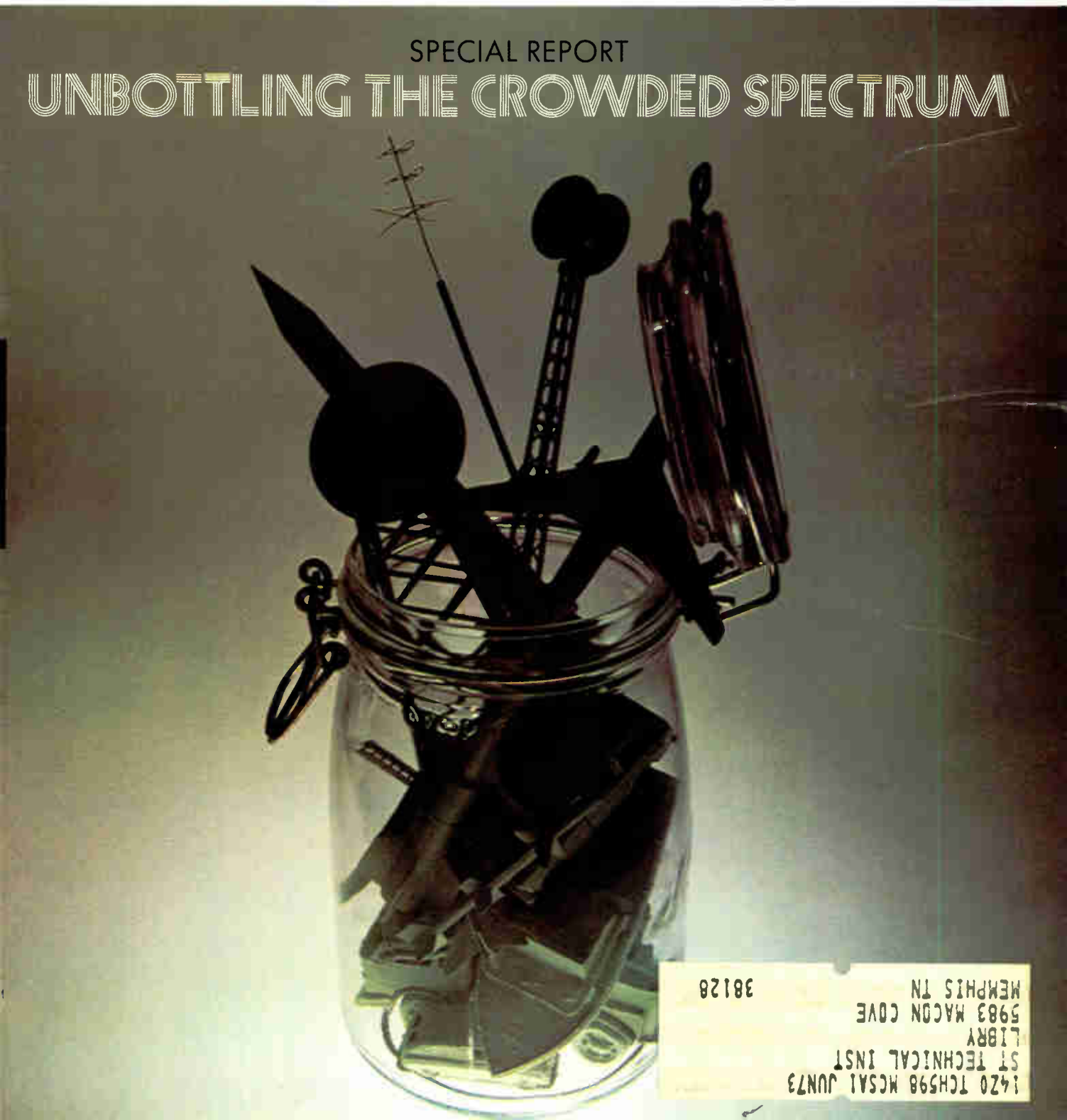
September 25, 1972 $1.00 A McGraw-Hill Publication

Electronics

SPECIAL REPORT

UNBOTTLING THE CROWDED SPECTRUM



What do you get when you cross a signal source with a calculator?

Automatic testing with HP's new 3330B AUTOMATIC SYNTHESIZER. In this one outstanding instrument, you get a flexible synthesizer, a top-performing sweep generator, and a precision level generator—all under digital control. Its built-in controller adds computer flexibility—you can forget about tying up an external computer for your automatic testing on the production line, and for the first time make this level of testing economically feasible in your lab.

For man-machine interfacing, 3330B's convenient swing-out keyboard, coupled with 9-digits of frequency and 4-digits of amplitude readout, gives you complete flexibility for setting up your test routines.

As a frequency synthesizer spectral purity is exceptional. Spurious is down 70 dB, and harmonics at least 40 dB below the carrier. Through its easy-to-use keyboard, you can, with 0.1 Hz resolution, set in any frequency between 0.1 Hz and 13 MHz, then automatically or manually increment (tune) that frequency by any amount. Each point has the synthesizer stability of ± 1 part in 10^8/day.

You can repeat the same automatic or manual sweeping operation with amplitude level. Its 100 dB range, 0.01 dB resolution and flatness of ± 0.05 dB make the 3330B a **precision level generator.**

Call on Model 3330B for your sweep generator needs, and you'll get performance levels of accuracy, linearity, and resolution never before available. That's because the internal serial microprocessor controls digital sweeping of synthesized frequencies or precise amplitudes. Through its keyboard and front-panel controls, you enter all sweep parameters—your 3330B takes it from there.

Systems Designers will find the standard 3330B fully programmable—ready for low-cost interfacing to other ASCII instruments and controllers, like marked card programmers, calculators, and computers.

Price? If you think about it, you would have bought a synthesizer, a sweeper, a marker generator, a counter, a programmable attenuator, and some computer time to come anywhere close to solving the same problems now done by the 3330B. At $6000 for a complete frequency lab, we think you'll agree that the price-performance ratio of the 3330B is great. (Model 3330A, priced at $5100, performs identically to the 3330B but has manual amplitude control and 13 dB range.)

For further information on the 3330A/B, contact your local HP field engineer. Or, write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

A092/1

It takes us less time to tell you what it's not.

What it's not.

It's not an office copier. But it's as fast and easy to use as an office copier. The output is a digital bit stream. And that's the major difference: You can optically scan input documents. Or pictures. Or patterns. Or characters to your computer system. Or storage system. Or high-speed communications system. Or pattern recognition system. In short, it begins to relieve the input bottleneck of your system.

What it isn't for.

It isn't for the guy without ideas. More applications exist than time to list them all. But you might consider these few: A photocomposition system for the typesetting trades. An optical character reader for computer input. A document storage and retrieval system for large filing requirements. A facsimile scanner for high speed communications (up to one megabit per second). A pattern recognition system for computer analysis of any type of graphics—such as line drawings, symbols, half tone prints, handwriting and fine art. An automatic inspection system for most surfaces; natural or manufactured; animal, vegetable, or mineral. An input to any machine requiring the translation of artwork to digital form—computer controlled knitting machines, welding machines, graphics plotters, and artwork generators.

Why you might not buy it.

You might not buy it if you like to tinker. It has one moving part and all solid-state electronics. You might not buy it if you're not in a hurry. It optically scans and digitizes a complete document in two to four seconds depending on the resolution desired. You might not buy it if you don't want photo-optic response. It recognizes every color—from light blue to dark red—and, like the human eye, differentiates the data from the background by degrees of contrast.

What it won't do.

It won't scan at infinite speeds. And it won't deliver at infinite resolutions. But it *will* scan at up to one megabit per second—with resolutions of 240 points per inch. That translates to mean our product can scan an 8½ x 11 inch field and then reduce it to digital data in less than four seconds. And that's about five times faster than anything else we know of on the market. And that's pretty important if you need your data rapidly digitized. If you need more information rapidly, call John Brown direct at (408) 734-1225.

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Sunnyvale, California 94086
(408) 734-1234

Electronics

The International Magazine of Electronics Technology

September 25, 1972

Highlights

USSR wants big homegrown computer by '75, 72
Difficulties in IC fabrication could prevent complete success of Russia's and the Eastern Bloc's five-year plan for its third-generation RJAD (pronounced "riad" as in "triad") series. Only the largest would be affected, however, and IBM 360s may be leased in the interim.

How order is kept in the frequency bands, 83
This in-depth Special Report surveys the crowded channels of the electromagnetic spectrum. The FCC and similar bodies are resorting to ever more refined regulatory control. In this job they are aided by computerized data bases and technological advances in electronic equipment.

Chart of many colors (opposite 98)
For easy and pleasurable reference, the *Electronics* foldout chart of the electromagnetic spectrum color-codes the frequency bands allocated to the different national and international services.

Silicon-on-sapphire MOS does much more, 113
Poor isolation between active elements is the main reason why MOS devices are slow. A sapphire substrate, overlaid with a film of silicon, makes for excellent insulation—and high speeds.

And in the next issue . . .
Part II of the series on automatic testing . . . component protection by metal oxide varistors . . . fast comparators.

The cover
Only continuing regulatory and technical improvements can make room for more users within the limits of the electromagnetic spectrum.

Electronics

Publisher's letter

The electromagnetic spectrum, if you look at it one way, is a resource—and a fairly finite one at that. True, the spectrum can't be depleted like oil. But, like land, it can get terribly crowded.

This issue, we home in on that very overcrowding. Starting on page 83, you'll find a 16-page special report detailing just why and where the spectrum is in trouble, as well as what is being tried by regulatory agencies and users alike to alleviate the crunch. And right after that, you'll find a four-color comprehensive spectrum chart, which reflects the latest changes that will go into effect on Jan. 1, 1973, based on agreements at last year's Geneva conference on space communications.

This is the third time *Electronics* has published such a chart. The first was in 1954, the second a decade ago. And a lot has happened since then, especially with the rise in satellite traffic and the extension of allocations up into higher frequencies. Our latest version, designed by Art Director, Fred Sklenar, combines attractiveness with a high degree of readibility.

Our Communications and Microwave Editor, Lyman Hardeman, was in charge of putting the report and the chart together. He personally interviewed officials in concerned Washington agencies, as well as many representatives of the electronics industries. And our field bureaus around the country and abroad pitched in and filed valuable input.

As for the special report, we think you'll be especially interested in reading the details about the two communications services that are feeling the greatest growing pains: land-mobile radio and microwave relay. The question is where to find the spectrum space for expansion of these services. One answer: take it away from other users. No wonder spectrum reallocation sets off fireworks.

Hardeman notes, though, that there may be other ways to determine who gets what in the spectrum. "There are more and more people, regulators as well as users, who are beginning to think that the law of supply and demand should apply to the spectrum resource—just as it does to our more tangible resources," he says.

"Unlike land and mineral resources, however, rights to the spectrum are given away. Therefore, there is no economic incentive for the spectrum user to make efficient use of the spectrum he is allocated. This situation has led some to suggest that the Government should place a value on some parts of the spectrum by renting or leasing channels. This would force the communications systems designer, they say, to appraise not just hardware costs, but also the value of the bandwidth that the communication system would use."

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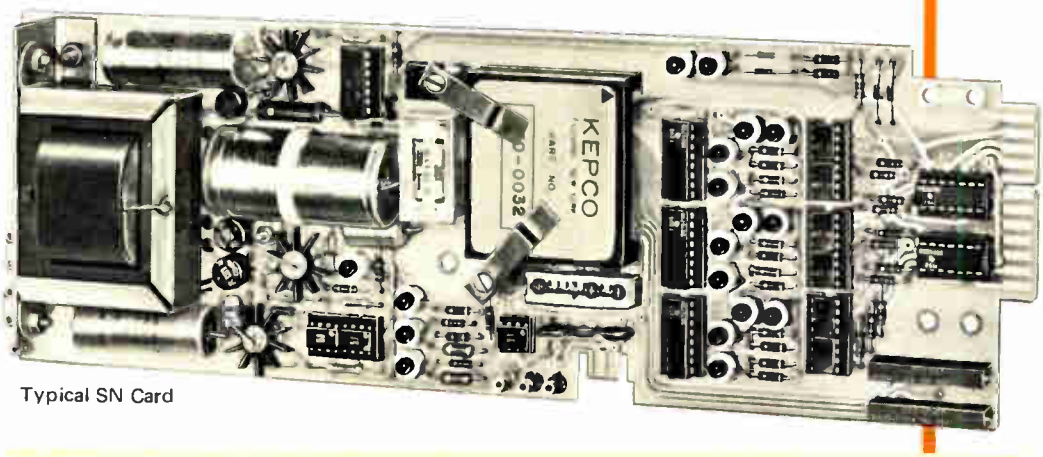
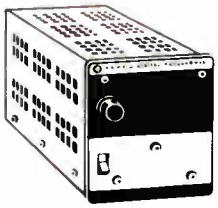
KEPCO programming interface

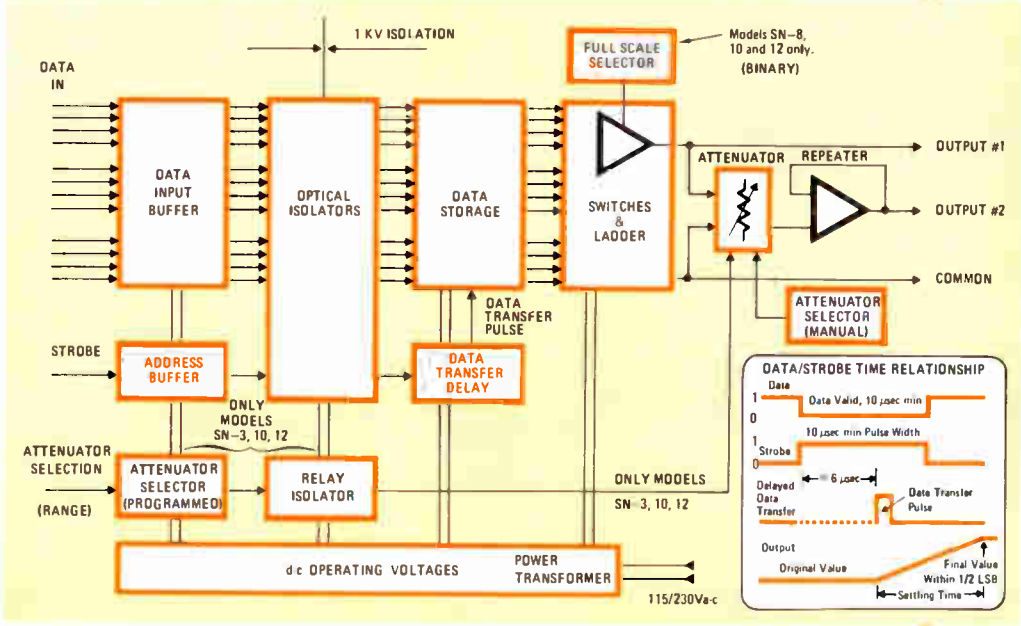


Typical SN Card

The five Kepco SN models offer a selection of DAC's for the digital control of anything that can be programmed by a 10V analog signal. You need no digital experience to use the SN. We've built-in the power—all you need is the 115/230V a-c line. We've built-in the data storage and delayed strobe for glitchless programming. All you need is a 10 microsecond pulse or a switch closure. We've built-in the isolation—so you don't need to worry about grounding. We've built the PC board and a variety of housings—all you need to mount them is a bench top or rack space or a small slot in your equipment.


The CA–6 enclosure accommodates 2 SN Cards.

The SN Cards mount up to 6 abreast in a convenient plug-in format.



SPECIFICATIONS	MODEL SN–2	MODEL SN–3	MODEL SN–8	MODEL SN–10	MODEL SN–12
RESOLUTION	2-Digit	3-Digit	8-Bit	10-Bit	12-Bit
INPUT DATA CODING	COMPLEMENTARY BINARY CODED DECIMAL 4 LINES PER DIGIT 8–4–2–1		BIPOLAR OUTPUT: COMPLEMENTARY OFFSET BINARY UNIPOLAR OUTPUT: COMPLEMENTARY BINARY		
ACCURACY @ 25°C (% OF FULL SCALE READING) SCALE FACTOR ERROR(1)	±0.2%	±0.1%	±0.1%	±0.1%	±0.05%
ZERO OFFSET	ZEROING TRIMMER IS BUILT-IN.				
LINEARITY	±0.2%	±0.05%	±0.2%	±0.05%	±0.01%
PRICE	$305.00	$440.00	$305.00	$387.00	$472.00

(1) May be calibrated with optional trimmer, Option "R" Price: $10.00. Add the option letter as a suffix to the model number.

For complete specifications and applications notes, write Dept. EH–14

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Readers comment

Phone speeds EKG

To the Editor: Phone-a-gram cuts electrocardiogram time much more than it was given credit for in Electronics review [*Electronics*, Aug. 14, p.42]. The Phone-a-gram system transmits a complete 12-lead scalar EKG to a computer center over dial-up telephone lines in just 80 seconds. A complete computer analysis is printed out only 45 seconds later—not in three minutes.

Three minutes is the average time it takes the Phone-a-gram subscriber to telephone the computer center, give the user number, patient name and vital statistics, transmit the EKG, and receive the coded diagnosis. The complete diagnosis and a chart are then mailed.

Michael A. Robinton
Sunnyvale, Calif.

McGovern's reallocation plan

To the Editor: Your Aug. 14 Washington commentary [p.60], claims that Sen. McGovern has not clearly defined a plan for reallocating our defense and aerospace capabilities to solve pressing problems. It also states that McGovern plans to convert missile and spacecraft engineers into health, educating, and pollution-control engineers.

McGovern has been working since 1963 on legislation to stimulate conversion planning by the major arms industries, and there is much documentation of his position. He is not so naïve as to propose the instant transformation of defense and aerospace engineers into warm bodies in unrelated fields. McGovern's priorities include transportation systems, such as high-speed ground transport, ATC and STOL; energy systems, such as fossil-fuel system improvement and nuclear-power and fusion techniques; and environment-related technological development.

Typical aerospace engineers will not have to be retrained to work in many of the fields mentioned above. We need more Federal funding of these major new civilian-technology programs to improve our quality of life and our competitive position in world markets.

Howard Salwen
Newtonville, Mass.

From the Datacraft DC-38 Building Block...

Comes a Memory You Can't Afford To Forget

The DC-38-S. You can't afford to forget it because we didn't forget anything in its design. We built it complete...and it is a complete magnetic core memory with the timing and control functions all on a single printed circuit board.

It is reliable. Datacraft's ideas on reliability in a memory system are: 1) Don't try to design around those techniques that can inherently fight reliability in traditional memories. 2) Do away with those potential pockets of failure entirely.

That's what happened. In Datacraft memories we wiped out such things as core stack risers, hard backpanel wiring, plus linear transformers and their accompanying problems. The design is a little unorthodox. It's modern and modular to satisfy current needs and adapt to fit future ones...you can forget about obsolescence.

Can you afford it? Pricewise, it's less than most. Combine low cost with the DC-38-S's reliability and performance...we think you can't afford not to.

Expandability
The DC-38-S is a complete memory with timing and control all on a single card. Using the 5¼" chassis and expansion in 4K X 18 increments, you can go to 20K X 18 or 40K X 9; expanding in 8K X 18 increments you can get a bank of 40K X 18 or 80K X 9.

For more information, write to the address below. If your application demands larger storage capacity, ask for our brochure on the two-card memory system, the DC-38-D.

The DC-38-S
Datacraft Corporation
P. O. Box 23550
Fort Lauderdale, Fla. 33307

Datacraft

40 years ago

From the pages of Electronics, September 1932

Advertisements running in metropolitan papers call attention to the use of photo-cells for testing the sharpness of the new Gillette safety-razor blades. The ads read: "Padlocked! The photoelectric sharpness-tester—a secret new Gillette device kept under lock and key—proves conclusively that the Gillette Blue Super-blade is the keenest blade we have ever produced."

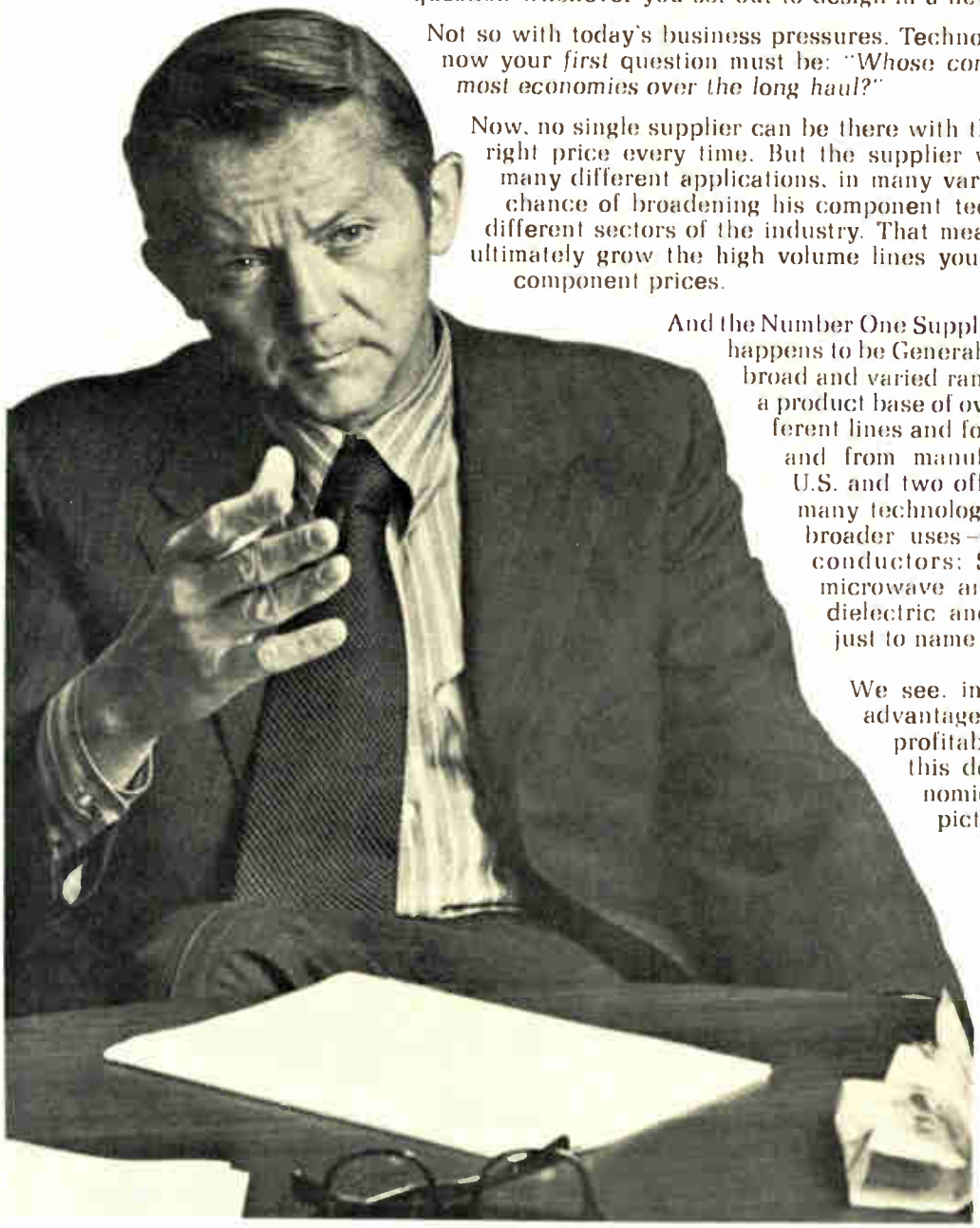
Inquiry to the research department of the company, by the editors of Electronics, confirmed the statement that the new method is guarded with the utmost secrecy. Theodore L. Smith of the Research Department writes: "This company has devoted a considerable amount of time and money to the development of this device, and for the time being, at any rate, it is the policy of the company to withold information regarding it."

An improved fluoroscope which projects a reversed, three-dimensional image has been developed at the California Institute of Technology. It is expected to facilitate internal examination of human bodies and other objects. The illusion of a substance is so perfect that a physician can make internal measurements with calipers, as exactly as if the subject lay dissected before him.

Two tubes cast two shadows on the screen at slightly different places. The tubes are set the same distance apart as human eyes, their beams intersect each other and cross in the patient's body before reaching the screen. A shadow of the same size, shape and depth as the person, transparent, showing bones and internal organs, is formed.

Reports from the Berlin radio exposition indicate that motion-picture film apparatus for television transmission has now reduced the interval between exposure and projection to twenty seconds. Thus, using motion-picture film as the necessary "relay" to get the amount of light needed with present systems, the transmitted picture need be only twenty seconds behind the action in reality. This is progress.

"Straight talk about buying your components from a truly broad line supplier."



Dr. Thomas A. Vanderslice, Vice President and General Manager Electronic Components Business Division, General Electric Company

"Who's got the edge in technology?" That used to be your instinctive first question whenever you set out to design-in a new component.

Not so with today's business pressures. Technology's still important. But now your *first* question must be: *"Whose component will give me the most economies over the long haul?"*

Now, no single supplier can be there with the right component at the right price every time. But the supplier whose product mix spans many different applications, in many varied markets, has the best chance of broadening his component technologies to serve many different sectors of the industry. That means he's the one who will ultimately grow the high volume lines you will need to lower your component prices.

And the Number One Supplier in that department just happens to be General Electric. We serve a very broad and varied range of manufacturers from a product base of over 40 categories in 13 different lines and four major technologies . . . and from manufacturing facilities in 12 U.S. and two offshore sites. We've led in many technologies we can now apply to broader uses—signal and power semiconductors; SCR's; optoelectronics; microwave and imaging devices; film, dielectric and electrolytic capacitors, just to name a few.

We see, in our breadth, a distinct advantage whereby we can grow profitably with you throughout this decade's tougher, yet economically sounder business picture.

GE won't leave you alone.

OUR NO 1 GOAL TO MAKE GENERAL ELECTRIC YOUR BEST BUY

BEST BUY Our No. 1 Goal

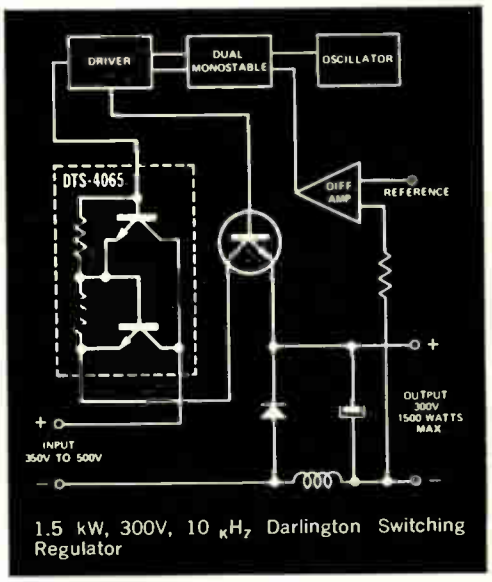
GENERAL ELECTRIC

NOW, 400V & 600V DARLINGTONS FROM

Delco Electronics
DIVISION OF GENERAL MOTORS CORPORATION, KOKOMO, INDIANA

Delco's new DTS-4000 series Darlingtons with V_{CEO}'s of 400V and 600V are triple diffused mesa units built for rugged duty. They come to you with a practical 15 Ampere rating that you can depend on all the way up to the high voltage requirements of ac motor speed controls, for instance—or the 1.5 kW switching regulator in the illustration.

And they offer new possibilities

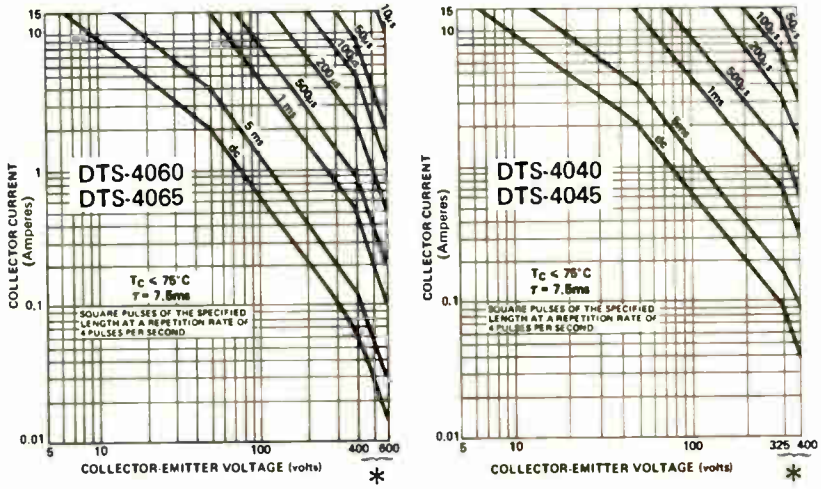


1.5 kW, 300V, 10 $_{K}H_{Z}$ Darlington Switching Regulator

in circuit design where dc drive conditions may have created awkward problems when using SCR's.

Our new Darlingtons can save you space and give you more design flexibility. The high energy capability of the DTS-4000 series is

SAFE OPERATING CURVES

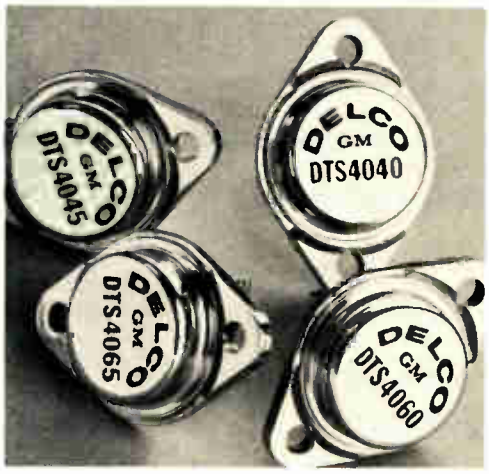


*Reverse Bias Required

TYPE	V_{CEO}	I_C (Cont.)	V_{EBO} (Max.)	$V_{CEO(sus)}$	h_{FE} @ I_C	t_f (com. base)	P_D(max.)
DTS-4040	400V	15A	20V	325V	250/3A	0.25μs	100W
DTS-4045	400V	15A	20V	325V	500/3A	0.25μs	100W
DTS-4060	600V	15A	20V	400V	250/3A	0.25μs	100W
DTS-4065	600V	15A	20V	400V	500/3A	0.25μs	100W

NPN—Triple diffused Darlington transistors packaged in solid copper TO-204MA (TO-3) cases.

HIGH ENERGY THE KOKOMOANS.



backed by safe operating curves up to 600 volts, as shown at left. And to further aid your circuit design h_{FE} is plotted continuously from 15mA to the maximum collector current rating of 15A.

As you expected, the new DTS-4000's are in stock and ready for delivery. Contact us or your nearest Delco distributor for complete details. Ask for Application Note 52 on the switching regulator.

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And as soon as he's finished designing, Graphic-15 can help him lay out the circuit. By putting each and every element where it'll work best.

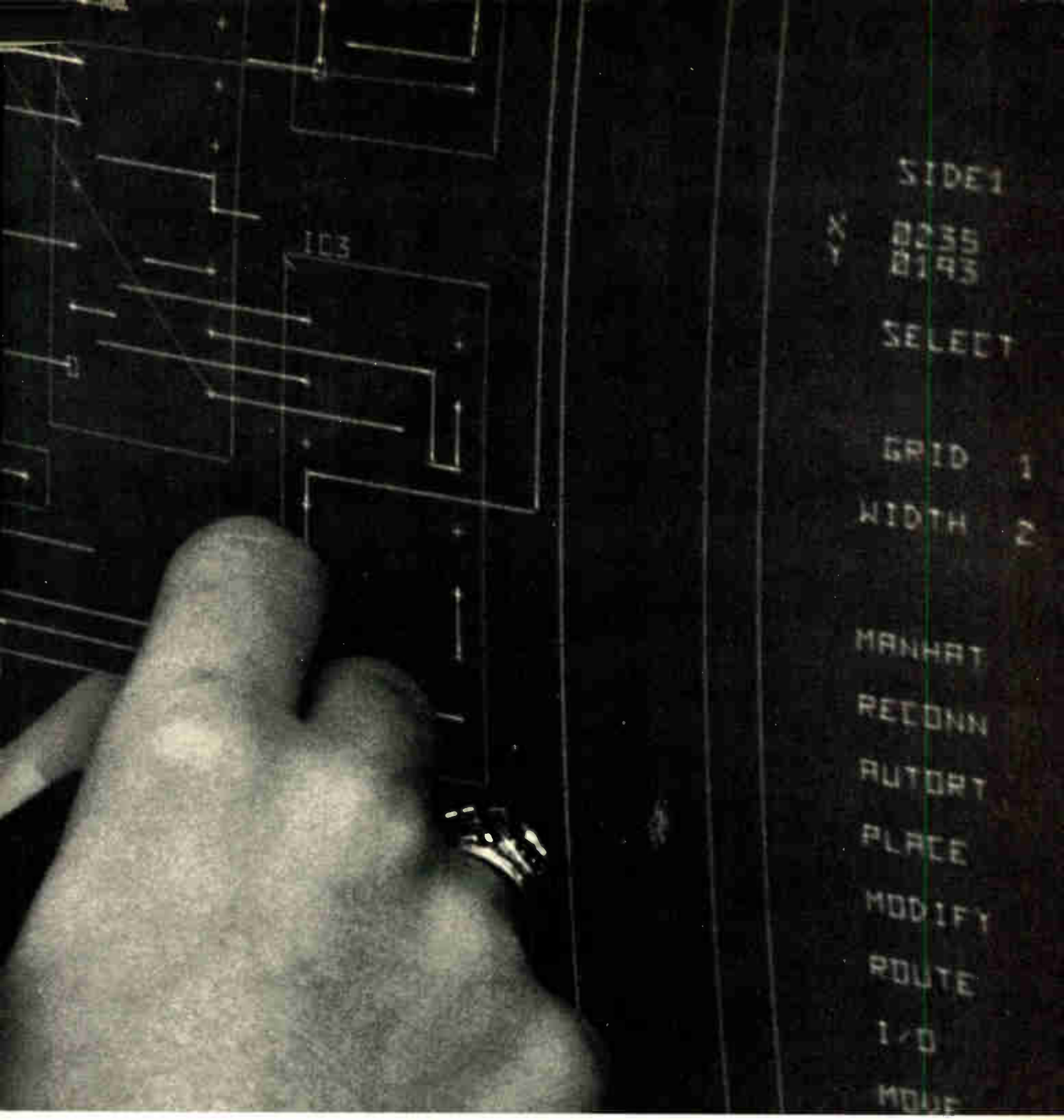
And when that's finished and checked, Graphic-15 can put out tapes for artwork and numerical control.

All of which can't help but save you all sorts of time. Energy. And money. Whether you're designing IC chips, PC boards or thick film devices.

Graphic-15 does it all.

But you won't have to become a computer expert. Graphic-15 puts you on line right away, thanks to a complete software application package.

It also offers a computer powerful enough to run a number of scopes simultaneously. A choice of 17" scopes or 21" scopes. Light pens. Writing tablets.



to blow it in 5 seconds.

Operating system software. Graphic software. The works. Graphic-15 does it all there, too.

And when you're not designing circuits, Graphic-15 won't just sit there. You can use its PDP-15 computer for all kinds of computing jobs. If you want to do some programming, you can use friendly, easy-to-learn FORTRAN IV.

Not long ago, computer-based graphic systems cost a couple hundred thousand. But that was before Graphic-15. Now prices start at under $63,000.

Which may help to explain why we've quickly become the most experienced supplier of interactive graphic systems in the world.

Graphic-15 does it all.

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digital

Circle 13 on reader service card

People

Henning moves the pieces on distributor game board

The semiconductor distribution game is something like chess, asserts O.F. (Orm) Henning. "As we make our moves, we can see the industry shifting in response," says Henning, distributor marketing manager for Texas Instruments' Semiconductor group. "There is no move in any marketplace without reverberations, so you make moves to minimize countermoves or to turn them to your advantage."

The purpose of the moves is penetration, and TI's recent rash of distributor changes points to its desire to capture new accounts, as well as a higher percentage of smaller customers. The change also reflects the firm's reevaluation of the role of the distributor in semiconductor marketing. Henning's modification of EIA figures predicts that in 1972, semiconductor business handled through distributor channels will top $222 million, or 18.3% of the total market, compared to about 10% 10 years ago. "And out to 1975, I expect we'll see 25% and possibly 30% of the industry's business going through distributors."

Riding the curve. Much of this growth Henning attributes to product maturity: "When a product gets two-thirds or three-quarters of the way up the growth curve, it enters the 'distribution zone' of marketing," he says. "It becomes a commodity, and price and availability become important." Most discretes and many integrated circuits have already passed that point on the bell-shaped curve.

Henning, armed with a BS in mechanical engineering from Marquette University, has been playing the distribution game for a year-and-a-half now; he was previously national sales manager for TI's Digital Systems division. He joined TI in 1955 after logging 10 years with International Register Co. and Honeywell's Industrial division.

The guys. Besides market penetration, TI plays for money, of course. "We now have a distributor network of 300 guys—guys that we couldn't afford to support on our own," Henning points out. "And the distributor collects receivables. If we had to collect them, it would change our cash-flow position and add to our clerical need."

Equally important are the economies that distributors can provide the buyers. In the tough money markets of 1969 and 1970, customers became highly inventory-conscious. "Now we're coming out of the doldrums, but the buyer hasn't forgotten that he can lean on the distributor," he says. And big department-store-type distributors perform a custom packaging function—"They can sell a mix of small amounts of compatible components and still maintain the price leverage," Henning adds.

TI picks distributors region by region, and claims it doesn't have a "national" distributor, although subsidiary TI Supply Co. and Cramer Electronics add up to about the same thing. "But we're moving away from the hip-pocket operator," he says.

Henning: TI Semiconductor distributor boss.

EIA's Sodolski pursues East European trade

Thirteen will become a lucky number if John Sodolski has his way. That is the number of American communications-equipment manufacturers' men that the Electronic Industries Association vice president took with him for two weeks in mid-September to Moscow and Warsaw to investigate the potential for U.S.

...this is the best way to view 7 channels of input data at one glance.

This multi-channel Monitor Oscilloscope (Model 1200A) features seven self-contained plug-in scope modules with selectable dual inputs per module. Bandwidth is DC—5 MHz, and each module has its own vertical attenuator and sweep rate control. A special plug-in is available for instrumentation magnetic tape recorder monitor applications which provides individual attenuator controls for both the "record" and "reproduce" inputs.

IN-LINE PRESENTATION: A key feature offered by Model 1200A is "in-line" placement of the seven CRT's, thus providing a level display of all traces. Such a configuration facilitates amplitude comparison between channels, as compared to a stacked or staggered trace arrangement.

TWO INCH DISPLAY HEIGHT: At last the multi-channel monitor scope can offer a display height which is compatible with the demand for signal level monitoring. The full 5 cm, or approximately 2", of display height provided by this unit greatly enhances amplitude resolution and improves viewing capability.

FRONT PANEL CONTROLS: All basic operating controls are positioned on the front panel for easy access. A trap door on each module located beneath the vertical and horizontal range switches tilts down to expose the position, focus, intensity and AC/DC coupling controls.

APPLICATIONS: Today's cost of data collection and analysis is high, hence the monitor of this data—as insurance against loss—is a must. Model 1200A fits ideally into record/reproduce signal monitor applications for magnetic tape recorders, and also into the real-time observation of multiple vibration signals, communication data, and biomedical and geophysical phenomena.

Interested? Call Bill Kraus at (714) 279-6572, or write to us at 7595 Convoy Court, San Diego, California 92111.

AVERAGE COST PER CHANNEL ONLY $385

From the leader in Multi-Channel Monitor Oscilloscopes

VU-DATA CORPORATION

Circle 15 on reader service card

hardware exports to the Soviet Union and Poland.

The Department of Commerce trade mission is the first of its kind sponsored by the United States. Sodolski, as mission director, believes the industry visit represents an appropriate working-level followup to the state visit earlier this year by President Nixon and a subsequent trip by Commerce Secretary Peter Peterson.

Conversion. Electronic communications "presents a fertile field for cooperation," Sodolski said on his Moscow arrival at the All-Union Chamber of Commerce, noting that "it is up to us to convert that potential into tangible trade benefits for our countries." Sodolski conceived the communications trade mission early this year [*Electronics,* March 27, p. 27], but the industry association turned sponsorship over to the Commerce Department.

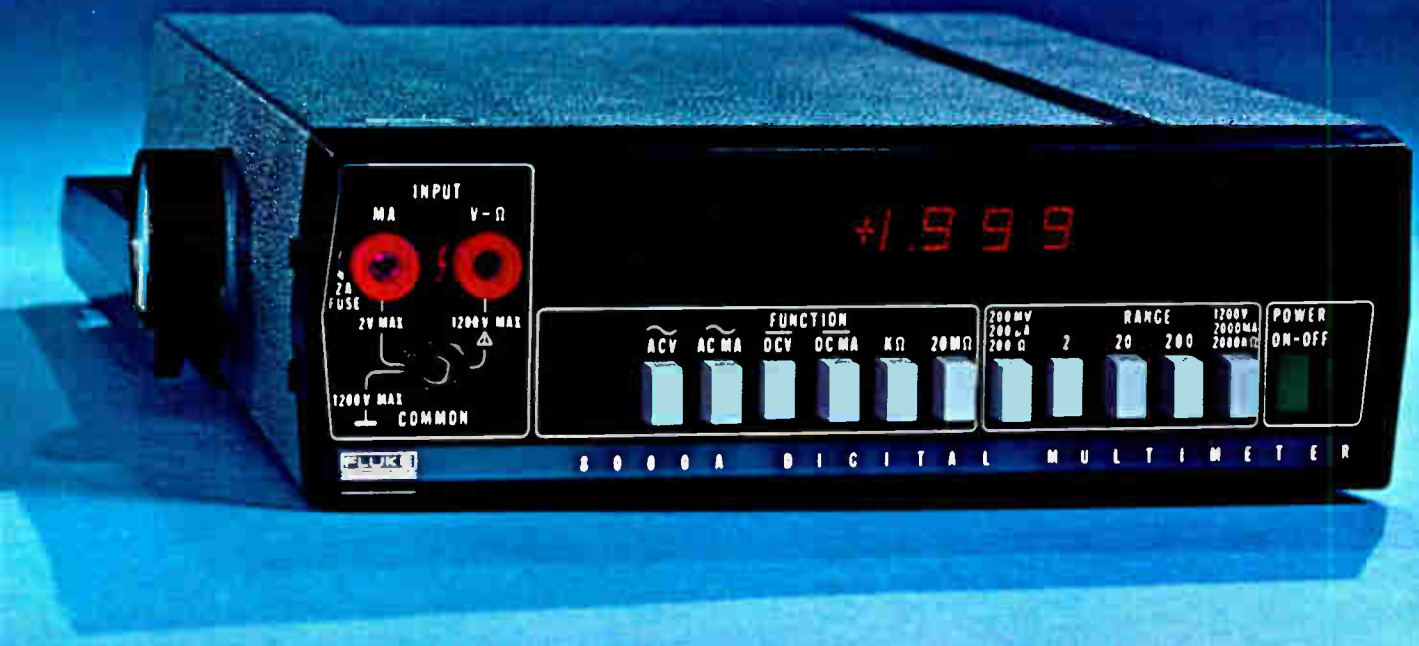
The 13 company men who spent a week in Soviet and Polish capitals sought to develop interest in such mundane items as two-way mobile radio equipment, telephone equipment, video and radio-broadcast hardware, and closed-circuit and cable TV systems. "There are," concedes Sodolski, "a few problems. Working them out was a purpose of the mission." Nevertheless, the electronics trade missionaries are unlikely to come home with pockets full of signed orders until such necessary details as credits and payments are worked out.

When he's not working on matters international, Sodolski spends most of his time in Washington watching out for the interests of 58 members of EIA's Communications and Industrial Electronics division, of which he has been staff vice president since 1967. Sodolski is generally credited by colleagues with vitalizing the CIE operation as that segment of the industry expanded.

Grape grower. In the time when he is not tending EIA matters, John Sodolski pursues a variety of other interests that range from reading and collecting Polish literature and history to growing grapes at his suburban Maryland home outside Washington.

Fluke problem solvers

The new multimeter with advanced L.S.I. for more function power. 26 ranges, 5 functions.



$299... Fluke's new 8000A, Try one for fifteen days, no obligation.

Now you can put the unmatched quality of Fluke instrumentation to work for you at the price of an ordinary multimeter.

Here's the DMM with more function power. Its got 26 ranges, including five ranges of ac and dc volts, five ranges of ac and dc current, and six ranges of resistance. Push button control gives you the simplest most reliable error-free operation possible. The new Fluke 8000A is the only multimeter using an A-to-D converter with inherent self-zeroing to completely eliminate offset uncertainty.

More details are on the next page, but we think you'll want to try this low-priced measurement system now. Fill in the coupon; we'll do the rest.

Circle 240 for more information

Ship me a Fluke 8000A for $299 plus $_____ for additional options checked below. I prefer the following payment option:

- ☐ Charge my ☐ Master Charge, ☐ BankAmericard, or ☐ American Express account for the full amount plus $5 shipping and handling.
  If using Master Charge, please indicate the 4 digit number appearing above your name ☐☐☐☐
- ☐ Bill against the attached company purchase order for the full amount plus $5 shipping and handling.
- ☐ Cash Order. My check for the full amount is enclosed. Fluke pays shipping and handling.
  (Washington state residents add 5% sales tax.)
  Return within 15 days for full refund if not delighted.

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- ☐ Rechargeable Battery — $50*
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- ☐ AC Probe 20A & 200A — $50
- ☐ HV Probe — $25
- ☐ Deluxe Test Leads — $5
- ☐ Carrying Case — $15
- ☐ Dust Cover — $8
- ☐ Rack Kit-Center — $30
- ☐ Rack Kit — ½ Rt or Left — $30
- ☐ **Send me literature only**

*Choose BCD data output or battery pack; both cannot be ordered in the same instrument.

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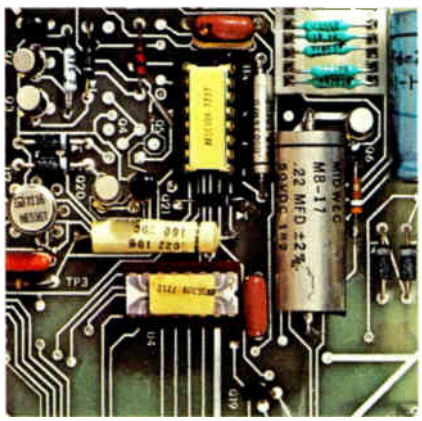
When you look inside you'll find the same high technology and quality we put in our $3000 DVM's.

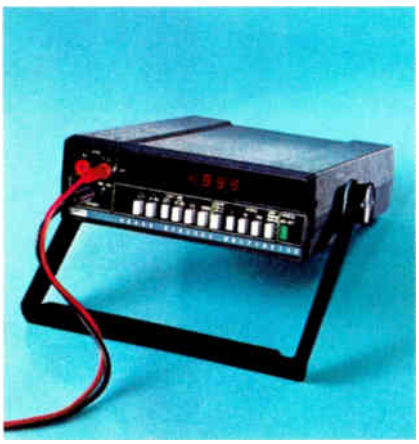
Take a look inside. The LSI chips, equivalent to over 3,000 circuit elements, are the most advanced proven semiconductor devices on the market today. Fluke is the only manufacturer using **both analog LSI and digital LSI** to give you increased reliability at lower cost with fewer parts. The Fluke 8000A has only ⅓ the number of parts used in a typical 3½ digit multimeter.



A simple guarantee
You can understand our 12-month guarantee. It's straightforward and honest. And you can believe we live up to it. If anything happens to your 8000A, take it or send it to your nearest factory service center. We'll give you 48-hour turnaround service in the U.S., Canada, Europe and the Far East.

Specs to work by
The new Fluke 8000A has a dc accuracy of 0.1% when you buy it. We guarantee it will still measure within that accuracy without recalibration a year later.
The case is rugged and tough. Drop this multimeter from a bench. Nothing happens to the works inside. We guarantee it.

Wide range of measurements
Measurement flexibility is broad enough to meet all the situations you're likely to encounter. The Fluke 8000A gives you 26 ranges to measure ac and dc voltages from 100 microvolts to 1200 volts, currents from 100 nanoamps to 2 amperes; and resistance from 100 milliohms to 20 megohms.



Wide choice of options
For a few dollars more, you can add a rechargeable battery pack to give you completely portable operation for over eight hours. And when you're back on the line, the batteries will recharge automatically. Other options include digital printer output, deluxe test leads, high voltage probe, rf probe, 200-amp ac probe, carrying case and rack mount kits.

A complete digital multimeter
But with or without options, the Fluke 8000A comes complete with test leads and spare fuses. It all adds up to an instrument you can count on day after day, year after year. Isn't this what you want in a digital multimeter at any price? Fluke thinks so.

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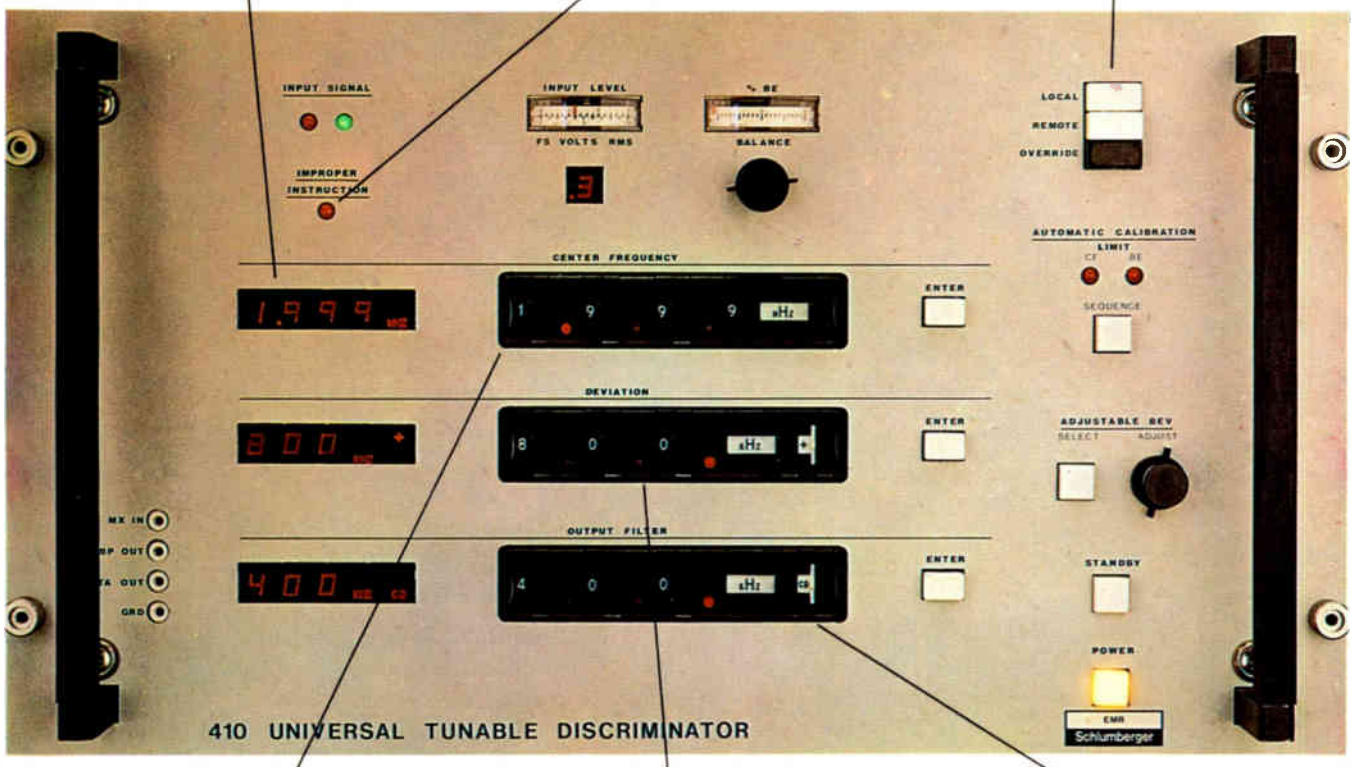

Select any center frequency; 200 Hz - 2 MHz

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EMR's new UTD (Universal Tunable Discriminator) can be tuned by computer or front panel control to demodulate virtually any FM data signal. With over 2 billion different settings, the UTD can accommodate all standard IRIG channels, multiples thereof and just about any "odd ball" channel you can name. Find out how the UTD combines this flexibility with top performance and ease of maintenance in our EMR 410 UTD Brochure. Or, better yet, call us and ask for your own demonstration. The odds are 2,000,000,000 to 1 that we can handle your FM data.

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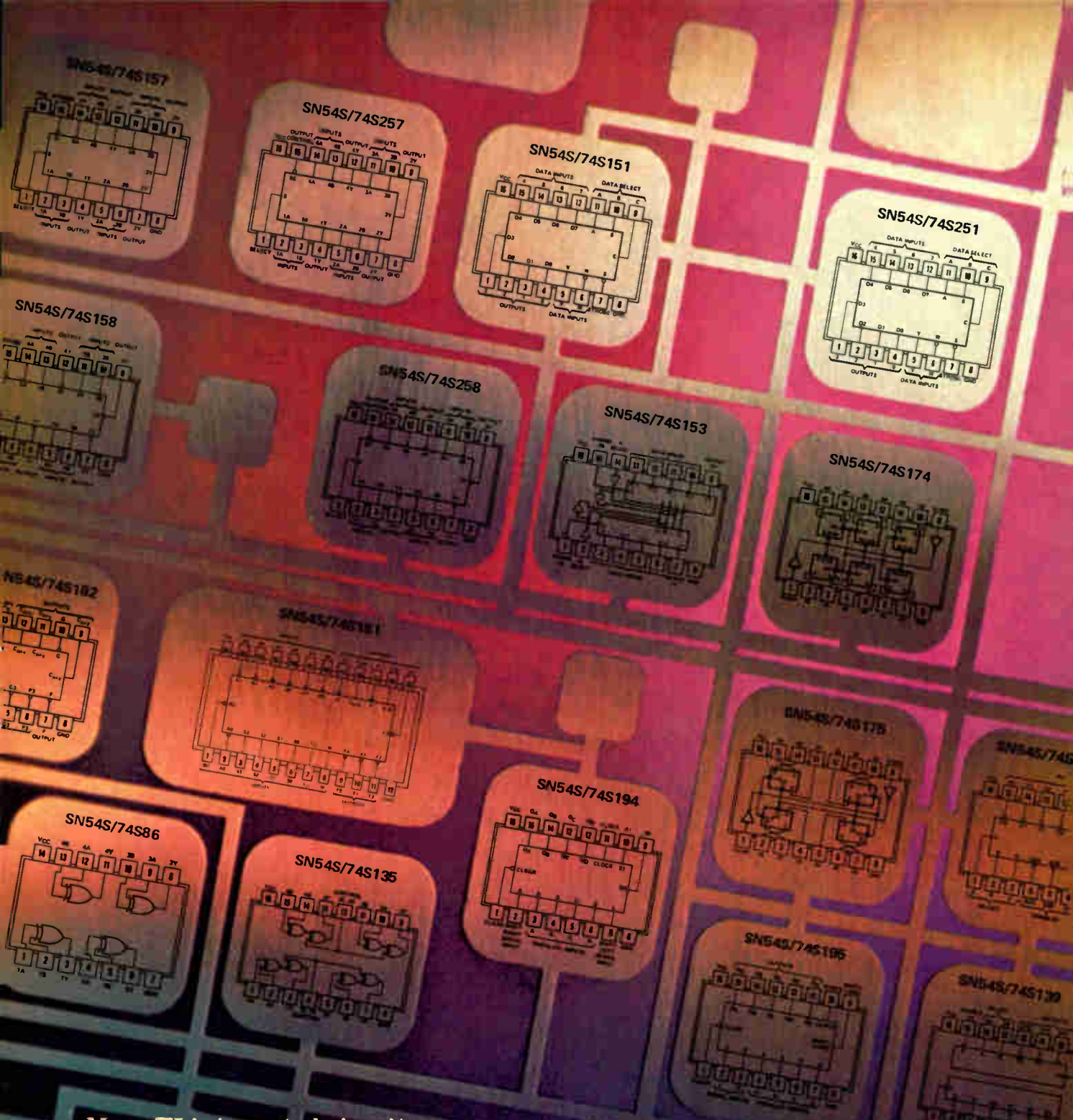

More TI integrated circuits are used in today's electronic systems than any other brand in the world. And for the reasons you'd expect: Technology. Volume. Price. Breadth. Dependability. Service. Quality. Weigh them all when you buy high-speed logic.

SCHOTTKY

TI announces more Schottky MSI:

decoders, D-registers, shift registers, multiplexers and arithmetic elements.

In any logic form, complexity is the key to low system cost, maximum performance and reliability.

You'll find your best choice of high-complexity, high-performance Schottky TTL circuits at TI – now and in the future.

We've just added more MSI circuits to the 3-ns 54S/74S line (nearly doubled it) and all are in volume production now.

Your best high-performance logic choice

TI's Schottky TTL reaches back through the evolution of transistor-transistor logic for reliability, design simplicity, volume availability, low cost and versatility – and combines these advantages with superior performance previously achieved only with unsaturated logics.

Here are the benefits of designing with TI Schottky MSI:

- Improved system speeds – internal-gate propagation delays as low as 1.5 ns, with an average of 2.4 ns.
- Reduced power dissipation – as low as 8 mW/gate, with an average of 13.7 mW.
- Total compatibility with all other 54/74 TTL families.
- Guaranteed operation over full military (–55°C to 125°C) and industrial (0°C to 70°C) temperature ranges.
- Full package range – plastic and ceramic DIP and ceramic flat pack.
- Fewer system interconnections for increased reliability.
- Fewer packages, smaller PC boards.
- Lower component and system costs per gate.

For new systems – or easy upgrading of existing designs

Not only can new systems incorporate the performance advantages of Schottky MSI, but existing designs can in many cases be upgraded by replacing 54/74 MSI functions with a pin-compatible, functionally identical 54S/74S version.

TI's Series 54S/74S Schottky TTL is totally compatible with all TTL...standard, high-speed, low-power and low-power Schottky. Together, these TI families offer more than 250 integrated circuit functions with compatible logic levels, voltage swings and noise margins. No interface circuits or level shifters are required. In addition, Schottky TTL will interface directly with DTL and most low-threshold MOS.

Broad choice of functions

Series 54S/74S offers you 17 MSI functions, supported by an SSI line that includes 13 gates, a power buffer, a line driver, and 4 dual flip-flops. MSI circuits available now include:

100-MHz Shift Registers/Storage Registers

SN54S/74S174	Hex D-type storage register
SN54S/74S175	Quad D-type flip-flop, complementary outputs/clear
SN54S/74S194	4-bit bi-directional shift register
SN54S/74S195	4-bit parallel-access shift register

Arithmetic Elements

SN54S/74S86	Quadruple Exclusive-OR
SN54S/74S135	Quadruple Exclusive-OR/NOR
SN54S/74S181	4-bit arithmetic logic unit and function generator
SN54S/74S182	Carry look-ahead generator for SN54S/74S181

Data Selectors/Multiplexers

SN54S/74S151	8 to 1-line
SN54S/74S251	8 to 1-line with tri-state outputs
SN54S/74S157	Quad 2 to 1-line, true output
SN54S/74S257	Quad 2 to 1-line with tri-state true outputs
SN54S/74S158	Quad 2 to 1-line, inverting output
SN54S/74S258	Quad 2 to 1-line with tri-state inverting outputs
SN54S/74S153	Dual 4 to 1-line

Decoders/Demultiplexers

SN54S/74S138	8 to 3-line
SN54S/74S139	Dual independent 2 to 4-line

Send for brochure

For data sheets on TI's Series 54S/74S Schottky TTL family, get a copy of CC-408. Circle 214 on Service Card or write Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

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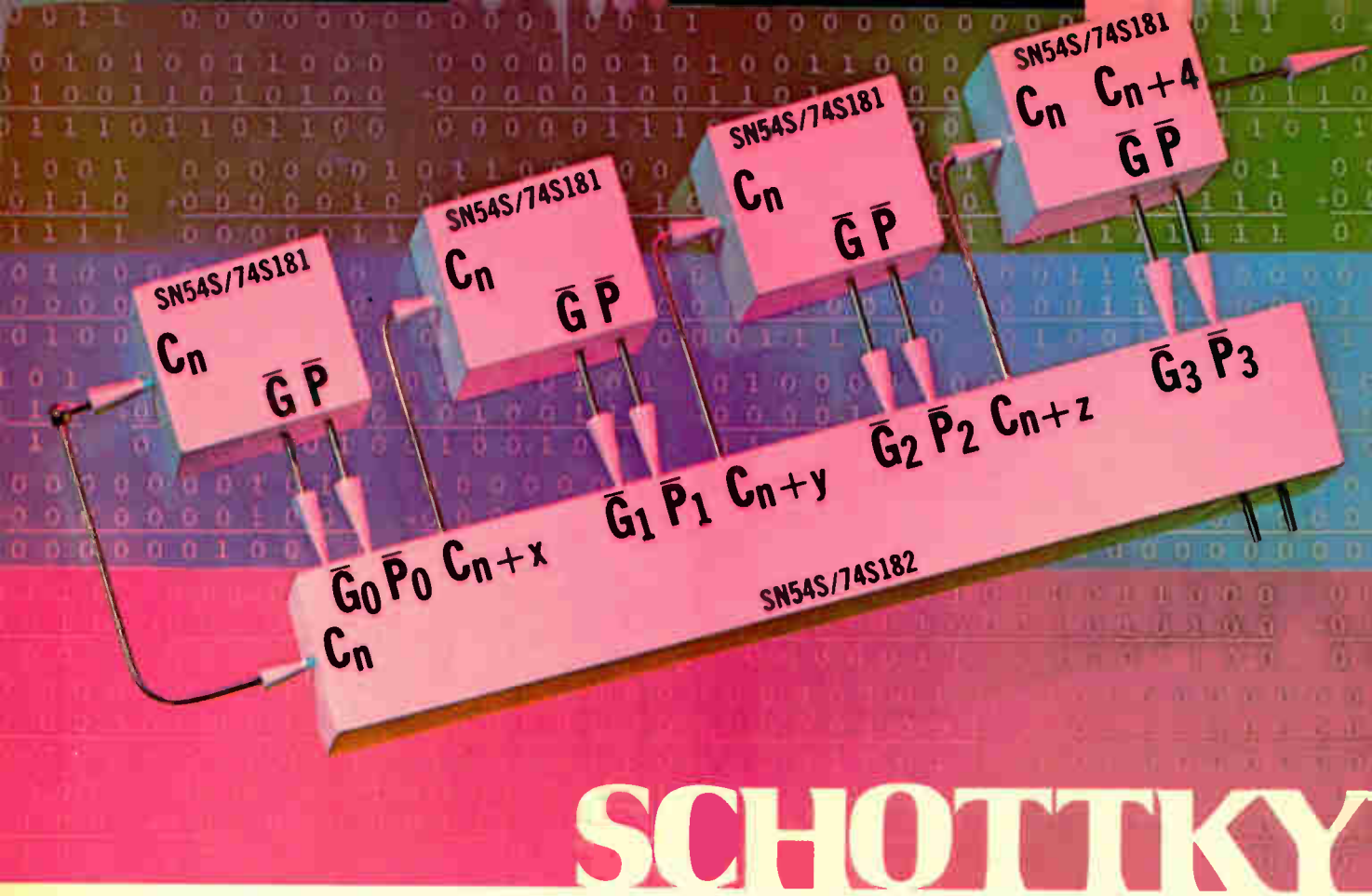

Add 16 bits in 19 ns— with Schottky TTL MSI

The fastest TTL adder/subtracter available is formed by TI's Schottky SN54S/74S181 and SN54S/74S182.

