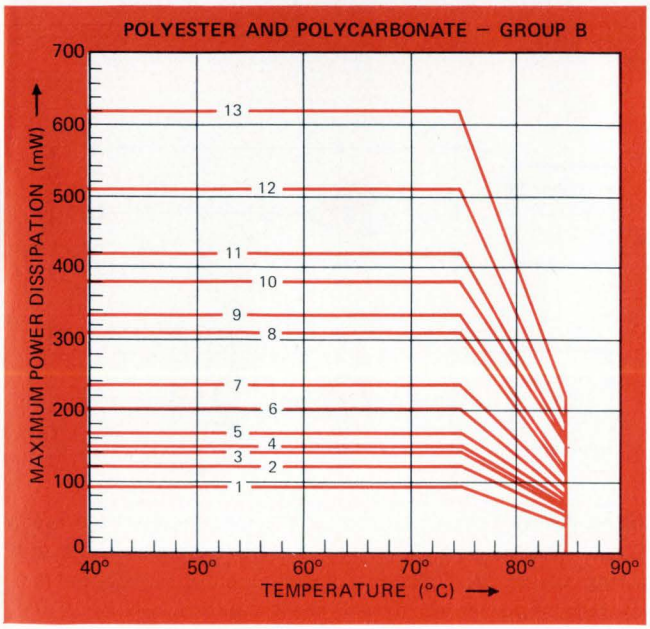
$$P = 0.214 \text{ W}$$

If the Group A capacitors are chosen, those with curve numbers of 8 to 12 can be used at 50°C, and the minimum size capacitor is 0.374 by 0.8666 by 0.571 inch.

When curves for maximum power dissipation versus ambient temperature are not given for a capacitor, the



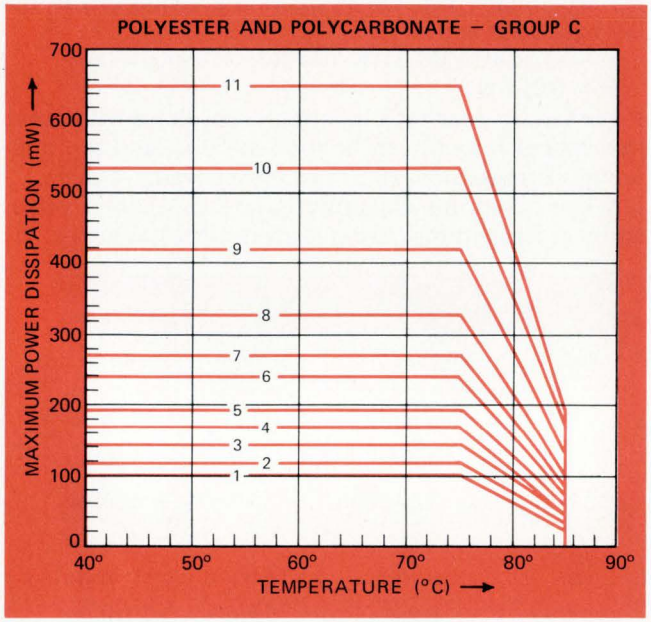

| GROUP A – DIMENSIONS | | | |
|---|---|---|---|
| Curve | Thickness (in.) | Width (in.) | Height (in.) |
| 1 | 0.157 | 0.492 | 0.354 |
| 2 | 0.197 | 0.492 | 0.394 |
| 3 | 0.236 | 0.492 | 0.433 |
| 4 | 0.236 | 0.689 | 0.433 |
| 5 | 0.276 | 0.689 | 0.472 |
| 6 | 0.256 | 0.886 | 0.453 |
| 7 | 0.295 | 0.886 | 0.492 |
| 8 | 0.374 | 0.886 | 0.571 |
| 9 | 0.374 | 1.18 | 0.571 |
| 10 | 0.394 | 1.18 | 0.709 |
| 11 | 0.472 | 1.18 | 0.787 |
| 12 | 0.492 | 1.18 | 0.807 |




| GROUP B – DIMENSIONS | | | |
|---|---|---|---|
| Curve | Thickness (in.) | Width (in.) | Height (in.) |
| 1 | 0.177 | 0.512 | 0.394 |
| 2 | 0.197 | 0.512 | 0.433 |
| 3 | 0.236 | 0.512 | 0.473 |
| 4 | 0.197 | 0.689 | 0.433 |
| 5 | 0.236 | 0.689 | 0.453 |
| 6 | 0.276 | 0.689 | 0.512 |
| 7 | 0.335 | 0.689 | 0.571 |
| 8 | 0.256 | 1.024 | 0.611 |
| 9 | 0.295 | 1.024 | 0.650 |
| 10 | 0.335 | 1.024 | 0.709 |
| 11 | 0.374 | 1.024 | 0.749 |
| 12 | 0.433 | 1.182 | 0.768 |
| 13 | 0.531 | 1.182 | 0.867 |

power dissipation must be limited to a value that will not cause the capacitor's internal temperature to rise above its maximum rated value. Some conservative estimates for this maximum internal hot-spot temperature are: 100°C for ceramic plate capacitors, polycarbonate capacitors, polyester foil capacitors, and metalized polyester capacitors, 125°C for solid electrolytic capacitors, and 90°C for conventional aluminum electrolytics.

Other factors can also limit the level of the applied ac voltage. For example, in film capacitors, the maximum ac voltage rating at line frequency must be respected at all frequencies since it is determined by dielectric strength, not power dissipation. Similarly, some capacitors are rated for voltage steepness, a rating that must be respected, regardless of waveform or dissipation. (Voltage transients in the order of 20 to 50 volts/microsecond can cause dielectric breakdown in metalized film capacitors.) Finally, if a capacitor current rating is given, it must also be observed, no matter what the result of other calculations. □




**GROUP C – DIMENSIONS**

| Curve | Thickness (in.) | Length (in.) | Height (in.) |
|---|---|---|---|
| 1 | 0.185 | 0.571 | 0.342 |
| 2 | 0.216 | 0.571 | 0.370 |
| 3 | 0.256 | 0.571 | 0.409 |
| 4 | 0.256 | 0.709 | 0.409 |
| 5 | 0.299 | 0.709 | 0.453 |
| 6 | 0.299 | 0.925 | 0.453 |
| 7 | 0.342 | 0.925 | 0.504 |
| 8 | 0.409 | 0.925 | 0.567 |
| 9 | 0.409 | 1.220 | 0.575 |
| 10 | 0.488 | 1.220 | 0.768 |
| 11 | 0.591 | 1.220 | 0.866 |

# General-purpose op amp forms active voltage divider

by Peter Church
*Parsec Laboratory, St. Thomas, U.S. Virgin Islands*

The everyday 741-type operational amplifier easily transforms a single-ended power supply into a dual supply.

For less than $1, the active voltage divider of (a) can be built. It is useful for powering circuits that require a balanced supply with a ground, but draw only a little current through the ground line. The output-voltage ratio, $V_1/V_2$, is determined by resistors $R_1$ and $R_2$:

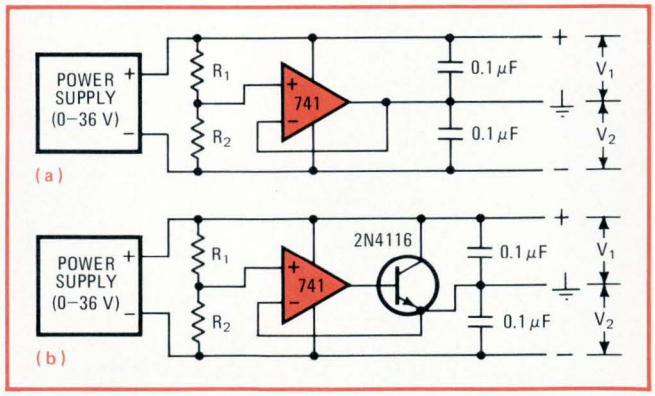
$$V_1/V_2 = R_1/R_2$$

This ratio can be kept fixed or made adjustable by using potentiometers as resistors $R_1$ and $R_2$. More current, up to 1 ampere, can be handled by the active divider by adding a heat-sinked pass transistor, as shown in (b).

For breadboarding, either divider configuration (a) or (b) simply may be included as part of the circuit being laid out. The 0.1-microfarad capacitors in divider (a) can be removed if no fast transients will be encountered in the circuit to be powered, provided that the op amp's level of internal noise can be tolerated.

The 741-type op amp is well-suited for this application because of its high gain over a wide power-supply voltage range and its excellent internal protection circuitry. The single-ended supply voltage should not exceed the op-amp's 36-volt input supply range. □

Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design, applications, and measurement ideas. We'll pay $50 for each item published.




**Active divider.** Ordinary op amp (a) changes single-voltage supply to dual-voltage supply. Resistance ratio ($R_1/R_2$) determines output-voltage ratio ($V_1/V_2$). Additional output current is made available by following the op amp with a pass transistor, as shown in (b).

# Engineer's newsletter

**Transmission-line analysis gets computer aid**

Computer-aided design programs are finally becoming available for transmission-line circuit analysis—a major design tool that's important because almost any circuit can be reduced to a transmission line. Besides its power and microwave applications, transmission-line analysis is **essential for high-frequency logic circuits that use ECL and Schottky-TTL:** at megahertz data rates, the tiny metal interconnects on a chip must be regarded as transmission lines.

**Aedcap, a general-purpose circuit analysis program,** now includes transmission-line models (see p. 153). Also, **a newly released program called Nacap,** written by the Nanodyne Corp. in Sudbury, Mass., employs transmission-line analysis as a computational tool.

**A FET makes an excellent rf switch**

For switching high-frequency signals, designers of rf circuits are finding that some of the analog FET switches now on the market make a good alternative to p-i-n diodes or electromechanical devices. FET switches are available that **can switch wideband (to 100 MHz) signals at rf levels with excellent off isolation and low insertion loss**—and they do it directly from 5-volt TTL levels without external circuitry. Check out Siliconix's DG 181/191 family of n-channel JFETs with MOS bipolar drivers.

**How to get power and voltage stability from rf transistors**

To compensate for variations in rf-transistor temperature at high power levels and maintain high efficiency at the same time, **use the collector resistance of a second transistor in series with the load.** This has the virtue of increasing voltage stability without degrading power efficiency because now **the desired increase in load resistance has been achieved with only a small voltage drop** across the load transistor's collector-emitter junction ($V_{ce}$). An ordinary resistor would maintain stability but produce a large IR drop (see p. 102).

**Falling behind? Study at home**

If you are worried that the good jobs are passing you by because your old college courses left you unprepared for today's technology, look into the IEEE home study program. Prepared by Britain's IEE, courses are available in this country in **field-effect transistors, pulse-code modulation, digital instrumentation, and modern control and processing theory.** On a post-graduate level, the program is aimed at the graduate engineer, and each student is assigned an individual instructor with whom he communicates. Cost is $75 per course, culminating in a certificate of completion. Write: Education Registrar, IEEE, 345 E. 47th St., New York, N.Y. 10017.

**The packaged breadboard**

**For keeping your breadboard circuits from looking like rats' nests,** consider the neat, packaged breadboard kit available from E&L Instruments. It contains a 5-volt power supply, a four-frequency clock generator, lamps, positive and momentary switches, and a socket system that is capable of holding dozens of ICs and passive components. Ask for Digi Designer from E&L Instruments Inc., 61 First Street, Derby, Conn. 06418.

# Both end user and engineer are targets of first National Computer Conference

## At the June conference in New York, which replaces AFIPS' spring and fall meetings, the scope of the exhibits and technical program has been expanded in hopes of attracting a record attendance

by Alfred Rosenblatt, *New York bureau manager*

☐ It will be "a complete department store of computer equipment," declares Gerard L. (Jerry) Van Dijk, conference manager of the 1973 National Computer Conference and Exposition. And just as in a department store, the equipment may be sporting price tags—to Van Dijk, "the biggest innovation" to hit a technical conference in the last 20 years.

Altogether, the first National Computer Conference, to be sponsored June 4–8 at the New York Coliseum by the American Federation of Information Processing Societies Inc. (AFIPS), is shaping up to be a complete sellout, predicts the show's management confidently. Some 70,000 square feet of space will be occupied by 250 companies displaying their wares in 700 exhibit booths. Some of the big mainframe houses like IBM and Control Data Corp. are also back after having abandoned AFIPS' conferences round about the beginning of the recent recession.

Attendance will set an AFIPS record, topping 30,000, predicts Van Dijk. And to make things more comfortable for everybody, he is covering the entire exhibit area with plush, red carpet. By way of comparison, the IEEE's annual meeting at the Coliseum in March attracted 25,000 people, 226 exhibitors, and occupied but 43,000 square feet of bare floor.

What is attracting the exhibitors to the NCC? It isn't simply the upturn in the economy, says Van Dijk. "For the first time we're also making the conference relevant to the computer user," he declares.

This has been accomplished by expanding the technical program and attracting just about every kind of hardware and software supplier to the Coliseum, he continues. From mainframe, peripheral, and communications-equipment manufacturers to systems houses and maintenance and service companies, "the computer user is not going to miss a thing."

The conference's management has expanded its definition of the type of person it wants to attract. The term "end user" no longer refers just to the manager of a data processing installation, but also includes the executive who would be the one to benefit from having a computer-based system installed in his business operation. Accordingly, the 1973 NCC is appealing in the promotional mailings that solicit attendance, as well as in its program and exhibits, to the upper level of management, which is concerned less with the computer itself than with what the total system can do. "I'm after people like the marketing manager at a tobacco company, the president of a department store, or the circulation manager at a magazine," Van Dijk explains.

"The data processing manager may select a computer system, but he too often has to sell the need for a machine upwards within his company," he continues. "And this may be difficult, if not suspect, in the eyes of a management not attuned to a computer system's benefits."

The goal of the AFIPS conference is to "get that buyer there, that creator of computer usage, so that he's going to say, 'Buy one of them,' " Van Dijk concludes.

In the past, the exhibits at the AFIPS were oriented too much to those building the computer-system hardware, Van Dijk continues. "The electronics engineers took over," he laments, with companies exhibiting components like cores and knobs and switches. Such companies are apparently dropping out this year.

Another long-term plus for AFIPS' new national conference, a good many agree, is the decision to substitute a single show for the two Joint Computer Conferences it had sponsored for 20 years in the fall and spring. The spring show was held in the northeast, often in Atlantic City, and the fall show was held in a city out West.

But things began turn-

**1973 NATIONAL COMPUTER CONFERENCE**

June 4–8, New York Coliseum, New York City.

Sponsored by the 13-member American Federation of Information Processing Societies Inc. (AFIPS).

Technical program and exhibits take place throughout the five days of the conference.

| | | |
|---|---|---|
| Exhibit hours: | Monday | 12 noon – 8 p.m. |
| | Tuesday–Thursday | 10 a.m. – 6 p.m. |
| | Friday | 9 a.m. – 12 noon |

Registration is available either for the total conference—program plus exhibits—or for exhibits only. Prices range from $5 for a one-day exhibits pass to $60 for the whole works.

ing sour for the two traditional shows after the fall meeting in 1969. CDC became the first large-scale mainframe manufacturer to drop out of the joint conferences, according to Tom Johnston, manager of exhibits and special promotions for Control Data Corp. Other companies dropped out, too, so that the conferences came to resemble shadows of their former selves. Only 14,000 came to the 1972 spring show in Atlantic City, down precipitously from the peak attendance of 30,000 in Boston in the spring of 1969.

"We didn't feel we were getting our money's worth participating in two similar computer conferences," says CDC's Johnston. Adds Roy Gould, exhibits manager for Digital Equipment Corp.: "The load of a twice-a-year show on many exhibitors was just too great."

Many also felt attendance at the joint conferences lagged because of their locations, often away from major population centers where computers are heavily used. Reacting to such criticism, AFIPS is now shifting its annual conferences from New York this year to Chicago in May, 1974, and to a metropolitan area yet to be chosen out in the West in 1975. Then the plan is to go back into New York again. Still, though the move to a once-a-year show in major cities seems generally well received, many exhibitors are waiting to see how the first one turns out before committing themselves to Chicago.

The decision to allow prices to be posted—"discreetly," cautions Van Dijk—is also likely to be popular. "We exhibit our products to sell them, don't we?" asks a spokesman at one peripherals supplier. But a man at minicomputer maker Interdata Corp. is less certain of the value. "Hardware prices are only part of a system's total cost," he points out.

### The technical program

As for the technical program at the NCC, it will consist of 103 sessions, panel discussions, and seminars—a number that the conference's general chairman, Harvey L. Garner of the University of Pennsylvania, terms "unprecedented." Generally, the joint AFIPS conferences had only a quarter to a third this number, points out AFIPS' communications director, Tom White. Many of the sessions will include not just the formal presentation of papers but also panel discussions and opinions from expert commentators.

Giving evidence of the shift in focus toward the end user, the methods and applications section will have 37 out of the 103 sessions. At the spring conference a year ago, "you would have been hard pressed to pull out five papers of interest to the user," observes White. But the science and technology section still dominates with 56 sessions. There are also five sessions of broad interest to management and five devoted to computer arts.

The 56 sessions in the science and technology portion of the program will include about 110 papers and almost 400 participants. And for the first time, a computer conference contains at least one session organized by each of AFIPS' 13 constituent societies.

Computer architecture and hardware is one of the major areas of concentration. Several new hardware developments reflecting on computer architecture are to be discussed during the session, "Advanced Hardware." Included are papers dealing with optical interconnections, the new feasibility of distributed processing systems that's due to the development of the computer-on-a-chip, and methods of tuning special-purpose hardware, or firmware, to an application with the help of a high-level language like Algol.

The session called "The Growing Potential of Mini/Small Systems" will review new techniques and applications for small systems, particularly those made possible through microcoding. Associative hardware devices will be the subject of "Associative Processors," with emphasis on their application to data management.

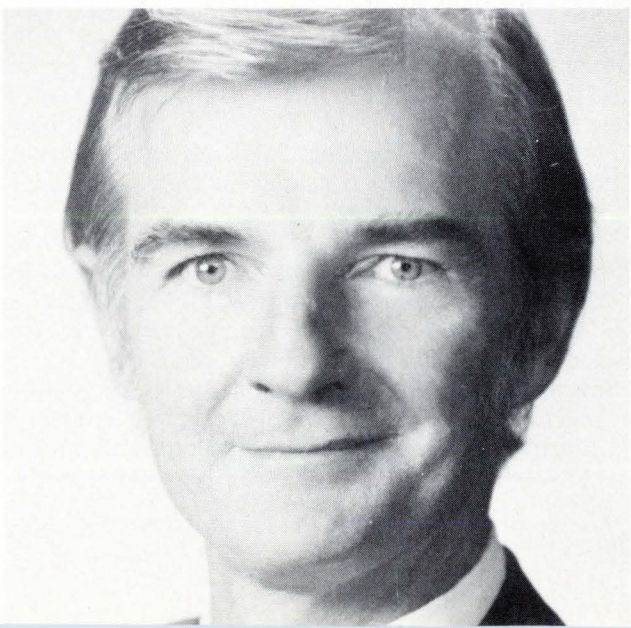
A session on "Storage Systems" includes papers on hierarchy and virtual systems, while military needs are addressed in "What's Different About Tactical Military Computer Systems." And finally, the architectural implications of virtual machine systems, as well as performance and applications aspects, will be discussed at the session, "Virtual Machines."

Another important group of sessions at NCC deals with communications networking and terminals. Both the economic and technical viability of computer networks are to be treated in "Network Computers: Economic Considerations—Problems and Solutions." And in a session organized by the American Institute of Aeronautics and Astronautics, "Data Communications Via Satellite," the burgeoning area of commercial data communications by satellite will be discussed. A related session, "Satellite Packet Communications," will examine techniques for using a single wideband satellite channel in a multi-access broadcast mode by transmitting addressed data packets from many ground stations. "Intelligent Terminals" will concern the division of labor between terminals and central computer, as well as the limitation of power inherent in such terminals.

Pattern recognition gets its share of attention with two sessions. One, "Ingredients of Pattern Recognition," discusses a device for inputting pictorial information into a computer, and advanced techniques for recognition. The other covers "Applications of Pattern Recognition," in medical diagnosis, character recognition, aircraft control, and screening of large masses of data.

Another important subject area is data-base manage-

**Conference manager** Gerard Van Dijk says, "The computer user will not miss a thing" at the first National Computer Conference.



**AFIPS' communications director** Tom White declares there are more technical sessions than ever before for the end user.

**General chairman** Harvey L. Garner, of the University of Pennsylvania, calls the size of the technical program "unprecedented."

ment. At a session on "Trends in Data Base Management" papers will discuss specialized processors, relational data bases, a technique for data-base sharing, and an algorithm for optimal distribution of data within a computer network. The session on "Performance Evaluation" will be concerned with measuring the performance of computer and teleprocessing systems according to economic and human criteria. And in the area of data security, sessions are devoted to an "Interim Report from the IBM Data Security Study Sites," "Data Security in Government," and "Secure Data Systems."

Finally, there will be sessions on computer graphics, computers in education, simulation and process control, and software.

### For the end user

Appealing to the end user, the methods and applications portion of the program falls into four sections: computer applications in industry, Government, and merchandising, and installation management.

Four of the six industry-oriented sessions are devoted to the use of the computer in the manufacture and operation of the automobile. Looking furthest down the road is a session, "Onboard Computers for Automobiles," at which papers to be presented include one by an IBM spokesman, "Automobiles and Computer Architecture," and one by a man from Ford Motor Co., "Tradeoff Considerations for Automotive Computers." Another session involved with projecting future applications is "Off Vehicle Diagnostics," which contains papers describing how computers are used to diagnose malfunctions and assist in tune-ups. A session dealing with "Computers in Automotive Design and Manufacturing" pays close attention to how minicomputers have invaded the auto plants. Capping the discussion of the automotive industry will be a luncheon address by Edward N. Cole, president and chief operating officer of General Motors Corp., and a session, "Automobiles, Computers and the Consumer," dealing with the impact of computers in terms of consumerism, safety, and emission control.

Still in the industry category, "Manufacturing Automation" will touch on the hardware and software available today for computer control of manufacturing, as well as on the shortcomings of existing systems. Another session looks at computers applied to publishing.

Seven sessions concentrate on data processing within various Federal, state and local agencies. "Computers in the Elective Process" will debate the pros and cons of computers in political solicitation and campaigning, and in the vote-counting process, and will concern the scope of such use and the possibilities of fraud.

Other sessions include "Five Year Master Plans for Computers in State Government," discussing approaches to plans in three sizable states—Texas, Illinois, and Michigan; a panel discussion on "Computer Operations of State Agencies and Universities," which deals with the sharing of computer systems; "Urban Services" which deals with such things as the application of computers to housing and welfare policies in New York City, traffic control, and deployment of police and fire fighters, and "Computers in the Congress," which will attract as speakers the data processing managers of both the Senate and the House of Representatives.

The three sessions about merchandising include discussion of "Point-of-Sale Systems" and "Data Processing Directions in the Retail Industry." The sessions on installation management stress discussions of cost effective operation. "Economics and Remote Terminals" tries to show how installation costs can be cut as a result of strategic use of remote operations and communications. At least three sessions deal with confidentiality, security and privacy with respect to data processing systems, and one of them, "Four Major Reports on Privacy and Computers" will present a quartette of recent national studies. Protection against data errors or losses is handled in "Data Integrity." In addition, a separate one and a half day seminar will be held on "Managing the Impact of Generalized Data Bases."

Software design and marketing is treated in "Development of Generalized Software Products" and in "Status and Future of Software Products Worldwide," and so is its legal status in "Legal Protection for Software." Also touching on legal matters is "Regulation of the Computer/Communications Industry."

Other sessions worth noting include "Voice Answerback Comes of Age," reflecting the increasing use of voice answerback with computer systems, "Metrication," dealing with how the computer is being applied to metric system conversion, and "Reliability for Integration into Human Affairs," which is concerned with real-time computer systems in such areas as health care, air and surface traffic control, criminal systems, and credit systems. □

# For the really tough applications, OEM's like VIDAR choose HP.

How do you record millions of telephone calls daily, process this data, and bill millions of customers monthly — without any errors? The VITEL division of VIDAR tackled this problem and solved it with their unique new telephone message metering system.

To record the raw data, VIDAR needed a magnetic tape drive with proven reliability at a competitive price. That's why VIDAR chose HP's 7970E Tape Drive. They needed the best of both worlds and knew that HP quality was the result of 33 years of experience in engineering and mass production techniques that lower costs and improve reliability.

The VITEL system records "one-shot" data at a telephone company central office to provide accurate usage information. For instance, one system in a major metropolitan area handles *3.6 million telephones* in over 100 offices. The system replaces mechanical message registers to bring a new level of accuracy to customer billing procedures.

