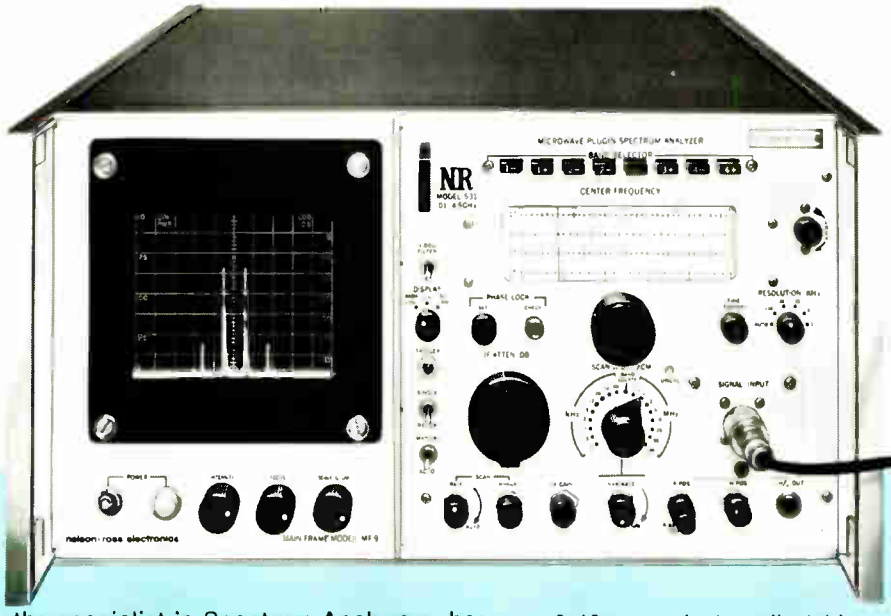
March 13, 1972 $1.00 A McGraw-Hill Publication

Electronics

14 NEW Lowest Cost Spectrum Analyzers

From Sub-Audio to Microwave



Nelson Ross Spectrum Analyzer Model 531
10 MHz to 4.5 GHz
Dispersion 0-1 GHz
Phase locked 1 KHz resolution
Price: $3,000

Nelson Ross, the specialist in Spectrum Analyzers, has the **Biggest Selection, Most Versatile Specifications and Proven Reliability . . . All This For The Lowest Prices.**

Now you can select a Spectrum Analyzer from 0.5 Hz to 6.5 GHz which is just right for your application. And, with Nelson Ross you'll save 50% or more by not paying for unnecessary extras that you'll probably never use.

The versatile Spectrum Analyzers illustrated here are typical of 14 complete analyzers and more than 30 plug-in analyzers available from Nelson Ross.

The complete instruments include the new MF-9 Calibrated Display Main Frame which provides bright, long persistence 8x10cm readouts, adjustable scale illumination and camera mount facility.

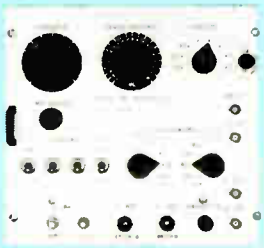
Our plug-in analyzers come in 3 complete series: • for the Tektronix "540/550 letter" series scopes • for the Tektronix 560 series scopes • for the HP 140/141 series scopes and the Nelson Ross MF-9 Display Main Frame.

Compare specifications, quality, ease of use and price. We're sure you'll join the thousands who have been selecting Nelson Ross Spectrum Analyzers for more than a decade.

Call, write or circle the Reader Service Number to get your new 44-page Nelson Ross Spectrum Analyzer Catalog. Then **you** can compare and save.

Typical Plug-In Spectrum Analyzers for Nelson Ross MF-9 Display Main Frame or HP 140/141 series scopes.

Sub-Audio: Model PSA-036
0.5 Hz - 2 KHz
0.5 Hz Resolution
Plug-In: $1,100
With MF-9: $2,100



Broadband: Model PSA-235
1 KHz - 25 MHz
200 Hz Resolution
Plug-In: $1,600
With MF-9: $2,600

Audio: Model PSA-031
10 Hz - 20 KHz
10 Hz Resolution
Plug-In: $ 800
With MF-9: $1,800

RF-TV: Model CATV
1 MHz - 300 MHz
Plug-In: $1,500
With MF-9: $2,500

Typical of more than 25 Plug-In Analyzers for use with Tektronix scopes.

For "540/550 letter" series
SSB Narrow-Band RF
Model PSA-201
0.6 - 36 MHz
10 Hz Resolution
$1,600

For 550 Series
Ultrasonic
Model PSA-023
0.15 - 500 KHz
150 Hz Resolution
$800

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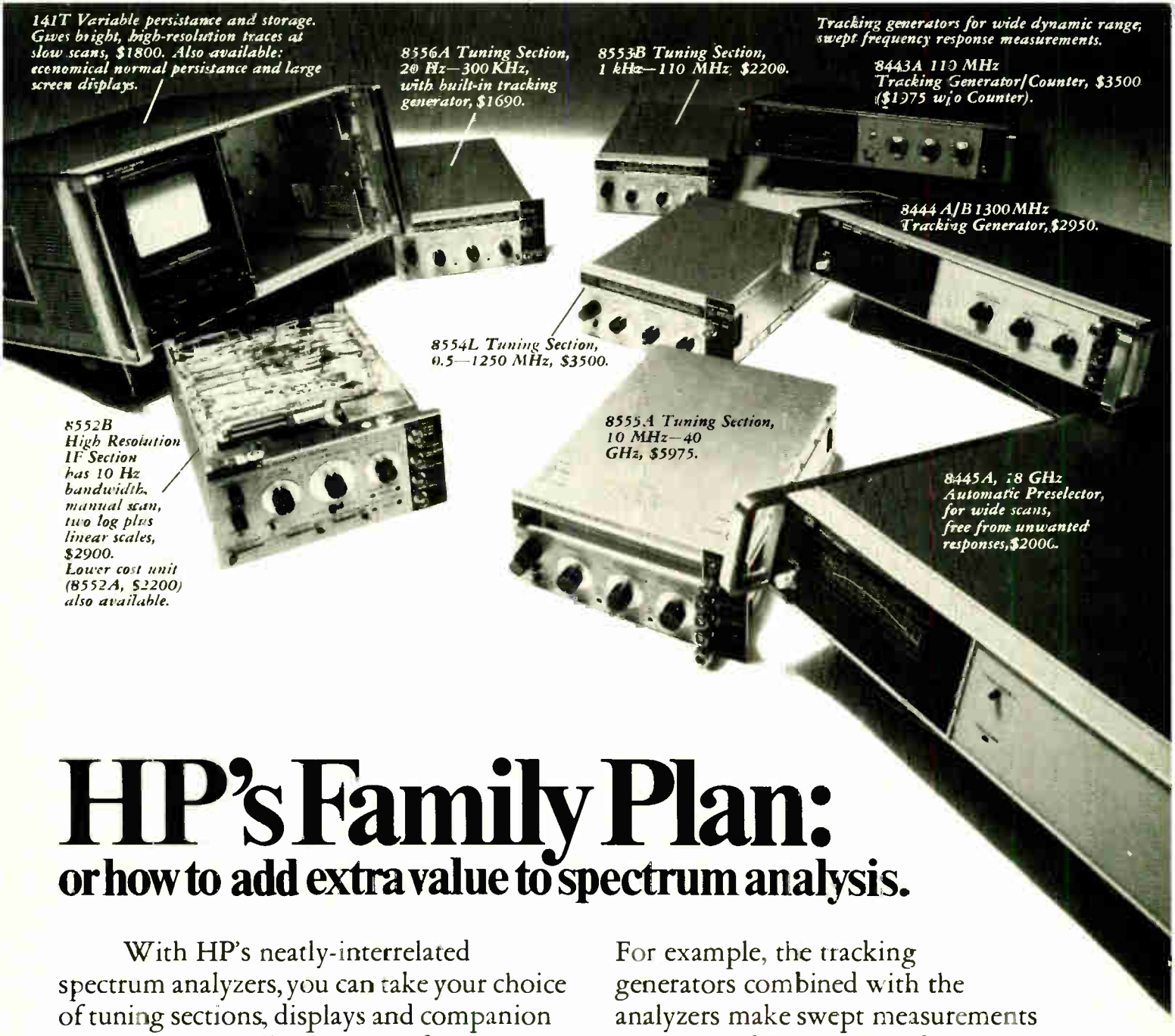
Circle 900 Readers Service Card



HP's Family Plan:

or how to add extra value to spectrum analysis.

With HP's neatly-interrelated spectrum analyzers, you can take your choice of tuning sections, displays and companion instruments to tailor a system for your measurement needs — all the way from 20 Hz to 40 GHz. Then, as your requirements expand, re-configure your system simply by adding the related piece of equipment. That's the value of our family plan.

By themselves, any of the 4 spectrum analyzers give you unparalleled signal analysis capability made possible by absolute amplitude calibration, low distortion, high resolution, and wide frequency scans coupled with the ability to zoom down to a narrow scan.

And the family value really multiplies when you add the companion instruments. For example, the tracking generators combined with the analyzers make swept measurements over a 120 dB range thus forming precision swept frequency test systems.

And our automatic preselector for the microwave tuning unit does away with image, multiple and spurious responses.

All in all, HP's family of spectrum analyzers gives you the greatest depth and breadth of performance and the best value in signal analysis equipment available anywhere. For more information, call your local HP field engineer or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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04111

SIGNAL ANALYZERS

Circle 1 on reader service card

Norden Encoders perform for you!

Look at these new additions to Norden's line. More are on the way.

		Total Count	Revolutions for Full Count	Diameter"	Model Number
NEW! Optical Absolute		10,000	50	2.25	OADC-23/4/BCDQ-200L
NEW! Optical Absolute		1,000	1	2.25	OADC-23/3/BCD-1000L
NEW! Optical Incremental: Series now available with shaft seal—permits drenched operation.					
NEW! Contact Size 11		8,192	32 or 64	1.06	ADC-11/13/BNRY-256L
NEW! Contact Size 11 Altitude Reporting Encoder		1,280	16	1.06	ADC-11-ALT-1280
NEW! Contact Size 11		10,000	100	1.06	ADC-11/4/BCDX-100
NEW! Contact Size 11		3,600	36	1.06	ADC-11/4-36/BCDX-100
NEW! Rugged Industrial Grade Optical Incremental Encoders					
All available with quadrature and internal squaring circuit options		2,000 Pulses	1	3.500	OADC-35/2000/INC
		1,500 Pulses	1	3.500	OADC-35/1500/INC
		1,250 Pulses	1	3.500	OADC-35/1250/INC
		1,000 Pulses	1	3.500	OADC-35/1000/INC
		600 Pulses	1	3.500	OADC-35/600/INC
		500 Pulses	1	3.500	OADC-35/500/INC
		300 Pulses	1	3.500	OADC-35/300/INC
		200 Pulses	1	3.500	OADC-35/200/INC
		100 Pulses	1	3.500	OADC-35/100/INC
Optical Incremental Encoders					
All available with index marker, quadrature outputs and internal squaring circuit options. Other counts on special order		100 Pulses	1	2.250	OADC-23/100/INC
		250 Pulses	1	2.250	OADC-23/250/INC
		256 Pulses	1	2.250	OADC-23/256/INC
		336 Pulses	1	2.250	OADC-23/336/INC
		500 Pulses	1	2.250	OADC-23/500/INC
		512 Pulses	1	2.250	OADC-23/512/INC
		1,000 Pulses	1	2.250	OADC-23/1,000/INC
		1,024 Pulses	1	2.250	OADC-23/1,024/INC
IC-Compatible Encoders. For direct interface with TTL & DTL circuits					
Binary		128	1	1.750	ADC-ST7-BNRY-E/L
		8,192	64	1.750	ADC-13-BNRY-E/L
		524,288	4,096	1.750	ADC-19-BNRY-E/L
Binary-Decimal Code		100	1	2.250	ADC-ST2-BCD/L
		1,000	10	2.250	ADC-3-BCD/L
		10,000	100	2.250	ADC-4-BCD/L
		100,000	1,000	2.250	ADC-5-BCD/L
		1,000,000	10,000	2.250	ADC-6-BCD/L
		360	1	2.250	ADC-3-36BCD-E-360L
		3,600	10	2.250	ADC-4-36BCD-E-360L
		36,000	100	2.250	ADC-5-36BCD-E-360L
		360	1	3.250	ADC-ST3-36-BCD/L
		3,600	36	2.250	ADC-4-36-BCD/L
		36,000	360	2.250	ADC-5-36-BCD/L
		360,000	3,600	2.250	ADC-6-36-BCD/L
External Logic V-Scan Binary Encoders					
		128 or 256	1	1.750	ADC-7/8-BNRY-XB
		8,192 or 16,384	64	1.750	ADC-13/14-BNRY-XB
		524,288 or 1,048,576	4,096	1.750	ADC-19/20-BNRY-XB
Single Turn Gray Code Encoders					
Available with various levels of RFI suppression		256	1	1.066	ADC/11/8/GRAY
		256	1	1.750	ADC-ST8-GRAY
		512	1	2.250	ADC-ST9-GRAY
		1,024	1	3.062	ADC-ST10-GRAY
Multiturn Gray Code Encoders					
Available with various levels of RFI suppression		1,024	4	1.062	ADC-11/10GRAY256
		1,024	16	1.062	ADC-11/10GRAY 64
Low Cost Magnetic Noncontacting Encoders					
	Incremental	128	1	1.750	MADC-18/128/INC
	Binary	128(V scan)	1	1.750	MADC-18/7/BV
	Binary	8,192(V scan)	64	1.750	MADC-18/13/BV
	Binary	524,288(V scan)	4,096	1.750	MADC-18/19/BV

For more information and detailed specs, write Norden, Att: Components Dept. 1000 Helen Street, Norwalk, Conn. 06856. Phone (203) 838-4471 TWX: 710-468-0788.

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The International Magazine of Electronics Technology
March, 13, 1972

Volume No. 45, Number 6

Electronics

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Publisher's letter

Changing roles, the theme of this week's cover story on the IEEE (see page 62), also fits the institute's president, Robert H. Tanner. First, he has thrown himself into a constant round of travels from his Canadian home to the U.S. to visit IEEE groups. His schedule is so tight that at one point our consumer editor, Jerry Walker, had to meet Tanner at LaGuardia Airport in New York in order to catch him for an interview.

That's about par for the course. In the past few years, our reporters have had to grab interviews with IEEE presidents in taxis on the way to airports, in hotel lobbies just before a fast trip to an airport. We even arranged to accompany one peripatetic president on an intercity plane flight, but poor weather converted that into a conventional office interview.

When he's not winging across the U.S., Tanner is also carrying on as the director of information for the newly-formed Bell-Northern Research organization in Ottawa, Ontario, though the company has given him leeway to attend to IEEE business.

And when he's not too busy at these roles, Tanner also keeps up with his spare-time favorite—architectural acoustics. During Jerry's interview, Tanner handled a telephone call—from a contractor seeking advice on the acoustics of a new building. Previously Tanner carried out the acoustical design for the Stratford Shakespearian Festival, the Expo Theatre in Montreal, Sir George Williams University, and Manitoba Theatre Centre in Winnipeg.

Among the roles Tanner and the IEEE are trying out has to do with assisting jobless EEs. Agreeing with one of the conclusions in our article on the job market (see page 109), the IEEE head points out that neither the institute nor the bureaucracy of the Labor department can create jobs. But the IEEE may be able to help indirectly. After talking to Tanner, Jerry observed, "maybe someone with three jobs is the best man to work on the unemployment problems."

Opinion, criticism, controversial issues, individual points of view—we strive to keep our pages open to them all. With our wide readership, we are a natural forum for the airing of the diverse viewpoints that keep the electronics industries vital, constantly changing, and strong. This issue, on page 78 in our technical articles section, we've printed yet another "opinion piece." This time, it's a rebuttal to a previous article, one which criticized IC makers for not designing what the user really needed, but what was easy to manufacture or looked good in spec sheets. We think you'll be interested in the debate—and the ones yet to come.

The 1971 index of articles published in *Electronics* will be sent to any interested reader who circles number 340 on the reader service card, just inside the back cover, and mails it in. Since the supply now available is limited, this is the last time we'll mention the offer.

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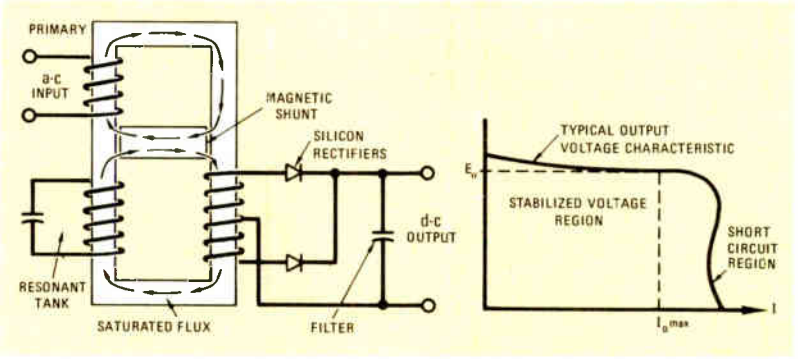
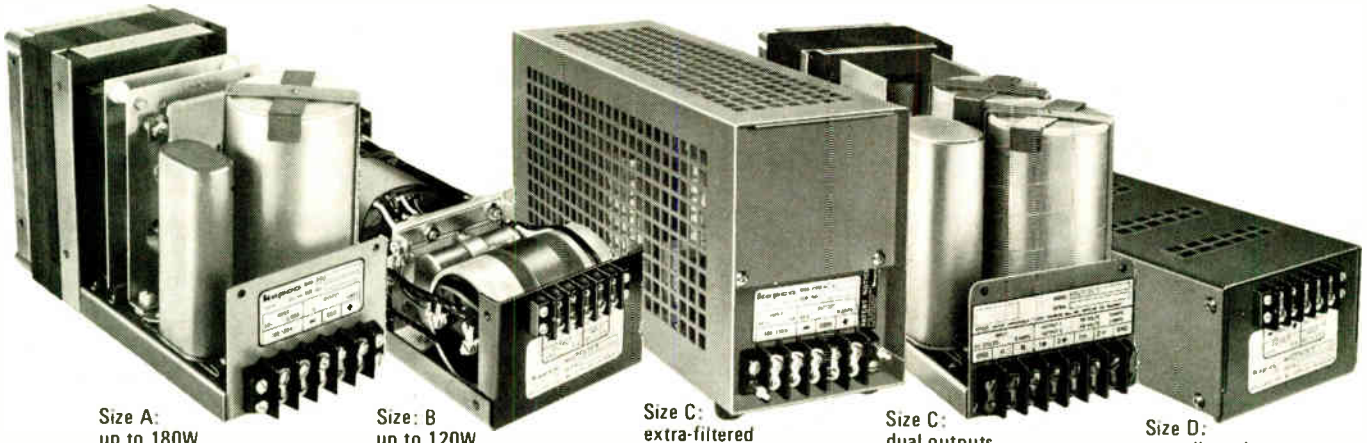
The ferroresonant voltage stabilizing principal depends on the saturation of a portion of the transformer's iron by the use of a resonating capacitor. The squarish waveform in the tank winding is amplitude isolated from the primary winding (and, therefore, the line's noise) and will collapse if overloaded to protect itself and your load.



Why do things the hard way? There's a nice, easy way to provide stable, transient-free, d-c voltages in your system . . . the Kepco PRM modules. Low cost power supplies which, by their elegant simplicity, yield rich dividends in reliability and longevity.

There's no clamped-down high voltage to break out of its regulator and mess up your circuits; no noise-generating switches or oscillators to confuse your logic; no delicate transistors requiring elaborate protection. Kepco's PRM power supplies use a self-stabilizing resonant transformer, oil-filled a-c capacitor, some silicon rectifiers and husky aluminum electrolytic filters. That, plus some copper wire is it!

Voltage is controlled by the saturation flux of the transformer's iron lamination. You can't get more rugged than that. There's no need for auxiliary overvoltage crowbars, trigger circuits, current limiters or even fuses! PRM's are inherently protected for every sort of abuse.



Size A: up to 180W.
Size B: up to 120W
Size C: extra-filtered (10-30 mV rms) to 180W.
Size C: dual outputs to 300W.
Size D: tap adjusted output to 60W.

- ±1% source effect (the "line regulation" for a 100–130V a-c unstable source).
- 100–300 mV rms ripple, spike free! Rejects line noise by more than 120 dB.
- Outputs from 4.5V d-c to 240V d-c.
- Built to exceed 200,000-hour service life.

For complete specifications and applications notes, write Department O–14

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Readers comment

To market

To the Editor: Your item in the International Newsletter of Feb. 14 erroneously states that SGS is withdrawing from European markets. SGS is not withdrawing from any market but is, thanks to the association with ATES and the powerful backing of STET, Fiat, and Olivetti, in a better position than ever to serve markets in Europe and the rest of the world.

The closure of the Swedish and German factories, the combined production of which never exceeded 10% of total group production, was a regrettable but necessary step to rationalize the production activities of the total group.

Nils Djurklou
International Advertising Manager
SGS
Agrate
Italy

Eurocontrol displays

To the Editor: Your article, "Air traffic control," [*Electronics*, Jan. 31, p. 31] does not mention what has already been done by Eurocontrol for its air traffic control system. Two color displays have already been put to service, and another 10 displays will be added to the system by July 1972.

These displays are manufactured and sold by C.I.T. Alcatel, a subsidiary of Compagnie Générale d'Électricite in its Villarceaux Center. Main features are four colors—green, yellow, orange, and red (corresponding to 14, 11, 9, and 7 kilovolts, respectively); an exceptionally fast patented switching device that reduces power consumption to less than 10 watts and switching time to less than 50 microseconds in the worst case (red to green and conversely); and a 4,096 16-bit-word processor allowing for the display of some 3,500 ½-inch vectors, or around 4,000 characters, or a combination of both (extension to 8,192 words is available).

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The most economical way to drill 1 to 12 hole sizes at 40,000 to over 300,000 precision holes per hour is with Excellon's rugged new

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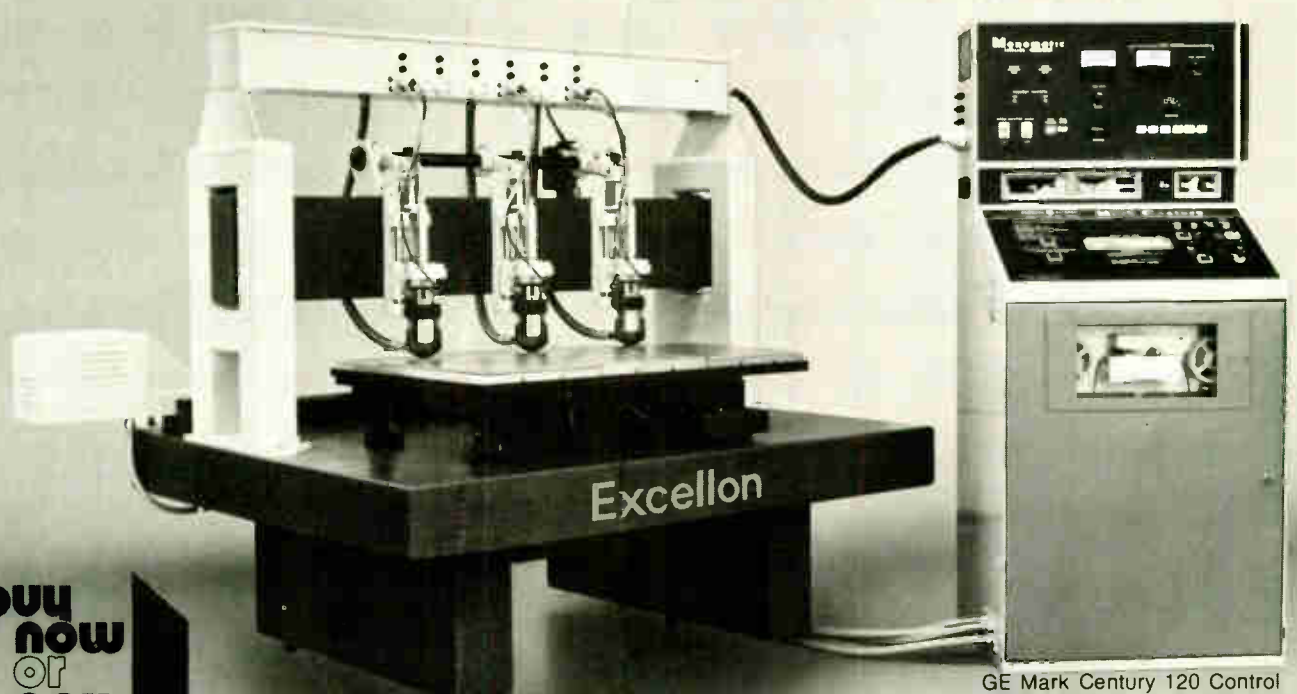
printed circuit drilling systems with automatic drill changing!