Combined as shown above they add 16 bits in 19 ns.

The S181 arithmetic logic unit, with a complexity of 75 equivalent gates, will perform 16 binary operations on two 4-bit words (or provide 16 logic functions of two Boolean variables). Average internal logic gate performance is 2.0 ns at 8 mW.

The S182 will provide the carry/look-ahead function for up to 16-bit word lengths. Total S182 delay is 4 to 7 ns, depending on logic path.

Upgrade existing designs

The Schottky S181/S182 combination is nearly twice as fast as its standard TTL counterpart (see table). And since they are functionally and mechanically interchangeable, it's easy to upgrade existing system designs.

COMPARATIVE SPEEDS

Bits	Schottky S181/S182	Standard 181/182	ALU Units	Look-ahead Units
1-4	11 ns	24 ns	1	0
5-8	18 ns	36 ns	2	0
9-16	19 ns	36 ns	3-4	1
17-64	28 ns	60 ns	5-16	2-5

High performance for new designs

For new designs, the Schottky S181/S182 offer speeds comparable to nonsaturating logics (19 ns versus 16 ns, typically, for the same function performed with ECL)—with lower power requirements and much greater design freedom.

Complete compatibility

TI's Schottky line—including the S181/S182, 15 other MSI functions and 19 SSI circuits—is totally compatible with all TTL. Standard, high-speed, low-power, and low-power Schottky. Together, these TI families offer more than 250 integrated circuit functions with compatible logic levels, voltage swings and noise margins. This enables the designer to optimize the speed/power product of his system.

Full temperature range and package choice

The SN54S/74S181 and SN54S/74S182 are available in both −55° to 125°C and 0° to 70°C temperature ranges...in plastic and ceramic DIPs and flat-packs.

Send for data sheets

For your copy of "New Schottky TTL" which contains data sheets on all of TI's Series 54S/74S Schottky MSI devices, circle 217 on the Service card. Or write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Tex. 75222.

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Meetings

International Conference on Cybernetics and Society: IEEE, Sheraton, Washington, D.C., Oct. 9-12.

International Telemetering Conf.: ITF, Los Angeles, Oct. 10-12.

Conference on Display Devices: IEEE, United Engineering Center, New York, Oct. 11-12.

Eascon: IEEE, Marriott Twin Bridges, Washington, Oct. 16-18.

Photo-Optical Instrumentation Engineers Annual Meeting: SPIE, San Francisco, Oct. 16-18.

Optical Society of America Annual Meeting: OSA, Jack Tar Hotel, San Francisco, Oct. 17-20.

Fifth Annual Connector Symposium: Electronic Connector Study Group, Cherry Hill Inn, Cherry Hill, N.J., Oct. 18-19.

International Conference on Computer Communications: IEEE, ACM, Hilton, Washington, D.C., Oct. 24-26.

Nerem: IEEE, John B. Hynes Civic Auditorium, Boston, Nov. 1-3.

Canadian Conf. on Communications and EHV Power Transmission: IEEE, Queen Elizabeth Hotel, Montreal, Nov. 9-10.

Electronica 72: Munich Fair Grounds, Munich, West Germany, Nov. 23-29.

Int. Conf. on Digital Satellite Communications: Intelsat, Unesco Building, Paris, Nov. 28-30.

International Conference on Magnetism and Magnetic Materials: AIP, IEEE, et al., Hilton, Denver, Nov. 28-Dec. 1.

National Telecommunications Conf.: IEEE, Astroworld, Houston, Dec. 4-6.

International Electron Devices Meeting: IEEE, Washington Hilton, Washington, D.C., Dec. 4-6.

Think Twice:

What's one of the biggest measurement problems in the computer industry today?

Low Duty-Cycle Measurements— Making timing-pulse adjustments, and finding noise pulses in, or locating missing bits from low duty-cycle digital signals. Countless lost hours and eyestrain have resulted from this problem—trying to view low rep-rate signals like those found in disc, tape, or drum peripheral units. But with your refresh cycle occurring at such long intervals, coupled with short phosphor persistence, it's no wonder that you've spent an inordinate amount of time making such measurements. And it's no wonder that you often came out from under your scope hood rubbing your eyes. Well, no more!

Storage CRT With Unmatched 400 cm/μs Writing Speed. Hewlett-Packard just made it possible for you to throw away your scope hood by developing a new bright, burn-resistant, high-speed, variable-persistence CRT—available in either 100 cm/μs or 400 cm/μs writing speeds. Placing these new CRT's into an all new mainframe that's optimized for high-writing-speed storage measurements, HP now gives you a new dimension in storage scopes—the HP 184A. This unique combination offers the highest writing speed available, and a display with brightness as great as you can find anywhere. For the first time you can find those elusive transients that before were too fast for your storage scope to follow—like nanosecond noise pulses.

Display True Replicas of Your Waveforms. You'll appreciate being able to adjust persistence down to 0.2 seconds; that's 75 times lower than a major competitive unit. For those measurements that require faster sweep times, you'll know you are displaying true replicas of your waveforms when you're using an HP 184A. Capture low duty-cycle pulse trains, through repetitive sweeps, simply by adjusting the persistence to "maximum," to build up the intensity of dim traces. This feature in the new 184A oscilloscope lets you do many jobs you previously allocated to expensive, single-shot scope/camera systems.

Variable-Persistence Storage and Standard in One Scope. Further, you'll find that your 184A is a true general purpose scope that offers you the capability to choose, by way of plug-ins, all the functional features of the HP 180 Series of oscilloscopes, including such items as selectable-input impedance, and sampling to 18 GHz. And for simplicity of operation, we think you're in for a pleasant surprise when you compare the 184A against the competitive unit.

Superior Technology. HP believes the most important part of a scope system is the CRT—the interface between you and your measurement. As the pioneer in practical applications of dome-mesh magnification, HP was first to expand the size of high-frequency CRT's to 6 x 10 cm; first to 8 x 10 cm; and first to 10.4 x 13 cm—all in high-frequency mainframes. HP was also the first to use dome-mesh technology to substantially lower power requirements for CRT deflection (making possible the only line of 35 and 75 MHz portable scopes with built-in battery packs—scopes that really are portable).

From The Storage Leader. HP was first with variable-persistence mesh storage for commercial applications—to give you a stored trace many times brighter than bi-stable tubes, and without annoying flicker. Variable-persistence, with its ability to build up waveform brightness, was the first CRT innovation that gave you a trace bright enough to let you tackle most single-shot or low rep-rate measurements problems. All you do is adjust persistence until the integrating storage effect brings your waveform up to a bright, clear display.

Burn-Resistant CRT's. HP placed variable-persistence in many of its scopes including the 181A, 1702A, and 1703A storage units. And now HP has developed, for its current line of storage instruments, carefree CRT's so highly burn resistant they require little more care than conventional CRT's. The new 184A high-writing-speed scope also has unprecedented inherent resistance to burns.

Yes, Scopes Are Changing. How many times have you wished for a scope that could display a low rep-rate digital signal brightly and clearly, and one that could also be used for a variety of general purpose measurements. That scope is here now in HP's 184A storage mainframe, $2200 (for only $500 more, you can boost your 184A's writing speed to 400 cm/μs), with plug-in capability to 100 MHz real time, or 18 GHz sampling. Think twice; put away your scope viewing hood and call your local HP field engineer for a demo today. Or write for our "No Nonsense Guide to Oscilloscope Selection." It covers the other members of HP's variable-persistence storage scopes. Hewlett-Packard, Palo Alto, California 94304. In Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan: YHP, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

Scopes Are Changing; Think Twice.

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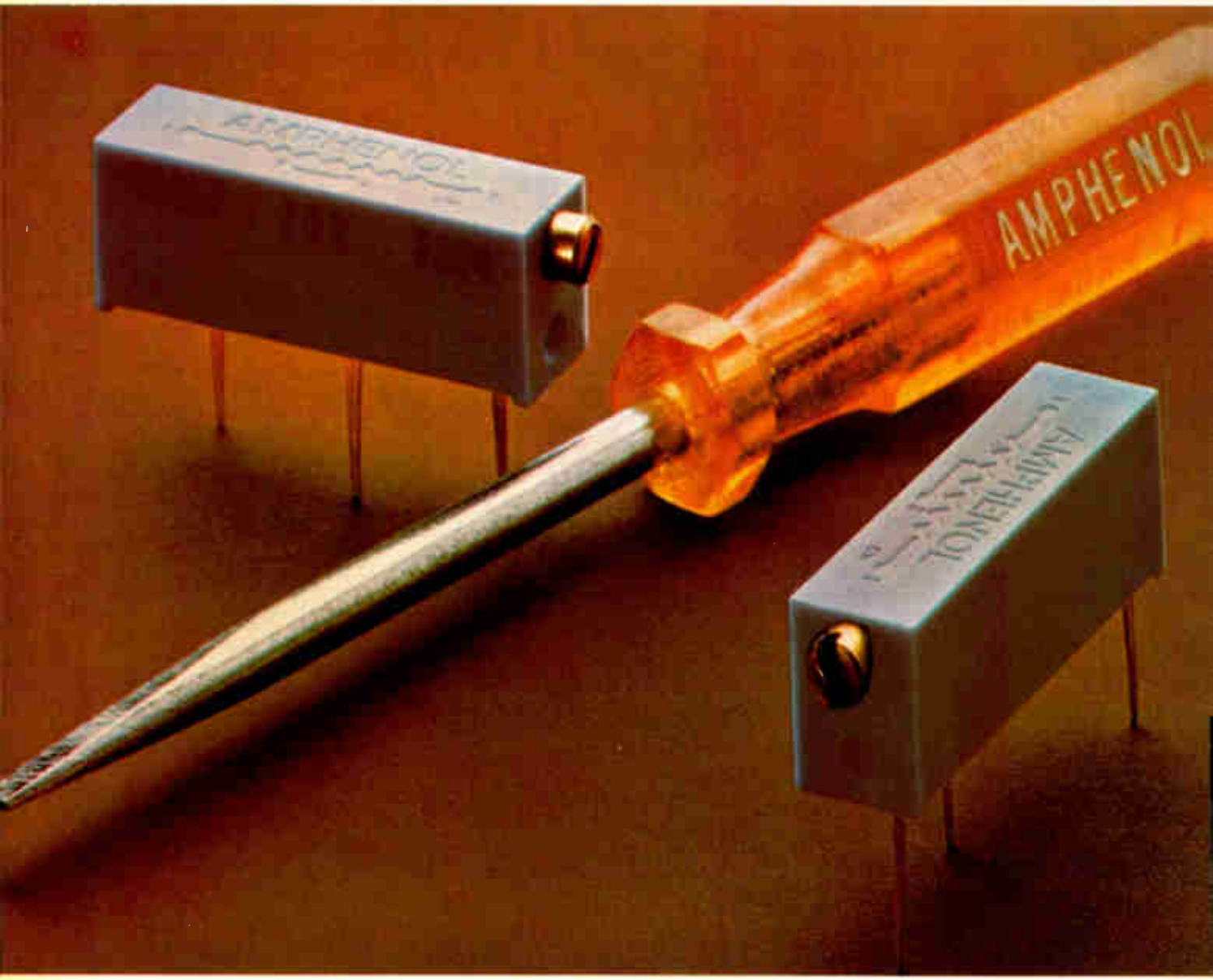
For fast, accurate settings,



test drive our 6034 trimmer.

Amphenol's 6034 Series trimmers have multi-finger contacts to give you better setability, lower CRV, and longer rotational life.

This ¾" cermet trimmer is designed with a low profile for maximum board stacking and has a solvent-resistant nylon case with epoxy seal for automated board cleaning processes. The Amphenol 6034 Series trimmer will operate at ambient temperatures up to 125°C and is completely humidity-proof. Three termination styles—P, K or Y terminals—are available.

The low-cost 6034 has a rotation life of 200 cycles minimum with no discontinuity. All are 100% inspected for noise, total resistance, continuity and end resistance before shipping.

A barbed lead screw, with a 15-turn shaft adjustment, positively seals and eliminates end play. Without the typical O-ring there is no chance of pinching or breaking the seal.

Your local Amphenol distributor can arrange a "test drive" on your board. Let us set it up for you. Write Al Nemetz, Amphenol Connector Division, Controls Operations, Bunker Ramo Corporation, 2801 South 25th Avenue, Broadview, Illinois 60153.

Circle 26 on reader service card

BUNKER RAMO AMPHENOL

Electronics newsletter

DEC poised to go into business-systems market

Watch for an early announcement from the **Digital Equipment Corp. marking its entry into business-oriented computer systems.** The new Datasystems 300, 500, 700, and 800 are based on existing mainframes and peripherals—PDP-8s are used in the 300 and PDP-11s in the other series. **Their market target overlaps that of IBM's System 7 line** and includes applications such as inventory control, order entry, general ledger work, sales analysis, and billing, depending on configuration. Even the smallest data system includes an interactive CRT terminal, tape memory, and a line printer. The computer can operate in either batch or on-line interactive mode, and can either stand alone, form the base of a hierarchical system, or operate in a network. **Prices run from less than $30,000 to more than $100,000.**

DEC does not plan to compete with its own OEMs. Instead, the company will sell directly only to large firms with enough knowhow to tailor the data systems to their own applications. DEC will, however, license various software packages and sell software support. Customers for small quantities will be left to DEC's many OEMs. With this multi-pronged approach, DEC hopes to compete successfully with the sales, software, and support coverage offered by giants like IBM.

Real-time computer with hardware executive

A real-time computer with a hardware executive system is being designed at the Systems and Research division of Honeywell Inc. in St. Paul, Minn. **It resembles the Symbol computer built at Fairchild Camera & Instrument Corp.** and now installed at Iowa State University, Ames, Iowa [*Electronics*, Feb. 15, 1971, p. 25] except that for real-time operation it will have to run at much higher speed. The original Symbol computer is oriented toward data-base manipulation in time-shared or batch mode, but not in real time.

To achieve the necessary performance, Honeywell engineers are working on LSI ECL queue memories faster than, but similar in function to, recent Fairchild 3341 and Signetics 3525 MOS queues. In addition, the Honeywell queue will be associatively accessible from the side. In pure queue mode, data must be removed from the memory in the same order it was put in, but the associative feature permits a mode of operation analogous to that of a restaurant hostess who keeps a party of six waiting at the head of the line for a large table while admitting twos and threes from farther back in line.

Microwave vendors guarantee MCI loan for contracts...

Two major microwave equipment contracts, with a value of more than $30 million, have been negotiated by MCI Communications Corp. for the Washington-New York and New York-Chicago legs of its national special service common-carrier route. Collins Radio Co. received the first $6 million in purchase orders under a 30-month, **$24 million contract for radios and associated electronics at 75 sites along 1,500 miles of MCI routes** linking 13 cities. CitCom Systems received a **$6 million contract for multiplex and associated electronics** for the same route.

Under the complex financial agreements, however, the vendors' respective parent companies—North American Rockwell and Compagnie Industrielle des Télécommunications de France—**guarantee MCI's $64 million credit agreement with six banks to the tune of up to 60% of the amount of their contracts.** One financial source saw a trend in the agreement: "What MCI has said, in effect, to its suppliers is: 'If you be-

lieve we can succeed and want our business, let us see the color of your money.' " He said he believed that in the future other **manufacturers may be expected to offer financial support to customers trying to develop new markets.**

...as AT&T gets OK for N.Y.-Chicago DUV digital link

AT&T is proceeding with plans to counter MCI and other special-service carriers with its own DUV (Data Under Voice) digital service [*Electronics*, Oct. 25, 1971, p. 34]. **While MCI juggles its resources, Bell has received FCC approval for a New York-Chicago DUV link** and says it need invest only $141,000 to set up the service.

What worries MCI and other competitors such as Datran and Western Union is what AT&T will charge for DUV. AT&T hasn't said, and the others fear predatory pricing.

Business, science calculators next for TI

Texas Instruments is bursting out of its test-marketing phase for consumer calculators in a big way **and will be making and selling business calculators in the first quarter of next year.** Its initial Datamath machine has been renamed the TI 2500, will be augmented by two new consumer desk-top models (see p. 32), and worldwide marketing under the TI name is underway. Production of the TI 2500 will begin this week in Riete, Italy, for the European market. **The Dallas firm expects to announce a new calculator every 60 to 90 days for the next several months.** After launching the business calculator effort early next year, which will include printing calculators, TI also plans to enter the scientific calculator market. A marketing organization of people with both consumer and business-machine sales experience will total about 25 in the next month.

At the same time, **TI says it definitely won't participate any longer in the Electronic Industries Association's monthly compilation of U.S. semiconductor production** now that it has quit the EIA [*Electronics*, Sept. 11, p. 25]. At the U.S. Department of Commerce, which just dropped its own quarterly compilation of semiconductor output, one source said exclusion of TI would make the EIA's estimates "essentially meaningless."

Addenda

Grumman Corp. and McDonnell Douglas Corp. **received the first of the losers' shares of the $2.6 billion space shuttle contract when North American Rockwell Corp.** subcontracted engineering studies totaling $12 million. NR says it will let $200 million in hardware subpacts early next year [*Electronics*, Aug. 14, p. 44] . . . The Digital Equipment Corp. soon may go into the custom software business. Although characterized by its managers as a "computer manufacturing firm" rather than a software house, there now is so much DEC hardware in the field that demand for software is growing from users outside of DEC's traditional OEM and so-called sophisticated end-users markets. **Thus, software development now scattered throughout the firm soon may be gathered under a single management, perhaps next year.** . . . An S-band low noise transistor with 2-dB noise figure at 3.4 GHz is being developed by Fairchild's Microwave and Opto-electronics Division, Palo Alto, Calif. **This is a noise figure improvement of a full 1 dB over current state-of-the-art S-band transistors.**

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cessed the same way as earlier NRMEC parts, with size reduction coming partly from the design of the calculating "system."

A one-chip version of NRMEC's concept of the parallel-processing microcomputer, the chip contains a central processing unit, input/output circuitry, a clock, and both random-access and read-only memory. The four-phase circuit contains a relatively simple four-bit parallel adder with few instructions, but the 504 eight-bit words of ROM can provide extensive programing capability, like the one in larger desktop machines. An additional 48 words of RAM are included.

Easy interface. Output is designed for seven-segment tubes. Low-voltage Ise-type tubes can be driven directly, and simple interfaces are adequate for high-voltage gas discharge or low-voltage LED displays. With the Ise tubes operating from the 15 volts required by the chip (at reduced brilliance), total power drain of the calculator can be as low as 300 milliwatts. The chip requires 60 mW.

Chip functions depend on the desires of the customer. In addition to the four basic functions, he may select such operations as constant multiplication and divide, floating or fixed decimal, chain operations, square roots, discounts, and mark-ups. If the customer accepts one of the standard chips, which has full accumulator memory, no setup is required. NRMEC, which has a number of customers for the chip already, has other versions under development. □

Commercial electronics

Pan Am buys Bendix anti-hijack unit

Pan American Airways has made the going great for the Bendix Corp. in the competition to sell anti-hijack, passenger-screening systems. The boost came earlier this month when Pan Am chose the Bendix-Ray and became the first U.S. airline to buy an X-ray system to screen carry-on bags and parcels.

For security reasons, Pan Am is not disclosing details on the number of units ordered and their location. However, the first of the units—made at the Bendix Aerospace Systems division in Ann Arbor, Mich., and said to sell for as much as $30,000—will be used for detecting weapons and explosives at the airline's terminal at John F. Kennedy International Airport, New York. It will be used as a "test-bed operation" before similar units are installed elsewhere, says Frank A. Cardman, senior director of security at Pan Am. A test in Europe is also scheduled.

The Bendix unit emits a low-level beam of X rays, which, at less than 30-millionths of a Roentgen at 4 feet, will not even fog film, according to the company. A single 40-nanosecond X-ray pulse penetrates the parcel and falls upon a fluoroscopic screen. Then the image is intensified, stored via a Lithocon storage tube, and presented on a TV monitor. The storage tube is the PEP 400 from Princeton Electronic Products, North Brunswick, N.J.

Market beckons. Just how large the market will be for such systems is difficult to estimate, but it will certainly be large as airlines intensify measures to protect against hijacking. That market may well begin to break open in the next six months.

Another manufacturer, American Science and Engineering Inc., Cambridge, Mass., says it is readying three units for use at airports. The ASR system, geared more for "mass-production" inspections, will probably screen luggage carried in the cargo compartments of the aircraft, a spokesman says.

Perhaps the largest single order thus far for X-ray inspection systems was made earlier this year by the Air Force's Postal and Courier Service. Some 37 units at a total price of $350,000 are being manufactured by Philips Electronic Instruments, Mt. Vernon, N.Y. However, these are high-dosage-level systems, which, unlike airline systems, are completely shielded. The Air Force is using them in Southeast Asia and will start this week in Europe to check the luggage of returning troops for weapons, drugs, and other contraband.

TI adds calculators

Texas Instruments has finally acknowledged that it's in the calculator business, at the same time announcing two under-$100 desktop machines. TI also renamed the hand-held model it has test-marketed as Datamath [*Electronics*, July 3, p. 44], calling it the TI 2500, and has slashed its suggested retail price from $149.95 to $119.95. Two new four-function desktop versions feature floating decimal point and entry and calculation overflow indication on a Burroughs Panaplex gas-discharge display on the eight-digit TI 3000 and the 10-digit TI 3500. In addition, the TI 3500 has chain/constant and floating/fixed decimal-point features. The TI 3000 is available now at $84.95; the TI 3500 will be out next month at $99.95.

Image of life

The same storage tube that's used in X-ray systems such as the Bendix-Ray is helping to cause excitement among medical men. The reason: ultrasound imaging devices that offer pictures with gray scale, rather than the silhouette-type image generated by X ray. "Basically," explains S.R. Hofstein, president of Princeton Electronic Products, "the technique is an extension of sonar" except that light is used.

A Princeton tube is used, for instance, in a system that enables the physician to "see" a human fetus in the uterus and determine if it is healthy.

A sister company, Philips Broadcast Equipment Corp., Montvale, N.J., has a low-level X-ray inspection system that Eastern Airlines was testing earlier this summer. Other low-level units are being used by organizations such as the Customs Bureau and the U.S. Postal Service. □

Meetings

IEEE Compcon finds West Coast home

Another computer group has decided to change its meeting policy. The IEEE Computer Convention, known as Compcon, has decided to schedule all future conferences the last week of February in San Francisco, beginning Feb. 27 to March 1, 1973, at the Jack Tar Hotel. The decision follows one by the American Federation of Information Processing Societies, of which Compcon is a constituent, to end its semiannual Joint Computer Conferences in favor of a single annual meeting [*Electronics*, July 31, p. 25].

The Compcon move is an overt attempt to emulate the highly regarded International Solid State Circuit Conferences, which for the past several years have been held during the second week in February each year in Philadelphia.

Meanwhile, some other constituents of AFIPS are said to be questioning the wisdom of the move to one meeting, as well as the restructuring of the meeting to a series of vertical use-oriented segments, as opposed to a horizontal, technology-oriented setup.

Flexibility. "Beginning with Compcon 73, we're going to institute informal evening sessions, like those at ISSCC," says Rex Rice, of the Systems Technology division, Fairchild Camera & Instrument Corp., Palo Alto, Calif., and chairman of the Compcon steering committee. "We're also going to permit five-minute quickie papers that show up at the last minute and aren't referred—an innovation that has proven to be highly popular at ISSCC."

"Previous conferences have all been difficult to organize," says A.S. Hoagland, of IBM in Boulder, Colo., president of the computer society. "But by zeroing in on one location, the national organization can work out continuing arrangements that don't require local chapter people, working from scratch, to set up a new conference every time."

Likewise, by establishing a more or less fixed time early in the year for the conferences, the chance of overlapping other important conferences is reduced or eliminated, and computer people can develop the habit of reserving the same week each year for the meeting. This will permit stressing of the technical quality of the meetings. □

Industrial electronics

BART starts with a subdued bang

It's not exactly what the engineers expect it to be, but it's running—albeit carefully. Its name is BART—for Bay Area Rapid Transit—a $1.4 billion surface and subway system. The 75-mile network eventually will link cities and suburbs of the San Francisco Bay area.

Hands off. View from the front end of a BART car shows Westinghouse controls.

As BART's first 28-mile leg opened earlier this month, there were electronic malfunctions. In fact, what's been billed as the "most advanced automatic train control system in the world" was relying on flagmen to record arrival times at each station and telephone ahead to the next two stations to make sure that the track was clear. The reason was attributed by a state spokesman to bugs in the Westinghouse Prodac 250 computer that normally performs such duties.

Problems. The bugs include problems in the train-identification system and the synchronization signal on the train itself, plus false-track-occupancy signals. But most serious ais the train's inability to decod speed instructions, says John Asmus, an electrical engineer with Parsons, Brinckerhoff, Tudor, and Bechtel, the general contractor for BART. He says that because a train isn't getting its speed orders, the fail-safe system cuts in and stops the vehicle. Asmus says the problem is Westinghouse's under its $26 million contract with BART. But Joseph Marshall, representative for the Westinghouse Industrial division, disagrees. "It's BART's problem, not the computer's."

Another problem, Asmus points out, is the failure of the train-identification system to transmit to the trains their identification numbers, which are normally picked up by the wayside equipment. Since the

wayside control isn't getting any signal from the trains, it automatically halts the vehicles. The malfunction in the synchronization system causes the trains to receive instructions out of sequence or not at all.

Promises. Michael Healy, BART spokesman, says that the problems stem from the interface electronics. Healy says that Westinghouse will be working toward a solution, expected "by the time we phase into the next leg of BART" in November.

But confusion and contradiction have been no strangers to the decade-old project. In an earlier incident, three BART engineers were fired in March after submitting to the public a study implying that safety was forfeited in favor of expediency.

Robert Kraehe, another spokesman, says that BART officials planned all along to operate partially by manual control for the first few weeks, but Daniel Helix, BART board of directors member, says that he was never informed of such a plan. Kraehe says, "You don't need automatic control with eight lousy trains," the number that will be running in the first phase of operation.

"Engineers are never ready to open anything. They always want six more months," he declares. □

Consumer electronics

Computer, laser: portrait by numbers

Remember those paint-by-numbers kits that promised to transform even the sloppiest amateur into a junior Van Gogh? Well, they're back in a bright new way this fall, thanks to Itek Corp. and a technological boost from NASA's Earth Resources Technology Satellite (ERTS) program. Only instead of presenting the outlines of such items as a vase of sunflowers or an old wooden bridge, the new kits—dubbed Personal Paintings by its merchandiser, the Craft Master division of General Mills—provide the wherewithal for paint-

NASA is facing a new challenge as Proxmire takes over subcommittee

Dawn's early light generates many long shadows in Washington. And not the least of these is the lean and determined image of Sen. William W. Proxmire jogging the four miles from his home to the Capitol Hill office where he regularly makes headlines as a trenchant critic of the nation's technological priorities.

Famous as a Senate rebel who prefers to operate unhindered by the unwritten rules of the upper chamber's inner circle, the 56-year-old Wisconsin Democrat has gained much celebrity and some success as the member who took over the chair of the little-known Joint Economic Committee and turned it into a versatile platform from which to challenge legislation he considers questionable: Federal funding of the supersonic transport, the Federal guarantee of private loans to Lockheed Aircraft, and NASA's space shuttle, to name but three.

New post. And next year Proxmire will gain yet another platform as chairman of the Appropriations Subcommittee on Space, a job that NASA officials know is almost sure to give him greater influence on their budget than he has had on the Senate floor, where he has tried unsuccessfully to introduce selected appropriations cuts.

In his new post in the upcoming 93rd Congress, Sen. Proxmire says he plans to introduce "adversary hearings" to scrutinize NASA programs, particularly manned projects like the space shuttle. Next year's hearings will feature opponents as well as advocates of NASA programs, and Proxmire says that NASA officials will be called upon to explain—if not prove—the value of the programs. "We hope to explore the implications of the programs," he says. NASA "will have to justify its programs in terms of benefits, such as a tax reduction," Proxmire says. With a general hold-down on expenditures, "a large amount of Government programs will have to be sacrificed" he warns. Although he seems satisfied with NASA's current $3.4 billion funding level, he suggests that NASA "help us hold it down."

Thus far, Proxmire says "the case just hasn't been made" for the benefits of the manned space program. He says he asked NASA "for a justification of the Apollo and space-shuttle programs" and was told they brought "more information on the origins of the moon, sun, and the earth, and the psychic satisfaction of watching man on the moon." He asserts that "neither of these means a thing when it comes to things like programs to save the life of a child."

Showboating. Unmanned programs fare better in Proxmire's book. In dismissing the "showboat elements" of the manned space program, he says testimony shows that "we've had very little scientific exploration with manned flights that couldn't have been made by unmanned. Viewed from the standpoint of resources, it makes sense to rely on unmanned exploration," partly because it's far cheaper.

A graduate of Yale, Proxmire received a master's degree from the Harvard University Graduate School of Business and worked for the J.P. Morgan investment firm before enlisting in the Army for six years during World War II. After the war, he returned to Harvard to lecture in political theory and earn another master's from the school of public administration. In 1949, he went to a Wisconsin newspaper as a political reporter before launching his political career in the state assembly a year later.

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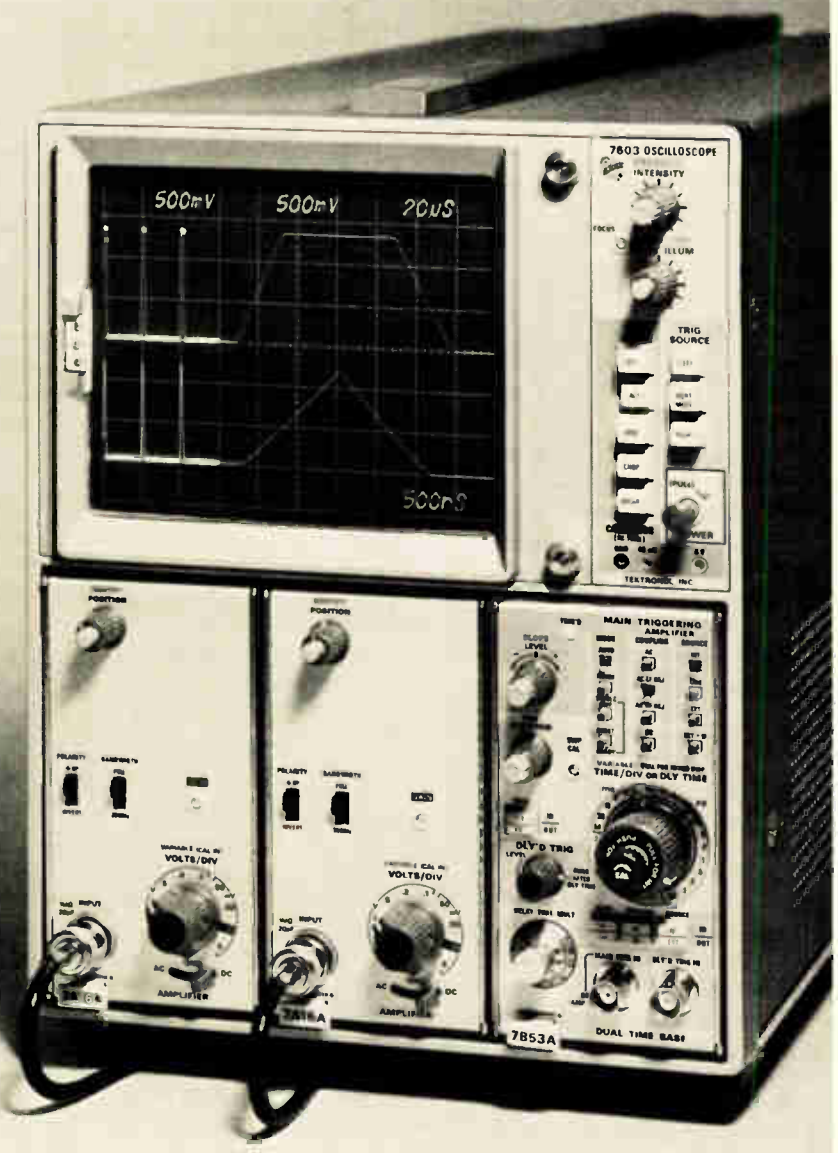

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Computer-assisted design

National's transistors stored in Aedcap

Transistor models for computer simulation can be taken from data sheets. But the method is cumbersome and, in practice, can be quite difficult. Now, in a move believed to be an industry first, National Semiconductor Corp. of Santa Clara, Calif., is offering customers the opportunity to try its transistors through circuit simulation before actually buying them. The new way gives the user easy access to a model that is more accurate than he could create for himself.

The device parameters are being added to the stored model file of the Aedcap circuit simulation system [*Electronics*, July 3, p. 81]. Aedcap, a proprietary product of SofTech Inc., of Waltham, Mass., is available through the nationwide time-sharing service of National CSS Inc., of Norwalk, Conn.

Customers who wish to test a National transistor in a circuit can do so simply by including the transistor in the standard Aedcap circuit description. During analysis of the circuit, the program automatically retrieves the device parameters from the file.

Thorough. National has gone to considerable lengths to provide models that are highly accurate—each discrete device may be called up in 36 variations, depending on the current, beta variation, and frequency. Also, each device has a separate group of models for each of six current ranges, and each of these groups has a separate model for high, typical, and low beta, representing the variations found in a typical production run.

Each of the 18 models is also available in a high-frequency version that takes into account the effect of the parasitic capacitance of the package. The high-frequency models are valid to 100 megahertz.

The program is being implemented initially on four or five groups of discrete transistors, each of which includes 50 to 60 devices. Long-range plans call for adding monolithic integrated circuits to the stored model files at a later date.

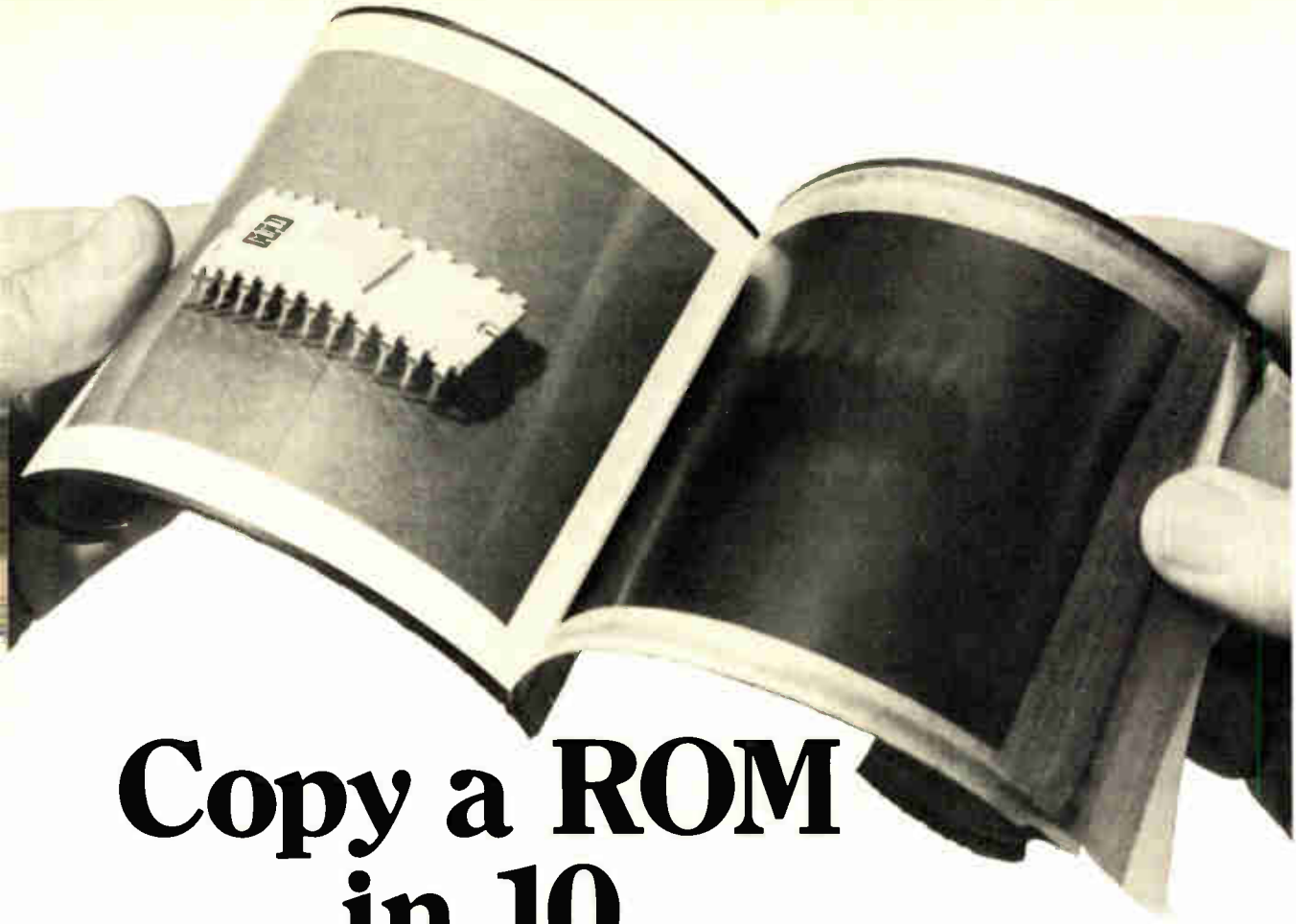
The first devices to be put into the Aedcap files are a group of 49 transistors known at National as process 20, a 2N2222 type of device. Other groups will be added at the rate of one every three or four weeks.

SofTech has modified the Aedcap system for the program by adding security measures that ensure the integrity of proprietary data. □

Manufacturing

Doped mask solves some GaAs woes

There is more wrong than right with available masking techniques for gallium arsenide semiconductor devices, and the same is true of the other III-V compounds. Unlike silicon, whose oxide forms an adequate mask layer, oxidized gallium arsenide is permeable to dopants and



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MM 6330	32x8	50	Open Collector	$ 12.00	MM 6230
MM 5330	32x8	50	Open Collector	$ 20.00	MM 5230
MM 6331	32x8	50	Tristate	$ 12.00	MM 6231
MM 5331	32x8	50	Tristate	$ 20.00	MM 5231
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impurities of manufacturing.

So engineers hoping to do photolithographic work on GaAs have to deposit materials on the GaAs wafer. And up to now, silicon dioxide, the most available material, hasn't been up to the task. SiO_2 masks often crack during diffusion if they are much thicker than 6,000 angstroms: but to act as an effective mask for GaAs, the layer should be nearer 8,000 Åthick.

New ingredient. But now the doped mask—silicon dioxide heavily doped with phosphorous pentoxide—has arrived. Graduate student B. Jayant Baliga and Professor Sorab K. Ghandi of the Rensselaer Polytechnic Institute, Troy, N.Y., have finished a set of experiments with phosphosilicate glass masks that show promise with GaAs and other III-V compounds.

SiO_2 cracks because its temperature coefficient of expansion doesn't match that of GaAs. But the addition of P_2O_5, which has almost 250 times the expansion coefficient of SiO_2, evens things out. And by varying the amount of dopant in the mask, the expansion of mask and substrate with temperature can be matched almost exactly. As a side benefit, the oxygen in the dopant compound helps prevent penetration of impurity ions, further protecting the GaAs during diffusion. The researchers were able to grow layers more than 10,000 Åthick and to control thickness to within ±1%.

Penalty. But there are few breakthroughs without drawbacks. In this instance, care is needed in growing the mask layer. To make the film, the gases phosphine and silane—both highly flammable and toxic—are simultaneously oxidized over the wafer. But the researchers point out that the gases can be monitored easily, and the oxidation process occurs at a relatively low 400°C—an advantage in the production of any semiconductor and especially advantageous if there are to be multiple doping steps with high-mobility compounds.

Photolithography, etch, and deposition are almost routine after the masking layer is formed. The researchers found the masking techniques suited to both tin and zinc, and diffusion occurred at relatively low temperatures. The best-fit situation for zinc was a diffusion temperature of about 800°C and, in the mask, a proportion of 20% to 35% of P_2O_5 by weight. The mask not only didn't crack, but easily kept undesired dopants from penetrating.

For tin, a higher temperature was needed because of its lower diffusion rate. But again, there were no problems, even though the temperature used was 1,100°C. The mask used with tin contained 20% P_2O_5.

And all went well after diffusion. Often with SiO_2 mask layers, reduction to room temperature causes fragile GaAs to crack, but with the doped mask, the GaAs remained intact. □

Communications

U.S. plans to test ship paging system

For some time the U.S. has been pushing a system for automatically paging ships at sea. But it couldn't sell the idea to the rest of the world because the system was untested, though it looked good on paper. To remedy this, the U.S. Maritime Administration recently issued requests for proposals and expects to award a contract in November for the development and testing of a Maritime Digital Selective Calling system. The U.S. will use the results of the year-long program to promote the system as an international standard before the 1974 World Administrative Radio Conference (WARC), which will decide frequency assignments for marine radio.

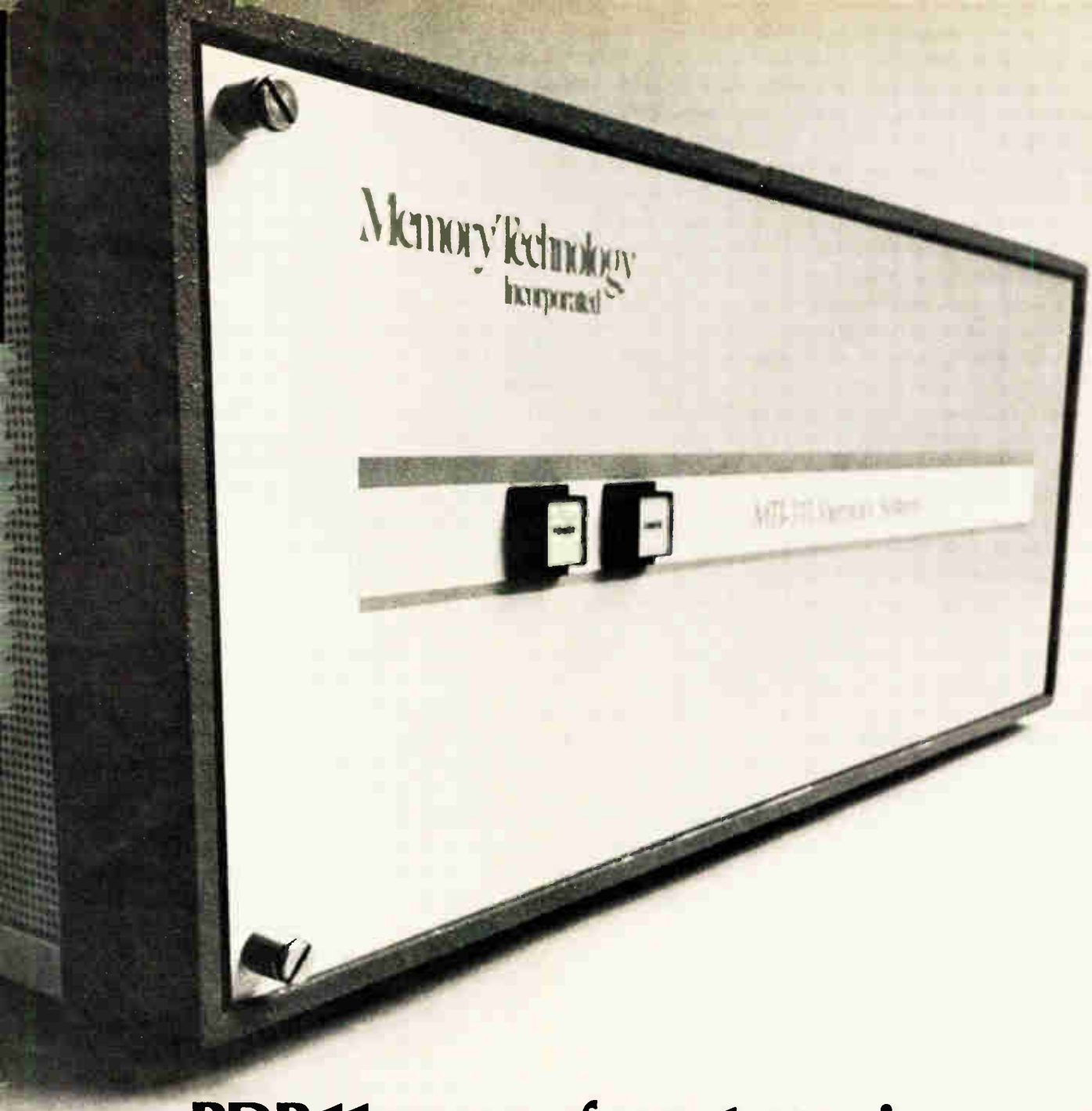
Anybody there? Almost all maritime nations agree that some system is needed to alert ships that there are radio messages for them. Typically, ship radio officers are on duty only eight hours, meaning that ships can't be reached for 16-hour periods. Even when officers are on duty, the procedures of finding an incoming call and selecting the proper communications channel are so intricate that it takes on the average about 12 hours to complete one two-way exchange of messages. The U.S. claims that its system is simpler and has more capability than proposed Swedish and Dutch systems or one by Germany adopted on an interim basis.

The U.S. system operates independently of frequency constraints because it uses the carrier frequency, explains Harry A. Feigleson, the Maritime Administration's project manager. Frequency-shift keying was chosen to format the binary information because it was straightforward, he says. The carrier frequency is zero; carrier frequency plus 100 hertz is a logic 1. Thus, a ship's receiver equipped with the system can be listening to the digital bit-stream traffic and automatically alert the crew when it hears an encoded message with the ship's name on it.

Limitations. Compared with the U.S. idea, the German Sequential Single Frequency Code system, which relies on preselected closely matched signal pairs, has several major disadvantages. It requires very stable circuits with accuracies down to about 2 hertz. It also is limited to about 100,000 ship-identification slots, not enough for worldwide use. And SSFC needs about a 2.8-kilohertz bandwidth, much too wide for the bandwidths now used in high-frequency telegraphy.

The Government agency expects to buy six of the American units, three for shore and three for ships, says Donald G. Woodring, project engineer. They consist of a demodulator, modulator, keyboard input device, control logic, and display of "lights and a buzzer to go off when a call is received," he says. Besides their ability to call up a ship as simply as a dial telephone, the units will be modular and flexible with options of an alphanumeric display to tell "who's calling you and at what frequency," of calling all ships by geographical area, by type, or by country, Woodring says.

Expected to draw heavy industry interest, the development program, estimated to be under $350,000, calls for the winner to build the



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equipment, test it in his plant and run the tests at the shore station, says Feigleson. Should the U.S. position prevail at WARC, the winner could well have an inside track to a world market. Strong U.S. backing for the system is assured, Feigleson says, as the White House Office of Telecommunications Policy and the FCC urged the Maritime Administration to undertake the project. Japan and Canada also reportedly support it. The system is a candidate for the planned multipurpose maritime satellite [*Electronics*, March 27, p. 68] □

Solid state

New isolation spurs C-MOS logic circuits

More and more semiconductor technology that was in the labs during 1970 and 1971 is going to market in 1972. Quickening the trend is the entry into the C-MOS market of Harris Semiconductor logic circuits built by dielectric isolation that are twice as fast and dissipate a tenth the power of equivalent gates and flip-flops.

Even more significant, it is these new isolation techniques, such as dielectric isolation and the more advanced polysilicon isolation, that are being applied to C-MOS to make it more competitive with bipolar transistor-transistor-logic circuits. Ironically, it was new isolation methods that made bipolar TTL circuits more competitive in size with MOS.

Indeed, this is the first time a passive isolation technique has been used to build standard ditigal logic. Harris adapted its custom process for these C-MOS circuits, which include dual and quad NOR gates, hex inverters, NAND gates, flip-flops, and buffers. All are pin-for-pin replacements for RCA circuits, except for a triple true-complement buffer, which is a Harris proprietary device.

LSI coming. Harris is planning to follow with 11 more ICs—four RCA types, three Motorola types, and four proprietary buffers, one-shots, and switches. But more important, by applying a polysilicon isolation process called polyplanar—similar to the polynotch of Motorola's VIP process—Harris believes it can build C-MOS LSI logic and is planning for chips with several hundred gates and more. This order of complexity is next to impossible with standard junction-isolated C-MOS because that configuration wastes space.

Harris will not only turn its poly-isolation process to logic, but it is planning a family of random-access memories as well. The first, slated for the end of the year, will be a 256-bit C-MOS RAM that breaks new ground by being completely TTL-compatible in input and output and having standard bipolar pinouts, making it pin-replaceable with the popular 256-bit bipolar RAMs. With its fast access time of 70 nanoseconds, cycle time of 100 ns, and its low operating power of 10 milliwatts, this static RAM should prove an attractive alternative to bipolar devices.

Two other poly-isolated products on the Harris schedule are a 2,048-bit programable ROM, the largest of its kind, and a 1,024-bit bipolar RAM. These are set for introduction by year's end or early 1973. □

Military electronics

Radar takes clean approach

Anyone who has ever manned a radar system knows that echoes from waves at sea or weather conditions ashore can reduce it to near uselessness. Much the same is true of airborne systems trying to spot targets through ground clutter; the targets are lost in the noise. The many attempts made to design clutter-reduction systems generally appear either to penalize the radar's sensitivity or to require special output waveshapes and consequent processing of the return. And this naturally raises system cost.

Now a research scientist at the Raytheon Co. laboratories in Way-

land, Mass., has come up with an approach he calls a dispersive constant false-alarm rate (CFAR) circuit. The nice thing about Harold R. Ward's approach is that not only should it work with simple and inexpensive radars but it also doesn't appear to exact a sensitivity penalty. Other schemes can cost a system from 1 to 3 decibels of sensitivity.

Simplicity. In contrast to the complexity of some clutter-reduction systems, the dispersive CFAR approach looks simple. Acting as a final stage in the i-f section are two delay lines and a limiter, and that's all. The delay lines are surface-wave devices, small and inexpensive.

Dispersive delay lines have delay or attenuation characteristics that vary with frequency. In Ward's approach, the delay lines used have time delay differences between the low and the high frequencies of signals fed to them. The input line has more delay at higher frequencies, while the line at the output has more at lower frequencies; their characteristics mirror each other. Between the delay lines is a so-called hard limiter which, despite the character of the signals fed to it, raises all to a specific amplitude.

The i-f strip presents the input delay line with a signal consisting of target return pulses and noise. The first delay line broadens the pulses, the limiter boosts everything to a set amplitude, and the output delay line squeezes the target pulses together again. But pulse amplitude now is higher above the background noise level than before. The noise content has been distributed over the time of its reception; because it is essentially random, it does not carry the phase signature that differentiates target returns from noise.

Raytheon's experimental system employed an X-band radar operating at 750 pulses per second, and using a 0.1-microsecond pulse. It was already equipped with a linear, or nondispersive, CFAR system for clutter reduction, and the goal was to find out how much improvement was possible with the new circuit. The dispersive CFAR used lithium niobate surface-wave delay lines with their 20-megahertz bandwidths centered around the 60-MHz i-f frequency. □

For the record

FCC denies stay. . . .

Citing possible harm to other applicants, the FCC has turned down requests by AT&T and Communications Satellite Corp. (Comsat) that it delay decisions on applications by other contenders in the domestic communications satellite (domsat) case until after the commission decides on the two companies' pleas to remove restrictions placed on them.

New commissioner Benjamin L. Hooks, who holds a tie-breaking role on Comsat and AT&T restrictions [*Electronics*, July 31, p. 23], voted against the stay. The FCC set Oct. 16 for all applicants to file their intentions.

. . . as Comsat seeks team

But, just before the FCC stay vote, Comsat announced that it is talking with MCI Lockheed, another domsat applicant, about jointly operating an end-to-end retail system. By this move, Comsat wants the FCC to relax its restrictions on the company operating both a wholesale system exclusively for AT&T and a retail system. In seeking FCC approval, it offered this deal: it would not fight for removal of the restrictions if the commission would permit it to operate a wholesale system exclusively for AT&T and be a minority partner with MCI Lockheed on a retail system.

WU integrates

In a program to establish a single system to integrate several heretofore independent customer groups, Western Union Corp. has installed a massive computer-controlled switching center at Middletown, Va. A principal node in Western Union's message traffic network, the new facility serves WU's Telex and TWX teleprinter networks, as well as telegram and mailgram users and international carriers in communication with terminals in the U.S.

Unique:

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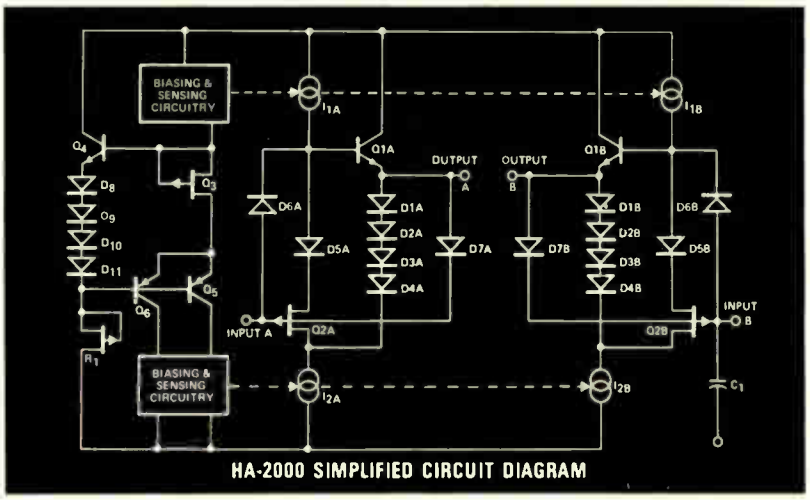
As a result, the HA-2000 offers almost limitless possibilities for low-input current, high source impedance applications such as buffers for op amps and comparators. In addition, because of its compatibility with so many other components, the device permits the user great flexibility in systems design at optimum prices. Find out about our new "universal" F.E.T. preamp. See your Harris distributor or representative.



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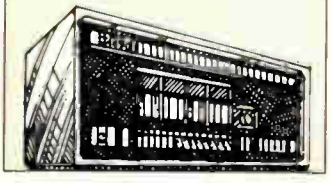
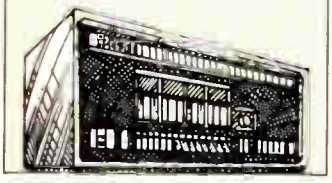


PDP-8/E (4K)
WAS
$4,990
NOW
$4,490



PDP-8/F (8K)
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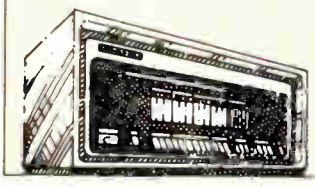
NOW
$5,150



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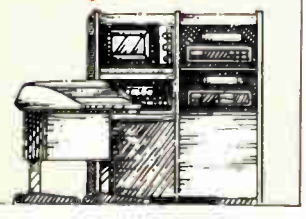

MM8-EJ
(8K core memory)
NEW
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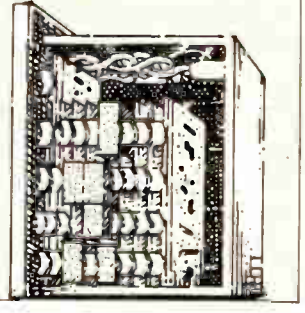

DISK PACK
(1.6M word disk pack)
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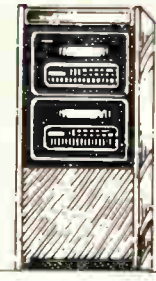

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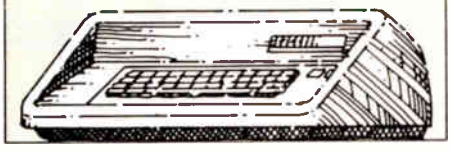
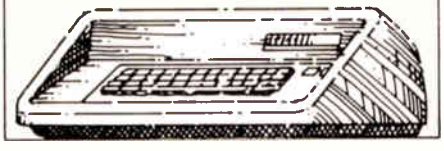


LA30A
(receive-only version of the LA30 DECwriter)
NEW
$2,500



VT8-E
(low-cost alphanumeric display)
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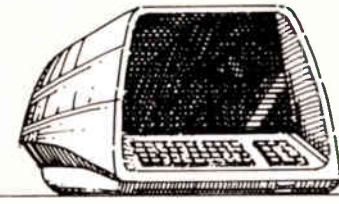
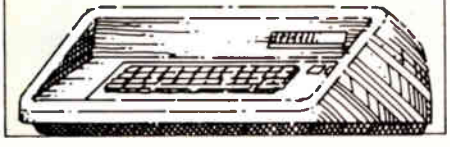


LA30-E
(DECwriter with EIA interface)
NEW
$3,195



RT02
(data entry terminal with alphanumeric display)
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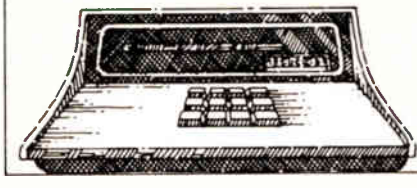

KL8-F
(asynchronous data interfaces)
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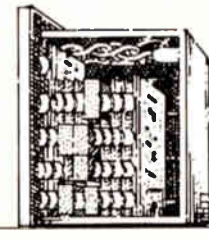
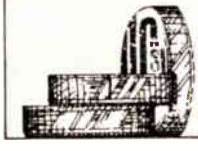


KL8-M
(modem controller)
NEW
$250

TECO
(text editor)
NEW
$55



BITMAP
(core memory management program for absolute binary programs)
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(operating system program with file and string manipulation)
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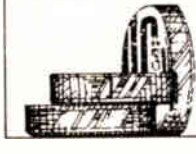
$150



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(file management program for PDP-8 systems using magnetic DECtape storage)
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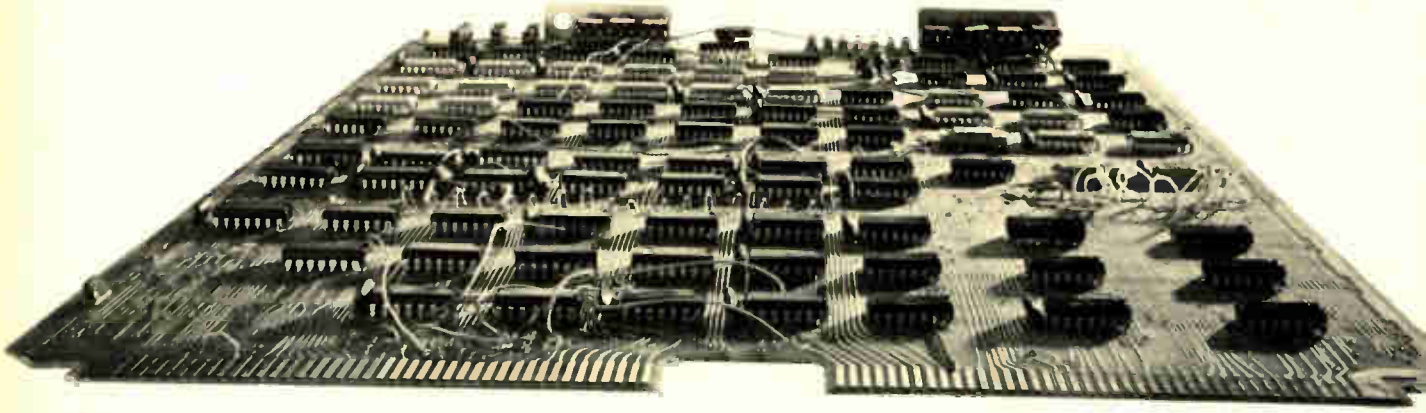
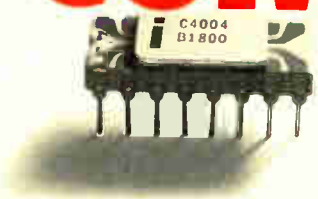
REPLACE ALL THIS RANDOM LOGIC



WITH A ONE-CHIP COMPUTER



Intel's 4004 4-bit central processor typically replaces about 90 TTL MSI and SSI packages. It's the heart of the MCS-4 set of four micro computer devices—which includes a 2048-bit ROM with a 4-bit I/O port, a 320-bit RAM with a 4-bit output port and a 10-port shift register for I/O expansion. They fit together without any interfacing circuitry to make complete systems with 32K bits of ROM and 5K bits of RAM. Using a few simple interfacing devices, you can build much larger systems with up to 96K bits of ROM.

Intel's 8008 8-bit central processor typically replaces about 125 TTL MSI and SSI packages. It's the heart of the MCS-8 micro computer set—which includes standard Intel ROMs, RAMs and shift registers. The central processor can directly address 16,000 8-bit bytes stored in any combination of these memory devices. The processor has interrupt capability, operates asynchronously or synchronously, and can perform as many as seven nesting sub-routines. Systems require some interfacing circuitry.

Both MCS-4 and MCS-8 micro computer sets enable you to build all types of complex random logic systems with a few standard LSI devices. The systems are micro-programmed with the ROMs—which gives you abundant design flexibility. In the prototyping stage you may substitute Intel's erasable PROMs for the ROMs. Later you may expand or update the system merely by changing the ROM program.

You can do truly proprietary system design while you eliminate all the disadvantages of custom LSI—the long development cycle, high development cost and potential obsolescence. In principle, this approach is the same as using a minicomputer in place of random logic. The difference is that your micro computer is much smaller and far less costly.

The MCS-4 and MCS-8 sets have individual features that determine which is best suited to any given application. Intel can help you make the right choice.

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For MCS-4 systems

1. Prototyping board, SIM4-01. Forms operational micro-programmed computer with Intel erasable PROMs in place of mask-programmed ROMs. Holds up to 8K bits of PROM and 1280 bits of RAM.

2. Larger prototyping board, SIM4-02. Like SIM4-01 above, but it holds 32K bits of PROM and 5K bits of RAM.

3. PROM programmer, MP-702. Intel erasable PROMs plug into this board for programming using a teletypewriter.

4. Fortran IV assembler gives you the assistance of any general-purpose computer in developing MCS-4 programs.

5. SIM-4 hardware assembler. Four PROMs plug into either SIM-4 prototyping board, enabling your micro computer prototype to assemble its own programs. PROM Types AO-740, 741, 742, & 743.