But OEM's like VITEL want — and need — more than rugged construction, reliable performance, and competitive pricing.

They want a broad range of data rates. Like 200,556,800 cpi NRZI, or 1600 cpi phase-encoded recording that's ANSI/IBM compatible. And flexibility, like 7 and 9 track, multi-density, NRZI and PE; all in one read-only tape drive.

Plus OEM Specials. Like 50-Hz 230-volt operation. Or personalized labels or logos. Even different paint on the front panel. And how about OEM discounts, and a one-page OEM agreement written in plain English.

For the full story call your local HP sales engineer or write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304; Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland; Japan: Yokogawa — Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-ku, Tokyo, 151.

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Circle 127 on reader service card

# Now that the world has flipped over our OEM Model 74, can we make them fast enough?

When we introduced our Model 74 in 1972, we knew we had a great little OEM minicomputer.

We just didn't know how great.

We knew a lot of OEMs would like the hardware multiply/divide, 16 general registers and directly addressable 8KB core — expandable to 64KB. But we didn't know so many OEMs would beat down our door to sign up for it within the first 6 months.

## What you need is what you get.

We had an idea that the 80-nanosecond solid-state Read-Only-Memory and the multiplexor providing an I/O system for communicating with up to 255 peripheral-oriented device controllers would turn on a lot of OEMs. But who would've guessed we'd have the big machine tool manufacturers, electronics companies, peripherals houses and controls companies standing in line for it?

## The $3600* OEM Model 74.

We were pretty sure a lot of OEMs would appreciate the upward compatibility of the Model 74 and our Mix and Match discount schedule, which gives cumulative credit for all machines bought, regardless of model. But we never even dreamed we'd have to tell our manufacturing people to make them by the bushel to keep our 30-day delivery schedule.

Maybe it's the $3600 price.

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*Basic 8KB Model 74 list.
With OEM discount, quantity of 61 – $2,160.

Circle 128 on reader service card

# Exhibits at computer show to hard-sell managers of industries

In common with all areas of electronics technology, the computer segment is moving aggressively into virtually every type of industrial activity. This will be very evident at the National Computer Conference, to be held June 4–8 at the New York Coliseum. Following are some of the significant products to be introduced. Others are in the section starting on page 153.

## No-refresh display holds full printout page

**In two computer-graphics** terminals, the displays will hold, without memory refresh, a full computer-printout page, a complex circuit diagram, or a large map.

Built by the Information Display Products division of Tektronix Inc., the models 4014 and 4015 interactive terminals provide all the hardware and software features of the company's 4010 display family, plus new ones made practical by development of a direct-view storage cathode-ray tube with a screen size of 11 by 15 inches. The 19-inch diagonal measurement gives the new tube about four times the display area of earlier Tektronix storage terminals.

The earlier models in the family display 35 lines of 72 characters and plot graphics in a vector mode on a matrix of 1,024 by 1,024 addressable points. In a line-printer format, the new types display 64 lines of 132 characters and, with the graphics resolution extended by a discrete plotting option, will generate graphics displays with 12-bit resolution. That resolution gives a matrix of 4,096 by 4,096 points. As in the previous systems, graphics inputs are made with cursor cross-hair controls.

Three other page formats are provided by the new models: 121 characters by 58 lines; 74 characters by 35 lines (compatible with the 4010-family format); and 81 characters by 38 lines, with a computer addressable scratchpad area (compatible with the model 4002A terminal). Sizes of the 7-by-9 dot-matrix characters are proportioned to the display format used.

Like the model 4012, the model 4014 generates a set of Ascii upper-case and lower-case characters. And the 4015 has both Ascii and APL character sets (A Programing Language originated by IBM). The model 4015's keyboard is optimized for APL entries. Tektronix 4010-family software packages include, besides APL graphics routines, software for terminal control and packages that allow the terminals to be used with minicomputers, IBM 360 and 370 systems, and time-shared computer services.

According to Robert Peterson, marketing program manager for computer terminal products, the new displays are not only the first to be large enough to allow a full magazine page to be set up by a computer-controlled typesetting system, but they will also make more efficient such new techniques as geocoding and entry of geophysical data from map displays. Geocoding is used, for example, to enter into a data processing system code words for the location of gas mains, street lights, and other map details. With the 19-inch displays, details on large maps can be entered on the new display with the cursor inputs.

Also, Peterson says, the models 4014 and 4015 will make it easier to design complex integrated circuits and printed-circuit boards with computers. "People in these fields have been telling us for years that they need larger displays," he re-

marks, referring to CAD jobs.

The new tube is a single-gun CRT with a directed beam. The beam scans in an analog vector mode to display graphics and in a digital mode to display characters and to scan the display in the computer-entry mode. Data may be stored indefinitely on the screen. However, Tektronix recommends the display be erased after an hour to prevent stationary images from being permanently retained by the phosphors on the screen.

The 4014 is priced at $8,450, and the 4015 at $8,950.

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 [341]

## Bare-bones and stand-alone microcomputers to bow

**Some 30 companies** have gone into business designing, programing, and packaging microcomputers with the MOS LSI chip sets that Intel Corp. introduced in 1971 and 1972 [*Electronics,* March 1, p. 63]. Now, Intel is jumping on the bandwagon it created. At the National Computer Conference, Intel will offer two microcomputers—the Intellec 4 and 8—that are comparable to minicomputers, except that they are slower and less costly.

Unlike the IMP-16C microprocessor cards that National Semiconductor Corp. introduced last month [*Electronics,* April 12, p. 42], the Intellecs are completely assembled, down to the cooling fans in the chassis. They will be sold in two versions that can be expanded by modules: "bare-bones" chassis-mounted computers that plug into host systems, and stand-alone table-top models with cabinets, control panels, and power supplies. Intel is also planning big-board variations for equipment manufacturers.

The Intellec 4, aimed primarily at system-control markets, features a large input-output structure. It handles 12 to 64 I/O channels through interface cards compatible with transistor-transistor logic. The memory, also expandable by modules, stores up to 5 kilobytes (eight-bit words) of instructions and up to 2,560 four-bit data words. Basic programs go into read-only memories on the processor card. Data and additional programs are stored in random-access memories. The mainframe, controlled by a set of 45 instructions, processes either decimal or binary words at a cycle time of 10.8 microseconds.

The Intellec 8 is a more powerful system with a 48-instruction set. It processes eight-bit bytes in 12.5 microseconds. The basic add and subtract routines take 40 $\mu$s. From 4 kilobytes to 16 kilobytes of programs and data, stored in read-only or random-access memories, can be addressed directly by the processor, which also handles real-time interrupts and runs from 12 to 32 I/O channels at a rate of 12,500 bytes per second under program control.

Both computers have monitor programs stored in ROMs and assembler software that can be loaded into the RAMs from tape. Once the monitor starts the system and loads the RAMs, the processors are controllable through teletypewriter channels. Software-development packages that will run on general-purpose computers are also available. They include assemblers and simulators for the Intellec 4 and assemblers, simulators, compilers, and a text editor for the Intellec 8.

Henry Smith, microcomputer systems manager, expects the basic Intellec 8 system to cost about $1,500, and $2,000 when packaged. The Intellec 4 will cost less. In cabinets, the computers weigh 30 pounds and measure 7 by 12 by 17 inches.

The computers are backed up by development accessories, including breadboards with wire-wrapped socket mounts, programable ROM modules, and a ROM pulse-programer controlled by software. With these accessories and the Intellec control panels, an engineer can work up systems having custom programs and peripheral interfaces. The panel has controls for debugging and programer operation.

Conceptually, the development aids are similar to the hardware simulators and programers that Intel supplies to chip-set buyers. In fact, Phil Tai, microcomputer engineering manager, says the simulators were the forerunners of the Intellec computers.

Intel discovered to its surprise last year, Tai recalls, that simulator-card sales were rapidly mounting into the $1 million-a-year range. Customers making one-of-a-kind systems and those that needed only a few microcomputers were using programed simulators, rather than buying and assembling chip sets.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [342]

## Printer/plotter is designed for minicomputers

**Convinced** that the minicomputer market needs lower-priced peripheral equipment, Gould Data Systems has developed an electrostatic printer/plotter that has a unit price of $7,600 for the hardware. Designated the Gould 5000, it prints alphanumeric data at 1,200 lines per minute and plots graphic material at 3 inches per second.

"Like other nonimpact printers," observes Peter A. Highberg, manager of printer products, "this unit operates quietly and requires minimum maintenance since it contains few moving parts." It offers minicomputer users extra flexibility, he adds.

The electronics for the 5000 is solid-state, has an 8-bit data path for input from the minicomputer,

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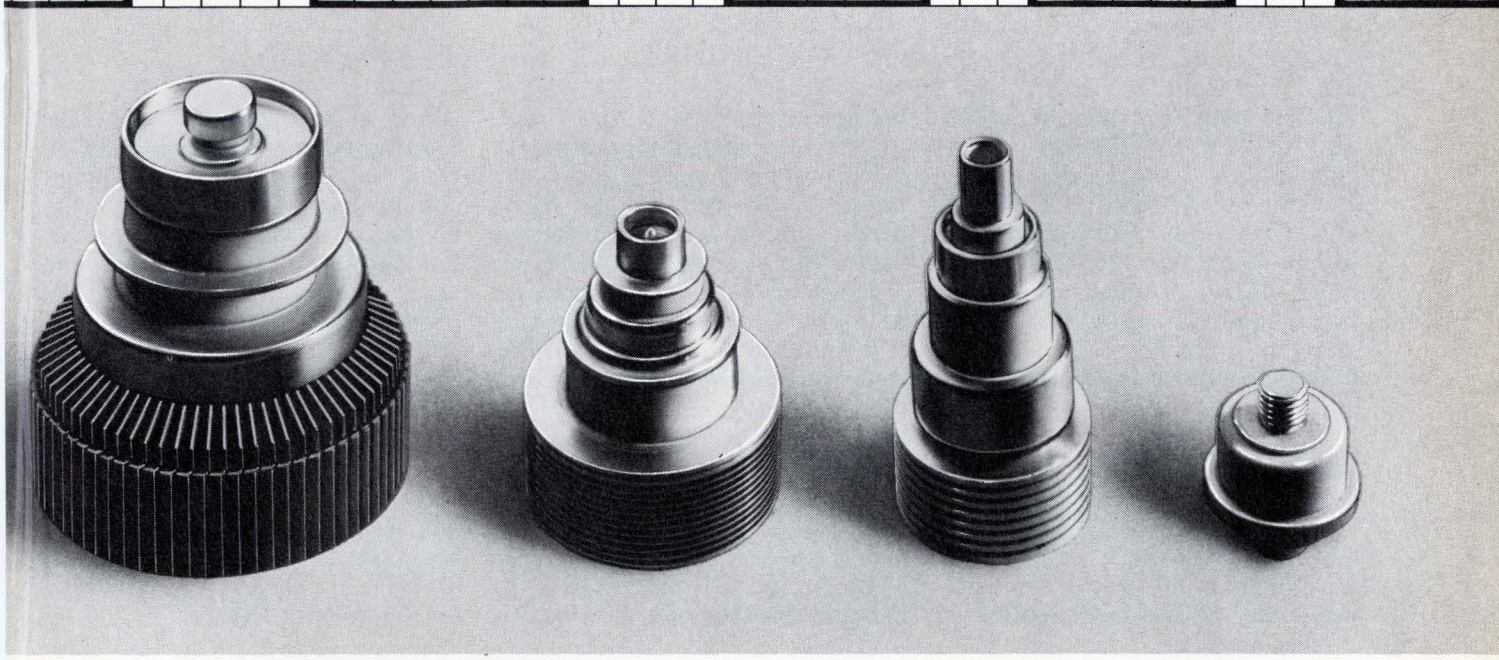

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| 6886 | 3000 | 15 | 250 | 6 |
| TH 363 | 3000 | 8 | 100 | 8 |
| TH 364 | 3000 | 8 | 100 | 8 |
| TH 366 | 3000 | 2 | 350 | 3.5 |
| TH 368 | 3000 | 8 | 100 | 8 |

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United Kingdom - THOMSON-CSF Electronic Tubes Ltd / Bilton House, Uxbridge Road, Ealing / LONDON W 5 2TT / Tel. (01) 579 55.11 / Telex : 25 659

Circle 131 on reader service card

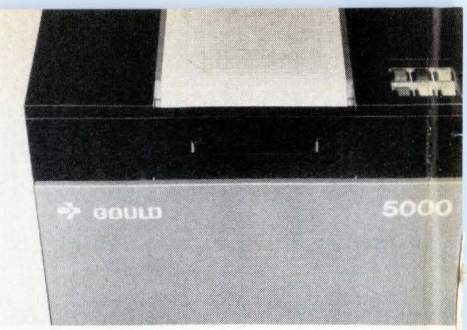
and comes with a 64-Ascii-character, 7-by-9-dot matrix font. The printer/plotter generates 132 characters per line and has a resolution of 100 dots per inch vertically and horizontally.

A full 96-character, 7-by-9-dot matrix font with upper and lower cases and a 128-character, 7-by-9-dot matrix font are available as options.

Computer printout is on 11-inch-wide coated paper. In the course of traveling through the printer/plotter, the paper first of all becomes electrically charged with invisible images, then is dowsed with fluid toner, which adheres to the charged areas, and finally emerges dry from the machine with the images visible.

The Gould 5000 has a 1,000-sheet fanfold paper-handling capacity. It will accept 400 feet of paper rolled on a three-inch internal diameter core.

A six-button control panel is recessed at the top of the unit, which comes in a floor-cabinet model 28 inches wide, 18 in. deep, and 39 in. high. Weight of the Gould 5000 is 195 pounds.




Printer and plotting software packages, as well as interface hardware packages, are available for most minicomputer systems

Gould Data Systems, 20 Ossipee Rd., Newton Upper Falls, Mass. 02164 [343]

## Plug-in processor speeds computer arithmetic

**The prototype** of a plug-in processor, which makes the Nova computer line multiply 10 times faster and divide 20 times faster, will be shown for the first time at the National Computer Conference by Floating Point Systems of Portland, Ore. The firm also will show a prototype of a floating point processor that's compatible with the Nova line.

The first processor will sell for $3,000. It includes 16 Boolean functions, n-bit shift, double-precision floating-point-compatible instructions, and high speed. The processor, a plug-in, fits on two standard-size cards and can be retrofitted in the field—no backplane wiring is required, says company president C. Norman Winningstad. He says the processor "doesn't fit everyone's needs," but is most advantageous for the business office that demands accuracy in nine-digit figures, for example. Winningstad attributes the high speed to hardware rather than software, pointing out that not only are multiplication and division much faster, but the processor also performs addition and subtraction. The processor's instructions are microcoded in the card, and it can handle up to 64 bits.

The second new product—a floating-point processor for the Nova—is aimed at the scientific user. The $3,500 processor adds, subtracts, divides, multiplies, and is fixed-point- and floating-point-compatible with the Nova software set. The processor works with Fortran Four and Five, notes Winningstad. The set plugs in on two boards and provides double-integer multiplication and division which, he says, "avoids scaling errors." The processor is designed for large dynamic ranges, where the user moves orders of magnitude during a single computation. Delivery time is 90 days for both units.

Floating Point Systems, 3160 S.W. 87th St., Portland, Ore. 97225 [344]

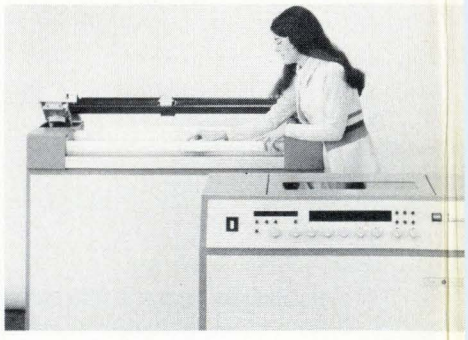
## Drum plotter completes IC mask in 6½ minutes

**In the wide realm** of graphic plotters, the special attraction of the drum plotter is its speed, and a new plotter from California Computer Products (Calcomp) offers what the company claims is the highest speed in its price range. The model 1036 drum plotter draws at 10.25 inches per second axial speed or 14.4 diagonal rate, and costs $22,720. It can plot an IC mask in 6½ minutes, a job that took earlier Calcomp drum models anywhere from 18 minutes to as much as an hour and a half to complete.

Main applications for the plotter include automated drafting, computer-aided design output, mapping and isometric drawings, and medical plots. The drum plotter is often used at test sites by checkout engineers.

A side consequence of a drum plotter's speed is a degree of inaccuracy—which is hardly surprising in view of the shrinkage and stretching in the 36-inch wide, 120-foot long paper roll it accepts. To reduce these problems, the new plotter includes a scale factor adjustment to compensate linearly for paper shrinkage. It's especially useful for the gridded paper normally used for IC-mask checking plots. Narrower paper widths can also be used with optional drums.

The model 1036 includes three programable pens, since IC makers seem to prefer three colors to help



# Celanex. It even sounds electrical.

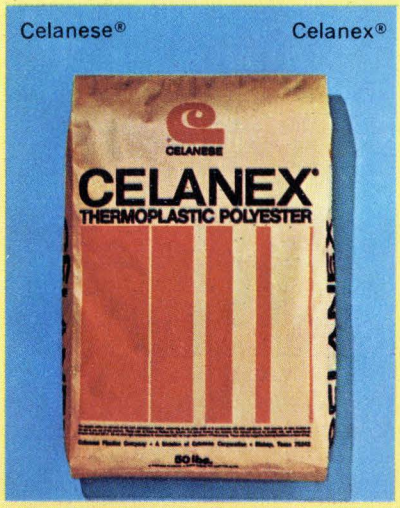
For electrical-electronic applications, Celanex thermoplastic polyester performs small wonders. One reason is that glass-filled Celanex combines all the advantages of DAP, alkyds and phenolics. With none of their disadvantages.

The parts illustrated feature some other good reasons for choosing Celanex. In the Airpax slide switch (a), for example, Celanex SE-O grade combines excellent electrical properties with wear resistance, low coefficient of friction. And it received sole support approval from UL.

In the Permonite TV cathode ray tube socket (b), Celanex 3310 replaced polysulfone. Celanex withstands high voltage and high temperatures. Remains dimensionally stable. Replacing alkyds and nylons, Celanex combines fine electrical properties with fast cycling and ease of molding in this high voltage contactor coil (c) by Essex International Controls Division, Inc. And the small grey TV tuner shaft (d) takes good advantage of another Celanex property—the lowest moisture absorption of any high-strength engineering plastic.

Celanex is also the high-strength insulating material for Magnum Electric Corporation's new, slimmer terminal strips (e). And Celanex's high dielectric strength assures an RMS breakdown voltage of more than 3,000 volts for the thin barriers between terminals. Celanex also contributes high arc track resistance and chemical inertness.

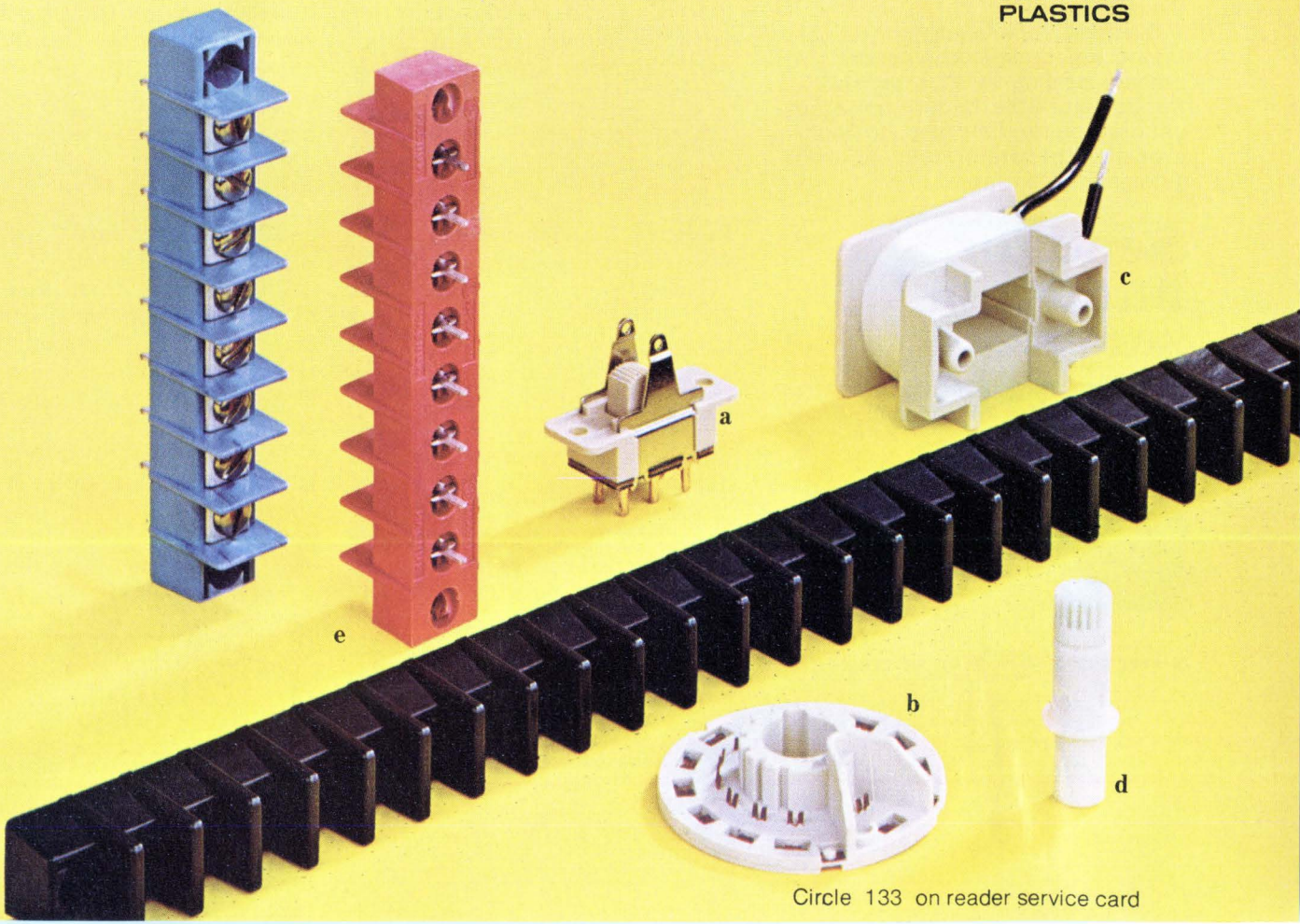
Plus all that, Celanex is one of the most processable plastics available. Molding is easier. Cycles faster. Which adds up to a very remarkable, performance-boosting, cost-saving engineering resin. Get the facts on Celanex. And on Celcon and Celanese Nylons. Write Celanese Plastics Co., Dept. X-607, 550 Broad Street, Newark, N. J. 07102.




Celanese Plastics Company is a division of Celanese Corporation. Canadian Affiliate: Celanese Canada Ltd. Export: Amcel Co., Inc., and Pan Amcel Co., Inc., 522 Fifth Ave., New York 10036.

## Celanex: the original thermoplastic polyester

CELANESE PLASTICS




Circle 133 on reader service card

distinguish the layers, and map makers often use three line widths for variation. Either pressure-flow ballpoint pens or liquid ink can be used at full speed.

Operation is digital, with minimum step size of 2 mils (or 0.05 millimeter in the metric model). Plot area is 33 in. by 120 ft.

Most machines are expected to be sold to end users, who will typically combine the 1036 with a model 915 controller. Input is from standard magnetic tape prepared offline, but the system can also be used with a minicomputer or on-line to a large-scale computer. It operates from common supply voltages.

California Computer Products Inc., 2411 W. La Palma, Anaheim, Calif. 92801. [345]

## Printer is versatile

**True printers** with both upper- and lower-case character fonts can cost twice as much as printers with only upper-case fonts, says Printer Technology Inc., but typewriters priced competitively with upper-case printers are comparatively slow, operating at 10 to 15 characters per second. With the introduction of the Printec 100-A, a low-priced, upper/lower-case serial impact printer, Printer Technology hopes to fill the gap.

Priced at $2,800 in single units, the 100-A uses a 96-character font and prints 70 characters per second from the company's multiple-split helix wheel. The wheel contains two full character sets and four associated hammers. Throughput is 26 lines per minute for 132 column lines, and 44 lines per minute for 72-column lines.

The Printec-100-A includes a two-channel vertical format unit and an 8-bit Usascii interface. Optional interfaces include buffered bit serial, buffered bit parallel, and remote control. Printer Technology can provide a complete packaged interface to a PDP-11 or Nova for about $4,000.

Applications include communications, word processing, text management, key-to-storage systems, preparation of CRT hard copy, and editorial and typesetting tasks.