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Circle 7 on reader service card

40 years ago

From the pages of Electronics, March 1932

Probably it has been the view of many that the close connection of electron diffraction to the complex theories of wave mechanics makes this subject a matter solely of theoretical interest. The article in this issue, however, would seem to thoroughly dispel this erroneous idea. Electron diffraction should prove of fundamental and practical importance to industrial processes of many kinds.

With Mr. Phillips' clear presentation of electronic refraction one more tool is given to commercial analysts and industrial operators.

Musical tones of a sweetness and purity never before produced; instruments permitting a range and delicacy of touch to do justice to which a new generation of composers will be required; violins that turn into French horns at the twist of a switch—these are among the revolutionary new electronic musical instruments now being demonstrated before the public and attracting wide interest among both musicians and laymen. Dr. Walter Damrosch discussed the future of these new instruments from the musician's standpoint at a meeting in New York last month. Dr. Leopold Stokowski has been making use of similar electronic oscillators.

Thus, for the first time in the history of music, it is now possible to create any desired quality of musical tone by scientific analytical methods. When one comes to think of it, all musical devices of the past have been mere accidental contraptions of hammers, skins, cat-gut, horsehair, brass pipe, strings, etc. For ages, musicians have had to use what they could get, with the crude means at hand. Our musical mechanisms thus have been hardly more than one step removed from the tomtom.

But the new electronic oscillators make it possible for the musician to create any wave-form, timbre, or tone effect he desires, and they afford a delicacy of control and touch, undreamt of with our present gross musical mechanisms which are operated by pounding, scraping or blowing!

THE PATH OF LEAST RESISTANCE

True 4-wire ohm measurements, fully autoranging over **9-complete ranges** (1 ohm to 200 M ohms) in only **20 msec**...with 0.01% accuracy ...Plus, only Dana's exclusive ohms guard allows in circuit measurements.

This is only one of the many features making Dana's 4800, premium performance DVM, a truly unique 4 digit measuring device.

Make **RMS AC measurements** of distorted signals ...and not only pure sine waves ...over a **1 MHz bandwidth** in only 350 msec with 0.03% accuracy. This outstanding performance is assured by Dana's remarkable RMS Distortion Insensitive AC Converter.

For DC measurements, 5 ranges are standard with **0.005% accuracy**...add a plug-in preamplifier and a 10 mV range becomes available with **1 μV resolution.** Selectable filtering, in this mode, further extends application flexibility.

We didn't stop there, though...the 4800 is more than just specifications. We added many features which you, the user, directly benefit from: 100% overrange in all functions and on all ranges, full autoranging, complete solid-state **isolated BCD** and **programming**...no more troublesome slow relays..., front panel override...protects against unauthorized and accidental tampering..., programmable front/rear input, illegal operation indicator, built in programming timeouts, plug-in IC's and accessories, and analog output.

Whether you need a basic DVM or a full multimeter, don't follow the wrong path in searching for a premium performance instrument ...let Dana guide you to the 4800.

DANA

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The Am2506

An ALU with an internal latch that effectively has zero propagation delay and zero power dissipation.

You can build a 16-16-bit register arithmetic system that runs at 11 MHz using just 11 packages, and save 650 mW.

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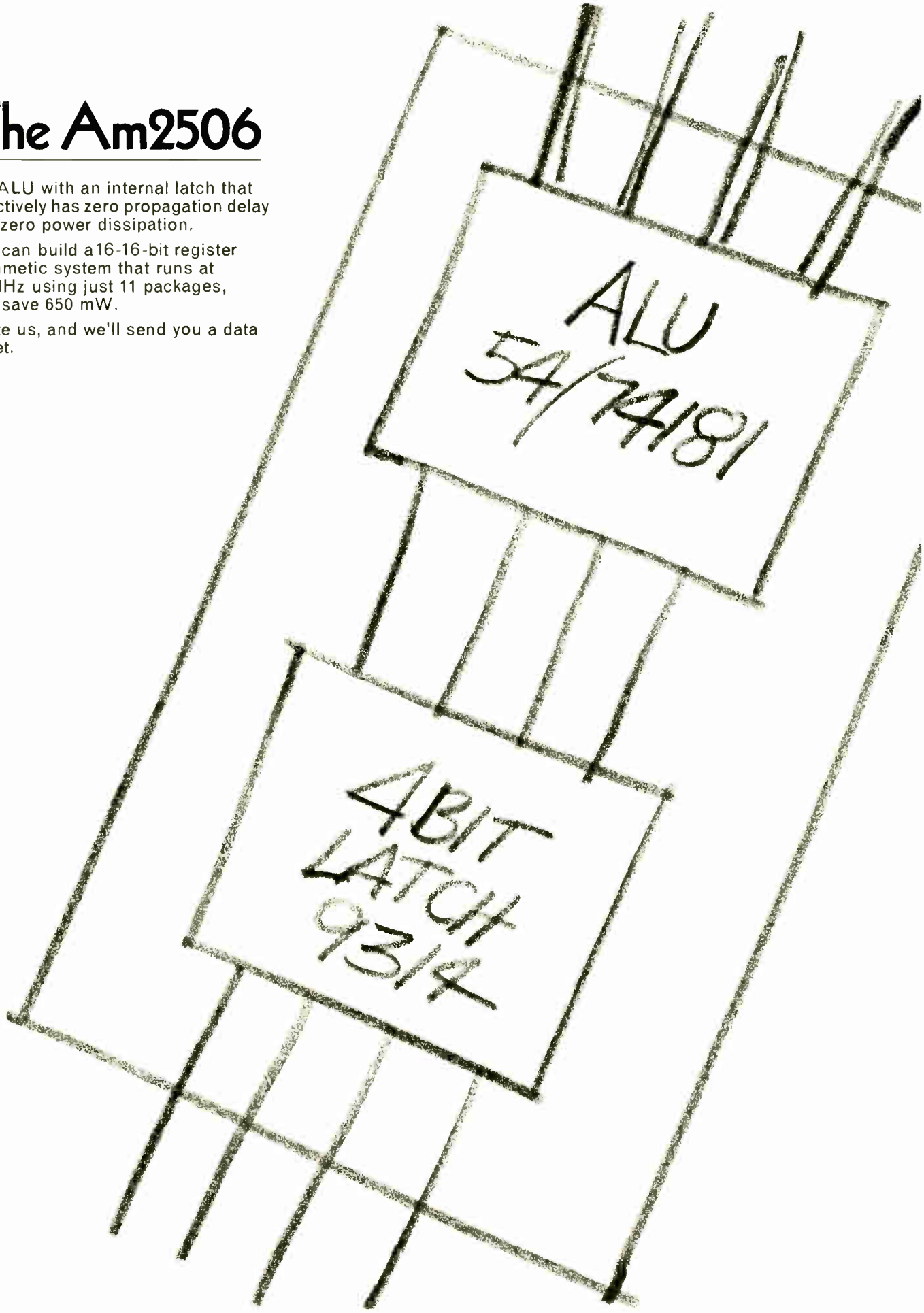

An ALU with a built-in latch.

The Am2506. Made for solving systems problems. Saves power. Saves logic time. Saves packages. First of its kind anywhere.

Fits in nicely with our standard ALU's– Am9340, Am9341, Am54/74181, Am54/74182 and Am9342.

Who's #1 in ALU's?

We are.

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901 Thompson Place, Sunnyvale, California 94086/TWX 910-339-9280/TLX 346306.

Circle 11 on reader service card

They said no one could build and sell a computer-controlled LSI/IC test system for under $100K...

then along came Macrodata!

"Once upon a time test equipment manufacturers convinced each other that $250K wasn't too much to pay for a computer-controlled DC/IC test system. In fact, they even convinced their customers.

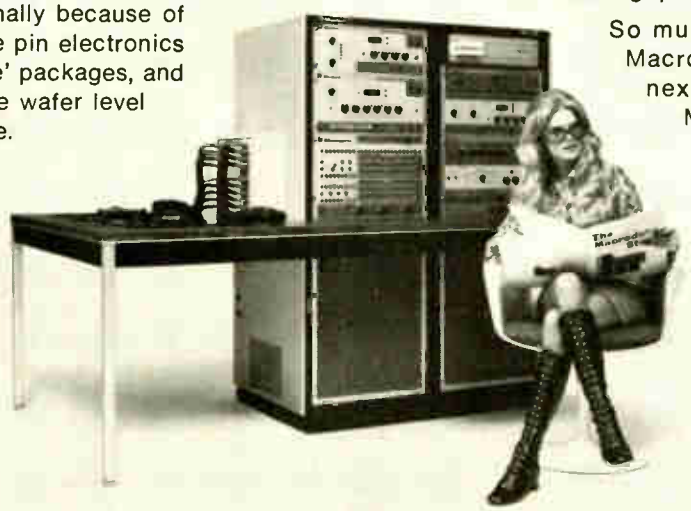
"Then along came Macrodata. First off, for only $200K, they built and delivered the first high-speed LSI test system, the MD-200. Then they set their sights on a system that could sell for about one-third of that price.

"No sooner said than done—they called it the MD-150. And within the first two months, many systems were purchased by leading IC manufacturers—installed and at work testing devices.

"The MD-150 is a cascaded, computer-controlled system designed to test all types of LSI/IC devices at functional speeds up to 5 MHz. It tests RAM's, ROM's, shift registers, and semiconductor memories, as well as random logic. It lets you test both MOS and bipolar devices optimally because of its unique interchangeable pin electronics and Macrodata's 'firmware' packages, and testing can be done at the wafer level and/or in the final package.

"When you buy the system, here's what you get: (1) *an MD-50 Sequencer,* which includes a computer and tape cassette that control the execution of a variety of test programs; (2) *an MD-100 Tester,* which performs functional testing and supplies control information to the device under test at 5 MHz; (3) *an MD-83 Automatic Parameter Tester,* which is capable of running a full complement of DC functional/parametric tests for single-pin or multiple-pin testing; (4) *an MD-73 Programmable Clock,* which consists of up to six, one-nanosecond, programmable 'clocks,' with rep rates of 11 MHz; (5) *an MD-44 Programmable Power Supply,* with up to nine, precision, programmable units; (6) *Pin Electronics,* with up to 42 channels, which can be configured for LSI.

"In plain talk, the MD-150 is here today, ready to work for you now. It is packed with many third-generation design features, and provides 5 MHz performance at half the price of other so-called competitive units, for as little as $60K. It requires no special software or add-on boxes, so you can launch right into a 'zero overhead testing' program immediately."



So much for Chapter II of the Macrodata Story. Look for the next exciting chapter soon. Meanwhile, for a free copy of the MD-150 brochure, use the reader service card; and if you can't wait, just call us directly.

Chapter Two. The Macrodata Story.

MACRODATA ™

Macrodata Company, Test Systems Division, 20440 Corisco Street, Chatsworth, California 91311, (213) 882-8880

Sales Offices: San Jose Area Tel. (408) 268-7714 · *Philadelphia Area* Tel. (609) 228-1325 Telex: 83-1496 · *New England* Tel. (617) 862-5700 · *Southeast Area* Tel. (205) 883-0140
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Everyone was tired of the old concepts, the old machines, the DC systems with the software hassle in IC testing...

then along came Macrodata!

"Once upon a time—not very long ago—you had to pay too much for a computer-controlled IC test machine. And upon delivery, your troubles were just starting—with the software and other overhead headaches.

"Then along came Macrodata! Having already solved the LSI testing problem, they tackled the DC problem and came up with the MD-183—a tester capable of fully characterizing devices. Here was a fully automatic DC functional/parametric test system selling for about half the price of the old computer-controlled test machines. Still, it gave you a data memory, a logic section, a control panel, a tape cartridge unit, an automatic parameter tester, and programmable power supplies.

"But the MD-183 wasn't too good to be true. The users discovered that the data memory was capable of holding all the data necessary for a complete device test. They liked the way the 183 performed sequential testing, binning, and logging automatically. And they were pleased to note that the logging counters track all passes and failures, as well as actual test values, and that the sequencing of tests on a particular device is computer-controlled with no software headaches. They could see the advantages of multivariable device characterization 'firmware' that was available off the shelf.

"So here at last was an automatic tester that could be set up for either single-pin or multiple-pin testing, capable of running a full complement of DC functional and parametric tests, including stress, leakage, continuity, and threshold—and you could buy it for as little as $34,520! As the news got out, the users were eager to get their hands on one. How about you? ? ?"

This is Chapter III of The Macrodata Story. Look for another exciting chapter soon. Meanwhile, for more information, just use the reader service card; or if you want to get your hands on a 183 now, call us directly.

Chapter Three. The Macrodata Story.

MACRODATA™

Macrodata Company, Test Systems Division, 20440 Corisco Street, Chatsworth, California 91311, (213) 882-8880

Sales Offices: San Jose Area Tel. (408) 268-7714 • *Philadelphia Area* Tel. (609) 228-1325 Telex: 83-1496 • *New England* Tel. (617) 862-5700 • *Southeast Area* Tel. (205) 883-0140 *Dortmund, West Germany* Tel. (231) 52 80 65 Telex: (841) 822-382 • *Milan, Italy* Tel. 671988 - 899248 Telex: (843) 34314 • *Tokyo, Japan* Tel. 03 985 5266 Telex: (781) 272-2171

People

Berezin tells how to get into swim of MOS

Many engineers can tell war stories about the hazards of designing with large-scale MOS, but it takes courage to stand before an audience at the IEEE convention and deliver a talk entitled "How to Jump into MOS Without Drowning." And that's just what Evelyn Berezin is going to do.

Berezin: Redactron couldn't find a garage.

Ms. Berezin is president of Redactron Corp. in Hauppauge, N.Y., which makes editing typewriters—systems that may include more MOS/LSI chips per pound of product than any other. And for her, getting to know how to swim has involved a 25-year career as physicist, logic designer, marketing executive, and product planner.

She went from a Ph. D. candidate at New York University (she was one of the first to win an Atomic Energy Commission fellowship back in 1946) to a logic designer of computers—"using tubes," she points out. By 1965 she was in charge of the systems department at Digitronics Corp., a firm that specialized in such things as on-line banking, racetrack totalizing, and hotel reservations systems.

There followed four years in marketing and product planning until finally, in November 1969, she helped organize Redactron. Its original core of seven people moved—not into that fabled garage of so many corporate histories—but into a modern 20,000-square-foot facility.

"It was an accident, really," she says. "Long Island was booming to such an extent at the time that we couldn't find a garage, which is what we looked for."

Adding space. Redactron has 160 employees now and is finishing a second 30,000-sq-ft manufacturing building. By summer, Ms. Berezin hopes to be turning out 100 editing typewriters—called Data Secretary—each month. The machines, which store letters on magnetic tape or cards so they can be edited and then typed out automatically at top typewriter speed, sell for upwards of $6,400 each. The Data Secretary is built around the typing head of an IBM Selectric; six standard and 13 custom-designed MOS/LSI chips are included to give the machine its extensive storage, retrieval, and control capabilities.

Redactron is supplying the operating assemblies of the editing typewriters being marketed by the Remington Rand division of Sperry Rand Corp. Ms. Berezin predicts that the total market for these machines will reach $500 million a year by 1975.

What about designing with MOS? "Don't leave it to your vendor," Ms. Berezin warns. "This can be a disaster because they can't possibly understand all of your problems." The tradeoffs are radically different from those involved with ordinary ICs, she continues, adding that the starting point is the total system and its physical implementation, not the logic design to make the system work.

Downing to hammer at space applications

Some NASA program managers must have breathed easier when Joseph E. Karth, the relentless Minnesota Democrat, announced he was resigning the chairmanship of the House Space Sciences & Appli-

NEW OP AMP CHAMP.

The new LM118 may well be the ultimate true differential operational amplifier. It not only has the fastest slew rate ever offered (a minimum of 50 volts per microsecond at A_V=+1), but *guarantees* it for every single device. In writing.

As if that weren't enough, the highly versatile LM118 is pin for pin compatible with general purpose op amps, has a 1MHz full power bandwidth, a unity gain crossover frequency of 15MHz, is internally compensated, can be offset nulled to zero with a single potentiometer, doesn't sacrifice dc performance for speed, comes in a TO-5 package and will soon be second sourced. (Once again giving testimony to the now-famous National Linear Circuit Motto: *"In order to be followed you have to lead."*)

Naturally, the entire LM118 series is available for immediate delivery at the following (100 up) prices: LM318H, $9.95; LM218H, $19.95; LM118H, $29.95.

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National

cations subcommittee for another assignment. But their relief could prove short-lived because he's been succeeded by Thomas N. Downing (D., Va.) in overseeing the space agency's unmanned space programs. And that seven-term house veteran believes that NASA isn't putting enough emphasis on applications, meaning that program managers can expect some sharp questioning on that score.

Downing says, "It is obvious that NASA is not applications-minded. Much more can and should be done in this area." The agency "is going to have to show the practical benefits of planetary and space science," he says, adding that space science has its place "if it can show applications."

"I'd like to see them dive in on the practical needs and benefits," the gray-haired representative says. "We've got to give the taxpayer something he knows and can use, like laser surgery." When the taxpayer questions the space program, he doesn't realize that miniature TV sets and heart pacemakers came out of it, Downing contends. It's a failure the congressman lays at the door of NASA's press agents, whose performance, he says, "has been really sorry in getting the message out to the public."

Good mood. NASA's specific problems are its specific programs like the now-canceled Grand Tour and the proposed $5.5 billion space shuttle, in Downing's assessment. The "mood" of the full House Science & Astronautics Committee is "favorable" toward the shuttle, he believes, but "the economics of the shuttle are hard to justify." In putting a man on the moon, "it was the goal that counted, and we were all swept up in it," he observes. But with NASA's present budget and its public image resting on "a plateau, now is the time to apply technology for all mankind."

The 53-year-old congressman believes that the country can have a "vibrant" space program at the $3 billion-a-year level NASA is proposing for the rest of the decade, but its "difficult job is to direct its goals within that limited figure."

For built-in reliability, design with "Scotchflex" Flat Cable/Connector Systems.

"SCOTCHFLEX" IS A REGISTERED TRADEMARK OF 3M CO.

"Scotchflex" Flat Cable and Connectors can offer you trouble-free packaging for your next generation equipment.

There's built-in reliability for your circuit inter-connects. Our flat, flexible PVC Cable has up to 50 precisely spaced conductors. The gold plated U-contacts are set into a plastic body to provide positive alignment. They strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

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Off-the-shelf stock offers you flat cable in a choice of lengths and number of conductors from 14 to 50. Connector models interface with standard DIP sockets, wrap posts on .100 x .100 in. grid, or printed circuit boards. Headers are available to provide a de-pluggable inter-connection between cable jumpers and printed circuit boards (as shown). Custom assemblies are also available on request.

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

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Only HP Offers You All This For The Low Price Of $2975

To build your personal desk-top computing system, start with the Series 9800/Model 10 Programmable Calculator. Your basic Model 10 comes with standard equipment that is either not available, or available only as an extra-cost option, on other machines.

If bad experiences have taught you that basic is synonymous with stripped—have no fear. The *basic* Model 10 can perform a complete regression analysis, or solve a system of 10 simultaneous equations.

Only HP Offers You A Fully Modular Calculator

The unique, modular/plug-in architecture of the Model 10 lets you "design" your own problem-solving system. You can expand the memory, add peripherals, or change the keyboard of your existing Model 10, at any time.

Only HP Gives You A Fully Expandable Dual Memory

The Model 10 has a unique dual memory system —one memory for programs and one for data. You can expand from the basic 500 program steps *and* 51 data registers to 2036 program steps *and* 111 data registers.

Beware of simple number comparisons with other calculators. The refinements in the memory design and the keyboard make the Model 10 so efficient that in most cases it requires *fewer steps to execute a given problem.*

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Interchangeable keyboard plug-in blocks give you a choice of powerful *Statistics* or *Mathematics* functions, complete with their own memories, under single keystroke command. Another option, the *User Definable Function* plug-in, lets *you* customize individual keys with operations uniquely important to *you.*

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By simply inserting the *exclusive HP Alphanumeric Printer Plug-in,* you can automatically generate labels, program instructions, or messages—in English—right on the printer tape.

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The I/O bus of the Model 10 lets you plug-in a Marked Card Reader, Paper Tape Reader, Digitizer, Typewriter, Tape Cassette, or the *exclusive* X-Y Plotter that plots linear, log-log, semi-log, or polar plots, and writes alphanumerics.

Only HP Offers You A Totally New System

The Series 9800 is no paper tiger. It's available now to free you from the drudgery of problem-solving so you can get on with your job of innovative thinking and designing. For more information or a "hands-on demonstration" at your desk, write: Hewlett-Packard, P.O. Box 301, Loveland, Colorado 80537. In Europe: 1217 Meyrin-Geneva Switzerland.

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We seal and stabilize the semiconductor element by passivating it with a unique Westinghouse process. This prevents degradation, even in assembly, and permits element stocking indefinitely.

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And our pace-conveyor assembly system enables us to assemble high-power rectifiers and thyristors (and special assemblies) faster than anyone else in the industry.

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Our "breakthrough" in high-power semiconductors is just the start. Ask about the benefits of Westinghouse research and development leadership in high-power semiconductors. For more information about "breakthrough," phone 412 925-7272 or write Paul E. Lego, General Manager, Westinghouse Semiconductor Division, Youngwood, Pa. 15697.

SC-2-72

You can be sure...if it's Westinghouse

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Meetings

International Electronic Components Exhibition: FNIE, Parc des Expositions, Porte de Versailles, Paris, April 6-11.

International Conf. on Magnetics (INTERMAG): IEE, Kyoto International Conference Hall, Kyoto, Japan, April 19-21.

International Symposium on Circuit Theory: IEEE, Sheraton-University Hotel, Universal City, Calif., April 19-21.

Southwestern IEEE Conf. & Exhibition (SWIEEECO): IEEE, Baker Hotel & Dallas Mem. Aud., Dallas, Texas, April 19-21.

Conf. on Computer Aided Design: IEEE, IEE, University of Southampton, Southampton, England, April 25-28.

National Telemetering Conf.: IEEE, Houston Shamrock Hilton Hotel, Houston, Texas, May 1-5.

Electrochemical Society Spring Meeting: Electrochem. Soc., Shamrock Hilton, Houston, Texas, May 5-12.

International Electronics Conf.: IEEE, AIP, OSA, APA, Queen Elizabeth Hotel, Montreal, Canada, May 7-11.

International Semiconductor Power Converter Conf.: IEEE, Lord Baltimore Hotel, Baltimore, Md., May 7-10.