6. Fortran IV simulator permits any general-purpose computer to simulate the micro computer you are designing.

7. Decimal addition routine, 16-digit, on PROM which plugs into prototyping board. Type AO-700.

8. User's manual This 115-page manual tells you all you need to know to use MCS-4 components successfully.

9. Library of programs, contributed by users, free to users.

For MCS-8 systems

1. Prototyping board, SIM8-01. Forms operational micro-programmed computer with Intel's erasable PROMs in place of mask-programmed ROMs. Holds up to 16K bits of PROM and 8K bits of RAM.

2. PROM programmer, MP-702. Intel erasable PROMs plug into this board for programming using a teletypewriter.

3. Fortran IV assembler gives you the assistance of any general-purpose computer in developing MCS-8 programs.

4. TTY Transmit/receive test program on PROM which plugs into prototyping board. Intel AO-800.

5. Chip-select and I/O test program on PROM which plugs into prototyping board. Intel AO-801.

6. RAM test program on PROM that plugs into prototyping board. Intel AO-802.

7. Bootstrap loader enables you to enter data or a program into the RAMs from a teletypewriter paper tape or keyboard, and execute the program from the RAMs. Consists of three PROMs (AO-860, 861, & 862) that plug into the prototyping board.

8. Users manual for MCS-8. This 55-page manual tells you what you need to know to use MCS-8 components successfully.

9. Library of programs, contributed by users, free to users.

Intel has formed a Micro Computer Systems Group with the sole mission of helping you build systems using micro computer sets. They developed the design aids above and will assist you in every other way possible.

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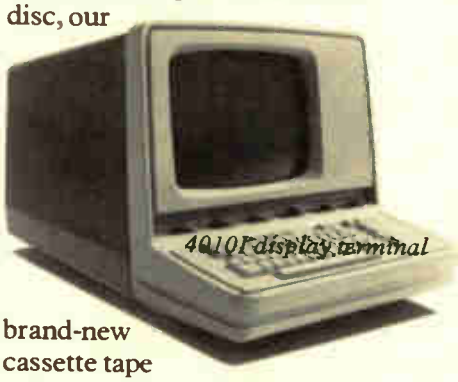

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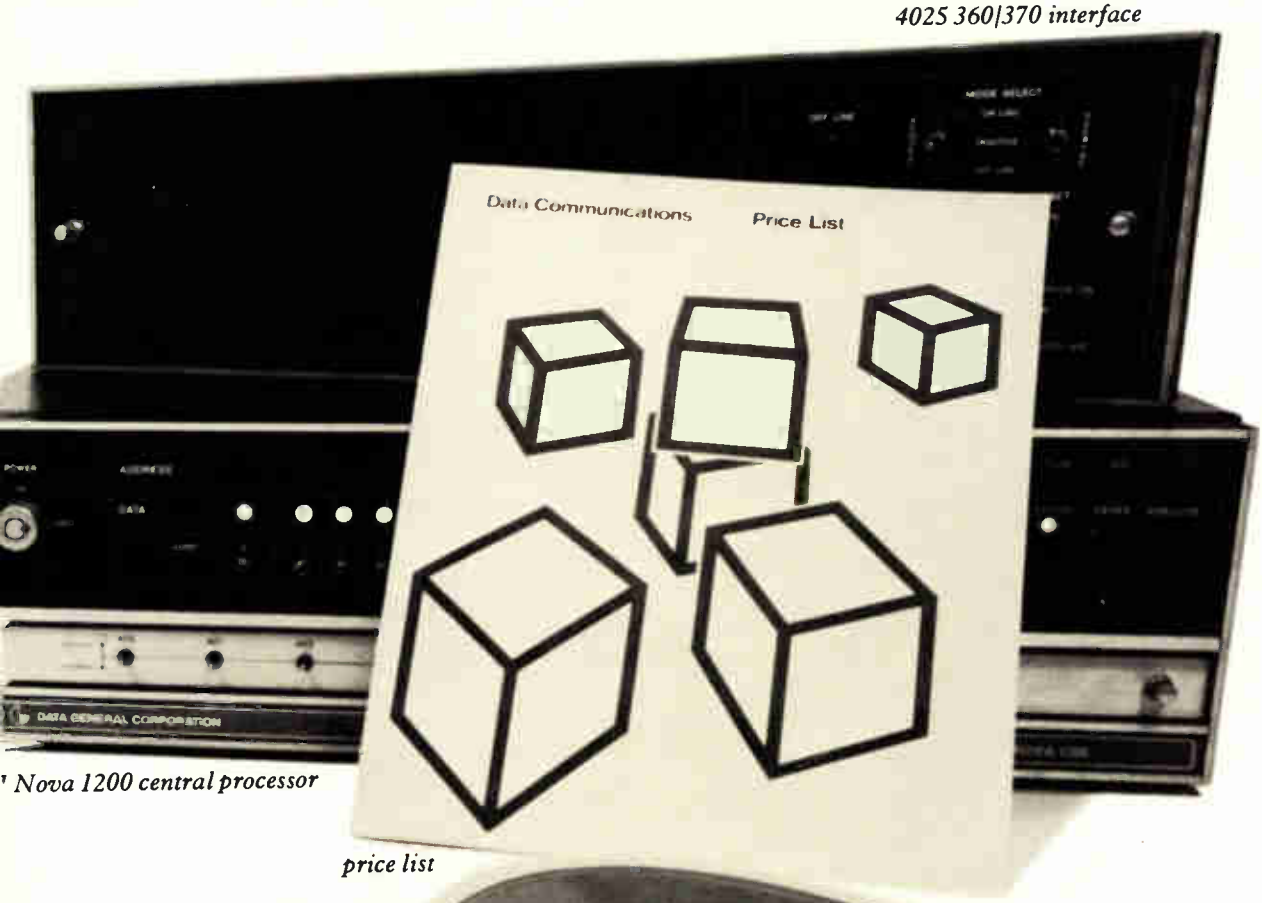

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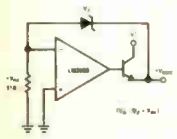
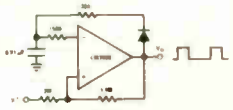
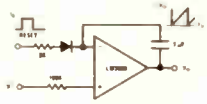
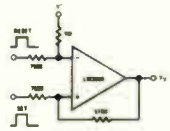
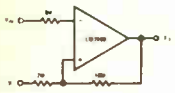
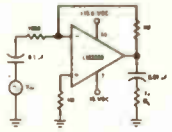

Voltage Regulator

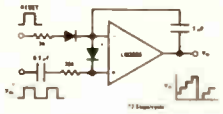

Pulse Generator

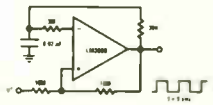

Sawtooth Generator

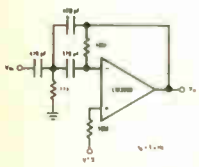

Bi-Stable Flipflop

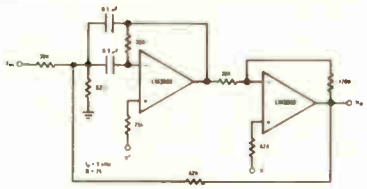

Schmitt Trigger

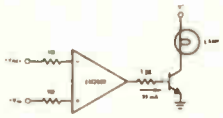

Operating with ± V_{OC} Supply

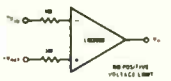

Staircase Generator

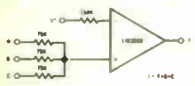

Squarewave Oscillator

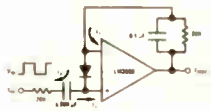

Hi-Pass Filter

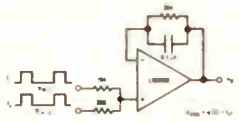

Bandpass Filter

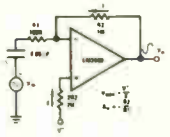

Comparator with Lamp Driver

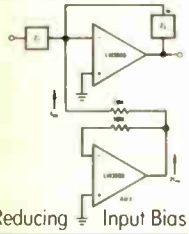

Comparator

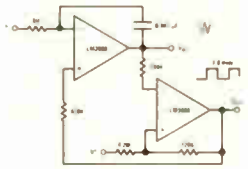

"OR" Gate

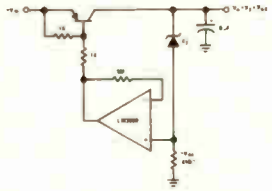

Frequency Doubling Tachometer

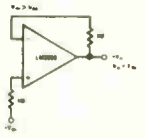

Input Summing Tachometer


Single Supply Biasing


Reducing Input Bias Current


Triangle/Square Wave Generator


Low (V_{in} $-V_o$) Voltage Regulator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NATIONAL

Washington newsletter

China to get 707 avionics . . .

Full Boeing 707 avionics systems will be included in the 10 jet transports the company has sold to the People's Republic of China for $125 million. And the prospect that China may later strike **an even larger deal for Boeing 747s** indicates the company will receive export approval for advanced inertial navigation systems if the Chinese want them. U.S. officials say **the White House joined with the Commerce Department in putting pressure on the Defense Department** and Cocom—the coordinating committee of the U.S. and its military allies which must pass on the sale of potentially strategic items to non-allies—not to raise any barriers to the transaction.

One point of leverage, sources point out, was the realization that **"China can get [the systems] elsewhere if they don't get them from us."** They also note that "anyone who has wanted to get a look at our systems has already had the opportunity, with so many 707s having been hijacked and held in other countries for several days before return."

. . . as trade potential is great

Other pressures for approval of the 707 avionics sales are competitive. The U.S. now sees an immeasurable **potential for long-term sales of conventional aircraft and ground air-traffic-control equipment** for China's primitive domestic air system, which now reportedly operates largely on visual flight rules. So it does not want to get off on the wrong foot by raising "unnecessary and possibly embarrassing" strategic embargoes.

Much on U.S. traders' minds is the recent Japanese diplomatic mission to China— the first since World War II—which is exploring Sino-Japanese trade opportunities. Though the U.S. retains its technological leadership in avionics, the strength of Japanese competition is recognized, once it can work out an agreement with the Chinese on World War II reparations and a peace treaty.

DOT to link expanded campus R&D to local firms

The Department of Transportation wants **to expand greatly its contracts for university research and development, now worth less than 1% of the Federal dollar total.** Strongly backed by DOT top brass, the plan includes "getting business to go in with us for such research," says a DOT official, and trying to "couple university research to where the technology is used at state and local" levels.

DOT must convince a skeptical Congress, however, which slashed a FY 1973 request for university R&D from $10 million to $4 million. Ultimately, DOT wants such funding to be on a par with that of other departments—at least Agriculture's annual level of $60 million, if not Health, Education and Welfare's high of $250 million plus.

FAA to buy more metal detectors

The Federal Aviation Administration now prefers active rather than passive metal-detection devices in the war against skyjackers. It recently bought **$2.7 million of active units** from six companies, including Sperry Rand's Sensor Group, Gainesville, Fla., and Westinghouse Electric's Electronics Systems Support division, Baltimore. A second buy, probably before year end, is also planned. The first buy was for **1,090 walk-through and 1,200 hand-held units for delivery by Jan. 1.**

Washington commentary

Military planners try net technological assessment

On the eve of World War II, Winston Churchill characterized Russia as "a riddle wrapped in a mystery inside an enigma." And in the 33 years since that assessment, many Western defense planners still hold that view when it comes to Soviet technology and its application to production of weapons systems. But that is beginning to change now with the formation of a long-needed Net Assessment Group within the Office of the Secretary of Defense. It is a body whose judgments are expected to have significant impact on the U.S. defense electronics community.

Surprisingly, the formation of a Net Assessment Group—or NAG, if you will—began only two years ago with the recommendation of the Blue Ribbon Defense Panel set up by the White House to study the complex, not to say muddled, operations of the Department of Defense and its soaring costs. As the panel pointed out, there is a difference between the operations of a NAG and military intelligence. The latter serves the former.

The need for a NAG

In justifying the need for a net assessment capability, the civilian panel put its case plainly: "There is no mechanism within the department to provide an integrated analysis which systematically places existing or proposed programs in the context of the capabilities and limitations of the United States and its allies versus possible antagonists. The Secretary of Defense should have available, on a continuing basis, the results of comparative studies and evaluations of U.S. and foreign military capabilities to identify existing or potential deficiencies or imbalances in U.S. military capabilities."

That recommendation, one of 23 made by the panel, was quickly adopted, and the responsibility for coordinating a NAG assigned to the deputy secretary of defense. With pressure to contain or cut back defense costs rising throughout the country, one senior Pentagon planner has now come up with a first and necessarily sketchy comparison of the Russian weapons system acquisition process with that of the U.S. And the conclusions of Barry J. Shillito, assistant defense secretary for installations and logistics, are that (1) "We are acquiring weapons significantly more sophisticated than Soviet weapons, in some cases with marginal additional capability or 'nice to have' features, and we are paying heavily for this additional sophistication and marginal capability," and (2) "In moving toward this additional sophistication and marginal capability, we are adversely affecting force size."

For Shillito, the Soviet system of defense procurement is not much of an enigma, even though an accurate comparison of its output with that of the U.S. on a dollar/ruble basis is "almost impossible" because of "the pervasive economic disequilibrium of the Soviet society." Shillito believes that nevertheless some general conclusions are possible about Soviet-U.S. defense industry trends. He asserts the two countries are heading in opposite directions.

The way for the U.S. to go

Defense electronics and aerospace engineering in the Soviet Union, for example, "is the prestige segment of their industry," according to Shillito. In the U.S. it no longer is. Moreover, the Russians have "consistently increased their floor space available for military production; consistently developed new weapons, aircraft, engines, combat vehicles, ships, etc.; regularly initiated production of the best of these individual weapons, and consistently insured the availability of their most competent technical and managerial talent for the military segment of their industry."

When Barry Shillito makes such declarations, he is not necessarily attempting to scare up larger U.S. military appropriations with the cry that "the Russians are coming!" What he is trying to point up is that the U.S. must make better and more selective judgments in the future on what weapons it decides to fund within the constraints of tighter budgets. And when the Pentagon does make a program decision, it must do a better job of holding itself and its contractors to costs.

Costs and standardization

Beyond the need to "move ahead rapidly" in improving its competence in net technical assessment, Shillito is convinced that America needs to do more by way of independent subsystem development. "This is a practice which the Russians religiously pursue and which European aircraft developers use to good advantage," he says, noting that production decisions there are withheld until completion of "early proof testing of engines, electronics equipment, airframes and the like." Adoption of this technique by U.S. industry could speed up research and development activity within the defense electronics industry, even though it would certainly lead to fewer, if larger, production contracts in the end.

—Ray Connolly

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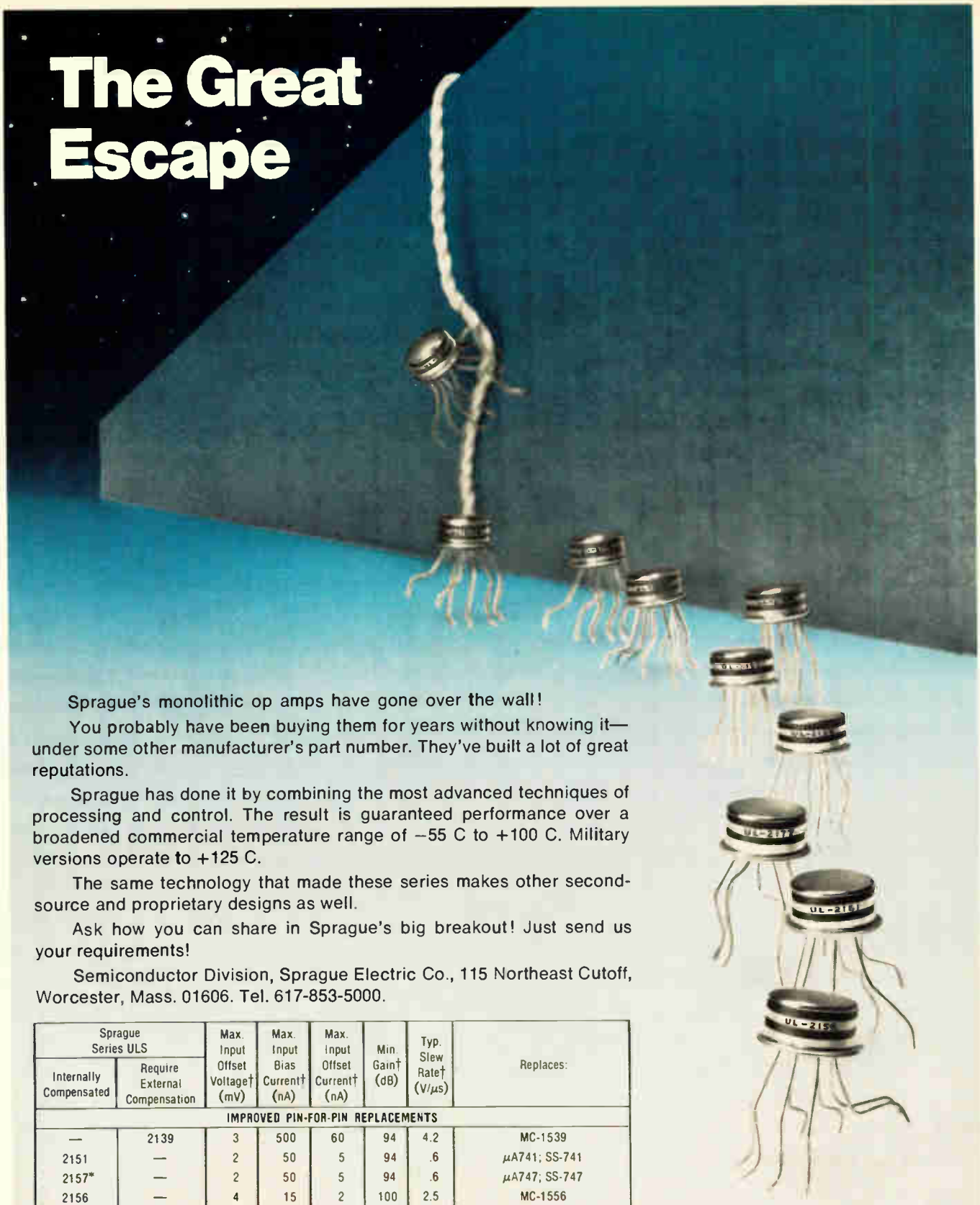
The Great Escape



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—	2139	3	500	60	94	4.2	MC-1539
2151	—	2	50	5	94	.6	μA741; SS-741
2157*	—	2	50	5	94	.6	μA747; SS-747
2156	—	4	15	2	100	2.5	MC-1556
—	2158	2	50	5	94	.6	μA748; SS-748
UNIQUE SPRAGUE DESIGNS							
2171	2172	2	15	7	94	1.5	Similar to MC-1556, SN-52771/SN-52770
2173	2174	2	3	1.5	100	.3	Similar to SG-118/LM-108, SG-108
2175	2176	2	3	1.5	100	1.5	Similar to MC-1556, SN-52771/SN-52770
2177	2178	2	.6	.3	100	.3	Similar to SG-118A/LM-108A, SG-108A

*Dual †T_a = 25°C

SPRAGUE
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Analog Products for Signal Processing

Two European video disk systems jockey for a market

The Philips announcement of its VLP video long-playing record system puts an end to speculation about what Europe's largest electronics company has up its sleeve in the video disk field [*Electronics*, Sept. 11, p. 29]. It also strengthens the disk as a contender in the video playback system market.

The system to hit the market first, though, is the one from AEG-Telefunken/Teldec, introduced two years ago [*Electronics*, Aug. 3, 1970, p. 127]. Now Europe's consumer products makers are wondering how the two European systems compare and which will eventually win out.

Whats ahead. The long uninterrupted playback time of the Philips system is a decided advantage over the German one. Flexibility is another, and reverse-motion, picture-by-picture, slow-motion and still-picture presentation should be desirable features in many applications. Easy handling is another plus point.

Still, audio-visual experts in Europe contend that both the Dutch and the German systems can exist side-by-side on the market place. As some people see it, AEG-Telefunken's Bildplatte playback system would be the top contender of the consumer market because of its lower price, whereas the Philips unit would find its prime market in the professional area.

Speaking for the AEG-Telefunken system is, besides low price, its development headstart, and its consequently earlier introduction. Most likely, it will hit the market during the second international radio and TV show in Germany next summer. Also likely to be ready for that event is a record-changer playback unit, which will partly overcome the limitation of short playback time. Interruptions between the disks, which carry 5 minutes of programs, are said to be less than half a second now—a dead time which should not be objectionable in many applications. With a 12-disk magazine, 60 minutes of color TV can be presented.

The price for the playback unit will probably range between $200 and $400, depending on whether it is a single-disk or disk-changing version. So far the company has patents pending in more than 80 countries, and licensing discussions with other firms are underway.

Details. Philips is rather vague in its statements on cost and introduction timing—understandable at this stage of development. "Within several years" is the time period given. As for cost, the company spokesmen will only say: "Within the price range that color TV sets currently sell for." The disk? Between $17 and $18 is an "orientation figure." □

France

Adaptive computer may control cars

The French government is considering putting up money for the development of a new computerized safety system for the car of the future. The system is ambitious: it would take over the function of the driver's judgment—the main factor in most traffic accidents.

The "active security" system would use a central minicomputer to correlate input from transducers monitoring environmental effects, such as outside humidity and temperature, and would limit acceleration, top speed, and suddenness of braking to fit road conditions. More important, the driver's physical condition would be evaluated by comparing his steering, acceleration, braking, and gear shifting movements against an ideal program. If drunkenness or fatigue causes the driver to perform below standard, the engine would shut off automatically.

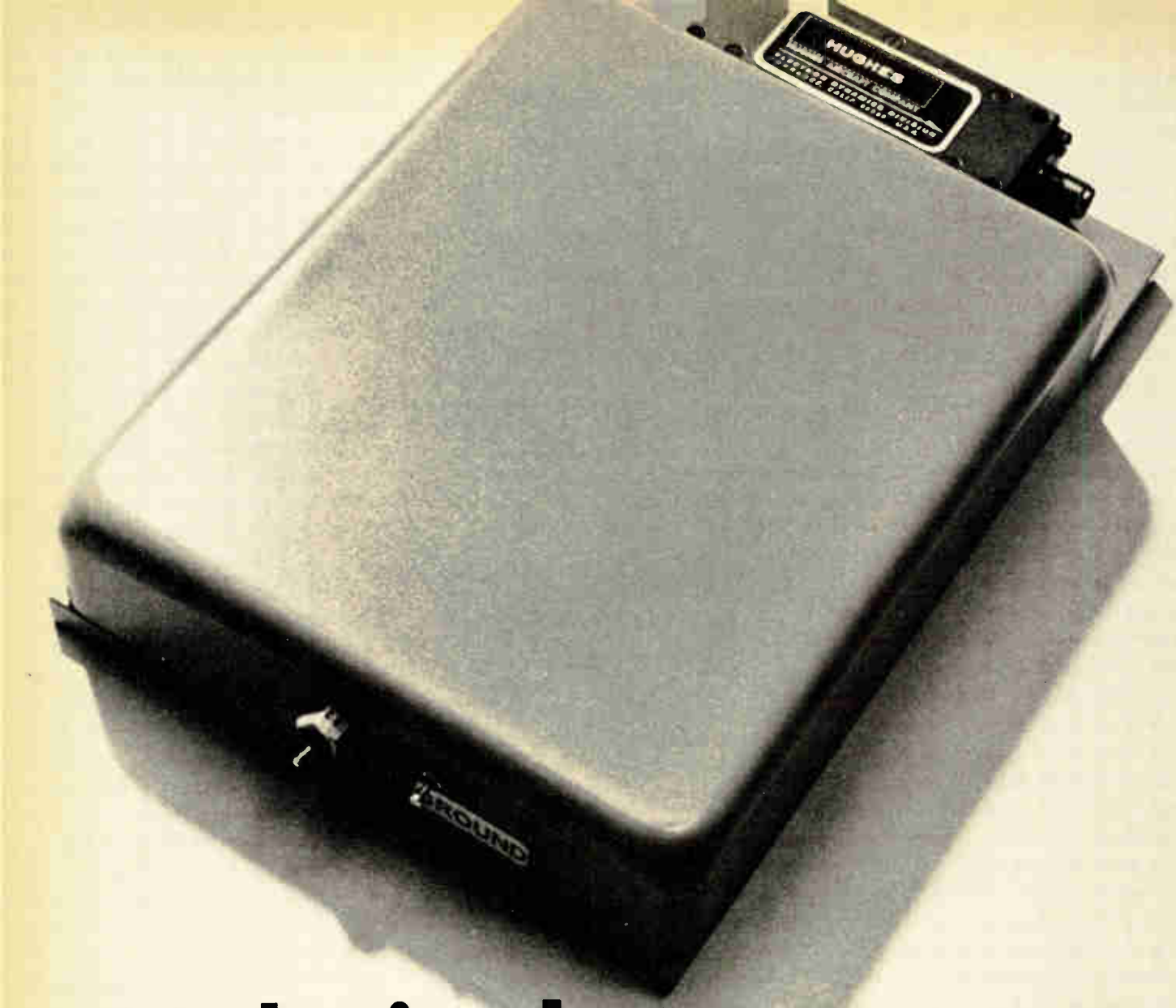
Developers. The French cable company Gregoire et Barilleau, which would use its multiplexing expertise to develop the simplified wiring for the system, will serve as prime contractor for the prototype development if the French government's scientific and technical research agency takes on the project.

The system was conceived by researchers at the Laboratoire d'Electronique et d'Automatique Dauphinois (LEAD) in Grenoble. LEAD figures about $260,000 would be needed to assemble the hardware and get the computer properly programed.

LEAD president Ferdinand Mayer says that the proposed system also would encourage more skillful driving. The driver's performance—the mean evaluation of his handling of the car as compared to the ideal computer program—would be displayed as a "score" on the dashboard.

"Suppose the program as drawn up by a test driver would produce a perfect score of 100," Mayer says. "A driver would try to score as close to 100 as possible. A beginner would probably make 20 or 30. A drunk might make 40. And the threshold of acceptable safety might be 65."

Other benefits from the system, Mayer says, would fall out from programing the computer with the driver's gear-shifting, accelerating, braking, and steering habits. If a thief tries to make off with the car, the computer would reject his movements and switch off the motor. Mayer sees this as the ultimate answer to the auto-theft problem. □



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International newsletter

Europe space plans stay up in the air

Disputes over the thrust of Europe's space activities have forced another postponement of the crucial space ministers' meeting to make the final decision on participation in the U.S. post-Apollo program and the future of the Europa-3 launch vehicle. Originally scheduled for Brussels in July, the meeting was postponed to late September [*Electronics*, July 17, p. 47]. Now the ministers have decided to shoot for a late-October meeting instead, due mainly to the Franco-German **disagreement over which program is more essential—post-Apollo or Europa.** NASA has pushed back its deadline for Europe's decision several times and now is reportedly willing to wait till the end of October. Currently, a "Committee of Alternates" is trying to arrive at a compromise program and agenda to recommend to the ministers.

Britain approves satellite to test communications links

The British Government has effectively given the go-ahead to a new British technology-proving satellite with a $1.25 million contract to Hawker Siddeley Dynamics Ltd. and Marconi Space and Defense Systems Ltd. **The award covers project definition of a geostationary spacecraft carrying experimental communications repeaters.** As well as testing geostationary operating techniques, the satellite will carry communications transponders, probably including one for 12-gigahertz television signals, one for L-band maritime communications signals, and another for pulse-code-modulated data up to 60 megabits per second. Experiments will include polarization discrimination of simultaneous multiple television transmissions. Weight will probably be about 900 pounds, and launch will come near the end of 1976. **The satellite will be located over the equator south of Britain, and its 1.5° antenna will focus transmissions entirely within the United Kingdom.**

Siemens reports success in blue LED work

The elusive blue luminescence diode is a step closer to reality, now that researchers at West Germany's Siemens AG have observed blue light emission from a diode employing gallium nitride as the key material. **In making the experimental device, the company is using a spinel substrate upon which single-crystalline, transparent gallium-nitride layers are deposited in a chemical gas-transport process.** The blue light emission was detected by methods based on X-ray analysis. Siemens says gallium nitride's band structure, which fulfills the energy balance requirements for luminescence, allows, with suitable doping, colors other than blue to be obtained. Before this can be practically realized, however, suitable contacts must be found that can inject into GaN the charge carriers required for electroluminescence.

British are still concerned over Japanese TV sets

The delegation from the British TV set manufacturing industry that visited Japan earlier this month to look into the rising exports of color sets to Britain **may have achieved some success, but how much remains to be seen.** British sources say Japanese industrialists stated repeatedly that they don't intend to do anything that will harm British set makers, but Britons will have to wait for a further meeting in London next spring to find out what this means in concrete terms.

Meanwhile, the British will watch Japanese activity closely. Immedi-

ately, there's no problem, **because British factories can't meet fully the domestic demand, especially of small sets. But, by next spring a crunch may come** if there's a seasonal drop in demand.

Fujitsu readies magnetic wand point-of-sale system

In the spring, Fujitsu will start delivering a new point-of-sale system **that uses a wand with a magnetic head to read encoded price labels.** The wand, which was developed jointly with Canon Electronics Co., can also read magnetic strips on standard bank credit cards. Fujitsu says that the use of magnetic tags and cards is superior to optical ones because no errors are introduced if tags are soiled or scratched. The terminal will not accept information from a tag unless it reads all digits of the tag. Higher priced versions of the system include an optional unit into which cards are inserted and automatically read. The point-of-sale unit also includes **a keyboard on which customer types a secret number,** which is recorded magnetically on the credit card but not visible to the eye, to verify that user actually owns the card. Price of the terminal in Japan is $3,300 without card reader, about $4,000 with the reader.

Plessey achieves high output, long life from yellow LEDs

Researchers at Plessey's Caswell Research Laboratories have found a way to get very high brightness plus acceptable life from yellow-emitting gallium-phosphide diodes. **Initial brightness of between 70,000 and 100,000 foot-lamberts over a 7-mil-diameter area drops by only 30–40% after 2,500 hours of continuous running.** For comparison, ordinary red LEDs are limited to a few thousand foot-lamberts for comparable life.

The diodes are mounted on TO-37 headers without special heat sinking and take 400 milliamperes at 4.5 volts with efficiencies around 0.05%. Pulsed repeatedly at 2 A for 1 microsecond, the diodes shine at 500,000 foot-lamberts. The gallium-phosphide substrate is 250 micrometers thick, topped with a nitrogen-doped vapor-epitaxial layer 15 micrometers thick, diffused to 5 micrometers with zinc. The substrate contact is offset, and the light is emitted through the substrate from the underside of the 7-mil-diamater diffusion-side contact. Plessey sees a market in film marking, where high brightness will allow faster film speeds, and **in LED active displays, where because the human eye will pick up enough light from short pulses to make fast animation possible.**

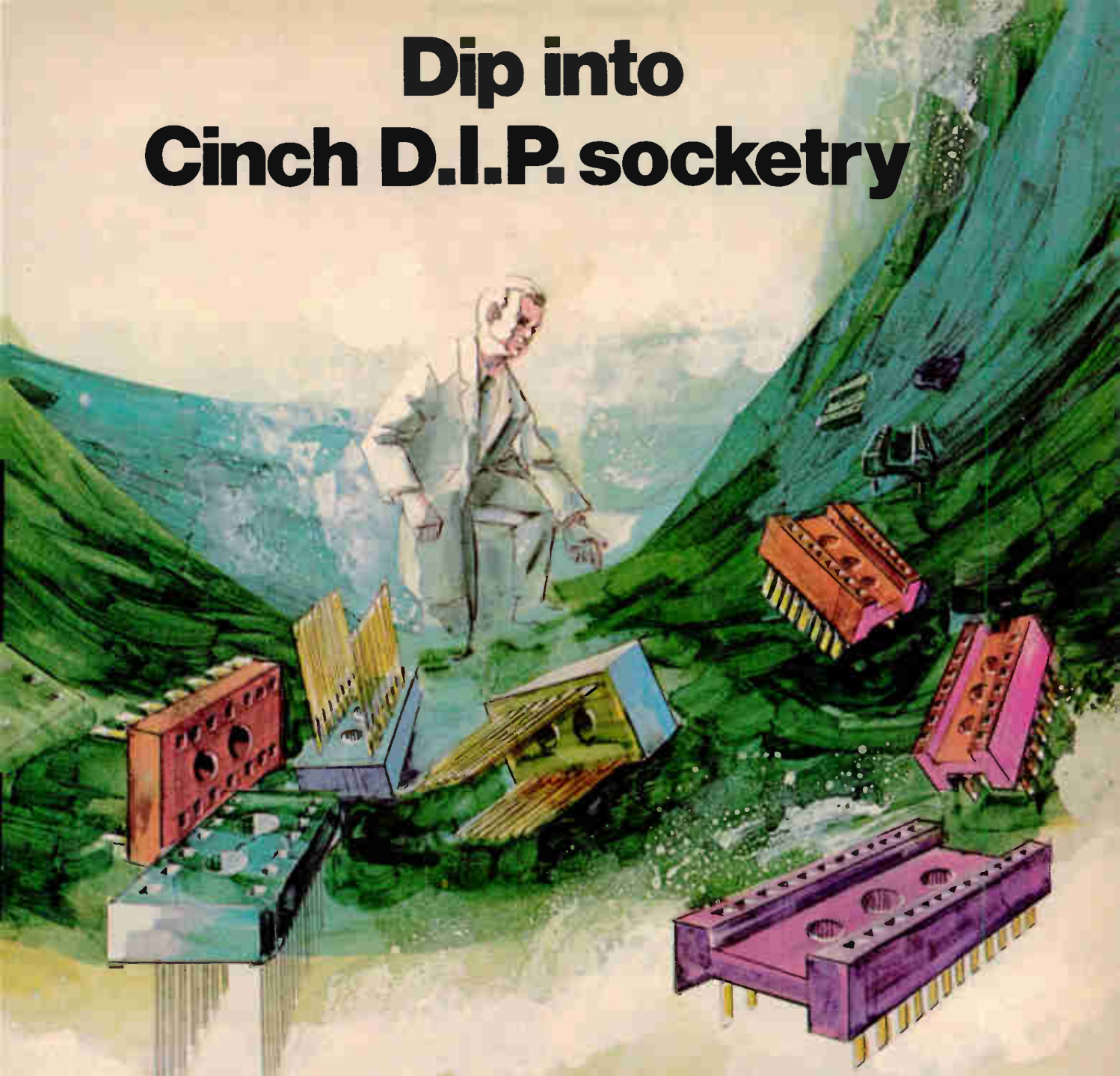
Sweden may require crash-locator gear for private planes

There is a good chance that Sweden will be one of the first countries in Europe to require private airplanes to carry crash-locator beacons. The Swedish aircraft owners association has requested that the government adopt regulations requiring that every private plane be equipped with some type of locator beacon. The move followed a government proposal that all planes be painted with a bright red stripe. The owners feel that it would be more efficient to carry beacons, which should cost less than $150.

Addenda

The price of General Telephone and Electronics Corp. stock, **the first public offering in Japan by a foreign company,** has been fixed at $28.25. . . . Meanwhile, **IBM announced it plans to apply for the listing of its shares on the Tokyo Stock Exchange** when such applications are accepted. The firm's intention has been conveyed to the Japanese Ministry of Finance and to the exchange.

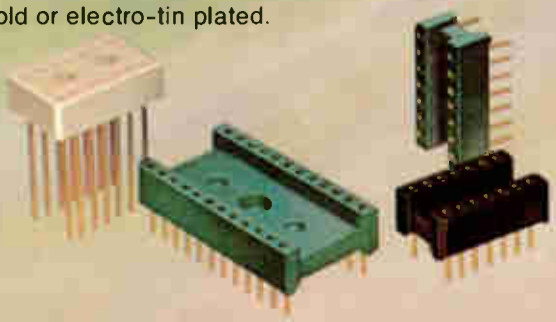
Dip into Cinch D.I.P. socketry



You'll find the 14, 16 or 24 pin DIP socket you need in the Cinch line. Try it . . . you'll like it!

Cinch sockets have a unique bowed pin contact that provides high contact forces but permits easy insertion and removal of the DIP. Broad contact surfaces give you maximum wiping action on two sides of the DIP terminal, be it flat, round or square.

You can choose from high performance diallyl phthalate or economical GP black phenolic mono-block insulators. The contacts are of beryllium copper for the best temperature stability, either gold or electro-tin plated.



Sockets with Wire Wrap* terminals and closed entry, one-piece insulators are also available in a variety of insulations and terminal materials . . . in addition to our DIP sockets with dip solder terminals.

Many styles are available off-the-shelf from Cinch distributors nationwide.

You can find out all about these sockets from your Cinch Distributor, Cinch Sales Office or by writing to Cinch Connectors, an Operation of TRW Electronic Components, 1501 Morse Avenue, Elk Grove Village, Illinois 60007, (312) 439-8800.

*Trade name Gardner-Denver

C-7202

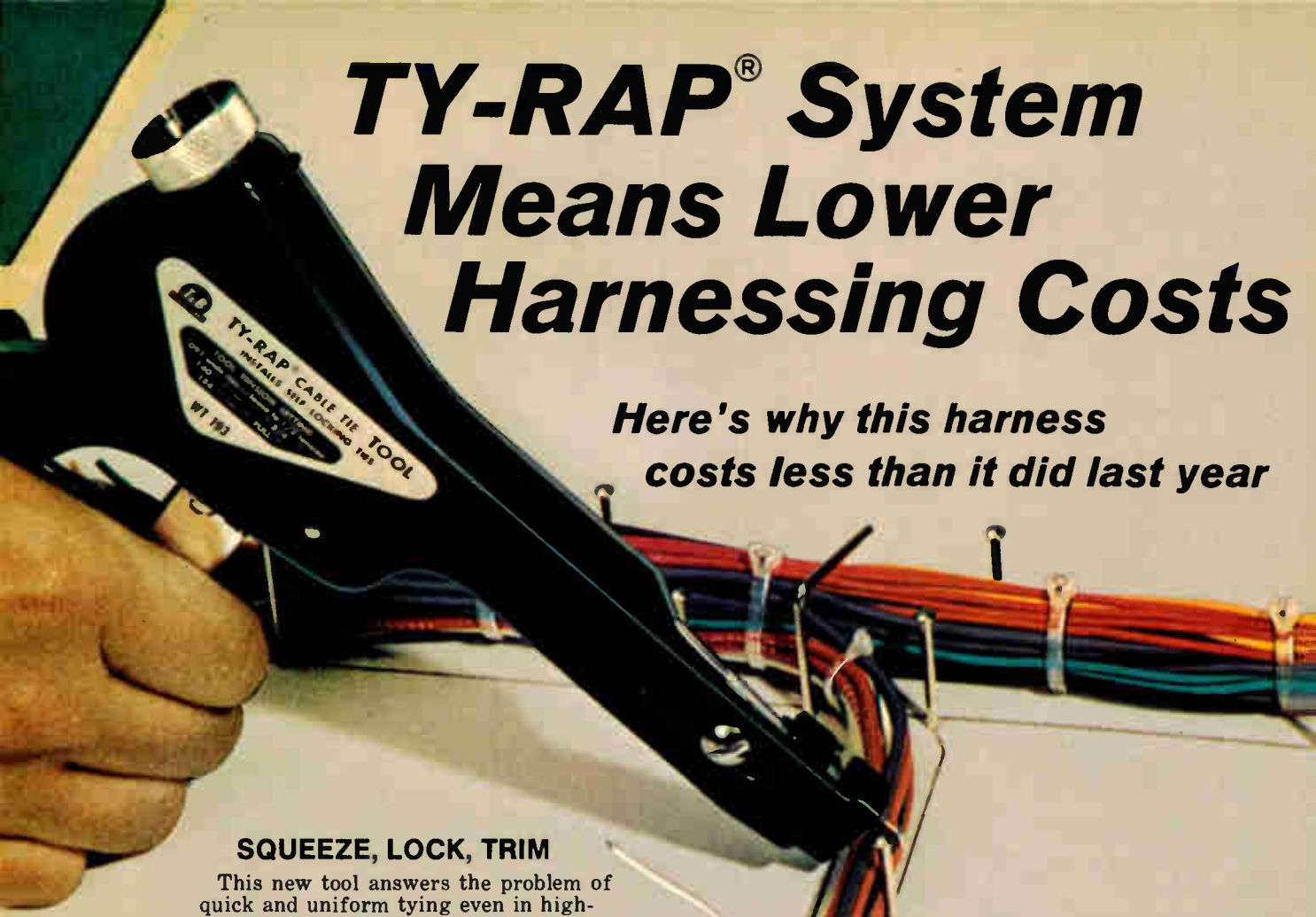
.•. cataloged in eem

TRW®
CINCH CONNECTORS

Circle 59 on reader service card

TY-RAP® System Means Lower Harnessing Costs

Here's why this harness costs less than it did last year



SQUEEZE, LOCK, TRIM

This new tool answers the problem of quick and uniform tying even in high-density wiring. The narrow nose and long slim body reaches into confined areas. A squeeze of the trigger cinches the self-locking tie to a preset tension, trims tie evenly. Eliminates rework! Tying uniformity is the responsibility of the tool rather than the installer.

GET A GRIP OF STEEL

One of the most important considerations in plastic ties is the reliability of the tying device. Now, only TY-RAP has a patented non-magnetic, stainless steel locking wedge embedded in the cable tie head. Your customers get a grip of steel every time with TY-RAP ties.

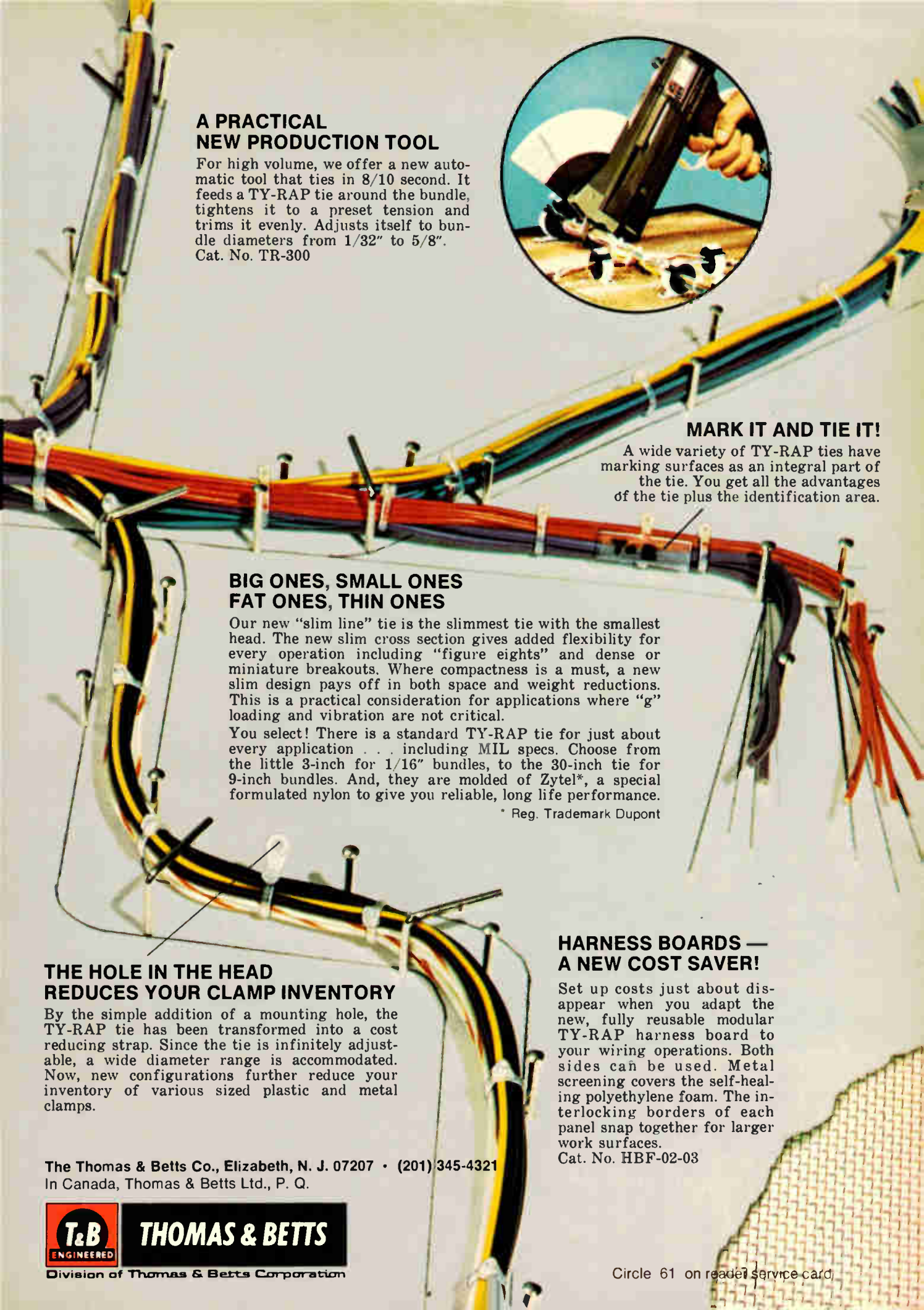
Hundreds of thousands of field-proven applications over 14 years are the credentials for TY-RAP tie reliability. This experience gives you a lower profile tie, a non-slip stippled back, a trademarked, curved tail, a low insertion force head, and the widest range of sizes and configurations. Your customer gets a higher quality job, at a lower installed cost to you.

Retainers that hold and shape the bundle during harness making are one of many aids available for board work.
Cat. Series TC-81

Harness installation and point-to-point wiring are further advanced through use of adhesive mounting bases and hundreds of other devices. Cat. No. TC-342A and TC-353A

How can the TY-RAP System lower your costs?
Write for our new guide and catalog.

Sold Only Through T&B Distributors



A PRACTICAL NEW PRODUCTION TOOL

For high volume, we offer a new automatic tool that ties in 8/10 second. It feeds a TY-RAP tie around the bundle, tightens it to a preset tension and trims it evenly. Adjusts itself to bundle diameters from 1/32" to 5/8".
Cat. No. TR-300

MARK IT AND TIE IT!

A wide variety of TY-RAP ties have marking surfaces as an integral part of the tie. You get all the advantages of the tie plus the identification area.

BIG ONES, SMALL ONES FAT ONES, THIN ONES

Our new "slim line" tie is the slimmest tie with the smallest head. The new slim cross section gives added flexibility for every operation including "figure eights" and dense or miniature breakouts. Where compactness is a must, a new slim design pays off in both space and weight reductions. This is a practical consideration for applications where "g" loading and vibration are not critical.

You select! There is a standard TY-RAP tie for just about every application . . . including MIL specs. Choose from the little 3-inch for 1/16" bundles, to the 30-inch tie for 9-inch bundles. And, they are molded of Zytel*, a special formulated nylon to give you reliable, long life performance.

* Reg. Trademark Dupont

THE HOLE IN THE HEAD REDUCES YOUR CLAMP INVENTORY

By the simple addition of a mounting hole, the TY-RAP tie has been transformed into a cost reducing strap. Since the tie is infinitely adjustable, a wide diameter range is accommodated. Now, new configurations further reduce your inventory of various sized plastic and metal clamps.

HARNESS BOARDS — A NEW COST SAVER!

Set up costs just about disappear when you adapt the new, fully reusable modular TY-RAP harness board to your wiring operations. Both sides can be used. Metal screening covers the self-healing polyethylene foam. The interlocking borders of each panel snap together for larger work surfaces.
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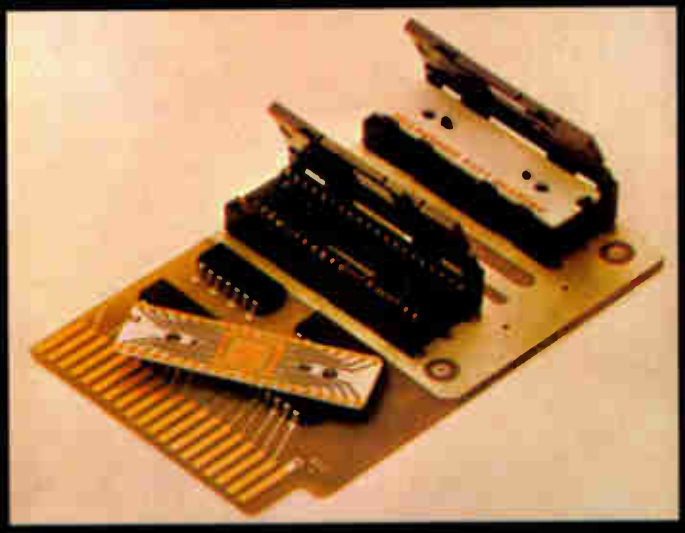
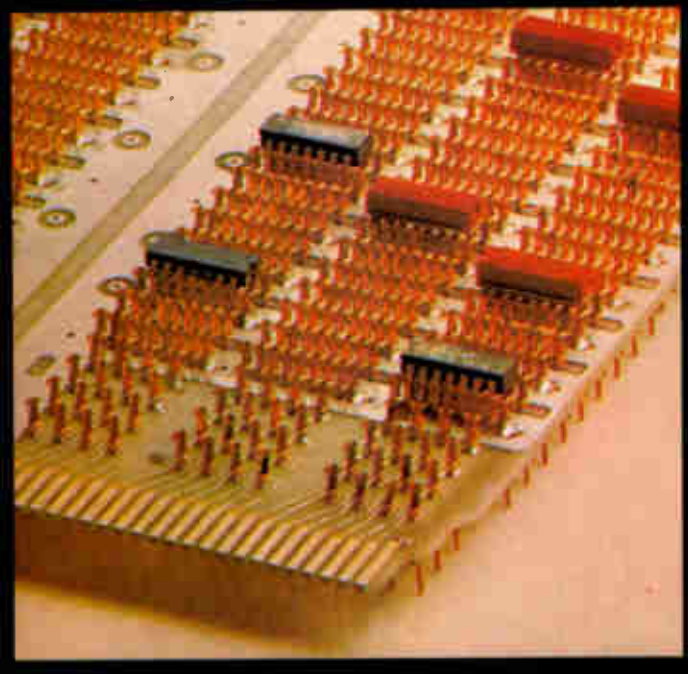
Division of Thomas & Betts Corporation

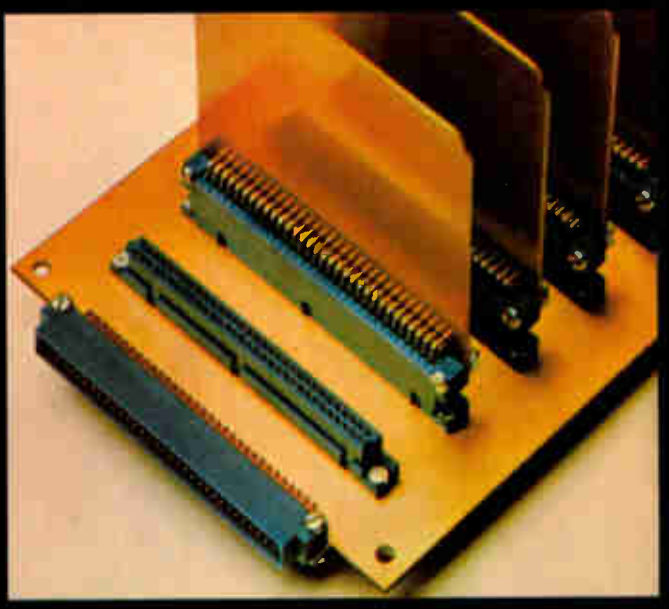
Circle 61 on reader service card.

New from Amphenol's Spectrum

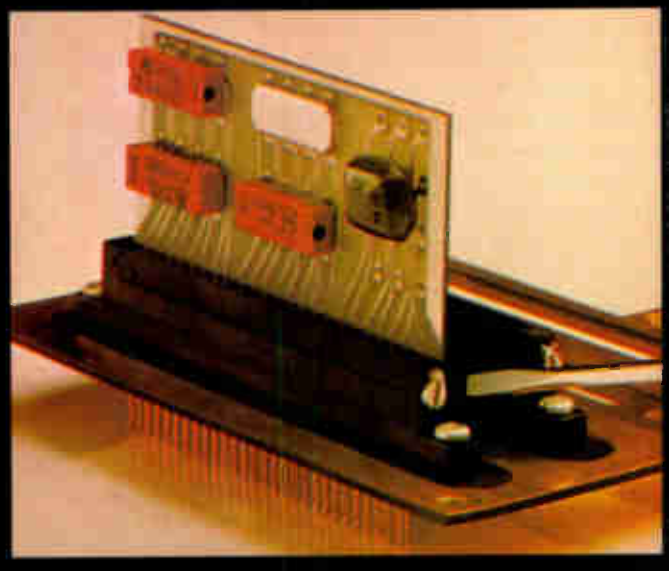


level 1 MOS/LSI Planar Plug-In connectors (above) for leadless, flat mount ceramic substrates. Permits fast, easy replacement of IC package, no screws, has snap-down lid. ■ Free-standing terminal (below) terminates IC's to PC boards for lowest total systems cost.





level 2 Box contact connectors (above) intermate with .025" square or round contacts. Low insertion force. Terminations for crimp, wire wrapping or wave solder. ■ Zero insertion force connectors (below) improve PC board and connector life by eliminating strain and wear.



Above are seven new ideas from Amphenol Industrial Division's Spectrum of interconnection capability.

Amphenol's SPECTRUM offers you *all four* levels of interconnections from our unmatched breadth of product line:

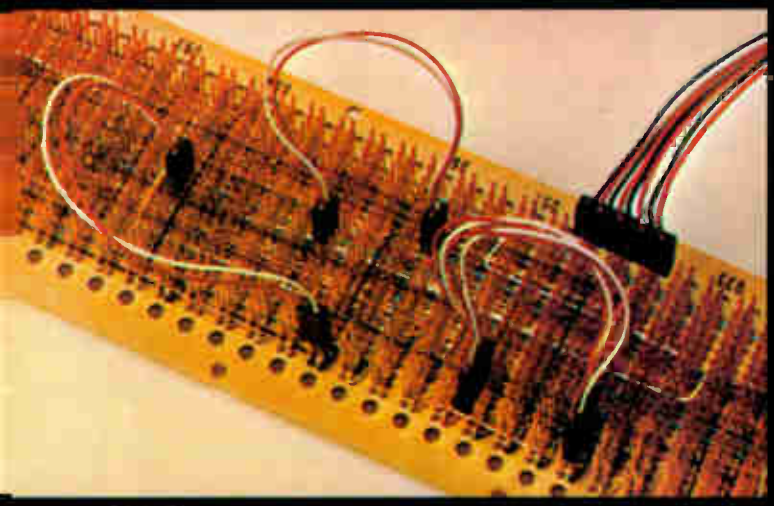
Level 1 . . . DEVICE TO BOARD OR CHASSIS. We offer interconnections for components such as tubes, relays, transistors, IC packages, trimmers, resistors or capacitors to a PC board or chassis.

Level 2 . . . BOARD TO MOTHERBOARD OR BACK PLANE. We offer interconnections for PC boards or other sub-circuit modules to a motherboard or to a back plane.

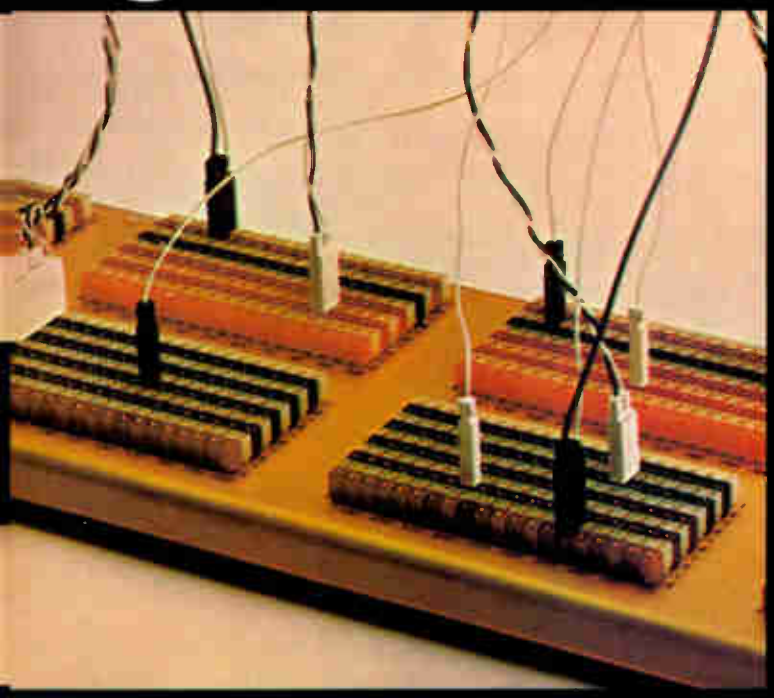
Level 3 . . . MOTHERBOARD OR BACK PLANE WIRING. We offer interconnections for levels to each other and to other sub-circuits with multi-layer circuit boards, wire wrapping, clip terminations, jumper techniques and dip-soldering.

Level 4 . . . INPUT/OUTPUT CONNECTIONS. We offer interconnections for power and signals to and from a system. This interface may be between sub-assemblies within the same enclosure or between individual units.

# of interconnections.



level 3 Low cost strip connectors (above) are used as jumpers in back plane wiring. Intermates with .025" square or round posts. ■ Circuit Concentration Bay (below) consists of wire wrappable panels that are five times as compact as the telephone distribution frames they replace.



level 4 Modular Integral Connector concept lets you make your own pin & socket connector to fit your needs. Five contact sizes, thousands of combinations. Sufficient components for six connectors in handy MIC-KIT. Design and assemble your own prototypes.

From the simple tube socket—to a myriad of electrical/electronic connectors—to complete and complex termination systems . . . SPECTRUM.

But SPECTRUM is far more than products. It is a depth of capability in engineering, manufacturing and quality control. Amphenol's SPECTRUM is a new height of service, availability and distribution backed by seven Amphenol interconnection-oriented divisions.

Amphenol can fulfill your total interconnection requirements because we are not limited to specifics such as one or two product lines, one or two levels. Therefore we approach your interconnection needs with complete open-mindedness.

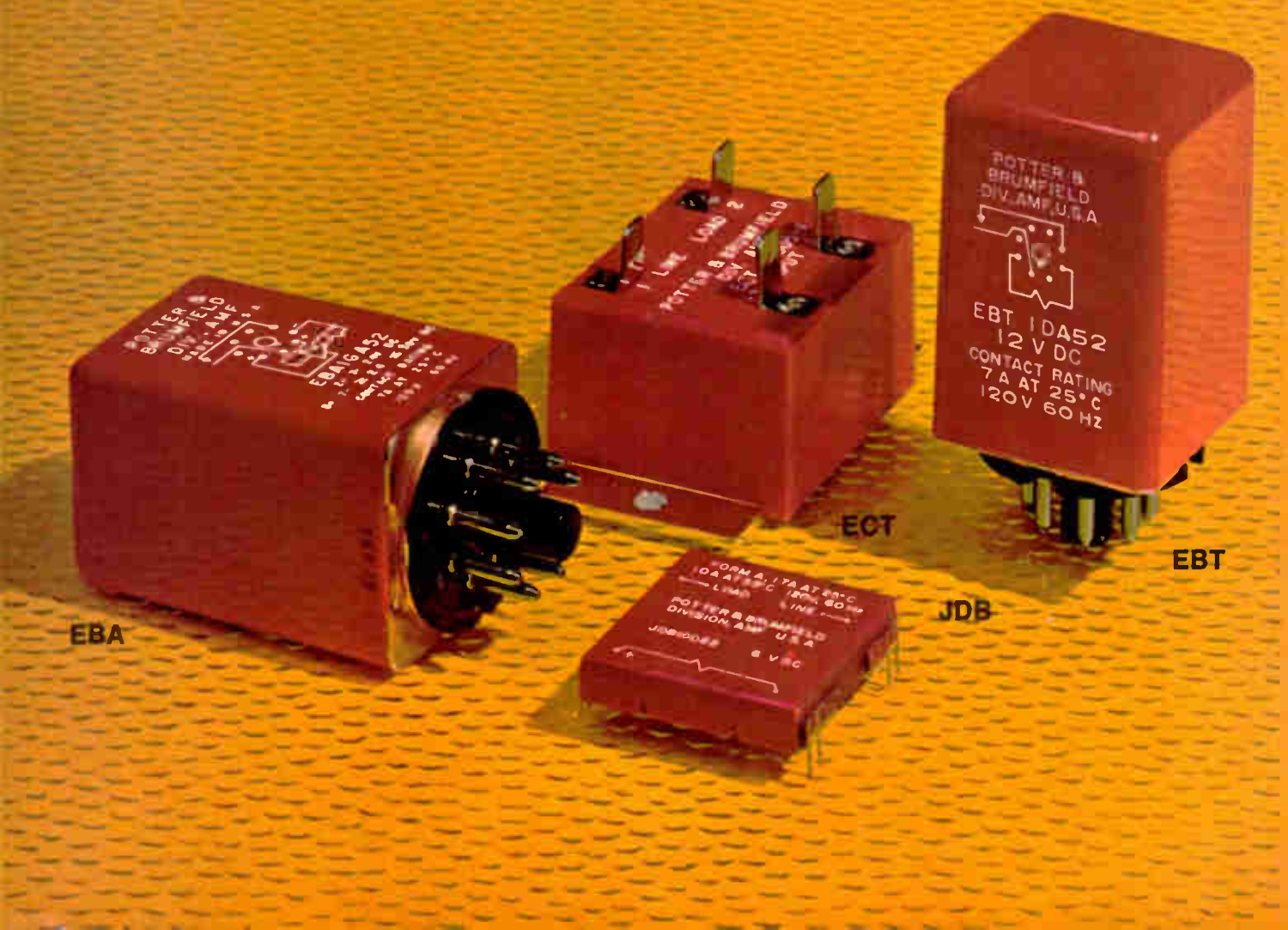
For more new ideas and specific information, write for your copy of "SPECTRUM." Amphenol Industrial Division, Bunker Ramo Corp., 1830 South 54th Ave., Chicago, Illinois 60650.

BUNKER RAMO **AMPHENOL**

Circle 63 on reader service card

P&B solid state hybrid relays work up to 100 times longer than conventional relays.

More than 10^7 operations.



The expected minimum life of P&B Solid State Hybrid Relays is in excess of 10 million operations for standard load current and ambient temperature combinations.

This uncommon longevity, plus exceptional reliability and a wide range of switching options, offers solutions to many critical switching problems. For example, you can interface semiconductor logic circuits with inductive loads like motors, solenoids and contactors.

P&B Solid State Hybrids will switch up to 7 ampere loads with input control signals as low as 60 microwatts. And they come in a variety of package sizes and terminal styles.