Delivery time is 60 days.

Printer Technology, Inc., Sixth Road, Woburn, Mass. 01801 [346]

## Disk system holds 50 megabits

**Designed for main-memory** extension, software storage, and similar applications, a compact single-disk drive is particularly suitable where low price and moderately fast access are required. It is also said to be designed for long-term reliability.

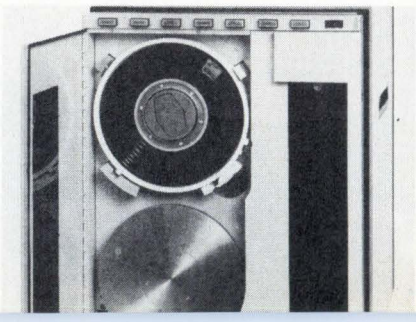
The series N from Wangco Inc. uses a single, nonremovable fixed disk in a package 5¼ inches high. Models 1211 and 1212 offer a capacity of 25 megabits, recording 2,200 bits per inch on 100 tracks per inch. The 1211 has a transfer rate of 1,562 kilobits per second, with a rotation speed of 1,500 rpm. The 1212 has a transfer rate of 2,500k/s, at 2,400 rpm.

The model N-2212 has a capacity of 50 megabits, with 2,200 bits/in. on 200 tracks per inch. Transfer rate is 2,500k/s at 2,400 rpm.

Track-to-track access time for all models is 15 millisconds, with an average of 70 ms. Recoverable error rate is a maximum of 1 in $10^{12}$ bits. Nonrecoverable error rate is 1 in $10^{12}$ bits.

The series-N is 5.25 in. high, 16.60 in. wide, and 22 in. deep. It weighs about 75 pounds with a built-in power supply.

Wangco Inc., 2400 Broadway, Santa Monica, Calif. 90494 [347]

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For more facts on the DMM-51, write today. Or call 714/774-1010 for a demonstration. You'll know a winner when you see one. Cimron Instruments, Lear Siegler, Inc., 714 North Brookhurst, Anaheim, California 92803.

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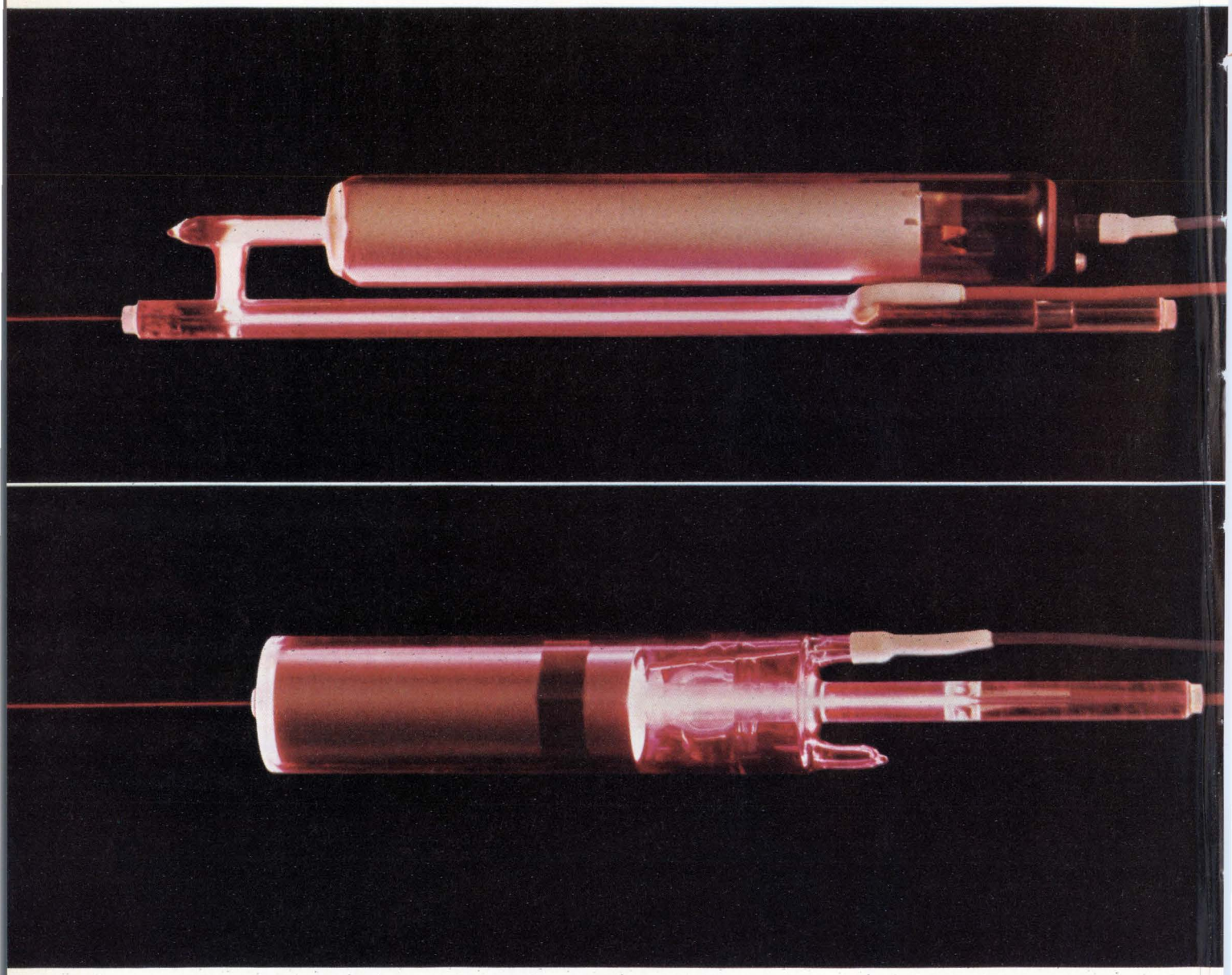
# SPECTRA-BOTH



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# SPECTRA-PHYSICS

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Instruments

# Solid-state unit generates 50 W

## Custom transistors help generator deliver in 225–400-MHz range

Using power transistors fabricated to its own specifications, Ailtech, a Cutler-Hammer company, has developed a solid-state sweep power generator that delivers a fat 50 watts across the 225-to-400-megahertz communications band. This 50-W output represents an order of magnitude improvement over the output power obtainable from the solid-state generators available until now, asserts Thomas D. Eccles, manager of rf instrumentation products at Ailtech's West Coast operation.

Eccles explains that although transistors capable of producing the 50-W output have been available for some time, it's only recently that their reliability has been considered "good enough." A metal migration phenomenon across the interleaved fingers in the power transistor structure would cause the unit to fail under extended high-power operation. Ailtech's specifications for the transistors are designed to overcome this, he says.

Another important feature of the new unit, the model 473, says Eccles, is that it's easier to set up and operate than are conventional vacuum-tube designs. The reason is that both power and frequency outputs are programable via an external dc voltage or binary-coded-decimal signal; and the output power is automatically leveled to within ±0.5 decibel. The result is that the model 473 "requires practically no effort to tune and adjust," so that it is particularly useful for repetitive production-line testing, says Eccles. Also, the generator's all-solid-stage design—basically a voltage-controlled oscillator followed by an amplification chain of transistors—is considered much more reliable than its vacuum-tube equivalent.

The model 473 power generator can be used in systems for checking such things as the output flatness of directional couplers and detectors; filter characteristics like cutoff frequency, insertion loss, and passband flatness; and antenna impedance characteristics.

The generator's output, which ranges from 50 W down to 1 W into a 50-ohm load, can be amplitude- or frequency-modulated. It is also completely protected against any load failure. Amplitude modulation can range from 0% to 95% of full 50-W peak power with a frequency range of dc to 20 kilohertz. Distortion is specified at 5% at full power and 50% modulation. The frequency modulation can range from dc to 1 MHz for less than a 10-MHz total deviation. Distortion is 1% for a 1-MHz deviation; symmetry is within 1%.

Frequency of the under-40-pound model is tuned with a single continuous control. Readout is on a direct-reading analog meter. Sweep sensitivity for an external sweep is 20 MHz per volt. Linearity over the total 175-MHz-wide range is within ±10%.

Price of the model 473 is $5,950.

Ailtech, 19535 East Walnut Drive, City of Industry, Calif. 91748 [351]

## Wideband multiplier provides fast measurements

Resolution of low-frequency events is usually costly, time-consuming, or inaccurate. A line of wideband multipliers developed recently is immune to noise and zero-crossing distortion and reduces measurement time significantly. For example, a 10-hertz signal is resolved to 0.1% in 1 second with the model 2100, and the company says the measurement is essentially error-free. Computations in revolutions per minute, gallons per hour, etc., can be generated with multiplication factors of 2, 4, 5, 6, 10—and up to 1,000. Key design technique is a phase-lock loop and frequency comparator-multiplier combination with inherent phase stability. Price of the model 2100

# Wouldn't it be nice if you could get one of National's new LM 321 pre amps plus one of their famous LM 308 op amps to use with it, plus data sheets and application notes all in one swell Designers Kit for 1/3 off–only $4.95?

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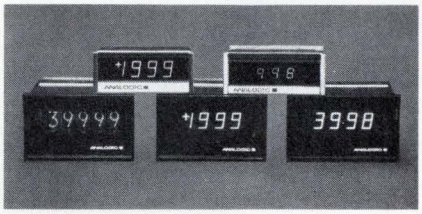
multiplier is $295, and delivery is from stock.
Valhalla Scientific Inc., 7707 Convoy Ct., San Diego, Calif. 92111 [353]

## Digital panel meters use plasma displays

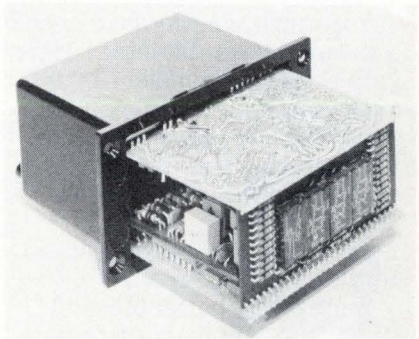
A family of four computer-compatible digital panel meters using Sperry seven-segment plasma displays includes one 3-digit, two 3½-digit, and one 3¾-digit units. The displays have characters high enough for long-distance viewing,



and continuous characters and planar construction for improved readability. In 100-piece quantities, the AN2530, a logic-powered (5-volt) 3-digit meter, sells for $52; the AN2532, a line-powered 3½-digit unit, for $95; the AN2535, a logic-powered model, for $85; and the AN2534, a line-powered 3¾-digit unit, for $130.
Analogic, Audubon Rd., Wakefield, Mass. 01880 [354]

## 3½-digit panel meter has unit price of $99

Offering a floating, bipolar differential input, the DM-2000 digital panel meter uses light-emitting diodes for its 3½-digit readout and sells for $99 in single quantity. Fea-



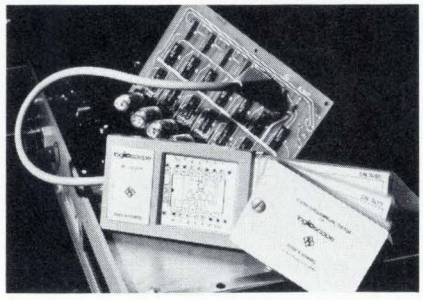
## New products

tures include an input bias current of 20 nanoamperes and an input impedance of 100 megohms, plus automatic polarity. The DM-2000 is accurate to within ±0.05%, and it can resolve to 100 microvolts over a range of 0° to 70°C. Input settling time is 50 microseconds, and up to 200 readings can be made asynchronously or synchronously.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [355]

### Pocket-sized instrument tests ICs during operation

Designed for rapid diagnostic and functional testing of DTL and TTL integrated circuits during operation, the Logiscope, type IFP, simultaneously displays the logic state of all 14 or 16 pins of an IC soldered into a module. A clip-on connector and a 1-meter cable connects the Logiscope, a pocket-sized instrument, to the circuit under test. Requiring no



power supply of its own, the tester receives its operating voltage from the test item, locating automatically the positive and negative poles. The influence of the cable capacitance on short clock pulses is balanced out by decoupling coils, so the functioning of the module under test is not affected. Price is $260.

Rohde & Schwarz Sales Co., 111 Lexington Ave., Passaic, N.J. 07055 [356]

### Function generator/filter keeps distortion under 0.1%

A novel design using an active filter permits the model 765 function generator to produce high-purity sine, triangle, and square waves from 1

# Burroughs panel displays help you sell your products

"The SELF-SCAN ® panel display provides a *CompuWriter*® feature never before available. . . now an average typist can set quality typography with ease because the SELF-SCAN panel displays each character and function as she keyboards so that she can verify or make corrections by individual character, word, or complete line. Burroughs panel displays DO help you sell your product." — *Mr. John Peterson, Vice President, Domestic Marketing, for Compugraphic Corporation, 80 Industrial Way, Wilmington, Massachusetts 01887.*

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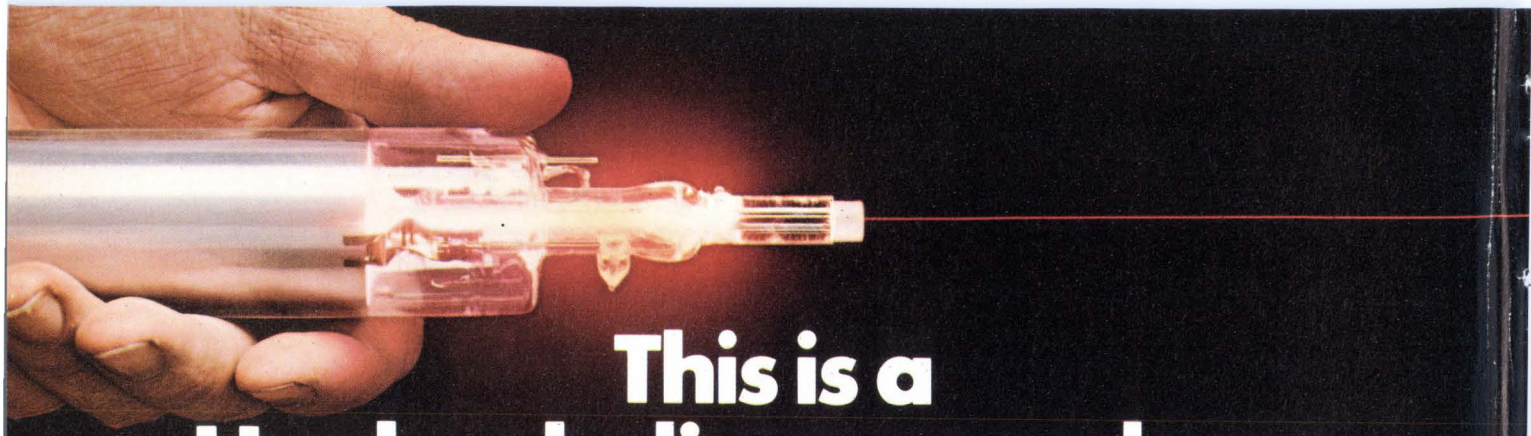
Circle 141 on reader service card



# This is a Hughes helium-neon laser. It might give you a big edge on competition. Then again, it might not.

New uses for helium-neon lasers are being discovered every day. Who knows? There may be an application that makes your product lighter, smaller, faster, more accurate or more versatile.

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Torrance, Calif. 90509

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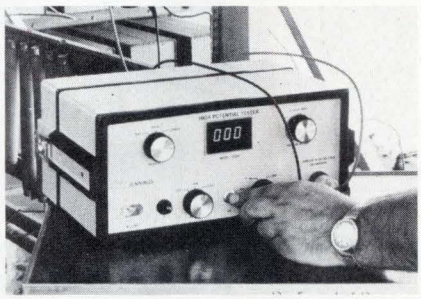
hertz to 100 kHz. Sine-wave distortion is less than 0.1%, the company says. The active filter is switch-selectable and can be used as a bandpass filter (nominal Q of 50) or as a notch filter (40 dB notch depth). Output impedance is 600 ohms, and output amplitude is adjustable from 0 to 10 volts peak-to-peak with no load. Price is $195 assembled, $145 in kit form.

Dytech Corp., 391 Mathew St., Santa Clara, Calif. 95050 [357]

## Dc high-potential tester weighs less than 20 pounds

Digital readout of test voltage and leakage current is provided in a portable dc high-potential tester that weighs less than 20 pounds. The tester, designated the model 16300, operates either from an internal

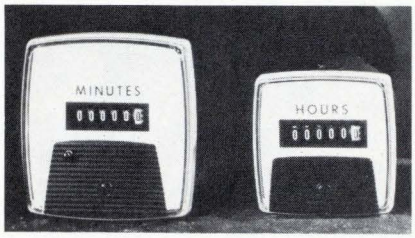


storage battery or from line voltage, and it contains an integral battery charger. Test voltage is adjustable from 500 to 25,000 volts dc, and the high-voltage power supply is electronically regulated against line and load changes. An adjustable current limiter protects the unit and provides nondestructive testing of components. The model 16300 tester is priced at $1,950, and delivery is from stock.

Marketing Dept., ITT Jennings, 970 McLaughlin Ave., San Jose, Calif. 95116 [358]

## Elapsed-time meters include back-of-panel models

For use where space is at a premium, a back-of-panel type is included in a line of elapsed-time meters designated the 240 series. The meters are offered in 2½- and 3½-inch Big Look styles. They have a six-digit display in hours and 10ths of hours, or in minutes and 10ths of

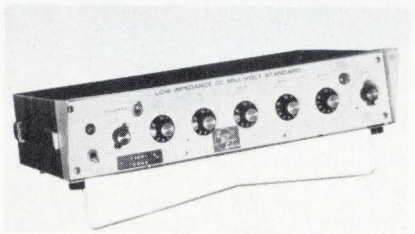



minutes. All of the meters, which are interchangeable with GE's type 236 and 235 units, are designed to meet ANSI shock and vibration specifications.

General Electric Co., Display Devices Marketing, 40 Federal St., Lynn, Mass. 01910 [359]

## Low-cost voltage references built for production-line use

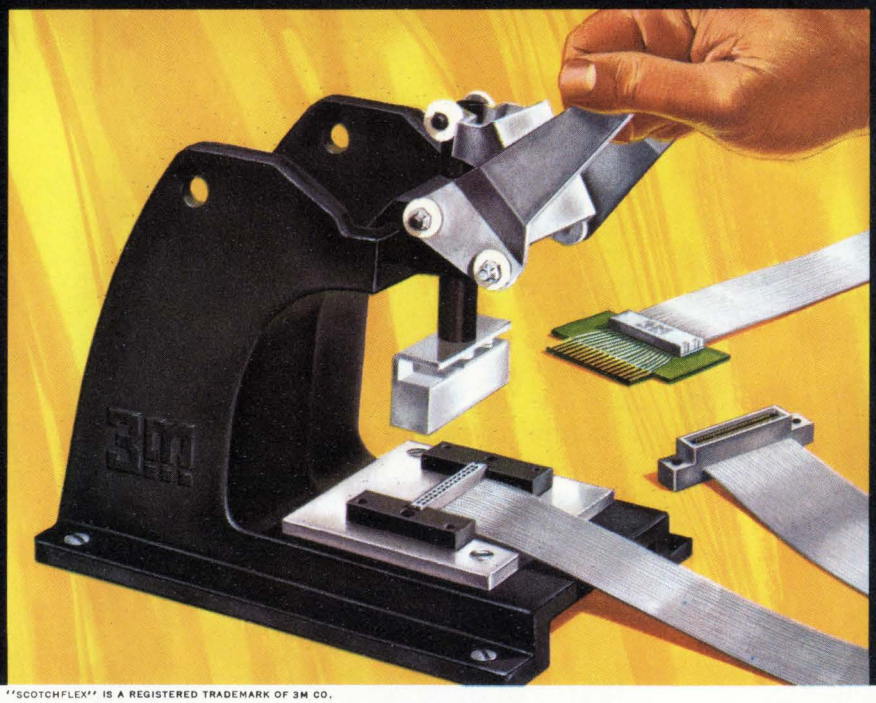
For applications that do not require laboratory accuracy, two voltage references offer substantial savings. The model E-10-D, which sells for $450, provides a voltage output that is selectable between 0 and ±11 volts dc in 100-microvolt steps. Output current is 50 milliamperes, maximum, and is both short-circuit- and overload-protected. The model



E-100-E, which is priced at $525, provides two output voltage ranges: ±10 V and ±100 mV, plus 10% overrange in both cases. Resolution on the 10-V scale is 10 parts per minute or 100 μV, 1 μV steps on the 100-mV range. Output current is 50 mA at 10 V, with an output impedance of 50 milliohms. These economy instruments are accurate to within 0.01% of the dial setting.

Electronic Development Corp., 11 Hamlin St., Boston, Mass. 02127 [360]

# "Scotchflex" Flat Cable Connector System makes 50 connections at a time.

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Build assembly cost savings into your electronics package with "Scotchflex" flat cable and connectors. These fast, simple systems make simultaneous multiple connections in seconds without stripping or soldering. Equipment investment is minimal; there's no need for special training. The inexpensive assembly press, shown above, crimps connections tightly, operates easily and assures error free wiring.

Reliability is built in, too, with "Scotchflex" interconnects. Inside of connector bodies, unique U-contacts strip through flat cable insulation, grip each conductor for dependable gas-tight connections.

"Scotchflex" offers you design freedom, with a wide choice of cable and connectors. From off-the-shelf stock you can choose: 14 to 50-conductor cables. Connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards. Headers for de-pluggable connection between cable jumpers and PCB. Custom assemblies are also available on request.

For more information, write Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

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Semiconductors

# High-speed '741' sells for $1.25

## IC replacement for standard op amp slews at minimum rate of 10 μV per μs

A high-speed replacement for the popular 741 operational amplifier offers 20 times the speed, yet costs only $1.25 in 100-up quantity. Some available high-speed op amps are priced in the $20 range and, unlike the new Motorola MC1741S, are not direct plug-in replacements.

This device, according to Ronald Campo of Motorola's marketing department, has the performance and characteristics of the 741 except that it has a guaranteed minimum slew rate of 10 microvolts per microsecond compared to 0.5 μV/μs for the conventional part. Correspondingly, power bandwidth is guaranteed to be 150 kilohertz, and is typically 200 kHz, 20 times the 10 kHz typical for a regular 741. The high-speed part also offers a typical time of 3μs to settle within 0.1%, an important property in digital-to-analog converters. When combined with a Motorola MC1408 DAC, the part produces a voltage-mode output DAC that settles in 4 μs and sells for $7.20 in 100-up lots.

Apart from the higher speed, Campo says, the new part is designed to act like other 741s, has a similar gain, and includes their standard features of short-circuit protection and internal frequency compensation. "It's very easy to use for anyone familiar with the 741," he says. "It looks and acts just like a standard 741 except for the higher-speed capability." The improved performance is obtained by changes in the internal circuitry of the part.

Besides the applications in digital-to-analog converters (a swiftly growing market, according to Campo), the part should be popular in any large-signal amplifier where distortion is undesirable.

The part is available in two packages, a TO-5-size eight-lead metal can, for both commercial (0° to 75° C) and military (−55° to +125° C) temperature ranges, and an eight-lead plastic mini DIP (the MC1741SCP1) having the commercial rating only. A ceramic DIP will be offered in the future.

Regular and high-speed 741s feature offset null voltage capability, power consumption of 50 milliwatts, no latch-up, and differential voltage ranges. They are designed for ±15-volt operation, have open-loop voltage gains of 100,000, and can supply output currents of more than 10 milliamperes.

Technical Information Center, Motorola Semiconductor Products Inc., P. O. Box 20924, Phoenix, Ariz. 85036 [411]

## P-i-n diode aims at uhf/vhf switches and attenuators

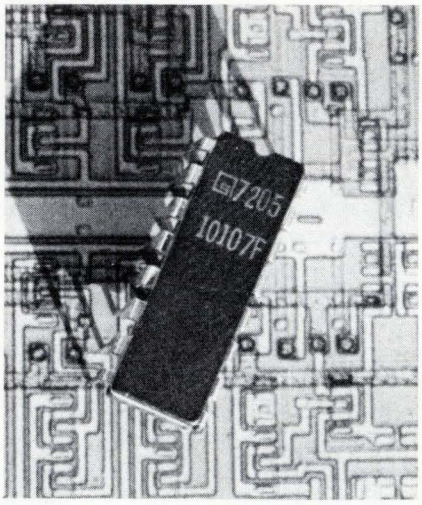
A low-capacitance, planar-passivated, silicon p-i-n diode is designed for rf switching, modulating, and automatic-gain-control applications. Designated the HP 5082-3077, it is intended for use in rf duplexers, antenna switching matrixes, electronically tuned filters, and variable rf attenuators. Effective minority-carrier lifetime is greater than 100 nanoseconds, resulting in low harmonic distortion in the range from 100 megahertz to 1 gigahertz. Dynamic range is from 1 ohm to 10 kilohms; reverse bias capacitance is less than 0.3 picofarad, and continuous-wave power switching capability is 2.5 watts. Price is $2.75 each for 1 to 99, and $2.20 for 100 to 999.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [413]

## ECL gate propagates in 2 nanoseconds

For use in high-speed comparator and parity functions, a triple two-input, exclusive OR/NOR gate has been developed in the form of an emitter-coupled-logic integrated cir-

cuit. Propagation delay of the model 10107 is brief: for one set of inputs, it is 2.0 nanoseconds, and for the other, delay is 2.8 ns. Each input is terminated with a 50-kilohm pull-down resistor which eliminates the need to tie unused inputs "low." The dc loading factor is one. Typical no-load power dissipation is 115 milliwatts per package. The unit has a high fanout capability together with high-impedance inputs, mak-




ing the circuit useful for a transmission-line environment. Typical output rise and fall times with all outputs loaded are 3.5 ns between 10% and 90%, and 2 ns between 20% and 80%. In lots of 100, price of the plastic-packaged version is $1.70 each.