Spring Joint Computer Conf.: IEEE, Convention Center, Atlantic City, N.J., May 15-18.

Aerospace Electronics Conf.: IEEE, Sheraton Dayton Hotel, Dayton, Ohio, May 15-17.

Electronic Components Conference: Electronic Industries Assn., IEEE, Statler-Hilton Hotel, Washington, D.C., May 15-17.

International Microwave Symposium: IEEE, Arlington Park Towers Hotel, Chicago, May 22-25.

What the industry taught us about data communications.

A rose by any other name...

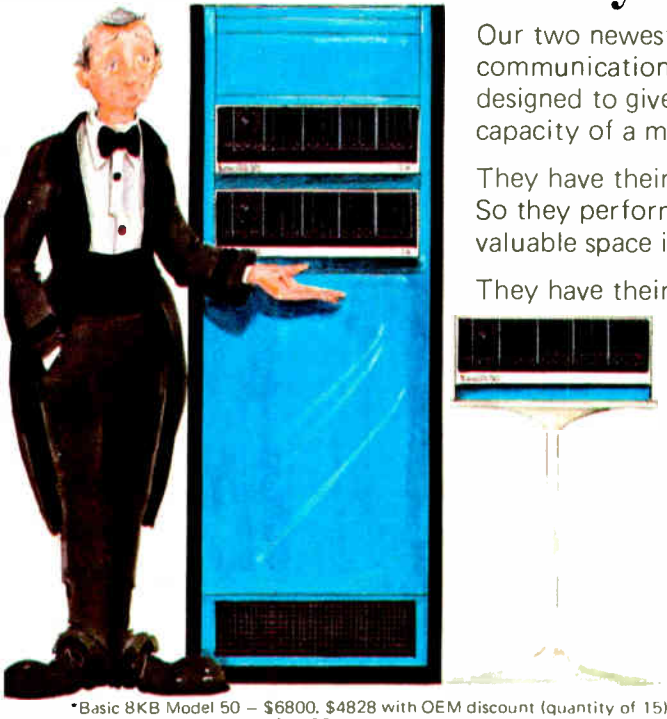
Everybody's got a data communications processor, right? Total capability. Complete systems. Full line. The whole schtick.

Everybody, that is, who has a general-purpose processor, a stop-gap communications program or two and an extra nameplate.

Earn while you learn.

Everybody's anxious to solve your data communications problem, too. They may never have tackled one like yours, but they're willing to learn. Especially when you're paying for it. After all, the risk is all yours.

Introducing the Interdata Models 50 and 55. What you see is what you get.



Our two newest data communications processors* really are data communications processors. With both hardware and software specially designed to give you up to 5 times the speed, power and data handling capacity of a minicomputer.

They have their own comprehensive data communications instruction sets. So they perform common tasks at hardware speeds — without taking up valuable space in core.

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*Basic 8KB Model 50 – $6800. $4828 with OEM discount (quantity of 15)
Basic 16KB Model 55 – $15,900.

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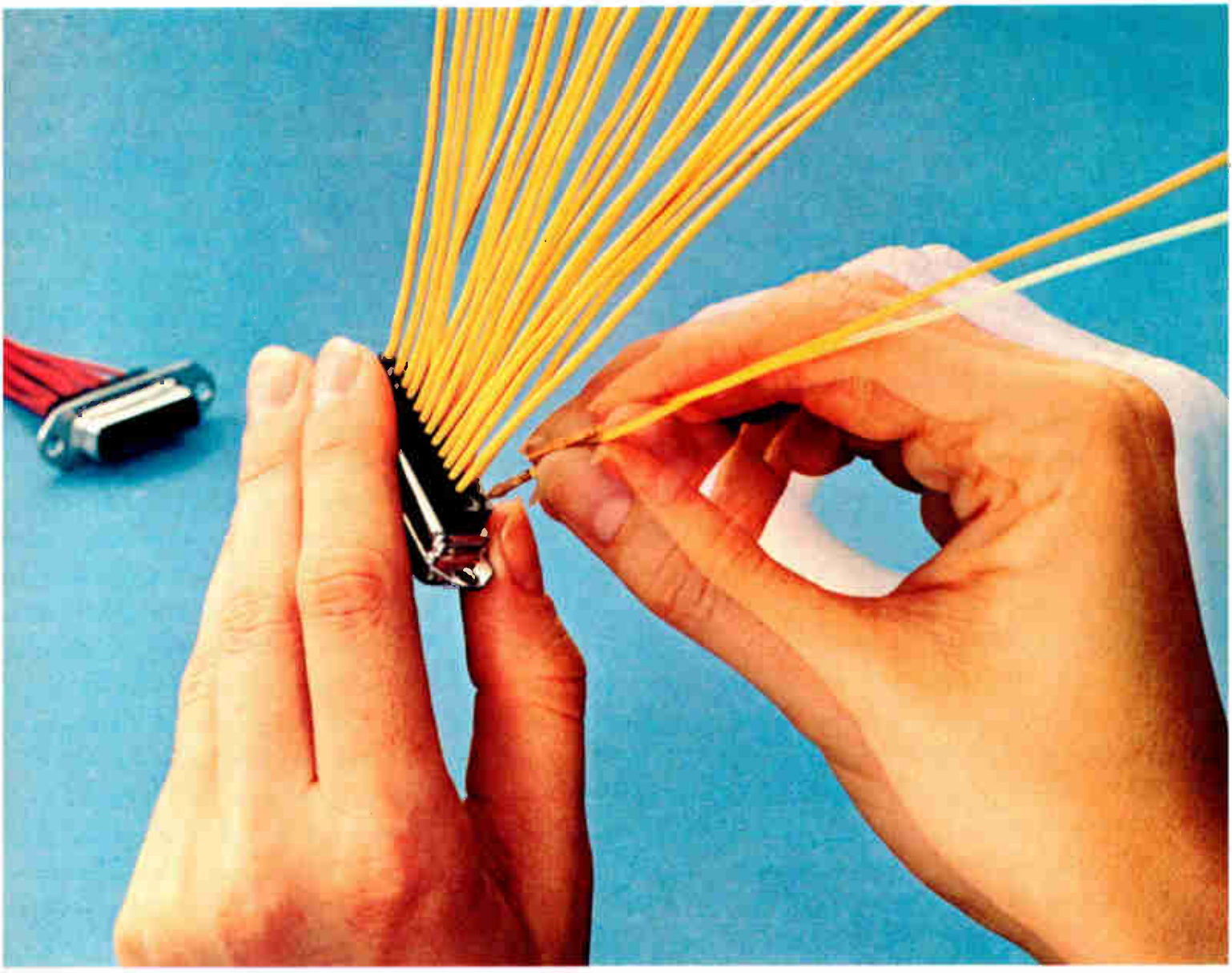
Make the simple move



to less assembly time.

Do it the easy way with Amphenol's 17 Series miniature rear-release connectors.

A gentle push from the back of the connector and the contact snaps securely in place. No tools or broken fingernails, just easy fingertip assembly. And to remove the contact for fast field servicing, insert a simple plastic tool in the back of the connector and out pops the contact.

You can have a choice of screw-machine contacts in bulk packaging, or stamped and formed contacts on a carrier strip. Semi-automatic crimping or hand tools available for either type of contact.

The Min-Rac® 17 Series connectors are available in 9, 15, 25, 37, and 50 contact configurations. All meet EIA Standard RS-232C for data communications input-output connectors. And all are intermountable and intermateable with other Min-Rac 17 Series connectors as well as competitive "D" type connectors.

Find out how simple it really is. Just write Dick Colt asking for the whole story on our Min-Rac 17 Series rear-release connectors. Amphenol Industrial Division, Bunker Ramo Corporation, 1830 South 54th Avenue, Chicago, Illinois 60650.

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Circle 24 on reader service card

Electronics Newsletter

March 13, 1972

Army going state of the art with S-band radar R&D

The Army's Antiballistic Missile Defense Agency will award two highly significant R&D contracts in the next few months. Not only will the agency be buying developmental S-band amplifier modules that will help decide the shape of future S-band phased-array radar **but also it is writing specifications around what can be achieved with present state-of-the-art devices instead of following the usual practice of aiming at pie-in-the-sky performance.**

One device spec calls for transistors, the other for any high-power, high-efficiency two-terminal device that can do the job. Although the spec demands 10-watt average power for both, minimum efficiency of 12% is required for the two-terminal devices, 25% for the transistors. **The military is being realistic and concerning itself with power on the target by specifying peak energy rather than peak power.** This permits the assembly using transistors to function as it can best—producing high average power with long duty cycles—and lets the two-terminal device deliver high peak power for shorter periods.

Though Gunns and Impatts are still in the two-terminal derby, **knowledgeable sources give the inside track to the more efficient complementary Trapatt,** which has a p epitaxial layer grown on a p+ substrate and then an n+ layer diffused onto that. The Raytheon Corp. has reported on a 10-watt, 1-gigahertz version with 35% efficiency, and work in the complementary area is also being done by Sperry-Sudbury, RCA, and Hughes among others.

Holographic memory to be marketed

A 12-megabit nonvolatile read-only holographic memory **is to be introduced as a commercially available product** within the next month by Optical Data Systems Inc. of Mountain View, Calif. The expected small-quantity price will be $1,500.

A cassette carrier holds the film, and any block of information on the film can be accessed within 3 seconds. Data-transfer rate is 100,000 bytes per second.

As a stand-alone unit, the memory can be used to store programs for minicomputers. However, with the addition of a small keyboard and some logic, **the holographic ROM becomes a credit-card verification system** that, in its present configuration, can store information on up to 250,000 "hot" cards.

AIL division of Cutler Hammer Inc., Deer Park, N.Y., is readying a 3-d radar for air traffic control at commercial airports. Originally developed under a military contract, one experimental version of the radar has been tested for over a year. A great advantage of a 3-d radar is that **it can display on a traffic controller's radar console the altitudes of all aircraft in his vicinity,** not just those equipped with the relatively expensive beacon transponders.

The AIL radar incorporates in a single unit mechanical scanning for azimuth and electronic scanning for height. Usually, either beacons or a separate radar system—the latter used almost exclusively by the military—perform the height-finding function. **Mitsubishi Electric Corp. of Japan announced last year it was testing a single-package commercial 3-d radar** [*Electronics*, June 21, 1971, p.68].

"Advanced signal-processing techniques," is all an AIL spokesman would say in describing how the radar determines altitude. The unit is under control of a minicomputer that also makes the height computations and drives the alphanumeric radar display.

Mostek combines self-alignment, depletion loading

Researchers at Mostek Corp., Worcester, Mass., have succeeded in **combining the accepted MOS self-alignment processes with ion implanted depletion loads**—and depending on the end applications, the payoff could lie in increased functional density, lower power requirements, higher speed, or a combination of these. "Compared to n-channel silicon gate MOS, for example, **silicon gate with depletion loads should yield two to five times better speed-power products,**" says Robert Palmer, director of research and development.

Speed-power products should improve almost regardless of which self-alignment technique is combined with depletion loading, Mostek says, and functional density should almost always exceed that possible with self-alignment alone. In slower applications the new "hybrid" breed MOS **should get within one or two orders of magnitude of complementary MOS power needs,** while noise immunity should be about equal to that of C/MOS.

No products have been announced yet to take advantage of the approach. but Palmer says that n-channel chips ranging from LSI random logic to large random access memories (about 4K) are under investigation. And because the process is simple, yields should be about the same as with Mostek's present line.

Rand automation study may revamp production lines

Radical changes in plant automation may result from a study under way at the Rand Corp., Santa Monica, Calif., for the Advanced Research Projects Agency of the Department of Defense. Although the project is in its infancy, **one of Rand's first proposals is to mount automated subassemblies on pallets that would move around the factory floor.**

The idea is not only to get away from the standard fixed assembly lines, but permit rapid production of prototypes. The use of robot devices will be a major factor in the study, according to an ARPA official.

Instrumentation amp is first monolithic version

What it claims is the "first true monolithic instrumentation amp" is due soon from Analog Devices Inc., of Norwood, Mass. Unlike building block op amps that sometimes are combined to emulate instrumentation amps, **the AD520 was designed from start as such a "system,"** say Analog spokesmen. They add that in such applications, op amps often have low common mode rejection, nonlinear gain, and input impedance that varies with gain.

To offset this, **the AD520 uses different design rules to make possible a typical bias of 30 nanoamperes, and nonlinearity is limited to 0.02% over a gain range of 1 to 1,000.** CMR between dc and 100 hertz, even with a 1,000-ohm input imbalance, ranges from 70 decibels at unity gain to 110 dB at a gain of 1,000. This spec alone makes the AD520 a potentially good circuit for electrically noisy electrocardiograph and electroencephelograph front ends. Input impedance independent of gain is about 2×10^9 ohms.

The best data recorders in Japan.

They come from Lockheed.

Apparently the Japanese figure nobody makes data recorders that measure up to ours. Not even the Japanese.

Take the Lockheed 417 recorders used for precision data recording.

They're the only ones light enough to carry in one hand (28 lbs.), small enough to fit under an airplane seat (17" x 15" x 7"), and rugged enough to work under vibration and in any position. Yet they're as accurate as large, ungainly rack machines.

The 417s come in intermediate or wideband models. And they record on up to 7 channels simultaneously, IRIG compatible. Direct frequency response ranges from 100 Hz to 375 KHz. FM frequency response is DC to 100 KHz at 30 ips.

For power (normally 13w) a 417 can use its self-contained battery. Or with accessories, it can use any power: 12 to 28v DC, 110 to 220v AC, 50 to 400 Hz.

The Japanese also picked one of our many custom-designed precision recorders to ride in their ionosphere research satellite. This particular recorder stores data at 565 bits per inch on 5 tracks, then plays it back at 26 times normal speed. Yet it weighs only 10 lbs. and gets by on 1/20 the power of a home tape recorder.

But for more down-to-earth uses, 417s are the answer. And back in the U.S.A. they go for as little as $7,000.

For more specs on any of our data recorders, write Earl Nadeau, Dept. 413-301, Lockheed Electronics Company, Plainfield, New Jersey 07061. Or call him at (201) 757-1600.

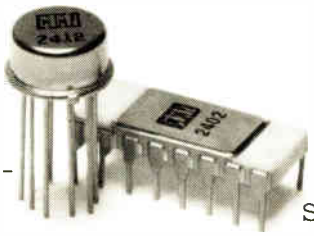
Lockheed Electronics

A Subsidiary of Lockheed Aircraft Corporation

Circle 27 on reader service card

Introducing SuperMOS.

The fastest shift registers you can buy.



Now, from Monolithic Memories — an advanced silicon gate technology that gives you product features you can't find anywhere else. Like shift registers with a guaranteed data rate of 60 Hz to 10 MHz at only 50μW per bit. Operating temperature range from —55° to 125°C. And full MIL-spec design in seven DTL/TTL-compatible configurations from dual 100 up to 1024 bits in standard packaging. In fact, we even have a shift register which doubles bit density and speed in the same package. Our MMI 3412. It's a pin-for-pin replacement for the 1405. In fact, MMI gives you pin-to-pin compatibility with any of the 1400 series you may be using now.

But don't take our word. Compare for yourself. That's why we've included the handy chart. It just goes to show we're not in MOS to be a me-too company. Even when it comes to price.

Proof:

	Register Organization	Temp. Range	Data Rate Typical Min.	Data Rate Typical Max.	Data Rate Guaranteed Min.	Data Rate Guaranteed Max.	Power @ 1 MHz	Unit Price @ 100Qty.
1402A	Quad 256	0 to 70°C	10 Hz	to 10 MHz	500 Hz	to 5 MHz	100 μW/bit	$8.10
MM3402	Multiplexed	0 to 75°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	9.00
MM2402	output	−55 to +125°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	18.00
1403A	Dual 512	0 to 70°C	10 Hz	to 10 MHz	500 Hz	to 5 MHz	100 μW/bit	7.20
MM3403	Multiplexed	0 to 75°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	8.00
MM2403	output	−55 to +125°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	16.00
1404A	Single 1024	0 to 70°C	10 Hz	to 10 MHz	500 Hz	to 5 MHz	100 μW/bit	7.20
MM3404	Multiplexed	0 to 75°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	8.00
MM2404	output	−55 to +125°C	5 Hz	to 20 MHz	60 Hz	to 10 MHz	50 μW/bit	16.00
1406	Dual 100 Open Drain	−55 to +125°C	10 Hz	to 3.5 MHz	500 Hz	to 2 MHz	400 μW/bit	2.25
MM2406		−55 to +125°C	2 Hz	to 8 MHz	30 Hz	to 5 MHz	200 μW/bit	5.00
MM3406		0 to 75°C	2 Hz	to 8 MHz	30 Hz	to 5 MHz	200 μW/bit	2.50
1407	Dual 100 20K	−55 to +125°C	10 Hz	to 3.5 MHz	500 Hz	to 2 MHz	400 μW/bit	2.25
MM2407		−55 to +125°C	2 Hz	to 8 MHz	30 Hz	to 5 MHz	200 μW/bit	5.00
MM3407		0 to 75°C	2 Hz	to 8 MHz	30 Hz	to 5 MHz	200 μW/bit	2.50
1405A	512 bit Recirculating	0 to 85°C	8 Hz	to 2.5 MHz	200 Hz	to 2 MHz	300 μW/bit	3.60
MM3405		0 to 75°C	2 Hz	to 6 MHz	30 Hz	to 4 MHz	100 μW/bit	4.00
MM2405		−55 to +125°C	2 Hz	to 6 MHz	30 Hz	to 4 MHz	100 μW/bit	7.20
MM2412	1024 bit Recirculating	−55 to +125°C	2 Hz	to 6 MHz	30 Hz	to 4 MHz	75 μW/bit	14.00
MM3412		0 to 70°C	2 Hz	to 6 MHz	30 Hz	to 4 MHz	75 μW/bit	7.00

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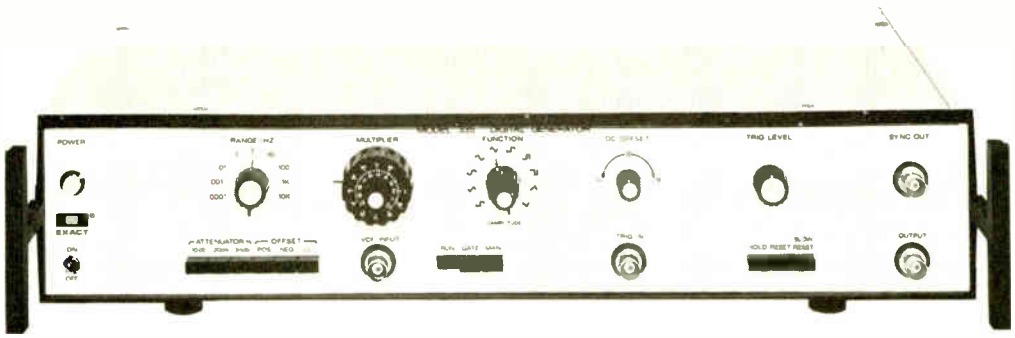

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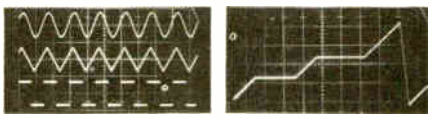
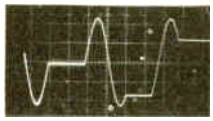
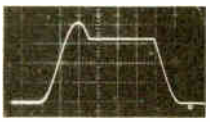


Sine, triangle and square.

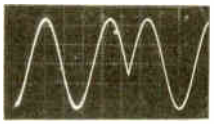
Ramp caught and held twice, and allowed to complete the cycle.



Sine wave caught and held at three different points.



Sine square pulse held at one point.



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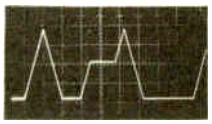

Triggered triangle started at −90°, second cycle has been held at one point.

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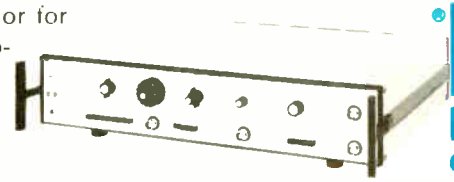

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Citizens' radio called big market if FCC okays fm band

Approval of EIA's suggested conversion of part of the 220–225-MHz range could mean $300 million market

If the FCC clears the remaining jurisdictional hurdles, citizens' band radio in three years could explode into a $300–$500 million annual market—10 times its existing size at retail. So says the Electronic Industries Association, which also claims that the FCC's blessing of its proposal to convert citizens' radio from am to fm would give U.S. producers an advantage over Japan and would eliminate some Federal spending on the development of an emergency mobile radio service (see box on this page).

As the FCC shows signs of action on EIA's year-old proposal, it is beginning to encounter opposition, too. Leading opponent of the plan to convert 2 megahertz of the 220–225-megahertz amateur band to citizens' radio is the 85,000-member American Radio Relay League, which would lose 40% of its assigned bandwidth.

Opposition from the amateur operators surfaced months after the EIA request got an indirect lift with a disclosure of the White House Office of Telecommunications Policy. OTP reported that the Defense Department, which has first claim on the frequency, was willing to consider release of the 220–225-MHz band for a secondary usage such as citizens' radio. FCC approval is still required, of course.

Compromise? Now the commission has submitted a proposal to the White House policy group for DOD consideration. Though OTP won't detail the plan, industry sources believe it is a 1-MHz compromise of the EIA plan to create an 80-channel fm service called Class E, plus a possible expansion of the existing am Class D service at the 26.96–27.23-MHz bandwidth.

Despite that reported cutback in the request, some EIA members say privately that even the 40 fm channels that 1 MHz would provide would go far toward eliminating the well-known problems of heterodynes now generated by am transmitters. More important, say others, is that fm at 220–225 MHz would prevent the abuse of citizens' radio for long-distance transmission that arises when am signals reflect (or skip) off upper layers of the geosphere.

Opponents, on the other hand, say manufacturers are simply trying to create a new equipment market artificially, and argue that fm transmissions at the proposed bandwidth

Making a market grow 10 times bigger

Expanding a market by a factor of 10 is no mean feat. Here's how the Electronic Industries Association says it can be done with citizens' radio after a two-to-three-year startup:

Class E radios installed at $200 each in one of every 10 cars sold annually in the U.S., a 10-million car market, would account for $200 million. John Sodolski, EIA vice president for the communications and industrial division, calls it a conservative estimate. Another $100 million would be generated by sales of base stations to one out of every two of these car owners, including such self-employed persons as doctors, plumbers, electricians, salesmen, farmers, and service-station operators. Pleasure boat operators, campers, motel operators, and others anxious to capitalize on business from mobile users would account for the remainder of the $500 million market estimates. Sales could begin as soon as three months after approval.

Manufacturer Gus Wirth, president of Echo Communications Inc., Cedarsburg, Wis., foresees modification of car radios "with one integrated circuit" to make one pushbutton an fm citizens' radio transmitter. Wirth not only foresees organizations like oil companies offering highway guidance, weather, and accident assistance services to mobile users, but also believes such services would do away with the need for expensive emergency broadcast systems now under investigation by the Department of Transportation. "Class E could resolve all of this," says Wirth, "and it wouldn't cost the taxpayers a dime."

Both Wirth and Sodolski believe Class E technology would give U.S. producers an initial advantage over Japanese manufacturers who have taken over much of the Class D equipment market with their own radios or those sold under a U.S. brand label. "At the moment," Sodolski says, "It is an established fact that U.S. manufacturers have some advantage in development and manufacture of Class E-type equipment."

could be jammed in as many as 14 states where the Pentagon still operates some of its older high-power radars.