Special triac, special reed

P&B Hybrids owe much of their reliability and outstanding performance to the combining of a reed relay and triac, each having characteristics specially selected to complement the other. This careful mating of semiconductor and relay greatly enhances the reliability of each and, in combination, produces a switching function of consistently superior performance.

Special snubber network

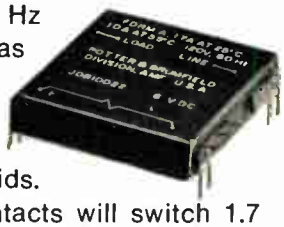
The internal RC network across the "contact" is tailored to the triac specifications and "contact" load ratings to limit sporadic, transient-induced conduction, to provide reliable turn-off of inductive loads, yet to minimize the off-state 60 Hz leakage current.

EBT Series switches 7 amps, 60 Hz @ 25° C ambient with normal load voltage of 120 V. Rated 5 amps. rms 60 Hz @ 55° C ambient. Operate time, 2 msec. Release time, 10 msec. Coil voltages from 6 to 48 VDC at nominal power of 290 mW. Has conventional octal-type plug-in terminals for mounting convenience. Fits P&B KR Series 8-pin sockets for conversion to screw terminals.

EBA Series has the same switching characteristics, package and mounting of EBT, but with control signal amplifier. Standard sensitivity is 60 microwatts. Requires 12, 18, or 24 VDC supply.

ECT Series has similar specifications as EBT but with a special package designed for direct to chassis mounting. Widely used in business machines and appliances. The ECT has quick-connect terminals. Screw-terminal adapters available.

JDB Series is a Dual Thin-Line reed-triggered triac for use on printed circuit boards. Designed for interfacing solid state circuits to 120 V 60 Hz loads such as contactors, fractional HP motors and solenoids. Form A contacts will switch 1.7 amps. at 25° C ambient or 1.0 A rms 60 Hz at 55° C ambient.



Potter & Brumfield Solid State Hybrid relays are available from leading electronic parts distributors. For complete information call or write your nearest P&B representative or Potter & Brumfield Division of AMF Incorporated, Princeton, Indiana 47670. Telephone 812 385-5251. In Europe, AMF International Limited, Oxford, Oxon, England and AMF Electrica, S.p.A., Milan, Italy.

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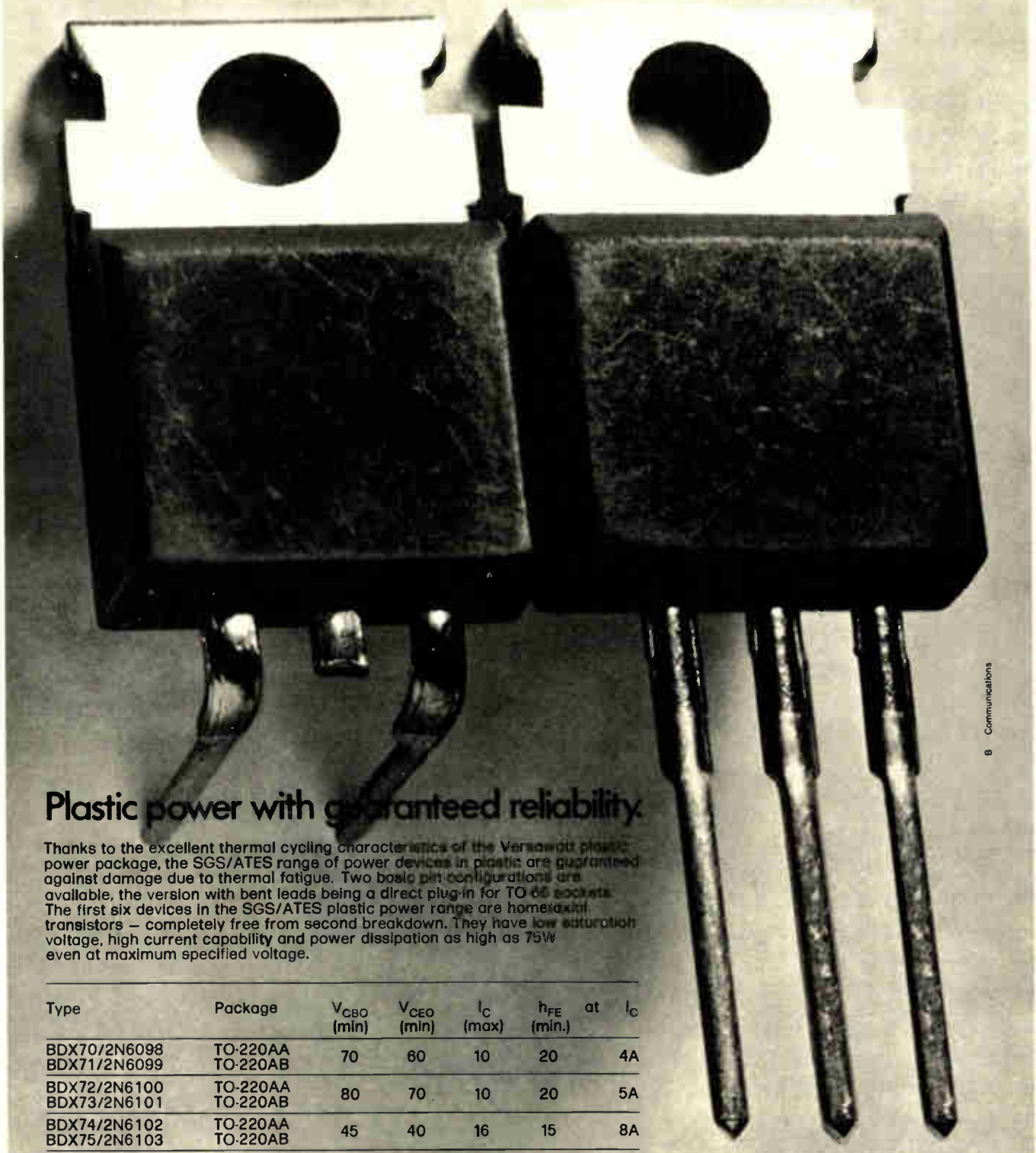
P&B makes more of more kinds of relays than anybody in the business.

Anybody.

Bestsellers



Plastic power with guaranteed reliability.

Thanks to the excellent thermal cycling characteristics of the Versawatt plastic power package, the SGS/ATES range of power devices in plastic are guaranteed against damage due to thermal fatigue. Two basic pin configurations are available, the version with bent leads being a direct plug-in for TO 66 sockets. The first six devices in the SGS/ATES plastic power range are homeaxial transistors – completely free from second breakdown. They have low saturation voltage, high current capability and power dissipation as high as 75W even at maximum specified voltage.

Type	Package	V_{CBO} (min)	V_{CEO} (min)	I_C (max)	h_{FE} (min.) at I_C
BDX70/2N6098 BDX71/2N6099	TO-220AA TO-220AB	70	60	10	20 4A
BDX72/2N6100 BDX73/2N6101	TO-220AA TO-220AB	80	70	10	20 5A
BDX74/2N6102 BDX75/2N6103	TO-220AA TO-220AB	45	40	16	15 8A

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Introducing two new A to D converters built the way you would if you could. Same with the price.

The first is our ADC-10Z.

The second is our ADC-12QZ.

Before we designed them, we asked ourselves two questions.

What do you really need?

How will you use it and how will it interface into your system?

Our two new converters are the answer. They not only have the performance but they're easier to use and design in.

Easier because:

1) The parallel data outputs can be connected for binary, offset binary, or two's complement coding.

2) We built in a status signal you can count on. When it says the parallel output data is ready, it's ready.

3) There's a serial output that really works. A strobe output we built inside synchronizes the serial data so that no external timing or synchronization logic is needed.

So even before you buy one, you know you're going to save time and money.

The ADC-10Z has 10-bit resolution and accuracy, 20μsec maximum conversion time, monotonicity over its operating temperature range of 0°C to +70°C, temperature coefficient of ±40ppm/°C, parallel and serial outputs, simplified serial data transfer, TTL/DTL logic levels, user selectable input ranges, an optional input buffer, and a price tag of $67 for one hundred or more.

The ADC-12QZ has all the good features of the ADC-10Z at 12-bit resolution. It's monotonic from 0°C to +50°C, has a temperature coefficient of ±30ppm/°C, converts in 40μsec (max.), and is priced at $92 for one hundred or more.

Through October 31st of this year, we'll sell you any quantity of these converters for the 100-piece price. And, we can ship them off the shelf right now when you need them.

Along with our 1972 Product Guide which shows you all the other things that we make to solve more of your problems better than anyone else.

Analog Devices, Inc., Norwood, Mass. 02062.
Tel. (617) 329-4700.

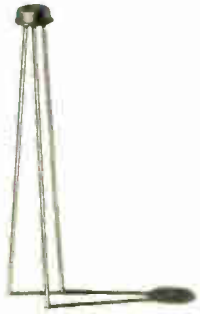
ANALOG DEVICES

Circle 67 on reader service card

Crystalonics has a 4-ohm FET with a 1-volt threshold for $3.69?*

That's almost right.

The best doesn't cost any more anymore.



Our 2N5066 has a 4-ohm typical (8-ohm maximum) R_{ON}. We have to admit, it does have an offset voltage, but it's only 300 microvolts typical (1 millivolt maximum). The off-current is still 1 nano-amp maximum, and it takes less than 1 volt to turn it on. The device does draw some current in the on state (less than 1 milliamp), but that's OK in most cases, because the signal source impedance is usually less than 1 ohm.

If you're getting suspicious, you're right. We lied . . . it's an NPN transistor, not a FET . . . but everything else we've said about it is the truth. Besides, do you really care?

If you're not miffed and are still interested, we have a "P-channel" equivalent (the 2N3677) at an even lower price. Both really warrant your investigation if you are designing analog switching circuits. We'll send you one of each to try if you'll drop us a note. If more data would help, circle the reader service number.

P.S. We also make the real McCoy.

*100-piece price

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Circle 68 on reader service card

U.S. homes in on calculators

Challenging Japanese domination of the business calculator market, Americans are exploiting their technology not merely exporting it

by Marilyn Offenheiser, Assistant Editor

Yankee ingenuity and Japanese initiative are locking horns again in the calculator arena, this time over business calculators—machines priced at $200 or more.

And old-line U.S. calculator makers such as Victor Comptometer, Monroe, and Singer are turning to electronics to regain a big chunk of business calculator sales they lost when Japanese manufacturers beat them to the punch in applying new U.S. technology, particularly MOS LSI.

Japanese calculator makers quickly exploited the advantages of MOS LSI in the class of calculators now known as consumer machines—those selling for $100 or less. But that's an entirely new market. Traditional U.S. builders of electromechanical machines didn't lose business to Japan when firms in that country began cashing in on the market's readiness for the simple four-function machines. Now American builders of consumer calculators are finding they can make and sell machines profitably for $100 or less, and are providing keen competition for Japanese firms [*Electronics,* March 13, p.120].

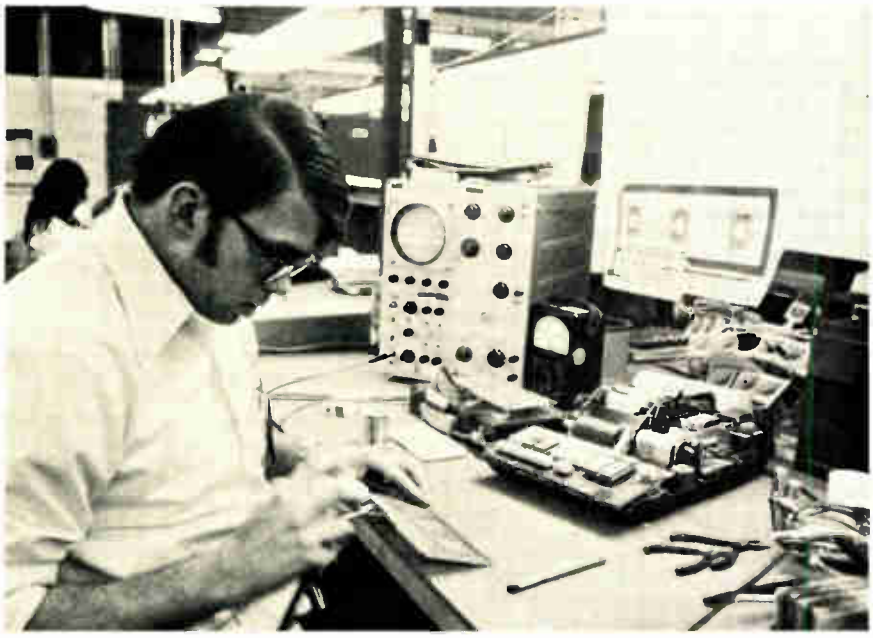
The same thing is now happening in the more expensive calculators—those offering such functions as square root, percentage, and memory. The major U.S. makers are converting from electromechanical to electronic machines, thereby reaping the benefits of reduced costs through mechanized processes as U.S.-developed MOS LSI technology gets more and more calculating functions on a chip. This approach to cost reduction is upstaging the former advantages of cheap labor for offshore assembly and Japanese manufacture of the machines to be sold by American firms on an OEM basis.

But the low assembly costs aren't solely responsible for the resurgence of American manufacturers of the middle-range calculators. Their responsiveness to the market's desire for electronic printing calculators is also a factor [*Electronics,* Aug. 28, p.51].

Advances in nonmechanical printers are reducing the Japanese advantage even more. That's why most U.S. industry estimates indicate that the Japanese share of the world business calculator market has slipped by 15% to 18% from a year ago, to rest at 70% by year's end. And Japan's portion of that market is projected to slip further to 50% in 1973, according to several U.S. calculator marketing men.

Gene N. Landram, vice president for marketing at Unicom Systems Inc., Cupertino, Calif., questions that the Japanese even now have 50% of the market. Landram says the Japanese have made "consider-

Test and assembly. Workers at Singer's assembly plant put together business calculators in three hours. MOS LSI has made manufacture in U.S. economically feasible.



able inroads in the last three years," but their progress was more at the low end of the range. And he says they are "so-so" in their knowledge of the middle-range calculators, explaining that they have little expertise in the field.

Philips Gloeilampenfabrieken, Eindhoven, the Netherlands, estimates that the Japanese now have 53% of the world market and furnish 22% of the machines sold by other countries, leaving 25% to manufacturers in the rest of the world.

A major semiconductor supplier estimates that the U.S. exported 800,000 to 900,000 of the business calculators made here last year, and several suppliers predict that the U.S. output will rise to 4 million business machines in 1973. The Japanese Ministry of International Trade and Industry estimates that Japan exported 1,266,404 business calculators in 1971, with 543,191 units going to the U.S. This year, the U.S. is expected to take 881,000 of the total Japanese export of 2,061,000.

Realizations. "The reason the Japanese got the market to begin with," says James Sheridan, president of the Monroe Calculator division of Litton Industries, "is that the U.S. did not realize what solid state could do for the electromechanical calculator. The Japanese did. We were caught off guard." Ned Salisbury, planning director of the Singer Co. Business Machine division adds, "Friden [a Singer acquisition] introduced a $2,000 transistorized calculator in 1964, but we didn't realize the significance of it."

In 1969, Japan's Sharp was the first to successfully apply MOS to business calculators. Using a systems approach, the company introduced a calculator having circuitry designed and provided by North American Rockwell Microelectronics Co. "Around this time," says an industry spokesman, "American firms feebly tried to buy circuits on a standard basis with short-term commitments and second-source arrangements, and the result was failure." However Victor Comptometer Corp., Chicago, one of the first U.S. companies to utilize the systems approach, established a long-term agreement with NRMEC, comments Victor Business Products division president, J.E. Smith.

The major manufacturers competing for an edge in the U.S. business calculator market include: Bowmar ALI, Acton, Mass.; Burroughs Corp., Detroit; Commodore Business Machines Ltd., Santa Clara, Calif.; Displaytek Corp., Dallas; Keystone Business Machine Co., Paramus, N.J.; Monroe, Orange, N.J.; SCM Corp., New York; Singer, New York; Unicom (being acquired by North American Rockwell); and Victor Comptometer Corp. Japanese contestants include Brother, Casio, Canon, Hitachi, Omron, Sharp, Ricoh, and Seiko Time Corp.

Still friends. Despite the competition, however, most U.S. companies have production agreements with the Japanese, principally for low-end business calculators. Hitachi makes units for Unicom and Singer, Brother for Singer, Casio for SCM, and Canon for Monroe. Says Unicom's Landram, "It just isn't worth the time and effort to make these machines at home."

But for the most part, reduced labor cost has had a significant impact on the over-all situation. It takes about 20 hours to assemble an electromechanical business calculator, but MOS LSI reduces assembly time to about three hours. "This has removed the Japanese labor edge," says an industry official. "It is most advantageous now to assemble the calculator in the country of sale."

In Japan, Sharp's Industrial Instruments group executive director, Tadashi Sasaki, predicts that U.S. manufacturers will divorce themselves from traditional Japanese companies to insure price competition. A spokesman for Canon says that, in addition, many small Japanese companies are supplying original equipment for U.S. companies, usually on a one-time basis.

However, some U.S. manufacturers were quick to start assembly at home. Keystone was one of the first companies to assemble business calculators in the U.S. Bowmar's president Charles Krakauer also cites national economic advantages in manufacturing in the U.S.:

Contender. Designed for office work, SCM's electronic calculator is now on the market.

"People go overseas for cheap labor; this forces others to do so. The result is a bad impact on the balance of payments, and on a long-term patriotic basis, you get nothing."

Commodore, with U.S. Government support, has set up an assembly plant in the Watts ghetto of Los Angeles, providing employment to minority groups.

The Japanese are also finding it advantageous to produce calculators in the U.S., rather than export them to the U.S. Singer's Salisbury points out that Omron was the first Japanese company to set up an assembly plant for business calculators in the U.S., with a plant located in Mountain View, Calif. Omron also has a calculator-assembly facility in Tijuana, Mexico.

Dependency. Another factor in the current Japanese lag in business calculators is a shortage of chips. Now that U.S. manufacturers have broken out of the electromechanical mold, they are tying up a large percentage of available chips. A Philips spokesman estimates the Japanese are depending on the U.S. for 90% of their circuitry. An SCM spokesman warns, though, that "although the Japanese are one or two years behind, they will quickly develop their own MOS LSI technology. We may also see new chip suppliers spring up in the U.S.," he adds.

Display supply has not been a problem, since most business calculators must provide printouts. Victor makes two printers to every display unit. The figure at Monroe is three to one and at Singer it is one to one. As a result, printer technology is advancing, particularly in efforts to

convert electromechanical printers to electronic units with a minimum of moving parts. Many companies are turning to thermal printers. Displaytek, for example, will market an electronic calculator with a thermal printer through Ian Jones International, Bayside, N.Y., and in Japan, Ricoh, Seiko, and Sharp have all introduced new printers.

European theater. Although the Common Market could exercise a potential influence, the European market for business calculators is up for grabs. Both the U.S. and Japan are gunning for control, despite the resident old-line European business calculator manufacturers. In addition to Philips, they include Precisa AG of the Paillard Group (Hermes), Switzerland; Olivetti, Italy; and Facit-Odhner, Sweden.

Burroughs has a foot in the door with an assembly plant in France, and other U.S. companies already in Europe are Monroe, Singer, and Bowmar. And Victor's Smith says that his company is considering setting up an overseas operation.

Most Japanese manufacturers have already penetrated the European business calculator market. Albert Schaerer, marketing manager at Precisa says, "The European calculator market is in a state of change. The Japanese dominate, but they are losing ground to the U.S." Schaerer says that if American companies are fast in coming out with good printers, they will capture both the European and the world market for middle-range calculators.

But a Canon spokesman says, "The addition of more U.S. calculators to the Japanese effort will make more unhappiness for the European companies." A Philips spokesman points out that, until recently, European makers bought Japanese business calculators, selling them under their own names, but that practice has diminished. "The result," he says, "is that the Japanese trade name is relatively new."

"The Japanese will have to be more aggressive, out of necessity," concludes Singer's Salisbury. "But there is also a great potential market in the developing countries of South America and Africa, and there again, the share of the market is anybody's game." □

Computers

USSR aims at big computer by '75

Comecon's smaller third-generation models are almost in production, but IC problems may delay the largest machines; leased IBM 360s may be called in

by Ivan Berenyi

The Soviet Union is rallying the Eastern Bloc in its struggle to develop a complete series of third-generation computers—the RJAD machines. In the second year of its five-year plan to produce enough new RJAD units to treble the Comecon's computer population by 1975, the chances of reaching all targets are still slim. But today, several of the smaller models are on the verge of going into production, and the RJAD series has become a reality.

There will be seven models in the series: the ES (for Unified System) 1010, 1020, 1021, 1030, 1040, 1050 and 1060. The largest models, the 1050 and 1060, will be manufactured in the USSR, while Poland, East Germany, Czechoslovakia, Hungary and Bulgaria will each produce one of the others, either independently or with the Soviet Union. Rumania opted out of the series right from the start.

The Communists' real need is for the big systems, for central planning and control applications. But if the Russians hold to their intention to use emitter-coupled logic in the large RJAD machines, they will almost certainly run into teething problems which could hold up production for several years.

In the meantime, the demand for big systems from the West will grow fast. The rapprochement between the U.S. and the USSR following President Nixon's Moscow visit makes it likely that trade embargoes will soon be eased and that 360/65s and perhaps 370s, too, will find their way east before this year end.

Negotiations. So far, the largest IBM computer sold to the Eastern Bloc is the IBM 360/50. However, Peter Stevens, president of London-based Leasco World Trade, is presently negotiating an agreement with the Russians that could give the USSR large IBM machines on which to pattern the largest RJAD computers.

Earlier this year, according to news sources in Europe, IBM seemed ready to swamp the Eastern market. But now the situation is different. Leasco Europa, offering the IBM 360 configurations but better payment

RJAD COMPUTER SERIES							
	ES-1010	ES-1021	ES-1020	ES-1030	ES-1040	ES-1050	ES-1060
Basic execution time (microseconds):							
simple instructions	*	15	20–30	5–8	0.9–1.8	1	0.5
floating point add/subtract		–	50–70	7–10	2.5–3.5	1.5	0.5
single-word multiplication		80–120	400	30	7	3	1
double-word multiplication		–	1,200	60	12	12	1.5
Compatibility		Special set of command instructions	Fully program-compatible				
Main memory capacity (1,000 bytes)	8 (expendable)	16–64	64–256	128–512	128–1,024	128–1,024	256–2,048
Data transmission rate via multiplex channel (1,000 bytes/s)	160	35–220	25	40	50–200	100–450	100–450
No. of selector channels	1	2	2	3	6	6	6
Speed of data transfer (1,000 bytes/s)	240	250	200	600	1,200	1,300	1,300
Type of ICs	TTL					ECL	
Country of manufacture	Hungary	Czechoslovakia	USSR Bulgaria	USSR Poland	East Germany	USSR	USSR

*Simple instruction set. Slave or satellite to other models. Add time: 2.6–3.6 ms per byte

BESM-6. This machine (left) could be prototype for larger entries in RJAD series.

and maintenance terms than IBM, may have nipped the computer giant at the post.

"We expect to become the USSR's major suppliers of 360s under a guaranteed-minimum agreement," says Stevens. His company looks to chalk up orders worth $50 million in the Soviet Union alone and is rapidly building up strength in the rest of the Comecon area.

It is even possible that Eastern Europe may choose to lease 360s within the next two years, says Leasco Europa's chief, David Woodward. As in the West, he points out, East European users would prefer to have a machine for only two to three years, and leasing would also ease the hard currency problem, which the Comecon countries at present overcome by opting for deferred payment.

Progress. But leasing agreements, if and when they come about, would probably apply only to the larger IBM computers. Significant progress has been made on the smaller RJAD models. An example is the ES1010, which is being manufactured at the Videotron plant in Szekesfehervar, Hungary, under license from France's CII. (The ES1010 is in fact the Mitra 15.) The first units are expected to be installed before the end of the year, with mass production starting in 1973.

Higher up the RJAD range is the ES1021, which will be a small to medium-scale computer, roughly comparable to the IBM 360/30—and not fully program-compatible with the larger RJAD models. The ES1021 is slated for production at the ZTA factory in Prague, Czechoslovakia.

Already in production in East Germany, however, is the Robotron (or R) 21, unveiled at this year's Leipzig Fair. It differs from ZTA's projected ES1021 in being fully RJAD-compatible, but has the same 64 kilobytes of core memory and virtually identical operating speeds. To produce two such similar machines would be a poor use of limited production resources, and the East Germans may have stolen a march on the Czechs, as well as a share of the production.

The smallest fully compatible

model in the designated range is the ES1020, a joint Bulgarian and Russian production with a maximum of 256-kilobytes of core memory. A prototype of this machine, which aims to emulate the IBM 360/40, was displayed last year at the trade fair in Plovdiv, Bulgaria. Production is held up, according to the Soviet press, by problems in the economic production of integrated circuits.

The ES1020's central processor is to be manufactured at the Ordzhonikidze plant, near the Caspian Sea, where the Soviet's present Minsk series is made. Other parts will be made at the IZOT Works in Sofia, Bulgaria.

Third generation. Memories for the RJAD EC 1020 go on line in Bulgaria.

Problems. If ICs remain a problem, this could also affect production of the ES1030, whose manufacture is another cooperative effort, this time of Russia and Poland. The CPU for the 1030 will be manufactured at the Elwro plant in Wroclaw, Poland, with ICs supplied by the Soviets.

The ES1030 was seen for the first time at the June fair in Poznan, Poland. The model was equipped with Russian ICs, whereas every other Polish computer there was built with Texas Instruments' Series 400 or French ICs. While fully assembled, the machine was a prototype.

The only other RJAD machine for which there is a known schedule is the ES1040, a medium-size to large computer roughly comparable to the IBM 360/50. It is to be manufac-

tured by Robotron in East Germany, and is scheduled to make its appearance in about six months. Development is reported to be on schedule, and since the East Germans have shown with the R21 that they can overcome the problem of obtaining ICs, this could prove to be the first RJAD machine to reach the Comecon market in quantity.

Apart from the problems of volume production of ICs, another setback to RJAD is likely to be caused by lack of software. Although the Polish descriptions of the ES1030 speak of a "wealth of programs produced in Comecon countries," the Eastern Bloc is still well behind the West in the development of non-scientific software. But these countries are hoping to ease the problem by setting up an international software pool, to which any user can apply for programs to fit his job.

Strengths. Peripherals will present less of a problem, for the East Europeans are better equipped here than anywhere else. The Poles are now producing a wide range of peripherals—tape drives, printers, card and paper tape devices—at their Meramat plant.

The East Europeans are in fact fast reaching the stage where they may be able to market their low-cost peripherals in the West. Robotron already has an export marketing agency, Buromaschinen Export GmbH. There is also a strong possibility that Leasco will act as sales agents for Polish peripherals, says Woodward, Leasco Europa president.

Even computers are beginning to roll out of the Communist bloc. The Russians have sold Minsk 22s to North Vietnam, India and Mongolia, and a BESM-6 to the Bhaba Atomic Research Centre in Bombay. East-West Agencies in the Hague, Holland—the western outpost of the Mashpriborintorg import/export agency in Moscow—sold Minsks to the UK and claims U.S. sales too.

The prospect of Communist computer exports on a significant scale, however, is still in the very distant future. For the present, the trend is firmly in the other direction. □

Ivan Berenyi is a freelance writer who specializes in Eastern Bloc technology.

Management

Consultants: useful but no panacea

The electronics company that can define its problem will find the independent thinking of reputable consulting firms valuable

by James Brinton, Boston bureau manager

Evaluating a new market, deciding whether to participate in it, and coming up with product lines for it are jobs for which an electronics company often needs outside help. And consultants can provide that kind of independent analysis. But they offer a variety of services, and their would-be client can be misled if he really isn't sure what he wants, if he doesn't communicate clearly, or if he fails to monitor a consultant's performance closely.

Most experienced managers realize that the client-consultant relationship is a two-way affair. Nonetheless, industry opinions range from "consultants are invaluable" to "their reports aren't worth the paper they're written on." For their part, consultants resent being used as "tools of boardroom politics," or "just to salve a manager's conscience before he swings the axe," or, perhaps worst of all, being presented with problems the clients themselves don't understand—"that's a no-win game," says one consultant.

Strangely, it was the recent recession that eased the relationship. As industry was forced to lay off engineers and market analysts, consultants were called in to fill the newly created gaps in corporate expertise.

Getting cheated. But now that industry is having to rely on outside help, is it getting its money's worth? As ever, companies have to know what to watch out for. For example, at least two consultant firms tried to repackage and sell for $1,000 a copy a Department of Commerce survey called "EDP Global Export Program," which targeted sales opportunities in Europe and Japan. Meanwhile, the department was selling summary reports at $10, and reports directed at specific countries—Japan's alone ran to about 900 pages— just for the printing cost. All-day briefings by Commerce Department experts were free.

A basic rule is therefore to stick with firms that have good reputations, and to crosscheck with other firms who have used their services. But beyond that, Howard Wing, director of product development at the Raytheon Co., Lexington, Mass., has developed some general rules to smooth out client-consultant dealings:

- Make the goal of the contract clear. Then map out a strategy for keeping close touch with the consulting firm. The goal may be well stated to begin with, but it is bound to change a bit as new data is uncovered—that's why a communications format is needed.
- Deal with local firms rather than distant ones because it is easier to communicate face to face. In market research, however, the larger firms tend to do better than the smaller ones, and much better than individuals. One-man outfits are generally better suited to the solution of strictly technical problems.
- Make shorter contracts rather than long-term ones. This forces both client and consultant to keep redefining goals and to keep in touch. Also, performance can be made a condition of renewal. Each month, Wing and his staff review the output of each data or consulting service they retain. "We ask what each firm did for us that changed corporate thinking—after all, you don't retain a consultant to bolster your ego—and if the answer is 'nothing,' we drop the service."

Department head Thomas T. Bamford of Arthur D. Little's Research and Development division, Cambridge, Mass., would find life quite satisfactory under Wing's rules. "Too often," he says, "we are asked to do non-jobs like finding data that agrees with a firm's plans; other times the client has no clear idea of what his goals should be."

Bamford adds that the description of the task must include a clearly defined end point. "We must agree on the point at which our job is finished. If not, and if we feel that there is still work to be completed, the client can wind up feeling that he is dealing with a leech." That pitfall is also pointed out by Samuel B. McFarlane, vice chairman and founder of Electro-Print Inc., Cupertino, Calif., a three-year-old high-technology venture capital company. He comments, "Once you start with a consultant firm, you can almost never turn them off. There's always some new area they feel you should explore. It just doesn't stop," unless you make it stop.

Avoiding the fog. The theme of faulty goal definition threads its way through many tales of client-consultant dissatisfaction. If things are confused or covered up within a firm, they are bound to be presented to the consultant in a foggy fashion, and the client generally gets a bigger bill than he thinks he deserves. As one industry source acknowledges, "Once you had lost all direction somebody would yell for a consultant. If you did that, the odds were heavily in favor of the same people being disgusted with the consultant's performance. After all, he wasn't given much more than your own sense of confusion to work

within the first place."

One reason for this state of affairs, according to Joseph A. Grippo, manager of market development and administration for Stanford Research Institute's Management Systems division, Menlo Park, Calif., is that in high-technology industries qualified technical types are commonly found "who have mastered their technical areas but who don't put that much emphasis on management. To some of them, outside help is an admission of failure," and thus something to be concealed.

The president of a small semiconductor firm notes that "the consultant is called in when top management begins to wonder whether the people working for him really know what they are doing."

Jules Y. Caplan, director of advanced development programs at the Lockheed Electronics Co., Plainfield, N.J., is not one of those types. He calls in consultants only after the preliminary work is done. "We know our company and what it can do technologically," he says, adding that it is erroneous to expect an outside consultant to determine what business a firm should be in, or where it should be heading. "It is a total waste of time to call in a consultant to do your prethinking for you," he says. "Researching a market is not that mysterious; there is a tremendous amount of data available: innumerable market studies, a whole body of literature, and personal contacts. Consultants can't substitute for hard work and digging." Still, once the field is defined, Caplan has nothing against bringing in consultants to help keep the company on the right track.

But what does an executive tell his boss when, after defining his goals and following all the other rules, the consultant he has retained comes up with a market summary totally at odds with everyone else's? Even if the consultant is right, why the differential?

For starters, Lockheed's Caplan warns that with the 10 to 20 firms supplying data processing market projections, the spread has been very wide. "Never depend on a single source of information," he says. Caplan likes to obtain at least a dozen studies, and he weighs each one before making up his mind. Wing of Raytheon agrees on the need to crosscheck, and along with his own recommendations to management he includes a file of clippings from the trade and financial press to offset his own bias.

As for why information varies in the first place, the vice president and managing officer of Booz, Allen & Hamilton Inc.'s Information Systems division, Harvey L. Poppel, figures that when you make a forecast, you know you are going to be wrong, so the question is by how much. At any rate, the trends in a field should be obvious."

Balancing biases. N. Richard Pyes, a vice president for product planning at Dittberner Associates, Bethesda, Md., says that projections may vary for a number of honest reasons. First would be the consultant firm's bias—some tend to trust specific sources of information, but don't range very far beyond them, while others may not understand the data they gather. Also, some consultants are always a little optimistic while others are a little pessimistic. To balance some of this, and to help with problems of definition, Dittberner "always puts down its assumptions so that a client will know how we base our predictions," says the company's director of economic research, William J. Murphy.

Perhaps in an attempt to deny bias a foothold, some firms make a business of gathering data and selling it in unedited form. International Data Corp. in Newton, Mass., is a good example of this in that it either sells its data base information or does studies of the EDP market using the data base as a springboard. Also, raw data of this type can be computer cross-ruffed with other data bases to uncover—for example—sales territories that aren't living up to their potential.

But no matter what kind of data is desired or what problems—general or specific—are assigned, it is important to remember that consultants are not crutches for a faltering corporate policy, industrial psychotherapists, or camouflage for interoffice warfare. They can give help with marketing and planning problems. That is definitely value for money— provided their clients know what they want. □

Semiconductors

Motorola bets on CAD centers

Customers in Boston area now can configure their own MOS circuits with proprietary protection; chips are made in Phoenix

by Laurence C. Altman, Solid State Editor

To bring custom MOS design to the engineer, or to bring the engineer to custom design is a question that will find an answer now that Motorola Semiconductor Products has set up its Localogic CAD center in Lexington, Mass. (*Electronics*, Jan. 3, p. 30) This is the industry's first stand-alone facility, where a customer can design his own MOS LSI. This move has raised the eyebrows of some semiconductor manufacturers, and its success hinges on whether or not the economics of the custom end of the business will justify the cost of customer-designed circuits.

Motorola's idea is to establish several professionally staffed custom design centers in urban locations like Boston, where there are heavy concentrations of potential customers. Such centers will give the customer—in his own backyard—all the design tools available at the semiconductor manufacturer's home plant. Standard CAD programs at the remote center are used to generate chip designs, test programs, and masks for chips that are manufactured and tested in Phoenix.

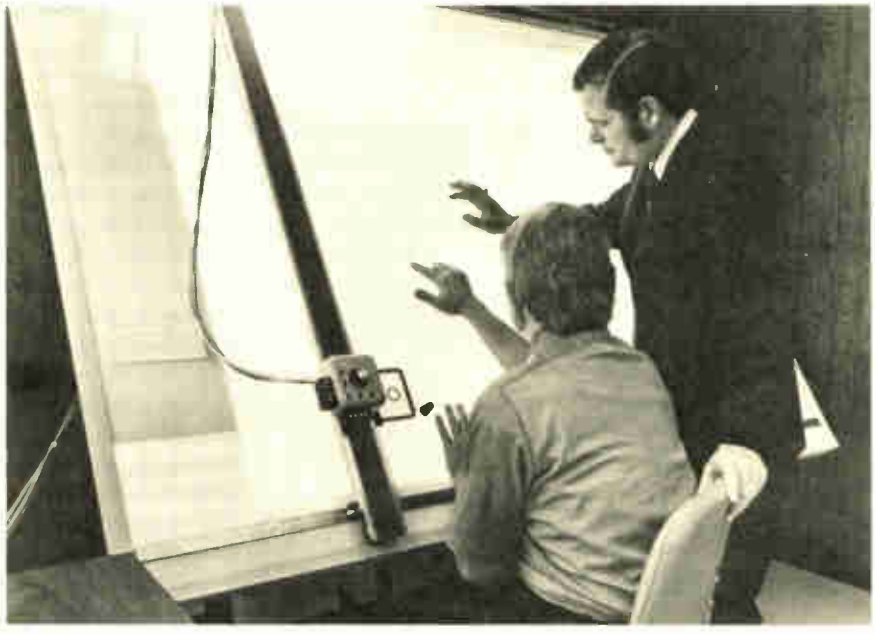
Optimism. Motorola officials are convinced that this arrangement will pay off handsomely. Jack C. Haenichen, vice president and director of operations for MOS, says that so many custom circuits will be produced in the future that it will be difficult to put enough engineers into the field to serve the market. "We need to localize our present central system," he contends. "Our ideal is to take our system to our customers, teach them to use it, and have them use our facilities to design their parts."

Attractive as this arrangement sounds, no other semiconductor manufacturer now plans to follow Motorola's approach. In fact, Fairchild Semiconductor, Mountain View, Calif., and Harris Semiconductor, Melbourne, Fla., are building their standard product lines at the expense of their custom business. C. Lester Hogan, president and chief executive of Fairchild Camera and Instrument Corp. is downright antagonistic. "A guy who comes to me with a suggestion for a remote design center had better be wearing armor—such a center would be a disaster."

Unlike Motorola, Fairchild Semiconductor is anxious to give its MOS product line a decidedly standard look—as quickly as possible. "Since April 1971," recalls Hogan, "we've been trying to shift our emphasis from custom to standard products. Who needs remote design centers?"

Trials. Floyd Kvamme, vice president and director of marketing at National Semiconductor Corp., Sunnyvale, Calif., doesn't think remote design centers are needed in the U.S. "We looked into setting up remote design centers some time ago," comments Kvamme, "and came to the conclusion that they weren't necessary. Communications between customers and the home office are good enough, and we feel that remote design centers are not required here." But communications in Europe present different problems, says Kvamme. "We will soon have a design center in Europe staffed with people who are familiar

Digital plot. In Motorola's Localogic center in Lexington, Mass., the locations of cells and their interconnections are digitized from this chip plot.



with our CAD setup for MOS."

At RCA's Solid State division in Somerville, N.J., William C. Hittinger, vice president and general manager, says, "While we don't see the need for design centers, we are prepared to establish design terminals at locations such as district sales offices or even in a customer's plant if the need arises." Hittinger feels that custom work is and will continue to be an important segment of the business. But maintains, "We can best serve our customers from our headquarters here," backed up by a second generation of design seminars in the offing.

Collins Radio Co., at its Newport Beach, Calif., operation, continues to offer its C-System for remote entry of MOS design data via remote computer terminals. But Gary Rawlings, regional marketing manager for Collins' MOS division says that his company doesn't plan to establish a center apart from its home computer.

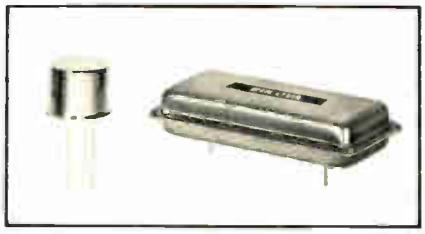
At the center. Nevertheless, Bob Diamond, who heads up the new Motorola design center in Lexington, Mass, claims he already sees strong customer interest in the center. The center's major computation is done on a Control Data Corp. 1700 computer, with a Digital Equipment Corp. PDP-11 doing the preprocessing and peripheral control. Input to the 1700 is by card reader, while outputs consist of Teletype readout, a line printer, and a digitally controlled plotter.

Diamond is quick to point out that, for complete security, a customer's design is contained on cards, which are removed from the center after the design work is done.

"Initially," says Diamond, "our thrust will be in MOS," And for this purpose, about 90 standard MOS function circuits, called Polycells, have been accumulated. Diamond points out that this library is growing. It already includes metal- and silicon-gate p-MOS, metal-gate complementary MOS and more than 100 TTL arrays.

"With the MOS capability alone," Diamond claims, "we can duplicate the function of any standard TTL chip now available. As for complexity, we can construct chips with the equivalent of up to 500 four-input gates. □

What's new in frequency control?

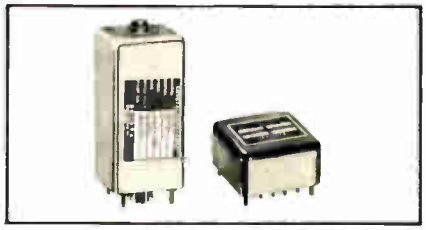


A new series of *highly miniaturized coldwelds* having a broader frequency output is now available. The units – developed by Bulova – feature tolerances as close as 3 ppm of nominal on initial adjustment, and aging rates up to 3 pp 10^8 per week. In the TO-5 can, for example, with a frequency range of 500 KHz to 160 MHz, Bulova coldwelds have a tolerance of ±.015% (from −55°C to +105°C, or to specs.) Aging is 1 x 10^{-7}/week after 4 weeks.

Circle No. 78

Group delay crystal filters offering perfect phase linearity for optimum data transmission are also available from Bulova. Overshoot is kept to 40 db (1%) below the steady state value. The filters provide distortion-free selectivity, at a maximum speed, and have a reduced error rate. Bulova's complete line of crystal filters meet all transmission specifications from 4 KHz to 150 MHz.

Circle No. 79



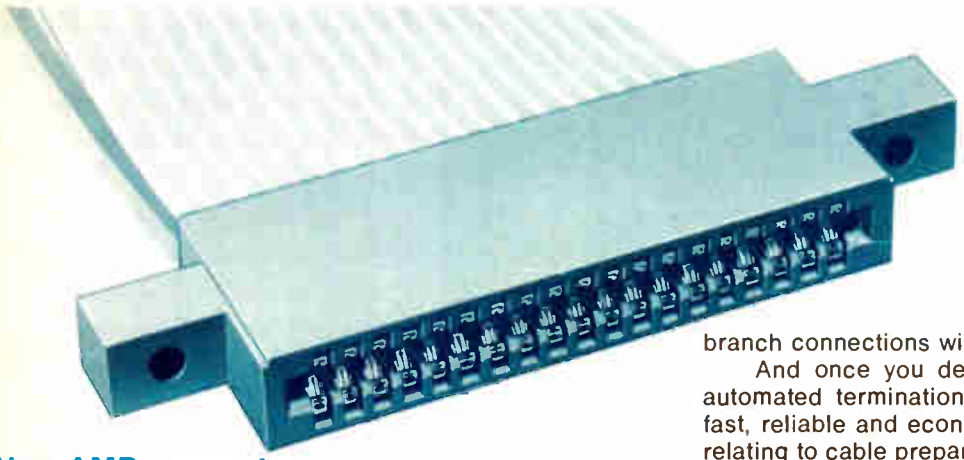
In crystal oscillators, the *temperature compensated TCXO-18* offers a frequency stability of ± 2 ppm over a temperature range of −55°C to +105°C. A voltage variable capacitance diode and thermistor network maintain stability without an oven. The *high stability PCOXO-5* – also by Bulova – has an aging of 5 pp 10^{10}/day. It's a commercial, plug-in package with frequency stability of 2 pp 10^{10}/°C over a range of 0° to +60°C, and short term stability of 11 pp 10^{10} per second.

Circle No. 151

The news in *subminiature fork oscillators* is a unit which uses less than 5 ma. The oscillator, developed by Bulova and designated the FS-11-1, takes up about ½ cu. in. of space and weighs one ounce. Their units have accuracies up to ±.0005%, 90% reliability for 200,000 hrs. and logic circuit compatibility.

Circle No. 152

Bulova has been making frequency control news since 1937. For information on Bulova's complete range of frequency control products, call 212-335-6000, see EEM Section 2300, or write: Bulova Watch Company, Inc., Electronics Division, 61-20 Woodside Ave., Woodside, N. Y. 11377.



New AMP connector for flat flexible cable

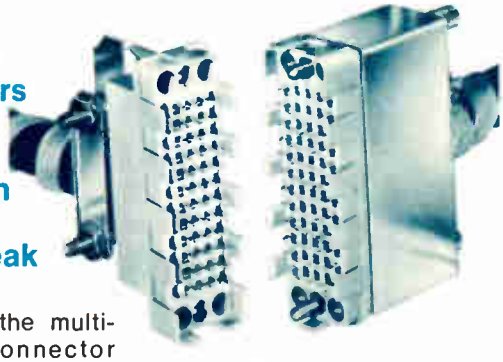
The one-piece printed circuit board-edge connector, with bifurcated contacts on .100″ centers, that we've just added to our line further expands the scope of AMP connectors for flat flexible cable applications. It's the broadest line on the market. And it makes it practical for you to capitalize on the weight and space savings, strength and flexibility of flat cable in just about any application you might imagine.

AMP connectors let you go cable-to-cable, cable-to-post, flat cable-to-round wire, and cable-to-board. They let you make "daisy chain" or branch connections without cutting the cable.

And once you decide on how to go, our unique automated termination technique makes getting there fast, reliable and economical. It works with zero effort, relating to cable preparation. No stripping, no soldering. Just cut cable to length and feed it into our machine, which dependably completes up to 3400 connections per hour. Our exclusive insulation displacement crimp technique produces positive, multiple-area contact between cable conductor and terminal, assuring top reliability.

CIRCLE 95 ON READER SERVICE CARD

Dualatch connectors reliably sustain more than 10,000 make-break cycles.



Here's the multi-position connector with the long make-break life... 10,000 cycles and beyond.

It has unique hermaphroditic contacts—reduces your inventory—requires 70% less make-break force. Housings are designed with positive polarization to prevent mismating.

DUALATCH connectors are available with 7.5 amp or 15 amp crimp contacts that can be applied manually. Or with automatic AMP machines for economical, reliable production in your plant at rates up to 3000 terminations per hour.

Also available with posts for automatic wiring, compatible with AMP TERMI-POINT* clip wiring. Or with manual, semiautomatic and automatic wrap methods. A variety of contact gold plating thicknesses are available for customer selection.

CIRCLE 96 ON READER SERVICE CARD

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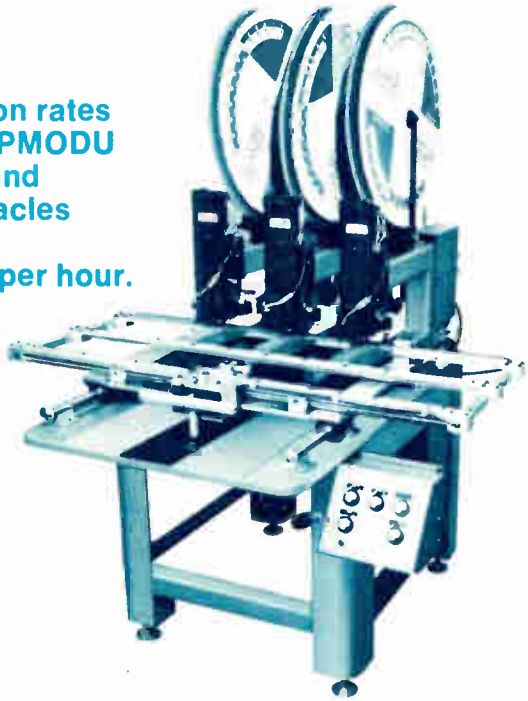
We have human-engineered these switches to make them thoroughly effective as a man-machine interface. White numerals, 0.180″ high, are readable even in dim lighting. Available in both matte and gloss finishes. In ganged units, readout numerals appear in accurate horizontal alignment for goof-proof legibility. Rated for 115 VAC or 28 VDC. Contact current rating: nonswitching—3 amps, switching—125 milliamps. Tested life expectancy: 1 million detent operations.

Thumbwheel switch terminals adapt to solderless interconnection methods, including standard AMP card edge connectors.

CIRCLE 97 ON READER SERVICE CARD

Insertion rates for AMPMODU posts and receptacles reach 12,000 per hour.



AMPMODU*, our post-receptacle interconnection system, now offers you even higher production capabilities than ever before. It's the ideal technique for modular-designed consumer or industrial electronics.

The secret is the AMP triple-head pantograph machine, which can insert AMPMODU contacts into three of your printed circuit boards at a time. Your operator uses a positioning pin and template . . . the three heads each move simultaneously, accurately. Rates up to 12,000 insertions per hour are readily achieved.

The machine will handle boards from .062″ x .125″ thick, with dimensions from 5″ x 13″ to 16″ x 13″.

And that all means simplified staking with maximum reliability and versatility at the lowest overall applied cost . . . AMPeconomation.

CIRCLE 98 ON READER SERVICE CARD

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The latest addition to our M-Series connectors gives you real production economy. They have posts for automatic machine wiring . . . four sizes: .022″ x .036″; .031″ x .062″; .025″ square; .045″ square.

Post sizes are compatible with AMP TERMI-POINT* clip wiring. Or with manual, semiautomatic and automatic wrap methods.

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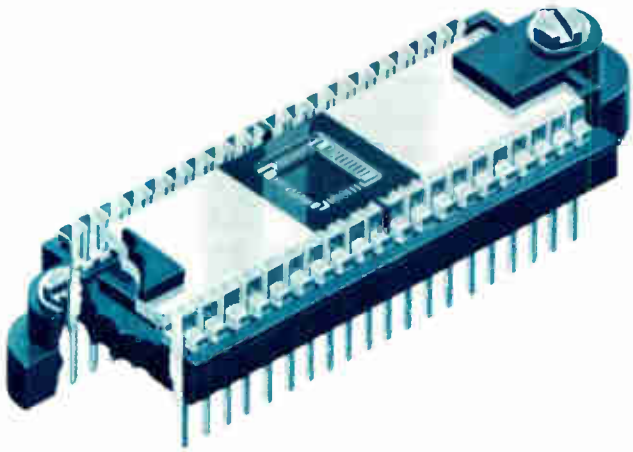
CIRCLE 99 ON READER SERVICE CARD



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New leadless substrate LSI packages eliminate the problems of handling and inserting many delicate leads, and simplify field replacement.

AMP now has a line of special connectors designed to make pluggability of these leadless substrates practical and reliable. Our connectors feature zero entry force insertion, a contact design with stored spring energy to maintain reliable contact, and a low profile.

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CIRCLE 100 ON READER SERVICE CARD

For additional information on any of the above products write: **Industrial Division, AMP Incorporated, Harrisburg, Pa. 17105.**

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Fingrip is a grabber.

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SPECIAL REPORT

HEAVY TRAFFIC CALLS FOR CROWD CONTROL IN THE ELECTROMAGNETIC SPECTRUM

Because of the growing demands being made on already overloaded portions of the spectrum, only a strong partnership between new technology and more sophisticated regulation can stave off potential chaos

by Lyman J. Hardeman, *Communications and Microwave Editor*

☐ Paralleling the population explosion on the earth is the congestion of another vital resource—the electromagnetic radio spectrum. In the U.S., pockets of excessive crowding occur in just about all bands under 10 gigahertz, and new technology, revised regulations and frequency reallocations are all being called upon to relieve the pressure. For instance:

- After saturating channels in relatively narrow bands at 50, 150, and 450 megahertz, land-mobile radio users are now searching for the most efficient methods to apportion a new band at 900 MHz.
- Marine radio users are now required to convert all 2-MHz gear to single sideband, and to move to newly assigned frequency-modulated channels in a band at 160 MHz for line-of-sight transmissions.
- Aircraft radios will continue to operate from 118 to 136 MHz, but a reduction in communications channel spacing from 50 to 25 kilohertz is being coordinated in a worldwide plan.
- Common-carrier microwave relay bands at 4 and 6 GHz are fully loaded in some urban areas, compelling the use of more costly equipment at 11 GHz and above.
- Navigation systems are also short of radio spectrum—entry of a new aircraft collision-avoidance system on one band at 1,600 MHz will probably force the radar altimeters presently using it to be moved to other frequencies at an estimated cost of $60 million, and even then the system is not guaranteed freedom from radio interference by the introduction of satellite communications systems operating on nearby frequencies.

To prevent the situation from degenerating still further, the regulatory agencies are having to refine their approaches to spectrum control. The Federal Communications Commission, for example, is now building computerized data files and developing computer programs that will analyze the information contained in the files. Thus equipped, the FCC will be in a position to plan intelligently for the future rather than having to patch up problems after hardware has been built. Similarly, the White House Office of Telecommunications Policy, which allocates portions of the spectrum to the military and other Federal Government agencies, is also stepping up its efforts to model and forecast potential radio interference problems.

Both efforts are essential not only for the growth of the electronics industry but to the entire economy of the U.S. and ultimately the world. If services such as land-mobile and point-to-point microwave relay are not allowed to develop in response to increasing demand, billions of dollars in industrial investment could be imperilled. The computer industry also, with its largest growth segment this decade projected to be in data communications networks, will depend heavily on an unjammed radio spectrum. And the broadcast industry, while tending toward some cable transmission, will continue to rely heavily on free space.

Economic considerations are not the only factor involved in good spectrum management, however. Priorities must be assigned to the various services, and these involve technical and political factors as well. The propagation characteristics of each band of frequencies are an example of the first, while the degree to which the service is in the national—or international—interest brings in extensive political debate.

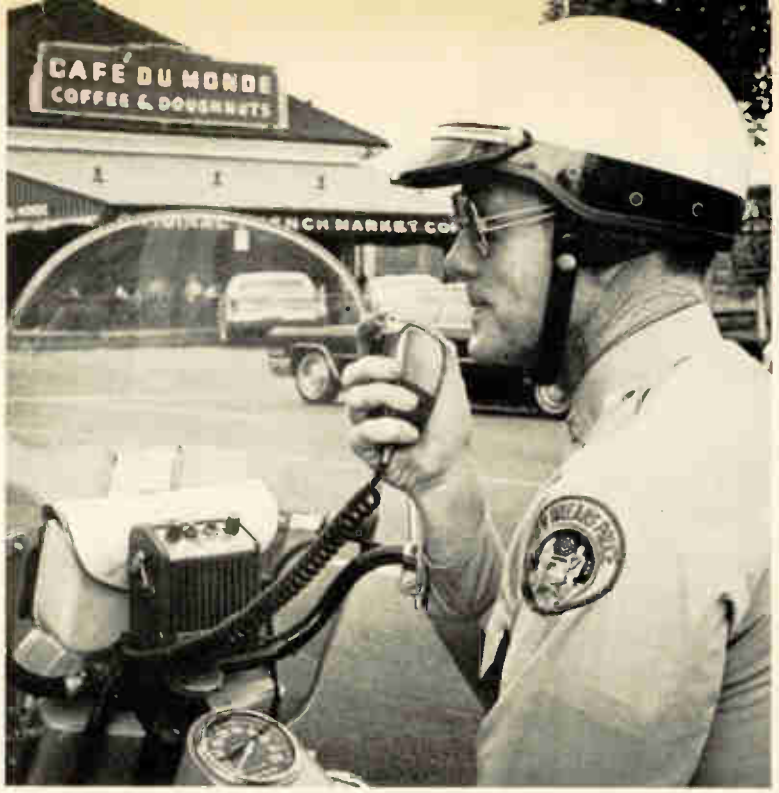
Bearing these complex issues in mind, world authorities have divided the radio spectrum into about 20 broadly defined services. (With minor exceptions, these are the ones identified in the legend for the spectrum foldout chart opposite page 98.)

Within national boundaries, these international categories are further divided to meet the needs of more narrowly defined user groups. In the U.S., for instance, over a hundred distinct subservices, for groups ranging from radio astronomers through the many kinds of land-mobile radio users, are provided for by the FCC.

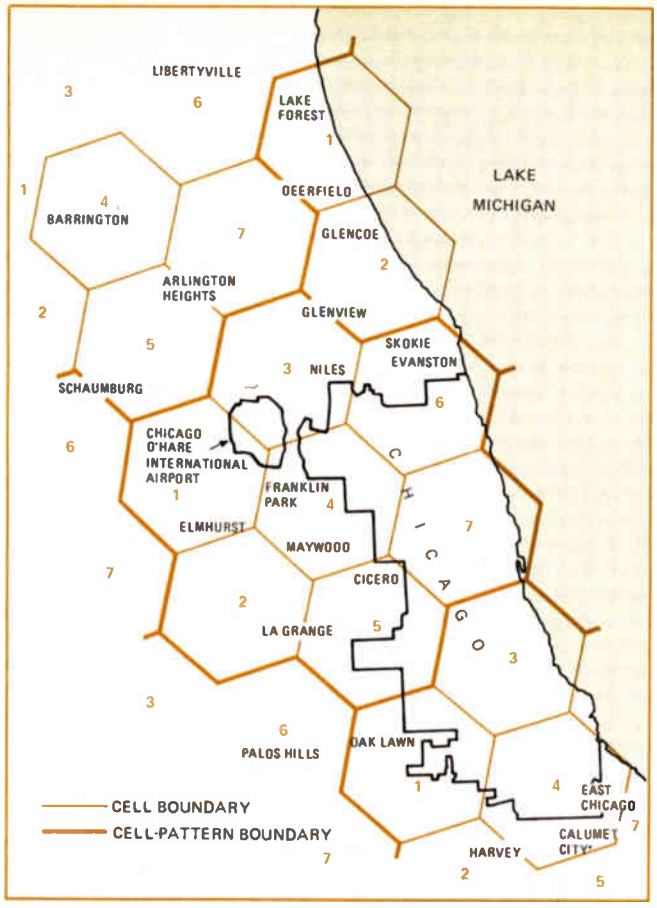
Mobile services

Of all the mobile services—and of all the other services, too—none has experienced nearly as fast a growth

SPECIAL REPORT



1. Mobile spectrum contenders. To keep pace with people on the move, activity in land-mobile communications has grown more rapidly than is the case in any other service. The traditional users of this service—police, taxicabs, and utilities—are now being joined by the automobile-telephone common-carriers and untold numbers of two-way portable units.



2. Honeycombed. Only a few seven-cell patterns are repeated in a proposal to honeycomb the Chicago area with a mobile telephone service. Seven sets of frequencies serve the seven cells, and a central control shifts a vehicle to a new frequency as it enters a new cell. To support future needs, each cell could be subdivided to create more user channels in the same geographic area.

rate as land-mobile radio. As a result, no other service has been subjected to as many technical and regulatory changes.

The Federal Communications Commission has had to make major additions to land-mobile allocations about every 10 years. The original allocation in 1940 of part of the 25-50-MHz band—now called the lowband range—was followed in 1950 by another set of channels in the 150-174-MHz or middle-band range and again in 1960 by frequencies in the high band of 450-470 MHz. Even so, this amounted to a total land-mobile stockpile of less than 40 MHz.

During the same period, therefore, to squeeze more users in, most land-mobile services had their single-channel spacing halved and re-halved to as little as 15 kHz—a reduction made possible by improvements in modulating and carrier-stabilizing schemes. But by the start of the '70s, the struggle between taxi services, state and local governments, public utilities, and other users had again become desperate.

The solution, for this decade at any rate, lay in the relatively little use broadcasting companies were making of some uhf television channels. Noting this, the manufacturers and users of mobile radios began to urge the FCC to re-allocate some of these channels. Despite considerable resistance from the broadcasters, the FCC has recently done just that, transferring two blocks of uhf television bands centered at approximately 500 and 900 MHz.

The first is a block of frequencies from 470 to 512 MHz. Permission to share them with the bottom seven uhf television channels was granted over a year ago to land-mobile radio users in the U.S.'s top 10 urban areas. To date, reports Emmett B. Kitchen, who is responsible for the licensing of these stations at the commission, applications for only about 35 mobile radio systems, and only about 25 to 30 licenses have been granted. While the commission expected this band to catch on a little quicker than it has, Kitchen acknowledges that it does "take about this long for radio manufacturers to develop product lines and for users to implement their long-range planning."

With the second new block of mobile frequencies, things have not progressed even that far. Consisting of frequencies in the vicinity of 900 MHz, the block displaces the top 14 uhf television channels plus 26 MHz previously used by the Government. This 115 MHz of virgin bandwidth provides two unusual opportunities, according to Raymond E. Spence, the FCC's chief engineer. First, there is no problem of having to design around previous hardware standards. Second, because of the quantity of spectrum now available, user requirements will not be limited by the number of available channels—rather, the market for land-mobile radio will be limited by manufacturers' ability to supply economically practical equipment.

As yet, however, service or entity has been assigned any spectrum at 900 MHz. Final licensing of users by the FCC is pending what Spence calls "a deliberately lengthy period of time to assure proper consideration of all social and economic, as well as technical implications."

The reason is that some of the technical implications concerning maximum spectrum efficiency and methods of implementation of 900-MHz systems are hotly contested. Debate becomes polarized over the issues of whether a private dispatch system can be efficiently incorporated into a mobile telephone service, and whether or not an unnecessary monopoly would develop if the American Telephone and Telegraph Co. were granted exclusive right to 75 MHz of the 115 MHz total.

The dispatch vs mobile telephone issue

The standard dispatch system, which accounts for about 90% of the present land-mobile radio market, characteristically handles very short messages, is shared between groups of typically 20 to 40 stations, and allows a user access to any channel he finds free. City police and fire departments, and private service industries are representative dispatch users. By contrast, in mobile telephone services, the average message lasts for several minutes, the subscriber obtains access to channel through an operator or by dialing, and he then has exclusive use of his channel during his conversation. Doctors and business executives are the traditional users of mobile telephones.

In formal comments filed with the FCC on July 20, AT&T proposed to combine a dispatch and a mobile

telephone service at 900 MHz. The company further stipulated that wire-line common-carriers be given a long term commitment to the exclusive use of 75 MHz of the band, and that AT&T be authorized unrestricted entry into the dispatch market.

Other manufacturers, however, including RCA, General Electric, and Motorola, feel strongly the mobile telephone markets should be open to all. They also propose separate systems for dispatch and mobile telephone service, and contend that the two services simply do not mix well in practice.

"We see no benefits either in spectral efficiency or in cost savings to the private dispatch user from the combination of both services into a single system," says Glenn R. Petersen, general manager of GE's mobile radio department and chairman of the land-mobile section of the Electronic Industries Association. He adds, "Such a monolithic system would be over-designed from the standpoint of the private dispatch user and could actually be wasteful of spectrum."

In rebuttal, AT&T replies that the other firms provide no solid justification for their statements. The FCC is now reviewing all comments, and Raymond E. Spence is hopeful that the Commission's position and subsequent rulemaking on how to apportion frequencies in the 900-MHz band "will be on public record by the end of this year."

The cellular approach

Industry is entirely in agreement, however, that a cellular or space diversity approach to a mobile telephone service in this band is desirable. The cellular concept takes advantage of the geographical distances between mobile radio stations to improve spectrum utilization, and several industry filings have provided the FCC with detailed plans for cellular systems.