Signetics, 811 East Arques Ave., Sunnyvale, Calif. 94086

### Quad line receivers aimed at data communications

Offering built-in threshold hysteresis, two quad line receivers called the SG1489J and -AJ are designed for data-interfacing applications. The A version provides a greater margin of hysteresis, more than double that of the AJ version. Both types offer logic threshold shifting and input noise filtering capability. Input resistance is 3.0 to 7.0 kilohms, and input signal range is ±30 volts. Primary application for the devices is in interfacing terminals with data communications

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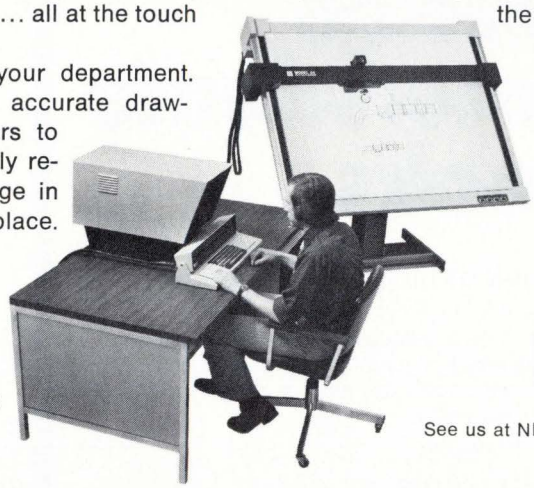

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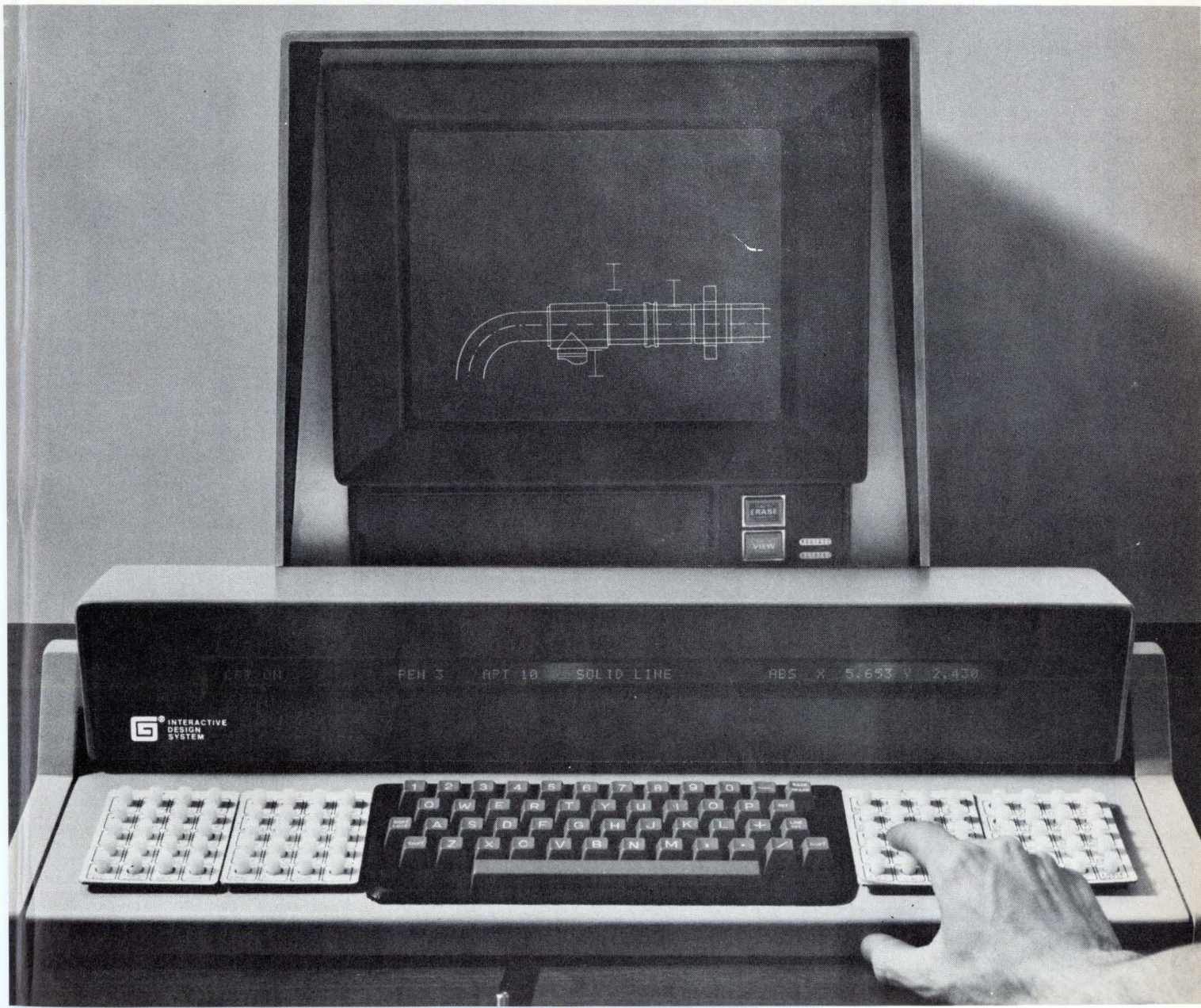
# Push Button Drawing.



equipment that meets EIA standard RS-232C. Package style is 14-pin Cerdip. In 100-lots, price of the J version is $4; for the AJ type, $4.50.

Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. 92683 [416]

### Crystal oscillators clock four logic families

Multipurpose crystal-controlled low-frequency (10- to 250-kHz) clock oscillators feature bipolar design with buffered output. Designated the SQXO-2 series, the units are built for use in circuit applications requiring square-wave outputs that are compatible with C-MOS, TTL, DTL, and RTL. Oscillator and all related components are


housed in a TO-5 package. The quartz crystal, which is photolithographically produced in a tuning-fork configuration, is then laser-tuned to the precise frequency. Power requirements are 0.2 to 2 milliamperes at 5 volts, depending on frequency. Prices start at $19.50 each in 100-lots and at $10 each in quantities of 1,000. Delivery time is stock to four weeks.

Statek Corp., 1233 Alvarez Ave., Orange, Calif. 92668 [417]

### Voltage regulators housed in plastic packages

Seven fixed-voltage regulators housed in plastic power-transistor packages are designed for applications where a simple, low-cost unit is needed that can provide a moderate amount of current without complex current-boosting circuitry. The MC7805/24 series posi-

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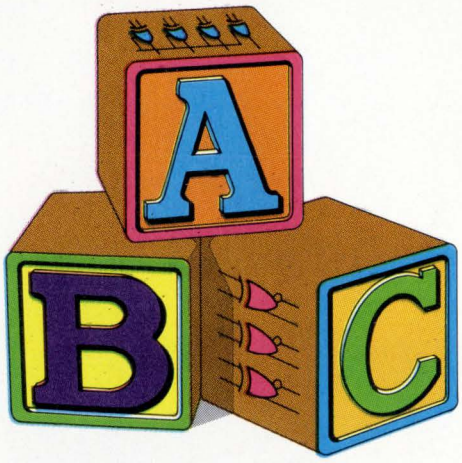
Circle 149 on reader service card

# ECL 10K: Now easy as ABC

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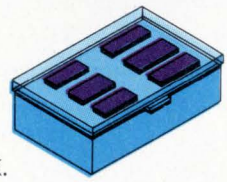
| ALTERNATE SOURCED FUNCTIONS | | | | | |
|---|---|---|---|---|---|
| 10101 | 10106 | 10110 | 10116 | 10119 | 10131 |
| 10102 | 10107 | 10111 | 10117 | 10121 | 10161 |
| 10105 | 10109 | 10115 | 10118 | 10130 | 10162 |

| SIGNETICS ORIGINATED FUNCTIONS | |
|---|---|
| 10112 | Dual 3-Input 1 OR/2 NOR Gate |
| 10113 | Quad Exclusive OR with enable |
| 10171 | Dual 1-of-4 Demux/Decoder (Low) |
| 10172 | Dual 1-of-4 Demux/Decoder (High) |

**Compatibility.** Pin-for-pin identical with Motorola MECL 10,000, with industry-accepted temperature coefficients and ranges (−30° to +85°C). Two in-depth, production-proven sources insure service and delivery. You can use Signetics ECL 10K in mixed systems without the subtle penalties or noise immunity reductions that occur with compensated 10K families. Switching rise/fall times are compatible with conventional system layouts.

FREE ECL 10K PARTS KIT

To introduce our new ECL 10,000 products, we're offering an Evaluation Kit: six free parts to give you first-hand experience with Signetics optimized ECL 10K.



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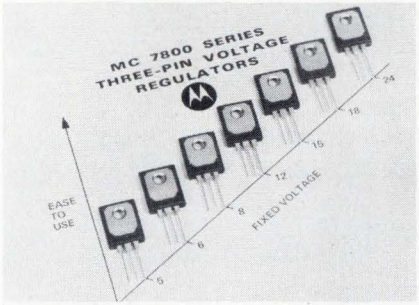
tive voltage regulators can supply more than 1 ampere at nominal voltages of 5, 6, 8, 12, 15, 18, or 24 volts. The devices have only three terminals—input, output, and ground—and they require no exter-

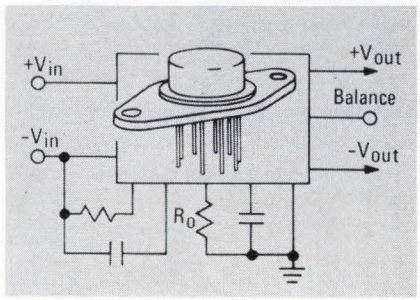



nal components. The regulators can be attached to a heat-sink surface with a machine screw through a hole in the package. Maximum input voltage is 35 v on all types except the MC7824, which is specified at 40 v. Price is $1.75 in 100-lots.

Technical Information Center, Motorola Semiconductor Products Division, P.O. Box 20912, Phoenix, Ariz. 85036 [418]

## Voltage regulator handles wide range of inputs

A variable, dual-tracking voltage regulator offers a 45-volt input and an output range of 50 millivolts to 42 v. Only one external resistor is required to set to desired output voltage. With 0.2% load regulation,




the RM/RC4194 provides 200 milliamperes at both outputs simultaneously; with external pass transistors, it can supply up to 10 A or greater. The unit provides thermal-shutdown protection when temperatures approach 175°C. Prices start at less than $2 for 100-lot quantities.

Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040 [419]

Data handling

# CAD program adds models

## Aedcap extends capability to transmission lines; improves other models

First introduced about two years ago, Aedcap, one of the principal general-purpose circuit analysis computer programs in use today, is now being updated. Half a dozen new built-in models are being added to its library, allowing the user to take advantage of the latest modeling techniques. Aedcap (Automated Engineering Design Circuit Analysis Program) can perform both linear and nonlinear circuit analysis [*Electronics*, March 27, 1972, p. 123].

The program can now directly analyze transmission lines, as well as circuits that are described by either Y or S parameters. Besides being important for electrical power applications and microwave circuits, transmission-line modeling is also a significant factor in the analysis of emitter-coupled-logic circuits and Schottky-TTL circuits. Such high-speed logic circuits require the metal interconnection paths on a chip to be regarded as transmission lines having a characteristic impedance, an attenuation constant, and specified length.

Also, Aedcap now makes use of the Gummel-Poon bipolar transistor model. It is more accurate than the well-known Ebers-Moll model because it accounts for the variation of transistor beta with collector current and for base-width modulation, which causes the transistor's collector-emitter resistance to change with base current. The figure shows how this resistance is constant (parallel slopes) for the Ebers-Moll transistor characteristics, but is variable (changing slopes) for the Gummel-Poon characteristics. (These curves converge at some early voltage, $V_A$.)

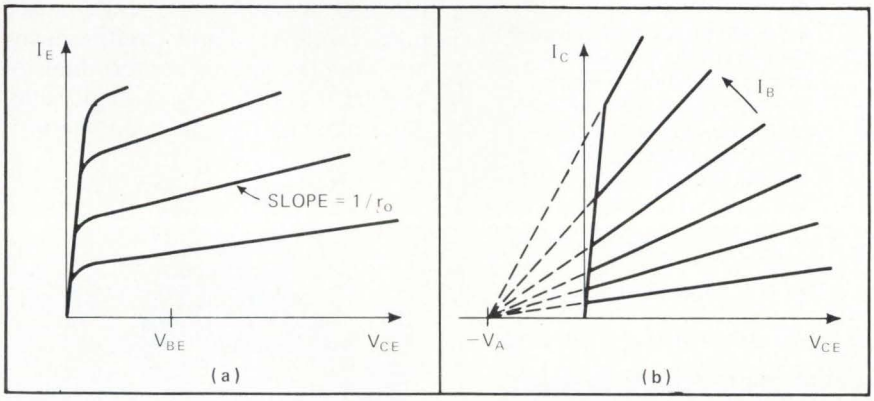
In addition, Aedcap now has a more accurate model for the MOSFET—a model that is based on device geometry, rather than processing parameters. This makes MOSFET model parameters easier to measure. Moreover, n-channel devices can now be handled as easily as p-channel devices, making the new MOSFET model ideal for analyzing complementary-MOS circuits.

Two new diode models round out the additions to Aedcap's model library: the Schottky-barrier diode and the zener diode. The program's existing junction-diode model was modified to get the two new diode models.

SofTech Inc., 391 Totten Pond Rd., Waltham, Mass. 02151 [361]

## Channel concentrator allows sharing of computer ports

Designated the model C-32, a data channel concentrator connects data from modems, terminals or multi-




**Improved transistor modeling.** Ebers-Moll curves (left) with parallel slopes do not account for base-width modulation, as do converging slopes of Gummel-Poon curves (right).

## New products

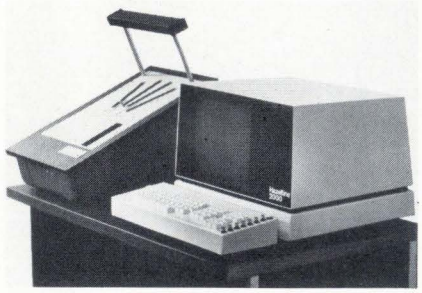
plexers to available computer ports on a first-come first-served basis. The unit makes connections in response to such signals as data termi-


nal ready, ring indicator, and request to send. The C-32 can concentrate up to 32 channels to up to 16 computer ports; larger systems are also available. The unit requires no speed or code programing and can switch asynchonous or synchronous data at rates up to 9,600 bits per second. Price of the concentrator starts at $3,250.

Timeplex Inc., Box 202, 65 Oak St., Norwood, N.J. 07648 [363]

### Security system protects privacy of computer data

Designed for continuous on-line use, a security system called the Identimat 2000H protects confidential data or programs stored in computers. The system consists of a video terminal and a device that measures the geometry of the hand. The latter device allows only authorized persons to access the computer, and the unit continuously monitors the line to the terminal. A user of the system keys in his employee number or code on the ter-



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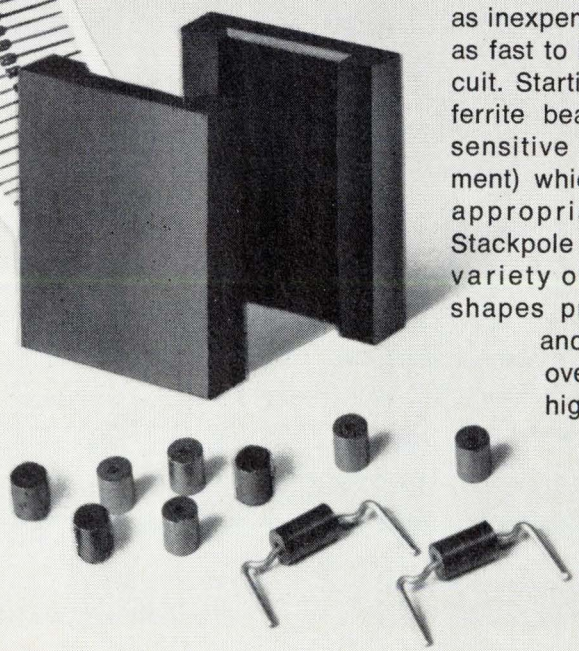
Now beads are available with leads, cut and formed or on lead tape. Most equipment that is capable of automatic insertion of lead tape components can be modified to accept this special Stackpole bead.



No other filtering method is as inexpensive . . . and now as fast to insert in your circuit. Starting with a simple ferrite bead (a frequency-sensitive impedance element) which slips over the appropriate conductor, Stackpole has available a variety of materials and shapes providing impedances from 1 MHz to over 200 MHz. The higher the permeability, the lower the frequency at which the bead becomes effective.

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|---|---|---|---|---|
| Initial Permeability | 2500 | 850 | 500 | 125 |
| Volume Resistivity @ 25°C | $1.0x10^2$ | $1.4x10^5$ | $1.0x10^3$ | $2.0x10^7$ |
| *Effective Suppression At: | 1 MHz | 20 MHz | 50 MHz | 100 MHz |
| Curie Temperature | 205 | 140 | 200 | 385 |

*A tutorial guide on how these passive components behave with frequency and geometry is available from the Electronic Components Div.

Impedance varies directly with the bead length and log [O.D./I.D.]. Beads are available in sleeve form in a range of sizes starting at .020″ I.D., .038″ O.D., and .050″ long. The bead on lead tape is .138″ O.D. and .175″ long. Where quantities warrant, other beads on leads and/or lead tape are a design possibility. Tight mechanical tolerances are held in sizes and shapes as varied as the pair of giant, mating channels shown on the left which are used to eliminate the effect of transient noise in computers.

Sample quantities of beads are available for testing. Consult Stackpole Carbon Company, Electronic Components Div., St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.

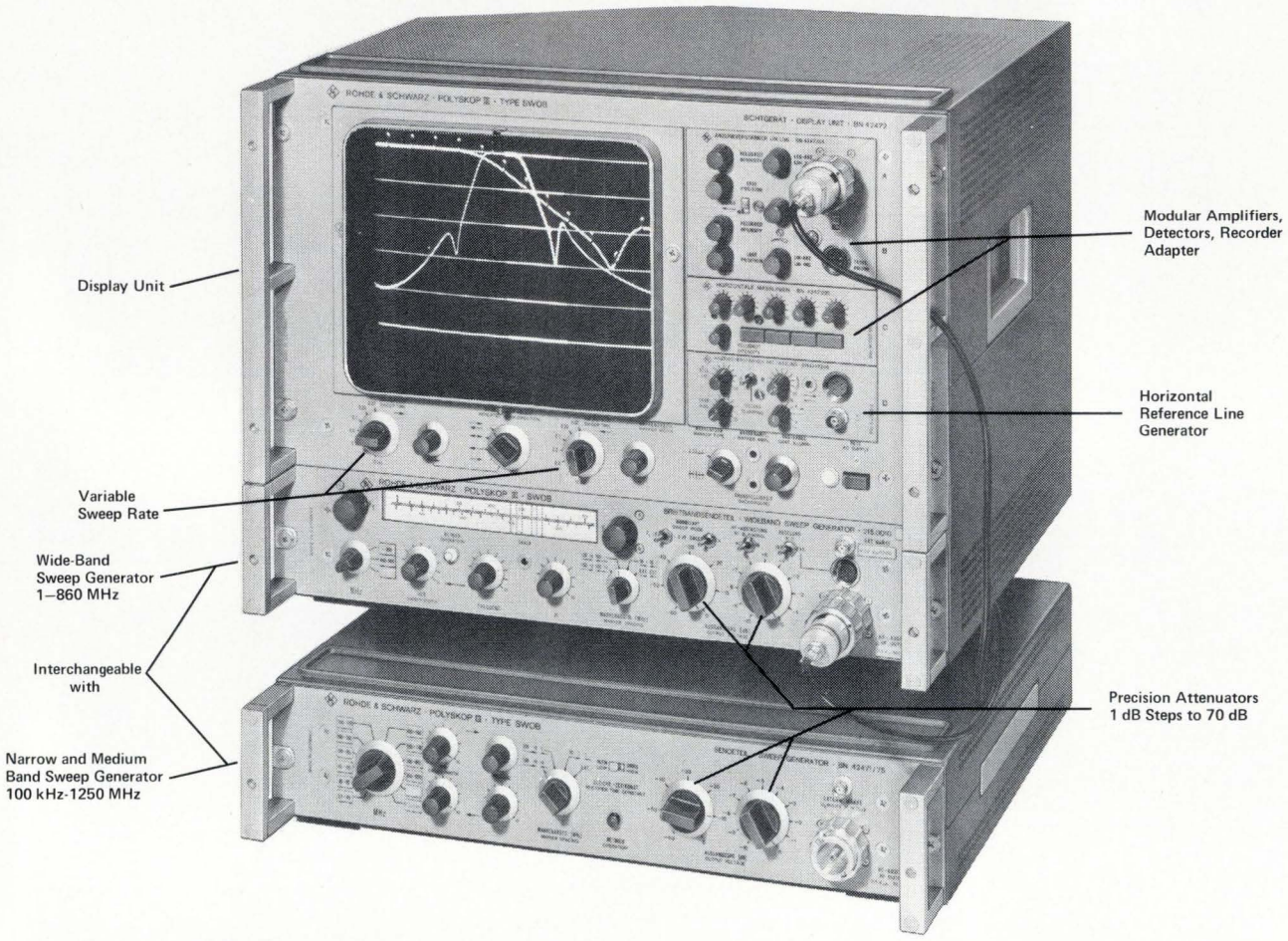
**STACKPOLE**
**ELECTRONIC COMPONENTS DIV.**

Circle 155 on reader service card

# POLYSKOP® III

## INTEGRATED SWEEP TEST SYSTEM

## 100 kHz - 1250 MHz

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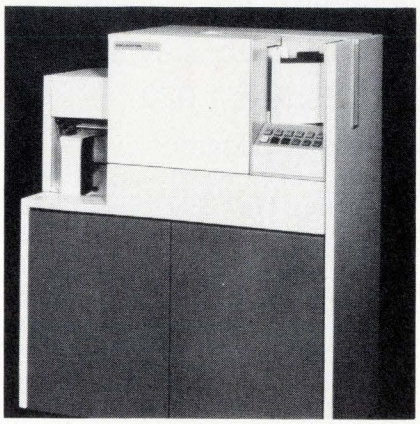
minal; the computer relays a signal to the terminal and security unit, and the user places the hand on the security unit for decoding and verification.

Identimation Corp., 408 N. Paulding Ave., Northvale, N.J. 07647 [364]

## Reader-punch handles up to 285 cards per minute

The RP-100, a reader-punch for 80-column cards, features a side-friction picking system with positive roller-controlled transport, a cam-



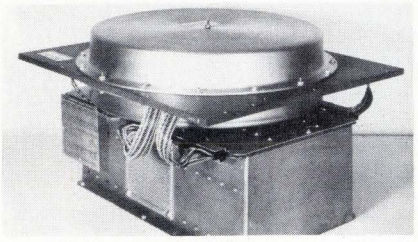
driven punching system, and automatic verification in its punch operation. The unit punches 100 to 285 cards per minute, the latter when only the first column is punched. Reading speed is 400 cards per minute. Price is $11,750.