Integrated electronics

Insulated-gate FET gets a bipolar output

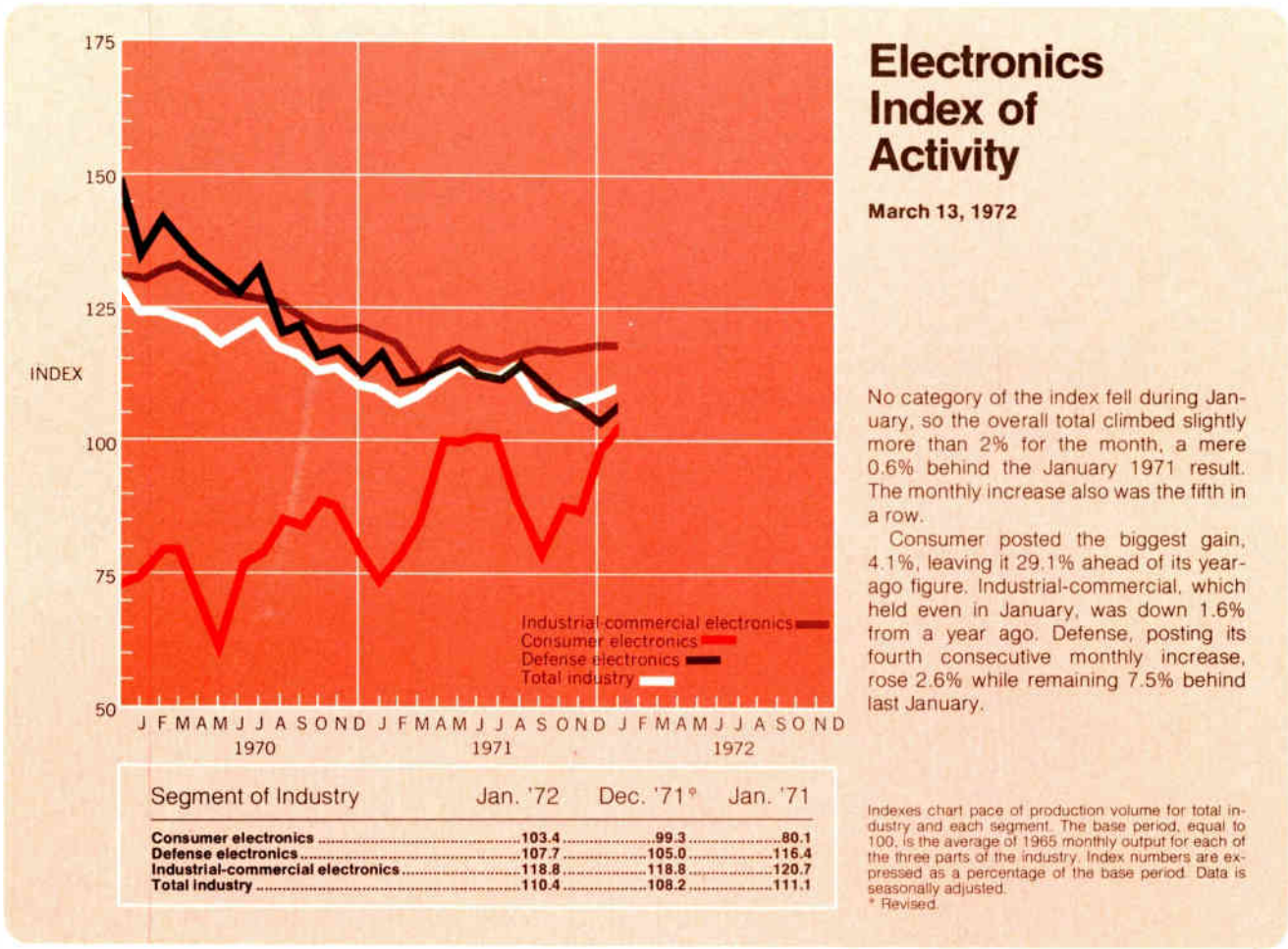
The insulated-gate field-effect transistor, the basic MOS device and a building block of many shift registers, operational amplifiers, and the like, has developed new muscle: high-current output. Bell Laboratories engineers at Allentown, Pa., have turned the trick by giving the IG-FET a hybrid structure that combines a FET input and bipolar output right in the same device.

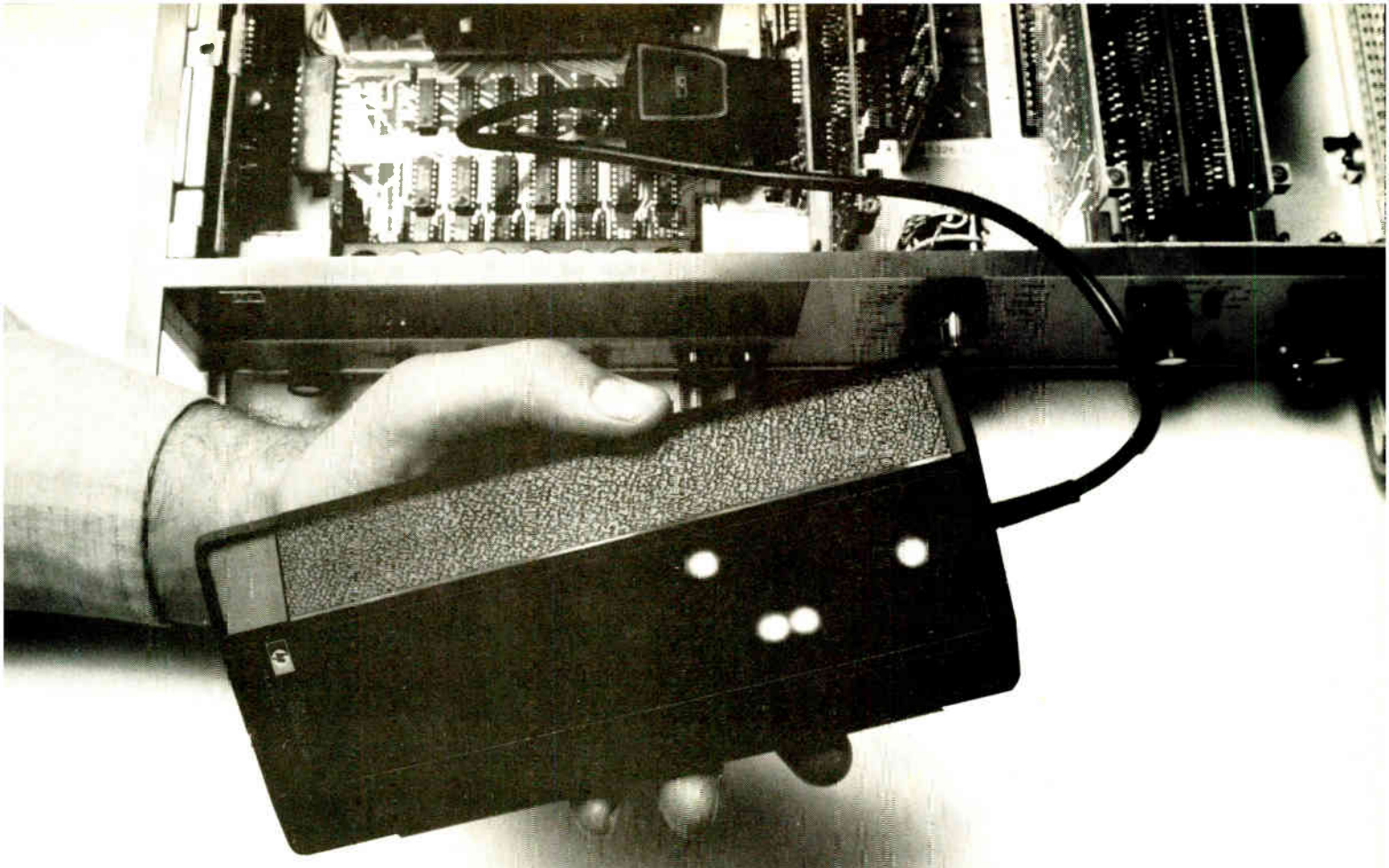
The new device—dubbed BIG-FET—is built for use in driver/decoders to interface with light-emitting-diode displays. It takes the FET's low power dissipation, modest power needs, and high packing density essential for decoding a LED display, and adds the high current needed to drive LEDs. In fact, the hybrid approach promises power savings of 30% to 90% over equivalent all-bipolar circuits.

Traffic cop. G.T. Cheney and T.F. Thomasco of Allentown's digital IG-FET circuits group say that the new circuits just went into production at Western Electric factories, and soon will be installed in a new Traffic Service Position System—Bell's name for a computer-controlled operator console that eliminates many of the manual functions of the old switchboards. Bell will replace the Nixie cold-cathode tube readouts with LED displays, and the new circuits will save power-supply costs and space.

The BIG-FET structure is elegant—the drain current in the FET structure doubles as the bipolar base current, because an $n\theta$ region is diffused into the drain of a p-channel FET. The FET's drain acts, at the same time, as a base in an npn bipolar transistor. The channel current of the IG-FET becomes the base current of the bipolar transistor in the structure.

The display can be connected to the drive/decode circuit in parallel or series. In the parallel, or shunt, arrangement, the LED is connected from the collector of the bipolar transistor (which is the substrate of the IG-FET) to the emitter, which communicates to ground through a resistor. Here, the current drawn from the power supply is essentially constant: when the LED is on, the bipolar transistor is off, and the current is controlled by the drop across the LED and resistor to ground. When the LED is off, the bipolar transistor is on and the current path is from the power supply, through

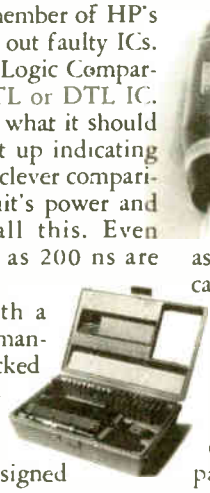




The IC troubleshooters march on.

This one tells a bad IC from a good one in 5 seconds or less.

Here comes the latest member of HP's Troubleshooters searching out faulty ICs. Just clip the HP 10529A Logic Comparator onto an in-circuit TTL or DTL IC. If the logic function isn't what it should be, bright red LEDs light up indicating which pins are at fault. A clever comparison scheme uses the circuit's power and input stimulus to do all this. Even dynamic errors as brief as 200 ns are stretched and displayed.



It comes complete with a self-test board, operating manual and all accessories packed in a handy case. It costs only $295.

We're thinking ahead. Because the case is also designed to hold our other two Troubleshooters — the HP 10525A Logic Probe and the HP 10528 Logic Clip.

The probe lets you trace pulses through integrated circuits simply by touching a pin. The probe's tip flashes a signal for pulses as narrow as 25 ns, and indicates pulse polarity, pulse trains and logic states. It's almost like having an oscilloscope squeezed into a ball-point pen. $95.

The clip is a convenient state indicator. It slips over your DTL or TTL package and bright LEDs display the static state of all 16 (or 14) pins at a glance. It operates like 16 binary voltmeters. $125.

You can buy all three as the HP 5010A for $495, saving you time, aggravation and $20.

The IC Troubleshooters march on. Wait until you see what we're working on now! Just call your HP field engineer to get your hands on them right away. Or if you want to know more, write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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the bipolar transistor and resistor to ground.

Thus, the same current is drawn from the power supply at all times—a saving in power supply requirements, because it's not necessary to regulate for large swings.

In the series configuration the circuit offers maximum power conservation because now the power is dissipated only when a LED is to be energized.

Companies

Wyly pledges UCC assets to Datran and Penisten

Communications securities analysts periodically question how Data Transmission Co. (Datran) will manage to last until 1974, when its proposed 35-city switched digital data network goes on the air [*Electronics*, July 5, 1971, p.77]. In fact, to the industry and Government officials who prowl the halls of the FCC, the engineering data in Datran's proposal has always seemed more impressive than its financial plan.

Penisten: Get Datran back on cash track

Sam Wyly, chairman and founder of University Computing Co. of Dallas, which owns Datran, appeared to have the answer when the question surfaced again after his appointment of Glenn Penisten, from Texas Instruments, as Datran's president and chief executive. "We are behind Datran 100%, and would be willing to sell some of UCC's equipment and other assets in preference to selling Datran."

Among those other assets, Wyly listed some of the Gulf Insurance properties, a large revenue producer that includes Gulf Atlantic Life and Security Life, and all or part of UCC's Computer Leasing Co.

The reaction in the communications industry was that income generated from disposal of the Gulf properties alone would be sufficient to keep Datran going at full tilt for two more years until it begins producing its own revenues. The company expects to get its first construction permits from the FCC by April and then begin to build the first part of the net from California to Texas, linking San Francisco, Los Angeles, Phoenix, and Dallas.

Texas touch. As for the 40-year-old Penisten, his role as vice president and manager of the New Enterprises division of TI's components Group marked him as a product management heavyweight. "Glenn Penisten is a major loss for TI," says one official at the company, from which departing executives rarely receive such bouquets. "I consider Penisten the man largely behind our successes in TTL, opto-electronics, power semiconductors, and MOS."

Despite the fact that Penisten must still demonstrate his ability to transfer his product performance expertise to a service-oriented communications company, Sam Wyly clearly foresees no problems. "Penisten has been responsible for the performance of several thousand people and for sales objectives of several hundred million dollars," points out Wyly, "and that's the size I expect will be in a few years." Moreover, he sees a parallel between Datran's system and the introduction of TI's semiconductor, Boeing's 707, and the Xerox copier. All required "breakthrough strategy, both technologically and in terms of market penetration."

Datran says it has achieved one breakthrough of sorts—a cut in its systems costs—by moving from reed matrix switching technology to solid state, with Stromberg Carlson developing a switch to be used in conjunction with Comten controllers.

Financing. Despite these economies, Datran's system will still cost about $400 million and require an estimated $300 million financing scheduled in four phases. The first $35 million phase, using company and privately raised funds, was scheduled for completion this winter. Though UCC has sunk $12 million into the operation to date and expects to continue funding Datran at $500,000 to $600,000 a month, negotiations for the first plan have yet to bear fruit. Earlier talks with Raytheon Co. and United Utilities Inc., among others, were broken off when, financial community sources report, the buyers pushed for controlling interest, rather than the 30% equity represented by the $35 million.

Thus a major Penisten task appears to be getting Datran back on its financial timetable. This includes completion of a second phase equity offering of $70 million by this fall, of which UCC is pledged to pick up half. The biggest economic hurdle will come in the spring of 1973, however, when Datran seeks upwards of $85 million through debt with warrants, some of which is expected to be sought through equipment vendor financing. The fourth and final phase is proposed for the winter of 1973-74, with a public offering of $100 million more.

Optoelectronics

Rectangular waveguide brightens laser light

The military laser market last year amounted to a whopping $50 million, more than half the total laser market of $90 million, and may get a further boost from a newly imple-

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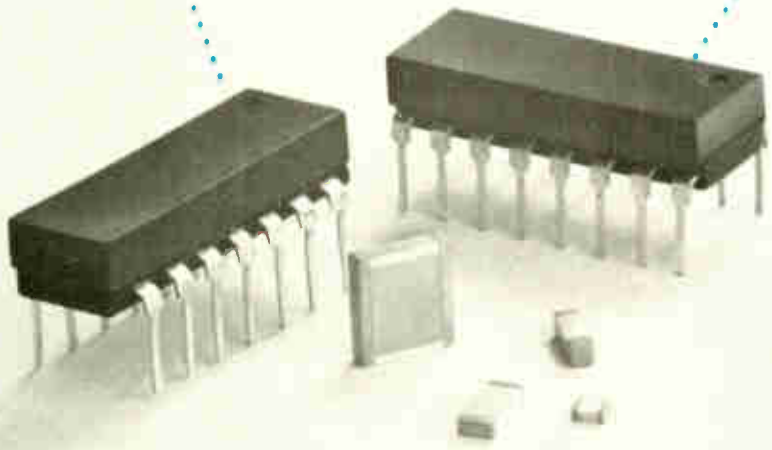

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ULA-70	.180	.070	.060	330	2,700	18,000	22,000
1805	.160	.050	.020	to 1,800	to 6,800	to 47,000	to .15 μf
ULA-78	.190	.090	.060	560	4,700	33,000	47,000
1808	.170	.070	.020	to 3,900	to 15,000	to .10 μf	to .27 μf
ULA-60	.230	.255	.060	2,700	22,000	.15 μf	.47 μf
2225	.210	.235	.020	to 15,000	to 56,000	to .47 μf	to 1.5 μf

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mented method of coupling diode lasers in illuminating systems.

The Army's Night Vision Laboratory at Ft. Belvoir, Va., is using rectangular fiber-optic waveguides to couple the outputs of a 200-element gallium-arsenide-diode laser illuminator, increasing the average radiant emittance of the system by a factor of 20 over illuminators coupled by conventional waveguides.

Because GaAs diode lasers are small and cheap they are ideal as the source of energy for infrared illuminators in ranging, guidance, and tracking systems. But small as diodes are, the projection optics needed to beam the energy out of the cavity and into the field are large. This heavy front end optical system has added weight and size to the illuminator—especially bad for large-element arrays. With rectangular fibers, however, the cross section of the waveguide can be made to match the rectangle of the laser's cross section, dramatically reducing the size of the projection system.

Bright and light. Using RCA lasers and Sperry waveguides, workers at Belvoir managed to increase the radiant emittance from 0.25 watts per square centimeter to 4.84 watts/cm^2 and average power from 80 to 100 milliwatts. What's more, a computer model indicates that, with this technique, a working system with a 200-diode array is possible that will supply 1,200 watts peak power, or 600 milliwatts average power, with a lens system only 1.92 inches in diameter and weigh only 1.17 pounds.

National in LED business with four versions

Convinced that light-emitting diodes will replace incandescent bulbs as indicators in instruments and computers, National Semiconductor Corp. has jumped into the market with four LED products. Floyd Kvamme, director of marketing, says "A large percentage of repair calls on computers is to replace front-panel lamps, and because LEDS have a much longer life expectancy than bulbs, we feel that the LED lamp business will be excellent."

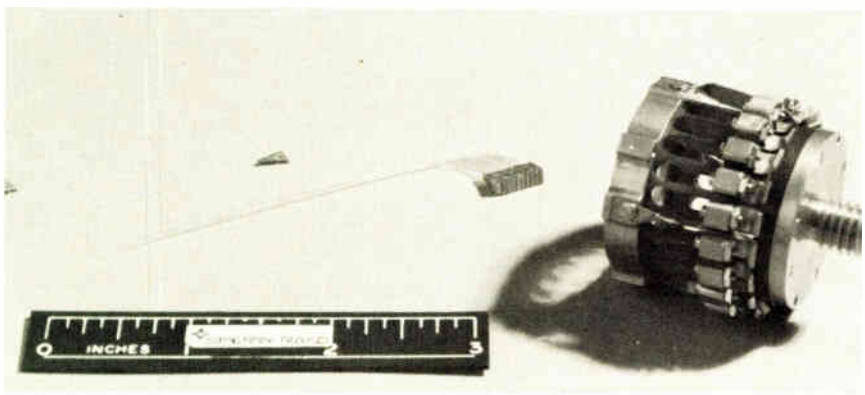
The first products include two point sources—one with a clear lens and one with a red lens—and two diffused emitters, one clear and one red. Gallium arsenide phosphide is used in all four. The package configuration is similar to Fairchild's FLV 100, essentially a two-LED TO-106 transistor package with a ceramic bead and a clear or red plastic top.

Package. Kvamme says that, since National has had years of experience with the TO-106 package, the company was able to get its product to market in a much shorter time than if it had developed a new package from scratch.

As for the competition, Kvamme maintains that the TO-106 package provides better contrast than the cast plastic packages employed by Monsanto and Litronix, and that the National parts are as bright as, if not brighter than, anything on the market. Price is also on a par—in single quantities, the lamps cost $1.03 each; this drops to 59 cents in quantities of 1,000.

As of now, LED displays are not in the picture at National. As Kvamme puts it, "We will concentrate on getting our normal share of the lamp business." For National to get involved with LED displays, Kvamme says, "It will take the development of a dollar-per-digit device."

Market booster. Rectangular waveguides used at the Army's Night Vision Lab in a new method of coupling diode lasers could give push to the military laser market. In 200-element illuminator, average radiant emittance is increased by a factor of 20.



Manufacturing

Laser vs diamond saw: scribing jury still out

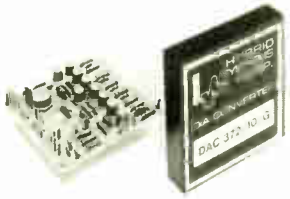
Despite the lure of the laser's bright lights, diamonds still are a semiconductor wafer's best friend—at least if you ask people like Matt Pennings, president of Tempress division of Sola Basic industries Los Gatos, Calif. Tempress is about ready to ship to several semiconductor makers the first production models of its diamond wafer-dicing saw. At $12,500 apiece, Pennings figures he can convince even more semiconductor houses that his saw is a more economical way to improve scribe-and-break yields than the more than $50,000 it takes to install a laser scriber.

However, the first big user of laser scribers, Motorola Semiconductor Products division in Phoenix, Ariz., is committed even more heavily to the laser. Assuming that expected capital equipment appropriations come through, it could easily add five systems within the next year to the five already installed, according to Stanley Kleban, Motorola's group operations manager for discrete products.

Blade is key. The key element in the Tempress saw is the 1-mil-wide blade—a nickel disk impregnated with diamond—that's mounted on an aluminum disk for greater strength. The saw can cut through a

Data Conversion Modules

Performance...



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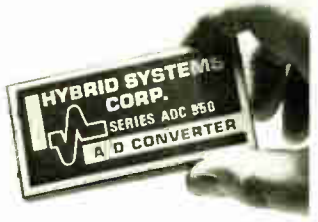

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Electronics review

wafer at the same speed that a diamond scriber moves across the wafer, while still preserving the orientation of the dice—a prerequisite for automated handling systems. The blade leaves a kerf only 1.6 mils wide, says Pennings, which is well within the usual street left for conventional diamond scribing. Pennings adds that other types of saws—wires and slurries—leave kerfs up to 4 mils wide.

The Tempress saw can also be used as a scriber with the same kerf loss, but its advantage over the diamond scriber is that it cuts more deeply and produces clean, square corners on the separated dice. The blades, however, do wear out—but Pennings says they're good for "many cuts;" a good ballpark figure is 40 wafers per blade—and must be replaced at about $12.50 each if they're bought in large quantities.

Nevertheless, Motorola's Kleban, without intentionally punning, says he sees "a very bright future for lasers," whose advantages over scribing as well as sawing make them the "number one method of dicing." He points out that one laser scriber has replaced four diamond scribers at Motorola, and this has been done while he's still involved in smoothing out the setup time for the laser. Once the lasers are running full steam, he says, the advantage will be even greater.

Kleban acknowledges that a heat-damage zone is inevitable with the laser scriber, but he says that he's able to scribe easily within the 3-mil-wide streets normally set up for diamond scribers, and he can even use the laser on devices that have junction areas as close as 1 mil to the laser scribe edge.