To visualize such a system, imagine Chicago to be divided into several areas, each comprising a pattern of seven cells (Fig.2). Assume that each of the seven cells is assigned 10 frequency channels different from those assigned to the other six cells in the pattern. These groups of frequencies are then repeated in correspondingly positioned cells in other seven-cell patterns. As a mobile station moves from one cell area to another, a central control switches it to a vacant channel on another frequency in its new cell.

Potentially, the cellular approach requires much less spectrum to provide a given quality of service to the user. The size of the cells determines how efficiently the radio spectrum is used—the smaller the cells, the more times they can be repeated in the same geographic area, and the more times they're repeated, the greater the number of people who can use each channel. For, "if a pattern of say seven cells just barely covers a city," notes Martin Cooper, vice president for land-mobile radio at Motorola's Communications and Electronics division, "then we're no better off than we would be with a single cell for the whole city." But "if we fit two of these cell patterns into a city, then we double the potential utilization of each channel, and so on."

The greater efficiency of the cellular approach is achieved only at the expense of a more complicated system. When a user leaves his assigned cell, he must be shifted automatically to another frequency in his new cell. This requires a vehicular locating technique that, besides adding complexity to the system, could require additional spectrum assignments.

Nevertheless, both AT&T and Motorola have already demonstrated working hardware in a cellular system to FCC officials. And, whether combined with a dispatch service or restricted to a mobile telephone service, the cellular concept seems destined to be included in the FCC's final rulemaking for the 900 MHz band.

Decentralization is next

For the future, a still more sophisticated approach to relieving land-mobile frequency congestion is to be tried, in the shape of decentralizing the allocation of frequencies to services. As a start in this direction, the Commission recently established its first Regional Spectrum Management Center, which in June of this year moved with a task force of some 29 people to new quarters in the Chicago suburb of Park Ridge.

"A major reason for such a decentralization move stems from the shortcomings of present nationwide block allocation methods," explains Don R. Precure, who leads the task force. In the past, the same block of channels reserved for taxicabs in New York City has been wasted in the backwoods of the Pacific northwest, while channels reserved for forest conservation service in Montana have lain idle in New York. The Spectrum Management Center is presently concentrating on the land-mobile problem, though ultimately it will be responsible for coordination with all FCC bureaus in developing decentralized frequency management techniques.

The expectation is that, since each region has a unique set of problems depending on geography and population distribution, each regional center will be given authority and responsibility for licensing in accordance with local requirements. But it will not merely re-order service priorities on a regional basis—the new rulemaking incorporates the so-called pool system in which a reservoir of land-mobile frequencies is pooled into two categories (Fig. 3). Police and fire communications are lumped into a high-priority category, where quick access to a vacant channel is necessary. Other services, depending on the geographic region, will be distributed among five groups in a second category.

The essential groundwork for the decisions confronting the commissions' task force is to be provided by the establishment of a comprehensive data file from two sources. The first is the information contained in the licensee's station application. The second is channel occupancy data measured by a spectrum analyser which is capable of monitoring signal levels for all land-mobile channels at the rate of 300 channels per second.

The chief opposition to the FCC's decentralization move comes from user groups who want to be granted higher priorities in the service categories. But in the absence of what the commission feels are any viable alternatives, it appears likely to make only minor changes in the rules as they are presently proposed, before adopting them sometime this fall.

PROPOSED BREAKUP OF LANDMOBILE CHANNELS FOR CHICAGO

CATEGORY 1	CATEGORY 2			
	Group A	Group B	Group C	Group D
Police Fire	Special emergency Highway maintenance Forest conservation Local government	Power Telephone maintenance Railroad	Petroleum Forest products Special industry Motor carrier Auto emergency Business, taxi Motion picture Relay press	Mobile telephone
MHz Channels	MHz Channels	MHz Channels	MHz Channels	MHz Channels
25–50 206 150–170 94 450–470 25 470–476 10	25–50 96 150–170 147 450–470 35 470–476 10	25–50 66 150–170 112 450–470 17 470–476 5	25–50 240 150–170 120 450–470 232 470–476 15	25–50 14 150–170 22 450–470 40 470–476 12
Total: 335	Total: 288	Total: 200	Total: 607	Total: 88
	Total category 2: 1,183 channels			

3. Land-mobile reservoir. Under the pool system proposed for the Chicago region, a multitude of land-mobile subservices would be divided into groups based on each service's channel availability requirements and on compatibility of types of services within each group. As the plan is extended into other regions, services might be regrouped to reflect the unique needs of that region.

"If we don't proceed with spectrum conservation techniques like those now," points out Edwin J. Schafer, an attorney for the task force, "then crowding in the future will be so bad that no one will be able to get their messages through. Even in the unlikely case that the pool system is not successful, the data base we will have generated will be infinitely better than what we now have, and we will be able to make more meaningful responses to future problems."

Boat owners steer toward vhf

At sea, the mobile-radio situation is not as bad as on land. The two main problems concern crowding in the 2,000–2,850-MHz band and the excessive time required to get in touch with a ship on the high seas.

The channels in the 2,000–2,850 kHz band are shared between some 240,000 commercial and recreational craft licenses, and the interference problems this congestion sets up among these stations are made still worse by the over-the-horizon propagation characteristics of 2-MHz signals.

To provide relief for these marine users, the FCC last year opened 23 new channels in the vhf range from 156 to 162 MHz by reducing channel spacing from 50 to 25 kHz. In addition, it has outlawed the use of double-sideband equipment in the 2-MHz band after Jan. 1, 1977, and required all craft fitted with radios to have a vhf capability by that date [*Electronics*, April 10, p. 72].

Along with the FCC, the Coast Guard and the Maritime Administration are also becoming increasingly concerned with delays in communicating with ships at sea. Recent Coast Guard studies show that the average calling time to establish contact is over five hours for ships in the North Atlantic, mainly because a ship's radio operator is off duty or not tuned to the frequency of the calling station. From the point of view of conserving channel use, too, "this calling time is wasteful of the spectrum, since a large majority of these calls are never received by the ship being called," observes Walter E. Weaver, a maritime specialist in the FCC's aviation and marine division.

To reduce the delays, the Maritime Administration is now working on an automatic digital selective calling system. A plan is being internationally coordinated to equip future shipboard communications gear with digital decoding circuits; these will automatically detect a coded bit stream sent by a calling station and alert the ship's crew to the fact. The Maritime Administration expects to award a development contract for a prototype of the calling system later this year. Data taken from tested hardware is to be made available to organizations within the International Telecommunications Union by early 1974.

Also included on the FCC's agenda is the preparation of U.S. proposals for the 1974 World Administrative Radio Conference on Marine Communications. Among other issues to be discussed will be the proposal for an international distress frequency at 156.8 MHz, specific frequency assignments and allocations for marine satellite systems, and further international coordination of the automatic selective calling system.

Air mobile services

As on land and sea, so in the air—the airlines and private pilots are also in the process of halving their single-channel bandwidth—this time from 50 to 25 kHz in their still overused 118–136-MHz communications band. But splitting channels used in aircraft communications is not as easy as that for land-mobile radios, because aircraft operate internationally and must be assigned channels on an international basis. Consequently, a time-consuming worldwide coordination is needed.

Groundwork for the current split from 50 to 25 kHz started over a decade ago, and may not reach its goal for another year or even two, or until the members of the International Civil Aviation Organization have taken final action on a proposal passed last April in Montreal by the Seventh Air Navigation Conference. As in the 118–136-MHz communications band, channels in the 108-118 MHz navigational band are being squeezed from 100 to 50 kHz. The goal is to provide room for additional vhf omnirange stations.

Citizens band: a popular service

Least well organized of all forms of mobile radio—perhaps because there is least urgency for it to be well organized—is citizens-band radio, the service designed to bring spectrum to the people. The chaotic overcrowding is concentrated in a small band centered at about 27 MHz, where over 800,000 licensed "CBers" in the United States fight over 23 channels. Contributing to the problem are the relatively untrained operators and those operators without licenses who bootleg on the channels.

To reduce the confusion, the Electronics Industry Association [*Electronics*, March 13, p. 31] is proposing reallocation of 2 MHz of the 220–225-MHz band now shared by hams and Government radar systems. "The frequencies proposed for the new class E service are high enough to prevent long-distance skip transmissions which plague the 27 MHz band," notes John Sodolski, vice-president of EIA's Communications and Industrial division. He adds, "With 80 channels to play with and a transceiver cost of $200–300, the service should adequately satisfy the demand for a personal radio service."

The FCC is on the verge of taking some action on EIA's proposal, confirms Prose Walker, chief of citizens radio operations at the FCC. But any decision in favor of citizens radio is expected to come hand in hand with a requirement that citizens-band transmitters be equipped with automatic transmission identification circuitry.

An automatic identifier would use logic circuitry to modulate the transmitter with a precoded digital burst every time the set was keyed. Such a system is necessary, says Walker, to give the commission an effective method of monitoring a service with millions of users, and to increase spectrum efficiency by no longer requiring the radio operator to spend time on identifying each transmission by voice.

Amateur radio service

The authorized amateur radio operators seem a much more self-disciplined lot. There are over 700,000 of them scattered over the globe, all busily engaged in self-training, intercommunication, and technical investigations solely out of personal interest. Allocations for the hams start with a band at 1.75 MHz (160-meter wavelength), and are spaced approximately at harmonic intervals throughout the spectrum.

Amateurs seem to be doing their part in adapting to the spectrum crunch. "After many years of using double-sideband modulation in the lower-frequency

Spectrum usage abroad

Spectrum crowding occurs not just in the U.S. In Japan, for example, it's largely the result of having 100 million people crowded into a small geographic area. In Europe, complications arise from the existence of many independent nations packed tightly into the one small continent.

Japan controls use of the spectrum through the Radio Regulatory Bureau of the Ministry of Posts and Telecommunications, which has about 3,000 civil employees. The Administrative Director of Communications is a smaller executive body which could be compared to the Office of Telecommunications Policy in the U.S.

Japan's land-mobile radio service at 150, 400, and 460 MHz is very congested and, as in the U.S., new mobile frequencies are being made available, sometimes at the expense of television broadcasters. In June, 1968, the Minister of Posts and Telecommunications ruled that all vhf television must be switched to uhf within 10 years of that date to make room for added vhf mobile services.

Citizens' radio in Japan's 26–27-megahertz band suffers from the same bedlam that exists in the U.S. However, fm broadcasting from 76 to 90 MHz remains relatively unused in Japan. The top 6 MHz of this band cannot be used in regions where television channel 1 (90–96 MHz) is located for fear of interference with TV reception.

Japan's 4-gigahertz (3.6–4.2 GHz) and 6-GHz (5.925–6.425-GHz) systems on the Tokyo-Osaka route are completely saturated, and new systems are being built at 5 GHz (4.4–5 GHz). It's this situation that has forced the country's communications laboratories to develop quasi-millimeter-wave systems [*Electronics*, March 27, p. 81] and accelerated their activity in coaxial cable development.

In Great Britain, interference problems are aggravated by the closeness of other nations. The country broadcasts six national programs in the 647–1214-kilohertz band, but because of regular public complaints about interference from foreign broadcasters, duplicates many of them on vhf stations between 88 and 95 MHz. In addition, there are 20 radio stations for domestic broadcasting between 95 and 97 MHz. All radio broadcasting in England is run by the British Broadcasting Corp., which is publicly owned but independent of government control.

Mobile radio congestion problems in England are still at tolerable levels, thanks to reductions in channel spacing. For some equipment 12.5-kHz spacing is reported.

Marine communication for the island country also appears tolerable. "There's a problem in that some unauthorized users and atmospheric conditions at lower frequencies cause interference, but there's no crisis," says one Post Office official. Nevertheless, satellite repeaters are being considered for maritime use.

"So far it's only talk," comments the Post Office official, "but it must come." As yet, however, no one can agree on what frequencies are best for satellite links—shippers prefer vhf because it would keep their costs down, but communications authorities generally prefer L-band because the vhf spectrum is already overcrowded.

amateur bands, we have in the last few years converted almost entirely to single-sideband modulation," says William I. Dunkerley, a ham and managing editor of QST. QST is a monthly magazine published by the American Radio Relay League, an organization of U.S. amateurs. Besides relieving the over-all congestion problems, says Dunkerley, single sideband gives the ham greater capability for picking up weak signals.

The hams do run into unfavorable publicity about interference between their broadcasts and television reception. ARRL rfi specialist Lewis G. McCoy says that "we continue to dispense information to our members on solutions to these problems," but claims "the problems are most often traced to low-quality consumer electronics. Television manufacturers design for the general TV receiver environment, and 99.5% of the time no interference problem results." And for the remaining one-half percent? The majority of American television manufacturers, according to McCoy, will supply free of charge a high-pass filter for their set's rf input upon receiving a written request describing the problem.

Radio amateurs have also joined the space communications bandwagon. They were provided expanded amateur satellite allocations at the World Administrative Radio Conference (often called simply the Space Conference) that met in Geneva last year mainly to discuss satellite matters. "These satellite service provisions apply to all bands now used exclusively by amateurs, and to a small portion of the bands previously shared by amateurs and other services," says John Huntoon, general manager of the ARRL.

Fixed services

Fixed point-to-point microwave services are generally concentrated in bands between 1.85 and 13.25 GHz. While some bands are shared by Government agencies, railroads, power utilities, and state police and highway departments, the more congested bands are used by common-carrier communications companies. Nor has the formal FCC acceptance of specialized common-carriers, who provide leased services to multiple customers, helped matters, for now the bands at 2, 4, 6, and 11 gigahertz are becoming saturated even more rapidly.

The techniques that have evolved to help combat these saturated conditions all aim at extracting greater efficiency from the fixed-service allocations. Among them are improved antenna designs, better modulation systems, and progress in developing a comprehensive microwave data file. By now, in fact, refinements in analog frequency-modulation techniques are allowing carriers to pack up to 1,800 voice channels within a fixed bandwidth.

Improving the sidelobe characteristics of antennas is the solution to many interference problems today. Moreover, "a current trend is toward the use of antenna feed designs to better illuminate the parabolic-dish reflector," observes Laurence H. Hansen, director of antenna engineering at Andrew Corp., Orlando Park, Ill. "Combining this and more conventional side-lobe-reducing designs, wide-angle sidelobes (from about 10° to 70° off-axis) have been reduced by about 10 decibels and backlobes by as much as 30 dB."

4. Saturated. Microwave relay routes in the 4- and 6-GHz bands are saturated in urban centers such as New York and Los Angeles, forcing the move to 11-GHz frequencies and higher. The use of low-sidelobe antennas and space-diversity backup systems would increase spectrum utilization efficiency at all frequencies.

This kind of performance can stand comparison with that of the horn-type antennas (shown in Fig. 4) that AT&T often uses in its high-density microwave routes. In price, however, the new parabolic antennas typically cost 30% to 60% less.

Space diversity is more efficient

Satisfying reliability requirements is, however, having to take a costlier form as pressures for more efficient use of the microwave spectrum build up. For years, point-to-point relay systems have employed frequency diversity to add reliability to their long-haul microwave links. When adverse propagation effects prevent the use of a specific carrier frequency, an alternate frequency is switched into the same antenna pair and propagation path. Since one reserve frequency is typically maintained for every five or six active circuits, the net result is to reduce efficiency of spectrum usage, and the FCC rules now require that a minimum of three active channels be in service before frequency diversity methods can be employed. As the microwave spectrum becomes more crowded, it may become necessary to discontinue the use of frequency diversity altogether.

The more spectrally efficient—and more costly—method of achieving added reliability is space diversity. Here, rather than having a backup frequency, a separate pair of antennas is placed in the line between two

stations to provide an alternate path. The technique is being incorporated into about 90% of all new common-carrier microwave relay systems, reports Paul L. Coffrey, a systems engineer at Prodelin Inc., a Hightstown, N.J. manufacturer of microwave antenna systems. "Until the last few years," he estimates, "probably 90% of all systems used frequency diversity"—an about-face that indicates the extent of the anticipated need for high spectral efficienty.

Cross polarization used more

The same need is bringing cross polarization, or the simultaneous transmission of two radio signals over the same path with electric field vectors rotated 90° apart, into more and more regular use. With today's technology, two cross-polarized microwave antenna systems can achieve typically over 20-dB isolation between two signals at the same frequency.

For frequency-division-multiplexed, frequency-modulated analog signals which require about a 60–65-dB signal-to-interference ratio, cross polarization has been used to add the necessary isolation between two relay systems operating in the same geographic area. And with the crowding of analog systems at many parts of the country, cross-polarization techniques are sure to find more applications.

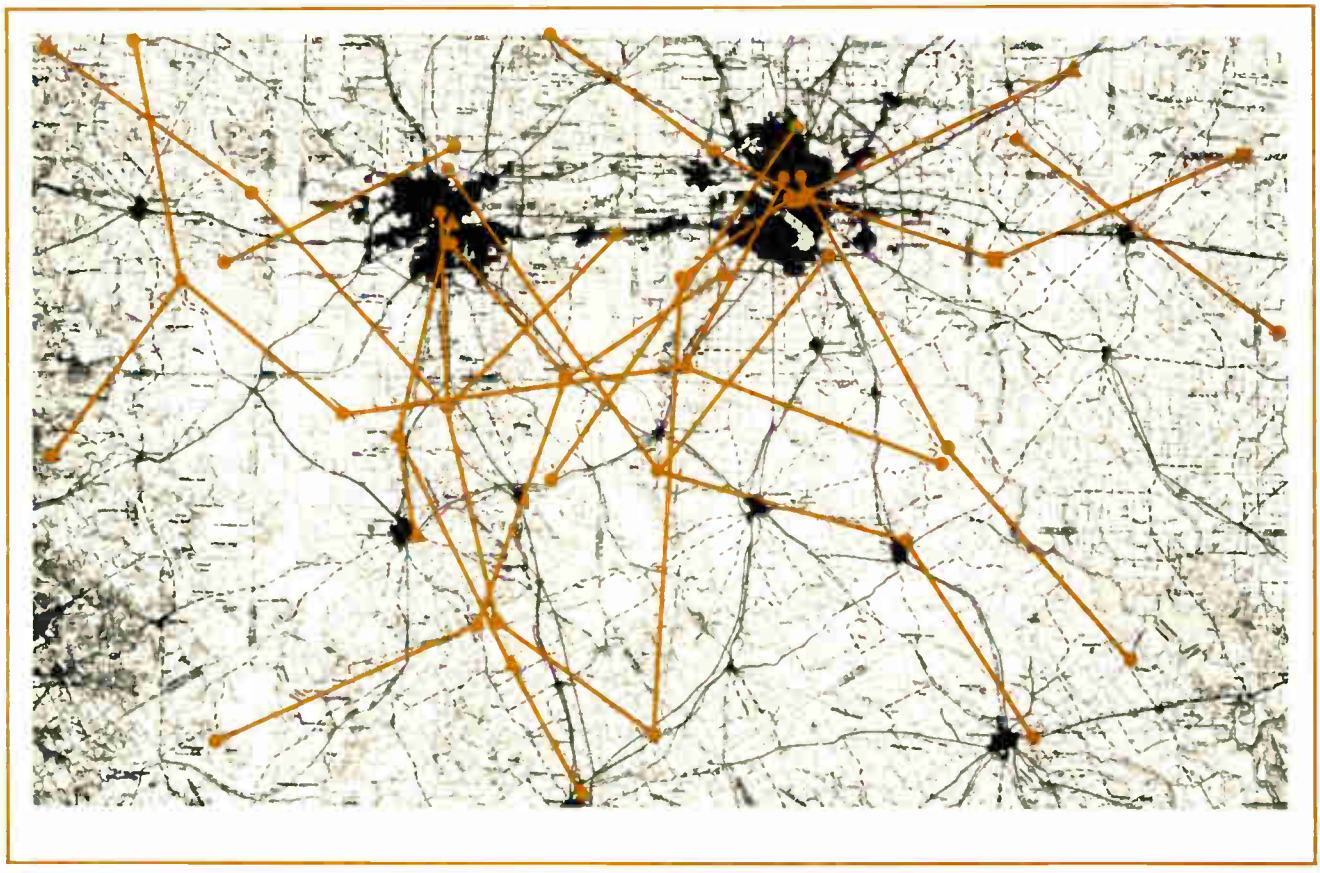
The most promising future for dually-polarized waves, however, is derived from the nature of digitally modulated signals. Such a signal can tolerate 15–20-dB signal-to-interference margins and consequently is much less susceptible to interference than analog modulation schemes. Two cross-polarized digitally-modulated signals on the same frequency can therefore be transmitted over the same microwave link without any noticeable degradation. The result is a doubling in spectrum efficiency.

One of the first cross-polarized digital microwave systems was recently built and demonstrated by Raytheon's Service Group, Norwood, Mass. According to William C. Swanson, marketing support engineer at Raytheon, the new system transmits 600 digitally encoded voice channels on each of two 11-GHz carriers for a total of 1,200 voice channels in 30 MHz of bandwidth.

Digital modulation on microwave

Moreover, the incidence of digitally modulated microwaves is likely to boom over the next decade with the growth of data communications needs. In anticipation of accelerated growth in that area, the Federal Communications Commission is now reviewing comments on what industry considers are the more desirable modulation techniques and when they should be used [*Electronics*, Feb. 28, p. 105]. While recognizing the efficiency of frequency-division-multiplexed frequency

5. Computer-aided spectrum design. Microwave-relay route designers at Microwave Communications Inc. have enlisted the aid of computers in locating possible new routes. Here, a computer-generated plot of existing 6-GHz routes serves as an overlay for a relief map of the Dallas-Ft. Worth area. Data files of existing links are being upgraded to include more information on antenna directivity, spectral characteristics of the radios and the precise geographical location of relay towers.



modulation for analog voice transmission, respondents to the FCC inquiry unanimously suggest a form of digital modulation for transmitting information between computers.

Microwave spectrum study goes public

Not surprisingly, collection of a large data base is recommended as a means to more precise management of the microwave frequencies in the future. The advice is contained in the three-volume study of "Frequency Assignment Techniques for Microwave Systems" made public last summer by the FCC and prepared for the commission by Computer Sciences Corp.'s Systems division of Paramus, N.J.

The report documents in detail the present frequency assignment methods, recommends changes for more effective spectrum utilization and suggests an approach to the mechanics of gathering the specific data required. In summarizing the study, Manfred Westheimer, a senior member of CSC's technical staff, recommends that an FCC task force be created to collect and administer a data base which he says "should be standardized for all FCC bureaus and should reside with the commission." The study further recommends that the present bureau concept be retained because of each bureau's long-term understanding of the unique operational and technical problems of the industry it regulates.

On June 1, the FCC invited industry comments on the recommendations of the study, pointing out that they "would have a far reaching effect on management of the radio spectrum between 1,850 and 13,250 MHz." There is little doubt that a comprehensive data file is needed, according to commission officials, who will be evaluating both the study and industry comments, which are due by Oct. 2. Still to be resolved, however, are such problems as whether the computer files will be maintained by FCC or a designated independent contractor.

Broadcast services

Since the nature of broadcasting allows one assigned channel frequency to serve any number of receivers with equal ease, this service is relatively immune to pressures of population increases. Yet the broadcasting servicesareatpresentallocatedfullyone-halfofthetotal electromagnetic spectrum below 800 MHz. Moreover, the relatively low-loss characteristics of propagation at these frequencies make them economically valuable.

It is therefore no wonder that other radio users have looked hungrily to broadcast territory for spectrum relief—and not too surprising that the FCC has listened to their arguments. In defending television channels around 900 MHz from use by land-mobile radio users, for instance, the Association of Maximum Service Telecasters suggested that land-mobile congestion is caused by wasteful management practices resulting in an inequitable distribution of users on presently available channels. The Federal Communications Commission, however, ruled "that it would be in the public interest" to go on with its plans to make 900 MHz available to mobile users.

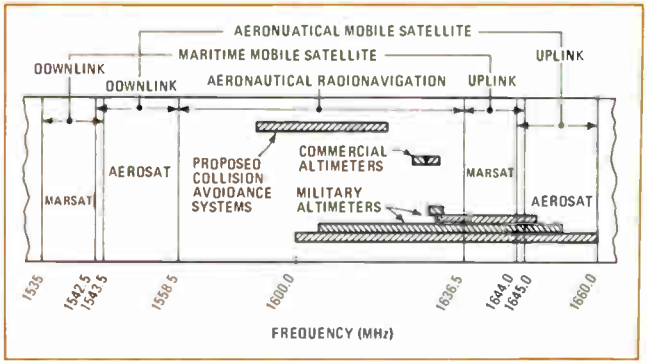
The methods of allocating specific frequency bands for broadcast services vary widely from country to country, but the service is generally divided into five basic subservices: international; standard a-m broadcast; fm broadcast; and vhf and uhf television. International broadcast frequencies are reserved in a number of narrow bands in the hf region from 3 to 30 MHz. They are shared by all countries. To minimize interference problems, broadcast schedules of each country's use of these frequencies are filed with the International Frequency Registration Board in Geneva well in advance of the broadcast date.

In the United States, domestic broadcast frequencies are well-known. A-m stations occupy 107 channels spaced 10 kHz apart and centered at about 1 MHz. Fm broadcast channel spacing is 200 kHz in the 88–108-MHz range. Vhf television occupies twelve 6-MHz channels scattered between 54 and 216 MHz. Fifty-six channels now remain for uhf television use, except that the bottom seven of these channels are shared with land-mobile radio users who operate in heavily populated urban areas.

A freeze on the licensing of new a-m broadcast stations is presently in effect at the FCC pending a policy decision on how remaining channels should be used. The commission is determining priorities in licensing criteria such as what are the market demands for a new station, how many f-m stations serve the same market,

Reason for uhf TV taboo	Geographic separation required	Spacing between channels
Co-channel	~ 180 miles	0 channels
Selectivity	55	±1
Intermodulation	20	±2, ±3, ±4, ±5
Local oscillator radiation	60	+7
I-f beat	20	+8
Sound image	60	+14
Picture image	75	+15

6. Taboo In '52. Minimum geographic separation between uhf television stations due to interference between stations is based on the performance of receivers designed 20 years ago. Since then, technology has generally advanced, so a study is being made to determine if any of these taboos can be relaxed.



7. Room for CAS. The navigation band at 1,600 MHz is being altered to meet the requirements of modern transportation systems. Aircraft collision-avoidance systems have been granted primary rights to the center portion of the band. This introduces potential interference problems with radar altimeters, future satellite systems.

and whether a new station should be licensed or an existing station should be allowed to increase its power. These tradeoffs are expected to be resolved and the freeze lifted by early 1973.

As in a-m broadcast services, unused f-m broadcast and television frequencies are not to be found in major urban areas. F-m broadcast and television services, however, have not been subjected to a licensing freeze on remaining channels in less populated areas.

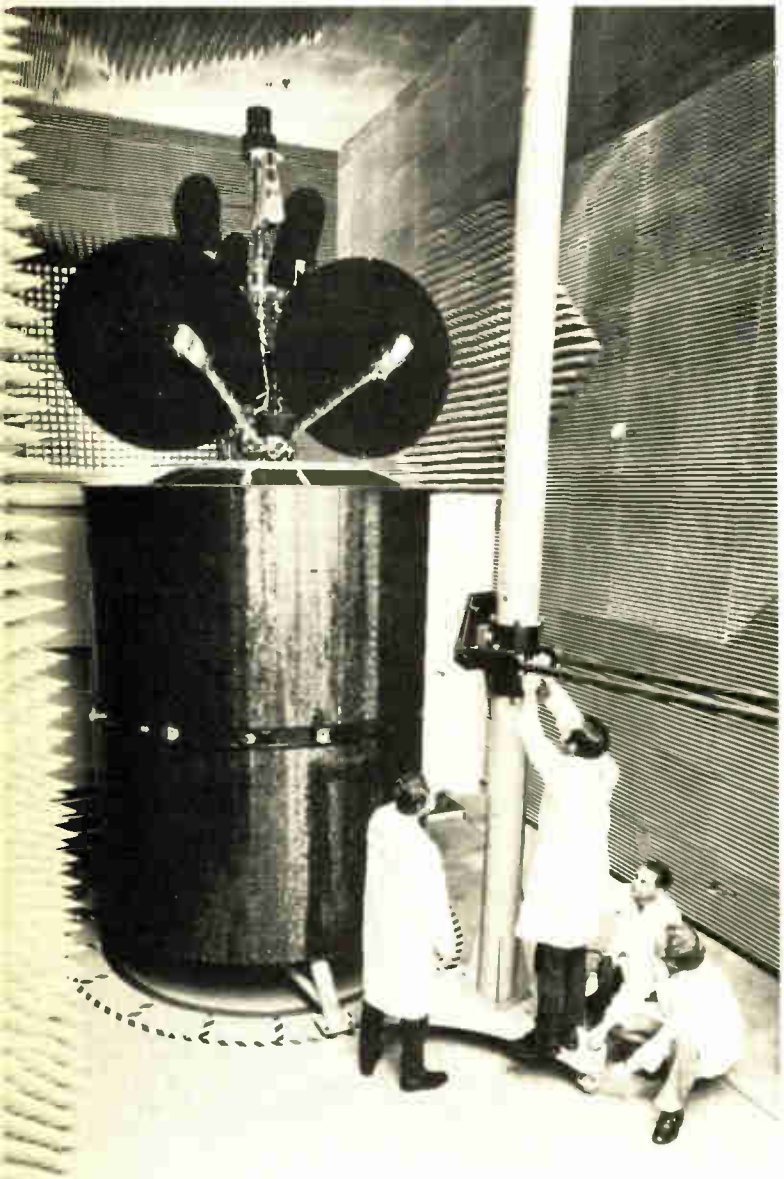
A second look at uhf TV taboos

Still, though the commercial broadcasting is not subject to the same congestion pressures as other services, that use the electromagnetic spectrum, economics and technology can bring other pressures to bear. For instance, in 1952, when the FCC first made uhf channels available for use by commercial television stations, a number of minimum geographic spacing requirements were specified. These minimum station-to-station separation limits are referred to as uhf television taboos (Fig. 6). But after 20 years, uhf television tuner design has seen extensive change, suggesting that some of these restrictions could be relaxed. This would allow more station assignments in any fixed geographic region, or alternatively, allow the same number of stations to operate within a smaller bandwidth.

So the commission has started a program to study the possibilities. A sampling of some 50 typical commercial receivers has been purchased for evaluation by the FCC's laboratories, and initial testing is expected to be completed by the end of this year.

Present taboos are based on receiver characteristics such as intermodulation distortion, selectivity, local-oscillator radiation out of the receiver rf terminals, and image rejection. Many of these parameters are interdependent, and the circuit design which maximizes spectrum efficiency is not obvious. For example, one of the more recent approaches to tuner design uses a solid-state amplifier directly at the rf input, rather than amplifying the signal at lower frequencies after down-conversion in a superhet receiver. But "while the direct amplification approach reduces the local oscillator radiation from the set, it can also increase cross-modulation distortion and degrade selectivity," says Alfred Sfreddo of General Instruments Inc., a Chicopee, Mass. company who supplies tuners to many receiver manufacturers.

Meanwhile, it looks as if solid-state device technology may soon provide a solution to the intermodulation problems in uhf amplifiers. A dual-gate field effect transistor announced last month by Signetics Corporation [*Electronics*, Aug. 14, p. 141] has very linear input-output gain characteristics. "This results in cross-modulation performance several times better than the bipolar transistors now used," claims George Urbani, marketing manager at Signetics. Several receiver manufacturers are now testing the performance of the new devices in tuner circuits.



Radiodetermination services

By international definition, radiodetermination means the determination of position, or the obtaining of information relating to position, by means of radio waves. The broad service includes both radionavigation functions like those performed by the Omega network or by instrument landing systems and the radiolocation functions of radar or direction-finding systems.

Characteristically, a difficulty that planners face here is the need to reconcile interim measures with as yet only vaguely specified long-term requirements. A case in point is one of the more recent systems competing for spectrum in radionavigation bands—a "universal" microwave landing system scheduled for operation by 1980 [*Electronics*, Jan. 3, p. 43]. Spectrum space at both C-band and Ku-band is being coordinated internationally for this service, "which is expected eventually to replace existing landing systems in the vhf and uhf bands," says Richard F. Bock, associate program manager for avionics at the Federal Aviation Administration. In the meantime, however, the FAA is faced with an array of industry proposals to provide an interim landing system on the same frequencies, and is being

8. Ten years in space. A decade after the launching of the first communications satellite, Intelsat IV craft now relay up to 9,000 two-way voice circuits. Rapid growth in the use of satellites forced regulators to make spectrum available for this technology.

pressured to decide on a design that officials can only guess will be compatible with the final microwave landing design [*Electronics*, Aug. 28, p. 29].

A somewhat differently contested radionavigation band is a segment 125 MHz wide centered at 1,600 MHz (see Fig. 7). Several types of military and a couple of civilian radar altimeter systems have been operating in parts of this band for some time on a temporary basis. Then in 1970 the aviation and electronics industries were granted authority to a band between 1,592.5 and 1,622.6 MHz for eventual use by airborne collision-avoidance systems. Vigorous development is now underway on at least two competing approaches [*Electronics*, Dec. 20, p. 69].

To further squeeze the original navigation band, last year's Space Conference in Geneva, among its other activities, revised the international rules to make room for mobile satellite services. The FAA's Aerosat system [*Electronics*, Feb. 28, p.38] and the Maritime Administration's Marsat system [*Electronics*, March 27, p. 68] have already been proposed to use these bands. The satellite systems have been proposed for experimental development, with operational status in these services not expected until the 1980s.

All this activity in the 1,600-MHz band prompted the Office of Telecommunications Policy, with technical support from Department of Commerce's Institute for Telecommunication Sciences, to begin a study of possible interference modes between these systems. Both measured data and results obtained from mathematical models are now being analyzed.

Among the more significant interference modes, according to Raymond D. Jennings, project engineer at the Institute's Boulder, Colo., laboratories, are the effect of the higher-power pulsed-type altimeters on collision-avoidance systems, and the effect of a Marsat shipboard transmitter on both CAS and altimeters. As for an Aerosat transmitter, though it could cause interference to both altimeters and collision-avoidance systems that operate on the same aircraft, Jennings thinks that proper filtering techniques may be able to provide these systems with sufficient isolation.

There appears no easy solution to the dilemma at 1,600 MHz. After all of the technical facts are presented, a policy decision will have to made—in this case, by OTP and FCC. Radar altimeters have only temporary rights in this band, but the military estimates that it will cost it $60 million to move to other frequencies. Even though

The spectrum regulators

Worldwide, the allocation of radio frequencies is an important job of International Telecommunications Union (ITU), a regulatory agency of the United Nations. ITU's headquarters are in Geneva, Switzerland, and it has 141 member countries. From time to time it schedules conferences that serve as an international forum for negotiating and drafting rules for spectrum allocations. These rules become the Radio Regulations of the ITU and are, in effect, international treaty agreement between the member nations.

Within the ITU two permanent bodies are in charge of important aspects of spectrum management. The International Radio Consultative Committee (CCIR) uses information provided by member nations to develop recommended standards, practices and system planning. The International Frequency Registration Board (IFRB) examines and registers those frequency assignments of which it is notified by the ITU members.

Each ITU member undertakes to license specific service assignments within its borders in accordance with the international guidelines. In the U.S., two organizations share this responsibility: the Federal Communications Commission (FCC), and the White House Office of Telecommunications Policy (OTP).

A regulatory and control agency responsible to Congress, the FCC makes the rules for the industrial, commercial, and consumer users of the spectrum. Internally, it is organized into bureaus responsible for each of the major service users (common-carriers, broadcasters, mobile-radio operators, etc.). In addition, the FCC Chief Engineer's office, backed by the Commission's laboratories in Laurel, Md., evaluates technical and frequency management problems common to all services.

The OTP allocates frequencies to the Department of Defense and other Federal Government agencies, and reports to the president under an executive order established in September, 1970. It controls the Interdepartment Radio Advisory Committee (IRAC), which represents the military services and each Federal Government agency that requires the use of spectrum. IRAC maintains a file of all frequency assignments within the Government sector and helps in the spectrum planning for the coordination among Government users. Other support for OTP comes from Department of Commerce's Office of Telecommunications which in turn includes technical assistance from its Institute for Telecommunication Sciences (ITS) located in Boulder, Colo.

Another major Government research and development organization is the Electromagnetic Compatibility Analysis Center (ECAC), a group with technical responsibility for analyzing spectrum compatibility problems within the military services. The Annapolis, Md., center has a staff of several hundred spectrum engineers, who are primarily involved in building a computerized data base and in generating spectrum analysis models.

Over and beyond the formal Government organizations that manage the spectrum are numerous associations and special-interest groups who provide the vital technical and marketing inputs necessary for a properly engineered spectrum.

The Electronic Industries Association (EIA), for example, in addition to developing technical standards and market data and distributing them to electronics manufacturers, also collates the views of its members on spectrum usage and presents them to the appropriate legislative bodies. On the technological level, in cooperation with the Institute of Electrical and Electronics Engineers (IEEE), it has formed a Joint Technical Advisory Council (JTAC) to "respond to the urgent need for unbiased technical evaluation of problems concerning the utilization and conservation of the radio spectrum." JTAC has published a number of reports on spectrum utilization, among them its 2,000-page "Spectrum Engineering—The Key to Progress," in 1968.

these units are being slowly phased out, this still leaves the interference problems between CAS and the mobile satellite systems to be resolved. OTP is awaiting final inputs of the technical evaluation, and a decision from the FAA on what kind of collision-avoidance system will be used.

The CATV/air-traffic control issue

Other potential compatibility problems exist between aeronautical navigation services and the cable television industry. For example, while the FAA operates vhf omnirange and other aircraft navigation systems in the bands from 108–118 MHz, cablecasters also have a need for these frequencies in some of their broadband coaxial links. According to Bill Hawthorne, frequency coordinator at the FAA, "the Administration is concerned that when cablecasters operate systems that transmit in the 108–118-MHz band, a broken overhead cable might radiate signals that would be hazardous to aircraft."

The National Cable Television Association acknowledges the potential dangers. Delmer Ports, NCTA's chief engineer, says that present 12-channel cable systems use only the vhf television broadcast frequencies. "But to meet new FCC rules, which require a minimum of 20 channels to be furnished on CATV in the top 100 U.S. markets, it is convenient to use the 108–118-MHz band," says Ports. "And when more than 20 channels are added, it becomes almost necessary to transmit in the FAA bands."

To get an accurate measure of the magnitude of the potential interference problem, the FAA and NCTA are supplying the Department of Commerce's Institute for Telecommunications Sciences, Boulder, Colo., with equipment to make field tests. If these tests show that a potential danger exists, it may become necessary for cablecasters to bury their cable when operating in the vicinity of airports and remote FAA facilities, where accidental radiation would be most hazardous. Alternatives are to install open- or short-circuit detectors in the cable system that would automatically turn it off when a malfunction is detected, or to take measures to make aircraft navigation systems less susceptible to interference.

9. Tested. Emissions from a growing number of accidental radiators such as microwave ovens, diathermy equipment and ignition systems must be shielded to minimize interference with communications receivers. R-f sources must be frequency-stabilized within the bands reserved for industrial, scientific, and medical (ISM) purposes

Space and other services

The arrival of the communications satellite, while certainly the most important technological development in the last decade to have impact on the frequency spectrum, unfortunately occurred after virtually all usable spectrum had already been allocated to terrestrial services. Yet from launch until retirement, satellites are completely dependent on the use of radio frequencies; their operational status is telemetered to earth, and their positions are controlled by radio from earth; and more significantly, in terms of bandwidth used, the services performed by satellites are inherently accomplished through the use of the frequency spectrum.

This conflict forced a complete re-evaluation of worldwide telecommunications services in 1963, and culminated with the World Administrative Radio Conference in Geneva last year. At that conference, satellite allocations were defined that parallel those of long-established terrestrial services. Thus, broadcast from space is defined as a Broadcasting-Satellite Service, while the use of satellites for the relay of point-to-point microwave is defined as a Fixed Satellite Service, etc. But the Geneva conference did, in addition, identify and provide for four unique Satellite Services. They are:

- Space Research, involving the use of spacecraft for scientific purposes.
- Earth Exploration, in which information relating to the earth's characteristics, such as weather or crop conditions, is obtained from instruments on earth satellites.
- Space Operations, having to do with operation of spacecraft such as the tracking, telemetry, and control.
- An Intersatellite service, for linking satellites.

While the 1971 Space Conference opened some large millimeter-wave bands for exclusive use by satellite services, the more usable satellite bands today are shared with fixed terrestrial services.

A unique service

Almost the last of the services to be discussed here—the use of the frequency spectrum by radio astronomers—is quite different from the others in several ways. First, the astronomer does not radiate energy into the spectrum, but must have a spectral region void of man-made activity to enable him to receive minute signals from space. Also, the radio astronomy service must usually be justified on strictly scientific grounds, even though the technologies developed and discoveries made are often applied to more down-to-earth needs.

Radio telescope measurements of celestial bodies reveal characteristics quite different from optical pictures. Also, because of the properties of radio sources in the galaxies, each frequency permits a unique look into space. Because of this uniqueness of each radio frequency, spectrum managers have reserved small segments at regular intervals from 20 MHz to over 200 GHz for radio astronomy use.

Finally, there has to be some way of coping with the

uncountable types of electronic devices which may radiate sufficient energy to be potential spectrum polluters. They include such things as microwave ovens, medical diathermy equipment, automobile ignition systems, cordless microphones, automatic garage-door openers, and an increasing number of electronic games.

Spectral radiation from most of these gadgets is controlled through FCC rules and regulations. Part 15 of the rules applies to very-low-power devices used for communications, or to equipment where radiation is an undesired byproduct of its operation. An FCC license is not required to operate these devices, but its manufacturer must gain certification from the commission.

Part 18 of the rules applies to industrial, scientific and medical devices, which are intentional rf generators but do not involve the use of radio receivers. Such equipment often generates very high rf power levels for bulk heating. To prevent these radiators from interfering with sensitive communications receivers, several small segments of the spectrum have been set aside for them. The equipment used in these bands must meet FCC requirements to ensure that minimum stability and out-of-band signal-level standards are followed.

Future trends and issues

This glimpse at the problems besetting each major service segment has pointed up the areas in need of immediate attention. And the question at once arises: what can be done to handle things better in the future? Undoubtedly, some of these problems would not be as critical today if spectrum managers of the past had had the tools to plan further into the future and been able to react faster when interference situations arose.

Consequently, the building of data files and analytic capabilities is central to all programs aimed at avoiding future problems. And promising techniques such as modulation and operation at higher frequencies, as well as management concepts such as selling or renting spectrum, must also be explored.

Building a data base

Virtually every spectrum utilization study performed so far concludes that the most effective way to wage war on spectrum congestion is through the use of a comprehensive data base and advanced analytical techniques. It is through the use of an expanded data base that the recently created Chicago task force expects to improve control of the spectrum allocated to land-mobile radio (p. 86). And the building of comprehensive data files is an essential part of the proposals for solving point-to-point microwave congestion problems (p. 91).

The organization with the most experience in accumulating and analyzing such information is the Electromagnetic Compatibility Analysis Center (ECAC) in Annapolis, Md. The center is managed for the Department of Defense by the U.S. Air Force.

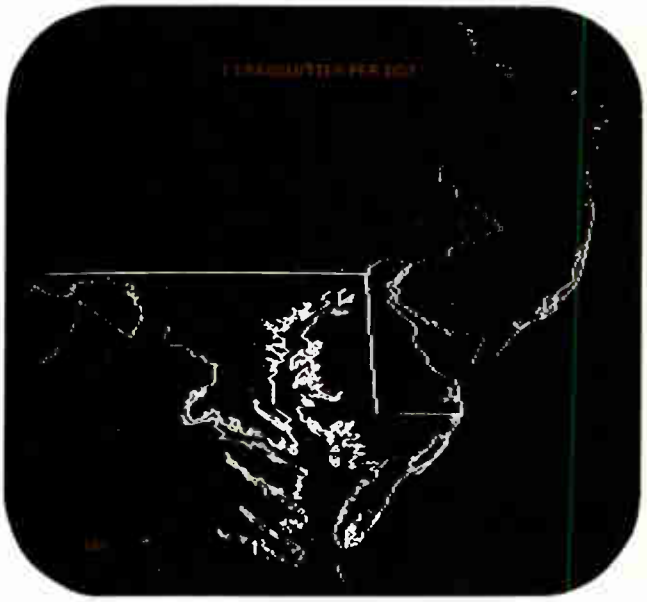
The ECAC computerized data base includes extensive information on electronic equipment characteristics (spectrum signatures) and locations. It contains data on:

- 136,000 communications and radar equipments operated by the military.
- 117,500 equipments operated by the FAA and other Government agencies.
- 600,000 transmitters licensed through the FCC.
- 15,000 other systems.

In addition, ECAC's files record topographic data showing terrain elevation points at approximately half-mile intervals for some 2.8 million square miles of the earth's surface. This data assists in the engineering of line-of-sight communications paths and determining radar coverage.

To accommodate such an extensive data base, the Center uses a Univac 1108 with over 100 million 36-bit words of random-access storage. And to make use of this information in the solution of interference problems, the Center maintains hundreds of programs of mathematical models—among them a Site Analysis

10. Equipment density. By accessing ECAC's extensive files, a CRT terminal can obtain a map of the density of radio transmitters assigned within specified band limits. Progessively smaller geographic regions can be requested until ultimately a printout of each station in the data bank is identified by equipment characteristics.



Model, which provides an automated means of interrogating the topographic data base to locate blind spots in a radar system's field of vision; a Receiver Selectivity Routine which synthesizes receivers' selectivity curves from their normal characteristics documented in the data base; and the Spectrum Occupancy Display program, which obtains a count of the number of equipments which are assigned frequencies within a given channel increment in a specified geographic area (Fig. 10). According to ECAC, this last computer program may in the future make use of data files based on inputs from the FCC and the International Telecommunications Union in Geneva.

Modulation techniques

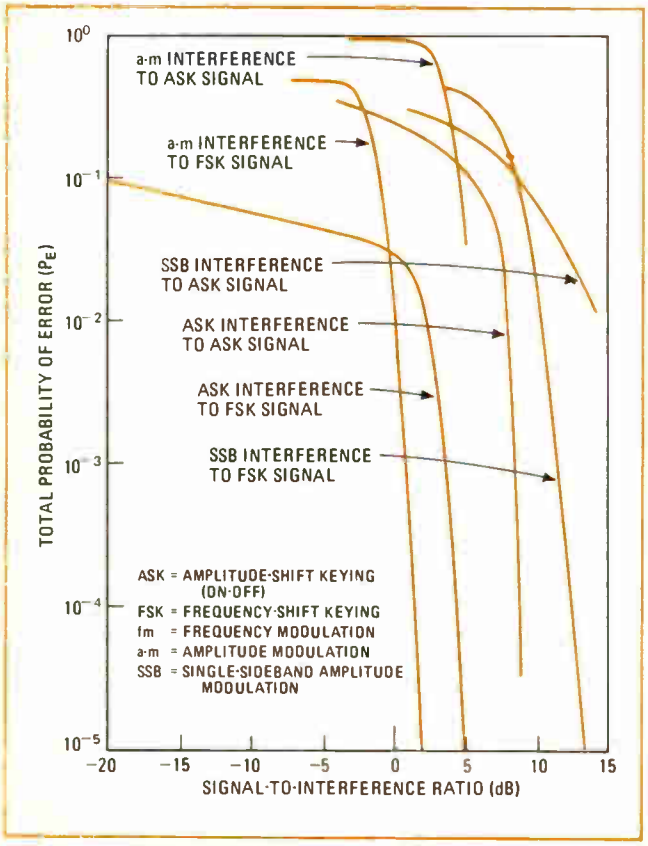
The type of modulation chosen for a communications system has long been dictated by spectrum usage considerations. Bandwidth required for double-sideband amplitude modulation, for example, is equal to twice the highest modulating signal frequency. That is why many radio rules are being changed to force the use of single-sideband modulation, which produces the same quality of service for only about half as much bandwidth. Frequency (or phase) modulation, on the other hand, theoretically requires infinite bandwidth. But by increasing power in practical fm systems, modulation bandwidths can be reduced to tolerable limits.

With the increasing use of radio communications to link computer systems, however, noise immunity has become absolutely central to the evaluation of transmission efficiency—and therefore spectrum efficiency. An error-free data link is essential to ensure that excessive time and spectrum are not wasted by retransmission of corrected data.

To provide guidelines showing what types of modulation are least susceptible to errors caused by other interfering signals, and what types of modulation cause the greatest degradation in other systems, engineers at the Electromagnetic Compatibility Analysis Center have related error probabilities to signal-to-interference levels for a number of digital modulation schemes (Fig. 11). Summarizing the results of the investigation, Robert J. Mayher, senior engineer at ECAC, points out that over a wide range of interference conditions, there is a sharp drop in the error rate in a digital transmission system once the signal-to-interference ratio gets above 10–15 dB. This is a much lower ratio than that generally required for analog systems.

Spectrum for rent?

The electromagnetic spectrum is indeed a resource of great economic and social value. But unlike land, oil, and many other resources, authorized spectrum users have no proprietary or leased rights to their resource,



11. Digital modulation tradeoffs. In digital transmission, there is a sharp drop in error rate when the signal-to-interference ratio gets above 10 dB. Notice that single-sideband-modulated interference signals cause the greatest degradation to other systems, while the frequency-shift-keyed signal appears least susceptible to interference from other systems.

12. Spectrum alternatives. For high-capacity communications between any two fixed points, buried and underwater cable, millimeter waveguides, and fiber optics promise feasible alternatives to the use of the radio waves in free space. These techniques either are in use or have reached advanced development stages.

and therefore cannot sell or rent any portion of their allocation. Spectrum users likewise do not pay for the portion of the resource they use, so they lack direct incentives to include the value of the resource in a communications system's cost-tradeoff analysis or to transfer their rights to others who value the spectrum more.

The fact that the law of supply and demand has worked in the management of other resources has stimulated U.S. authorities to consider applying it to the spectrum. The goal, according to Wilfrid Dean, assistant director of the Office of Telecommunications Policy, is to provide the spectrum user with economic incentives and hence a means for self-regulation. From the initial OTP look at the matter, Dean concludes that "economic constraints should be placed on spectrum users, and we are now evaluating further the idea of assessing a fee on spectrum use."

Any such OTP plan would apply only to Government users of the spectrum, however. The FCC has also at times considered concepts such as renting or leasing to non-Government users, but so far neither regulatory body has detailed how such a system might be implemented.

Alternatives to airwaves

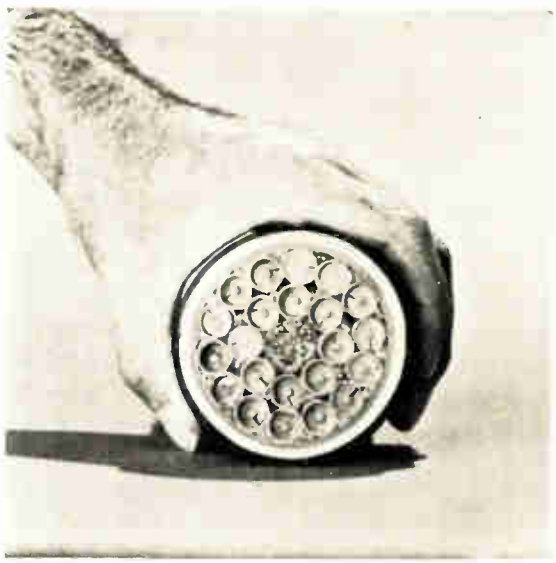
Advancing technology has given the engineer a means of squeezing added services into the crowded spectrum. Yet some segments of the spectrum are already saturated and the demand for new services continues unabated.

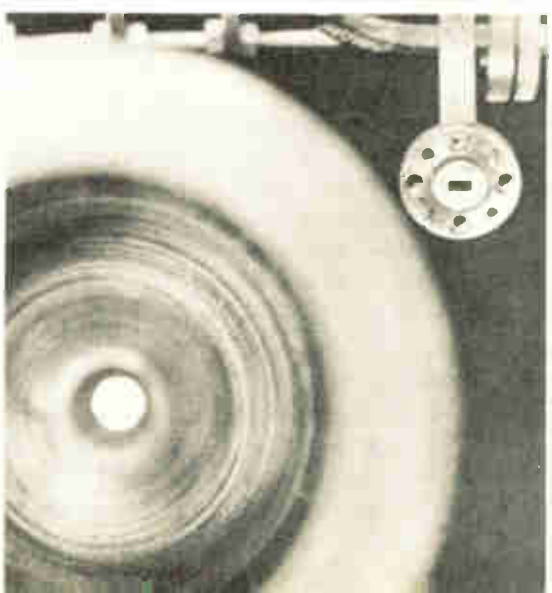
Advancing technology also, however, provides alternatives to the use of free-space transmission. The more promising of these alternatives include coaxial cable, fiber-optic "pipes," and millimeter waveguides, all of which lend themselves to high-capacity routes between fixed terminals. The chief inhibition to their development has been their high cost. But the force of this inhibition is weakening, as the need for alternatives to the use of spectrum space increases, and as the costs of some of these high-technology systems have already begun to drop.

Coaxial cables

Long-haul transmission facilities in the United States have grown at a steady rate of 15% per year for the last 20 years. At present, about one-third of these circuits are on coaxial cables and two-thirds on microwave radio. It is expected that the 15% over-all growth rate will continue past 1980, with an increasing portion of the circuits on coax.

A new long-haul coaxial system (designated L5 with a capacity of 90,000 two-way voice circuits) has been developed and tested at Bell Laboratories. The L5 system has two-and-a-half times the capacity and less than one-half the single-voice-channel cost of previous co-





axial systems, according to Bell. The first L5 system is being installed between Pittsburgh and St. Louis with commercial service scheduled for January 1974.

Underwater cable has since 1956 provided a very attractive substitute for the use of high-frequency radio circuits in transoceanic voice communications. It will continue to serve as a cost-effective alternative to international satellite links.

More radically, cable television (CATV) systems are very rapidly penetrating the commercial broadcast business. With a number of technical and political details still to be thrashed out, more advanced CATV concepts provide for two-way services such as home meter reading and shopping by TV [*Electronics*, May 8, p. 91].

Both technology and time seem to be working for the cablecaster, for the potential capacity of the wired-city is far in excess of today's radio and television broadcasters, and the cablecasters' demands on the spectrum resource are virtually zero.

Fiber optics

In the visible light spectrum alone the theoretical information bandwidth of glass optic fiber is about 3,000 times the total allocated radio spectrum below 300 GHz. But today's optical modulation technology limits practical lightguide operating bandwidths to the order of 100–200 MHz, states Robert Maurer, manager of applied physics research at Corning Glass Work's laboratories in Corning, N.Y.

Nevertheless, announcements this summer of advances in laser modulating techniques (*Electronics*, Aug. 28, p. 45) and the construction of a glass fiber with a loss of only 4 dB per kilometer in the visible light spectrum (*Electronics*, Sept. 11, p. 30) bring optical waveguide nearer to becoming a practical communications medium.

Millimeter waveguides

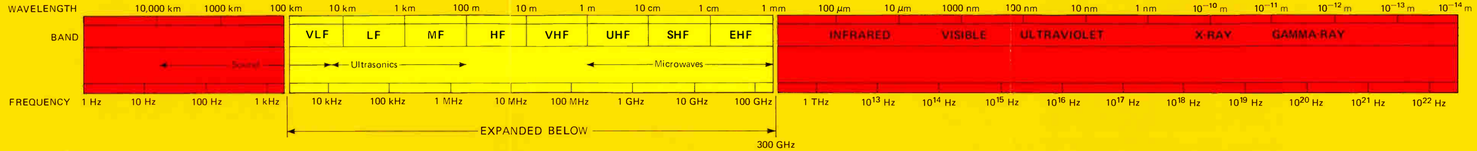
A final but very important spectrum conserving technology being developed would make use of buried pipe capable of carrying a quarter-million two-way voice conversations simultaneously. Potentially much cheaper than coax, millimeter waveguide is that much more attractive as a substitute for the spectrum resource.

Bell Laboratories is currently working on such a system, which would operate from 40 to 110 GHz. A manufacturable repeater for one of these systems, announced last year by Bell, uses Impatt oscillators in the transmitter (*Electronics*, Dec. 20, 1971, p. 22). Moreover, a 20-mile one-hop millimeter-waveguide system is now being constructed for a field evaluation scheduled in late 1974, adds Paul T. Hutchison, millimeter-waveguide project coordinator at Bell Labs, Holmdel, N.J.

AT&T is projecting commercial operation for the first millimeter waveguide link in 1978 between New York and Philadelphia, and plans 14 additional systems by 1985. Cost for millimeter waveguide transmission, according to the company, will be about $1 per circuit mile, compared with a $3.75 figure for the present L4 coaxial system. □

Electronics

ELECTROMAGNETIC SPECTRUM



1. The radio spectrum is divided into bands allocated for broad services defined by the International Telecommunications Union. While consistent with worldwide assignments, the chart applies specifically to services and subservices for users within the United States.

2. Included are the provisions of the 1971 World Administrative Radio Conference held in Geneva. The new services become effective on Jan. 1, 1973.

3. R indicates an aeronautical radio band reserved for aircraft flying major air routes. OR bands are used for "off-route" service. In the United States, OR bands designate military users, and R bands apply to civil users.

4. For detailed regulations concerning emission into the radio spectrum, consult official documents of the country of interest. In the U.S., this information is contained in the Rules and Regulations of the Federal Communications Commission. The rules are available on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription for the 10-volume series costs $42.25 and includes basic loose-leaf volumes, plus all amendments, which are mailed when issued. Each volume can also be purchased separately. An index showing costs and major topics of each volume is also available.

Radio Regulations prescribed by the International Telecommunications Union, which all member nations must follow, can be obtained in a loose-leaf edition for $17.00 or 64.50 Swiss francs. Order from the ITU General Secretariat, Place des Nations, 1211 Geneva 20, Switzerland. Copies are also available from the United Nations headquarters in New York.

VLF

3 kHz–30 kHz
(100 →10 km)

LF

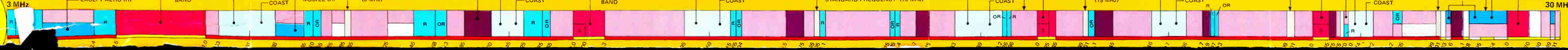
30–300 kHz
(10 →1 km)

MF

300 kHz–3 MHz
(1000 →100 m)

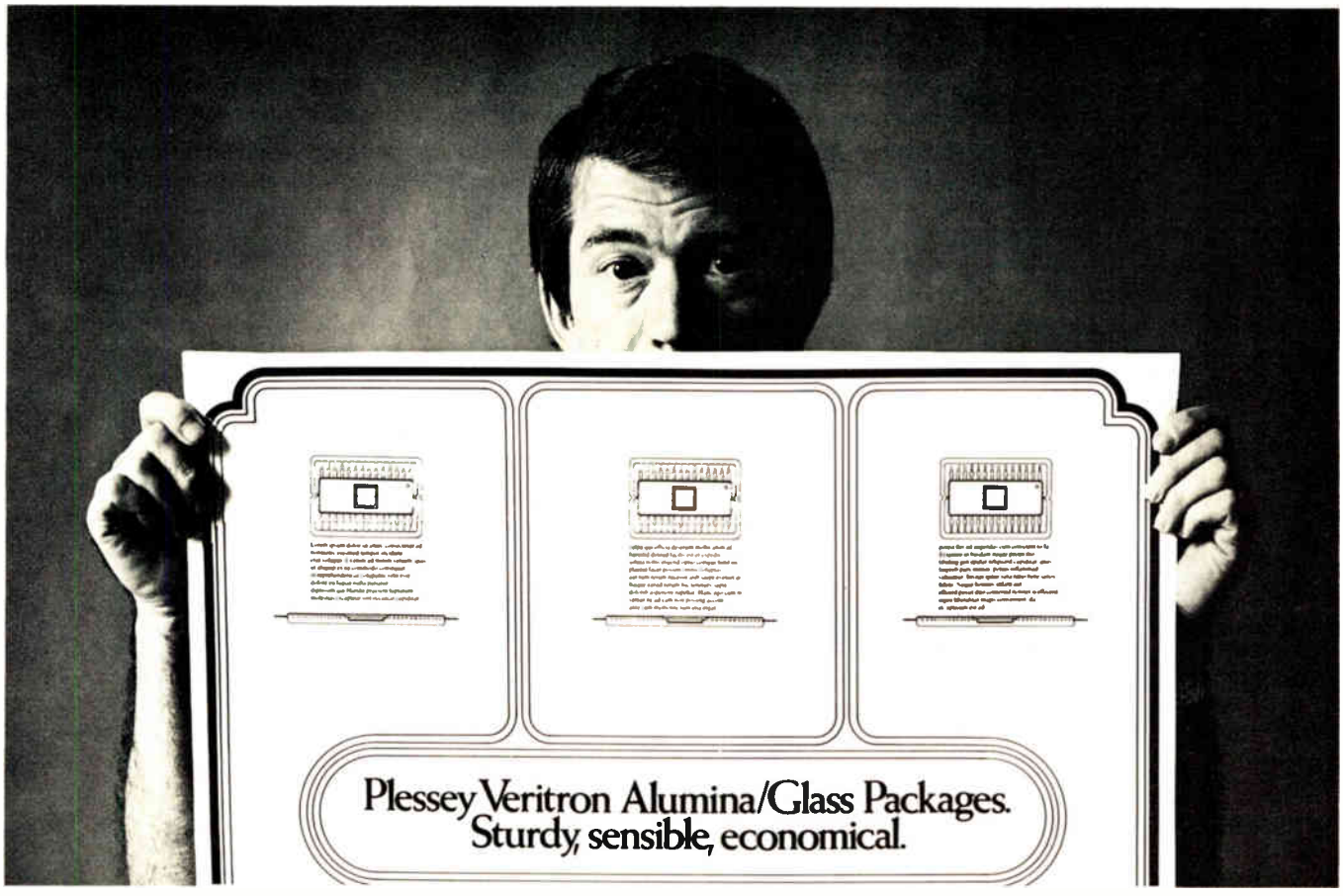
HF

3–30 MHz




VHF
30–300 MHz
(10 →1 m)
30 MHz
300 MHz
SHARED WITH RADIO ASTRONOMY
ISM (40.68 ± 0.02 MHz)
AMATEUR 6-METER BAND
ALSO CITIZENS BAND CLASS C (REMOTE-CONTROL MODELS)
VHF TELEVISION CHANNELS
MARKER BEACONS (75 MHz)
VHF TELEVISION CHANNELS
FM BROADCAST (100 CHANNELS SPACED 200 kHz APART)
VOR
PRIVATE AIRCRAFT
EMERGENCY 121.5
AIR-TRAFFIC CONTROL
FLYING SCHOOL
AIR-TRAFFIC CONTROL
AMATEUR 2-METER BAND
RECREATIONAL BOATS
ALSO SPACE TELECOMMAND
ALSO GOVERNMENT (157.0375 – 157.1875 MHz)
ALSO NON-GOV'T FIXED AND LAND MOBILE (173.2 – 173.4 MHz)
VHF TELEVISON CHANNELS 7–13
NON-GOVERNMENT TELEMETRY
CITIZENS BAND CLASS E PROPOSAL
EMERGENCY AIRCRAFT SURVIVAL (243 MHz)
UHF
300 MHz–3 GHz
(1000 →100 mm)
300 MHz
3 GHz
PROPOSED COAST GUARD HARBOR NAVIGATION
ILS GLIDESLOPE
ALSO SPACE OPERATIONS (401–402 MHz)
STANDARD FREQUENCY SATELLITE ONLY
METEOROLOGICAL SATELLITE (406 – 406.1)
BIOMEDICAL TELEMETRY (8 CHANNELS EFFECTIVE MAY, 1972)
CITIZENS BAND CLASS A (16 CHANNELS)
LAND MOBILE ALLOWED ON BOTTOM SEVEN UHF TV CHANNELS IN TOP TEN URBAN AREAS IN U.S.
UHF TELEVISION
COMMON-CARRIER MOBILE SYSTEMS (ALSO UHF TV TRANSLATORS ON INTERIM BASES)
PRIVATE SYSTEMS
ISM (915 ±13 MHz)
STUDIO-TO-TRANSMITTER LINK
PRIVATE FIXED
TACAN/DME
1030 MHz
1090 MHz
AIR-TRAFFIC-CONTROL RADAR BEACONS
AIR ROUTE SURVEILLANCE RADAR
HYDROGEN LINE
ALSO SPACE OPERATIONS
AERONAUTICAL TELEMETERING
PROPOSED MULTIPOINT DISTRIBUTION SYSTEM (2150–2162 MHz)
ISM (2450 ± 50 MHz, MICROWAVE OVENS)
AIRPORT SURVEILLANCE RADAR
SHF
3–30 GHz
(100 →10 mm)
3 GHz
30 GHz
COMMON-CARRIER MICROWAVE RELAY
INTELSAT IV DOWNLINK
RADIO ALTIMETER
PROPOSED INTERNATIONAL MICROWAVE LANDING SYSTEM
AEROSAT (GROUND/SATELLITE)
ISM (5800 ± 75 MHz)
INTELSAT IV UPLINK
COMMON-CARRIER MICROWAVE RELAY
ALSO SPACE RESEARCH DOWNLINK (7145–7235)
AIRBORNE DOPPLER RADAR(8.8 GHz)
PRECISION APPROACH RADAR
AIRBORNE DOPPLER RADAR
PROPOSED INT'L MICROWAVE LANDING SYSTEM (TO TOUCHDOWN)
AEROSAT (SATELLITE TO AIRCRAFT)
AEROSAT (AIRCRAFT TO GROUND)
PROPOSED COLLISION-AVOIDANCE SYSTEMS
RADAR ALTIMETERS
WATER RESONANCE (22.235 GHz)
ISM 24125 ±125 MHz
EHF
30–300 GHz
(10→1 mm)
30 GHz
300 GHz
NOT ALLOCATED
PASSIVE
OXYGEN RESONANCE (60 GHz)
MOBILE
AERO MOBILE
MARITIME MOBILE
LAND MOBILE
RADIONAVIGATION
AERO RADIONAVIGATION
MARITIME RADIONAVIGATION
RADIOLOCATION (RADAR)
SPACE RESEARCH SATELLITE
EARTH EXPLORATION SATELLITE
INTER-SATELLITE SERVICE
BROADCAST
AMATEUR
FIXED
RADIO ASTRONOMY
STANDARD FREQUENCY
METEOROLOGICAL AIDS
S SATELLITE ASSIGNMENTS
↑↓ UPLINK, DOWNLINK
GOVERNMENT
NON-GOVERNMENT
SHARED

We have this fantastic hang-up on alumina/glass packages.