Documation Inc., Box 1240, Melbourne, Fla. 32901 [365]

## Disk memories provide 12.8-megabit storage

A family of fixed-head disk memories for OEM minicomputer applications provides up to 12.8 megabits of storage capacity. Designated the 6000 series, the memories feature double-density phase-modulated recording, and noncontact flying heads. Units are available in eight- to 128-track configurations, with memory capacity of 100,000 words per track. Alternately, 4,096 16-bit words per track can be accommodated, providing up to 512,000

words of storage capacity. Packing density is nominally 2,700 bits per inch; 1,800 or 3,600 rpm is offered; access time is 8.3 milliseconds at



3,600 rpm; and bit serial transfer rate is 6 MHz. A typical price is $10,000 for a single unit and $7,000 in quantity.

Information Data Systems Inc., 2020 Winner St., Walled Lake, Mich. 48088 [366]

## CRT displays 1,920 character positions

The series TDV 200 video display terminal is a CRT with keyboard, control logic, character generator, refresh memory and interface. Features include capability for 80 characters per line, 24 lines, and 1,920 maximum displayable character positions. Character generation is accomplished by a five-by-seven dot matrix displayed as five-by-14 using interlace. The memory is a dynamic MOS shift register, and the scan method is designed for a standard raster of 625 lines.

Tandbergs Radiofabrikk A/S., P.O. Box 9, Korsvoll, Oslo 8, Norway [367]

## Disk, tape drives are aimed at OEM, systems applications

For applications in both OEM equipment and as parts of systems, two disk drives and a tape transport are aimed at the minicomputer market. The model 6000 tape transport is a 10½-inch IBM-compatible unit offering file search and rewind at 200 inches per second and a maximum data transfer rate of 72,000 characters per second. Two models of the disk drive are available; the 8100/5 storing 25 million bits, and the 8200/5 with a capacity of 50 million bits. Price of the transport is under

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And, "Scotchpar" Flame Retardant Film, available in 1 to 5 mil thicknesses, has the electrical and physical properties of standard polyester films, with the added benefit of a much better winding surface.

Learn more about "Scotchpar" Type 7300 film, the built-in fire extinguisher by, writing 3M Company, 3M Center, 220-6E, St. Paul, Minnesota 55101.

3M COMPANY

## New products

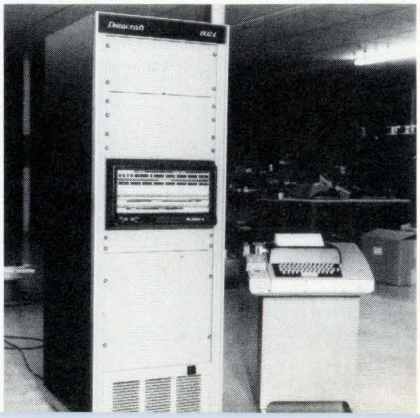
$3,000 in OEM quantities; the 8100/5 disk drive, $2,800; and the 8200/5, $3,100.
Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92705 [369]

### Print-plot system is for use with matrix technique

An off-line print-plot system is built to operate with Versatec's 8½-, 11-, and 20-inch line of printers, plotters and printer-plotter units that use the Matrix Electrostatic Writing Technique—MEWT. The new matrix print/plot system is designed to be used with IBM-compatible 37.5-inches-per-second magnetic tape; nine-track NRZI, 800 bits/inch; nine-track phase-encoded, 1,600 bits/inch; or seven-track NRZI, 200, 556, or 800 bits per inch.
Versatec Inc., 10100 Bubb Rd., Cupertino, Calif. 95014 [368]

### Computer's cycle time is 750 nanoseconds

A medium-scale computer designated the Slash 4 is aimed at scientific and real-time users and offers a cycle time of 750 nanoseconds. The basic price of $19,900 includes 24,000 bytes of memory, 128 to 356 24-bit words in 8,000 word increments; parity; hardware multiply/divide/square root; priority interrupt control system; four external priority interrupts; five registers; one eight-bit input-output channel; and software. Aimed at the end-user, the computer uses a core memory. A combination of semiconductor and core types is planned for future models.
Datacraft, 1200 Northwest 70th St., Box 23550, Fort Lauderdale, Fla. 33307 [370]



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Now a great looking solid-state display for only $2.95.* HP's new low-cost digit is really something to see. Wide viewing angle and bright, evenly-lighted segments offer excellent readability.

Designed for commercial applications, the 5082-7730 Series is a pin-for-pin replacement for other displays such as the MAN 1, MAN 7, DL 10 and DL 707 and offers a large 7-segment 0.3 inch character with right or left hand decimal points. Quality? Still the best around. Contact your nearby HP distributor for immediate delivery. Or write us for more details.

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Industrial electronics

## ICs challenge SCRs in power

Three hybrid transistor units can put out from 2 to 24 kilovolt-amperes

In the high-power conversion field, the transistor had been considered a "soft" pulse device unable to withstand instantaneous overloads. That has changed now with Texas Instruments' development of three integrated power-transistor switches designed specifically for jobs usually performed by silicon controlled rectifiers.

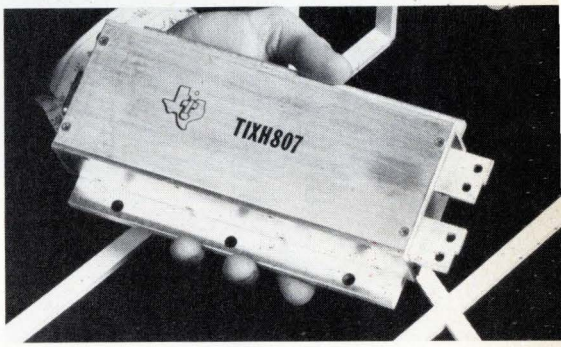
The three hybrids supply power outputs ranging from 2 to 24 kilovolt-amperes. The TIXH807 is rated at 150 amperes and 100 volts, the TIXH808 at 200 A and 100 V, and the TIXH809 at 60 A and 400 V. And, TI is working toward a switch rated at 100 A and 500 V.

In its design TI has combined a power transistor drive with sufficient overload protection to enable the devices to compete in the high-power conversion market. Housed in a conduction-cooled aluminum case measuring 7 by 3.5 by 1.6 inches, each switch weighs 3.3 pounds. Applications include dc choppers for motor controls, dc to ac converters, and ac to dc converters that are used in a broad gamut of machine tool, industrial control, communications, hand tool, power supply, induction heating, frequency conversion and other systems.

Each switch—actually a dual integrated unit—contains two identical circuits which may be connected together for a single push-pull output, or operated as two independent switches. A signal generated by diode-transistor or transistor-transistor logic can be used to control the peak power of 24 kilovolt-amperes at a frequency range between dc and 10 kilohertz. Typical turn-off time is 0.5 microsecond, or about an order of magnitude greater than an SCR's. The units also feature optically coupled isolation between input circuitry and the power system.

Internal circuitry turns off each switch within about two microseconds if its load is short-circuited, and operation begins again in 2.5 microseconds. If the short circuit continues, the switch will turn off again and recycle at a frequency of about 400 hertz until the short condition is eliminated.

Protection is also provided against overheating. The signal for this condition is fed into a Schmitt trigger which, with its hysteresis characteristic, ensures that the temperature recovers by a safe margin before operation resumes. The integrated power switches can absorb a




transient overvoltage up to an energy level of 5 joules.

Evaluation quantities are available in 12 weeks after receipt of order. Tentative prices range from $785 for single units to $450 each in 1,000-piece quantities.

Texas Instruments, Inquiry Answering Service, P.O. Box 5012, M/S 308, Dallas, Texas 75222 [371]

## Plug-in construction makes counters flexible

All-modular plug-in construction enables the user to tailor a line of presettable counters to his exact specifications. The input, output, and counting circuit boards all plug in, permitting combinations of 17 types of inputs, 10 types of output, a 1- to 5-digit readout, one or two presets, or totalizer only. Counting speeds ranging from 50 to 20,000 counts per second are possible. The

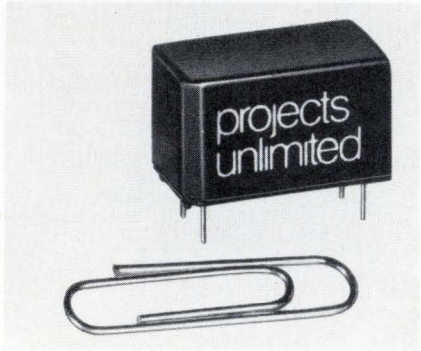
## New products


counter will accept almost any type of input, including ac or dc voltage, pulse, photoelectric, proximity, vane pickup, magnetic pickup, and shaft encoders. The numerical readout is a bright green that is legible to 20 feet. Prices start at $100.

JMR Electronics Corp., 1424 Blondell Ave., Bronx, N.Y. 10461 [374]

### DIP audio indicators eliminate arcing, rf noise

Called DIP-Alarm, a line of audio indicators in dual in-line packages plugs into a standard 16-pin DIP socket or printed-circuit board on 0.300-by-0.700-inch centers. They contain no moving contacts, so problems of arcing, electrical interference, and rf noise are eliminated. Sound output is 80 decibels in the range of 400 hertz to provide extra audible penetration. Units range in dc voltage from 1.5 to 15 and will operate from −55° to +55°C. They weigh slightly under 8 grams. Typical applications are in automotive warning systems, metal detectors, fume detectors, depth finders, audible tuning devices, monitoring systems, alarm circuits, continuity test sets, timers, medical instruction, telephone sensors, and various types of home alarm systems.




Projects Unlimited, 3680 Wyse Road, Dayton, Ohio 45414 [375]

### Temperature controllers have triac output, operate to 650°F

Featuring 0.1° sensitivity over the range from room temperature to 650°F, a line of solid-state temperature controllers designated Quantem is priced at $37.50 each in quantities of 50. The controller is supplied as a compact 4.4-inch-square protected circuit board with built-in power supply and triac output, plus matched precision setpoint potentiometer, dialplate, and encapsulated sensor. The unit connects directly to any 120/240-volt, 60-hertz power source. The controller is suited for appli-

COOL POWER FROM SEMTECH

# SEMTECH NEWS

SILICON RECTIFIERS & ASSEMBLIES CERAMIC CAPACITORS

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# METOXILITE RECTIFIERS SET INDUSTRY STANDARDS

**Metoxilite, the material that pushed Semtech to the forefront of the industry for sub-miniature medium power silicon rectifiers, now makes its debut in a whole new spectrum of "state-of-the-art" devices. Metoxilite (metal oxides) is fused to the metallurgically bonded junction-tungsten pin assembly forming a "tough" sub-miniature package. Designed to electrically approach the theoretical, the Metoxilite rectifier, introduced in 1969, is the result of years of applied research and extensive testing. You'll see them used in stringent military and space environments as well as industrial and commercial applications. JAN and SIN parts available in most types.**

## PRESENT STANDARDS

The Metoxilite 3-amp series is the first family introduced by Semtech. Supplied in an axial leaded package, it filled the product gap in the industry between the lower current axial leaded rectifier and the higher current stud packages.

### 3-AMP METOXILITE RECTIFIERS (6-AMP/MIL-STD-750)

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400 600, 800 & 1000V
Reverse Current @ 25°C: 1.0 μA; @ 100°C: 20 μA
Forward Voltage @ 3A, 25°C: 1.0 to 1.1V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165" D x .165" L
Types: 1N5550-54

FAST RECOVERY (Trr) 150-250 ns
Peak Inverse Voltage: 50, 100, 200, 400 & 500V
Reverse Current @ 25°C: 1.0 μA; @100°C: 20 μA
Forward Voltage: @ 3A, 25°C: 1.1V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165" D x .165" L
Types: 1N5415-19

## RECTIFICATION EFFICIENCY IMPROVED

The Metoxilite LO VF rectifiers open the door previously barred to the designer who required high efficiency rectification with ultra fast recovery times. These units are ideally suited to today's power supply design technology.

LO-VF WITH FAST RECOVERY (Trr) 100 ns
Peak Inverse Voltage: 30 and 50V
Reverse Current @ 25°C: 1.0 μA; @100°C: 20 μA
Forward Voltage @ 3A, 25°C: 0.9V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165" D x .165" L
Types: 3L03 & 3L05

## RADIATION RESISTANT RECTIFIERS

Specifically designed to operate in a radiation environment. Now available in Metoxilite. Extremely rugged part is ideally suited for missile and space applications.

Peak Inverse Voltage: 100, 200, 300 & 400V
Average Rectified Current: 1A
Forward Voltage @ 1A 25°C: 1.2V
Reverse Current @ 25°C: 1 μA; @ 100°C: 25 μA
Single Cycle Surge: 30A; Recurrent Surge: 6A
Reverse Recovery: (Trr) 300—1000 ns
Body Dimension: .070" D x .165" L
Types: R1, R2, R3 & R4

## THE WORK HORSE

The Metoxilite 1-amp rectifier family introduced with the 3-amp family has since become the workhorse of the industry. Utilizing the .060" diameter die, it offers more capability than the similar devices now available in the industry.

### 1-AMP METOXILITE RECTIFIERS (3-AMP/MIL-STD-750)

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400 600, 800 & 1000V
Forward Voltage @ 1A. 25°C: 1.2V
Reverse Current @ 25°C: 0.5 μA; @100°C: 25 μA
Single Cycle Surge: 50A; Recurrent Surge: 10A
Body Dimension: D x .165" L
Types: 1N5614-22

FAST RECOVERY (Trr) 150-500 ns
Peak Inverse Volt.: 200, 400, 600, 800 & 1000V
Forward Voltage @ 1A. 25°C: 1.2V
Reverse Current @ 25°C: 0.5 μA; @100°C: 25 μA
Single Cycle Surge: 25A; Recurrent Surge: 6A
Body Dimension: D x .165" L
Types: 1N5615-23

## NEW GENERATION 1N645

Our new ½-amp Metoxilite rectifier is small enough to replace the unreliable whisker type devices (1N645-7). This rectifier is now available in the Metoxilite non-cavity case with a high temperature metallurgically bonded internal assembly.

### NEW ½-AMP METOXILITE RECTIFIER

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400, 600, 800 & 1000V
Average Rectified Current: 0.5A
Reverse Current @ 25°C: 100 nA ; 100°C: 7 μA
Forward Voltage @ 0.5A, 25°C: 1V
Single Cycle Surge: 25A; Recurrent Surge: 5A
Body Dimension: .070" D x .165" L
Types M2, M4, M8 & M0

FAST RECOVERY (Trr) 150 ns
Peak Inverse Voltage: 100, 200, 400 & 500V
Average Rectified Current: 0.5A
Reverse Current @ 25°C: 250 nA; @ 100°C: 15 μA
Forward Voltage @ 0.5A, 25°C: 1V
Single Cycle Surge: 12.5A; Recurrent Surge: 3A
Capacitance @ 4V: 20 pF
Body Dimension: .070" D x .165" L
Types: F1, F2, F4 & F5

## LO-DYNAMIC Z-ZENERS

Semtech's new Metoxilite low dynamic impedance zeners offer voltages of 6.8 to 120 volts for 1, 3, and 5 watt applications. This new series of devices offers ⅓ lower dynamic impedance when compared at the same operating current to those presently available. As an added plus, the device is radiation resistant. The zener body measures .165" long (max.) and is .110" in diameter (max.). Types SX30-120.

## FOR VOLTAGE MULTIPLIERS

Introducing the Ministac in Metoxilite, multi-chip high voltage rectifier, particularly adaptable for high frequency applications such as voltage multipliers.

### NEW METOXILITE MINISTAC

MEDIUM RECOVERY (Trr) 2 μs
Average Inverse Voltage: 2, 3, 4, & 5 KV
Average Rectified Current: 125 mA
Reverse Current @ 25°C: 100 nA; @100°C: 7.0 μA
Forward Voltage @ 125 mA, 25°C: 5V
Single Cycle Surge: 7A; Recurrent Surge: 1.25A
Body Dimension: .070" D x .215" L
Types: M20, M30, M40 & M50

FAST RECOVERY (Trr) 250 ns
Peak Inverse Voltage: 1.5, 2.0, 2.5 & 3 KV
Average Rectified Current: 100 mA
Reverse Current @ 25°C: 100 nA; @100°C: 7.0 μA
Forward Voltage @ 100 mA, 25°C: 5V
Single Cycle Surge: 5A; Recurrent Surge: 1.25A
Body Dimension: .070" D x .215" L
Types: F15, F20, F25 & F30

## SUB-MINIATURE HIGH VOLTAGE METOXILITE RECTIFIERS

A sub-miniature high voltage rectifier obtained by Semtech's unique technology. A multi-junction device high temperature metallurgically bonded and fused in a non-cavity Metoxilite case. This small device is designed to solve packaging problems where size and environmental criteria are critical.

MEDIUM RECOVERY (Trr) 2 μsec
Peak Inverse V: 1000, 1500, 2000, 2500 & 3000V.
Average Rectified Current: 250 mA
Forward Voltage @ 100 mA, 25°C: 3.5V
Reverse Current @ 25°C: 1 μA; @ 100°C: 20 μA
Single Cycle Surge: 14A; Recurrent Surge: 2.5A
Body Dimension: .110" D x .215" L
Types: 1N3643-47 & SM20, SM25 & SM30

FAST RECOVERY (Trr) 300 ns
Peak Inverse Voltage: 1500, 2000 & 2500V
Average Rectified Current: 250 mA
Forward Voltage @ 100 mA, 25°C: 4V
Reverse Current @ 25°C: 1 μA; @ 100°C: 20 μA
Single Cycle Surge: 10A; Recurrent Surge: 2.5A
Body Dimension: .110" D x .215" L
Types: S15F, S20F & S25F

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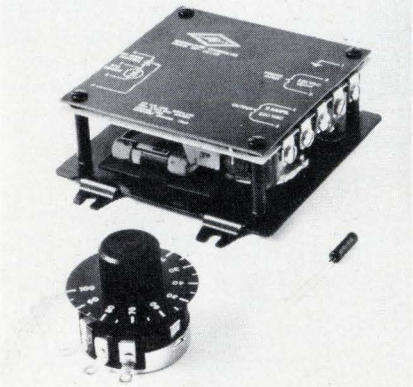
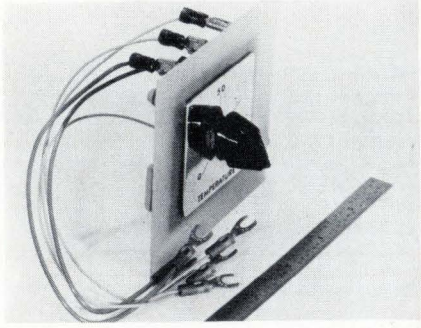


paper machinery, water and chemical baths, and food processing.
Heinemann Electric Co., 138 Magnetic Dr., Trenton, N.J. 08602 [376]

## Controller design eliminates rfi problem

A time-proportioning temperature controller, the model 5CX-62, has a complete solid-state control circuit. Zero-voltage-crossing firing of the triac virtually eliminates rfi noise commonly associated with phase-modulated controllers. The circuit design will not permit half-cycling, which assures freedom from possible transformer saturation problems. An isolated-case-output is provided to facilitate heat-sink mounting without need for electrical insulation. Quick-connect spade lug terminals are provided for easy installation. Thermistor sensors are used in a Wheatstone Bridge arrangement for good control sensitivity. Standard TX series probes provide temperature control from



# WESTON
# the newest family name in frequency counters.

Meet the newest name in frequency counters—from the country's oldest manufacturer of test equipment.

For the engineer, service technician or serious hobbyist, there's the new Model 1252, an autoranging crystal-clock counter, 5 Hz to 30 MHz range, 6-digit, and all solid-state circuitry. It features four autoranging gates plus two pre-set gates, automatic blanking of leading zeroes, and an unbelievably low price.

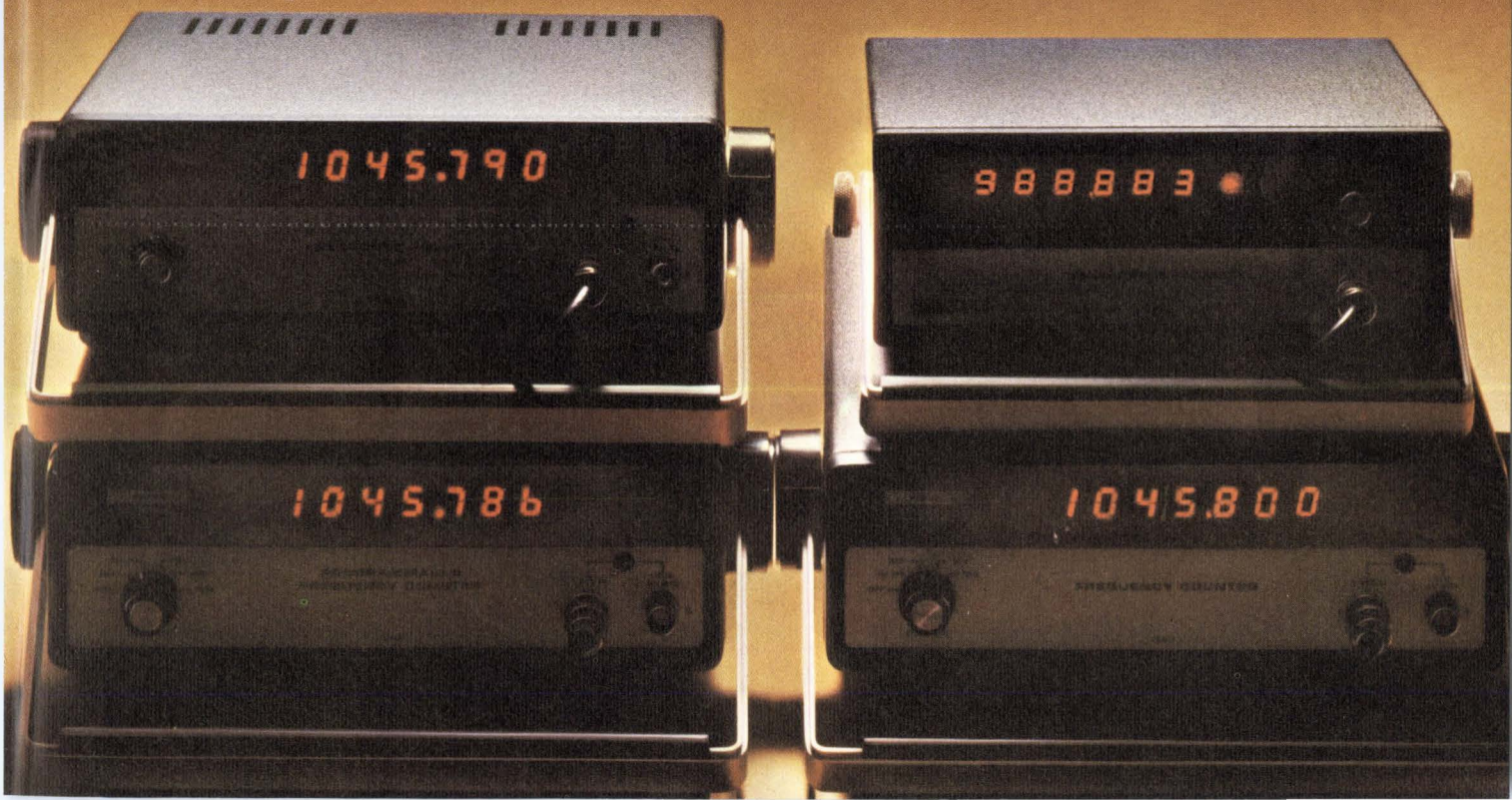
Those wanting more capacity in a counter can find it in Model 1253, a 1 Hz to 200 MHz instrument, with separate 1-megohm and 50 ohm inputs, 7 digit LED with overrange indicator, 1 MHz time base, and external clock input.

Great for precision work. Comparably low priced. Scientists, technicians and experimenters requiring the utmost from a counter can find the answer in either Model 1254 or Model 1255. Both have high-stability TCXO time bases, 1 Hz to 200 MHz range, BCD output, push-button re-set (first display is always correct), and remote programming capability. Model 1255 also has a pre-scaled 600 MHz capability.

Oh, yes, the WESTONS have a couple of cousins, too. There's Model 1251, a programmable 20 MHz timer with 100 nsec. resolution. It provides time interval, period, time average, event and ratio measurements in a 5-digit LED display. And, there's Model 1259, a 600 MHz scaler which will automatically extend the range of any counter to 6 MHz–600 MHz.

You can recognize the strong family resemblance in all these new members of the Weston test equipment team. They're all lightweight, compact and easy-to-use. Each has a lockable, multi-position handle which serves as a tilt-stand. See them all at your nearby Weston distributor today.

Circle 217 on reader service card.



# Try any one for 10 days free

## (Your WESTON distributor is betting you'll never want to give it up.)

Weston, the leader in portable test equipment, is willing to bet that once you try one of our digital DMM's, you'll never want to give it up.

So, during the next few months you can try any one of these compact, portable, almost indestructible multimeters for 10 days—FREE! Just pick the one that suits your needs best.