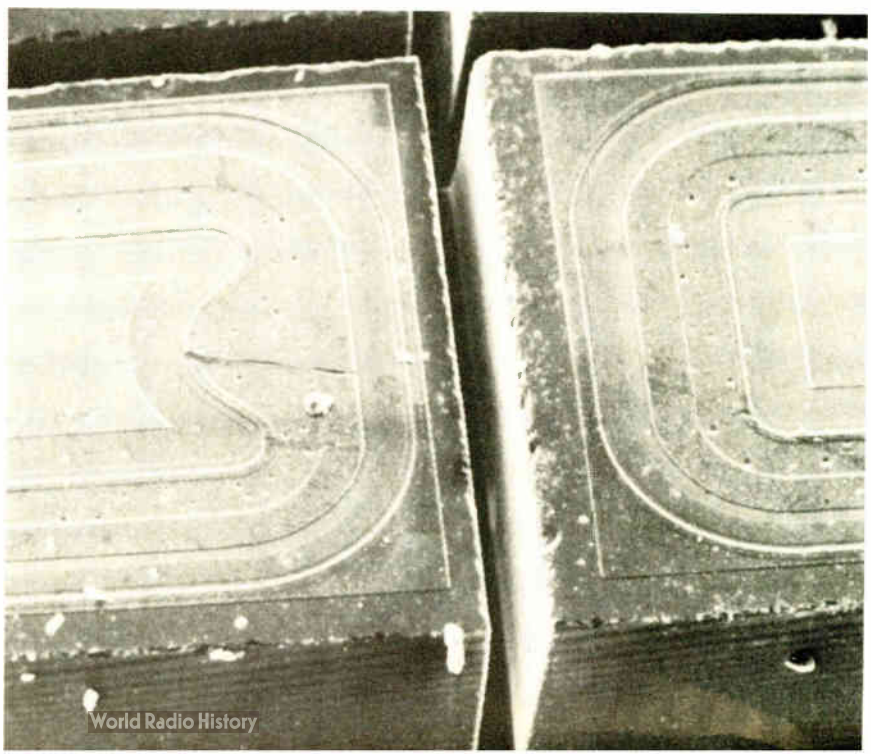
Space electronics

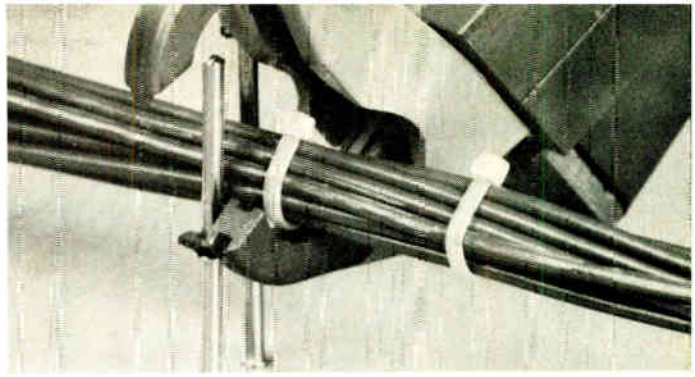
NASA pares Grand Tours to economy class

NASA, forced to scrub the proposed unmanned Grand Tours to the outer planets because only the planetary scientists liked the program, has come up with an economy plan. The White House and Congress thought that $700–$900 million was too much to pay for more information about Jupiter, Saturn, Uranus, Neptune, and Pluto, and other scientists feared the far-reaching program would divert tight NASA money away from their own programs [*Electronics*, Jan. 31, p. 79].

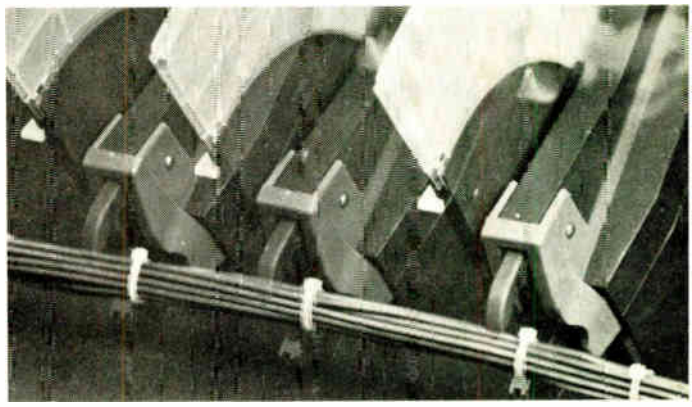
Now NASA is planning a budget tour costing "no more than $360 million," which it hopes should

Clean cut. As the debate over whether lasers or diamond saws make better scribers continues, Tempress is about to ship its diamond wafer-dicing saw. Kerf is only 1.6 mils wide.

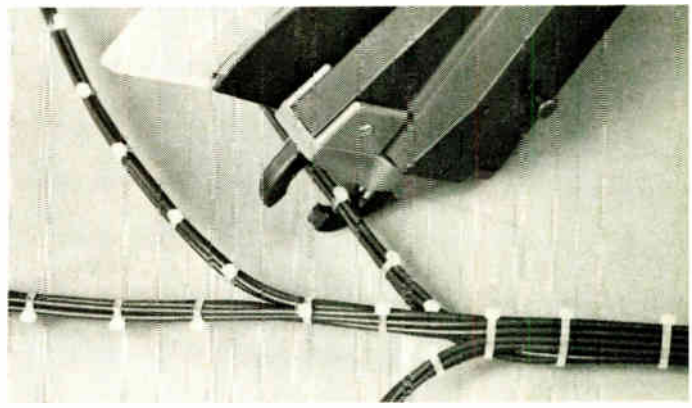




goes where hands can't



ties in less than a second



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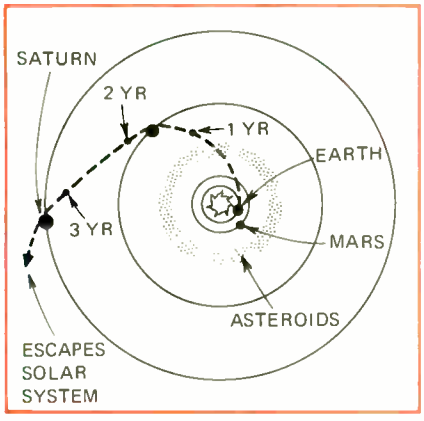
please everyone. But, of course, at bargain rates you don't always get the longest itinerary or the newest type of equipment. Robert S. Kraemer, director of planetary programs, explains that the new outer-planet missions would use just two spacecraft to be launched in 1977 to Jupiter and then Saturn. The craft would use a lot of electronics equipment designed for the Mariner and Viking orbiter series, as well as for the aborted Thermoelectric Outer Planets Spacecraft (TOPS) programs [*Electronics*, March 30, 1970, p. 108] that were to form the Grand Tours.

Big contract. Even so, the project would be a sweet plum to a contractor. The request for proposal for an estimated $150 million is expected to be issued mid-1973, Kraemer says. The space agency hasn't given up exploring the outer planets, and is thinking about other missions, which because of their complexity could cost more. "Clearly, the company doing this project has a leg up," he says, because any follow-on tours would probably be sole-source contracts.

Passage of the 1977 Jupiter-Saturn mission seems almost certain. NASA Administrator James C. Fletcher is expected to give the program his formal approval shortly, and Congressional reaction is reported favorable. The new program will cost only $7 million for fiscal 1973 because NASA has $10 million left over from the previous year, Kraemer says, adding that NASA also has promised Congress that peak funding in fiscal 1976 will be less than $90 million.



Round and round. Not-so-Grand Tour proposed by NASA would have two craft launched in 1977 to Jupiter and Saturn.

Although NASA is finishing design concepts, Kraemer points out that the 100-pound scientific payload of the Mariner 1973 Venus/Mercury craft "looks pretty good" as a basis. "One shouldn't be too surprised if this mission is similar," he says. "If industry wants to get started on studies, it should look at that payload and work from that." The Boeing Co., Seattle, is building the craft under Jet Propulsion Laboratory, Pasadena, Calif., project management.

Solid state

Fairchild aims 95100 ECL at mainframe houses

Fairchild Semiconductor, in a new marketing thrust, has developed a family of emitter-coupled logic—labeled 95100—designed for the mainframe builder. This is a change in philosophy. When Fairchild introduced its 9500 ECL series last year, its feeling was that the mainframe houses would prefer to go to a custom product line; the result was that the standard line was aimed at the small-system builder.

Tom Longo, vice president and general manager of the Digital Products division, says that Fairchild made ECL easy for the small-system builder to use by making it temperature-compensated. This meant that the user didn't have to worry about keeping all the ICs at the same operating temperature. But to make a standard family for the mainframe builder, Fairchild decided that there was still a greater problem—power supply variation.

The result is that the 95100 family is both voltage-and temperature-compensated. Longo says that what changed the thinking of the large computer houses was the 7400 transistor-transistor logic series, which showed them the advantage of a standard logic family. And Motorola's success with its MECL 10,000 series may also have had something to do with it: the speed-power factor

Electronics review

of the 95100 is 45 picojoules; for the 10,000 it's 50 pJ. Both offer 2-nanosecond-per-gate propagation delay.

Variation. Longo says, with totally compensated 95100 ECL devices, the usual ECL design requirement to regulate supply voltages within a ±2% range can be relaxed to ±10% if operating on a nominal 5.2-volt supply. If a 5.5-V supply can be used, ±15% variation can be tolerated. This is greater than the variation that can be tolerated in standard TTL logic. To the user, the wider supply tolerances mean that less expensive power supplies can be used and that, in most cases, on-card regulation can be eliminated.

Power supply compensation was achieved by building an on-chip voltage regulator. The trick, according to Longo, was to keep it extremely simple and small so that it didn't take up too much chip area. The circuit chosen is similar to one used in the μA 746 voltage regulator. The V_{be} drop of a diode is compared with the V_{be} drop of an emitter follower, and the resultant signal is applied to the voltage reference circuit normally included in an ECL circuit. (Since ECL circuits are current switches, each gate level contains a current source that is fed by a voltage reference.)

"It's the type of thing that, once you've done it, you ask yourself 'Why didn't I do it before,'" says Longo. In the 746 voltage regulator, the implementation of their concept takes many more components than could be used on an ECL chip, but Longo points out that in the 746 the voltage available was only 1.2 V, "but in the 95100 series circuits we have 5 V to work with, and this enabled us to shrink the parts count."

The first devices available in the new family include the 95102, 95103, and 95104 dual, triple, and quad OR/NOR gates, priced at $1.80 in quantities of 100. These will be followed in the second quarter of 1972 by a 260-megahertz dual D and J-K flip-flops and a line of MSI building blocks, such as 200-MHz counters and a four-bit arithmetic logic unit, decoders, and multiplexers.

Test snafu

Even as Fairchild announced its new 95100 ECL family, Motorola admitted that it had recalled all but four varieties of its MECL 10,000 from distributors because of a problem in final testing. Jack Miller, manager of digital IC marketing, says certain tests were performed incorrectly, raising the possibility of excessive leakage current. The recall started Feb. 21, with all recalled devices to be retested and back on the shelves by March 10.

Miller says that the problem was not reliability or packaging. He points out that parts won't deteriorate, so that if they are working properly now, there is no need for concern.

Government

Customs plans national computer-terminal network

As American companies automate their import activities, the job of the U.S. Customs Bureau becomes both larger and more complex. Last year Customs processed 8 million detailed entries, and the number alone is growing 10% a year. As a result, the agency wants to turn to computer terminals to keep up with the growing mountain of data and regulations.

What Customs has in mind ultimately is AMPS—for automated merchandise processing system, a nationwide $60 million computer network using 1,800 terminals. It would be the "most complex commercial system ever to be installed from a design point of view," states John W. Edwards. He was director of corporate systems for Polaroid Corp. before he joined the Customs Bureau last year as assistant to the commissioner for automatic data processing.

The off-the-shelf system would use four computers with an "upper medium range, one megabyte, third-and-a-half generation ma-

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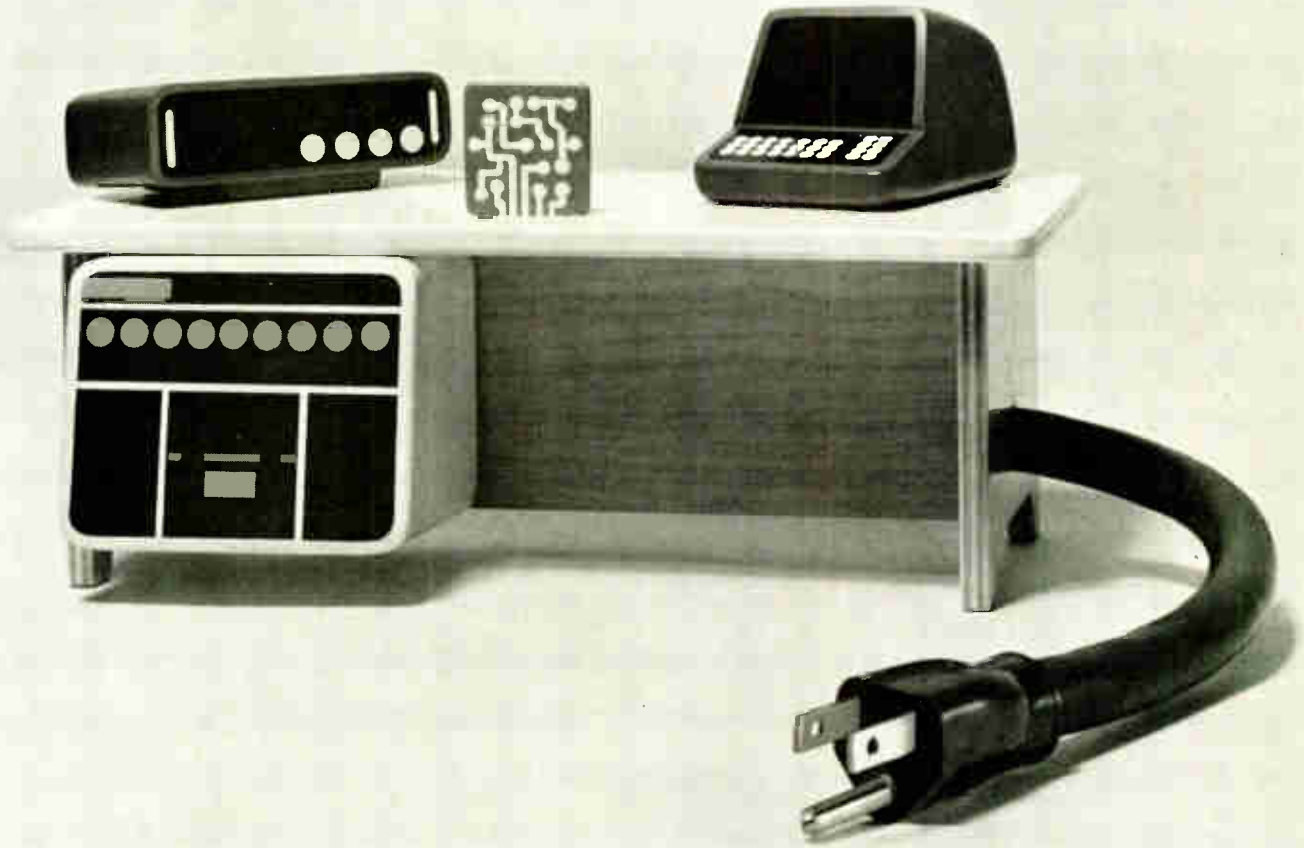

Circle 95 on reader service card

chine" in Washington as the keystone, he says.

Customs will set up its system in carefully planned phases, Edwards says. In May the service will issue requests for proposals for the Washington computer, a smaller field computer, and proprietary software, and in July it will select a vendor. After a year of evaluation and training, a second 15-month operational testing phase will begin at the port of Seattle, with the two computers connected. If in 1974, after the Seattle trial, the bureau decides that the hardware can handle Customs' complex rules and regulations, it will go out to industry for bids on the national system to be phased in over three to five years.

Terminals. As terminals are an integral part of the proposed network, the Treasury department agency this summer will also issue RFPs for various types of terminals. The service plans to buy programable, CRT, and other types for operational tests. "We're 100% confident that the hardware can do the job," Edwards says, "but we want to make sure that the system we designed matches our needs."

The planned system will have these subsystems: classification and value, codifying valuations and duties; central quotas, keeping track of limited import items; "information on tap," accessing issues that arise after disputes; and a management information system, which would in part provide trade statistics to the Departments of State and Commerce. "To get the data collection as close as possible to the source," Edwards says the bureau would offer use of the terminals to large shippers and brokers to put their data directly into the system.

Wideband. For the future, the service is considering modifying the national network. Edwards says, for instance, by using concentrators, mass switching, and wideband capabilities between computers so that files could be transferred between computers on short notice. A by-product of the system, Edwards points out, is that it can be used for criminal intelligence to trace the possibly illegal actions of importers.

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Electronics review

But he adds that the system will be data-secure and fully in accord with Federal regulations protecting the rights of individuals.

For the record

Two specials. Two new computers appeared only a day apart earlier this month when General Electric Co. and IBM announced a process-control minicomputer and a communications controller.

GE's new GEPAC 3010/2, replacing its earlier GEPAC 3010, is intended for both utility and industrial applications. Existing software, operator consoles, and peripheral equipment can be used with the new machine, as well as new disk and tape units and a new card punch.

IBM's new communications controller, dubbed 3705, coordinates the operation of 352 telephone lines—twice as many as IBM's largest previous controller—and relieves the central computer of many routine tasks associated with data transmission.

TI consumer? In response to reports that it is getting into the consumer calculator market, Texas Instruments has admitted that "the possibility certainly exists that we may find it desirable to some day be in the calculator end equipment business."

Sited. With the Army award of a 60-month, $382 million prototype demonstration program of its Hardsite ABM system to McDonnell Douglas Astronautics Co., the program also got a new name. Now called SIM—for site defense of Minuteman—the package has an $800 million potential with the inclusion of modified Spring missiles by Martin Marietta.

McDonnell Douglas gets $10 million as its first increment. Its five subcontractors are expected to share roughly this way: GE terminal defense radar, $78 million; CDC computers, $31 million; GTE Sylvania command and control communications, $9 million plus; Braddock, Dunn & McDonald engineering, $1.5 million; TRW systems planning, $100 million.

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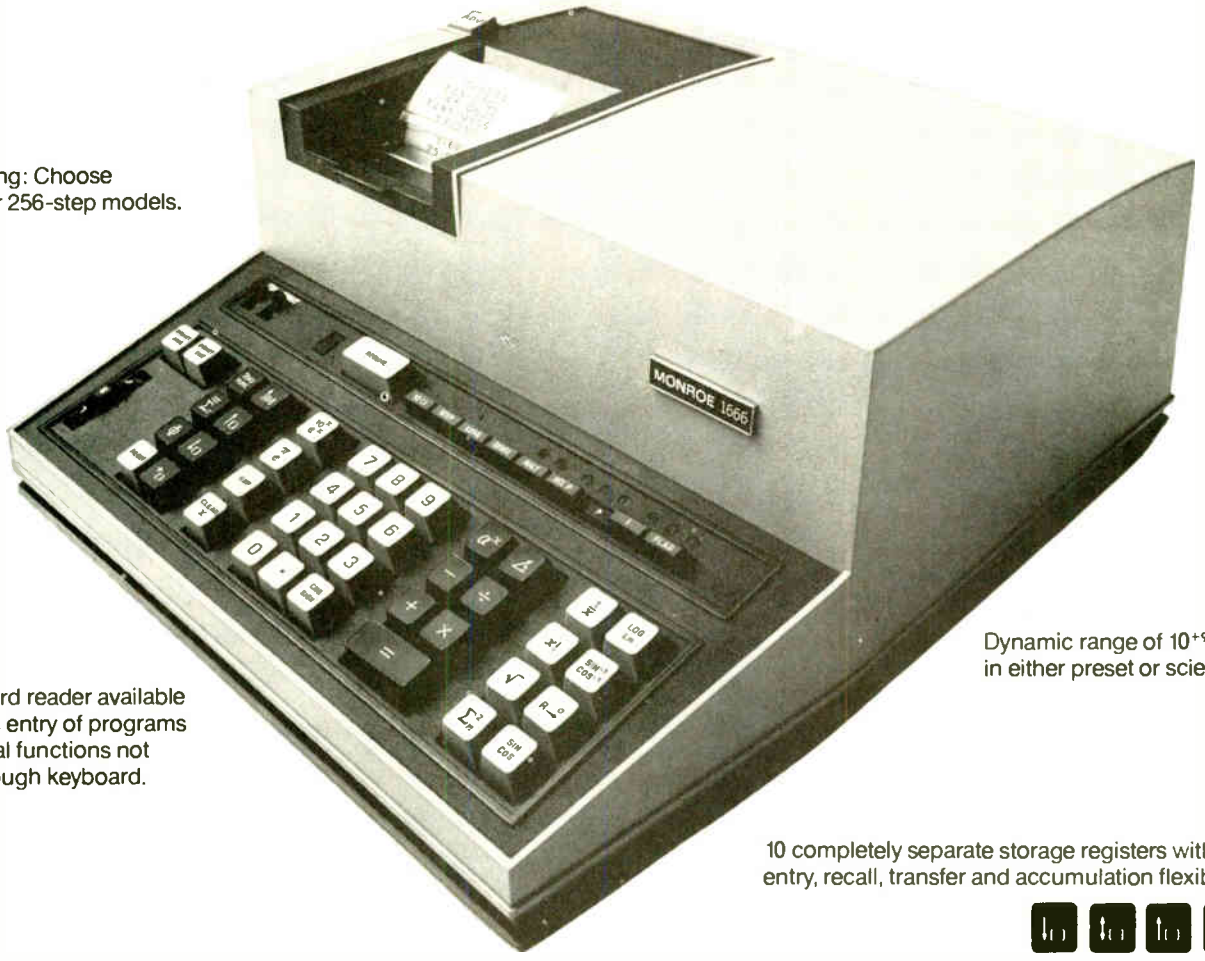

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Washington Newsletter

March 13, 1972

B-1 avionics switch seen jeopardizing whole program . . .

Postponement until May 31 at the earliest of an Air Force B-1 avionics integration contract award is jeopardizing the B-1 advanced manned bomber program's future, say Congressional Defense Committee sources, who note it "has always been a chancy thing politically." In addition to being subject to compromise in strategic arms limitation talks with the Soviet Union, the B-1 has been the target of defense-spending critics, who are expected to become still more vocal now that the service has decided to revise the avionics package. **The change is generally viewed as delaying the program, and escalating the unit cost of the first three planes above the $50 million level.**

. . . amended RFP separates offense, defense units

At the end of February, the AF Aeronautical Systems division distributed a 25-page amendment to its request for proposal to the four competitors for the avionics award—Boeing Corp., Hughes Aircraft, IBM Corp., and the Autonetics division of North American Rockwell, the aircraft's builder. **The amendment calls for two identical computers for use in navigation and weapons display in the B-1's offensive system, plus an identical or similar computer for such defensive uses as electronic countermeasures.** Bidders are to submit a 75-page revision to their proposals no later than March 15, and **the computer options they propose must all be deliverable, either currently or within 12 months** if qualified for development in another major program. The Air Force expects a 45-day review period after its own contractor selection by April 15.

All the competitors, except IBM reportedly, included the Univac 7532 computer in their proposals. It's a radiation-hardened version of the firm's 1832 model chosen for the Navy's S-3A antisubmarine warfare plane. **Univac contends the 7532 is still in the competition because the processor "is off-the-shelf** by our interpretation of the Air Force criteria." But the logical alternatives would be such existing processors as IBM's 4-Pi or AP-1, the latter being developed for the Air Force F-15 fighter, or Autonetics' SRAM.

FAA to develop ground station for time-frequency CAS

Requests for proposals are expected to be issued very shortly by the FAA for a developmental model of a ground synchronization station that will test the concept of time-frequency-based collision avoidance systems. **RFPs also are due out for a study on the number and location of stations needed for a national time-frequency CAS.** Developed by McDonnell-Douglas and backed by the airlines' Air Transport Association, the approximately $400,000 ground station development also would include the testing of airborne synchronization hardware. **The FAA estimates that a time-frequency CAS would require 65 stations by 1981 at a cost of about $30 million.**

But whether time-frequency or RCA's Secant interrogator/transponder technique should be the national standard is a decision the FAA has yet to make. The agency recently told the Senate aviation subcommittee that it wouldn't be able to estimate when it could decide until January 1973. **Both the FAA and the Defense Department told the committee that more testing is needed of all CAS systems** [*Electronics*, Jan. 31, p. 29]. However, **the FAA repeated its preference for ground-based systems** over airborne units such as time-frequency or Secant.