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Logic circuit converts synchronous motor to stepper

by Michael D. Doering
Food and Drug Administration, Bureau of Radiological Health, Rockville, Md.

A simple circuit that is compatible with transistor-transistor-logic circuits can convert a two-coil synchronous motor to a synchronous stepping motor. Since circuits that perform this conversion are not available commercially, the designer is usually forced to use relays or come up with his own stepper control circuit.

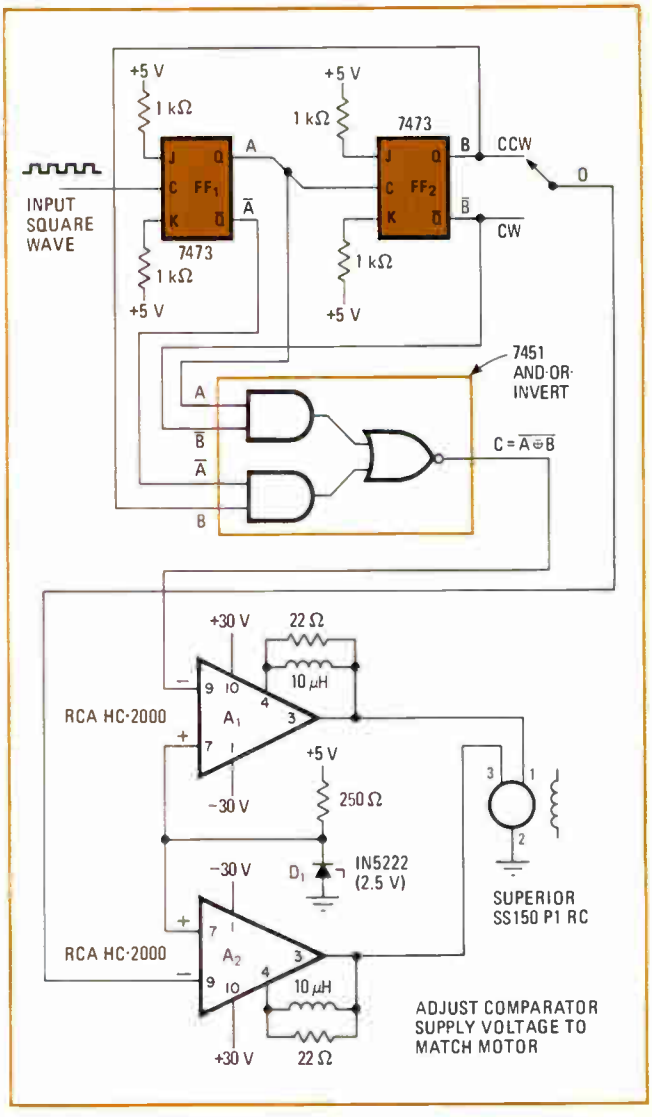
The problem of conversion generally arises when a variable-speed synchronous motor is needed that is capable of delivering up to 1,800 inch-ounces of torque, or when a variable-speed adaptor is required for a motor that is already installed. The converter, therefore, must be a high-current, high-voltage, variable-frequency circuit that can drive a two-phase 115-volt ac motor.

A variable-frequency square wave, which can be supplied by TTL integrated circuits, drives the converter and establishes motor stepping speed. Motor-speed accuracy depends on how accurate the input square-wave frequency is. The size of the step and the maximum stepping speed are determined by the motor used.

Flip-flops FF_1 and FF_2 are connected as a repeating two-bit counter, which has its output decoded by an AND-OR-INVERT circuit. This arrangement provides the four states, which are noted as A, B, C, and D in the diagram, needed to make the motor step properly.

The position of the switch at the output of FF_2 determines the direction of rotation. As can be seen from the figure, the D state simply represents the switch-selected B or $\bar{B}$ states.

Output states C and D are fed to the inverting inputs of high-power comparators A_1 and A_2, respectively. The voltage levels of these two states are then compared to the reference voltage established by the 5-v supply and zener diode D_1. Each comparator drives a separate motor coil and can develop a 75-v 100-watt output. □



Stepping a synchronous motor. Logic circuit plus high-power comparators step two-phase synchronous motor in clockwise or counterclockwise direction. Frequency of input square wave determines motor stepping speed. Two-bit counter formed by flip-flop pair and AND-OR-INVERT circuit produce four logic outputs (A, B, C, and D) that control motor. Each comparator output supplies one motor coil.

Ring counter eliminates false gating signals

by Glen Hamilton
Dickson, Tenn.

A ring counter that performs reliably at speeds up to 7 megahertz can be designed to prevent counting errors caused by false gating signals. Besides being able to clock in either direction (up or down), the counter can be reset from any ring output without losing a clock pulse. Only five dual in-line integrated-circuit packages are needed—a binary counter, a quad latch, a quad NAND gate, and two BCD-to-decimal decoders.

When the input clock pulse rises to logic 1, the binary counter is incremented up or down, depending on the position of switch S_1. The unused clock input to the binary counter must be held continuously at logic 1. For most applications, switch S_1 can be eliminated because only one clock direction is required. To switch between the two clock inputs, two gates must be added so that

the unused connection is always held at logic 1.

With the transition of the input clock pulse from logic 1 to logic 0, the binary counter outputs are loaded into the latches. The next clock pulse enables the NAND gates, allowing the $\bar{Q}$ signals from the latches to pass to the decoders, which then select the appropriate ring output to be enabled. Each succeeding clock pulse sequentially steps and enables the decoder outputs.

The number of stages in the ring is determined by the ring output at which switch S_2 is placed to implement the reset function. When the ring output tapped by switch S_2 is enabled, the binary counter is set to the number appearing at its preset input lines. These preset inputs can be either hardwired or made selectable.

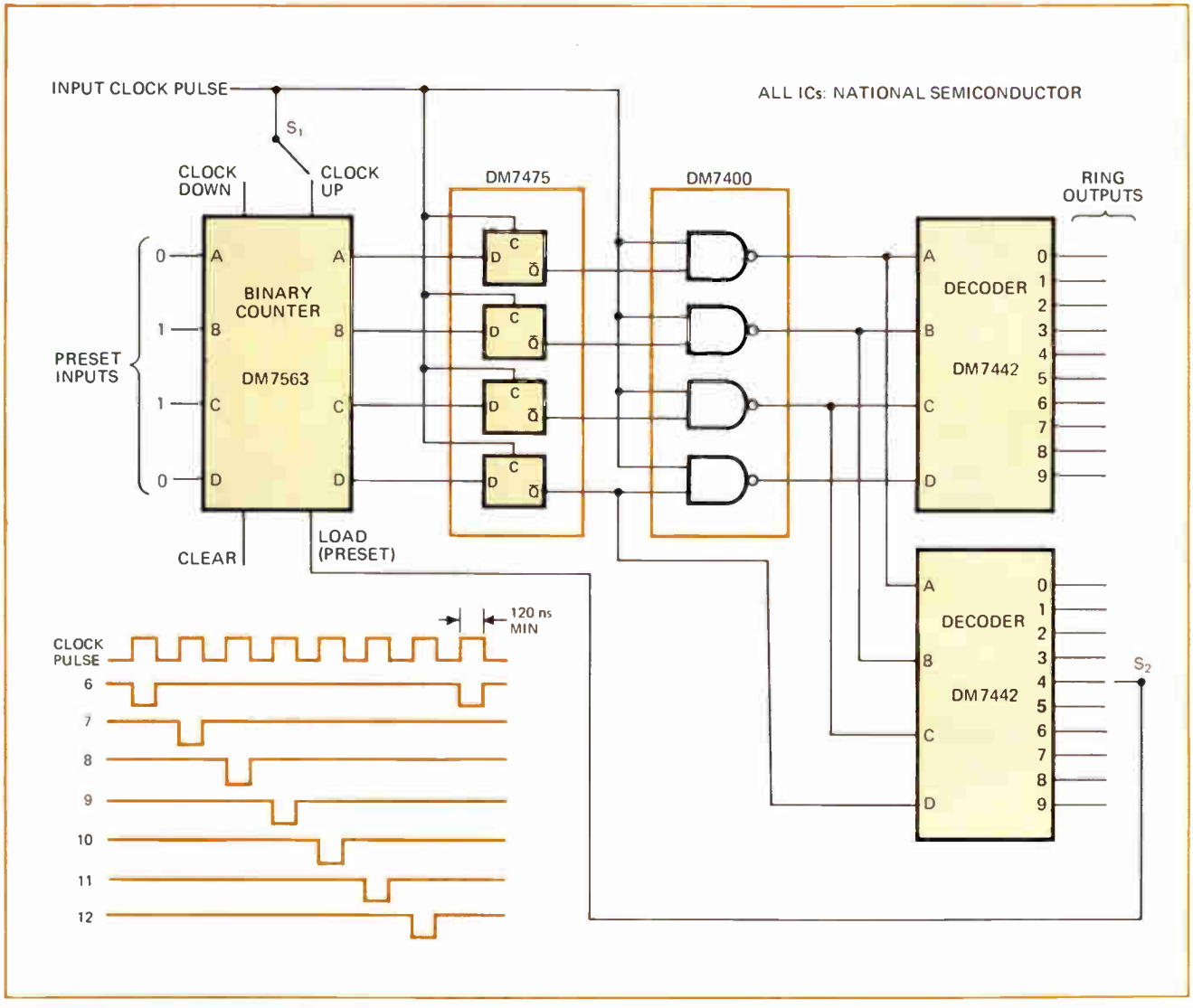
For the wiring connections shown, the binary counter has the binary number six continuously held at its preset inputs, and the ring counter's reset function is placed at the fourth output line of the second decoder. This hookup resets the binary counter to six each time the twelfth ring output is enabled, causing the ring counter to step sequentially from six to 12 and then repeat, as indicated by the waveforms in the timing diagram.

All ring outputs are disabled (in the logic 1 state) when the input clock pulse is logic 0. During this time, the ring outputs are inhibited by the NAND gates to prevent false gating due to transients. Also, all ring outputs are always 180° out of phase with the input clock pulse, and a transition from logic 1 to logic 0 is required to reset the ring counter. This means that the ring counter will be reset only when the ring output selected by switch S_2 is enabled (in the logic 0 state).

The circuit can also be used as a frequency divider that has its output pulse frequency determined by the width of the input clock pulse. Any integral divisor, from 2 to 15, can easily be selected by switch S_2. The divided frequency may be taken from any of the ring outputs.

The binary counter is provided with CARRY TO and BORROW FROM pins, permitting counters to be cascaded for generating more than 15 outputs. With two binary counters, up to 256 outputs can be produced, as long as an appropriate number of decoders is used. □

Sure-clocking ring counter. Input clock pulses sequentially step data through binary counter to latches (flip-flops) to NAND gates to BCD-to-decimal decoders. Switch S_1 permits clocking up or down, while switch S_2 selects number of stages in ring. S_2 also carries reset signal that sets binary counter to its preset input number. Counting proceeds only for clock transition from logic 0 to logic 1.



Complementary output stage improves op-amp response

by Robert Gagnon and Richard Karwoski
Raytheon Co., Equipment division, Sudbury, Mass.

The performance of a conventional 741-type operational amplifier can be considerably enhanced if it's given a complementary-transistor output stage. The op amp's gain-bandwidth product is extended from its normal 1 megahertz to 7.5 MHz for a 250-ohm load resistor, while slew rate is increased from 0.5 to 5 volts/microsecond. Similarly, the full-power bandwidth reaches 50 kilohertz, as opposed to 15 kHz, and the bandwidth at a voltage gain of −2 becomes 2.5 MHz, rather than 330 kHz.

The output stage (a), which contains transistors Q_1 and Q_2, acts as a current buffer, providing extra load drive capability. It is basically a bootstrap configuration using degenerative feedback. Transistor Q_2 is the principal source of load current, and the stage's dynamic input impedance is the product of the load resistance and the current amplification factors of both Q_1 and Q_2.

The two outboarded transistors form two complementary pairs with the output transistors inside the op amp—outboarded transistor Q_1 complements internal transistor Q_3, while Q_2 complements Q_4. This configuration (b) makes it possible to keep voltage gain independent of output load conditions and to be determined by a resistance ratio:

$$e_o/e_i = R_2/R_1$$

where R_1 is the load resistance for the op amp, and R_2 is the input resistor to the output stage.

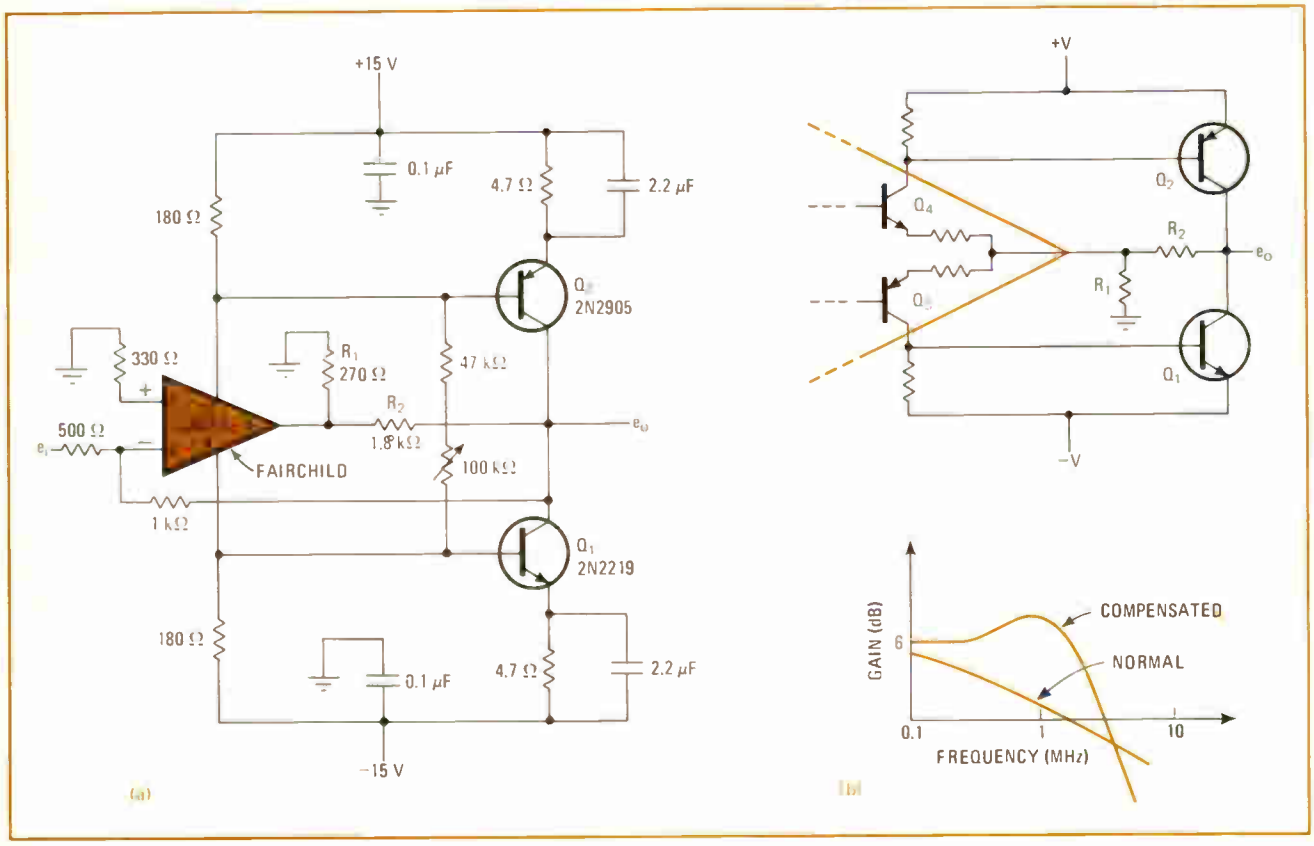
If $R_2/R_1 = 10$, the op amp output voltage swing need only be ±1 V to realize a circuit output voltage swing of ±10 V. In practice, a resistance ratio of 6.7, with $R_1 = 270$ ohms, yields the best over-all results because of how the op amp responds to this load resistance value.

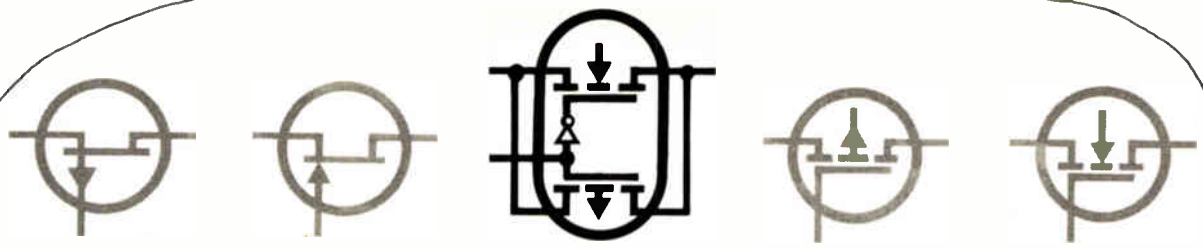
For a load resistance of around 300 ohms, the op amp's maximum output voltage swing is reduced by about 30%, but its slew rate remains approximately 0.5 V/μs for small voltage excursions. By fixing the gain of the output stage at about 10, the slew rate of the over-all circuit is increased by a factor of 10, and the op amp's frequency response is extended.

Undesirable high-order effects of the 741-type op amp are far enough beyond its nominal 1-MHz crossover frequency that instability due to the gain added by the output stage is not a problem. A 100-kilohm cermet potentiometer is included in the circuit to permit cancellation of crossover effects. It should be adjusted at the full-power bandwidth limit—50 kHz and a maximum output voltage of 20 V peak-to-peak. □

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

Boosting op amp performance. Output stage (a) multiplies op amp slew rate by 10 and extends crossover frequency to 7.5 megahertz. As shown in (b), external transistors Q_1 and Q_2 complement internal transistors Q_3 and Q_4, respectively. Resistor R_1 acts as op amp load resistance so that resistance ratio R_2/R_1 fixes overall circuit gain. Additional gain lets op amp operate at low output voltage.





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- ±15 V Analog signal range
- Break-before-make switches
- ON resistance <500 ohms
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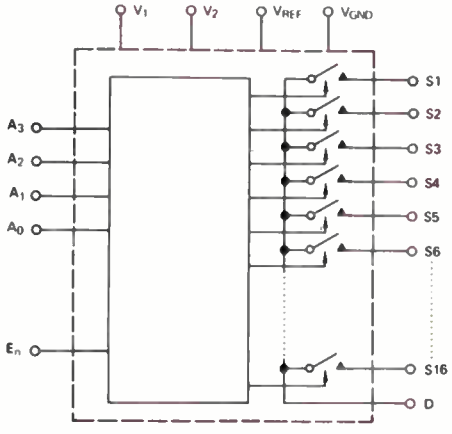
DG506 Function Diagram



Decode Truth Table

A_3	A_2	A_1	A_0	E_n	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

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Silicon-on-sapphire substrates overcome MOS limitations

When grown on a film of silicon overlying a sapphire chip, depletion-mode devices can be so effectively isolated that the MOS process is made to yield bipolar performance

by A. Karl Rapp and Edward C. Ross, *Inselek Inc., Princeton, N.J.*

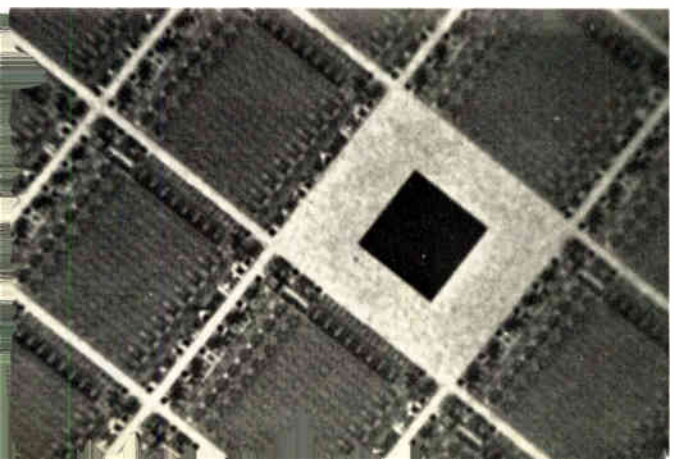
☐ A new family of devices may well be destined to fill the awkward gap between the inexpensive but slow MOS and the fast but costly bipolar technologies. Tests of silicon-on-sapphire substrates show they outperform—yet are just as reliable as—conventional bulk-silicon substrates when used as the basis for MOS devices. And, when topped with complementary deep-depletion-mode as well as enhancement-mode devices, SOS chips now coming off the production lines set still higher MOS performance standards.

For example, an SOS eight-channel TTL-compatible analog multiplexer is 10 times faster (50 ns channel-to-channel) than previous MOS devices. The 50-ns access time for an SOS 64-bit static random-access memory puts it in a class with many bipolar RAMs though it uses 10 times less power. Moreover, a 1,024-bit RAM in prototype production achieves the lowest propagation-delay power product of any RAM. Finally, SOS 256-bit shift registers have 10 times the speed of comparable static registers—and all their inputs are TTL-compatible.

MOS and bipolar manufacturers have not ignored the gap between them. The former have developed dynamic circuits and silicon-gate and n-channel processes, while the latter have to a degree enhanced circuit density and lowered cost by increasing the sophistication of their processing techniques.

However, neither has been wholly successful. With MOS, the use of dynamic circuits to achieve high speeds introduces problems of timing and control of high-voltage fast-rise-time clock pulses. With bipolars, because charges move through the material instead of over the surface, there's large inherent power dissipation.

MOS that does more. Silicon-on-sapphire MOS circuits can achieve bipolar speeds. SOS shift registers and analog multiplexers are in production, as are static RAMs like the 256-bit devices on this wafer. Metal cube (seen as black square) is registration guide for masks.



What's needed is a technology capable of fabricating circuits that are static (need no clocks) and TTL-compatible, that exhibit bipolar speeds in the 30- to 50-ns range but with sharply reduced power dissipation, and that retain the attractive economies of MOS fabrication. All this is achieved by silicon-on-sapphire technology.

How it happened

SOS MOS technology evolved naturally out of the conventional bulk-silicon approach. Bulk MOS devices are fabricated in virtually a semi-infinite solid (when the thickness of the starting silicon wafer is compared to device-diffusion lengths), but almost all of the action of any consequence takes place at the silicon surface. In addition, while the silicon in the device region is all-important, the silicon between devices degrades circuit performance and contributes to a reduction in yield by permitting field inversion and other failures to occur.

The simplest solution to bulk silicon limitations is to use a first-order approximation to a surface of silicon (i.e., a thin film) which can be dielectrically isolated as islands on an insulating substrate. Of the many approaches to realizing such a technology, the most successful has been SOS.

The starting material for SOS MOS technology is a substrate of single-crystal sapphire Al_2O_3 upon which a film of single-crystal silicon is epitaxially grown. The film is typically 1 micrometer thick and has a 1-0-0 orientation. The principal metallurgical, chemical and electrical properties of SOS films prove to be as good as or better than those of chemically or mechanically polished bulk silicon wafers.

The process

Starting with a silicon-on-sapphire wafer, the first step in building complementary SOS devices is to etch the silicon film from those areas of the wafer in which electrical devices will not be formed. These areas are the sapphire isolation regions that supply the high degree of electrical separation characteristic of SOS devices. The etch is accomplished through a silicon dioxide mask and leaves islands of silicon on the sapphire (Fig. 1a). A preferential etch insures that the edges of the islands are tapered, since this makes it easier to interconnect active areas reliably in the final structure.

The other process steps are relatively standard. A silicon-dioxide layer acts as a mask for n+ diffusions (Fig.

1b). Similarly, after stripping that layer, a second SiO_2 mask defines the p+ regions (Fig. 1c).

The p+ diffusion mask is then removed and a thick layer of SiO_2 is grown to reduce parasitic overlap capacitance from the gate and crossover (Fig. 1d). A channel-definition mask is used to remove the thick oxide from the channel regions of the transistors, and the active gate oxide is grown. Finally, contact holes are etched, and aluminum evaporated and defined in the usual fashion. The completed structures are shown in Fig. 1e.

From the processing steps outlined above, it should be apparent that, aside from the initial etching of the SOS film, the fabrication of SOS MOS devices uses traditional bulk silicon techniques and equipment. Consequently, standard process variations, such as silicon-gate technology, are readily adaptable to SOS.

Why it's better

The advantages SOS technology has are worth analyzing in detail. Because of the presence of good isolating sapphire, both p- and n-channel SOS transistors can be formed in a single layer of high-resistivity silicon, whereas bulk n-channel devices require critical doping procedures to insure stability. A level of interconnects is available in SOS devices that is free of the parasitic capcitance which exists between the active diffusions and the substrate of bulk-silicon devices.

Since there is no silicon between devices, there is no possibility of field inversion leakage in SOS devices. Since the n-type silicon between the source and drain regions of the transistors floats, there is no source-to-body effect and therefore no need to bias the substrate, as there are in bulk-silicon devices. And since diffusions expand through the film to its interface with the sapphire, there is virtually no junction capacitance in the SOS structure—junction capacitance is one of the major factors limiting the speed of bulk MOS devices.

Unlike an enhancement-mode p-channel MOS transistor fabricated on conventional silicon, one fabricated on SOS approaches an ideal square-law device. The reason, again, is absence of the source-to-body effect.

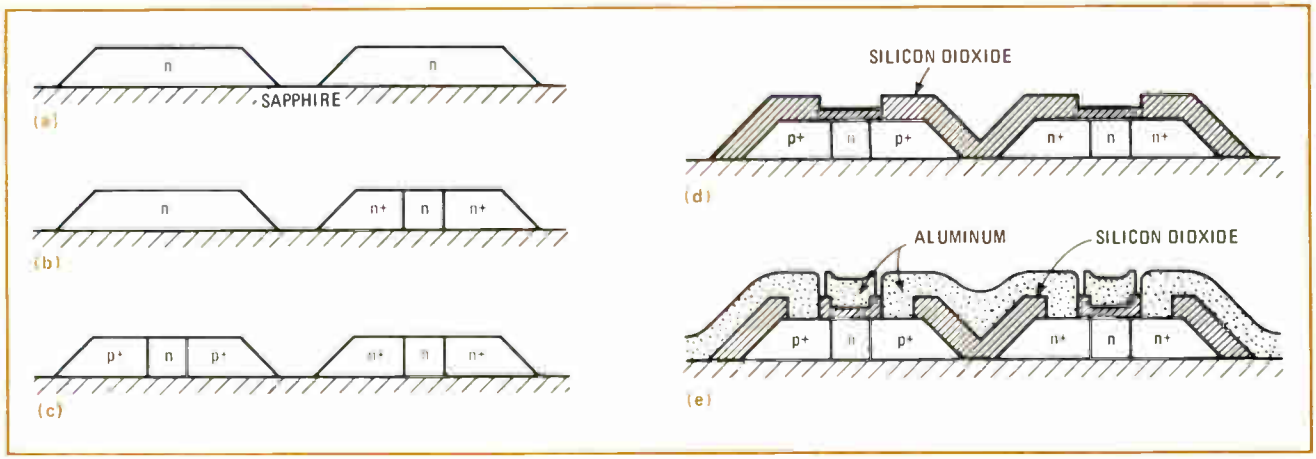
Finally, SOS MOS circuits can be laid out even more compactly than bulk MOS circuits. Once more, the principal reason for the large area savings in SOS is that the close proximity of adjacent silicon regions combines with a lack of concern that field inversion or depletion-layer punch-through may cause unwanted coupling across the sapphire, as it does in bulk silicon. Thus, future products, such as a 1,024-bit RAM will have significantly increased packing densities at significantly higher performance.

Because SOS technology uses proven MOS techniques and well-known silicon processes, SOS device parameters can be controlled as efficiently as existing bulk devices. One factor greatly affecting the quality of any semiconductor device is the nature of the interface between the active silicon island on the sapphire substrate and the silicon dioxide insulator above it. In turn, a measure of the quality of this silicon surface is the field-effect mobility of the current-carrying charges. By measuring the drain current as a function of gate voltage for small drain voltages, interface data can be obtained, and from knowledge of the physical device parameters the field-effect mobility can be calculated.

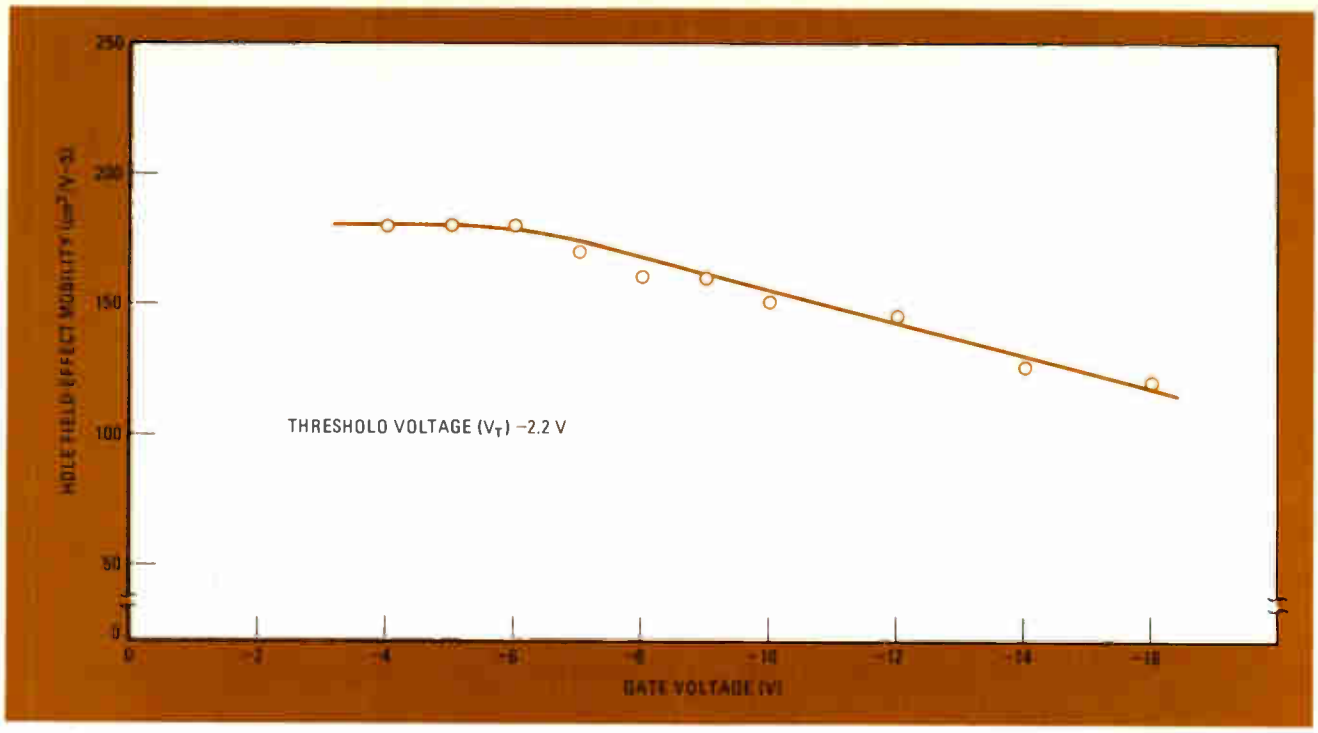
Typical results of such experiments are graphed in Fig. 2, which shows hole field-effect mobility as a function of gate voltage. These results are so close to those for bulk silicon that they indicate that the parameters associated with bulk MOS devices are equally applicable to SOS MOS devices.

Another important device characteristic is the consistency of threshold voltage, V_T. Both the uniformity of impurity concentration at the silicon surface and the control of fixed charge at the oxide interface affect the spread between threshold voltages of devices on the same chip. Test results for SOS MOS devices show that the oxide charge is in every way comparable to that of bulk-silicon devices, being routinely kept below 5×10^{10} charges per square centimeter on 1-0-0 silicon.

However, in terms of matching threshold voltages, SOS has a very distinct advantage. Not only is it relatively easy to obtain v_T matches in the 20–50-millivolt range, but a substantial portion of that distribution falls within a few millivolts. One important implication here is that differential amplifiers, heretofore nearly totally



1. Doping it out. Building complementary SOS memories starts with a selective etch of the silicon film on an n-type silicon-on-sapphire wafer, leaving active n-type silicon islands isolated by sapphire, as shown in (a). Diffusion for the required n+ and p+ regions (b and c) are made, and a thick layer of silicon dioxide is grown, after which a channel is etched over the gate and the active gate oxide is grown (d). The structure is completed when contact holes are etched through the oxide and aluminum contacts are evaporated on.

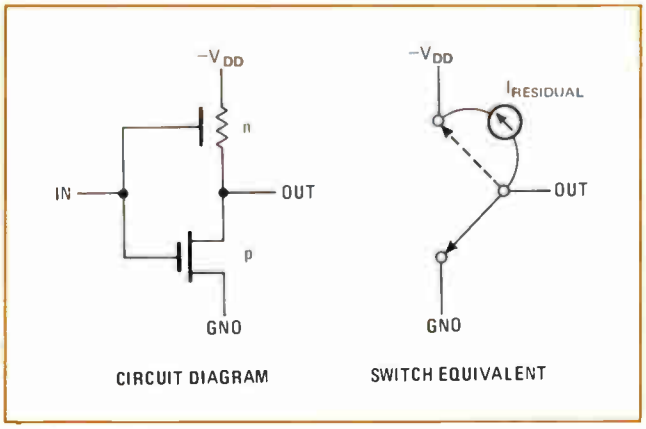


2. Quality counts. Because of the high quality of the silicon interface carrier mobility is high. Typical hole mobility in such a structure is at least as good as in bulk silicon, indicating no degradation in transistor characteristics when structures are built on silicon-over-sapphire.

conceded to bipolar technology, are now open to attack from SOS MOS.

Minimizing reverse leakage currents is important for many applications such as multiplexers, where the amount of leakage current determines the switch-to-switch isolation. Results of measurements of leakage currents for enhancement-mode p-channel SOS transistors give values which are typically 50 picoamperes per mil of channel width.

To test the stability of a SOS MOS structure, a standard technique of applying a large positive voltage to the gate of the transistor, while simultaneously raising the temperature of the device, was used. For bias field strengths of 2×10^6 volts per centimeter, applied for 10 minutes, threshold voltage typically changed by only 50 mv. This kind of stability is due to the clean-oxide techniques developed for bulk-silicon MOS devices.



3. Key element. The heart of a complementary logic and memory device is the inverter (a), in this case an n-channel depletion-mode plus a p-channel enhancement-mode transistor. Basically the inverter functions as a single-pole double-throw switch (b).

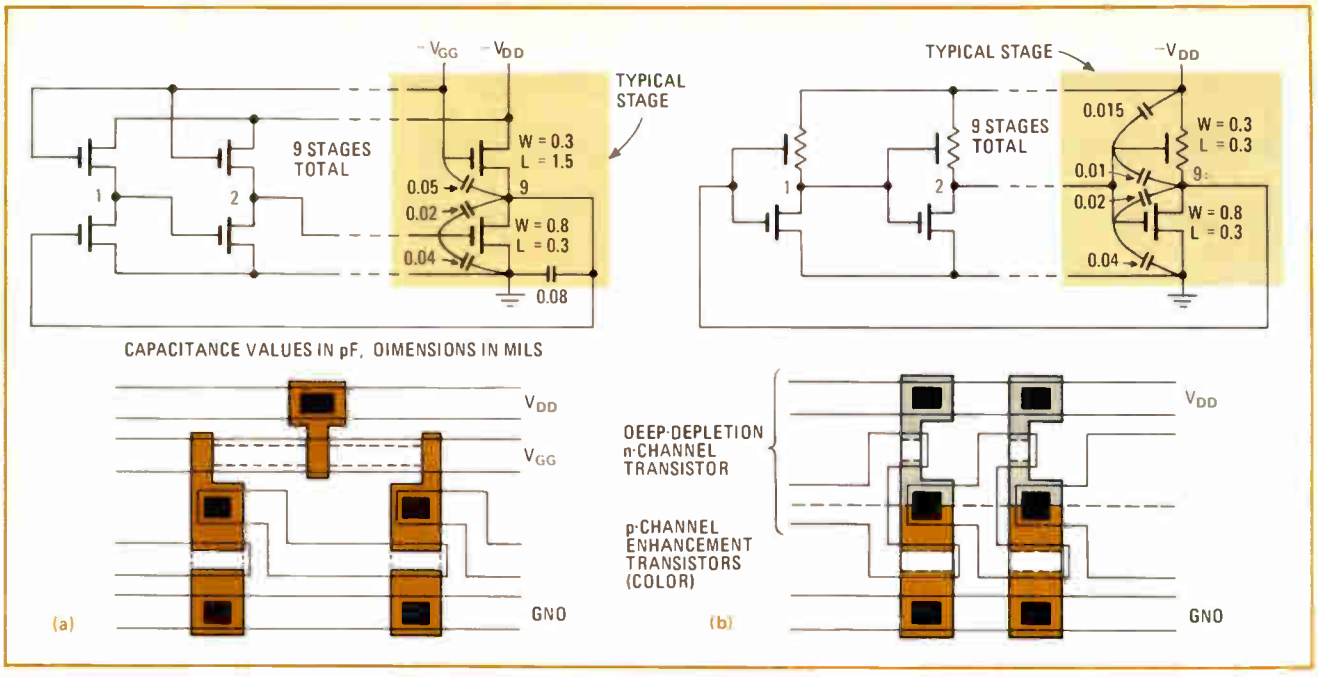
Deep depletion plays key role

Providing n-channel deep-depletion devices along with p-channel enhancement devices on the same sapphire substrate with little increase in processing complexity is a major strength of SOS technology. Combining these two devices yields high switching speeds and the low power dissipation usually associated with complementary operation. The high speed is a direct result of the deep-depletion device's high electron mobility (500 cm²/volt-second). The low dissipation is because the deep-depletion device, though not entirely off like a normal enhancement-mode transistor, draws very little current. (The deep-depletion device can be represented as an enhancement-mode transistor with a small current source in parallel.)

The basic element in deep-depletion complementary technology is the binary inverter shown in Fig. 3. It comprises p-channel enhancement and n-channel deep-depletion transistors. (In the figure, the resistor-like symbol for the depletion device serves as a reminder of the small residual current that flows at zero gate-to-source bias.)

The circuit functions as a complementary-symmetry inverter—that is, in either a logic 0 or a 1 state, only one transistor becomes a low-resistance path. The single-pole, double-throw switch configuration (Fig. 3) illustrates the operation. The current source represents the small residual current of the depletion transistor—typically a few tens of microamperes.

Circuits employing the complementary structure of Fig. 3 are completely static. They provide the speed and power advantages of dynamic, single-channel MOS techniques without requiring complicated, multi-phase, clock-pulse controls. In addition, combining the advantage of the complementary configuration with the very



4. Study in contrasts. The circuits and topographical layout of a nine-stage inverter ring made with SOS technology (b) are much simpler than one made with bulk silicon (a). Besides, the SOS structure is 10 times faster, four times smaller, and consumes half the power.

low capacitance of SOS structures produces static circuits that have the speed of bipolar TTL, but dissipate only a fifth to a tenth the power of their TTL equivalents.

The SOS payoff: boosting performance

How much increased performance can be gotten with SOS devices can be seen by comparing a typical nine-stage inverter circuit built with deep-depletion SOS techniques to one built with standard bulk p-MOS techniques.

In general, if an odd number of inverter stages is connected in series, and the last-stage output connected to the first-stage input, a "logically" unstable network is formed. This inverter-ring will then oscillate at a frequency related to the inherent speed of the inverter.

The period of oscillation, T, divided by the number of stages, n, is equal to the pair delay of the inverter with fan-out equal to 1—or $t_{pd} = T/n$.

Typical circuit values and layout topologies for the static SOS device and the static bulk device are shown in Fig. 4a and Fig. 4b, respectively. To make it possible to compare these structures at the same impedance level, the inverter transistors were made identical for the two cases.

The results of a computer transient-analysis simulation for the two cases showed that the SOS structure was 10 times as fast as the bulk-silicon structure and dissipated considerably less power—12 v × 100 μA = 1.2 mW/stage (bulk) versus 12 v × 20 μA = 0.2 mW/stage (SOS). Moreover, because of the bulk-pn-junction capacitance, dynamic dissipation for the bulk circuit is about twice that of the SOS circuit at any given frequency.

The high-speed, low-power dissipation properties of SOS MOS and n-channel deep-depletion loads are what have made possible the new family of integrated-circuit products mentioned much earlier. Anong these products are the L02 multiplexer, the A01 and A02 read/write memories, and the S01 shift register, all of which are TTL-compatible.

The L02 eight-channel analog multiplexer, besides being 10 times faster (50 ns channel-to-channel), dissipates only 50 milliwatts, or a fifth the power of other MOS devices.

The A01 64-bit read-write memory was designed to replace equivalent bipolar RAMs, but provide a tenfold power reduction. Its 50-ns access time makes it competitive with all but the fastest bipolar versions. It is organized as 16 words by 4 bits.

The A02 256-bit memory has an even faster access time (35 ns), but provides dual-rail sense currents at its output. Like the A01, it dissipates 0.5mW/bit. Both these RAMs are static—outputs are valid as long as addresses are held and no refreshing of data is required.

A unique feature of both the A01 and A02 is the use of input latches. If three-state TTL is used to drive these RAMs, address-line and other inputs retain last states when the TTL control is floated. Thus, the memories have self-contained address and data-input registers, a feature that eliminates the external registers used during sequencing.

Impressive register

Perhaps the most impressive SOS product introduced to date is the 256-bit static shift register. Ten times faster than any static register of comparable size, the S01 accepts TTL levels at all inputs—including the clock inputs. Most MOS registers are not TTL-compatible, and they require voltage-shifting interface circuits when used with bipolar logic. Clock drivers were built on the chip because no available commercial drivers would provide MOS voltage levels at a 10-to-20-MHz rate.

Also included on the chip are controls for internally recirculating data or selecting one of two input terminals. This feature adds to the system flexibility of the product. □

Sixteen-bit conversion gets a lift from IC technology

Accuracy problems that have inhibited commercial devices have been solved by tight initial matching and close thermal tracking of transistors on a single chip, which makes feasible their trimming to within 1 ppm

by Wayne Marshall and Cyril Brown, *Analog Devices Inc., Norwood, Mass.*

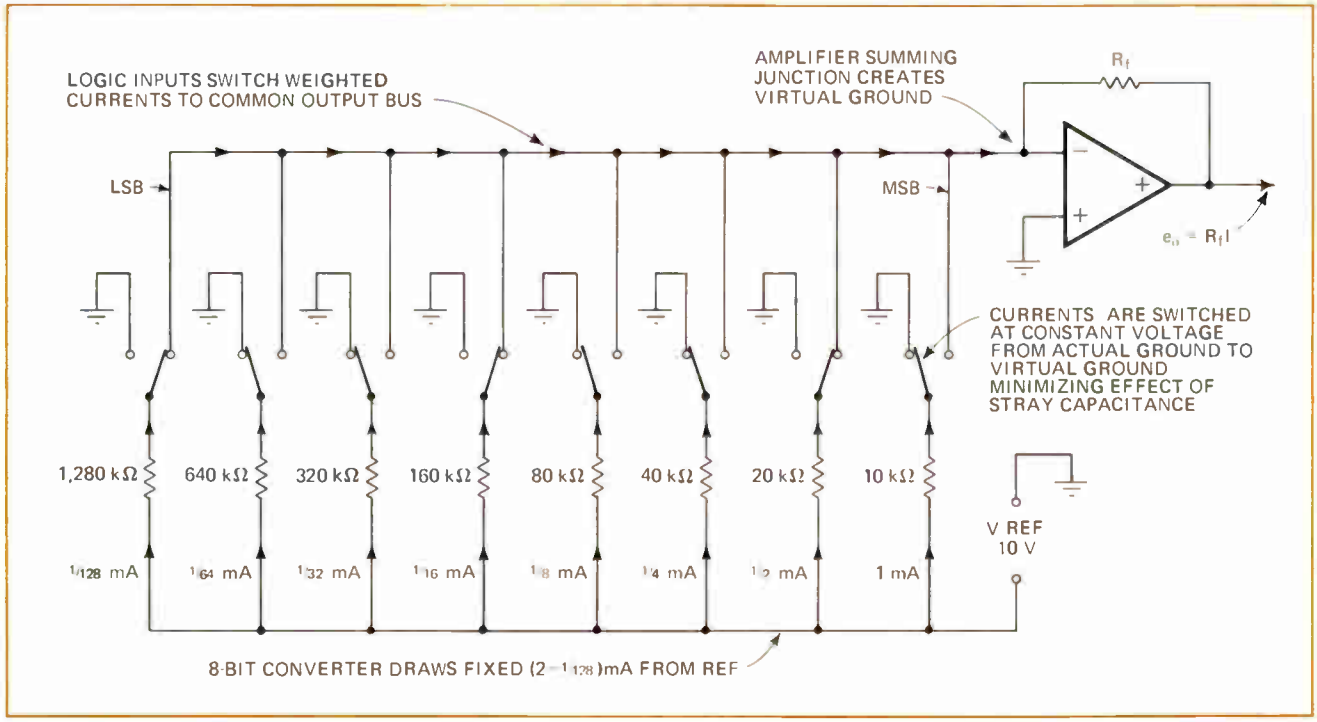
☐ While most engineers would be perfectly willing to buy and use 16-bit converters, many might be discouraged by a vociferous few who contend that practical 16-bit devices cannot be built. But monolithic technology has overcome the worst obstacles, and this initial article explains how. The second article in this two-part series will explore applications of these converters.

A 16-bit d–a converter (which also forms the heart of a successive-approximation type of 16-bit a–d converter) provides approximately 150 μv of resolution at 10 v full scale. Considering that a typical base-emitter voltage varies by roughly 2,400 μv/°C—or 4,000 ppm/°C, based on a nominal V_{BE} of 0.6 v—it becomes apparent why some engineers say 16-bit conversion is impossible.

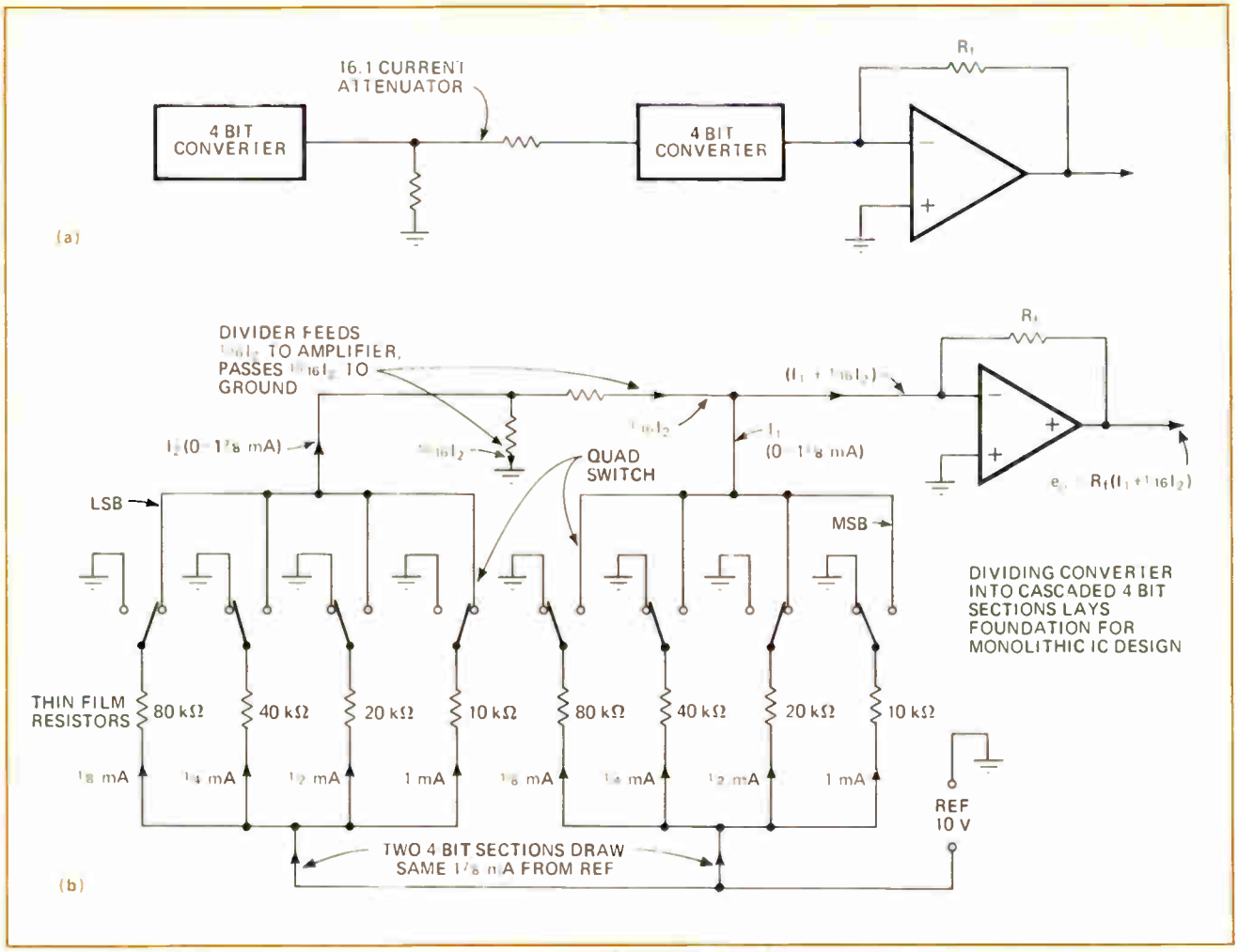
The obvious way to built a d–a converter is to use the in-line arrangement of digitally switched resistors shown in Fig. 1. This type of converter uses one precision resistor for each bit, with the Nth resistor having a value 2^{N-1} times the value of the smallest (most-significant-bit)—MSB—resistor. The current through these resistors also varies exponentially with the number of bits. Thus, while this approach is perfectly acceptable for a small number of bits—say, up to eight—it is useless at the 16-bit level. The ratio of the largest current (and resistance) to the smallest is 32,768:1 in such a converter, and satisfactory tracking between the weighted currents and resistances is simply impossible with this design.

An alternative approach is the cascaded quad (Fig. 2). This design consists essentially of individual 4-bit d–a converters, cascaded via 16:1 current attenuators to provide up to 16-bit resolution in four-bit increments. Since the 16-bit resolution is built up with cascaded four-bit sections, the span of metering resistance values is held at 8:1, while binary-weighted current values are fixed at the same reasonable 8:1 range. This ratio is easily handled by monolithic IC techniques.

Since a relay with a life of, say, 10 million operations, would fail after less than 400 full-scale up-down sweeps



1. Straightforward. The in-line converter has the virtue of simplicity, and it's OK for only a few bits, but tracking problems make it unsuitable for high-resolution applications. The Nth resistor is 2^{N-1} times as big as the MSB resistor—a pretty big number when N = 16.



2. Cascaded quad. By using individual 4-bit converters cascaded via 16:1 current attenuators (a), this design approach limits the span of metering resistances to 8:1. Circuit details are shown in (b). This design can be produced with good yields in a monolithic integrated circuit.

if it were used in a 16-bit converter's least-significant-bit (LSB) position, it is clear that some form of electronic switching must be used in a 16-bit converter. The current-switching arrangement illustrated in Fig. 3 is almost universally used in high-speed converter designs.

Concept illustrated

The basic switching concept is shown in Fig. 3a. When the digital input closes switch S, the switch grounds the emitter of transistor Q_1, thus cutting it off. Consequently, the precision current that formerly flowed through Q_1 to the output circuit now flows instead to ground. The output circuit is thus deprived of this particular bit's worth of weighted current. Figure 3b shows a semiconductor switching configuration that approaches more closely an Analog Devices monolithic quad switch. Here, the upper driver transistors divert the weighted currents away from the output whenever the input logic levels, applied through the isolating diodes, drive them into conduction.

Several semiconductor parameters determine whether or not a given quad-switch component will meet the accuracy requirements of a high-resolution converter. These include initial match of V_{BE} and beta for all four current switches in each quad, plus the variation of these parameters with temperature and time. The switches can be selected for 12-bit operation with no great difficulty; however, for 16-bit operation, the switches are first selected for 14-bit operation, and then trimmed for the final two bits of performance.

To demonstrate how the V_{BE} and beta drift compensation work, consider the procedures applied to the 12-bit design, and then the discussion will be expanded to encompass 16 bits.

As Fig. 3b illustrates, all the precision current-weighting resistors are connected to a common −15-v reference source. In series with each resistor is the actual switching transistor (with its associated V_{BE} drop) to connect the weighted current values to the output bus. Thus, because trimming is unacceptable at the 12-bit level, the reference voltages actually connected across all the current-determining resistors must match within the 12-bit tolerance. Since the nominal reference voltage across the weighting resistors is 10 volts, a 12-bit accuracy level (0.01% LSB) requires a uniformity of switching transistor V_{BE} voltage drops to within 0.01%.

Tracking is the key

Crucial to the selected compensation technique is the ±½ LSB V_{BE} and beta tracking from switch transistor to switch transistor over the working temperature range. In essence, a temperature-compensation loop stabilizes

current in one switch, and, because of the extremely close tracking between switches, extends the compensation process to all four switches on the same chip. Herein lies the supreme advantage of monolithic construction of the switching circuits. It is virtually impossible to find 12 discrete switching transistors with closely matching V_{BE} and beta that can provide parts-per-million tracking over wide temperature ranges.

Because of the 1:8 disparity in current density from the MSB to LSB switching circuits, a close V_{BE} and beta match for 12 discrete switching transistors is out of the question. The reason is that both V_{BE} and beta are functions of emitter current. Monolithic quad-switch design not only provides the basis for tight initial V_{BE} and beta matching, but it also gives the designer freedom to scatter auxiliary transistors quite liberally throughout the circuit. In this way, the quad current switching junctions can all be made to operate at identical current densities.

The constant-junction-density concept, which is essential for tight V_{BE} and beta tracking, depends on using more and more paralleled transistors to handle the quad switch's progressively higher LSB-through-MSB current levels. One single switching transistor handles the ⅛ mA LSB current, while the next-most-significant-bit switch uses two parallel transistors to share the ¼ mA current between them. The succeeding switch circuit handles ½ mA, and hence uses four parallel switching transistors, and so on.

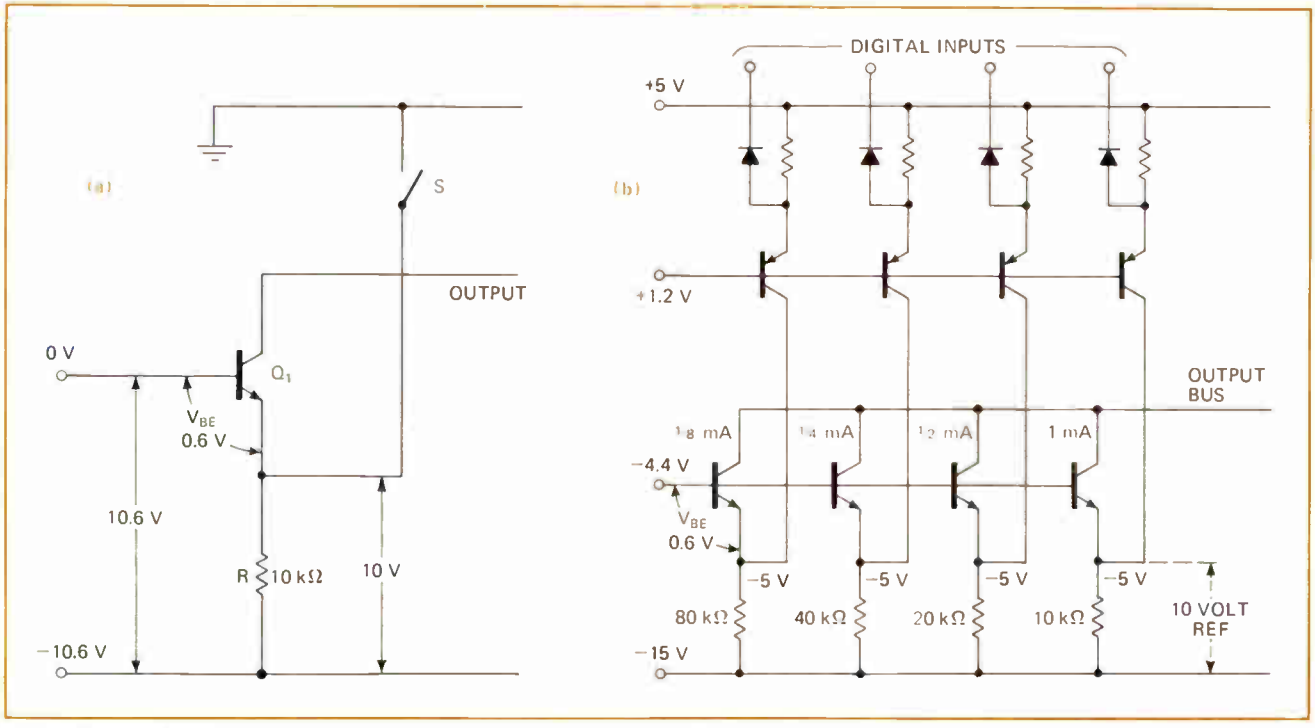
But identical currents aren't enough. How can the circuit get around the 2,400 $\mu V/^\circ C$ drift of V_{BE}? The versatility of monolithic circuitry provides the answer. This technology enables the quad switches to feature their own built-in provision for V_{BE} and beta corrections. In essence, a current-sensing circuit adjusts one of the external reference voltages—either the −4.4-V base voltage, or the −15-V reference voltage—to hold the weighted currrents at the correct values, regardless of V_{BE} and beta drift. The upshot is a reduction in scale factor or "gain" drift from 0.024%/°C to a temperature coefficient of a few parts per million. Further, because all switches are now forced by the compensation circuitry to operate at constant-current values, fractional parts-per-million relative tracking between the four switches on each substrate now becomes a reality. This tight tracking capability, of course, is the keystone to meaningful 16-bit operation.

Fig. 4 shows the compensation arrangement in its simplest form. Physically located on the same substrate as the four sets of current switches is a fifth transistor—identical in every respect to the LSB switch—that acts as a built-in transducer to sense V_{BE} and beta deviations. The sensing transistor is connected into an external error-detecting circuit that monitors this sensing transistor's operating condition, and this circuit continually readjusts the transistor's base voltage in opposition to combined V_{BE} and beta changes. In this way, the external compensating circuit controls the nominal −4.4-V base-supply voltage and forces the sensing transistor to operate at constant current.