**Model 4440** Lowest cost, plus high performance. Full 3½ digits. 17 ranges, 20 mV to 1000V, 200 ohms to 2 megohms, plus AC/DC current. Blinking overrange indicator. Self-contained, re-chargeable battery—over 8 hours continuous operation. Or, use AC line converter. ($285. list)

**Model 4442** 20 ranges, plus amazing accuracy. ±.05% of reading ± one digit—guaranteed! All solid-state circuitry built around MOS/LSI chip. Automatic blanking of unused digits conserves power. Battery or AC line converter. ($325. list)

**Model 4443** Lowest price, most precise, DC-only DMM available. 13 ranges, 200 mV to 1000V (100uV res.), 200 ohms to 20 megohms (0.1 res.), plus current. ±.05% of reading ± one digit—guaranteed! Battery operated. Complete with charger. ($285. list)

**Model 4444** The autoranging maximinimultimeter. Choose VAC, VDC, Ohms or DC current. The 4444 does the rest. Instant automatic range selection. Plus four full digit display including polarity. Ultimate accuracy in a portable, ±.02% of reading ± one digit. No other portable offers more, does more. ($575. list)

So try one today. Send in the attached postal reply card for more details. Your nearby Weston distributor will contact you. Weston Instruments, Inc., 614 Frelinghuysen Avenue, Newark, N.J. 07114.

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☐ #217. Weston Frequency Counters: All ☐ Model 1252 ☐ Model 1253 ☐ Model 1254 ☐ Model 1255 ☐ Model 1251 Timer ☐ Model 1259 Scaler ☐

☐ #218. Send me detailed information on Weston's 10-day free trial offer on DMM's. ☐ Or, have my nearby Weston distributor contact me. Phone_____.

Name_____

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Company_____

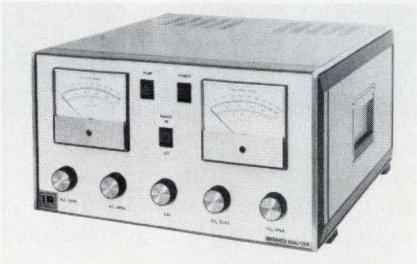
Address_____

City_____ State_____ ZIP_____

-65° to +425°C in four ranges. Price is $29.20.
Oven Industries Inc., P. O. Box 229, Mechanicsburg, Pa. 17055 [377]

## Infrared analyzer measures gas-mixture constituents

By sensing the attenuated infrared energy, the NDIR gas analyzer measures the concentration of the gas constituents in a gas mixture. The unit was designed for various



gases including CO, $CO_2$, HC, NO, and $SO_2$. Optional features include linear outputs, internal optical calibration (which eliminates the need for span gas), and corrosion-resistant fittings for process streams. The analyzer is capable of measuring up to three gases simultaneously and is suited for applications in petrochemical, food, medical, and metals industries.
Infrared Industries Inc., P. O. Box 989, Santa Barbara, Calif. 93102 [379]

## Centering computer added to precision gaging systems

An electronic centering computer that will automatically center the chart recording of parts being measured on roundness machines has been added to the Gould line of precision gaging systems. CompuCenter I operates as a component of the company's spindle-drive Surfanalyzer 136 and 360 roundness-gaging systems. Used in combination with a simple locating fixture, the CompuCenter makes repetitive production-line measurements almost automatic. When connected to a roundness system, CompuCenter I accepts electronic signals from the

## New products

recorder for readings up to two times full scale. CompuCenter I is set up to work at 4 revolutions per minute. The full centering process

takes 30 seconds. A green "ready" light indicates to the operator that the computation is complete, and the recording pen can then be lowered onto the chart.

Marketing Manager, Measurement Systems Division, Gould Inc., 4601 Arden Dr., El Monte, Calif. 91731 [378]

### Digital countdown timer made for industrial jobs

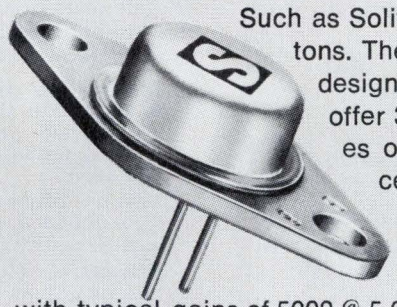
Model I-ms digital countdown timer displays both minutes and seconds in large luminous numbers for close control. Push-button controls provide virtually uninterrupted oper-


ation and include "reset," "preset," and "power." A digital readout indicates the time required to complete. An audio alarm is also available. The standard unit operates on 115 volts, 60 cycles, with other voltages and time ranges available. The price is $75 in small quantities.

Nucon Co. Inc., 2557 Charleston Rd., Mountain View, Calif. 94040 [380]

# Oh, you Darlington!

## *10 Beautiful AMPS of Unequalled Performance*



Some of the best things come in small packages. Such as Solitron's 10 Amp single diffused Darlingtons. These NPN Silicon Power transistors are designed into a compact TO-66 package, but offer 30 watts dissipation and $BV_{CEO}$ ranges of 50, 80 and 100 Volts. They have excellent second breakdown capability and low leakage characteristics. Typical $I_{CEO}$'s at an elevated temperature of 100°C are less than 1.0 mA, with typical gains of 5000 @ 5.0 Amps and $V_{CE}$ (sat) @ 5.0 A typically 1.2 Volts. Identified as the SDM 2501-6 Series, these Darlingtons are ideal for power switching, inverters, converters and audio amplifier applications.

**For complete information, prices and engineering application assistance, dial toll-free 1-800-327-3243. Or write:**

**Solitron DEVICES, INC.**

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## New products/materials

**A silver/urethane** conformal coating consists of a pure silver filler in a polyurethane resin. The one-component conductive air-drying system adheres and conforms to various substrate materials and cures at room temperature. When dry, the material is reflective to microwave energy.

Tecknit Wire Products Inc., 129 Dermody St., Cranford, N.J. 07016 [476]

**A silver metalization process** for mica electronic applications comprises two products—mica silver type 1 for screening and mica silver type 2 for brushing applications. The preparations are applied to mica to form electrodes for capacitors and for conductive lines. Price per ounce is $10.

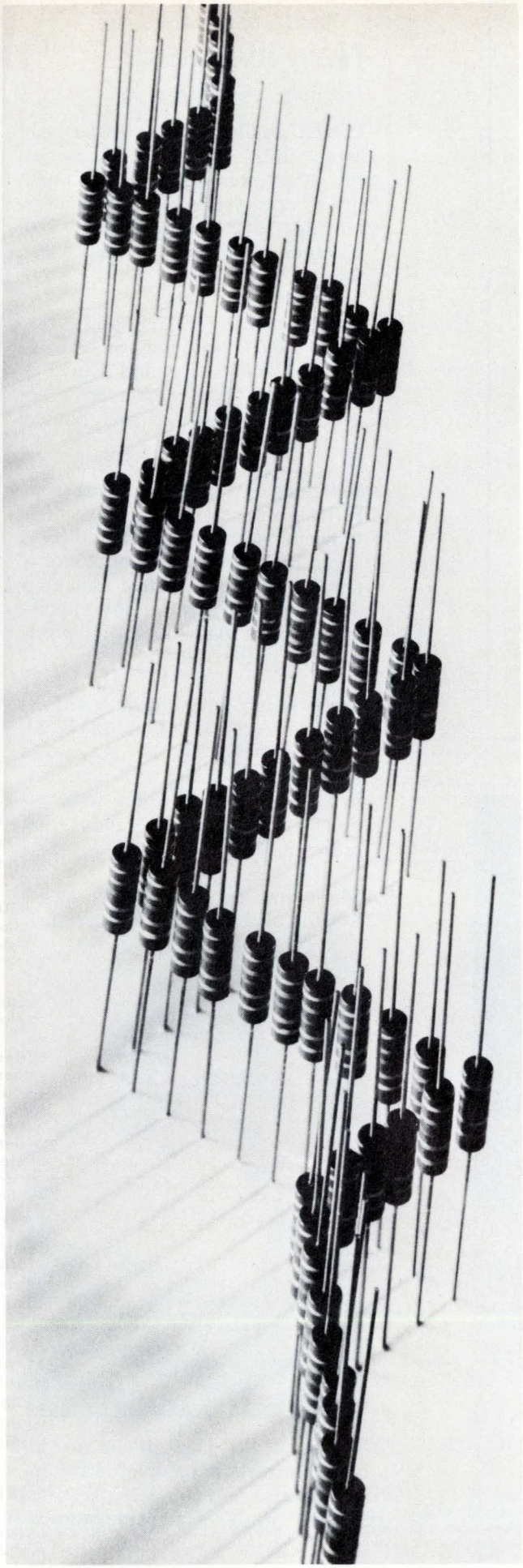
Transene Co. Inc., Rte. 1, Rowley, Mass. 01969 [477]

**A one-component silver epoxy** with a work life of one week is designated Ablebond 36-2. The conductive material retains 0.0001 ohm-cm resistivity to 400°C and has a 1,000 psi lap shear strength after 250 hours at 200°C. It can be dispensed in 4-mil dots or screened. Price for the material in a 1-cc syringe is $3.30. A one-ounce jar costs $13.75.

Ablestick Laboratories, 833 W. 182nd St., Gardena, Calif.[478]

**Eccomold 195R is an epoxy** molding powder with a flow soft enough to encapsulate glass-enclosed reed switches. Although higher molding temperatures may be used, the material can be molded at 250°F. Molding pressures are from 100 to 1,000 psi. Price is $1.75 per pound in 2,500-pound lots.

Emerson & Cuming Inc., Canton, Mass. [479]



# Buying your carbon comps from distributors?

# Then here are five good reasons for buying IRC.

**Delivery.** TRW/IRC carbon composition resistors are available. A full line of RCR S-level ¼, ½, 1 W from 2.7 ohms to 22 megs is in stock at your local TRW distributor. If you need his name and address, contact us.

**Quality.** IRC carbon comp performance has been proven in use by the billions—consumer, industrial and military applications. Ours were the first resistors to receive hi-rel qualification and are backed by nearly a billion test hours—*with no failures.*

**Price.** TRW distributor stock—with the same competitive price for *both* industrial and mil spec applications —is standardized on S-level RCR types (best failure rate level available in the industry).

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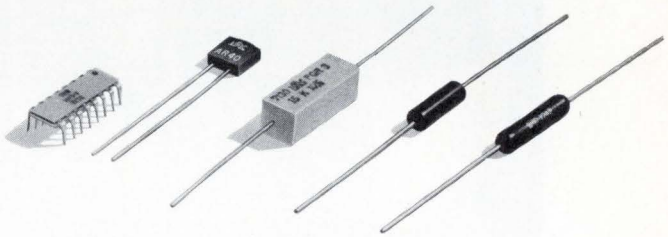


**Complete resistor choice.** TRW offers a total resistor capability—carbon composition, thin film, Metal Glaze™, wirewound and other types. Broadest line in the business. All from *one* source—your local TRW distributor. He'll be glad to work with you on all your resistor requirements.

Contact Distributor Operation, TRW/IRC Resistors, an Electronic Components Division of TRW Inc., 401 N. Broad Street, Philadelphia, Pa. 19108. Phone (215) 923-8230.

**TRW® IRC RESISTORS**

# New literature

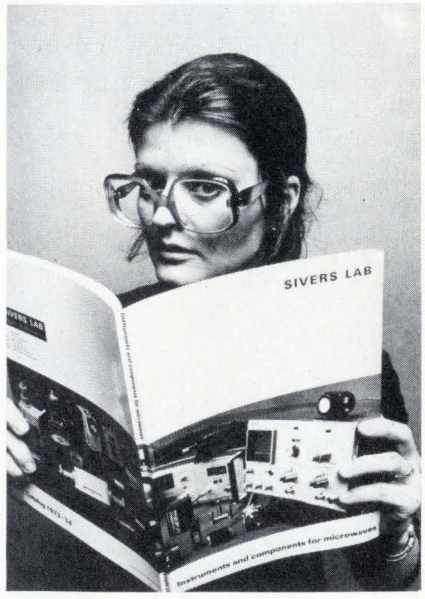
**Crystal oscillators.** A 14-page brochure from Vectron Laboratories Inc., 121 Water St., Norwalk, Conn., covers crystal and clock oscillators ranging from 1 hertz through 200 megahertz. Circle 421 on reader service card.

**Relay sockets.** Viking Industries Inc., 21001 Nordhoff St., Chatsworth, Calif. 91311, has issued a catalog covering the company's relay socket connectors and related hardware. [422]

**Switching.** A two-page catalog from Fifth Dimension Inc., Box 483, Princeton, N.J., describes the theory, application, and specifications of a family of mercury-wetted switching devices that operate in any mounting position. Both dc and rf products are covered. [423]

**Power supply.** Elcom Industries Inc., Civilian Terminal, Hanscom Field, Bedford, Mass. 01730. A line of modular power supplies is described in a data sheet providing information on features, specifications, and ordering. [424]

**Microwave.** Sivers Lab, Box 42018, S-126 12 Stockholm 42, Sweden, is




offering a 104-page catalog providing information on microwave instruments, YIG devices, ferrites, rotary joints, electromechanical

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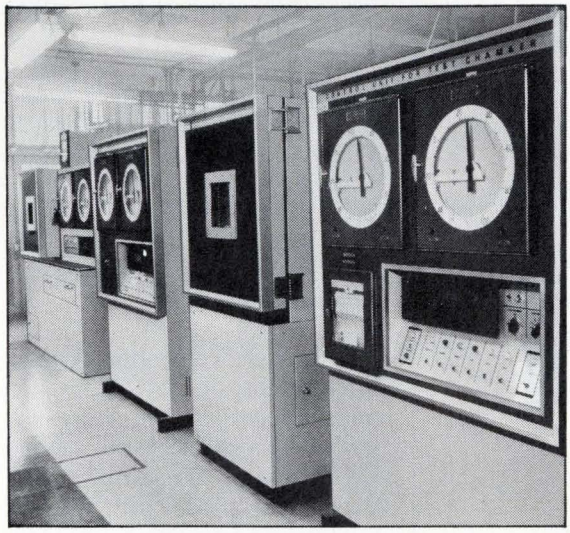

If you could take an express trip from the North Pole to the equator, you'd experience roughly the same effect as our special environmental testing has on the fingertip-size "Toko Pulse Transformer." More than a thousand hours of exhaustive testing in temperatures ranging from −55°C to +85°C and humidity increasing from zero to 98% allow no rest for these electronic machine parts. In addition, anti-vibration and anti-shock tests are repeatedly performed to satisfy uncompromising Toko standards.

Only after repeated and severe testing can we determine if the quality of each piece of circuitry is acceptable. From the radio and TV components that brighten our everyday lives to the electronic miracles that will enable man s exploration of the universe, even a single flaw in the smallest electronic part could spell failure . . . even disaster.

No wonder, then, we strive to maintain such strict standards for all Toko products. Achievements like the development of the Pulse Transformer, Delay Lines, Wire Memories, Super-Miniature Coil and other innovative Toko products require this conscientious attitude, combined with a pioneering spirit, ready to meet every demand placed on the Toko brand wherever it appears in the world.

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**Toko (U.K.) Limited:** 59-67 Gresham Street, London

## New literature

switches, and transmission-line components. Included are calculation charts for high-power designs [425]

**Calculator.** A four-page brochure provides information on the model 1175 electronic printing calculator available from Facit-Addo Inc., 501 Winsor Dr., Secaucus, N.J. 07094. A chart is included, as well as a diagram of the keyboard and information on operating procedures. [426]

**Switches.** Seacor Inc., 598 Broadway, Norwood, N.J. 07648. An eight-page catalog describes the series MX push-button-switch system. [427]

**Core memories.** Standard Memories Inc., 2801 E. Oakland Park Blvd., Fort Lauderdale, Fla. 33306. A six-page brochure describes the company's line of add-on compatible core memories which expand IBM 360 computers to up to four times capacity. [428]

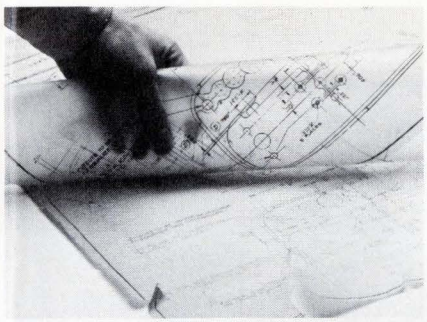
**Temperature controller.** A high-low limit protection device designed to limit process temperature is described in a brochure available from Eagle Signal Division, Gulf + Western Industries Inc., 736 Federal St., Davenport, Iowa 52803 [429]

**Packaging hardware.** A short-form catalog describes the product line of the Scanbe Manufacturing Corp.,


3445 Fletcher Ave., El Monte, Calif. 91731. The products include socket cards, files, sockets and strips, and wiring. [430]

# Don't overdraw. Use these Kodak shortcuts:

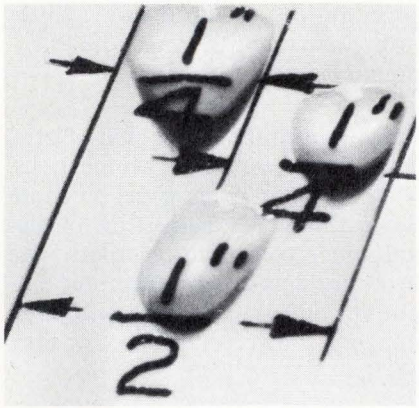
## The snappy restoration shortcut.



Why waste time retracing your old, battered drawings? Restore them by making sharp, clean photographic reproductions on Kodagraph film. Weak lines come back strong and clear. Stains virtually disappear. And instead of gray lines on yellow, you'll have snappy, contrasty, black-on-white prints.

## The drop-of-water shortcut.

Why retrace the whole design for a few revisions? Just order a second original on Kodagraph wash-off film. Then use a drop of water and erase unwanted details.




Draw your design revisions on the film and you're done.

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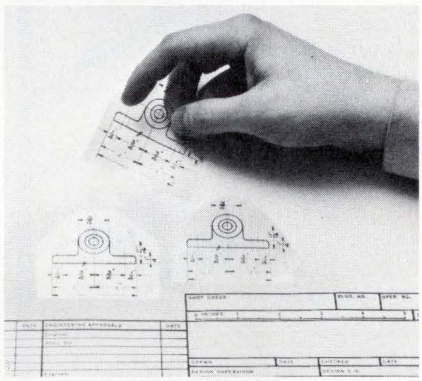
Why draw the same detail over and over? Kodagraph film will do the job for you. That way you draw the detail just once. Make as many photoreproductions as you need. Cut them out, paste them down, and make a Kodagraph film print of the paste-up.



Now you have a superb second original for subsequent printmaking.

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Drop us a line for more facts on how you can reduce drafting time and save money too, with Kodagraph films and papers. Eastman Kodak Company, Business Systems Markets Division, Dept. DP832, Rochester, N.Y. 14650.

**Kodak products for engineering data systems.**

Kodak

## New literature

**Disk drives.** Diva Inc., 607 Industrial Way West, Eatontown, N.J. 07724. Specifications and descriptions are given in a brochure describing seven magnetic-disk-drive systems. [431]

**Connectors.** A 28-page catalog from Solitron/Microwave, Connector Division, Cove Rd., Port Salerno, Fla. 33492, contains photographs and dimensional drawings of several types of TNC connectors. [432]

**Disk drives.** International Memory Systems, 14609 Scottsdale Rd., Scottsdale, Ariz. 85260. A 24-page manual covers the line of moving-head disk drives and controllers and provides schematics and specifications. [393]

**Product catalog.** A comprehensive catalog from BLH Electronics Inc., 42 Fourth Ave., Waltham Mass. 02154, describes wire and foil strain gages; pressure transducers; strain gage, process control and calibration instrumentation; and proprietary systems. [434]

**Image recorder.** Dicomed Corp., 7600 Parklawn Ave., Minneapolis, Minn. 55435. A six-page brochure describes the company's line of digital-image color-film recorders. The brochure details how computer output is converted to high-resolution imagery and recorded on color film. [435]

**Capacitors.** Sprague Electric Co., 35 Marshall St., N. Adams, Mass. 01247, has released an eight-page engineering bulletin to simplify ordering MIL style CE70 and CE71 electrolytic capacitors to the D revision of MIL-C-62/12. [436]

**Fiber optics.** American Optical Corp., Fiber Optics Division, Southbridge, Mass. 01550. A fiber optics catalog covers the company's standard line of products as well as custom-design capabilities. Featured in the catalog are flexible Fiberscopes used to view inaccessible areas, light guides, image conduit, clad rod, faceplates, and components. [439]

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* Advertisers in Electronics International
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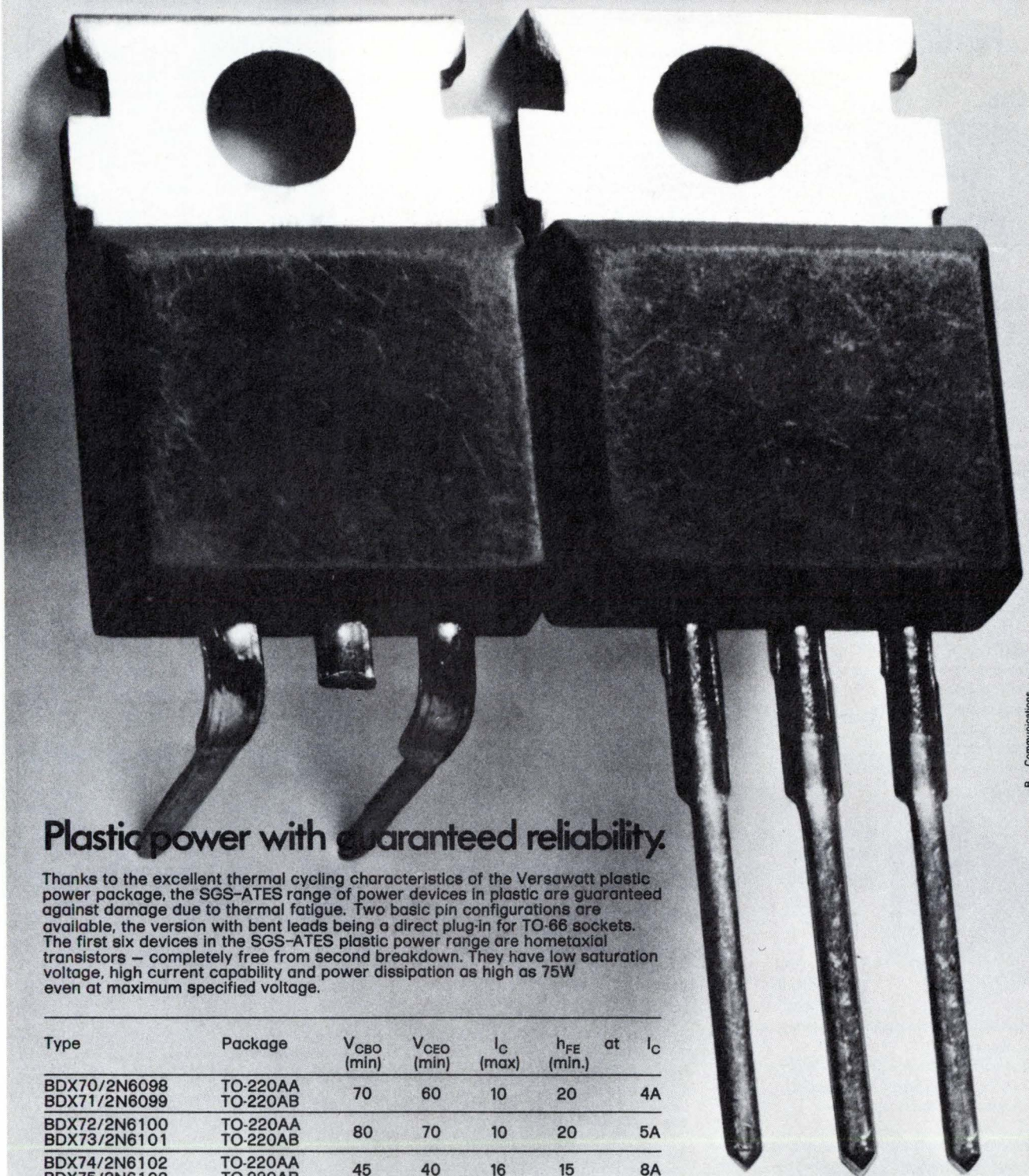
# Bestsellers



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*Item:* When today's average worker of 22 retires, he and his wife, according to Social Security actuaries, will receive an annual pension of *$38,000*. Moreover, the total amount of Social Security he and his wife can expect to collect *will surpass half a million dollars!*

*Item:* The average American doesn't know it, but the single most valuable asset he now possesses is his Social Security. It is equivalent, in maximum brackets, to a guaranteed 5% income on cash in bank, stocks or real estate worth *over $100,000*. Moreover, every cent of this bounteous income is *TAX FREE!*

*Item:* Most Americans still believe, mistakenly, that Social Security is a dole exclusively for the aged. The fact is, however, that *10 million* Americans under the age of 60 (and averaging a mere 30) are now collecting Social Security. These non-old age pensioners receive *$13 billion* annually, and both their number and the amounts of money they collect are bound to increase in years ahead. So generous has Social Security for younger Americans become, in fact, that it amounts to Free Money.