Washington Commentary

Communications chaos brands FCC a disaster . . .

The Federal Communications Commission is a shambles, an example of all that can go wrong when politics mixes with technology. **Presidential appointment of the seven commissioners is invariably motivated more by political friendship** than communications expertise. And the FCC's static budget has never permitted it to grapple effectively with the communications explosion that began after World War II. Even now, for example, six years after the Common Carrier Bureau determined to examine the economics of the Bell System in order to regulate its profits, the commission is still questioning whether it is equipped to do the job. The answer, of course, is that it is not.

Fundamental to the FCC's problems is that it has lacked the leadership necessary to build strong policies. Instead, it has functioned largely as a fireman, dealing with individual crises as they arose. The consequent communications snarl reduces groups seeking to improve their lot to operating like purse snatchers, grabbing what frequencies they can and running. This, for example, is how the American Radio Relay League depicts the latest effort of citizens' radio makers and the Electronic Industries Association to clean up citizens' band [p. 31].

. . . leaving field to White House

It is no wonder, therefore, that **Washington has produced a new man-on-horseback charging to the rescue of the commission and the communications industry.** He is the Office of Telecommunications Policy's **Clay T. Whitehead.** Styled by one national newsweekly as a Federal czar who comes on like a small-town Jaycee, Whitehead's detractors at the FCC prefer to think of him as "a small-town Jaycee who wants to be a czar." And that is proving their biggest mistake.

Though young and soft-spoken, Whitehead comes on like the Rand Corp. alumnus he is, shooting down a Transportation Department's proposal for an internationally produced aeronautical services satellite or negotiating a cable television compromise for the long term. **Whitehead says he wants to "rewrite the Communications Act of 1934"** that created the FCC. And given a Nixon reelection in November, he will have another four years to try it.

With his 65-man, $3 million operation—miniscule by Federal agency standards—the OTP director will need it. Rewriting the communications act is not only technically difficult, it is politically tricky since it assumes a restructured FCC. And there is the rub for some communications professionals: the commission is an independent regulatory agency, a creature of the Congress, but the OTP and its head are responsible to the White House.

Advocates of Whitehead's philosophy of regulation by policy say there is no threat, of course. The FCC's independence, they argue, is illusory since the White House controls its budget. Moreover, Congress still must pass on White House proposals to alter the status quo.

Whitehead's critics, who see him as a benevolent despot pretending to a larger communications throne, may be right, of course. The telecommunications policy office is his creature, born of a reorganization he directed while on the White House staff. At the moment, however, he represents just one organization in the communications struggle attempting to bring order out of chaos. **The fact that OTP is having more success than the FCC these days says less about the commission** than about Whitehead's ability effectively to exploit the principle that nature abhors a vacuum.

—Ray Connolly

Right for the times!

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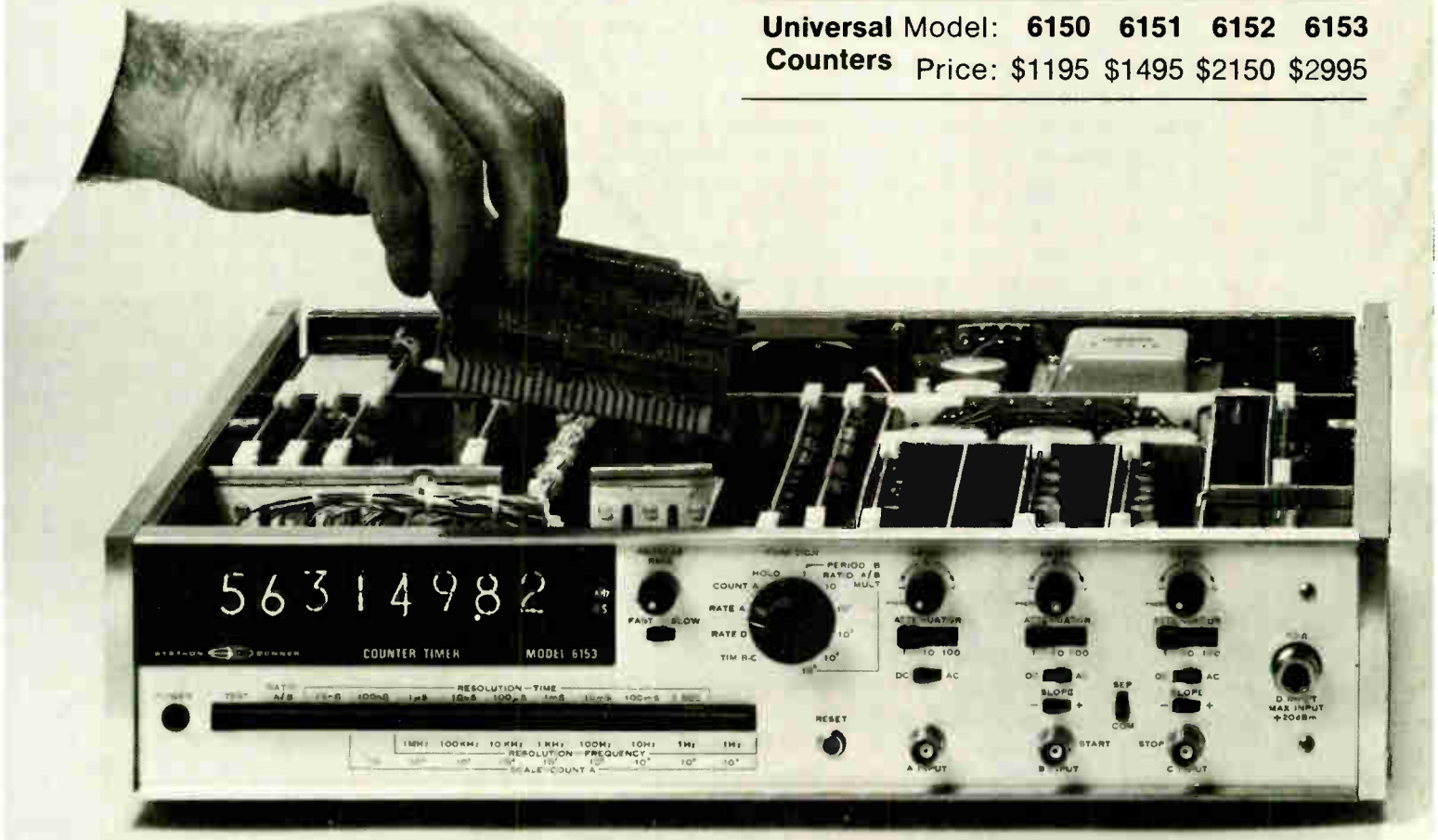

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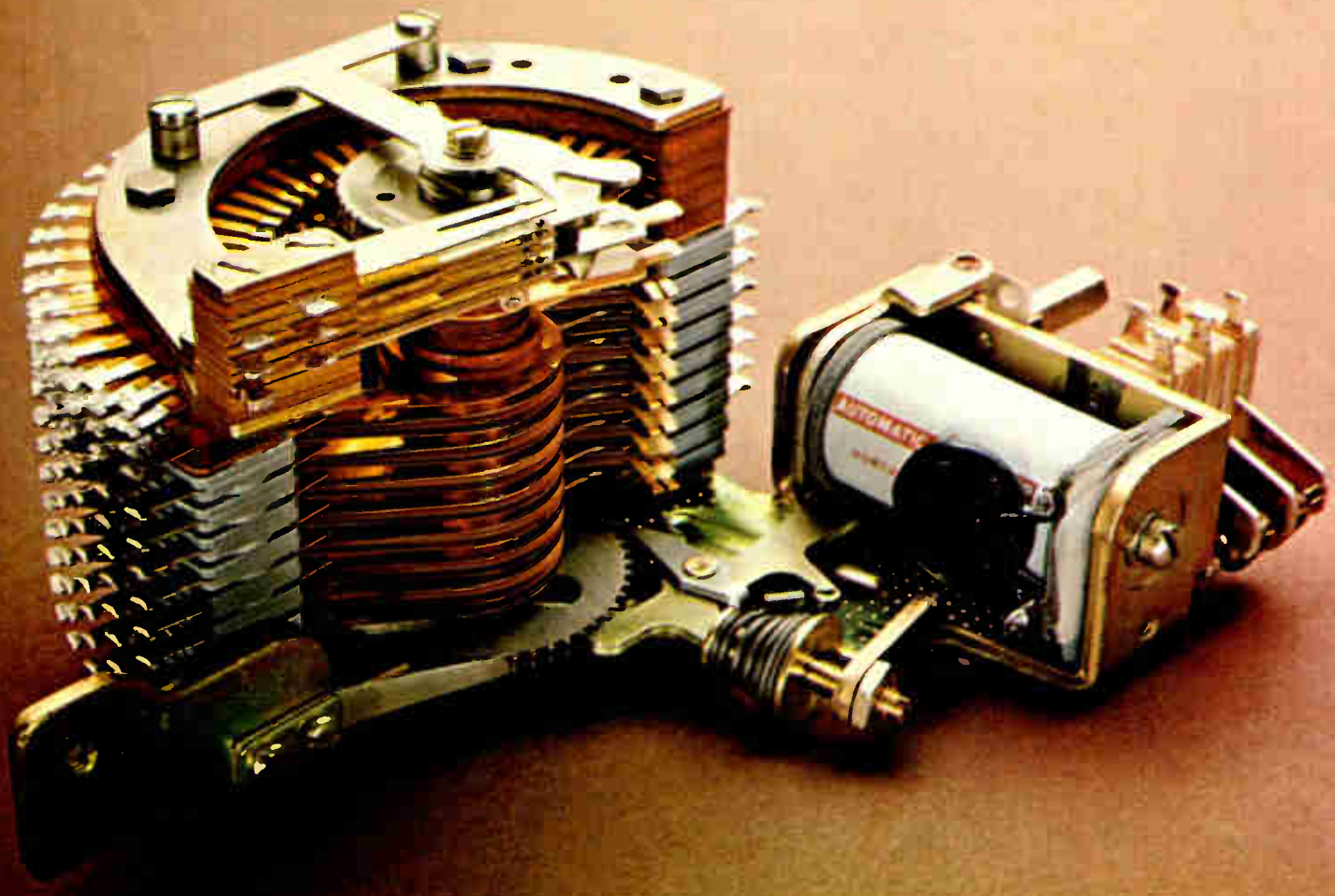
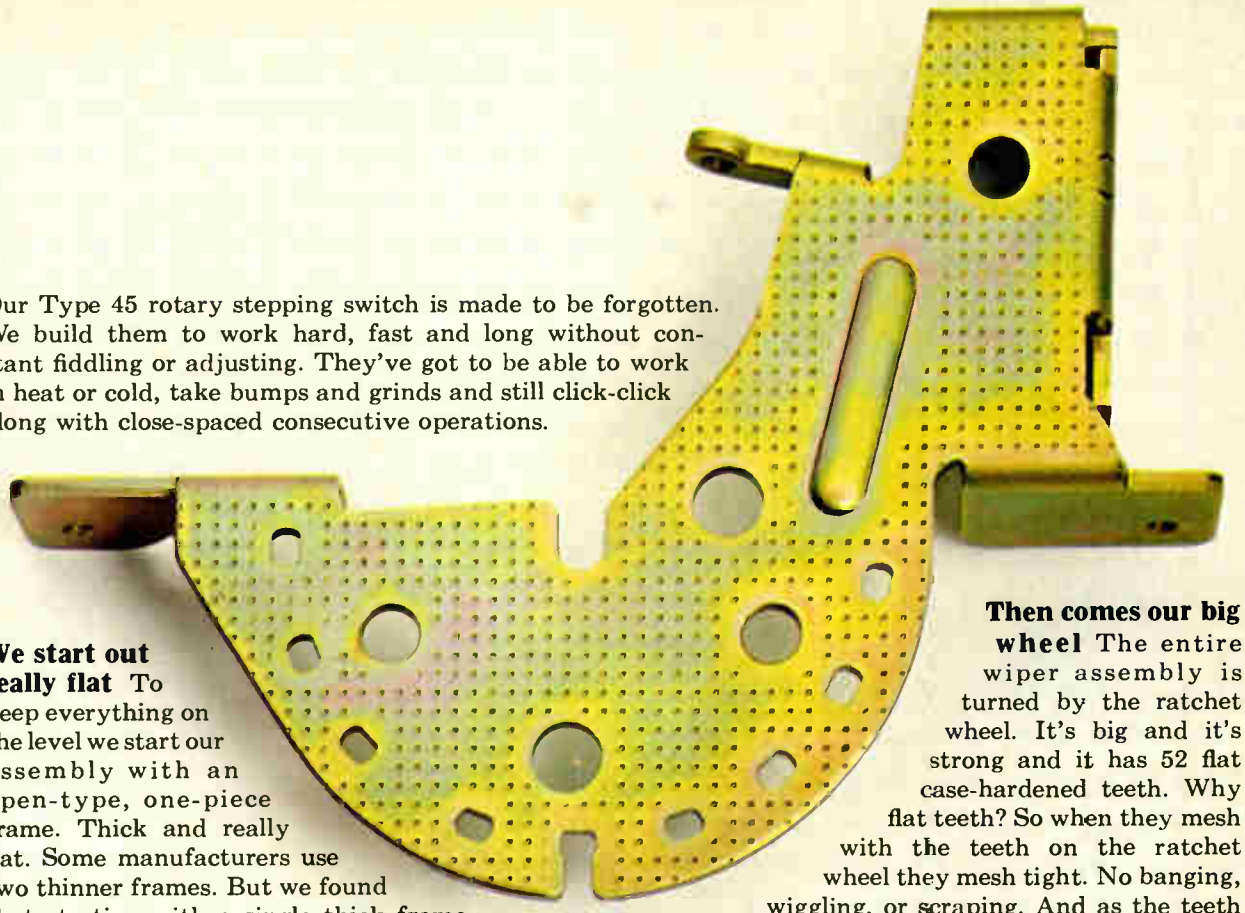


Our Type 45 rotary stepping switch is made to be forgotten. We build them to work hard, fast and long without constant fiddling or adjusting. They've got to be able to work in heat or cold, take bumps and grinds and still click-click along with close-spaced consecutive operations.



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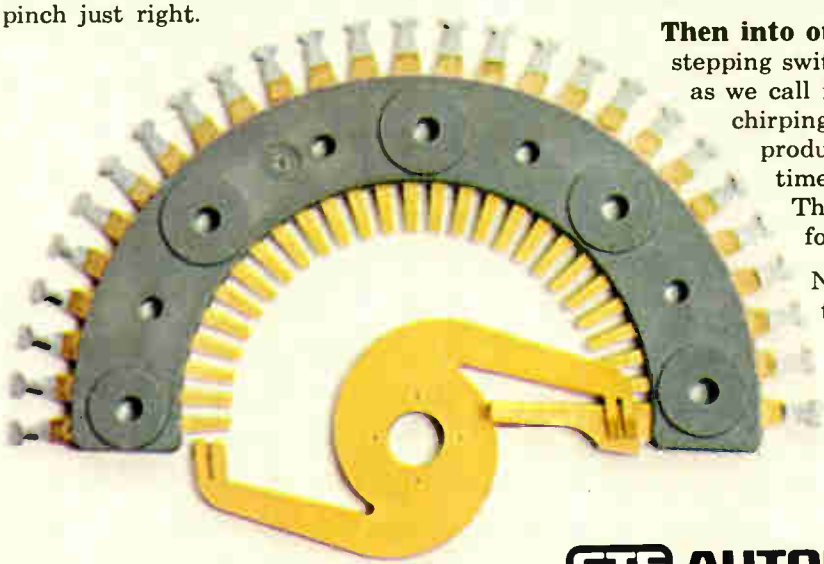
Then we supply a pinch that's just right Each pair of wipers is tension-adjusted during assembly. As they click around the bank levels on a flat plane, we want each pair to pinch the contact just the right amount. Too hard a pinch and the contacts will wear out quickly. Too soft a pinch will cause a poor connection. We teach our wipers to pinch just right.



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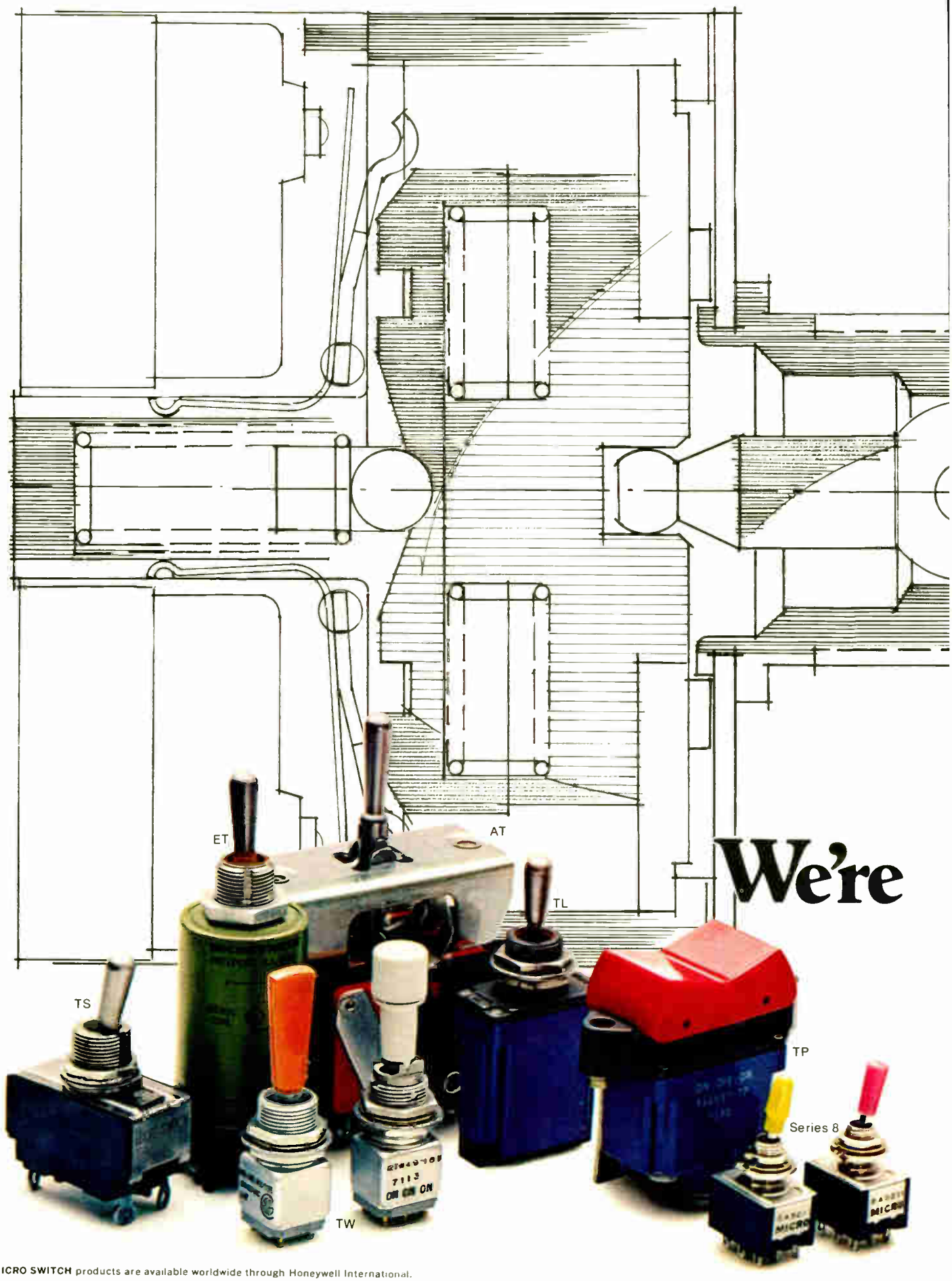

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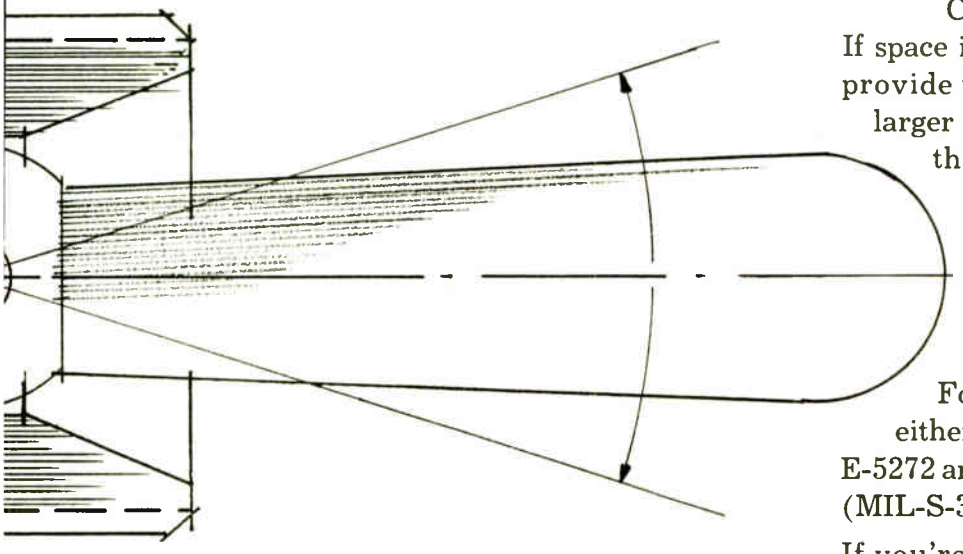

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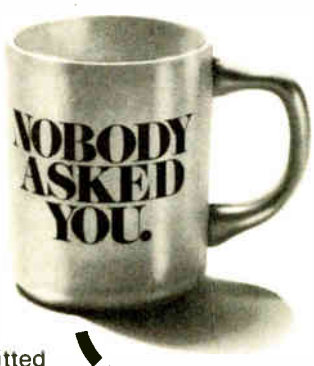
It will take you 1 cup of coffee to fill out the "sound-off" sheet on the following page, and for doing so IEC will send you this FREE COFFEE MUG.* Or see IEC at IEEE, Booth 2633, and have your say. (We'll let you have the coffee mug, either way.)



*Quantities are limited! Forms will be acknowledged in the order they are received, and must be submitted by May 15, 1972. Offer limited to U.S.A.

You bet I've got something to say...

. . . about Function Generators

( ) Who needs a function generator? My RC oscillator does everything that I need to do.

( ) I'm content with the function generators available today. Models that I like best are _____.

( ) **Wide Frequency range** is ( ) extremely critical ( ) important ( ) not significant for my needs. The narrowest frequency range that I would consider for my requirements is ____Hz to ____MHz.

( ) **Output Voltage** is ( ) extremely critical ( ) important ( ) not significant for my needs. The narrowest voltage range I would consider for my requirements is ____mv to ____v into a ____ohm load.

The Function Generator waveforms that are important to me (order of importance) are:

( ) Square wave ( ) Triangular wave ( ) Sine wave

( ) Pulses ( ) Ramps ( ) _____

I'm not sold on function generators. What bugs me most is _____

. . . about Pulse Generators

Pulse repetition frequency range is ( ) extremely critical ( ) important ( ) not significant for my needs. The narrowest PRF range that I would consider for my requirements is _____ Hz to _____ MHz.

Rise/Fall Time is ( ) extremely critical ( ) important ( ) not significant for my needs. The slowest rise/fall time that I would consider for my requirement is _____ ns.