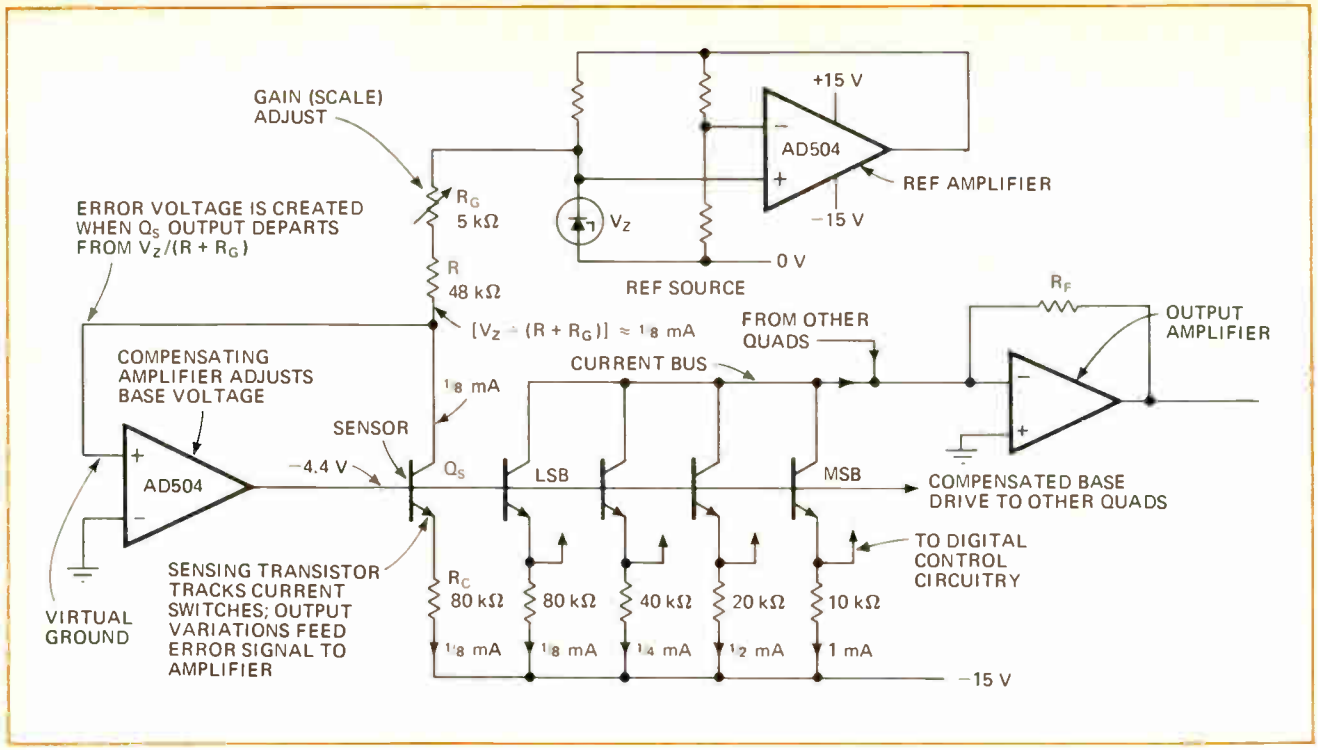
Because the sensing transistor is in tight physical proximity to the four quad switches, and, moreover, because it has electrical and thermal characteristics identical to these switches, changes in the sensing transistor's V_{BE} and beta will be closely repeated in all four switches on the same chip.

Stabilizing the current

Fig. 4 shows that the sensing transistor, Q_S, is connected to the −15-V rail via an 80,000-ohm resistor, R_c, that forms an integral part of the converter's monolithic divider network. Since this R_c has the same value as the



3. Current switching. Basic circuit (a) shows how precision current is switched between ground and the output line, thus eliminating load transients on the reference-current source. Detailed circuit (b) shows diode-transistor switches replacing the mechanical units.



4. Compensation. Sensing transistor, Q_S, not only stabilizes the transistor current by compensating for temperature-induced charges in beta and V_{BE}, it also corrects for temperature-induced changes in the metering resistors and for minor power-supply variations.

current-weighting resistor connected to the LSB switch, collector current for the compensating transistor has the same value as the LSB current of that quad. The compensating transistor's collector connects directly to the noninverting input terminal (summing junction) of the external stabilizing amplifier. A zener reference source—which establishes the basic gain-stability limitation of the converter as a whole—is also connected via a resistor and scale-setting potentiometer to the same amplifier's noninverting terminal, where it sets up a ⅛ mA current that is bucked by the ⅛ mA from the sensing transistor's collector.

Temperature-induced V_{BE} and beta changes, as well as V_{BE} and beta variations caused by aging, will tend to alter the sensing transistor's ⅛ mA output, thereby modifying the voltage at the sensing amplifier's input terminal. The amplifier will then react by altering its output voltage, hence the quad switch's base drive, to restore the sensing transistor's collector current to its original ⅛ mA value.

Actually, because the error-amplifier loop gain isn't infinite, the current won't quite return to its original level. However, with compensating-amplifier loop gain upwards of 100,000, collector-current variations will be reduced by a factor of 100,000 or more. The upshot is a reduction in effective V_{BE} drift from 2,400 μV/°C down to the nanovolt-drift region. Errors caused by beta variation are compensated in the same proportion.

Escalating to 16 bits

Quad switches intended for the most-significant position of a 16-bit d-a converter are selected for an equivalent error in an untrimmed condition of 0.002% of full scale. This requirement translates into a sum of V_{BE} and beta switch-to-switch deviations below an equivalent 0.2 mV level. The quad components are actually plugged into a high-precision four-bit test set, and the four individual transistor switches are then inspected for output differences exceeding 0.2 mV. When connected with the 10-V reference supply, the worst-case mismatch of 0.2-mV-in-10 V yields a starting-point nonlinearity of 0.002%. Thereafter, hand-trimming carries the switch-to-switch matching process to the 0.0001% tolerance required for ±½ LSB linearity at the 16-bit level.

Since individual weighted currents must be trimmed to ±1 ppm of ideal values to give meaning to the converter's ±½ LSB linearity, considerable ingenuity must be invoked to achieve adequate trimming resolution. For example, how do you trim an 80-kilohm resistor to 1 ppm? A series trimmer would require a resolution of 80 milliohms, which is virtually nonexistent, while a parallel trimmer for the same 1-ppm resolution would have to provide fine adjustment in the 80,000 megohms region. That's no more available than an 80-milliohm trimmer.

To achieve the necessary resolution, Analog Devices combines shunt and series methods. In fact, tiny currents are injected into each output circuit (or subtracted), using shunt resistors fed from a considerably attenuated temperature-compensated reference source. The voltage source for final 1-ppm trimming is derived from the −15-volt rail, and temperature regulated by a spare sensing transistor on one of the downstream quads. (The most-significant quad's own sensing transistor is occupied with V_{BE} and beta compensation.)

In the next article, 16-bit converter applications—both straightforward and unusual—will be described, along with hints on how to avoid introducing errors that exceed 1 LSB, thus wasting a major part of the converter's usefulness. □

Micro-power phase-locked loop widens designer's choice

by David Morgan
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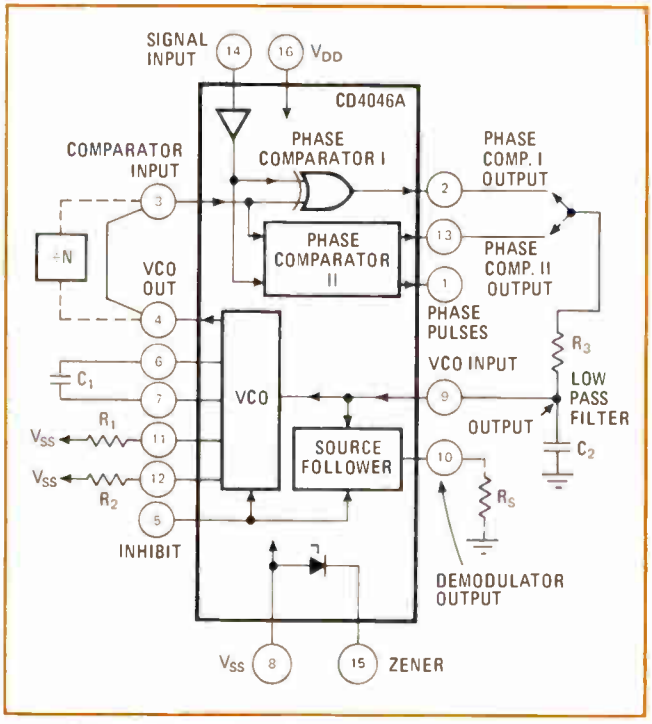
Monolithic phase-locked loop (PLL) ICs have found wide acceptance in both analog and digital systems since they were first introduced. However, these bipolar ICs, which cover a wide band of frequencies, typically consume upwards of 100 milliwatts of power.

Now a monolithic complementary MOS phase-locked loop may change all that. The C-MOS IC used as an fm demodulator consumes only 600 microwatts of power when operating at 6 volts and a frequency of 10 kilohertz—less than 1/160 the power needed by its bipolar counterparts.

A basic functional diagram of the CD4046A PLL is shown in Fig. 1. The PLL structure consists of a low-power linear voltage-controlled oscillator (VCO) and provides the designer a choice of two digital-type phase comparators. Both comparators share a common signal-input amplifier and a common comparator input. A 5.4-V zener diode is provided for supply regulation, if necessary. The VCO can be connected either directly or through frequency dividers to the comparator input of the phase comparators. And an external low-pass filter is used to handle any configuration changes that are needed for different applications.

The phase comparators shown in Fig. 2a are driven by a common self-biasing input amplifier. The phase-comparator signal input (terminal 14) also can be directly coupled for signal swings within C-MOS logic levels— logic 0 is equal to or less than 30% of (V_{DD}–V_{SS}), logic 1 is equal to or greater than 70% of (V_{DD}–V_{SS}). Smaller input-signal levels must be capacitively coupled to the input signal terminal.



1. C-MOS phase-locked loop offers a choice of comparators.

TYPICAL ELECTRICAL CHARACTERISTICS OF THE CD4046A C/MOS PHASE LOCKED LOOP

VCO	
Maximum operating frequency	500 kHz
Linearity	1%
Center frequency	Programmable with R_1 & C
Frequency range	Programmable with R_1, R_2 & C
Temperature stability	500 ppm/°C
Phase comparators	
Choice of two functions:	
I) Mixing and with center frequency	
II) Edge-triggered and with 0-phase tracking	
Input amplifier sensitivity (ac coupled)	250 mV rms
General	
Supply-voltage	5–15 V
Power consumption ($C = 0.0001\ \mu F$, $V_{DD} = 6$ V)	
f_0 = 10 kHz	0.6 mW
f_0 = 100 kHz	2 mW

Phase comparator I is basically an exclusive-OR network having the typical triangular phase-to-output response. In the absence of signal or noise at the signal input, the average output voltage is one-half the supply voltage. The capture range, or the span of frequencies over which the PLL can acquire lock, depends on the characteristics of the low-pass filter employed and can be made as large as the lock range.[1]

When phase comparator I is used, the PLL system can stay in lock, even with high levels of input signal noise, but the system may lock into input signal frequencies that are close to harmonics of the center frequency. Also, the phase between the comparator and the input signal varies between 0° and 180° as the signal-input frequency changes, and is 90° at the center frequency of the capture range.

Phase comparator II is an edge-controlled memory network that operates on the leading edges of the signal and comparator inputs. It comprises four flip-flop stages, with common reset, control gating, and a tri-state output circuit. The tri-state output consists of both p- and n-type drivers sharing a common output, but both drivers are never on at the same time.

If the input frequency is higher than the comparator frequency, then the p-type output driver is on continuously; if the input frequency is lower than the com-

parator frequency, the n-type output driver is kept on. If these frequencies are the same, but the phase of the input signal lags that of the comparator, the n-type output driver would remain on for a time that corresponds to the phase difference. If the frequencies are equal, but the signal phase leads that of the comparator, the p-type driver is kept on for a time corresponding to the phase difference.

This type of phase comparator adjusts the VCO input voltage until input signal and comparator frequencies are equal in both phase and frequency. When this stable condition occurs, both driver stages are off. In the absence of an input signal, phase comparator II adjusts the VCO to its lowest possible frequency. This comparator has a lower signal-to-noise ratio than phase comparator I and could lock on noise signals. However, it will not lock on harmonics of the VCO signal, as will phase comparator I.

The VCO shown in Fig. 2b, unlike its conventional phase-locked counterparts, is a square-wave oscillator with a 50% duty cycle. This allows the unit to directly interface with other C-MOS devices, such as the PLL's digital phase comparator, counters, and so on. Not only does the C-MOS VCO consume significantly less power than bipolar types, but an "inhibit" input is provided, which enables the VCO and the source follower or turns both off to minimize standby power consumption. The high input impedance (10^{12} ohms) of the VCO simplifies the design of low-pass filters by permitting a rather wide choice of resistor-to-capacitor ratios.

As in conventional VCOs, the frequency range and frequency offset are adjustable. Resistor R_1 and capacitor C_1 determine the frequency range of the VCO, and resistor R_2 will provide a frequency offset, if required. A source follower allows monitoring of the VCO input voltage without loading of the low-pass filter.

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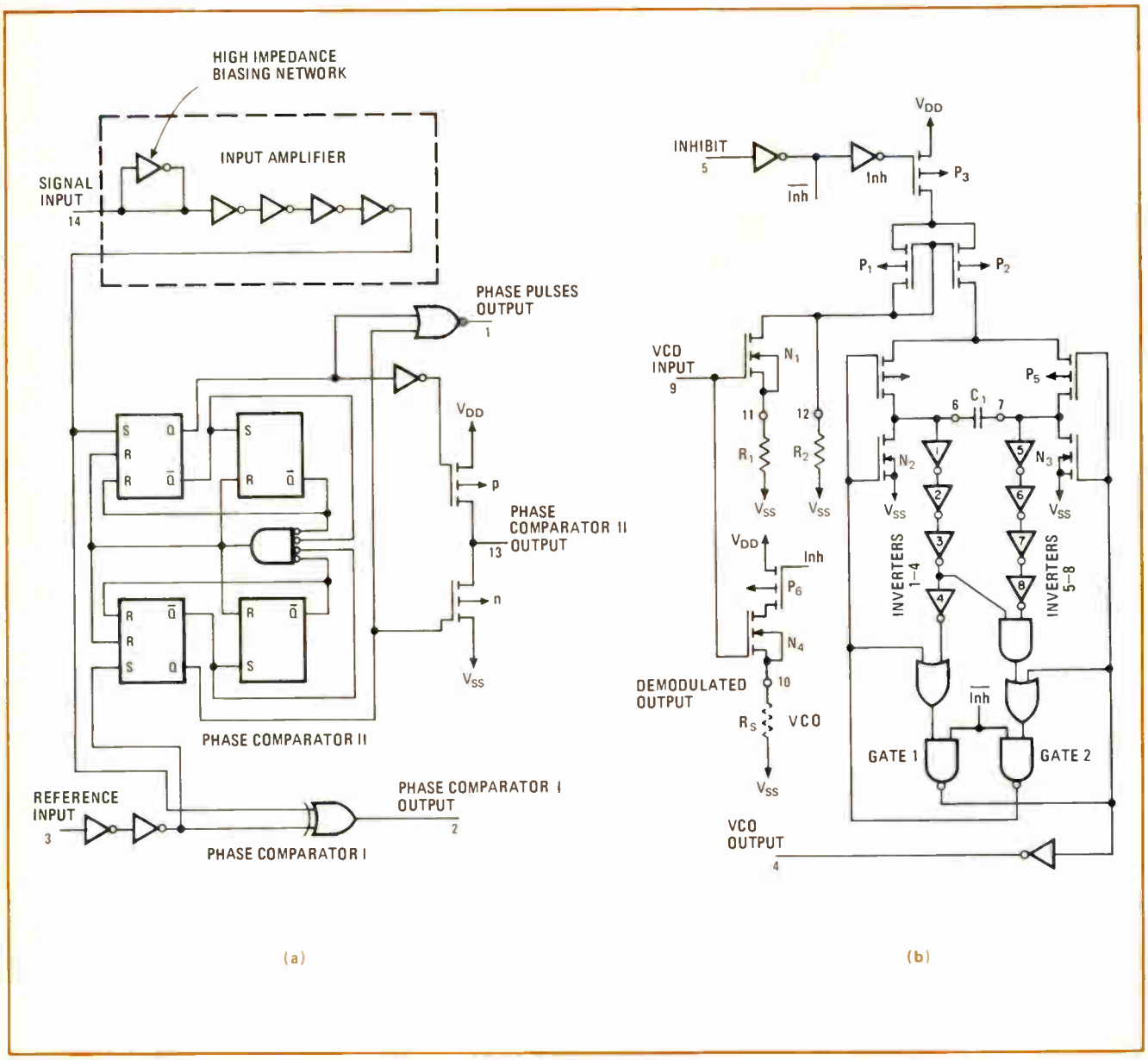
1. Floyd M. Gardner, "Phaselock Techniques," John Wiley & Sons Inc., N.Y., N.Y., 1967

2. Digital route. Diagram details phase comparator (a) and voltage-controlled oscillator (b) circuits of phase-locked loop.



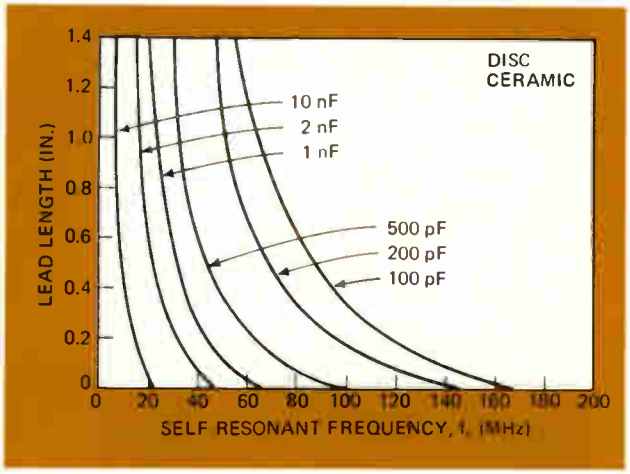
Charts find capacitor self-resonant frequency

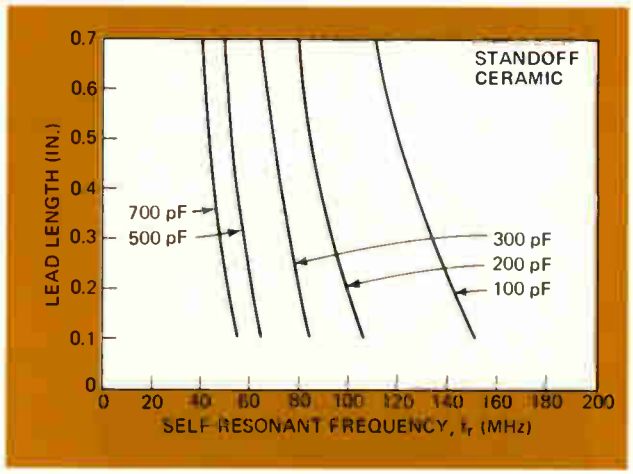
by Robert B. Cowdell
ITT Gilfillan, Van Nuys, Calif.

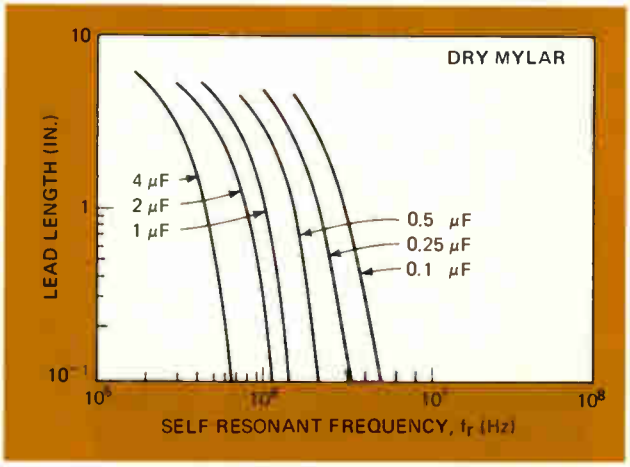
To decide which of the various kinds of capacitors available is best suited for a particular filter application, it's necessary to know their self-resonant frequencies. Self-resonance depends both on the type of capacitor used and the amount of lead length required. The charts plot the self-resonant frequency of several commonly used capacitor types for various values of lead length and capacitance.

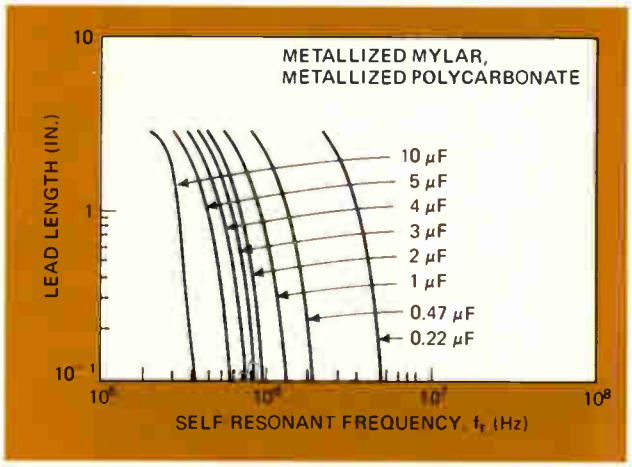
For low-pass filter work, dry Mylar capacitors are the most popular because they are inexpensive, rugged, and fairly small. When capacitance values must exceed 5 microfarads, paper capacitors are a good choice. Ceramic units find use in miniature filters because of their high volumetric efficiency, and mica units are better suited for higher-frequency applications □

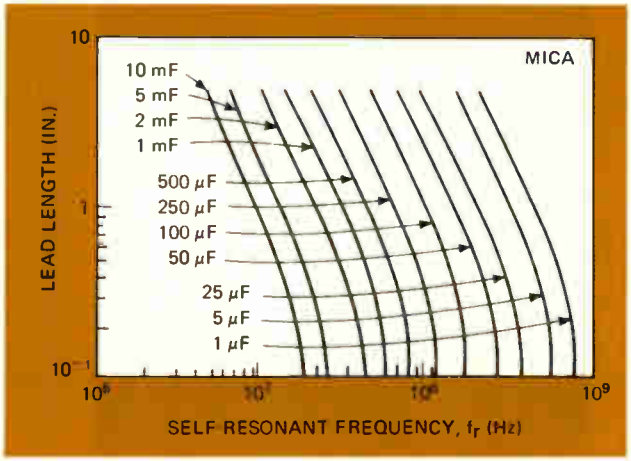
Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design, applications, and measurement ideas. We'll pay $50 for each item published.

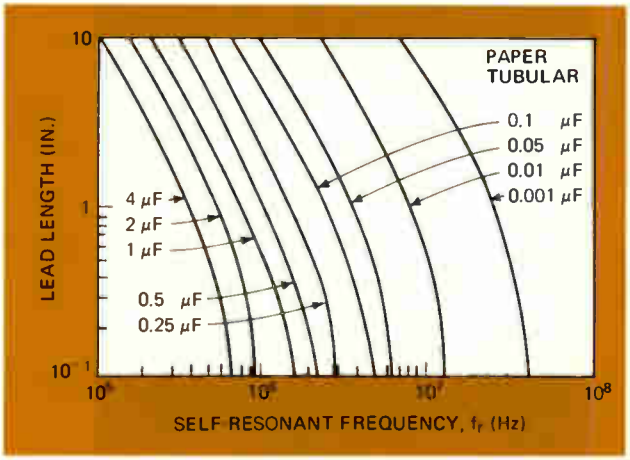












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Circle 124 on reader service card

Engineer's newsletter

Ultrasonic unit and mirror test for bad bonds

If you're plagued by faulty interlaminar bonds that keep managing to escape inspection, a new ultrasonic testing method might be the answer. Developed by TekTran, a Newark, Ohio, maker of nondestructive test systems, **the method depends on the adhesive used in bonding and, in some cases, mirrors.** As an illustration of what its test can do, TekTran says that the technique has been used to pick up bad bonds in a 1-by-2-by-1/16-inch ceramic substrate already mounted on a printed-circuit board. The components were too valuable for random destructive testing, but voids couldn't be tolerated.

The test is based on the same ultrasonic principle used for years to inspect welds and brazements: **The density and elastic properties of the adhesive so closely match those of the base materials that, to the ultrasonic unit, a sound bond looks the same as the base materials.** The mirror is necessary because, rather than focusing on the bond and looking for reflections, the unit focuses on a reflecting surface behind the test piece and detects absence of reflection. A void blocks either the reflected or transmitted wave, giving two chances to pick up a flaw.

Gas supplier lists levels of all contaminants

Contaminants in the electronic gases used in the manufacture of semiconductor wafers can be ruinous. So engineers engaged in that work should be cheered by the announcement that **a maker of such gases will now routinely report levels of contaminant concentration for all harmful materials.**

Three-H Corp. of Wanamassa, N.J., which has supplied arsine, phosphine, and silane to electronics researchers requiring gases of ultrahigh purity, will now sell gases for production of epitaxial and dielectric materials. **The company promises to provide purchasers with analysis reports listing concentrations of all impurities**—Among them arsenic, cadmium, chromium, copper, iron, selenium, silicon, tellurium, and zinc—**down to part-per-trillion levels.** Three-H says it can do this because of unusually rigid quality control.

Philips simplifies inspection for irregularities

Here's a relatively inexpensive and simple way to measure surface irregularities of a micrometer or less. Developed at the Philips Research Labs in Eindhoven, The Netherlands, by J.P.M. Verbunt, **it uses a microscope as its only precision optical component.** Familiar interference methods require additional optical aids. In the Philips system, a drop of proprietary liquid is placed on the surface being inspected, and then illuminated by a monochromatic light. Interference rings are viewed through the microscope.

Addenda

The second edition of Microdata's Corp.'s "Microprogramming Handbook" is available from the company at 644 East Young St., Santa Ana, Calif. **It contains a microprogramed computer primer and a rather extensive glossary.** Cover price is $2.50. . . . Add to your library Westinghouse's new data sheets giving rating information and curves for its disk-form silicon-controlled rectifiers. Address the Semiconductor division at Youngwood, Pa. 15697.

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Our New Model 20 Programmable Calculator. Latest In the Series 9800.

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The Model 20 can be plugged into our hardworking Series 9800 Peripherals: X-Y Plotter, Typewriter, and Card Reader, to name a few. An added plus—it interfaces with test instruments. The basic unit, including our built-in alphanumeric display and printer is $5,475, with immediate delivery.

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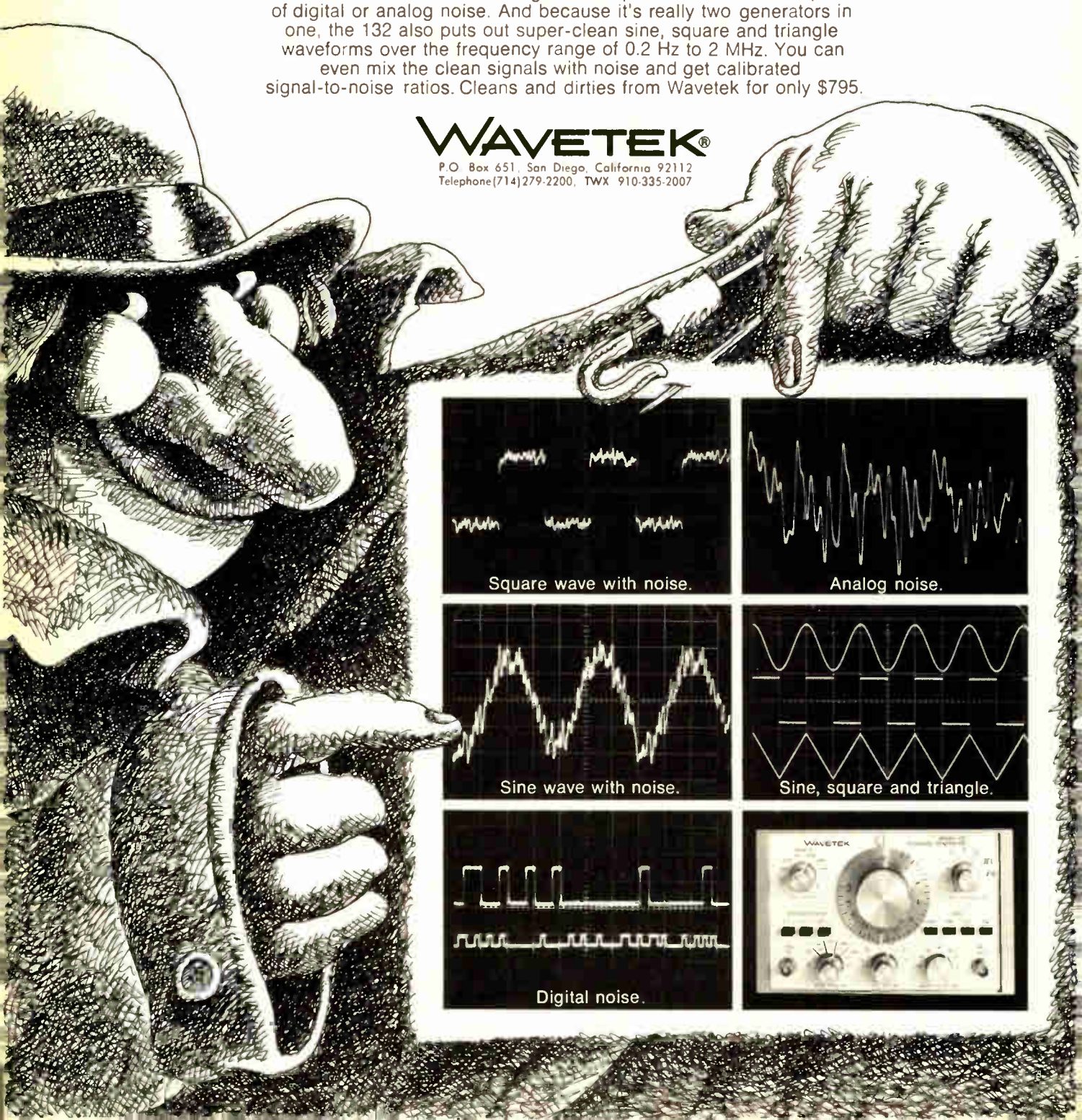

Square wave with noise.

Analog noise.

Sine wave with noise.

Sine, square and triangle.

Digital noise.

Keyboard Basic programs calculator

Separate key is used for each instruction; computer-like machine has a microprogram-controlled central processor

by James Brinton, Boston bureau manager

Calculators have come a long way since makers took the cranks off the sides, and the latest to evolve is the hybrid model 2200 from Wang Laboratories Inc., Tewksbury, Mass. Although it operates like a calculator through its keyboard, the 2200 is the first calculator to offer Basic computer language. One of the higher-level languages, Basic makes entries more comprehensive and problems easier to state.

It's called a calculator, but the 2200's architecture is much like that of an advanced-design minicomputer with a microprogram-controlled central processor. From the outside, the 2200 looks much like a so-called intelligent terminal with an 8-by-10½-inch CRT display, cassette data store, and keyboard.

Perhaps the feature that will attract most attention in the 2200 is its keyboard Basic. Instead of forcing the user to type in Basic language commands letter by letter, the 2200 has a key for each instruction, and a single keystroke does the job. This is not only faster than the former method, but reduces errors made during problem entry.

Errors are spotted during a program run by an arrow, followed by a code identifying a mistake. And, if through some massive combination of mistakes or power failure, the operating system goes down, the user can push a button and reset it in about a second; this is a holdover from calculator design and compares favorably with the lengthy periods often needed by pure computer systems.

While Wang plans to build a market base for the 2200 within its traditional areas of scientific and engineering computation, the new machine is flexible enough for use in education, finance, and computer-aided design. Much of this flexibility comes from the 2200's microprogram architecture. The machine has about 6 kilobytes of braided-wire read-only memory which make possible the Basic language keyboard and several other features unusual in either a computer or a calculator. Wang has used braid instead of MOS because that memory is still less expensive on a cost-per-bit basis. But since the 2200's design is not static, MOS can be used later.

MOS random-access memory already makes up the machine's 4-kilobyte standard complement. Though this, like the microprogram store, expands to 32 kilobytes, Wang engineers point out that far more of the 4-kilobyte RAM is available for use than with many standard minicomputers because much of its usual content already resides in the braided memory.

There may be cases where the user would want to expand both stores. Wang engineers envision the possibility of eventually offering keyboard Fortran and other languages. Users perhaps could switch from language to language by addressing different sections of an enlarged read-only memory, all the while maintaining the convenience of keyboard instruction entry.

Even without memory expansion, the 2200 can be customized easily. A row of special-purpose keys allows the operator to insert up to 32 complex instructions. These keys, for example, can make the 2200 emulate the model 700 scientific calculator, and the setup time is measured in minutes.

Basic software now makes it more economical to program applications than has been possible on previous computing calculators. Also, applications which formerly were too difficult to program on such systems now become relatively simple. The CRT, because of its speed of display, also enables users to easily write Basic-language programs. And in addition to its speed, the tube shows relatively large blocks of data—14 lines at 64 alphanumeric characters per line.

Keyboard Basic and its associated

New products

microprograming also speed up storage of programs after they are written. The console's built-in cassette storage now can be loaded faster than is usual with minicomputers that must depend on Teletype as the primary data entry mechanism. In contrast to the 100-character-per-minute rate of Teletype-supported systems, the 2200 can transfer data into and out of its cassette store at about 125 characters per second.

To protect stored programs, Wang provides separate tables in memory for console and program-controlled operations; thus it is almost impossible to damage the system's software through inattentive use of the keyboard.

Adaptable. For added flexibility, the keyboard detaches from the CRT console and can be connected several feet away from it. This approach allows plug-compatible specialized keyboards to be used with the system—perhaps with new microprograming—making the hardware capable of performing totally different tasks than those for which it was originally purchased.

Like computers, the 2200 calculator will be equipped with a large line of optional peripheral equipment. Although initially the list is limited to additional CRT consoles, cassette stores, and serial printers, the system already will interface with teletypewriters if desired by the user, and forthcoming are accessories like disk memories, line printers, graphic plotters, and others.

The 2200 system is modular; a user can buy only the central processor and its standard memory. He can then attach his own Teletype and come up with a system costing only $3,500, and with much of the power of the whole 2200.

Or the user can purchase only the keyboard and central processor. This is perhaps an optimum choice for customers with small budgets, as it offers the advantage of microprogramed keyboard Basic language at only $4,200. Initial deliveries of the model 2200 are scheduled for January.

Wang Laboratories Inc., 836 North St., Tewksbury, Mass. 01876 [338]

Pocket multimeter has lab accuracy

The size of a transistor radio, digital instrument provides 4½-digit resolution and consumes a maximum of 0.75 watt

Applying many of the same techniques used more than two years ago in a benchtop digital multimeter [*Electronics*, June 21, 1971, p. 99], Data Precision Corp., Wakefield, Mass., has developed a 3½-digit meter that fits into a shirt pocket and offers accuracies comparable with those of laboratory instruments.

The model 245, which can run on battery power, measures resistance, ac/dc voltage, and ac/dc current with 20,000-count resolution, and sells for $295. A seven-segment plasma display is provided in the 245; a single MOS chip combines counter, latch, code conversion, and display multiplex circuitry in one package; and complementary MOS is used for logic control.

To cancel the noise and internally produced errors that trouble most meters, an improved version of the company's Triphasic analog-to-digital conversion technique is used.

Total maximum power consumption is 0.75 watt, but only when the unit is run from an ac line adapter, so that much of the power is dissipated in the adapter. Normally the 245 runs off current from four internal rechargeable nickel-cadmium batteries, when it uses about 0.25 W.

Overload recovery is fast, whether for voltage or resistance measurements, and it usually occurs within the time slot between conversions. Current protection is simple, with ordinary 32-volt automotive fuses designed into the 245's test probe and spare fuses in the battery compartment. The nickel-cadmium batteries are good for a full day's operation, and this includes operation with a full display for the entire period.

The specifications of the 245 read like those for much larger meters. Minimum common-mode rejection ratio with a 1,000-ohm source-impedance unbalance is at least 120 dB when measuring dc, and more than 100 dB at 60 hertz. Under battery operation, the ratio is said to be so high as to be unmeasurable in practice, and because of the meter's size and weight, it is fair to expect that most measurements will be made when using battery power.

The four ac and dc voltage ranges are 1, 10, 100, and 1,000 V, making for resolutions of 100 microvolts, 1 millivolt, 10 mV, and 100 mV respectively. Polarity is automatically shown on dc measurements. In ac ranges, it is possible to overrange the meter to 1.9999, 19.999, 199.99, and 500 V, respectively. Dc overrange capability is the same, but extends to 1,000 V in the top range. Accuracy of measurement on dc scale is specified at within ±0.05% of reading, ±1 least-significant digit, over six months.

A voltage coefficient of ±0.00001% of reading per volt is significant only on the 1,000-V range. Input impedance is at least 10 megohms on all dc voltage scales, but on the ±1-V scale, it is a comfortable 1,000 megohms to minimize circuit loading. On the ac scale, input impedance is a minimum of 1 megohm in parallel with a maximum of 50 picofarads.

Worst-case ac inaccuracy is ±1% of reading ±0.02% of full scale—again over a six-month period. The current scales are ±1 to ±1,000 milliamperes, with overrange capabilities comparable to those on the voltage scale. Resolution extends down to 1 microampere. Worst-case inaccuracy on dc current measurements is ±0.2% of reading ±1 least-significant bit. And again, the specification is for a six-month period.

Dc-measurement temperature coefficient is within ±0.02% ±0.001% of full scale/°C. The specifications are only slightly higher in ac applications.

Resistance ranges run from 1 kilohm to 10 megohms, and overranging again is possible up to 19.999 megohms. This means that the 245 resolves resistances as low as 100 milliohms, while still extending useful resolution higher than most costly analog ohmmeters.

Accuracy and temperature coefficient specifications are comparable to those for the voltage ranges.

The model 245, which weighs only about a pound, comes equipped with six batteries, a pair of test leads, and a battery charger—which doubles as the equivalent of an ac line cord, as the meter's batteries remain in circuit during ac operations.

Delivery time is 30-60 days.

The Data Precision Corp., Audubon Rd., Wakefield, Mass. 01880 [339]

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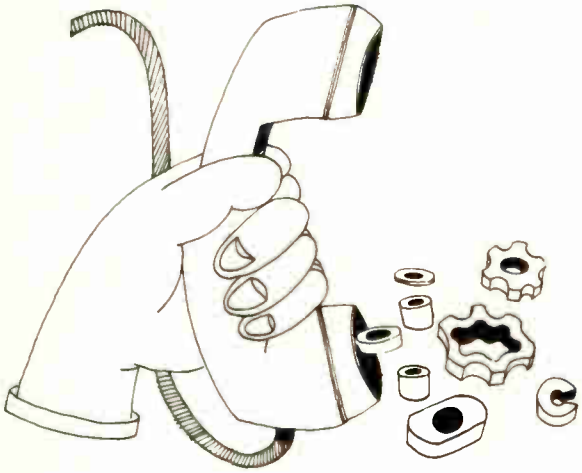

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YCM-8D (ALNICO-8)	7,500- 8,300	1,700-1,850	5.5- 6.5
YCM-8E (ALNICO-8)	7,500- 8,500	2,000-2,150	5.5- 7.0
YCM-9B (ALNICO-9)	10,000-11,000	1,350-1,500	9.0-11.0
HICOREX ($SmCo_5$)	7,700- 9,200	7,700-9,000	15.0-21.0

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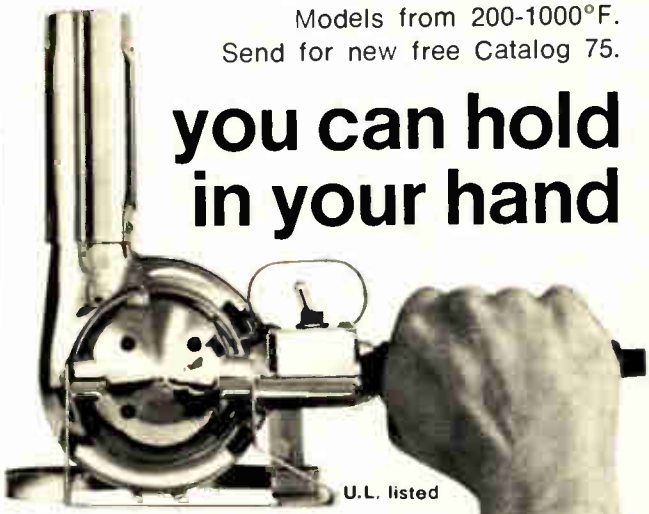

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Instruments

512-MHz counter costs only $895

9-digit unit counts to 220 MHz directly, has sensitivity of 10 mV

Because frequency counters are broadband instruments, it is difficult for them to measure receiver radio frequencies directly. The usual procedure is to measure the local-oscillator frequency and then sub-

tract (or add) the i-f to arrive at the desired result. Except for expensive computing counters, Ballantine's new model 5700A is believed to be the first digital frequency counter that can perform this subtraction (or addition) automatically. This Autoconvert feature, which adds $75 to the counter's basic price of $895, employs a prewired card to introduce the desired offset into the instrument's readout. Extra cards can easily be wired by the user for whatever frequency offsets are needed.

Because of its Autoconverter option and its range-from 5 Hz to 512 MHz-the 5700A is expected to find wide application in such communications applications as the servicing of landmobile radios. In such field work, it is common to find oscillators that are considerably less stable than their laboratory counterparts. Therefore, the 5700A allows the user to selectively blank from one to four digits of the counter's nine-digit display by means of four frontpanel pushbuttons. This not only eliminates potentially confusing data, it shortens gate time, thus speeding measurements.

Since the 5700A counts as high as 220 MHz directly, it can resolve frequencies to within 1 Hz with a 1-second measuring interval. For the rest of its range it uses a 2:1 prescaler, which doubles the required measuring interval. Because most competitive units use 4:1 or 10:1 prescalers, they require up to 10 seconds to make a single measurement to full 1-Hz resolution.

The prescaler in the new counter is unique in that it does not use tunnel-diode dividers. Instead, it employs Motorola's new MECL III flip-flops [*Electronics*, Sept. 11, p. 186]. This eliminates the temperature-drift problem associated with tunnel diodes and gives the counter a sensitivity of 10 mV all the way up to 512 MHz.

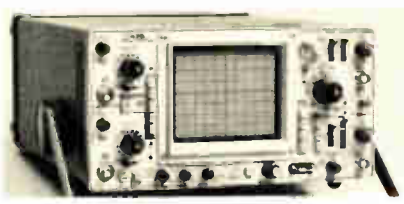
The counter's time base is a 10-MHz crystal housed in a self-regulating solid-state oven. This keeps the crystal's frequency drift below two parts in 10^6 over the temperature range from 0°C to 50°C. The crystal aging rate is less than two parts in 10^8 per day.

For even greater stability, a $195 option is available. It offers short-term stability of 1 part in 10^9/day, long-term stability of 4 parts in 10^7/year, and temperature stability of 2.5 parts in 10^9/°C.

Ballantine Laboratories Inc., P.O. Box 97, Boonton, N. J. 07005 [351]

200-MHz portable scope has 2 μV/cm sensitivity

Two 25-pound portable dual-trace oscilloscopes achieve full bandwidth at their highest settings. The model 465 is priced at $1,725 and offers a 100-MHz bandwidth at 5 mV/division. The model 475 is priced at $2,500 and has a 200-MHz bandwidth at 2 mV/cm. Both have an 8-by-10-cm display with rise-time graticule, and the 475 also offers a



1-nanosecond sweep speed. Other features include trigger view, function push-buttons, probe ground-reference button, battery operation, and full-range internal trigger selection.

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

Monitor measures radar noise performance

A radar noise-performance monitor is adaptable for use on most pulsed radars. In many systems, the first measurable sign of an impending receiver failure is degradation of noise performance. Often, the decay is so gradual that it escapes the operator's notice, especially if it is indicated on a visual display only. The monitor is synchronized to the radar, so that noise injection and sampling can be accomplished only during the dead time, and the monitor introduces little or no degradation of operational performance.

Ailtech, a Cutler-Hammer Co., Farmingdale, N.Y. 11735 [355]

Multimeter probe covers wide frequency range

Designed for use with the company's model 2795 multimeter, a high-frequency probe, model 2791, offers a measuring span from 0.1 to 25 volts rms. Frequency range is from 10 kHz to 800 MHz, and the unit can be used as an indicator up to 1 GHz. Accuracy is to within 15% through 300 MHz. The instrument can be used with any voltmeter with a 1 Vdc-megohm range.

Simpson Electric Co., a member of Katy Industries Inc., Electrical Equipment Group, 5200 West Kinzie St., Chicago, Ill. [358]

Oscillographic recorder offers a choice of input plug-ins

A choice of input plug-ins, a new ink system, and carbide-tipped stainless-steel pens are components

New products

of a two-channel oscillographic recorder. At least 10 different combinations of signal conditioners can be used with the model 7402A. Three preamplifier plug-ins are

available with sensitivities of: 1 μV/division with a differential, floated and guarded input; 1 mV/div with a differential, balanced-to-ground input; and 20 mV/div with a single-ended input. Price of the mainframe is $1,450; inputs and options are extra. Delivery is from stock.

Hewlett-Packard Co., 1501 Page Hill Rd., Pal Alto, Calif. 94304 [356]

Calibrators designed for digital, analog instruments

A series of precision programable calibrators is designed for use with digital as well as analog instruments. The 300 series is a source for voltage, current and resistance calibration in 3-, 4-, and 4½-digit ac and dc ammeters, voltmeters, multimeters and a-d converters. Voltage accuracy is to within 0.005% dc and 0.05% ac. Six voltage ranges are provided to 1,000 V; six current ranges are provided to 10 A, and six resistance values to 1 megohm. Percent of

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New products

reading error is shown directly on a deviation dial.

Rotek Instrument Corp., 40 Guinan St., Waltham, Mass. 02154 [357]

Digital filter samples at up to 80 kilohertz

The model 4136 is a single-channel digital filter that can realize up to eighth-order designs at variable

sampling rates of up to 80 kHz. All classical filter types can be programed via 12 16-bit filter coefficients, including Butterworth, Chebyshev, Bessel, and Cauer. The unit can also be used as a prefilter in digital signal-processing applications. Price is $8,500.

Rockland Systems Corp., 230 W. Nyack Rd., Nyack, N.Y. 10994 [359]

Digital panel meter has auto-expand feature

A line of digital panel meters is designed with auto-expansion so that when the reading goes down to 10% of full scale, a scale expansion by a factor of 10 takes place. When the

meter is used to replace a conventional 3½-digit panel meter, enhanced resolution to the low end of the range is provided. Impedance is 100 megohms, input readings are up to 20 v, and the units operate off a 5-v supply. Price is $100 in 200-unit quantities.

Digitan Systems Co., 5001 16th Ave., Brooklyn, N.Y. 11204 [360]

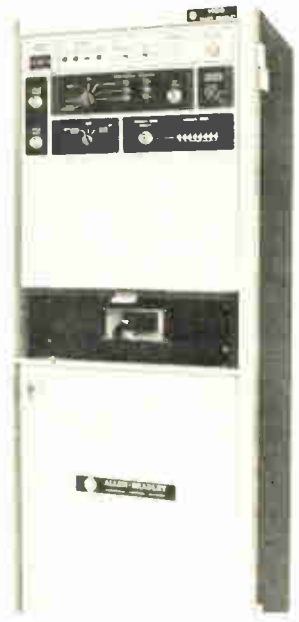
Industrial electronics

British systems fill out N/C line

Allen-Bradley adds three low-priced, compact, hardwired controllers

A numerical control system designed by Plessey Numerical Controls Ltd. of Great Britain is now being manufactured and marketed in the United States by Allen-Bradley Co.'s Systems division. Designated the 1100 Series, the hardwired controllers fill out the lowest-priced end of Allen-Bradley's line of N/C equipment.

The new series is available in three models—for point-to-point, turning, and milling applications. Model 1100P is a two-axis, point-to-point system with an optional full third axis. Resolution is 0.001 inch (though other resolutions are also available), and the unit has a +3.3-axis word format. Model 1100T is a two-axis contouring system designed specifically for lathes and features both linear and circular interpolation. The model 1100M is a two-axis contouring controller for milling machines. Resolution of the turning and milling models is 0.0002 inch, and they have a ±2.4-axis word format.



Each unit is a complete system, Allen-Bradley points out, and includes feedback encoders and drive systems. Modular integrated circuitry used in the design affords a built-in test capability that allows internal malfunctions to be pinpointed automatically. In addition, each model comes with both absolute and incremental programing capability and, with low-power integrated circuitry, fits into a single-bay, totally enclosed, nonventilated cabinet.

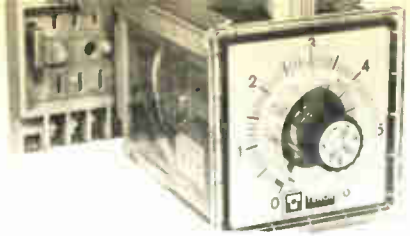
Other features of the series include switchable inch or metric programing, direct inches-per-minute feed-rate coding, and a unidirectional tape reader. There is also feed-rate override, sequence number display, full manual data input, and mirror-image capability so that mating parts can be machined from the same program. The controllers also have three jog speeds—fast, slow, and creep—and operate with either EIA or ASCII coding.

There is also a broad range of options available with the series 1100 units. For example, each unit can be supplied with a full third axis, up to 32 tool-length offsets, and up to 8 tool-radius offsets. Silicon-controlled rectifier drives may be specified in 0.5-, 0.75- and 1.5-horsepower units.

Allen-Bradley Co., 747 Alpha Drive, Highland Heights, Ohio 44143 [371]

Industrial timer provides six scales

An industrial timer, model 650, is designed for such applications as process control, machine-tool control, laboratory research, and testing. The 650 is furnished for either on-delay (reset on loss of power) or off-delay (non-reset on loss of power) operation. The unit features six selectable timing scales covering 0.2 to 6 seconds, 2 to 60 s, 0.2 to 6 minutes, 2 to 60 min, 0.2 to 6 hours, and 2 to 60 h. Fine adjustments within a timing range are also possible. The timer operates on 120

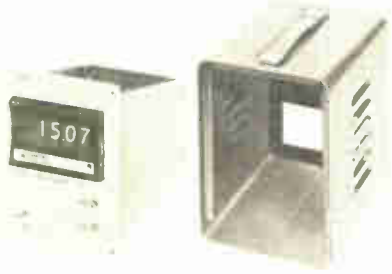


volts at 60 and 50 hertz or 220 V at 60 and 50 Hz, and nominal power consumption is 10 volt-amperes inrush, 8 VA sealed.

Tenor Co., 17020 W. Rogers Dr., New Berlin, Wis. 53151 [373]

Digital pressure indicator is accurate to within ±0.15%

A digital pressure indicator called the model 15 PSI is suitable as a secondary standard test gauge for calibration of pneumatic controllers and transmitters operating at 3–15 pounds per square inch. Accuracy is to within ±0.15%. Other pressure ranges are available from 4 to 1,500 psi at accuracies to within ±0.25%.



The system consists of a 3½-digit panel display that provides one part in 1,500 resolution, a built-in regulated power supply to operate from 115 V, 50–60 hertz, and pressure sensor. Price ranges from $410 to $490, depending on options.

Ametek Instruments and Controls, 860 Pennsylvania Blvd., Feasterville, Pa. [374]

Timer offers eight ranges from 2 to 300 seconds

A percentage timer, called the series PAS, is offered in eight time ranges from 2 to 300 seconds. The PAS is rated for 1 ampere rms steady-state maximum, with a typical voltage drop of 1 volt maximum. Operating as an on/off recycling timer, the ratio of on-to-off percentage is adjustable over one cycle with a common control, the total cycle time always remaining fixed. Repeat accuracy of

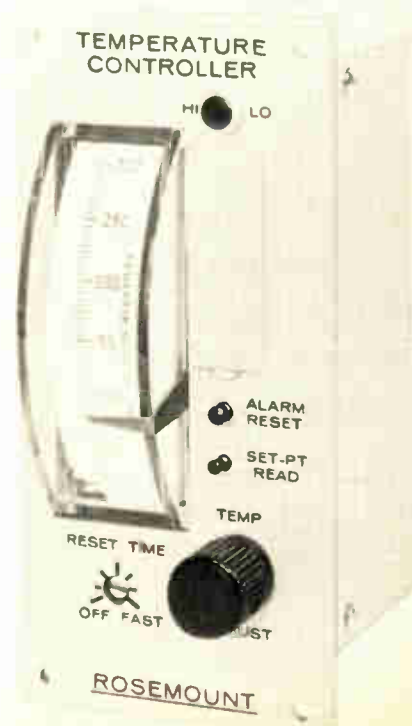
New products

the time delay is to within ±2% under fixed conditions, and the total cycle time tolerance is ±10%. Price is from $18 in quantities of 500 to 999. to $24.65 for 1 to 9 units.

Omnetics Inc., P.O. Box 113, Syracuse, N. Y. 13211 [375]

Temperature controller gives at-the-machine regulation

Individual controllers for at-the-machine temperature control provide a number of different control functions, including proportional, manual, and automatic reset. A variety of output signals is available to interface with process equipment. The units have self-contained power stages up to 2 kilowatts at 230 volts ac. and pushbutton set-point indication with remote set point is available. The units, called the series



3210, can be used for remote digital or analog temperature readout.
Rosemount Nashville Inc., 100 Hiel-Quaker Blvd., Interchange Industrial Park, Lavergne, Tenn. 37086 [376]

Vibration monitor uses amplitude-measuring pickup

The model VT-12 vibration monitoring system uses a seismic amplitude-measuring vibration pickup to measure machine vibration. Adjust-

able alarm and trip set-points operate relays and associated panel lights when vibration exceeds preset levels. A front panel meter displays vibration amplitude, and pushbutton switches actuate an internal calibration circuit that can also cause the trip and alarm levels to be shown. Frequency response is from 10 to 1,000 hertz.
The Indikon Co., 76 Coolidge Hill Rd., Watertown, Mass. 02172 [377]

Temperature controllers handle 300 W per cubic inch

The models 5C1-105 and 5CX-105 temperature controllers provide 1.2 kilowatts of control in a 2-inch-square by 1-inch-high package. The ac zero-voltage-crossing circuit used is insensitive to environmental temperature changes from −20°C to +70°C and line fluctuations from 100 to 140 vac. Up to 10 amperes of output current controls temperatures from −65°C to +425°C.
Oven Industries Inc., 1106 E. Simpson Rd., P.O. Box 229, Mechanicsburg, Pa. [378]

Data handling

Disk can store 96 million bits

Double-track-density type provides random-access time of 75 milliseconds

Taking its cue from the large IBM-plug-compatible disk makers, the DataStor division of Iomec Inc. has developed a double-track-density version of its well-established 2000 series Iodisc. The new model, which employs one fixed and one removable disk per drive, is called the Iodisc 2004; it has a storage capacity of 96 megabits, compared with 48 megabits for the 2002. And from the user's viewpoint, the best thing about the doubled capacity is that it costs only 10% more.

The 2004 has a capacity of 1,624 tracks, including 24 spares, with a track density of 200 tracks per inch. Bit density is 2,200 bits per inch, and data transfer rate is 1.56 megabits per second, nominal. Total disk storage capacity is 78.6 megabits for the 24-sector-per track version; 81.9 megabits with 16 sectors per track; and 96 megabits for the full-track version. Access time, including head setting, is 75 milliseconds for an average random move, and 35 ms track-to-track.

The key to increasing the track density lay in the head-positioning system. In the 2004, the four heads—one per disk surface—are positioned by a voice-coil actuator, which is controlled by a closed-loop servo system called Optotrack. In turn, Optotrack employs a light-emitting-diode photosensor circuit, along with precision track-positioning grids for adjusting the heads.

The new 2004 drives can be furnished complete with controllers and interfaces for most minicomputers, including DEC, Data General, Hewlett-Packard, and Microdata models. Three types of cabinets are available to house complete subsystems for either laboratory or business office. Major system components—drives, power, controllers—are also available for custom packaging by the OEM customer.

Iodisc 2004 disk drives can be shipped within 60 days of receipt of order, and are priced at $3,995 to OEM customers in lots of 100.

DataStor Division, Iomec Inc., 345 Mathew St., Santa Clara, Calif. 95050 [361]

CRT display offers 20-μs full-screen settling time

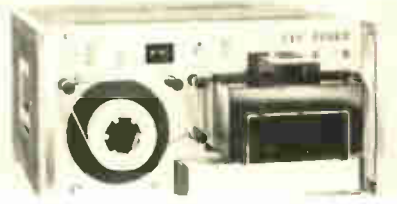
A 0.0001-inch spot size and full-screen settling time of 20 microseconds are features of the model

PD1200 CRT display. Applications include film and hard-copy printing recorders, flying-spot scanners, film readers, computer-output displays, and TV monitors. The unit can scan at rates from dc to the maximum bandwidth capability of the deflection system. The unit is capable of random-access X-Y deflection. Price is $18,500

Gould Inc., Data Systems Division, 20 Ossipee Rd., Newton, Mass. 02164 [364]

Data-tape punch operates at 70 characters per second

Designed for off-line data logging, a versatile data-tape punch with a wide range of formatting flexibility can be connected to measuring instruments that have TTL-level, BCD outputs. Line numbering and



sampling control are built into the model 3489A. When enabled by a front-panel switch, a built-in data counter adds a four-digit number to each data line. A built-in interval timer permits unattended operation. Punching speed of the 3489A is 70 characters per second. Any code up to 8 bits can be programed, along with special-format characters. Price is $3,000.

Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304 [365]

Display terminal can protect any of 2,000 characters

The model 7700A CRT terminal, for data transmission and reception, offers a capacity of 2,000 characters. The unit has the ability to put any character or group of characters in a protect status, so that the operator

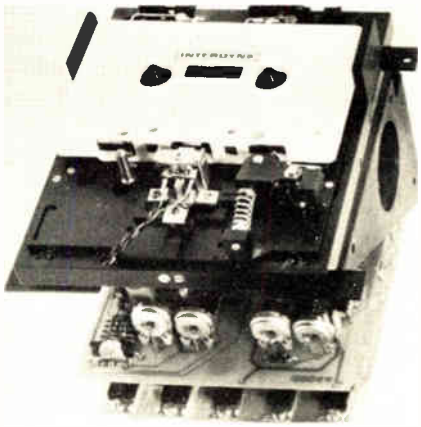
can enter a character matrix on the screen and keep these characters while altering other input data. The 7700A, which can transmit its cursor location to a computer, has full cursor and editing controls.

Lear Siegler Inc., Electronic Instrumentation Division, 714 N. Brookhurst St., Anaheim, Calif. 92803 [366]

Digital cassette drive writes, reads at 20 in./s

A data-transfer rate of 16,000 bits per second, fast search, and dual-threshold detection are features of a cassette digital tape drive that is designated the model IC2511. Write/read speed is 20 inches per second, and capstan-controlled search speed is 40 inches per second.

The dual-threshold circuitry is similar to that used in reel-to-reel recorders. Setting a higher threshold for the initial read-after-write, and automatically switching to a lower

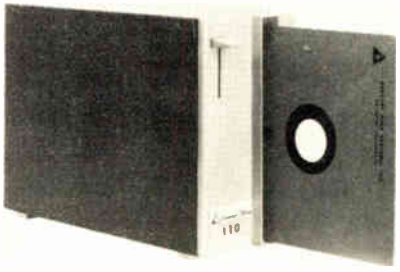


threshold for subsequent read operations, provides greater assurance of error-free data by assuring that the dropout level was within a preset value during the write operation.

Interdyne Co., 14761 Califa St., Van Nuys, Calif. 91401 [368]

Disk system transfers data at 33,000 bits per second

The model CDC-100 random-access floppy-disk drive is for applications in computer program loading, storage, and other tasks where paper tape, card, and cassette devices are now used. The unit uses a 7.5-inch, four-mil Mylar-jacketed disk that



stores over 1.4 million bits of data on 64 tracks. Data is transferred at 33,300 bits per second, and track-to-track access time is 40 milliseconds. The units are available with read-only, read-write, or read-after-write capability. Price is $500 in OEM quantities.

Century Data Systems Inc., 1270 North Kraemer Blvd., Anaheim, Calif. 92806 [367]

Packaging & production

Tubing made of fused quartz

Heavier walls lengthen life of containers used in diffusion furnaces

An expensive aspect of semiconductor manufacture is the short service life of quartz tubing used in epitaxial-growth and diffusion furnaces. Its premature failure is often caused by its poor dimensional stability at high temperatures and fast devitrification rate.

A high-purity translucent fused quartz tubing developed by the lamp glass department of General Electric Co. is said to solve these problems. Known as GE type 511 fused quartz, the material provides wall thicknesses of 6 millimeters instead of the usual 3 mm.

Reportedly it has demonstrated unusual service life at Raytheon Semiconductor in Mountain View, Calif. where it is used for arsenic diffusion on silicon wafers. Suraj Puri, senior engineer at the Raytheon plant, said one tube has been in service 24 hours a day since November 1970, at 1,290°C. A second has been in service since April.

The tubes are 5 feet long, with inside diameter of 96 mm and outside diameter of 108 mm. When a new tube is inserted in the furnace, it is mechanically rotated for eight hours at furnace temperature in order to achieve devitrification and increased strength. Furnace temperature is maintained at 1,290°C for processing of the semiconductor materials; arsenic trioxide is the dopant.

Bombs, boats, and sleds used in the process are also made of the GE type 511 fused quartz, as are the rods used to insert and remove bombs from the furnace. The fused-quartz bombs have a capacity of 45 2¼-inch-diameter silicon wafers. Each process cycle takes about half an hour.

General Electric Co., Lamp Glass Dept., 2400 Highland Rd., Richmond Heights, Ohio 44143 [391]

Modules combine TTL speed, convenient packaging

A series of modules, called DipLogic, combines the DipStik package developed earlier by Stanford Applied Engineering with transistor-transistor-logic devices to provide logic blocks. The company also supplies complete system software and wiring services. Based on the series 7400 TTL devices, the DipLogic family has 22 universal modules, such as gates, flip-flops, and multivibrators, and 10 functional modules, including counters registers, decoders, and latches. Each module consists of a cartridge holding up to five DIP ICs. The cartridge is inserted in a receptacle assembly, which serves as the module housing and as interconnection points for system wire-wrap terminations. Elimination of the standard card connector improves system reliability.

Stanford Applied Engineering, Advanced Packaging Products, 2165 So. Grand Ave., Santa Ana, Calif. 92705 [340]

Universal coil winder is fully automatic

Eliminating all hand processes and the resultant errors, a fully automatic turret winder designated the model WE-202 uses wire sizes 24 to 40 to wind single-pi lattice-wound self-supporting universal coils on axial-lead resistor type form, paper tubes, etc. Fully automatic operation includes hopper-feed loading device, pulling and twisting taps in 3 seconds, cutting taps, cutting leads to any specified length, securing leads with wax or cement, and ejecting finished coils.

The winder can handle coils with diameters from ⅛ inch to 1 in. and up to ¾ in. long. Price of the WE-202 is $15,750.