The biggest problem in connection with Social Security—as the government itself is first to admit—is giving the money away. That is, the public's woeful ignorance of the availability of funds has prevented its full distribution. *Over one billion dollars*, according to experts, remains undistributed in U.S. Treasury vaults simply because no one steps forward to claim it.

To help overcome this shocking public ignorance, and see that you get your share of the Social Security largesse, the editors of **Moneysworth**, the authoritative new consumer-affairs and personal-finance fortnightly, have prepared—as a public service—a comprehensive, lucid, savvy, astonishing new manual entitled *STAKE YOUR CLAIM! How to Work the Social Security Gold Mine*. A copy is yours *ABSOLUTELY FREE* with a subscription to **Moneysworth**.

*STAKE YOUR CLAIM! How to Work the Social Security Gold Mine* is more than just an encyclopedic reference work with charts, tables, descriptions of benefits and sample application forms. It is a personal adviser in a field of finance where impartial advice is otherwise almost impossible to obtain (the government, of course, is biased and lawyers are almost never willing to accept Social Security cases because, by law, they are not permitted to charge more than about $10 per case). Among the priceless nuggets of information you will pick up from *STAKE YOUR CLAIM!* are answers to such questions as:

- How can you qualify for a pension even though you have never worked a day in your life, or contributed a cent in Social Security taxes, or even nearly reached the age of 65?
- How can you arrange to collect Social Security from *both* Canada and the U.S.?
- Why is it crucial to check the balance of your Social Security account periodically?
- Does it ever pay to take out *two* Social Security cards?
- Is it true, as some say, that you should "shop" at different Social Security offices since different interpretations of regulations can result in pensions of different amounts?
- What steps, if any, are necessary to protect your pension from attachment by creditors?
- Since, as studies have shown, two out of three workers *over*pay their Social Security taxes, how can you check on your payments and possibly obtain a refund?
- What forms of deception have people employed in order to maximize their Social Security benefits and collect pensions early?
- What federal program helps retired persons get jobs to supplement Social Security?
- What happens to your pension if an employer deducts Social Security taxes but fails to forward them to Washington for credit to your account? What special steps should you take if the firm you work for is financially shaky?
- How do you go about getting one of Social Security's huge "lump sum" payments?

In short, *STAKE YOUR CLAIM! How to Work the Social Security Gold Mine* is a treasure map to the Social Security mother lode, telling what pitfalls to avoid, what tools to use, how to find your way through the maze of regulations and how to hit pay dirt. Its editor and compiler is Ralph Ginzburg, the 43-year-old publisher of **Moneysworth**, who himself collects $99.40 in Social Security every month and has been getting Social Security since he was 25. To repeat, a copy of *STAKE YOUR CLAIM! How to Work the Social Security Gold Mine* is yours *ABSOLUTELY FREE* with a subscription to **Moneysworth**.

In case you're not familiar with **Moneysworth**, let us explain that it is America's most ingenious periodical dealing with personal finance and consumer affairs. It will positively flabbergast you with its inventiveness for making and saving money. In less than three years it has bestowed the Midas touch upon *nearly a million* ecstatic subscribers and has become the most widely read newsletter *IN THE WORLD*. Perhaps the best way to describe **Moneysworth** is to list the kinds of articles it prints:

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**Digital Wristwatches: A Product Rating**
**Buying a New Car for $125 over *Dealer's* Cost**
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**Dog Foods Fit for King**
**How to Contest a Bad Credit Rating**
**Quadraphonic Hi-Fi: Innovation or Hype?**
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**Earn Interest on Your *Checking* Account**
**How to Fight a Traffic Ticket**
**14 Ways to Save on Your Phone Bill**

In sum, **Moneysworth** is a shrewd, trustworthy financial mentor. It is the quintessence of sophisticated gainsmanship.

The staff of **Moneysworth** is a team of hard-nosed, experienced journalists with a record of genius in the field of consumer affairs. Its publisher, as we mentioned earlier, is Ralph Ginzburg, creator of the daring and flamboyant magazines *Fact*, *Eros* and *Avant-Garde* (Mr. Ginzburg was first to publish Ralph Nader). **Moneysworth**'s editor-in-chief is Albert Lee, a former top editor of *Better Homes & Gardens*. Radiating from this nucleus of editorial energy are reporters and product-testers throughout the U.S.A. Together they create America's first—and only—consumer periodical with *charisma*.

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This PERSONAL BUSINESS section is written by McGraw-Hill editors to give you helpful information on the better management of your leisure time and money. Personal Business covers everything from taxes and investments to education and travel. We feel that today, more than ever, personal-business planning is of prime concern to businessmen and professionals.

SECRETARY '73

# Still available: Your own 'Girl Friday'

Are you looking for a private secretary with the appeal of an Ali MacGraw, the style of a Lauren Bacall, and the tact and polish of a man like yourself?

It may just be possible to find her among the new crop of young commercial school, junior college, and even four-year college grads who will be eyeing the secretarial market next month. Or, your search may well encompass a lightly seasoned crop, say, those above age 30. Whichever way, though, if the screening is to be for top talent, the finalists will be *vintage '73*—you won't find an old-fashioned girl in the bunch.

What this means, actually, is that you will be confronted with some fresh viewpoints and attitudes, including some on Women's Lib—*and* demands—that may or may not come as a surprise.

The evidence adds up: In major urban areas, Women's Lib, though no earth shaker among secretarial types, has kindled some degree of determination to rid the office of its (so the gals say) ancient anti-female inequities. And on top of this, the record shows, too, that women in business have lately been making many solid gains, oftentimes as executives themselves.

And so the coin is two-sided. For his part, the businessman in today's competitive climate needs a highly skilled secretary—as his job gets more complex, the girl who sits outside his office must be just that much better qualified. But conversely, *he* too needs to be better qualified, especially in terms of having broader ideas on delegating duties to his secretary. Today's secretary has a No. 1 complaint: she gets too little responsibility and not enough authority.

"What the executive's secretary wants makes common sense," says a Boston company president. "She wants work on a higher level, a little clout to do it, and money to go with it. As her boss, you expect more—and you get more."

Management consultants and psychologists to the trade for the most part agree to this proposition, and feel that this kind of awareness of Women's Lib and its broad implications is surely a sensible idea. At the same time, they point to a veritable officeful of ideas on how to sift and screen secretarial talent to find, as one says, "the *particular* Girl Friday you're looking for."

The professionals suggest these rules for starters:

■ *Type.* Get a girl who *wants* to be a good, highly regarded and well paid secretary. Says New York consulting psychologist Dr. John Drake, of Drake-Beam Assocs.: "Get someone whose needs will be met by the job you offer—not one who wants to step up into management herself. Ask her very directly about her ambitions; you may be surprised at the candid answers you get."

If "emotional needs" are delved into, the psychologists will often center in on the secretarial applicant who has a need to be helpful. "For example," says Dr. Drake, "you might pick a girl who's been in activities that demonstrate the helpfulness quality—church work, hospital volunteering, and such."

Some very open questioning along these lines can be fruitful. " 'How do you honestly feel about getting coffee for the

boss?' is the kind of question that may prove revealing. Some very fine private secretaries—capable of doing many things in an office—actually *like* getting coffee for the boss."

■ *Balance.* Pick a secretary who will balance your own shortcomings. Dr. Mortimer Feinberg, a Manhattan psychologist who has consulted with a number of major companies, cites speechwriting as the sort of chore that can be part of such balancing. "If you make a lot of speeches," he says, "but find that writing them is an agony, hire a bright girl with the skill to take bare ideas and put them in the form you want."

Dr. Drake offers the example of the executive who is introverted (possibly in science or engineering) and somewhat removed from the office staff about him.

> "Pick a secretary who will balance off your shortcomings"

"He needs a secretary who is gregarious and can handle the people in the outer office." Or, he adds, the man who abhors routine and whose desk shows it should hire a good organizer.

Katherine Gibbs School, the New York-based training ground for countless high-powered secretaries in business, reports that such tasks as speechwriting are increasingly part of the workload carried by many of its 18,000 graduates. "One of the tricks in hiring a secretary," says Barbara Lyon who is in charge of the school's alumni relations, "is to take advantage of these special talents and make up for some abilities you lack. Don't hire a girl just like you."

■ *Mood.* Pick a secretary who is pleasant, but not obsequious. The ever-smiling, fawning gal is a type to screen out, say the pros, because she is apt to be concealing some sort of inner frustration. "It can mean bitterness," says Dr. Alexander Wesman, of Psychological Corp. "—for instance, wishing that she didn't have to work in an office at all."

The obsequious type also may fall short in other ways. Here the prime example is that of the secretary who is so "nice" that she is unable to tell the boss when he is dead wrong and heading into some embarrassing blunder.

"Let's be honest," notes the Boston company president, "whether you're top man or middle management, you want a girl who can help you out of possible jams and deal with others for you—so you want a girl with some spunk." One of the important jobs of the top-notch secretary, he adds, is to shoo away the idle talkers, favor-seekers, and problem children that tend to converge on the office of the senior executive.

■ *Vitality.* Try if you can, say the pros, to pick a girl who has that intangible spark that somehow attaches the word "success" to whatever she does. "You can find all sorts of abilities—that's fine," notes a Columbia Business School psychologist. "But when you hire her, get someone who manages to convince you at her *first* interview that she's vitally interested in the job. If she's passive, she lacks the quality you want and need most: enthusiasm."

However depressing it may be, the evidence says clearly that the cute, good looking girl of, say, age 20 or 22, though well trained and bright as one might wish, will oftentimes find it a lot harder to make the grade as an executive secretary than someone five or 10 years her senior. The ideal age bracket, say consultants, is 30 to 45—at least, where fairly sophisticated duties are in store. The 30-year-old remains ripe for training on the job, a major plus; and this holds, too, for the woman of 40, provided she isn't set in her habits and attitudes.

"Remember that a person of 40 or more may relate better to older men in the office," says Dr. Drake. "This may or may not fit your situation."

If the woman to be considered is single, fine—though the warning sounded is to steer clear of the "old-maid" type. If she is married, make certain that her husband is steadily employed, but there is a twist here that some psychologists like to emphasize:

> "She wants work on a higher level, a little clout—and *money* to go with it."

You'll likely be better off, they say, if his job is below the management or professional level. At the same time, don't hire a secretary if she will be earning as much or more than her husband. This can mean trouble, and a phone call to his employer may keep you out of it.

If she has children under 16, be sure that they have steady daytime home supervision. This can, of course, be crucial, and it's a point to clear early in the interview.

Ideally, the experts maintain, a top executive or key middle-management executive should have a girl with two years of college, or more, plus the usual secretarial training. In any case, don't reject a girl as being "overqualified" because she is a college graduate—unless she has an advanced degree. The gal hired should score well above average in secretarial-skills and language-usage tests—but beware "personality tests" which can be faked by a job-seeker.

What about hiring a male secretary in this day of liberation? Do changing attitudes mean you'll have to hire a "Man Friday" one of these days? Probably not, says Dr. Wesman: "He's a rare bird, and likely to remain so." ■

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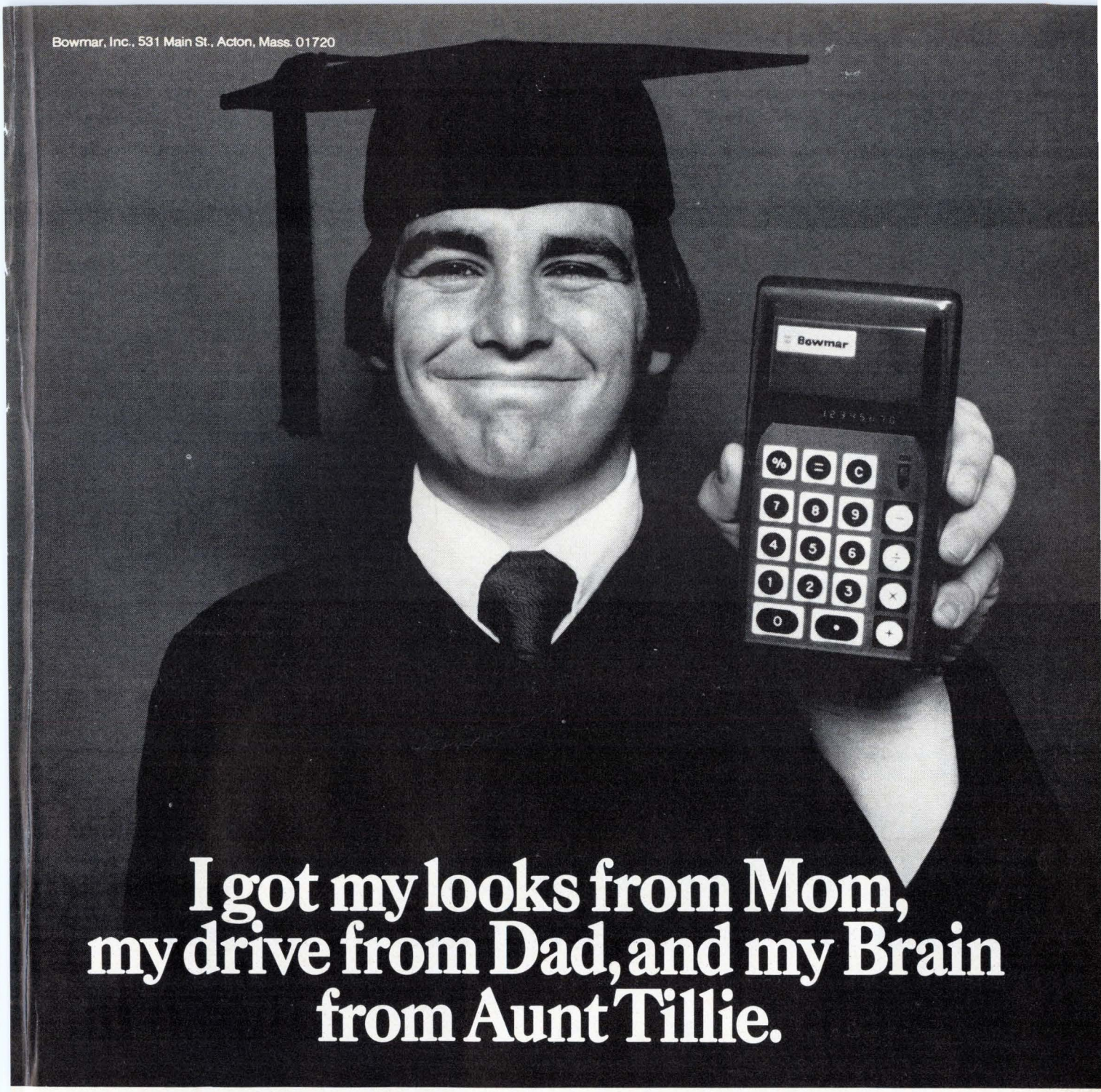


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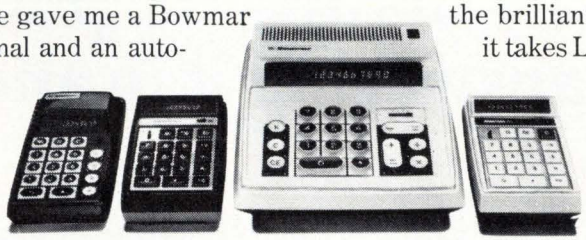

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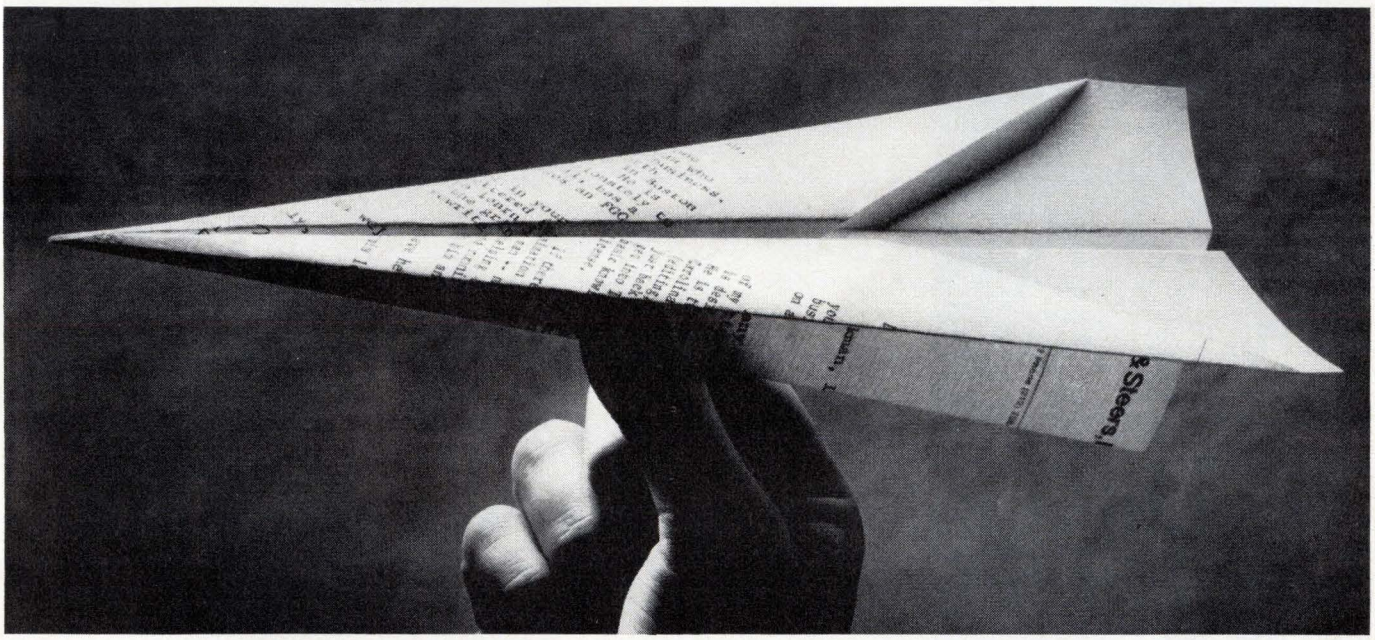

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# Looking over the choppy sea of used craft

A Newport Beach, Calif., boat dealer is rubbing his hands with joy. In one recent 30-day period more than $250,000 worth of second-hand craft sailed away from his docks with new owners. Up the coast, a prominent Seattle jurist is selling his California-built Columbia 36 for $19,000—$1,000 more than he paid for it five years ago.

They are just two of the happier beneficiaries of a phenomenon of the nearly $4-billion boating industry—the perky market in used boats. It's moving right along with new-boat sales, which, due to an early spring, were booming by mid-March this year, even in usually late-to-thaw New England.

What's sparking the used-boat business? Trade-ins for new boats, for one. But there are also pocketbook reasons. Approached with proper care, the better parts of the used-boat market—reputable brokers, dealers, and responsible private owners—can be where the best dollar-for-dollar deals can be made, particularly by newcomers to the boating craze.

"You have to be some kind of rich eccentric," snorts a sun-baked Miami salt, "to buy your first boat right off a dealer's showroom floor. Read the classified ads. Even we old-timers do; it's a comfort to know what your own boat might be worth. And talk to boatmen. They're a loquacious lot. If there's a real bargain around, it won't remain a secret long."

Admittedly, most boatmen agree, the better deals are usually made in the moderately-priced ranges and up—with "moderately priced" meaning between $6,000 and $12,000 these days.

Boats, indeed, are high, and good ones hold their value in the market. So why buy *used* when you can get *new* for a few thousand more? The reason veteran seamen give is that you are buying not just a bare boat but one to which equipment has been added.

"The buyer of a new $20,000 boat may easily add $3,000 worth of equipment right away," explains Seattle yacht dealer Jay Wheeler. "You might have to pay him most of the $20,000 for his boat, but you won't pay anything for the equipment."

The market for second-hand smaller boats—those which originally cost $5,000 or less—operate pretty much like the used-car market. These craft have a quicker depreciation, as do their motors and other gear. But they are often the best place for real beginners to look.

Before even scouting for bargains, old salts strongly advise tyros, first, to do a considerable amount of sailing or motorboating to jell their thinking: Do you prefer cruising, day-sailing or racing? Where will you boat—lake, river, sheltered harbor, sound, or open sea? Does your family want to come along, and what are *their* preferences? Even with all questions pinned down, few beginners come up with the right boat for all time.

While some old-timers insist that there are too many *caveats* for beginners in the second-hand market, and that they should stick with brand-new equipment from established dealers, they offer these bits of advice for a safer passage in such waters:



- Fiberglass hulls are all the rage, and for a reason—they are less work and resist worms and other deteriorators. Avoid wooden hulls unless maintenance is your joy. Plywood hulls are out of fashion, but are good values if in good condition.
- Have any boat you consider pulled out of the water and examined by a qualified boat surveyor. His fee—usually no more than $2 to $2.50 a linear foot, plus haul-out costs—might be the best investment you make that day. Banks dealing in boat loans can refer one to you.
- Favor brand-name products over unknowns. They hold their resale value better, and some even appreciate. Learn the better foreign names, too. In some cases, reputed superior craftsmanship has given them the value edge over comparable American makes.
- If you can afford it, go for the sailboat with an inboard auxiliary motor. "Outboards are a pain," says one California sailor. "They're either hung up on the stern or down in a well where they're hard to use."
- Be prepared, psychologically as well as financially, to spend more than you ever intended. Off-season storage fees, for instance, can run up—and are a reason why many boats come on the market at season's end. In Miami, for instance, open-air space costs $1.50 per linear foot of hull, per month. Scarce covered storage is $2 a foot, per month.