Pulse amplitude is ( ) extremely critical ( ) important ( ) not significant for my needs. The narrowest amplitude range that I would consider for my applications is _____ mv to _____ v into a _____ ohm load.

The other Pulse Generator capabilities that are important to me (in order of importance) are:

( ) External Trigger ( ) Baseline Offset ( ) Adjustable Pulse delay

( ) Adjustable Rise/Fall Time ( ) Gated Output ( ) _____

( ) I'm not sold on Pulse generators. What bugs me most is _____

. . . about Test Instruments in general

Unique applications that have developed in my use of test instruments include: _____

My biggest gripe about test instrument manufacturers and their products are: _____

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Circle 60 on reader service card

Technical articles

Special report: IEEE bends to the winds of change: p.62 (cover)

New directions are being initiated by the IEEE leadership in response to members' discontent, reports Gerald M. Walker. See page 62.

Social problems are the focus of many IEEE technical sessions this year, writes Alfred Rosenblatt—and marketing techniques also rate discussion. See page 67.

Exhibits now are emphasizing applications, not components. Despite foreign defections, the number of exhibitors will probably be a respectable 400. See page 70.

The cover: The militancy of the IEEE's membership can be read into the Institute's arrow-in-circle symbol.

ICs shape up to current systems needs: p.78

Off-the-shelf ICs were designed for yesterday's systems, and in today's context are often not very appropriate. Authors Richard Percival and Jerry Gray describe some new devices that take systems needs into account and that are generally more flexible and versatile than their predecessors. Counters with an edge-sensitive hold state and a combination D and J-K flip-flop are among the circuits discussed.

Digital-to-analog converters for the unconverted: p.84

There's a lack of standardization in the manufacture of digital-to-analog converters that turns evaluating products from different makers—and even from the same maker—into a bothersome business. Understanding the rationale of the devices, though, allows the designer to make intelligent price/performance comparisons, and editor Harry R. Karp has worked out the best way of going about the analysis.

At last—a software-based inexpensive interface, the T-box: p.92

Instead of costly hardware controllers, the peripheral devices linked to a minicomputer can use software-based T-boxes. And different peripherals can all use the same type of T-box, explain authors David H. Chung and Don B. Hay. In this situation, the processor takes over some of the normal controller functions.

And in the next issue . . .

Principles of digital rf bandpass sampling . . . where isolation amplifiers can be very useful . . . quasi-millimeter-wave communications.

SPECIAL REPORT

IEEE at the crossroads: leaders ask directions

Beset by membership apathy and disunity, institute brass reappraises professional goals and tests feasibility of socio-economic action—but the extent of new programs hinges on how much members will pay

by Gerald M. Walker, *Consumer Editor*

☐ There's a certain irony in an English-born Canadian assuming leadership of the Institute of Electrical and Electronics Engineers when the most pressing problems are U. S.-born. But President Robert H. Tanner, director of information for Bell-Northern Research in Ottawa, Ont., may just bring it off.

As Tanner, an expert in architectural acoustics, digs into his third month in office, it's clear that he's going to be a good listener. He and the rest of the leadership are trying to find out how the until-now silent majority of members in the six United States districts want the institute to proceed on socio-economic issues and hope that, for better or worse, the passive mass will speak up.

Both the militants who want sweeping changes in goals to reflect the EE's professional interests and the conservatives who prefer the traditional technical information base were heard from during the political infighting that led to the eventual defeat of a controversial amendment to the IEEE constitution last fall. The outcome last November was close, but two-thirds majority was needed to pass. Although a record 36% of members voted, 64% chose to ignore the ballot. The amendment, generated by an unprecedented petition of members, would have changed the emphasis of the IEEE from a technical information center to a full-time career booster. (See "After Galindo, what?" p. 65) Approximately 18% voted for the change and 18% against, including the four non-U. S. districts. [*Electronics*, Jan. 31,

p. 29.] The strength of the pro ballots shook up the board of directors enough to cause them to recognize that something had to be done to move the creaking IEEE organization into new, broader activities.

The first outward sign of new life was a lengthy questionnaire mailed to U. S. members late last year. Its purpose was to find out what new activities, such as political action and pension plans, engineers want IEEE to pursue and, more important, to find out how much they are willing to pay to get these changes. As of a month ago, more than 50,000 returns were in—more than the combined total of ballots on the constitutional amendment—indicating that the moribund members are at last deciding that IEEE is something more than a motherly dispenser of technical publications.

In some respects Tanner and company are not waiting for the final results to begin tooling the institute's ponderous machinery for new tasks. Tanner has the optimistic vigor of a Canadian, but retains the cool of an Englishman that will serve him well as he tiptoes through the political spectrum represented on his board of directors. Although moves initiated by the national headquarters have been flavored with caution, nonetheless, they represent significant new directions. At the same time, Tanner is quick to reassure everyone that the goal is to broaden, not alter, the technical information function of IEEE.

Service is aim

"More than ever, our abiding philosophy is to serve the needs of the members," Tanner affirms. "This means maintaining technical activities at a high level and doing whatever we can to help the under-employment and unemployment situation. Other agencies far bigger than IEEE are saying they cannot pull jobs out of the air. This is going to be a complex task."

Besides the poll of U. S. members, headquarters has taken other steps with potentially far-reaching implications. These include:

- A change in by-laws to permit individual districts to carry out district-level programs paid for by special assessments of the district, but monitored by the board.
- Formation of the U. S. activities committee by the six regional directors.
- Establishment of an IEEE office in Washington, to be headed by Dr. Ralph Clark, a chairman of the Joint Technical Activities Council.
- Set up of local offices in Los Angeles and Toronto, reporting directly to New York headquarters, to communicate directly with members.
- An intellectual effort by a special committee to define the purposes of the IEEE in today's environment.

This last activity may or may not lead to an amendment to change the constitution. The leadership is trying to establish whether or not these plans are within the boundaries of the constitution, and, if not, how the boundaries should be changed. The important first step was loosening constraints on the regions to act independently on local programs, which essentially means con-

Tanner answers gripes

Some complaints about the IEEE have been around almost as long as the society. Here are a few of the better-known criticisms and responses from IEEE President Tanner.

Complaint 1. The IEEE is too company-oriented—at the expense of individual members.

Reply: "This is mentioned over and over, but anyone who looks at the organization and sees the trouble we go through to serve members and how little formal contact we have with industry would realize this is nonsense. In fact, we have found a need to increase company management's awareness of the institute to improve understanding of its value to engineers."

Complaint 2. The IEEE is too academically oriented, too ivory-tower.

Reply: "We are an educational institute and research-oriented, but the the number of academics on the board of directors is only about five out of 28, which is not excessive. We welcome the participation of academic members, for it gives us a window on the universities to find out what is currently being taught. On the other hand, the academic members also pick up experience about industry."

Complaint 3. IEEE does not communicate with grass-roots members adequately.

Reply: "I don't see how we could make the channels of communication any shorter. Every member can reach headquarters either through the local section chairman or through his specialty group president. Both sources lead back to the board. However, this communication is like the telephone—it's there, but you have to pick it up to use it."

Complaint 4. The IEEE has not done enough to get the engineer's contributions to society recognized by the outside world.

Reply: "This is true for one major reason. After studying what it would take to mount an effective public relations program to the media, we found it would be too costly. But it is not a dead issue. A lot of institute activities have been overlooked by the press and television, so public relations has got to be in two stages—first, convince the media that the engineer is newsworthy, and then get coverage. There was lots of interest in stories about out-of-work engineers, but when we announce something more constructive, it's not deemed news by the media."

centrating on unemployment assistance. It also means that the six U. S. districts can band together for a national project, such as retraining, without ruffling the feathers of Canadians and Europeans because these efforts will be paid for by the participating regions.

The office in Washington reflects the complexity of political involvement by a group such as the IEEE and, to a degree, acknowledges that combined efforts by united engineering groups cannot satisfy all the demands of individual participants. James H. Mulligan Jr., the energetic immediate past president, believed in linking arms with other engineering organizations to influence Washington on the socio-economic issues and was instrumental in getting seven societies into a joint effort to prod the Government to action on engineering unemployment programs.

As Donald Fink, IEEE's affable general manager, explains, "We have more to gain by banding together and little to lose. Joint action tends to make us visible."

Pooling Sought

"The idea was to pool capabilities so that we don't have to duplicate some program that another engineering organization is doing," he adds. For example, the National Society of Professional Engineers, a long-time Governmental activist, has become the lobbying arm for IEEE. And Fink feels that the joint effort has paid off in the Nixon Administration's apparent interest in funding more research and development. Still there are special subjects that IEEE wants to attack through its own Washington office.

First, Tanner stoutly maintains that this will not be a lobbying operation. The objective is to provide a two-way channel of information on technical matters between the institute and influential members of Congress, as well as Federal agencies. Nor will this office concentrate on unemployment, though its activities could have an indirect effect on hiring more EEs. An example of its activities might be a Federal program to monitor environmental pollution. The Washington representative would make sure that experts recruited by IEEE provide technical information to the congressmen preparing legislation or funding for the program. These experts might also testify at hearings so that nontechnical lawmakers and bureaucrats recognize the technical consequences of their decisions. The Washington office will also feed back information to members concerning the impact of Government projects on EE jobs.

The offices in Los Angeles and Toronto are also information-gathering centers reporting to headquarters. Headed by Jerry Goldenstern and George Armitage, respectively, these field locales are part of Tanner's grass-roots movement. Other field offices will be opened elsewhere if the two experimental stations are successful in getting members to communicate more effectively.

But as in everything else, you don't get something for nothing, which is part of IEEE's current dilemma. Invariably members need a society most when times are hardest. As a consequence, the technical and socio-economic programs already voted by the board of directors have put the society into a deficit for this year. At

After Galindo, what?

Embittered by the defeat of the constitutional amendment that he helped put before the membership last year and pessimistic about the future of EEs, Dr. Victor Galindo has not given up his cause. At the beginning of the year, he moved from TRW Systems group in Redondo Beach, Calif., to a professor's chair at Virginia Polytechnic Institute, Blackburg, Va., to fulfill a long-time desire to teach.

The proposed amendment called for two objectives—"the primary purpose of the IEEE," it stated, would be "to promote and improve the economic well-being of the membership." The second purpose would be "scientific, literary, and educational."

He feels that the so-called Galindo amendment should have passed. But because of a combination of political naïveté on his part and outright hostility by some on the board of directors, the membership did not get a clear understanding of what the vote was all about, he contends.

Now Galindo says that he'll be back—if not in the front row, at least somewhere—in the effort to revive the amendment. "I'm really a very poor politician," he confides, "but I've learned a lot from this experience. It is possible to start another petition for an amendment, and this time I would see that the proposal is worded more cleverly than the last one. I've also learned that it's impossible to work with a reluctant board—some support on the board is needed."

He admits that the wording of the amendment was a political mistake because it was so easily misinterpreted, but does not foresake the intent of the amendment. "In light of the board's condemnation in 1970 of political action for IEEE, I felt the strong wording of the amendment was valid to push the board in 1971. This hurt us because some chose to interpret the amendment wording, 'the primary purpose,' to mean a reduction in the technical functions. This was not intended, and to interpret it otherwise was dishonest."

Galindo denies that the amendment was a bluff to shake up the leadership. "The intention was to have it passed," he states. "Many were surprised that it did not pass, for it wouldn't have done any harm."

Now the IEEE militant has another shakeup for consideration by the society. He believes that there should be a change in the way the board members are nominated and elected. Galindo is thinking of offering an amendment that would make it impossible for a current board member to nominate new members because the process tends to perpetuate leadership of like thinking.

This concept may not sound like the best way to win needed friends on the board, but some now serving supported the first Galindo amendment and may be inclined to help give him another day in court.—GMW

the same time, membership has leveled, and operating costs have risen. Student memberships are down nationwide by 8 to 10%. Equally ominous, freshman EE enrollment at 79 engineering schools is off by 11%, a decline that may come to haunt IEEE membership in two or three years. There is little doubt that these factors spell a dues increase, just when many IEEE members are questioning if they are getting enough for their money.

Dues draw gripes

Judging from the reactions from some members, higher dues will not be accepted easily. Complains Egon Loebner, department head of the special projects section of the Hewlett-Packard Co. Solid State Laboratory, Palo Alto, Calif.: "There's no inflow of new, younger members. The organization has grown old and is experiencing hardening of the arteries." An active member for nearly 20 years, he adds that, although IEEE "has lots of money," it has not apportioned it properly.

Loebner would like to see the dues structure altered so that payments would depend on ability to pay and type of services rendered to the individual. For some members, the cost of even the traditional services of IEEE—publications and technical meetings—seems inordinately high, despite their consistently high standards. One of the dissenters is Dr. Stephen K. Burns, associate professor of electrical engineering at Massachusetts Institute of Technology, who admits he is in the IEEE solely for access to the journals and meetings. Burns has been in, out, and back again as a member. Now chairman of the Boston chapter of the Professional Group on Electronics in Medicine and Biology, he doubts the value of IEEE as a political action group.

Activism advocated

By contrast, Carl Kramer, sales manager for Hybrid Systems, Inc., Burlington, Mass., a 13-year member, believes that the functions of information center and career booster go hand-in-hand. Though uncertain about what specific activities IEEE should pursue, Kramer plans to remain a member "because I think it will change and become more politically active as it should have been years ago." He would like to see more "commenting on the value of things" and thinks the society should be more critical of Government spending plans.

While the national organization agonizes over new programs, local sections feel less constrained. The Long Island section, for example, is ahead of the national membership in its move toward socio-economic programs. This section has increased membership, despite the hard times for Long Island's electronics firms, and has initiated meetings devoted to career issues. Last year the group invited all the congressional candidates from the area to address the members on what can be done in Washington to help Long Island engineers.

Though section chairman Joel Snyder, an engineering consultant for the last nine years, continues to work from within IEEE, he is becoming more militant. "I wouldn't mind having the six U. S. districts split off to form a U. S. society of EEs that would be an affiliate of IEEE," he states. "That way, the national group would be responsible for ethical and professional standards of U. S. members, and the international group could concentrate solely on technical information."

North of the border. Canadian Robert H. Tanner, IEEE president, feels he can cope with U.S. problems—if members will help.

Snyder contends that Tanner is the ideal president to accomplish this split, since as a Canadian he cannot be accused of "taking the U. S. out of IEEE." Part of the reason for a separate U. S. organization would be to oversee the quality of EEs. "Let's face reality," he observes, "there's a surplus of engineers, and the only way we're going to keep everyone employed is to insist on qualifications. I'm not advocating control of the number of engineers—only control the standards of education. There should be an IEEE seal of accreditation on courses and rules of acceptance at schools. What we don't need is more poor engineers," Snyder emphasizes.

Apathy cited

Despite this section's success at handling both technical and political programs, it shares with the rest of IEEE the frustration of dealing with apathetic members. "It's difficult to respond to members who don't surface," complains New York section chairman Alexander Kohan, an engineering manager for American Telephone & Telegraph Co., New York. "Our biggest problem is to generate enough interest to make members active. If a member comes forward and makes noise, his participation will give him an outlet to get results. We can't do much with people who deride the whole operation from the sidelines with no alternatives to add," he frets.

Disagreeing, Robert McClure, a 20-year member and chairman of the board of Telpar Inc., Dallas, contends that many members aren't apathetic, just frustrated.

Meditating militant. Career activities have been too slow in coming VPI Prof. Victor Galindo charges. He wants IEEE to change now

"IEEE has had essentially no value to most of its members, but we're coming to a crossroads," he comments. "The survival of the profession literally dictates that IEEE will have to adopt a more activist posture, such as the approach taken by the American Bar Association, the American Medical Association, and the American Institute of Certified Public Accountants. These organizations not only serve as a medium of communication within the profession, but control the value of their people by controlling the supply part of the supply and demand curve. They make a code of ethics binding upon their memberships, with violation leading to possible expulsion. The IEEE must develop this right to speak for its members on a wide variety of issues and should not be afraid to take controversial positions," McClure contends.

Many members do not agree with these sentiments, however. A Midwestern member echoes the feelings of this segment of IEEE opinion, warning, "A politically oriented society with an apathetic membership letting the leaders speak for everyone is dangerous." Pointing to the activities of labor unions and the AMA, he adds, "Such organizations could put the interests of members above those of the rest of the country. I prefer to protect myself on an individual basis."

All of this turmoil indicates that the situation is fluid, but the betting is that an overwhelming majority of members will favor socio-economic activities and a more politically oriented organization. However, there is a gap between finding the will of the majority and implementing it, with strong inertial forces acting against immediate changes.

Acting against the forces of inertia is soft-spoken president Tanner, who early on set a fast tempo for his tenure at the top of the organization. In one eight-day stretch he had direct contact with 17 different IEEE groups. It's also apparent that he has made himself available to discuss local problems by phone at any time the caller can find him in his office. The question is, can a Canadian actually handle the U. S. problem?

"I find it an advantage," says Tanner. "When speaking to Washington officials I'm neutral in U. S. politics, so they listen." Turning on his ever-present dry wit, Tanner smiles, "It worries me that the Canadians may think I've deserted them." □

IEEE to consider application of technology to society's ills

Intercon '72 schedules discussion on civil problems and marketing, as well as an upgrading of presentations for the technical sessions, with time set aside for give-and-take with the speakers

by Alfred Rosenblatt, *New York bureau manager*

□ Responding to the criticism that engineers should do more to combat technology's unhappy side-effects—and harness it for social good—the technical program committee has focused a significant portion of Intercon '72 sessions on the myriad problems that technology has either caused or could help cure. More than a dozen of the 79 sessions in the technical program fall in this category—dealing with subjects such as the ecology, urban planning, education, law, and public health.

However, more than three dozen sessions will concentrate in five conventional technical areas—communications, computer technology, transportation, automated testing, and microwave systems. And to help members promote sales, the program presents a half-dozen sessions dealing with the marketing problems confronting electronics industries executives.

As in previous years, the technical program is divided into two parts—a 55-session "technical" section at the New York Hilton Hotel, and a 24-session "applications" section at the New York Coliseum, where the exhibits are housed.

However, an unusual feature this time around is that scheduling only three prepared papers for most of the 2½-hour sessions at the Hilton allows at least an hour for a panel-type discussion in which speakers may question each other and accept questions from the floor. The aim is to promote informal contact among those attending the meetings—à la the smaller special-focus technical conferences such as last month's International Solid State Circuits Conference.

As for the quality of the papers, which at past IEEE shows have been noted for once-over-lightly approaches to their subjects, there's been a conscious effort to upgrade them. "We wanted 'real' technology, so we asked

the IEEE's professional groups to help organize the sessions," says J.L. Jatlow, chairman of the technical program committee. "The result is that we have the advanced papers usually reserved for the groups' meetings."

Also associated with the Intercon '72 program will be a special two-day symposium at the Americana Hotel on "Engineering in the Hospital," featuring a paper by consumer advocate Ralph Nader on problems of working with medical electronic equipment, and five one-day courses on circuit design and network analysis subjects, offered at IEEE's New York headquarters.

Priority shift

By devoting so much of its technical program to environmental problems, the IEEE is, of course, acknowledging the shift in national priorities away from the science and technology of recent years. More to the point, however, the organization is also reacting to the decrease in the number of jobs available for electronics engineers.

What is learned at the convention will, Jatlow hopes, "broaden the engineer's perspective" and encourage him to pursue a career in one of the new types of industries. A worthwhile hope, certainly; but industry observers say there is little evidence that this application of EEs to other fields will occur very rapidly.

Civilization's situation vis-a-vis its environment will be presented at Intercon 72's highlight session, "Ecology—Problems and a Technical Approach to Solution," on Tuesday evening at the New York Hilton. Speakers from the U. S. Environmental Protection Agency and the United Nations Conference on the Human Environment will explore the problems faced in this country and abroad. And at least one solution will be suggested when E.M. Bradburd, of ITT, proposes "A Plan for a Nonprofit Environmental Control Engineering Corporation."

Also in a problem-discussion mood will be session 6E, "Technological Effects on Society—an Open Forum," on Wednesday afternoon at the New York Hilton. And how engineers might consider the role they play in society will be discussed by Steven H. Unger, a professor of electrical engineering at Columbia University, in "Personal Responsibility of Engineers for Their Work." In a like vein, session 2C, "Philosophy of Electrical and Electronic Technology," on Monday afternoon at the Hilton, will be devoted to a discussion on how concern about social impact might be incorporated into a "philosophy of technology." Featured on the panel will be Dennis Gabor, the Nobel prize winner in physics.

Considerable attention is also paid in the technical program to the field of communications. Eight sessions will be devoted solely to this topic, including land-mobile and satellite communications, together with community antenna television systems. Some of the program's most celebrated participants will be at session 2A, "CATV—What's Happening?" on Monday afternoon at the Hilton. Federal Communications Commission chairman Dean Burch will consider the effects of Federal regulation on the growth of the CATV industry.

At the session, the president of Comsat Corp., Joseph V. Charyk, will discuss a proposed system for setting up a CATV network via satellite. Peter C. Goldmark, veteran electronics inventor and president of Goldmark Communications Corp., will describe how a combination of satellites and community television could lead to a deurbanization of the nation and "The New Rural Society." Also speaking at the session will be representatives from two commercial CATV organizations, Computer Television Corp. and TelePrompTer Corp.

The system techniques to be applied to the 900-megahertz band recently assigned to land-mobile services by the FCC will be discussed by a panel at session 6A, "900 MHz—A New Horizon in Land-Mobile Communications," on Wednesday afternoon at the Hilton.

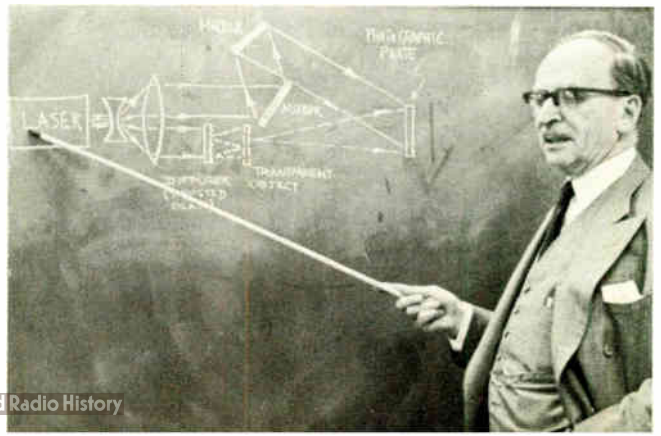
Another panel (session 3F, "Telecommunications Policy and Society—a Case Study, Data Networks of the Future") Tuesday morning at the Hilton will examine the impact on society of future communications systems. Panelists include representatives from the White House Office of Telecommunications Policy and AT&T.

Other communications-oriented sessions will include 4F, "Looking Ahead at Data Communications in Canada and United States," and 4G, "Regional Satellite Communications Systems," on Tuesday afternoon at the Hilton, and 5E, "New Areas in Communications" on Wednesday morning.

The application of circuit-design techniques to communications systems will also be considered. Session 3H, "Precision Hybrid Microelectronics in Telecommunications and Instrumentation," on Tuesday morning at the Hilton, will be concerned with the use of thin-and thick-film circuits, and session 7CJ, "Application of Microwave Technology to Today's Communication Systems," on Thursday morning at the Coliseum, will review microwave advances.