George Stevens Manufacturing Co., 6001 N. Keystone Ave., Chicago, Ill. 60646 [392]

Wire-wrapped connectors come in 92 varieties

A series of 92 direct card connectors for printed-circuit board applications are available in either 0.100- or 0.125-inch centers. The series 9 wire-wrapped units also come with any number of contacts from 5 to 50 dual-contact positions. Other features include 0.025-inch-square wire-wrapped tails and bifurcated contacts. Price averages 2 cents per contact.

National Connector Division, Fabri-Tek Inc., 5901 South Country Rd. 18, Minneapolis, Minn. [395]

Desoldering system provides variable heat control

The Mighty-Vac is the designation of a desoldering system for removing components and solder from printed-circuit and microcircuit boards. The unit provides variable heat control and allows the operator to desolder from very small to very

large areas. An instantaneous vacuum capability speeds the process and protects components that are thermally sensitive. Price starts at $189.

Manix Manufacturing, Box 65, Feasterville, Pa., 19047 [393]

Ultrasonic cleaning systems offer continuous operation

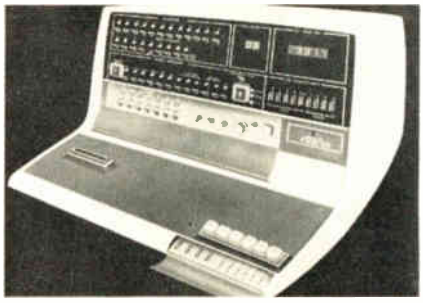
Designed to clean a wide variety of piece parts on a continuous basis, three ultrasonic cleaning systems are suited to multiple cleaning operations involving light loads where immersion time is critical. Each of three units comes equipped with adjustable timers to control processing cycles. Cleaning action is performed

by the implosion of thousands of microscopic bubbles that reach into minute crevices, serrations, and areas normally invisible.

Engis Corp., Hyprez Division, 8035 Austin Ave., Morton Grove, Ill. 60053 [394]

Memory tester designed for incoming inspection

The Interrogator II benchtop memory tester is designed for incoming inspection, engineering investigation, and wafer-probe analysis for semiconductor memory devices. The system consists of a processing console and test-head electronics. The test head is a remotely locatable unit that adapts to wafer probes, autohandlers and manual insertion stations. Functions of the unit include microprogramable address generation, data



generation, and error checking. Price is $14,000.

Computest Corp., 3 Computer Dr., Cherry Hill, N.J. 08002 [397]

Electron gun manipulator allows remote operation

An electron gun for welding applications can be aimed in any direction and moved remotely into position with the model 215-7 manipulator. After the gun has been mounted in the approximate area in which it is to be used, with mounting clamps provided, the chamber is closed and the gun positioned. Three remote motions are provided by the manipulator: rotation of the boom, which swings the gun in an arc, linear travel along the boom, and vertical movement.

BTI Industries Inc., 83-810 Tamarisk Ave., Indio, Calif. [396]

Keyboard system programs read-only memories

Designated the ROM Programer II, a memory programing unit comes with tape reader, typewriter-type keyboard, integral RAM buffer memory, optional ASCII-to-binary translation, device personality cards, programing boards, and a variety of socket modules. It uses keyboard data, a perforated tape or a master ROM or RAM as a data source. The

system will program PROMs of the fusible-link, floating-gate, or avalanche-induced-migration type in a variety of pin configurations.

Data I/O, 13256 Northrup Way, Bellevue, Wash. 98005 [398]

Tester checks all ICs except larger LSI arrays

A tester called the Doctor 32-II has the capacity to provide total testing of all integrated circuits except large

LSI arrays. The unit is computer-controlled and tests functionally, parametrically, and dynamically. It contains an eight-phase clock, in addition to an expanded address-generator microprogram.

Adar Associates Inc., 85 Bolton St., Cambridge, Mass. 02140 [399]

Test connectors are flexible, eliminate insert damage

A single-contact test connector, designated Flexcon, permits continuity, signal, and voltage testing, patching, probing, and connecting. Applications are in computers, missiles, electronic and telephone systems, and aircraft. The unit is for use with MS/AN miniature, subminiature, commercial, and wire-wrapped terminals. The unit is flexible; its shaft bends if an accidental side load occurs during plug-in, thus preventing connector contact or insert damage.

Air-O-Tronics Products Inc., P.O. Box K, Morrisville, N.Y. [400]

New products/materials

Crystal Clear 523 is a chemical for cleansing ceramic substrates used in thin- and thick-film applications. The material works as a surface-tension breaker so that surface contaminants otherwise unaffected by materials such as acetone and alcohol can be removed. The cleaner is volatile, and therefore it leaves no residue after use. Price is $25 per gallon.

Aremco Products Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510 [476]

A heavy-edged aluminum metalized film for use in capacitors is available in a choice of films. An extra-heavy strip of deposited metal at the termination edge improves the quality of the termination and provides a reduction in dissipation factors. This process also allows self-healing and clearing of the finished capacitors to be carried out with low energy.

Am-Met, subsidiary of Atlan-Tol Industries Inc., 29 Knight St., Norwalk, Conn. [477]

A synthetic foam epoxy system is for honeycomb edge-fill, radome repair, and other electronic and aerospace applications requiring low density and high strength. Tra-Bond 2125 is a unicellular material, composed of micrometer-sized glass spheres in an epoxy binder. With low shrinkage, it cures at room temperature to a hard gray material with a uniform point-to-point structure.

Tra-Con Inc., Resin Systems Division, 55 North St., Medford, Mass. 02155 [478]

Precious metals capacitor-electroding inks are custom-formulated and can be made compatible with every known ceramic capacitor system. Tests are conducted to match greenware acceptance, ink drying, and vehicle burnout to specified systems. Single-element, binary, and ternary metals are used to provide a range of materials to meet cost and performance requirements.

Electronic Material Group, Matthey Bishop Inc., Malvern, Pa. 19355 [479]

Two mildly acid electroplating formulations are called Accellerex 2C1 and Accellerex 2C2. The materials deposit 100 millionths of gold in 10 minutes and 5 minutes, respectively, and produce bright yellow deposits. The materials display resistance to corrosion, oxidation, and galling, and they exhibit low electrical resistivity. Applications include plating of connectors and switches.

Sel-Rex Co., 75 River Rd., Nutley, N.J. 07110 [480]

A resistive cermet composition for thick-film hybrid microelectronic circuits is called Ohm-Resist. The material is formulated as a screenable resistor paste with controlled rheology. It is applied by screening on ceramic substrates and is fired to generate discrete resistors and resistor networks. It is available in a selection of sheet-resistant values from 10 ohms to 100 kilohms and is suitable for applications in thick-film resistors and in computer applications. Price is $18 per ounce in 20-ounce quantities.

Transene Co., Route 1, Rowley, Mass. 01969 [436]

Eccofoam EFF-14 and Eccofoam EFF-14-FR are one part epoxy-based powders that cure to a fine structured synthetic foam with a density of 14 to 15 pounds/cubic foot. The cured material can be easily dug out and re-encapsulated when making repairs or replacements of components in an electronic module. It is designed to pack tightly around components and infiltrate into small crevices when vibrated, lending firm support. Price is $30/gallon.

Emerson & Cuming Inc., Canton, Mass. 02021 [437]

New literature

Logic probe. Advanced Digital Research Corp., 1901 Old Middlefield Way, Mountain View, Calif. 94040. The first of a series of applications notes describes the use of two digital test instruments. The logic pen measures logic levels and the presence or absence of pulses and pulse trains. The Chronos DTM measures period pulse width and delay of pulses and pulse trains in digital logic circuitry. Circle 421 on reader service card.

Resistor. Data sheet 3306, available from CTS Keene Inc., 3230 Riverside Ave., Paso Robles, Calif., describes the model VA-305 Cermide thick-film, vernier-adjustable resistor. [422]

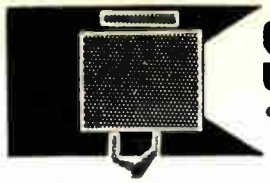
Epoxy tubing. Stevens Tubing Corp., 128 North Park St., East Orange, N.J. 07019, has published a 10-page catalog listing various sizes of open-stock tools on which Fiberglas laminated epoxy 155°C tubing is molded for coil and potting forms. [423]

Light-emitting diodes. A 52-page LED selector guide, designated SG721 and including switches, indicators and related readout devices, is available from Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237. [424]

Counting dials. Amphenol Connector division, Amphenol Controls Operation, 2801 South 25th Ave, Broadview, Ill. Low-cost digital turns-counting dials designed for panel-mounted 10-turn precision potentiometers and other devices are described in a bulletin that includes specifications, line drawings, and indication and rotation information. [425]

Power supplies. An eight-page catalog that gives specifications, dimensions and prices of 300 models of power supplies is available from ACDC Electronics Inc., Oceanside Industrial Center, Oceanside, Calif. 92054 [426]

Capacitors. Wesco Electrical Co., 27 Olive St., Greenfield, Mass. A data



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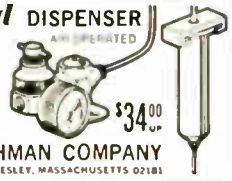

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sheet describes the type 32 PL, a polypropylene film-foil capacitor. [427]

Event recorder. A data sheet from Gulton Techni-Rite Electronics Inc., Route 2, East Greenwich, R.I. 02818, provides details on the 20-, 40-, and 60-channel stylus-deflection event recorders. The sheet discusses theory of operation, choices of chart drive and stylus actuation, and typical applications. [428]

Terminals and connectors. A 12-page catalog from Hoffman Industrial Products, 170 Allen Blvd., Farmingdale, N.Y. 11735, lists more than 1,000 solderless terminals and connectors, as well as crimping tools. [429]

Recorders. A four-page bulletin describes the Types R and RC Dynograph recorders available from Electronic Instruments Div., Beckman Instruments Inc., 3900 River Rd., Schiller Park, Ill. 60176. [430]

Timers. An 18-page brochure available from Oscilloquartz S.A., CH-2002 Neuchatel 2, Switzerland, designated "Time Scales 1972," gives the background of precise measurements of time and information on synchronization of timers. [431]

Thin-film materials. Materials Research Corp., Route 303, Orangeburg, N.Y., is offering a selector guide on thin-film materials. [432]

Microwave electronics. Cober Electronics Inc., 7 Gleason Ave., Stamford, Conn. 06902. A catalog provides information on high-power microwave electronics. Included are communications transmitters for earth-to-satellite applications, traveling-wave-tube amplifiers for calibration and testing, and rf sources for component testing. [433]

Timing cells. Two engineering bulletins give application information on Koolometer electrochemical timing cells and operating considerations for these miniature timers. Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247 [434]

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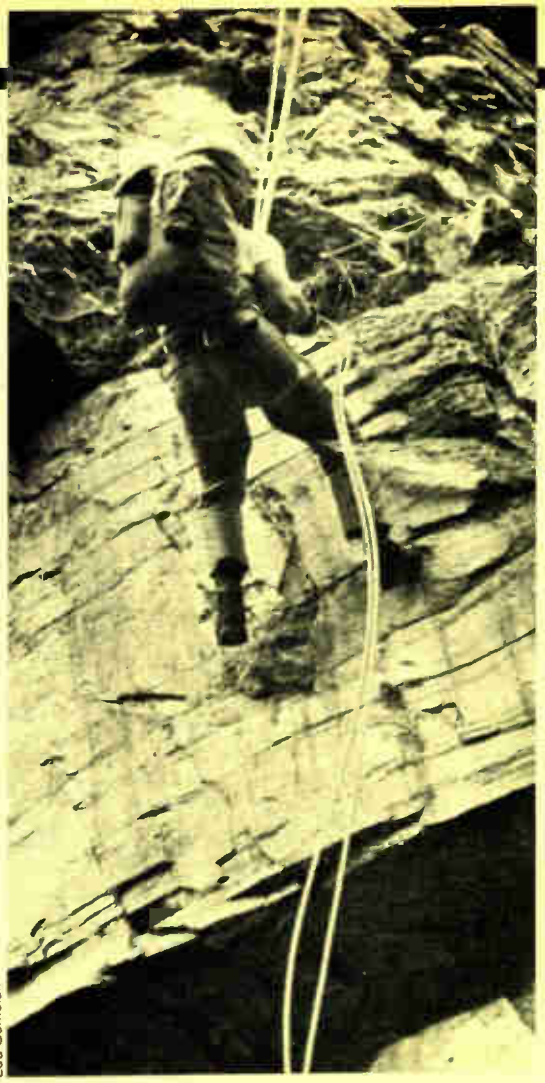

Lou Gomolak

personal business

SELF-HELP

Outward Bound: a cram course in lifemanship

The belaying rope seemed secure. So did the rappelling harness. Hesitantly, Peter Anderson backed to the edge of Linville Gorge in North Carolina and began a rappel down its 140-foot face. Suddenly his boots slid. Anderson clutched the ropes with soft, executive-suite hands. He dangled for a moment, then began to slip, coming down too fast. . . .

Anderson, the 30-year-old manager of the Detroit facility of Distribution Centers, Inc., was one of nine executives—and this writer—undergoing the sometimes hair-raising wilderness challenges of an Outward Bound School. We were taking a special nine-day manager's course of the North Carolina OBS, a fast-paced version of the 28-day courses conducted at the six OBSs across the country. In the U. S. alone, some 18,000 men, women and teenagers have discovered the challenges and rewards of Outward Bound. Since 1968, corporations such as IBM, Ford, Lear Jet, and many others have put some 600 executives through the OBS mill. According to the tenets of Outward Bound philosophy, all of them should have emerged with greater confidence in themselves and others—and thus higher capacities for teamwork—as a result of their plunge into the wilds.

Peter Anderson's unscheduled plunge down the face of Linville Gorge ended when his boots thudded heavily on firm ground. Angry, shaken, his hands bleeding from the ropes, he shouted up the cliff where the rest of the "crew" was preparing to descend. "Give them gloves," he bellowed. "They'll shred their hands if you don't." He tossed aside his 56-pound backpack and stared at his bleeding palms. "Who needs challenges like this?" he demanded. Then his face split in a grin. "Wow, that was *tremendous*!"

Unwittingly, Anderson's reaction—thinking first of others and then of himself—capsulized the purposes behind the Outward Bound program. It was to achieve just that sort of reaction that Dr. Kurt Hahn, noted German-born headmaster of Scotland's Gordonston School, established the first OBS in wartime 1941 at Aberdovey on the sea-swept coast of Wales at the behest of England's maritime service. He put together a program that helped tens of thousands of city-bred seamen to cope with the hardships of war at sea. Outward Bound's motto became (and remains today), "To Serve, To Strive, Never to Yield."

There are now 28 schools on five continents, all loosely associated with the Outward Bound Trust in Great Britain. Outward Bound, Inc. (Reston, Va. 22070) coordinates the activities of the six U. S. schools. They are the Outward Bound Schools of Colorado (P. O. Box 7247, Park Hill Station, Denver 80207);

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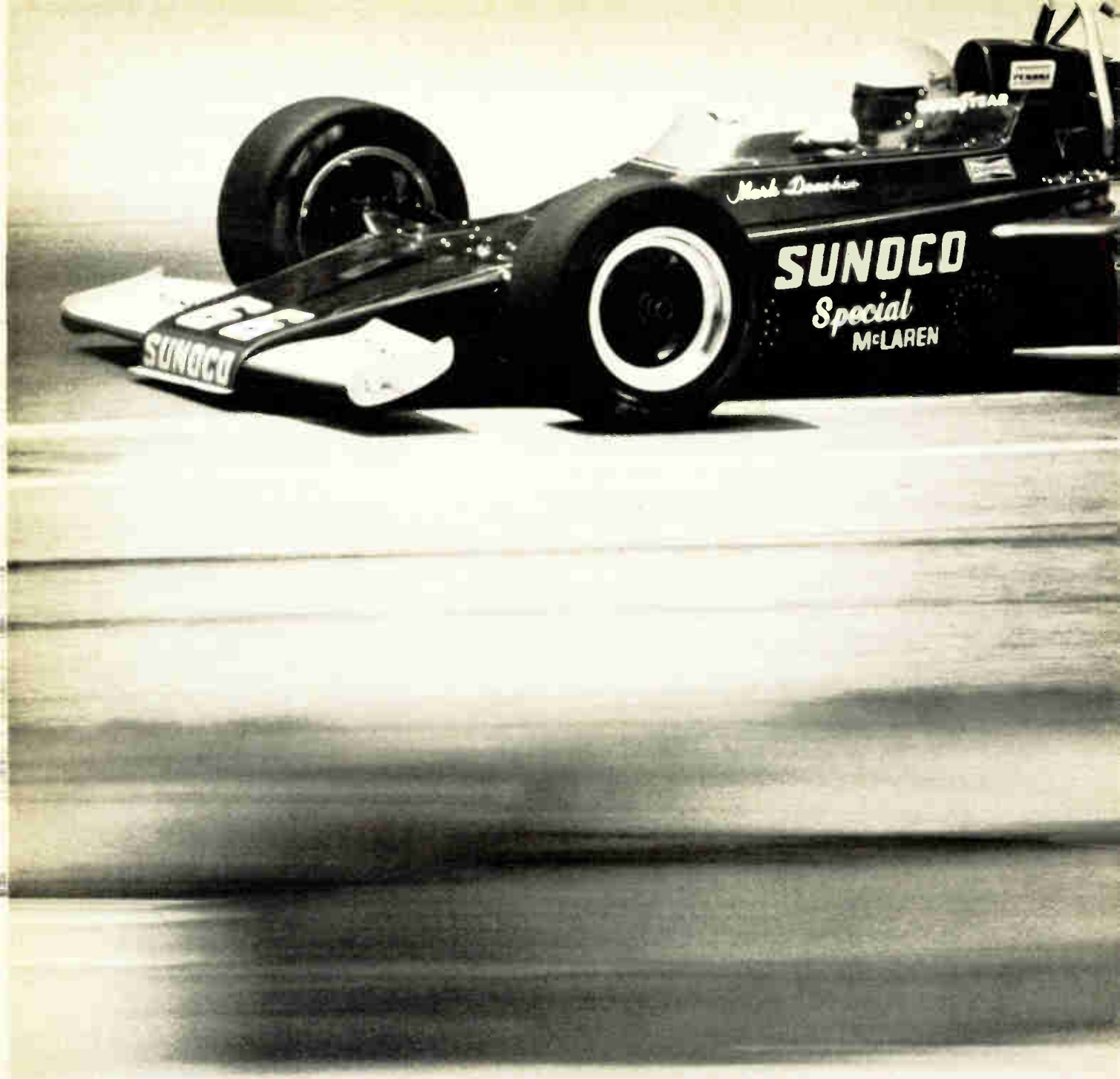

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Finally, for the hard core, the night before the 500, Duane Carter, Jr. won the feature midget at the fairgrounds. In a Sesco Chevy with Champion plugs.

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The complete 28-day course costs $400 (the nine-day manager's course in which Anderson enrolled, $300) and can include anything from sailing off the coast of Maine to mountaineering in the Rockies to trekking across the desolate Baja in Mexico.

None of the courses is for the faint of heart. In the past 10 years, six persons, including two instructors, have died in Outward Bound mishaps.

We, of course, did not know all that when we reported one recent rainy Friday to the North Carolina OBS. The first shock was to discover that Outward Bound not only abjures alcohol and drugs, but allows no smoking. Painful as

By LOU GOMOLAK
McGraw-Hill World News

it was for confirmed smokers, it was the least of our problems for the next nine days. Pouring rain and blisters were our companions. There were early (5:30 a.m.) runs, always up and down a nearby mountain, and plunges in icy streams. As part of the nine-day drill we were never told what to expect— challenges, such as Linville Gorge, were thrown at us without advance warning. You simply learn to take each challenge as it comes. It is Outward Bound's way of shaking people out of mental ruts.

Further, not one of the group was an outdoorsman to any mentionable degree. Three were company presidents, three were board chairmen. There was a professor, a minister and a department manager. They were not particularly athletic; Anderson, for one, admitted to being 45 pounds overweight. We huffed and puffed together through whatever the OBS instructors threw at us.

Actually, the very fact of our common out-of-condition state seemed to speed the process of pulling us together as a crew. Halfway through the course, the teamwork paid off. We were on our way to the Chattooga river in northern Georgia for two days of white-water rafting when a truck careened into a small river, smashing to bits. Unhesitatingly, our tenderfoot crew rescued the driver.

They were, in effect, acting out some of the basic concepts of Dr. Hahn, Outward Bound's founder. He believed that one learns to revere life by living it elementally; this builds self-respect, and from it grows compassion and respect for others. The sense of inter-dependence becomes particularly acute, we found, when the other fellow is holding the line on which your life literally hangs.

Results, of course, were not always heroic. During one rock-climbing and rappelling practice session, for instance, one of our executives actually hid in the bushes until we were ready to leave. But, perhaps due to our new-found Outward Bound insight, we realized that courage might have failed any one of us anywhere along the line. There were no recriminations.

That's what Outward Bound is all about. It's not a summer camp, nor is it a "survival" school. It is designed to broaden elemental insights into oneself and other people.

Sometime later, when we had had a few days to evaluate our feelings about the Outward Bound experience, Peter Anderson perhaps best summed up our crew's reaction. He recalled a three-day hike through some of America's most rugged bush country, along the slopes of the Blue Ridge Mountains. "I was so beat, my legs were rubber. They simply would not move, even after I'd rested. It was that kind of exhaustion," he said. "But you know, I think I'm a better man for it— better, in that I think I have more awareness of people, and therefore am probably a better executive, and so a lot better at my job."

Later, OBS student-executive Anderson felt it was all worth the travail.

Lou Gomolak


gallery
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the personal business shopper

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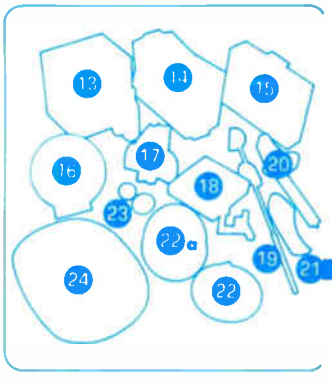

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Conditions for refinancing a mortgage are generally better now than at any time in the past three or four years. So if a breadwinner has lived in his home long enough to have paid off a fair chunk of the mortgage, and if his property values have gone up with the national average or better, he may have enough equity to raise the amount he needs without substantially altering his monthly mortgage payments.

Further, if his income has risen appreciably in the intervening years, he may be able to carry much larger mortgage payments. Say he bought a $30,000 house with one-third down in 1962, when he was earning less than $15,000. In a tight housing area, such as the New York or Chicago metropolitan regions, that house today may well be reappraised at $45,000. If his current income will carry the load, he might arrange a new mortgage of $36,000 (up to 80%) or so. On that basis, paying off his old mortgage (which is probably $13,000 or less by now) and other costs, leaves him with about $20,000 in cash.

Interest rates probably are as low as they are going to get in the foreseeable future. And this may be the last year when you can get a fixed low rate with ease. Variable-rate mortgages are due for a big push from the Federal Home Loan Bank Board, which hopes their use will help avoid the feast or famine condition of S&L deposits.

Right now, deposits are high, so banks and thrift institutions have plenty of cash to lend. You'll probably come out better, too, on a house reappraisal at current market values than you might have a year ago. The upward spiral then had tempered a bit, due partly to a slowdown in executive relocations. And alternate methods of raising cash still are pretty expensive.

"There are a lot of people who have never used the equity and the borrowing power they have in their homes," observes Thomas Grueling, senior vice president of the Home Federal Savings & Loan Assn. of Chicago. Instead, he notes, they frequently use short-term, high-interest-rate personal loans, which may get them into difficulties.

New borrowing, of course, costs money. Even the so-called open-end mortgage, now commonplace in conventional mortgages granted by savings and loan associations, does not make new money available without charge. State laws governing the mechanics of open-end mortgages vary, but there usually is some sort of loan service fee.

Mortgage loans insured by the Federal Housing Administration or the Veterans Administration cannot be refinanced. So if you want to tap the equity in your home, and you have this type of mortgage, you will have to refinance on a conventional basis.

Some insurance companies and commercial banks no longer pursue the home mortgage market, and if one of these holds your mortgage, you are unlikely to find it willing to refinance for you. In that event, you must shop around for another lender. This may not be easy.

Home Federal Savings & Loan Assn., San Diego, looks quite carefully before refinancing of mortgages held by other lenders. But it will refinance up to 80% of the reappraised market value of a home. So will its namesake (no relation) in Chicago and Bowery Savings in New York.

Some lenders, however, are far more conservative. For example, New Haven Conn. Savings Bank will not refinance for more than 75% of the initial amount of the mortgage, unless substantial improvements have been made. "We're concerned with a person's true equity in the property," explains vice president Robert Geir, "not inflated-value equity."

On the other hand, there are some lenders who are granting up to 90% loans on reappraised values. Milwaukee's Mortgage Guaranty Insurance Corp., which insures the top 15% of 90% conventional mortgage loans much as the FHA or VA insures government backed mortgages, says refinancing loans account for between 4% and 6½% of its monthly loan volume. The availability of private mortgage insurance doubtless encourages more lenders to refinance up to 90%.

Lenders generally agree, however, on the factors a borrower should consider before refinancing:

- Refinancing is just like getting a new mortgage. You pay the same closing costs, which can run as high as $600 or $700 on a $30,000 mortgage (not including the tax escrow advance you must pay a new lender), even though you have been a good customer for many years. So make sure you will clear a sufficient amount of cash to justify the higher cost. Generally speaking, lenders don't advise refinancing for anything less than $4,000.
- Don't give up a mortgage with a rate of less than 6% unless you absolutely cannot raise the money any other way.
- If you are over 40 years of age, make sure the new commitment will not conflict with retirement plans—you don't want carry a big house payment after your income goes down.
- Be sure you know where you stand on prepayment penalties. They can vary from state to state.
- Finally, it can cost you just to apply for refinancing. Bowery, like others, exacts a $35 appraisal fee, whether or not it makes the loan.

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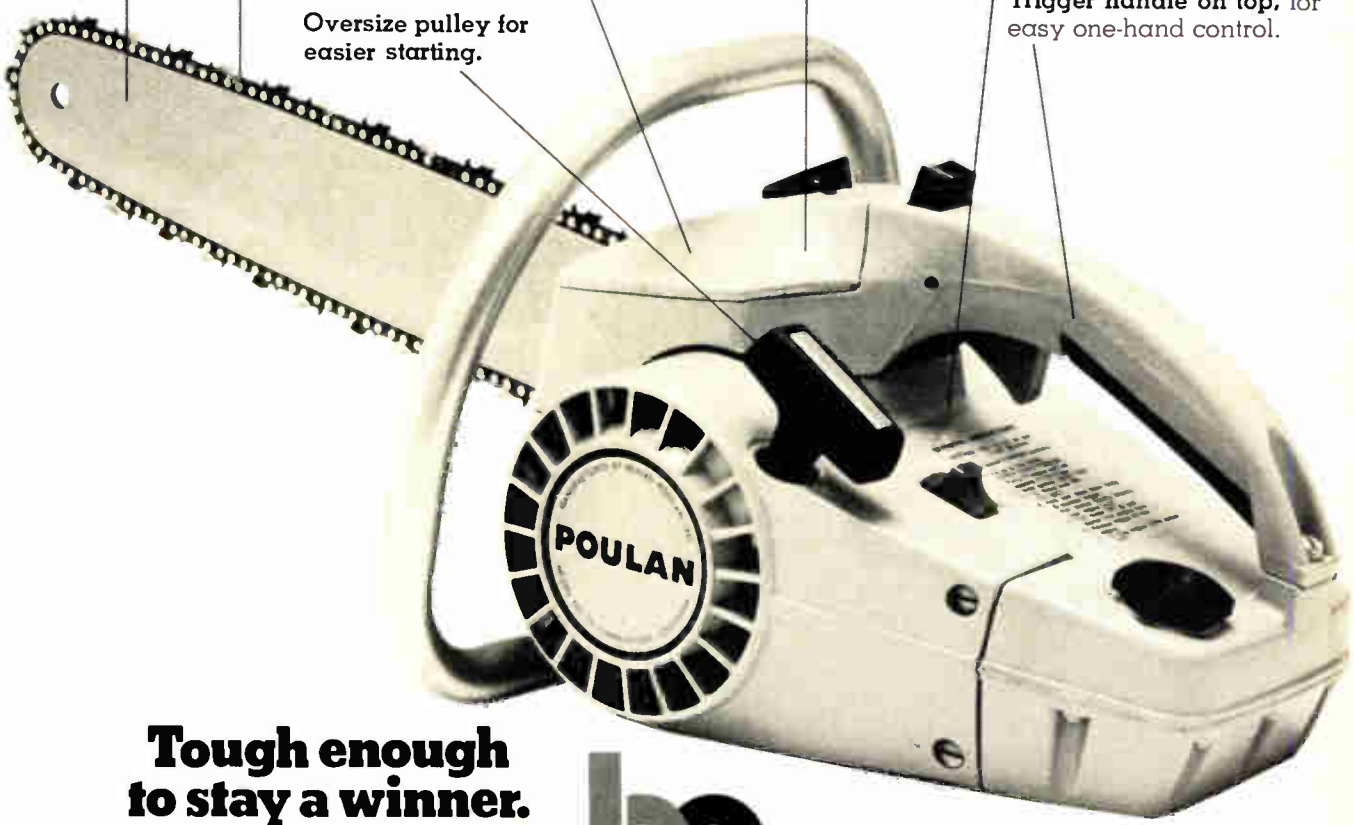

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EDUCATION

Some ways to miss the jobless fate of "Class of '72"

FLEXIBLE PROGRAMS PLUS GOOD COUNSEL ARE KEYS TO CAREERS

"At the bottom of every diploma they ought to write in indelible ink, 'This certificate in no way entitles the bearer to a job'." So says one grim member of the Class of '72—an Ivy Leaguer to boot. Months after commencement, he still has no job or even a reasonable offer.

But his predicament is not particularly rare. A lot of last June's college graduates will be among this fall's unemployed—or working at menial jobs to make ends meet until something opens up that is more in line with what they learned in college. Worse yet, the problem does not appear to be a temporary

By BARBARA RADLOFF

phenomenon caused by economic slowdown. The simple fact is that competition for jobs of college-trained quality is likely to become even more fierce. The reason: Back in the 1960s, when business wooed the newly graduated with juicy offers, only one out of 12 people in the labor force had a college degree. The way upper schooling has boomed, however, by 1980 one in six will hold a sheepskin.

The U. S. Dept. of Labor insists there should be enough college-level jobs to go around. The problem is that in some fields supply and demand don't balance at all times. The possibility, then, that four years of book-learning may lead to the unemployment line will remain a specter indefinitely for U. S. collegians—and their parents who foot the bills.

The result has been a shift in emphasis at traditional placement and guidance offices of U. S. colleges. "We are putting the emphasis on career guidance rather than job placement," says a New York University dean. Parents, too, can do their part, and here are some tips the experts suggest they pass along to their college-age young:

- Get skilled counseling help—and get it early.
- Avoid career planning with only the current job market in mind. Rather, look at how certain jobs will change in the fu-

ture—and how the demand for related talents may change, too.

- Look at careers or interests in "clusters"—not just at one specialty within a career spectrum.
- Plan college curriculum, above all, with an eye to keeping options open. Think in terms of a double major, a strong minor, or a series of courses in an area of alternative interest.
- Get a summer job, if at all possible. Preferably it should relate to one's choice of career. But getting and holding *any* job at least marks a student as responsible—and may even open a new vista or two.

Of all these tips, guidance counselors consider most important the suggestion of getting proper guidance early. "The idea is not merely to push square pegs into square holes," says Patrick McDonough, executive director of the American Personnel & Guidance Assn. in Washington. "Rather, early counseling gives the student the tools he needs to make decisions." Best of all, it gives him the chance to change his mind and possibly shift course before graduation is upon him.

As for the future job market, the U. S. Dept. of Labor's manpower experts keep a set of figures a student can hardly ignore. They predict supply and demand trends in various occupations. For instance, they currently indicate that in 1980 physicians, dentists, chemists, dietitians, physicists, and counselors of various sorts will be "significantly" in short supply. On the other hand, teachers, biologists, and mathematicians are likely to find jobs scarce. Despite the current poor market for engineers, their stock will rise. "With the declining enrollment (in engineering schools) now," says Neil Rosenthal, chief of the Bureau of Labor Statistics' Occupational Outlook Service, "there could be developing shortages."

The trend figures, available at any local office of the BLS, don't tell the whole story. How they are interpreted is what counts, and that is work for a competent guidance counselor. For example, a shortage of physicians does not assure a particular pre-med student a place in medical school. If he hasn't provided for alternatives, he might be in trouble.

For just this reason, the collegian should explore interest "clusters," or fields. Girls, for instance, should not automatically assume that if they want to work in medicine they must go to nursing school. Dietitians, therapists, administrators are all needed.

Flexibility is the key, and counselors more than ever are urging care in selecting courses and programs of study. The double major (carrying courses to fulfill requirements in two major subjects) is a frequent recommendation for students uncertain about career potentials. "Minoring" or taking a string of related courses in an alternate field are variations of the same idea. "The point," says Northwestern's Frank Endicott, "is to have an alternative—not to keep all your eggs in one basket."

In all the anxiety about the job potential of a college degree, counselors are issuing a couple of warnings. One is against abandoning liberal arts for strictly job-oriented training, although liberal arts graduates are usually considered the weak sisters of the job market. Counselors, noting that college should be more than a job-training factory, also note that liberal arts graduates may, in fact, have more options open to them than strictly business-oriented or engineering students. Their second warning is to parents: Ultimate responsibility for a career choice lies with the student. So he will need reassurance and encouragement, not parental pressure to do what father thinks best.

Most heartening advice to students caught up in career anxieties comes from Allan Carter, the national manpower expert who accurately foresaw the Ph.D. glut a decade ago. "There are never enough *good* people in any field," he says. "If a student is really committed, then I say charge ahead."

Battening down summer houses for the season

As the time draws near to shutter the family summer place for the year, the wise owner starts looking around for a real estate agent or other responsible party to keep an eye on his hideaway while he's back in the city earning the money to pay for it. Why bother with off-season surveillance? Because there may be, among other things, sizable tax deductions that could bear watching—casualty losses, for instance.

Further, if the place has been rented to others for part or all of the summer, it's a good time to establish what share of the rent the Internal Revenue Service is *not* going to get, that is, what part can be deducted as legitimate expenses.

Suppose over the winter the wind rips off some shingles, water damages the ceilings, or a family of raccoons raises hob. Hiring an agent or other caretaker may not prevent the damage, but it will at least let you know *when* the damage occurred—and that's important to the IRS. Except in cases of theft, IRS rules allow casualty deductions for the calendar year the loss *occurs*, not for the year in which it is discovered. Damage discovered next May would be hard to date.

Casualty losses are tricky enough without further complication. They can be deducted in excess of $100 and to the extent not insured. You can deduct loss from such "sudden" events as fire, storm (including sand storm), flood, freezing, landslide, tidal wave, theft and vandalism. But you cannot deduct for losses due to insects, erosion, rusting or rot—these aren't normally "sudden" enough. Proof, too, is vital, and it is good practice to take photos promptly, gather whatever clips local newspapers may yield, and get an appraiser's statement. A prompt report of any theft or vandalism to the police will also help your case.

When a summer place is rented out, tax deductions can be taken for such non-capital items as maintenance, depreciation and insurance. The question is: How much? Recent IRS rulings and court cases point to two main rules:

■ If a house is rented part of the summer and occupied by the owner the rest of the season, expenses covering only the period of rental can be deducted. What's more, the deductions cannot exceed the rental income, unless it can be shown that the rental was not a casual matter and that the owner really intended to make a profit.

■ If a house is up for rent at the beginning of the season, and the owner does not use it at all during the summer, then he should be able to deduct full expenses for the whole renting season—even if he had a rent-paying tenant for only a few weeks.

The issue of what's deductible in a part-time rental deal was fought out—unvictoriously—by the owner of a vacation house in Sea Island, Ga. The taxpayer offered his house for rent eight months of the year, reserving it for himself during a prime four-month period. He reported rental income of $3,600 the first year, $2,400 the second, and zero the third. Yet each year he claimed deductions of $3,200 for operating costs and $4,000 for depreciation. His declared losses for tax purposes thus ranged from $4,000 to $7,500.

The IRS cut his deductions to the amount of the rent for the first two years. It allowed nothing for the third. The Tax Court affirmed the IRS position—the beach house had never been put to income-producing use within the meaning of the law. The owner not only offered it only in the off-season, but claimed maintenance expenses that would not have been covered if he had rented it the best eight months of the year. It was clear to the IRS that he was not engaged in this activity for profit, and it thus cut his deductions.

Here is an example of what the IRS considers a proper arrangement: During a three-month season, an owner rents his house for two months for $2,000. He uses it himself for one month. His year-round expenses are $1,200 for mortgage interest, $600 for real estate taxes, and $900 for maintenance and utilities. Depreciation is computed at $1,200.

The owner must first deduct the $1,800 paid out in interest and taxes (they are deductible whether he rents or not). This reduces his rental income to $200. Thus, since part-season rental is not technically considered a business activity by IRS, only $200 of all remaining expenses are deductible.

When it comes to resale of a summer property, other tax problems arise. Contrary to the common notion, any capital gain an owner makes is not wiped out if he buys another summer place within one year—that rule applies only to a taxpayer's principal residence. And, any loss is normally not tax deductible, unless the property had been converted to rental use some time before the sale. But note that here, too, a part-of-the-season rental does not count. The rental period must be summer-long to qualify.

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The old bicycle just isn't what it used to be

SOPHISTICATED BIKES WITH FOREIGN NAMES ARE HERE TO STAY

The Great American Bicycle Boom that began a couple of years ago has reached a stage sportish fads do when they attain "status". Cycling is no longer child's play, although bikes and kids are still good companions. In the hands of adults, the bike has become a thing of sophistication with a price tag to match. The sport has developed a new breed of connoisseurs, and more than a few name-dropping snobs.

For the once-upon-a-time cyclist who is lured back to the saddle by autumn's invigorating air, it can be unsettling. The old one-speed bike he used to know has been relegated to the toy department, where tiny tots now spurn it. Even the three-speed and five-speed "English" bikes so popular a few years ago are hardly *de rigueur* anymore. The "in" machines are the "lightweights" (under 30 pounds) with *derailleurs* fore and aft that can flip the chain through a series of five, 10, 15 and even (in a model produced in Japan) 30 speeds. Foreign names dominate the field—and the conversation of the new biking elite. The one U. S. bicycle most admired is Schwinn's Paramount P-13, but that is largely because it is made of seamless, double-butted "Reynolds 531" tubing (British), and most of the components are by Compagnolo, the master (Italian) bikefitters.

Top-mentioned English bike among the new cognoscenti is the Raleigh Mark IV (the 1972 12-speed model lists at $425), but it, too, is Campagnolo-equipped. Indeed, the Italian bike makers—Cinelli, Frejus, Bottechia and Atala—seem to hold the current lead among America's name-dropping cyclists although the French (particularly ubiquitous Peugot) are right in there pitching.

Although the manufacturers over the past couple of years have been scrambling to keep up with demand for the professional-type bikes, they are still hard to get. Anyone, for instance, who wants a Raleigh Mark IV this fall can ex-

pect to wait a while after he puts in his order. Dealers across the country report some easing in the lower price ranges, but predict that the sought-after expensive bikes may remain in tight supply right through the season. The chief reason: Campagnolo is stretched to capacity in turning out the parts the manufacturers of the finer bikes need.

The advice of the new biking elite to newcomers is to hold out for the best bicycle they can afford (although they concede that there are some excellent 10-speed and 15-speed bikes in the $100-$200 range). They reason that a fine machine not only adds to the pleasure of biking, but should be considered a lifetime investment—$400, they note, is really not much for something that can be expected, with proper care, to provide enjoyment for 10 or 20 years.

Besides snob appeal, the high-priced bikes have obvious advantages. Their weight (30% to 40% less than ordinary bikes) means that they are that much easier to pedal over long distances or hilly terrain. For the casual biker who merely wants to run errands around the neighborhood, however, even the elite concede that a three-or five-speed, in-hub (the so-called "English") bike may suit one's purpose. Such bikes are certainly cheaper—around $80 for a good one.

The lower-priced bikes may also satisfy the main reason many American adults have taken to wheels: exercise. Dr. Paul Dudley White, the cardiologist, started it all when he prescribed biking as a deterrent to heart disease. The Cox Coronary Institute, Kettering, Ohio, meanwhile, tested a group of middle-aged men and found that a four-month biking regimen significantly improved their heart rate, oxygen consumption, and heart-recovery time. It's noteworthy that they only biked an average of 37 miles a week—well within the capacity of any normal person on an ordinary bike.

For fun and comfort, as well as exercise, however, there is considerable wisdom in getting the best possible bike for the individual—and his money. The most critical part of any bike is the frame (parts and accessories can always be upgraded), because it is the one part that really must fit the rider. The easiest way to check is to straddle the frame (not the seat) with feet flat on the floor and legs straight. If the crotch does not press the top tube, and there is no more than an inch between them, the bike is the right size.

While "Reynolds 531" is the current top favorite label for frames among aficianados ("Columbia" is a close second), a frame is sure to be good if its manufacturer guarantees it to be without seams, "double-butted" (the tubes are of heavier gauge at the ends, thinner in the middle, for less weight and greater resilience), and "lugged" (the tubing is joined by exterior sleeve-like braces).

For a quick visual check of a bike's worth, the newcomer can look in a couple of places. If the rear and fork tips (the points where the hubs attach) are brazed rather than merely plated or painted, it is probably a good frame. After hefting a couple of good bikes, one can almost tell by feel whether it is double-butted. Center-pull brakes, in which the cable is centered over the wheel calipers rather than attached at the side, generally identify a better-equipped bike. So do "quick release" hubs—those by which the wheel can be removed by flipping a lever rather than having to resort to a couple of wrenches.

Literature on biking has proliferated with the craze. Two good sources for tips on cycling know-how are the Bicycle Institute of America (122 E. 42nd St., New York, N.Y., 10017) and American Youth Hostels, Inc. (20 W. 17th St., New York, N.Y., 10011). Most comprehensive of recent books on biking and the care and maintenance of bikes themselves is *The Complete Book of Bicycling* by Eugene A. Sloane (Trident Press, $9.95).

Barebones look of this top-grade Raleigh is mark of status in new world of bikes.

=MISSISSIPPI PROGRESS REPORT=

INDUSTRIAL EXPANSION in the Greater Jackson area continues to set a fast pace. **GENERAL MOTORS** is among the recent newcomers to announce they will build a multi-million dollar plant in the Clinton Industrial Park, near Jackson. The 350,000 square foot facility to employ 700 persons will be used for the manufacture of electrical wire harnesses for cars to be sold in the fall of 1973.

EDWARD N. COLE, president of **GENERAL MOTORS,** stated the new plant will be constructed by Packard Electric Division of GM. It will be the corporation's first plant in the State and the 113th in the nation.

GULF STATES CANNERS, INC., also broke ground in the Clinton Industrial Park for a multi-million dollar 104,000 sq. ft. high-speed beverage canning plant which will have a start-up production of six million cases of carbonated beverages a year. The system will be among the fastest and most modern in the world, and eventually be the source of canned Coca-Colas for the entire Southeast.

ZINSCO ELECTRICAL PRODUCTS of Mississippi, manufacturers of electrical switch gear, transformers, and related products, announced a $2 million expansion at their Jackson plant. The new 125,000 sq. ft. addition will double present plant capacity and create 200 new jobs.

UNITED INNS INC., of Memphis, has started work on a 20-story, $7 million convention facility in downtown Jackson. The building will include a 2,000-seat convention hall, a dining room capable of accommodating 1,100 persons, 362 guest rooms, and four floors of parking for 400 cars.

FOR MORE INFORMATION about a location for your industrial needs write or call Harry D. Owen, Director, Mississippi Agricultural and Industrial Board, P.O. Box 849, Jackson, Mississippi 39205.

—William L. Waller, Governor

Today's blue-chip may be tomorrow's red-inked loser

THE TRICK'S TO FIND THEM WHEN THEY ARE STILL A-GREENING

Great Aunt Jane's favorite soap, no doubt, was Sapolio. She probably breakfasted on Force, a cereal to which she had been drawn by those "Sunny Jim" billboards she had passed in her Locomobile. And her life was made secure by a portfolio based on some of the bluest blue-chips of the day—American Cotton Oil, American Sugar, Chicago Gas, Distilling and Cattle Feeding, Tennessee Coal and Iron, and U.S. Leather Preferred.

Today an investor would as likely find one of those issues on a list of blue-chip stocks as to be run down by a Locomobile. Yet they were among the 12 stocks which in 1897 composed the Dow Industrial Average, and were the "core" or basic blue-chips for most carefully managed portfolios. As durably "safe" as core stocks are supposed to be, fashions do change in securities as in soaps or breakfast cereals. Of Dow's impeccable dozen of 1897, only General Electric has survived in blue-chip style, paying a dividend yearly since 1899. Certainly today's core stocks are no less immune to the erosion of time, and it is always possible that today's blue-chip may be tomorrow's Sapolio.

Since conservative and orthodox investment managers still, as in years gone by, select core stocks as the heart of their list, it's essential that an investor understand blue-chips and what can—or cannot—be expected of them.

Here, then, are some views from an expert, Gerald M. Loeb, author of the Wall Street classic, *The Battle for Investment Survival*—and the more recent *The Battle for Stock Market Profits* (Simon & Schuster)—and former vice chairman of E. F. Hutton & Co., Inc.:

The problem for the investor is that today's core stock is usually riding on yesterday's achievements. The real trick is to find the future blue-chip and buy the core stock of tomorrow before it has been widely recognized as such. Today's No. 1 favorite—and a top-rated blue-chip for several years—is International Business Machines. Yet it we t "undiscovered" for some time, and not so long ago. In 1949, when Vickers began publishing its list of the 50 most popular stocks with professional managers, IBM did not appear at all.

A proper way to look at blue-chip core stocks is to investigate and challenge their popular position. When you do this, you will find that they tend to fall into groups that can be handled in varying ways from the standpoint of investment.

Most top favorites can be expected sooner or later to slump. But some have the capacity for a comeback. For example, DuPont was a great core stock between 1949 and 1955. It was a stock to hold. Its high price of 1955 was approximately six times its 1949 high. After 1955, however, it changed characteristics, and its market pattern became saw-toothed. Its holdings in General Motors were distributed to DuPont stockholders between 1962 and 1965, a period in which it continued to trend downward. Then, in early 1970, DuPont began what appears to be at least a modest return to favor.

One thing the seeker after blue-chips should do is revise his attitude toward the word "speculation." Somehow, too many people connect speculation with danger or risk. Actually, the word is derived from the Latin "to view," which more properly should be interpreted as "to view ahead." A core stock that has been overworked can sometimes have a flat future, and can turn out to have been a poor purchase. On the other hand, an issue which is yet to prove itself—a "speculation," some might say—can actually be a safe and superior buy when the price trend and outlook are right.

A number of what many people regard as "safe" investments actually sell at excessive prices. Their holders think of them as "investments"—a word that somehow gives them a feeling of safety. It may not be justified. For example, buyers of long-term U.S. Government securities in 1946 accepted income yields of less than 3% as the price of "safe" stability. Such bonds declined drastically when they sold at close to a 7% yield basis in 1970. The many who bought American Telephone as high as $75 in 1964 simply for the security of its dividends must have been sorely shocked when they saw it selling as low as just over $40 in 1970.

A proper way to look a blue-chip core stocks is not to take them at face value, and to challenge their big "name" and popular position. It will pay investors to give more consideration to *valuations* and *future prospects* than to reputations and statistics that are, for the most part, water over the dam. Fifty years ago, names like International Paper, Bethlehem Steel, and Cities Service were highly favored. They don't appear on any blue-chip list today.

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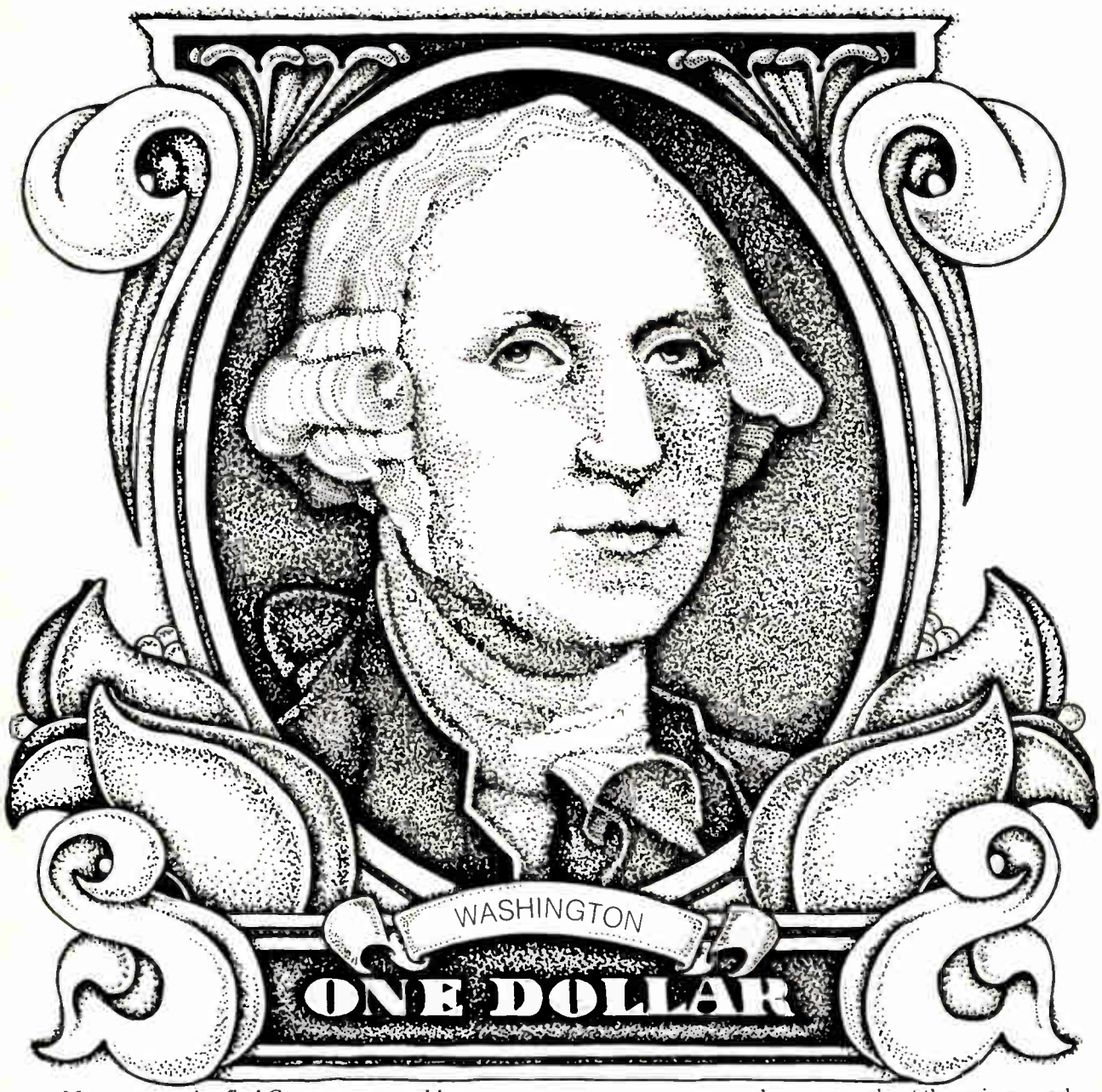

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J. Yes K. No

If so, is it a: L. Mobile Home M. Motor Home
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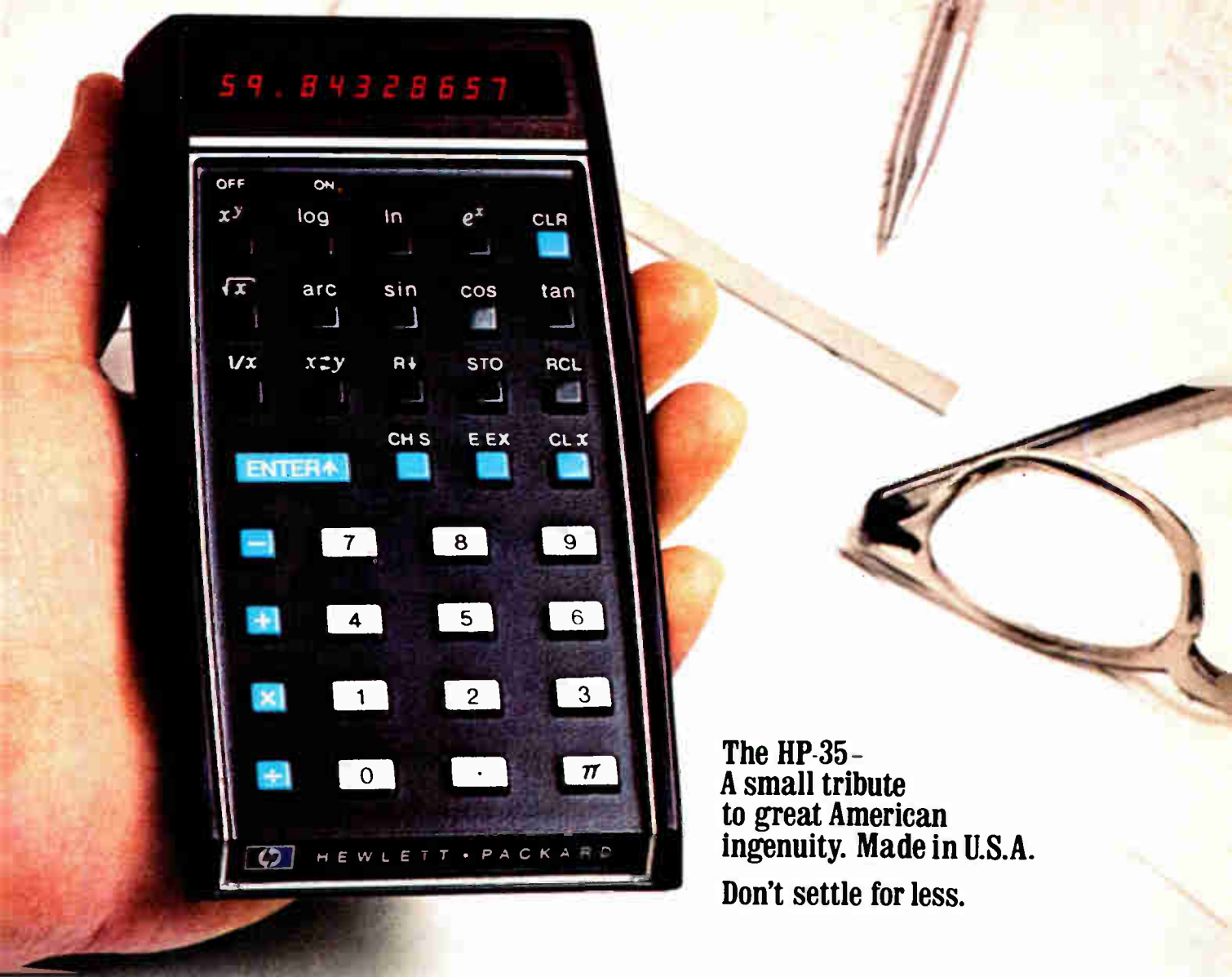

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by Joseph Wiltsee

IRS takes a shot at "vacations in disguise"

That lovely little *combo business-vacation trip* may be in trouble. Internal Revenue has quietly told its agents to clamp down on businessmen who lay on a heavy hand in deducting expenses. Seminars for executives, conventions, trade meetings—held in exotic surroundings—are in for close scrutiny. Business-fun trips by lone VIPs will get a going over, too. Too many vacations in disguise, says IRS. . . . *The rules*: If it's a U. S. trip, you can deduct for travel, meals, lodging, if the *primary purpose* is business. If vacationing is primary, you still may deduct direct business costs (a side trip to call on customers, for instance). If it's a trip abroad, you can deduct it *all* if business is primary and you go for less than a week, or—if longer—you spend less than 25% of the time vacationing. Beyond this, you allocate; if 10 of 20 days are for business, you deduct 50%.

What about a U. S.-foreign trip? If you fly from, say, San Francisco to New York, stop over, then fly on to London, the U. S. part is fully deductible—assuming business is primary. Only New York-London need be allocated. But if it's nonstop San Francisco-London, the whole cost must be allocated. . . . Who's to say what a trip's "primary purpose" is? This comes down to *clear records*: names, places, purposes, etc. *A 25¢ note pad can turn the trick.*

Stock-on-stock: More *stock dividends and splits* are in the works, and there is considerable confusion over how to handle the tax side. Boiling it: You pay no income tax on split or dividend shares, and the deal needn't be reported on your 1040 in April. One exception is where you've a choice of cash or stock; you pay tax, even if you take the shares. . . . A break: When selling split or dividend shares, you get capital gains treatment (max. 35% for 1972)—if you held the *original* shares over six months.

Joan Sydlow

McKinsey's George Foote

"Executive pay plans never stand still," says George Foote, the McKinsey & Co. compensation specialist. Right now, he notes, straight bonus plans have lost their glow due to Pay Board regulations, and there's a push for fresh ideas. "Hottest new item," Foote points out, "is the performance share plan—ideal because it's good for both stockholders and executives." . . . Here the executive is given an incentive award in phantom stock (he pays nothing and gets the shares at a future date). After four or five years, more or less, *if* the company has achieved a specified growth rate, the executive picks up the payoff. Usually, notes Foote, the goal is a 10% cumulative annual gain in earnings per share—for example, with $1 as the base, earnings would have to *total* $5.10 for a span of four years ($1.10, $1.21, $1.33, $1.46). . . . "You'll hear a lot more of this before long," says Foote. "Unlike the stock option, the executive doesn't pay out a dime."

Insurance world: Disability coverage that pays off for loss of income has taken a new turn. A report by J. K. Lasser, the tax people, shows that 40 insurers now have return-of-premium riders. Typically, you get back 80% of your total premiums, after 10 years, *if* payoffs have been 20% or less of the premiums paid. At age 40, $1,000-a-month disability payoff costs $700 a year, and *30% more* with the premium rider. It's a case of gambling on good health.

The good life

Even good backyard barbecue loses savor when it's a summer-long affair. To add a touch to beefsteak, try "glazed steak," originated at *The Leopard* in San Francisco. Broil a 2-lb. thick-cut prime sirloin 9 min. on each side. Spread the top with 4 oz. sour cream, and sprinkle with 2 oz. crumbled Roquefort. Put on the fire under a cover until cheese melts (3 min.); serve with a mixed salad and bottle of cabernet. . . . To pep up the gin-and-tonic routine, make a Ramos gin fizz the way they do at the *Sazarac Bar* in the Fairmont Roosevelt, New Orleans: Put into shaker with cracked ice 1 tsp. powdered sugar, ½ oz. lemon juice, ¼ oz. lime juice, ¼ oz. egg white, 3 dashes orange flower water, 1¼ oz. gin—and 2 oz. milk. Shake vigorously.

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These calculators are more than an engineer's pipe dream. You can see them today at UniCom branches and dealers throughout the country. Or just fill out the coupon. We'll see that you get information promptly. Or write us at 10670 N. Tantau Ave., Cupertino, California 95014.

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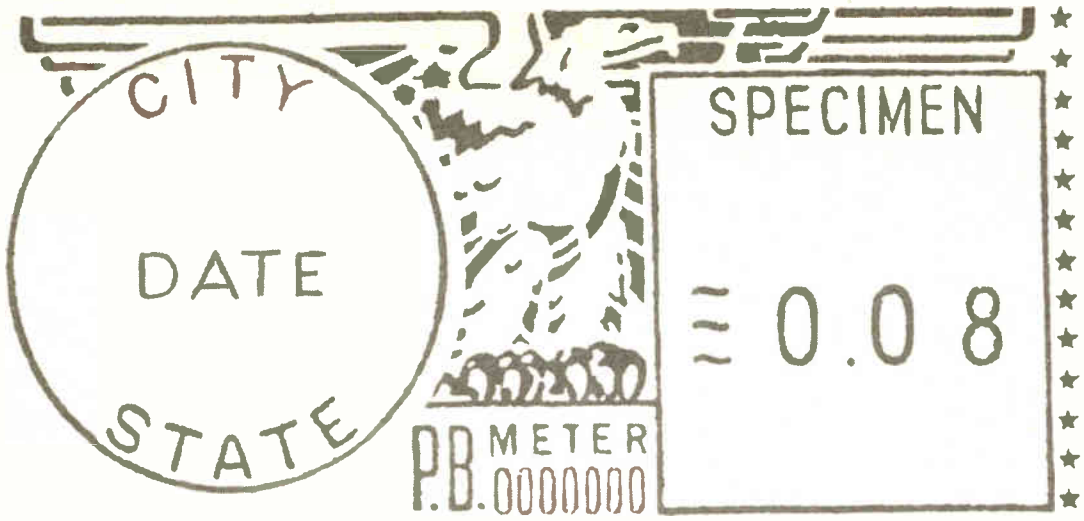
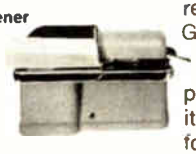


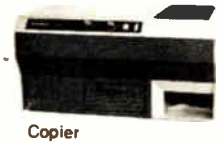
Your trusty Pitney Bowes postage meter could be the last step in a new direction.

With a Pitney Bowes postage meter clicking away in your mailroom you understand the importance of a good paper-handling system. You know that your business can't operate any faster than the paper it travels on. And you've already taken a step to get yours moving. Good.

MailOpener



But getting your mail out is the *last* part of your problem. How about getting it in? Do you lose time every day waiting for your letters to be opened? Our MailOpeners can do that while the mail is being sorted. And if the mail brings something that several people should see, one of our reliable copiers will copy it—at 30 a minute.



Copier

Collator

Then perhaps in answer to the mail, you'll want to send something out. If it is a multi-page report, we can collate it quickly and accurately. Any other kind of papers, we can feed, fold, insert into envelopes, also count and stack automatically and quickly.

Folder-Inserter

Addresser-Printer System

Then, of course, you'll want the envelopes addressed. One of our Addresser-Printers will do that (also invoices, payrolls, orders, government forms) at the rate of eight employees an hour. And talking of payroll, our Tickometers can endorse checks, also cancel, imprint and count in one operation—fast.

Tickometer

Next our mail scales (accurate to the 1/16 of an ounce) will save you the expense of over-paying, the embarrassment of under-paying. And our postage meter, of course, is already working for you... a good guide to the help you'll get from the rest of our machines.

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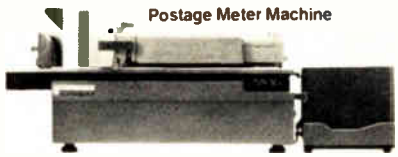

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