When the time comes to get rid of a boat—as it does eventually—the bigger it is the harder it may be to sell. An alternative for yachtsmen in this category is to give it away—as a tax-deductible contribution to support research and education (IRS allows gifts up to 50% of adjusted income for this purpose). In the past five years, for instance, the University of Miami School of Marine and Atmospheric Science has received $800,000 in donations of boats, some of which came to it in bequests fully tax deductible from the donors' estates. ■

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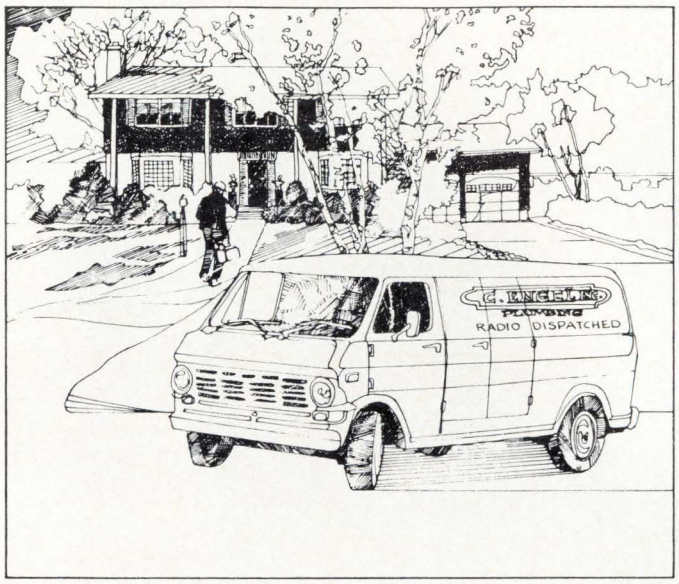


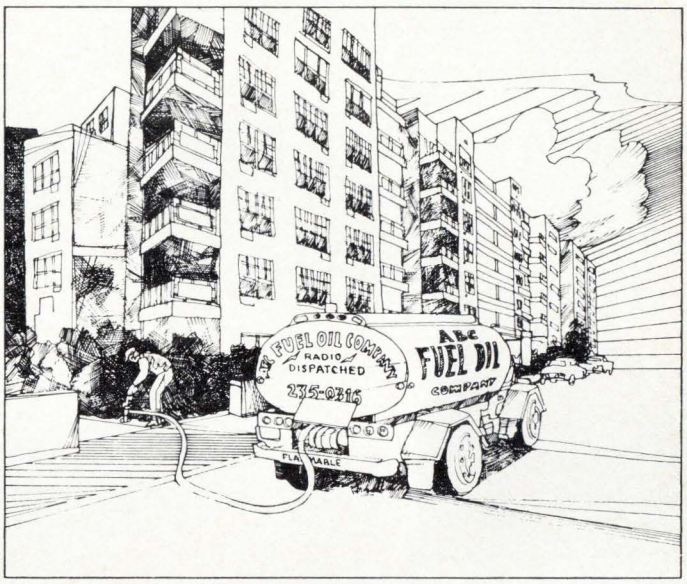


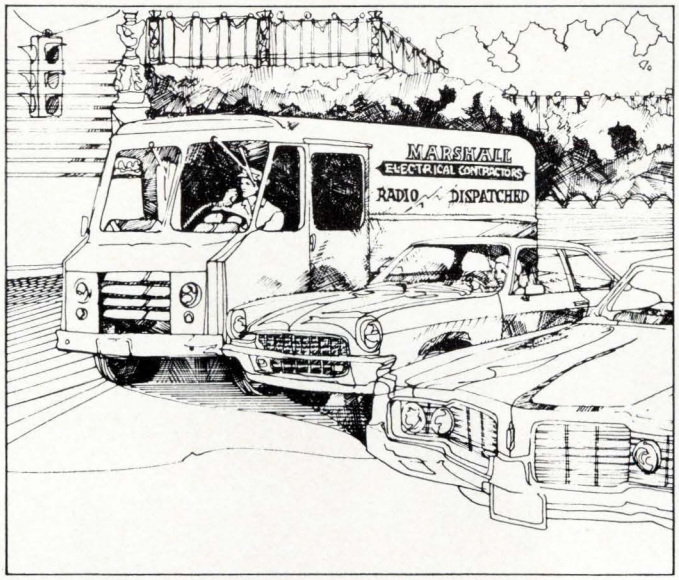


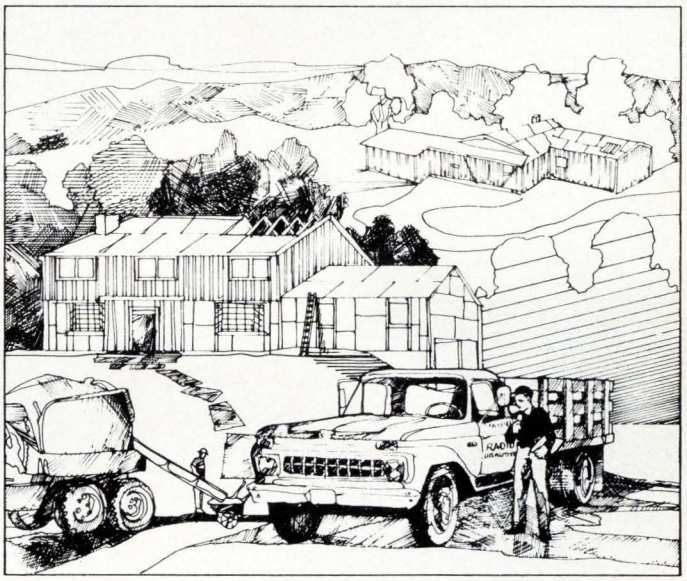

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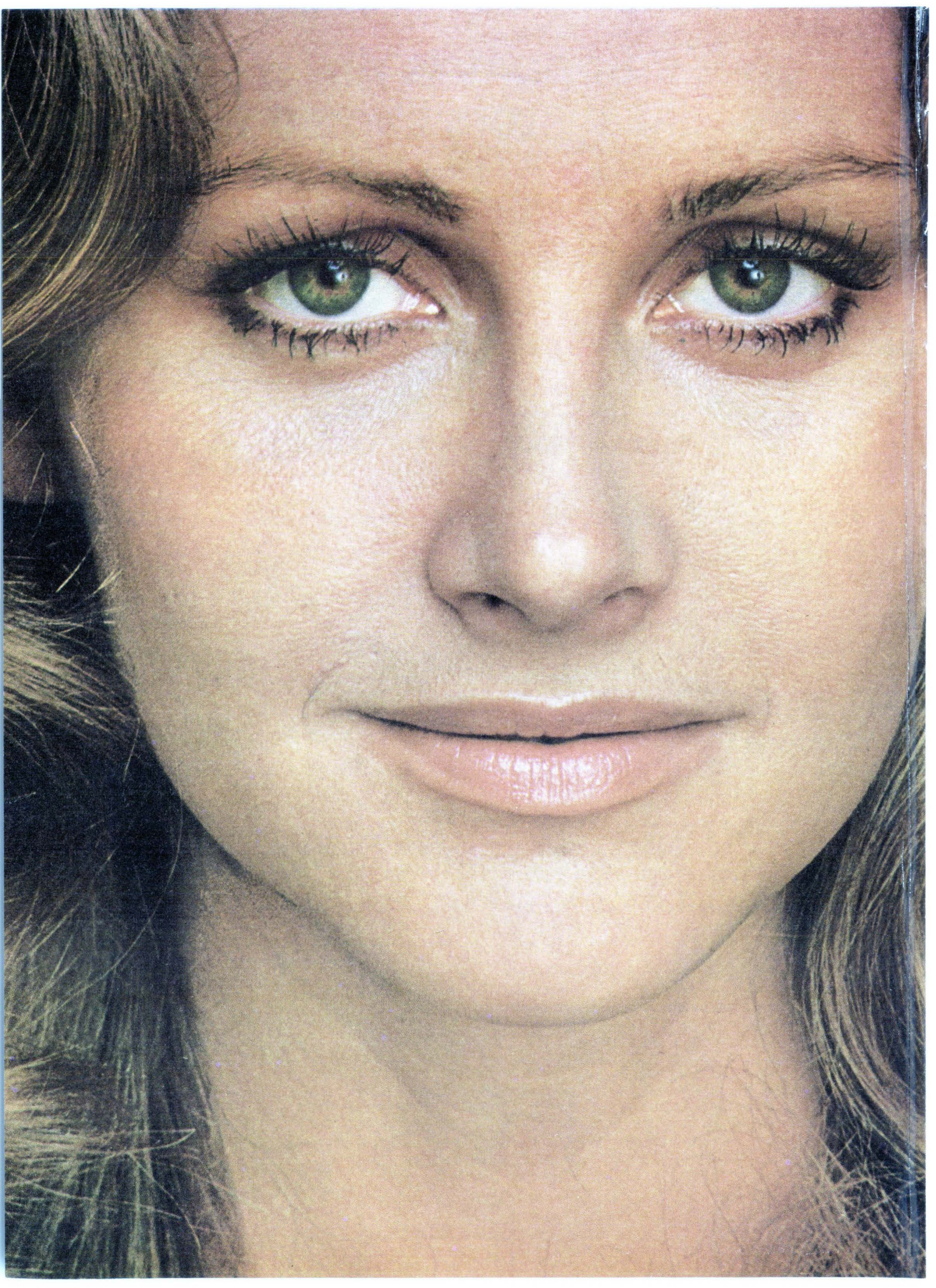

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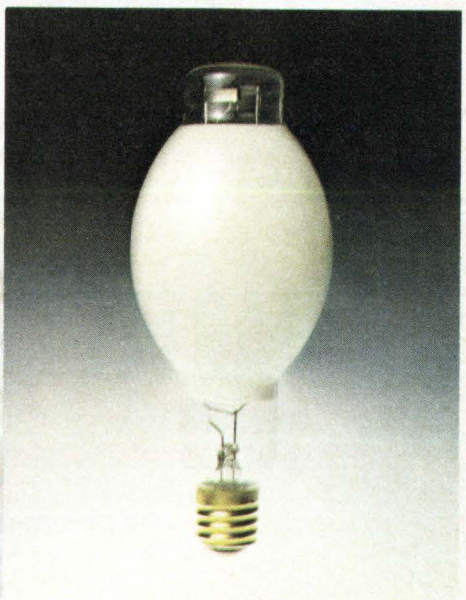

# Tips for survival in the dizzying commodities whirl

In the pits of the Chicago Board of Trade, the cries of the commodity men are fierce, the arm-waving and hand signals a language in themselves, and fortunes come and go with each tick of the clock. Until recently this was the almost-total domain of large commercial accounts. But the scene is changing. More and more small investors ("Call them *speculators*," insists one broker) are throwing themselves into the frantic futures market.

Commodity speculation could be the most hazardous "investment" around.

## THE MARKETS

Brokers say you can plan to lose on at least 60% of your transactions, and only hope that the remaining 40% result in big enough wins to make it all worthwhile.

How worthwhile? "Most successful speculators believe that if they don't make 50% on their money in bad years and more than 100% in good years, they have been wasting their time," says one speculator.

These markets have long been arenas only for those sophisticated enough to understand such gambits as fundamental analysis, margin calls, "spreading" and "going long." Lately, though, the opportunities to capitalize on big earnings has evoked the gambling instinct in the "small" investor—which means anyone with between $3,000 and $10,000 of risk capital. Many of these, unfortunately, know about as much about commodities as pseudonymical author "Adam Smith" who lost a bundle investing in cocoa futures, admitting, "All I know about cocoa is that it comes in little red cans . . ."

The typical new speculator is 45 years old, an executive type with a college degree and an income between $10,000 and $25,000 (although a large percentage make well over $25,000). There are 10 active commodity exchanges but the biggest is the Chicago Board of Trade, which trades $123 billion of the nation's $200 billion market each year—more than the value of all securities on the New York Stock Exchange.

But any similarity between commodities and securities trading ends there. The purpose of a commodities market is not conventional investment. It's to

transfer the risk of producing, selling and buying a commodity at a future date from the producer (seller) and ultimate buyer to the speculator.

The profits can be much higher, and the initial investment (on margin) much smaller, than in the securities market. For example, last November, a speculator could have purchased one contract for delivery of 5,000 bushels of March soybeans at $3.69 ¼ per bushel, and sold the contract three months later at $6.03 ¼ per bushel. Since the commodities buyer puts up only a percentage of the total contract (the performance bond, or "margin," is set by the brokerage house or exchange), and the margin at the time for soybeans was $1,000 per contract, the three-month profit ($30 commission included) amounted to $11,670.

The speculator who went short and agreed in November to deliver March soybeans at $3.69 ¼ would have lost $11,670 if he hung on until the delivery date. However, more than likely he would have sold his contract beforehand and got out with minimal losses.

Every brokerage house has its standards for accepting and rejecting small accounts. One large house, for example, will refuse anyone whose net worth is less than $50,000, or who has less than $5,000 to risk in the market. "We also try to judge an individual's temperament," says one broker. "If he is a nervous type, calling his broker every half hour to check prices, we don't want him." It is likely that somebody else will take the account, however (there are no "official" standards) but few will accept accounts of less than $3,000.

Having been forewarned, the would-be speculator who still wants to get in should observe the following rules:

■ Research commodities. Read about the government's changing agricultural policies, follow the price of a particular commodity for several months, play with "paper profits" for awhile. Also, learn the language of the commodities market—know what the various orders are—"sell-stop," OCO ("one cancels the other") and "on-close," for example.

■ Choose an advisory service and broker carefully. The printed services cost roughly $100 to $250 a year, with lower rates for trial subscriptions. Ask to see performance results of past recommendations, and look up issues of their weekly newsletter. As for choosing a broker, established firms usually have the best. However, chances are the small speculator will get a man on the bottom rung. The only advantage with a large house: They have the backup specialists to consult.

■ Spread your investment. Says one speculator, "By holding at least three different positions you improve the odds of holding at least one that's profitable." Then, once a market gets active and be-

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gins moving up, you can get out of unprofitable positions and begin cautiously "buying up" in profitable ones.

■ Beware of all margin calls (with few exceptions), and discretionary accounts (no exceptions). If the margin is 5% of the sale, and the market moves against you so that, say, 25% of the margin has been lost (this varies with every brokerage house, commodity, and type of contract)—the broker will call and ask for enough cash to restore margin. This is when to sell out and take the loss. Discretionary accounts—giving a broker the right to buy or sell commodity contracts

"Minimize your losses, maximimize profits, and get out of a loser . . ."

without prior approval—are no way for the new investor to learn anything about the commodities market.

■ Map out a rigid plan and, almost without exception, *do not deviate from it*. The basis must be: Minimize losses, maximize profits—and get out of a loser. Says one broker: "You must have a predetermined point at which you will get out of a contract if you are wrong . . . Many investors have a tendency to move too quickly—especially if they made money on their first contract. But many just blunder ahead without a plan, and it's really pathetic to watch them."

■ Use the stop-loss, and do not move your stops (with few exceptions). These can be entered at any time, but should be decided beforehand. "Sometimes it is all right to raise stops when you are riding a major trend," says one broker, "but never lower your stops if you begin to lose money. This usually makes for bad results."

■ Ignore most non-professional advice, and much of public opinion. Says a Merrill Lynch brochure on speculating: "The rule is to act cautiously *with* public opinion, *against it*, boldly.

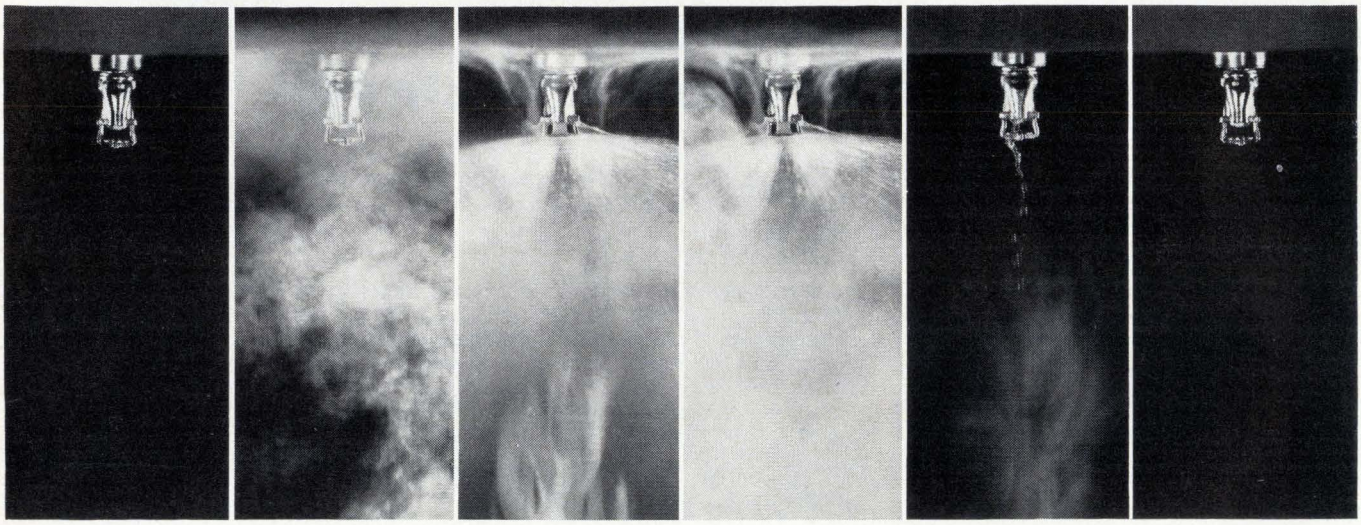
■ Take a percentage of your profits and bank them.

■ And one final rule: When in doubt—about anything—don't do it.

One speculation definitely to avoid currently is the commodity option, on which states are increasingly cracking down. An option is an arrangement whereby a speculator purchases the right to buy or sell a futures contract at a set price and time. It is a graduated form of dealing in commodity futures and is not for the small investor—at least not at this stage.

The final advice comes from Stanley W. Angrist, author of *Sensible Speculating in Commodities*: "Trade only with those funds you can afford to lose. That is, commodity trading is not investing for income; there is no assurance that even one of the next three trades you make is going to be profitable . . . And don't use borrowed money. There is nothing more liable to impair your judgment . . ." ■

# THE FIRST FULLY APPROVED ON-OFF SPRINKLER. AQUAMATIC FROM GRINNELL.



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# The tax mess and other woes

*THE TAX MESS:* The 16th Amendment clearly states: "The Congress shall have the power to lay and collect taxes on incomes, *from whatever sources derived* . . ." There's nothing there about capital gains, tax-exempt bonds, oil depletion and other loopholes that excuse the rich and super-rich from paying some $77-billion in income taxes and let big corporations off the hook for another $10-billion. Yet that's the way it is, according to author Philip M. Stern, and it's why he has entitled his latest book, *The Rape of the Taxpayer* (Random House, $10)—it's the little-guy, says Stern, who has to make up the difference.

The "loophole-ridden" tax code got a working-over by Stern in 1964 in his *The Great Treasury Raid,* a best-seller in its time. In *The Rape of the Taxpayer* he sharpens the attack with ridicule, calling the income-tax code a "$77-billion welfare program for the rich." He nails the

BOOKS

idea down from every angle (the book runs 483 foot-noted and thoroughly indexed pages), clearly to throw fuel on the sometimes sputtering flame under Congressional efforts toward tax reform. Stern calls for a truly "16th Amendment" income tax code. No deductions beyond those for dependents and costs of earning the income would be allowed. Such a no-loophole code, he claims, could reduce tax rates 43% in the lower and middle ranks. Some buyers of this $10 book, however, may be shocked to learn that Stern ranks them along with Jean Paul Getty as tax escapists; one plan he cites would actually *raise* the rate of anyone with a $25,000 taxable income or better.

*LIKE IT IS:* In a foreword to *I Hate to See a Manager Cry—Or, how to prevent the litany of management from fouling up your career* (Addison-Wesley Publishing Co., $5.95), Martin R. Smith puts credit where credit is due—to Robert Townsend's *Up the Organization.* "I realized," he notes, "that little had been written for the student, trainee, supervisor and middle-level manager using the Townsend approach. So here we are." Smith, an experienced consultant, takes the "litany" or conventional wisdom for corporate success as a manager (i.e., "Don't pass the buck.") and debunks it, item by item. ■

# Healthy, wealthy and wise

by Joseph Wiltsee

## How legal-age 18 shakes up your will, family debts, taxes

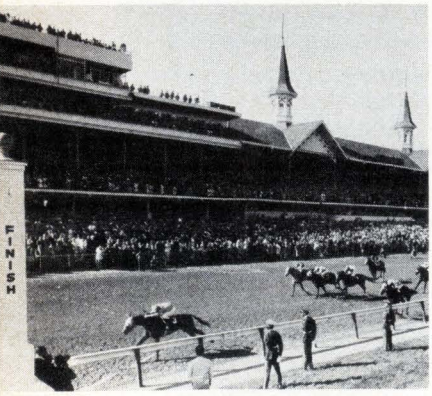

As a father, you may have to grapple with the effects of new laws in your state saying that a *youth or girl of 18* can not only vote but also operate as a full-fledged adult in many other ways, as well. Nearly 40 states are updating their laws, and a whole bagfull of possible problems arise. . . . *Family debts:* Your 18-year-old may become more closely responsible for his debts than before, with *your* responsibility diminished accordingly. This looks favorable—but what of the 18-year-old who legally obligates himself way over his head? . . . Or, *your will* might need revision; for example, where you've a trust which runs until your child reaches majority. The difference between his receiving the funds at 18 instead of 21 may be something you'd want to change.

*A custodian account* for a child also could require some redoing. At least, check state law to see *precisely* how the age-18 vs. age-21 rules are to be applied to such accounts (traditionally, the child gets the property outright at 21). . . . "The father's legal duty to support a child could be directly affected, too," notes a leading Washington, D.C., attorney who has followed the various state laws. "This could make custodian account funds more readily available for college education—but it could also cause the father to lose the child as a dependent." . . . A possible side benefit is that many age-18 laws will free up various *summer jobs* for more college students under 21 (examples: taxi drivers, store or plant guards, some bonded employees). . . . "The whole area is new and unclear," warns the Washington lawyer. "It needs some mulling over before any drastic step, such as revising a will. But it's a developing situation—and a lot depends, too, on the particular 18-year-old."

## Tax refund coming? —Better relax

If you've *a tax refund due*—and filed your 1040 near the April deadline—wait a little before you begin glancing in the mailbox. And above all, *wait* before you write to Internal Revenue about it—give the check six weeks to arrive (at least), and 10 weeks before making an inquiry. . . . If you write too soon, you'll clutter the paperwork process and may even cause more delay. It's like dropping a pencil down into the gears of a Xerox machine. . . . Or, if you've somehow already received the check, note that you're *not* scot-free. A check-in-hand doesn't rule out a later audit of your tax return—post-refund audits are common. Moral: Keep your 1972 records within arm's reach. . . . *Silver lining*: If one or two items on your 1040 are examined by IRS and you think the agent is wrong, you can appeal within IRS itself—and if you do, rest assured that over 60% of such appeals are "settled" for *less* than the agent originally demanded. Even full audits produce refunds about 7% of the time, and 40% end with no change in tax at all.

## The wines of Rioja and Piemonte




Churchill Downs: julep land

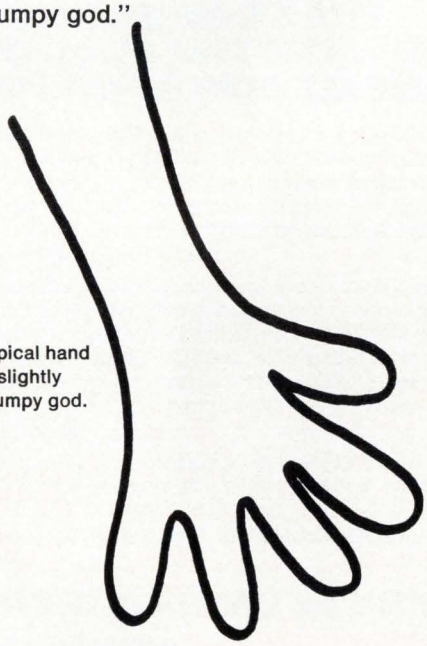
Anyone can *save money in buying wines* simply by picking for low price—but the pouring result can be a harsh, raspy drink. With many French, German and other fine wines at crushing prices, Frederick Wildman, the long-time New York expert, suggests that Spain and Italy are fertile grounds often overlooked. Some very good, sound wines are to be had, says Wildman, at modest prices. . . . In Spain, he points to the northern Rioja region, and particularly to the wines of "Cune" (Compania Vinicola del Norte de Espana). Two "great" reds are Imperial and Clarete that go well with meat and fowl; and Blanco Seco and Monopole, whites, are splendid with seafood. These imports are all in the $2 range, except Imperial, at $4. . . . In Italy, he suggests a departure from Chianti: from Guido Giri winery at Cuneo, in Piemonte, try Barbera d' Alba, a delicate red ($3.50); and from Santa Sofia, a winery near Verona, try Valpolicella Classico, a medium red ($3.50).

*Mixology:* Much liquor lore goes into the mint juleps on Derby weekend in Louisville, but a real warm-hearted substitute for such complex chemistry is a *mix*—Glenmore's Mint Julep Mix (70 proof). Served with a sprig of fresh mint, it can make you think you're on the clubhouse veranda at Churchill Downs.

# Petroleum and You (A History of the Former)

## Chapter One: Dawn of an Era

Man's first encounter with petroleum harks back to ancient times when cavemen came upon pools of crude oil which had seeped to the surface due to underground pressures. At first this was interpreted to be a sign that the gods were angry, yet when compared with such events as erupting volcanoes it seemed to many that "angry" was perhaps too extreme a term. Further study of the matter eventually led to the philosophy expressed in the thought "we are all sinners in the hand of a slightly grumpy god."



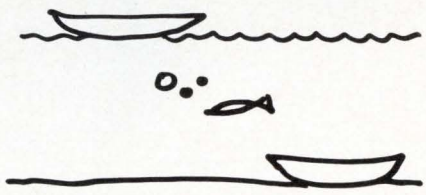
Typical hand of slightly grumpy god.

Whatever the case, the appearance of these petroleum pools brought about a profound schism among cavemen of the period. One group looked upon the seepage as some sort of mistake and wanted to get it back to wherever it had come from as soon as possible. On the other hand, a second group saw it as an omen, yet whether it boded well or ill they could not say since the whole subject of boding was at that time relatively unexplored. Nonetheless, one turns to this second group for the first touchingly awkward attempts of man to find a use for petroleum. A tribe from the frigid northernmost regions tried to wear it, but with little real success.

Early misguided attempt to fashion undershirt from petroleum.

Another tribe from the more cultured central regions were wont of an evening to gather at the hearth of the eldest tribesman and listen as he attempted to pluck simple melodies from petroleum. The results, though diverting, fell far short of their hopes.

Then, just when the advocates of petroleum were on the verge of despair, two amazing advances occurred. An early tribe settled along the early Nile learned that judicious use of pitch, a crude form of petroleum, was helpful in waterproofing their vessels.



Vessel treated with pitch on left, untreated vessel on right.

And at almost the same point in time, a tribe from the darkermost regions discovered that a branch dipped in the black viscous substance made, when ignited, a moderately serviceable torch. Consequently, given the migratory nature of the tribes during that era, it was only a short step from these two discoveries to the development of the first leak-proof torch.

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