The opening session Monday morning at the Hilton will detail examples of memory hierarchies and how

Notables. Joseph V. Charyk, left, president of the Communications Satellite Corp., and Dean Burch, chairman of the Federal Communications Commission sit down Monday afternoon, March 20, at session 2A to discuss: "CATV—What's Happening?" At the same time, Nobel prize winner Dennis Gabor, bottom, will participate in session 2C: "Philosophy of Electrical and Electronic Technology."



their performance can be measured and adjusted. The gamut of mass memories will be covered in session 3C, "Large Capacity Storage—Users and Technology," on Tuesday morning at the Hilton. Starting with a discussion of user requirements by an IBM man, speakers will go on to describe new systems being developed. These include a laser recorder memory from Precision Instrument Co., a holographic memory from RCA Laboratories, the Masstape magnetic memory from Grumman Data Systems Corp., and an optical disk memory from Ovonic Memories, Inc. Computer technology will be covered in roughly nine sessions altogether, with memory technology getting particularly close scrutiny. Session 5A, "Main Memory Technologies Through the '70s," on Wednesday morning at the Hilton, will present an overview by industry spokesmen.

Computer conflict

In an unfortunate program conflict, a second session concerned with computer technology has been scheduled for the same time. Session 5F, "Trends in Computer Hardware," deals with what the next five years will bring in that area. Among the speakers will be Robert Noyce, president of Intel Corp., who will discuss trends in semiconductors, and K.H. Olsen, of Digital Equipment Corp., who will outline trends for small systems.

Memory devices and systems applied to current computer designs will be discussed in session 6CI, "Memory Devices and Systems Applied," on Wednesday afternoon at the Coliseum.

And some of the general problems facing system designers applying MOS technology will be covered in still another session, 4CI, "MOS User Problems," on Tuesday afternoon at the Coliseum. For example, Evelyn Berezin, president of Redactron Corp., will tackle things headon with her paper, "How to Jump into MOS Without Drowning."

Session 7C, "A Multistream Computer Architecture for Large Systems," on Thursday morning at the Hilton, will be devoted to examining ways to arrange processors, high-speed memories, and peripheral equipment in different approaches to large systems.

Minicomputers and peripheral gear will be tackled at three applications-oriented sessions at the Coliseum. Session 3CH, "Matching Minicomputers and Peripherals" on Tuesday morning, is concerned with how minicomputers can be matched to available peripherals and how a simple processor may be used as an interface. Session 4CH, "Applications of Minicomputers to Industry," on Tuesday afternoon, will be devoted to several specific applications of the small machines—to communications, signal processing, and computer-aided design. There also will be an evaluation, by a system engineer from Foxboro Co., of software for industrial applications.

And finally, at session 5CK, "Advanced Instrumentation- the Built-in Computer," on Wednesday morning, speakers will tell how computers can be applied to extracting data in measurement applications.

A sampling of the session titles in the applications-oriented portion of the program at the Coliseum speaks for the coverage. Session 2CK, "Introduction of New Products—Coordinated Approach for the Marketing-Engineering-Manufacturing Interface" will lead things off on Monday afternoon. Tuesday morning, session 3CJ, will tell "How to Build a Marketing Organization." Session 5CJ, "Communication Techniques in Marketing," on Wednesday morning, will be devoted to advertising and public relations, and session 6CJ, "International Marketing," is to follow in the afternoon.

For the engineers working on controlling rapid-transit vehicles or who are interested in what's happening with aircraft landing systems, the program organizers have included session 3B, "Automatic Controls in Transportation" on Tuesday morning. Other presentations will include a Sperry Rand Corp. representative describing a street traffic control system for Washington D.C.

Microwave technology

Design of microwave system components also gets a fair share of session time. Session 6B, "Advanced Ferrite Components for Reliable Microwave Systems," on Wednesday afternoon at the Hilton, will feature ferrite materials and devices. At session 7B, "Advances in Microwave Solid-State Amplifiers," the following morning, C- and X-band solid-state amplifiers will be examined.

Over at the Coliseum, microwave integrated circuits will get a thorough overview at session 5CI on Wednesday morning. Subjects include lumped versus distributed microwave ICs, stripline, and packaging of ICs for system applications. Other system applications will be handled in session 6CK, "Microwave Technology in Transportation Systems."

Automated testing enthusiasts will have three applications sessions to choose from at the Coliseum—session 5CH on Wednesday morning will deal with "The Economics of Automatic Testing," and session 6CH in the afternoon with "Testing Digital Modules." The precise adjustment of hybrid electronic circuitry will be examined in session 7CI.—"The Art and Science of Hybrid Electronic Circuit Processing and Testing," on Thursday morning.

Some individual subjects may tickle the convention-goer's fancy. Consider, for example, these sessions at the Coliseum: 2CH, "Tooling Along with Lasers," on Monday afternoon; 3CI, "Optoelectronic devices—Problems and Pitfalls," the following morning; and 4CK, "Integrated Circuits for Electronic Power System Applications," on Tuesday afternoon. And at the Hilton on Monday morning will be the first IEEE session ever to have been organized with the help of a Russian scientist. It's session 1E, "Control of Large Power Systems in the U.S.S.R. and U.S."

Show spotlights pervasiveness of electronics in all industries

Number of companies exhibiting is down 15% from 1971 total, but IEEE managers see this as bottoming-out year for show; optimism is spurred by emerging applications of technology

☐ One of the biggest off-Broadway productions every year is the IEEE International Convention and Exposition, which opens March 20 at the New York Coliseum for its 1972 four-day run.

But it won't be as big as in 1971, when 35,228 visitors ambled through the Coliseum. And it will be nowhere near the peak year, 1962, when 74,734 persons sampled the products of 1,307 exhibitors. This year the show managers hope to welcome 30,000 patrons to the exhibits of 400 companies, 15% fewer than in 1971.

Still, IEEE officials are optimistic. "We think we've bottomed out, and we'll pick up at an even greater rate than the industry itself," says William J. Hilty, IEEE's director of convention and publishing services. "We would have been in good shape this year if not for the drop in overseas exhibitors."

Hilty and Joseph M. Doblmeier, exposition manager, attribute the defection of foreign exhibitors—there will be only 25 this year, compared to 90 in 1971—to the import surcharge imposed Aug. 15 by President Nixon, one effect of which was to muddy the competitive situation here of electronics made abroad. The November announcement removing the surcharge and effectively devaluing the dollar, came too late for foreign companies to change their minds.

"The show lags behind industry trends by about six months," explains Doblmeier, who expects the improvement in the industry's health to be fully reflected in next year's show. "But even this year we're getting some last-minute decisions to expand exhibit space," he says.

Another barometer that buoys the outlook of IEEE managers is the volume of exhibitor cancellations. In 1971, they got hit with nearly 50. This year, the total was about 10, one month before showtime. "And they're not principally for economic reasons," says Doblmeier, "but because of imminent mergers, reorganizations, or product lines not being ready."

The IEEE is not looking for the attendance and exhibitor curves to swing upward to the peaks of the 1960s. "It's a different industry now—and it's a different world," says Hilty. "There are many more defined specialties in the industry now, and electronics no longer sells to itself on the scale that it once did." The pervasiveness of the electronics technology is reflected in the institute's listing of electronic applications areas in its exhibit prospectus: they include appliances, chemicals, acommunications, medicine, manufacturing, optics, and transportation, as well as the traditional ones.

The tradeoff: cost versus exposure

Instruments—in the broadest sense—are recognized as the solid base of the IEEE exposition, and Hewlett-Packard Co. expanded its exhibit this year after cutting back in 1971. "We have a lot more new products, and are looking for media exposure," says Robert Boniface, vice president of marketing.

Another instrument maker—E-H Research Laboratories of Oakland, Calif.—finds that the IEEE Show has decreased in importance. "Five years ago if you weren't exhibiting, people would have assumed you had gone out of business. Now, they just notice you're not there," says Larry Hahn, a marketing manager. He sees a trend away from the big shows: "People are weighing the expense versus what you get back, and often finding it's not worth it." Nonetheless, E-H continues to exhibit at IEEE and Wescon because, says Hahn, "we hope it will help us, but it's a gamble."

The high cost has already discouraged Ballantine

SPECIAL REPORT

It's a buyer's market

Recruitment activities will be permitted at this year's IEEE Show, but that doesn't mean a return to the "flesh-peddling" that led to a recruitment ban in the 1960s.

The decision by the IEEE executive committee to allow posting of jobs-available notices was accompanied by restrictions. The move is "temporary." The recruitment must be done "with professional and ethical standards approved in advance." And it can be done by "reputable" personnel agencies as well as by companies and institutions. The bulletin boards will be in the outer registration lobbies at both the Coliseum and the New York Hilton.

Also in recognition of the job shrinkage, IEEE members who are unemployed may attend without paying a fee. This policy was begun last year.

Laboratories, Boonton, N.J. "It's strictly a value tradeoff," says president Fred Katzmann. "If IEEE were cheaper, it might become more attractive."

The sales manager of Wavetek Inc., San Diego, thinks this may be the company's last year at IEEE. "It just doesn't pay off for us," says Thomas G. Kurtz. "More and more it's becoming just a regional show. Wescon is no better. We'll probably be attending more of the smaller shows, where for $300 instead of $10,000 you can make a splash."

Another kind of splash, the spillover of electronics technology into more and more non-electronic industries, is a primary reason for cheerfulness about the future of both electronics and its biggest exposition. The evolution of the technology into an applications-oriented one was pointed up recently in an IEEE survey among 100 chief engineers—50 of them in electronics companies and 50 in non-electronic industrial classifications. They were asked: would you recommend to your engineers that they attend the IEEE Show? "The yes and no answers were in about the same proportion among non-electronic companies as in the electronic ones," says the IEEE's Hilty. "Electronics cannot easily be defined as an industry, he adds. "The operative question is: can an engineer apply electronics in whatever it is he's doing?"

One result of this applications emphasis is heightened interest in the show among minicomputer makers. Digital Equipment Corp., Maynard, Mass., the biggest in the field, chose the IEEE show this year for introduction of its PDP-16/M, which is aimed at OEMs. "The show provides the best sounding board for product announcement," says Robert Van Naarden, a marketing specialist for DEC. "It is attended by a good cross-section of the industrial market."

On the other hand, the big semiconductor companies are now conspicuously absent from the IEEE and other general electronic shows. "You don't exhibit in the industry you grew up in," is the explanation of the IEEE's Hilty. "In a business equipment show, you don't find pencils, sharpeners, or other commodities. Semiconductors have now become commodities. If you're marketing custom designs, you simply live in your customers' plants. In the case of a high-volume shelf item, the marketing weapons are price and delivery capabilities."

"The semiconductor people will all be here, though not as exhibitors," Hilty adds. "They know this is where their customers and potential customers will be."

Though international in subject matter, the IEEE convention is admittedly regional in the geographical profile of its attendees—like most conventions, IEEE officials point out. An analysis of the 1971 registration shows that 63.7% of the visitors came from New York-New Jersey-Pennsylvania, and the next largest contingent, 13.7%, from New England. Robert Cunningham, director of exhibits for Wang Laboratories, Tewksbury, Mass., sees the geographical profile as a plus. "The technological market is pretty heavy in New York, New Jersey, and New England," he says. But Cunningham adds a note of qualified optimism that typifies a large group of exhibitors: "We want sales, and in the past the IEEE show has produced pretty good leads and sales. There has been a falloff in attendance in recent years, and I'm looking for a better show this year with bigger attendance—if not, it will be in real trouble." □

A nice place to visit, but . . .

"It no longer looks like a reward when you send people to New York."

That comment from a West Coast electronics manager sums up the disenchantment of some with the traditional locus of the IEEE Show.

It's not only the cost that bothers engineers and managers. They cite crime, the surliness of hotel and restaurant employees and cab drivers, labor troubles, and union harassment of exhibitors. "It's a big hassle, since New York is totally under control of the unions," says Larry Hahn of E-H Research Laboratories. "If you even want to change a light bulb, the unions damn near picket the booth—an electrician has to come."

IEEE officials say that no one has ever presented any solid evidence to back up a suggested move out of New York City. And taking over a Chamber of Commerce role, they claim that things have changed for the better in the megalopolis during the last year or so. The economic squeeze has hit midtown hotels and restaurants, the IEEE's Hilty points out, and the employees realize that tourists and conventioners "won't come back if they're not treated courteously."

Union members, too, have become "more cooperative," according to exposition manager Doblmeier. Union problems were one of the reasons behind the "package exhibits" introduced this year. Exhibitors may rent a completely installed exhibit from among six standard designs, and for one price the IEEE will take care of everything except placing the products.

. . . AND WHEN TECHNOLOGY PALLS

A Guide to New York

For those intending to paint the town red during IEEE week, a warning—bring a big brush. Manhattan offers a plethora of things to see and do, and highlighted below are the week's events and doings in town.

Exploring New York's neighborhoods is an adventuresome departure from the business atmosphere of the midtown area. Chinatown, where Canal Street crosses Broadway, is a bit of Hong Kong in Manhattan, and immediately north is colorful Little Italy, centered around Mulberry St. Farther north, the blooms may have withered a little, but the flower children and bohemia of Greenwich Village are holding forth east, west and south of Washington Square. On the gaudy side, Times Square shines dangerously where Broadway crosses 42nd Street, and uptown, catch a glimpse of New York's fast disappearing Germantown—have a beer and hear an oomp-pah-pah on Street, east of Lexington.

New York and theater naturally go together, but unless your company has secured tickets, you may have difficulties seeing the biggies like "Applause," at the Palace Theater, "Follies," at the Winter Garden, "Jesus Christ Super Star," at the Mark Hellinger, and "No No, Nanette" at the 46th Street Theater. But somewhat easier to find tickets for are these current winners: "Lenny," at the Brooks Atkinson, "The Prisoner of Second Avenue," at the Eugene O'Neill, "Two Gentlemen of Verona," at the St. James, and "Vivat! Vivat, Regina!" at the Broadhurst.

A meander off-Broadway will provide several other excellent theater offerings, including "Godspell" at the Promenade Theater, "Kumquats" (the "world's first erotic puppet show"), at the Village Gate, "The Basic Training of Pavlo Hummel," at the Public, "One Flew Over the Cuckoo's Nest," at the Mercer Street Theater, and "The Fantasticks," now in its second decade, at the Sullivan Street Theater. For the really adventuresome, a trip off-off-Broadway will lead downtown to "John Wayne Doesn't Hit Women" at the famed New York Theater Ensemble, the "Musical Drunkard" at the 13th Street Theater, and the far out "Hooded Gnome" at the Playbox.

The nightclub scene will be in full swing, and appearing at the Americana's Royal Box on a double bill will be Pat Cooper and George Maharis. Elsewhere, Dusty Springfield sings at the Plaza's Persian Room, Peggy Lee hypnotizes at the Waldorf's Empire Room, and Gordon MacRae charms the ladies at the St. Regis Maisonette. The Temptations will be swinging at the Copacabana, and Johnny Ray adds to the nostalgia of the Rainbow Grill. For piano-lovers, Bobby Short is an institution at the Cafe Carlyle, and—for the game—Improvisation is a West-Side spot featuring spontaneous entertainment.

If the feet and spirit are both willing, dancing—mild and tame—can be had at Hippopotamus, Directoire, Shepheards, Thursday's, Wednesday's and Tuesday's, and every night, also, at Wheels, Nicos, and the Cafe Pierre. And everyone should be able to tell his grandchildren he's been to the oldest established permanent dance hall in New York—Roseland Dance City.

Music—long- and short-haired—echoes around town in varied strains. Edgar Winter will be at the Academy of Music, Sly and the Family Stone at the Apollo Theater, Bobbie Kolack at the Bitter End, and Sonny Rolands will be followed by Faro Sanders at the Village Vanguard. Beginning on March 18, Philharmonic Hall will feature Carlos Montoya, followed by Andre Watts, the Clancy Brothers, the Philadelphia Orchestra, and the New York Philharmonic Orchestra. At Carnegie Hall, Bread appears on March 18, and during the week, the Hall will offer the Beach Boys, the Ohio State University Concert Band and the Carnegie Mellon Kilt Pipe Band.

Opera buffs have a choice of "Salomé," "Falstaff," and "Fidelio" during the week at the Metropolitan Opera at Lincoln Center, or "Tosca," "La Traviata," "Susanna," "Summer and Smoke," "Maria Stuardi," and "Julius Caesar" at the New York State Theater, also in Lincoln Center. And although the New York State Ballet will be absent, ballet afficionados will be able to catch the Joffrey Ballet company with a varied repertoire at City Center.

There's enough in town to keep the sportsman busy too. On the 19th the New York Rangers meet the Toronto Maple Leafs; on the 22nd the exciting New York Knickerbockers play ball; and boxing fans in town on the 24th can experience the Golden Gloves finals. All three events take place in multi-faceted Madison Square Garden. And equiphiles will be able to bet on the trotters at Yonkers Raceway and watch the sport of kings as the horses are off and running at Aqueduct Racetrack.

New York is the center of the art world, and the city's museums are a cultural delight. For the modern-minded, there is the Museum of Modern Art, the Solomon R. Guggenheim Museum, the Whitney Museum, the Museum of Contemporary Crafts, the New York Cultural Center, and the Jewish Museum. For those whose tastes run to the masters, old-world charm is captured at the Metropolitan Museum of Art and the Frick Collection. The Museum of the City of New York, in addition to chronicling the city's history, runs a varied fare of contemporary exhibits, and also of interest are the Museum of Natural History and the South Street Seaport Museum. Many of these museums show special film programs as well.

And if the spirit and/or flesh need reviving, the Dharmadhatu Meditation Center is serenely located at 12 E 18th St., but for easier access to Midtown, the Yoga Therapy Center is an island of calm at 36 West 26th Street.

leading minicomputer OEM's and users agree...this Analogic "breakthrough" design provides...

- Greatest Flexibility
- Lowest Cost
- Optimum Performance
- Highest Reliability

FOR MULTIPLEXER/ ANALOG TO DIGITAL TO ANALOG COMPUTER/CONTROLLER INTERFACING

Here's what our latest breakthrough means to you:

To put it simply, Analogic's new AN5800 Series systems are, at the same time, the *most flexible, highest performance and lowest priced A/D/A interfaces* ever offered to the computer and/or control-system designer. In most applications they will save you from 30 to 45% over conventional designs.

Series AN5800 is not just a system; it's a large and diversified *family* of designs, ranging from a single computer-interfaced Multiplexer/Analog to Digital Converter to the most elaborate arrays of Multiplexer/Sample and Hold/Analog to Digital Converter/Digital to Analog Converter combinations with hundreds of input channels, power supplies, and complete front panel executive and monitoring capabilities.

Series AN5800 is the first new design approach to computer-compatible A/D/A systems in years. The essence of this new approach is our "Universal Motherboard," which is, we believe, a truly creative approach to modularity. The AN5800 Universal Motherboard is the result of thousands of man hours of extensive design, testing, and redesign.

It achieves *optimum* interconnection of modules in hundreds of discrete and practical combinations. For most A/D/A systems assembled on the Universal Motherboard, production cost is dramatically reduced . . . and *reliability and performance are significantly enhanced.* Unlike backplane-wired systems, this approach provides optimum signal and power-supply properly routed, guarded, and shielded, to sustain consistently high S/N ratios, minimum propagation delays, minimum pulse degradation, and near-ideal Analog-to-Digital isolation.

OEM Variations

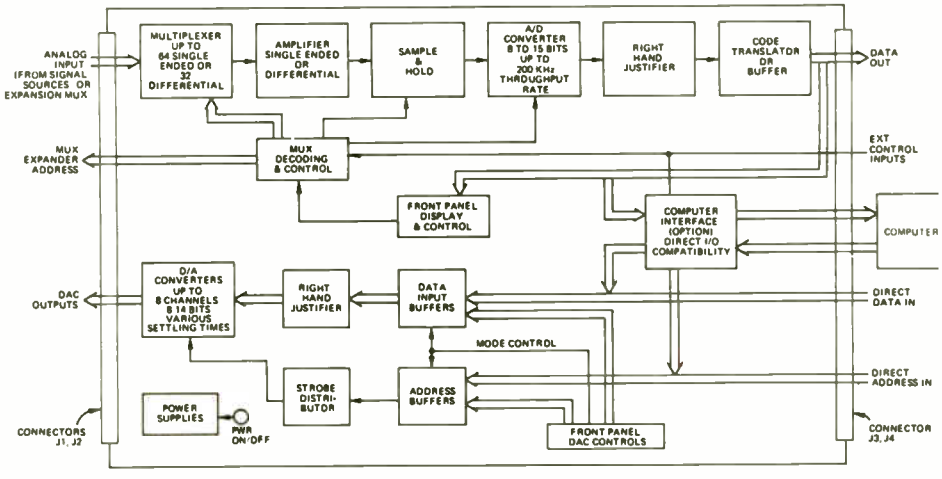
The AN5800 motherboard design *anticipates* your need for OEM variations. System function or capacity changes usually require only changing or adding cards, not rewiring. (For example, to change from 64 single-ended to 32 differential input channels does *not* require rewiring — it is accomplished simply by plugging in a differential amplifier instead of a single-ended amplifier!) Channel capacity is *easily expanded* . . . to a total of 2048 with compatible expansion hardware.

And it's worth repeating that the interconnections are optimum interconnections — virtually eliminating debugging, improving S/N ratios, preventing anomalous states, and indirectly (but significantly) extending the MTBF of the system, by providing unusually generous margins for both analog and digital circuits.

Creating Specific System Architectures and Capacities

By selecting from the very wide range of Analogic modules (a range that includes just about every system element used in high-level data acquisition) you can create an almost endless variety of systems. Here is a *very condensed list:*

- *A/D Converters* — successive-approximation, 8 to 15 bits, various speeds up to 200 kHz throughput, providing a full range of price/performance tradeoffs.
- *D/A Converters* — 8 to 14 bits, various speeds up to 200 nanoseconds settling time, including "glitch-free" designs. Here again a wide range of price/performance tradeoffs is provided.
- *Sample-Holds* — low droop 0.01% designs, with aperture uncertainty as low as 10 nanoseconds; including high-input-Z designs.



- *Multiplexers* — 8 to 16 channels per card, ultra-high-Z, with address decoding and expansion circuitry, differential as well as single ended MUX configurations.
- *Direct Computer I/O Interfaces* for most standard minicomputers.

Complete Thoroughly Tested Systems

AN5800 Series equipments are delivered (4-6 weeks) as complete, thoroughly tested systems, the overall accuracy of which is, in fact, higher than that predictable by summing the performance of the individual modules.

System Diagram

Shown here is the organization of a representative, large Series AN5800 system. Behind the single 3½" x 19" panel area: 64 channels of single-ended MUX (or 32 channels of 2-wire differential); high performance Sample-hold; A/D conversion ***(with a wide choice of resolutions, speeds and accuracies)*** including polarity, decoding, and converter-programming features; 8 D/A converters; power supplies; *plus direct computer I/O* interface for most standard minicomputer applications.

Some Typical AN5800 Specs

- ***Accuracies:*** ±0.006% to ±0.05%, consistent with bit and speed resolutions.
- ***D/A Channels:*** Up to 14-bits. Outputs, ±10v @ 10mA. May be addressed sequentially or randomly. Buffers and latches provided.
- ***Digital Interfacing:*** LOGIC: All inputs and outputs DTL/TTL compatible. A digital interface accepts up to 6 lines of addresses for selecting up to 64 channels plus sequential or random address strobe lines. Up to 15 bits of digitized data plus E.O.C. serial data and clock outputs.

RIGHT-HAND BIT JUSTIFICATION: Allows A/D and/or D/A data bits to be right-hand justified by having the LSB (rather than MSB) always in the same position, independent of number of bits. Directly compatible with most computers.

To Sum Up . . .

After all else has been said, the most compelling reason for switching to the AN5800 design is that you can, *without compromising performance* — indeed, while getting significantly improved performance, reliability and flexibility — you can ***increase your profit on any minicomputer or computer-control application by $1000 to $2000 per installation, and sometimes more.***

To Get Started:

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Designer's casebook

Stable voltage reference uses single power supply

by Mahendra J. Shah
University of Wisconsin, Madison, Wis

When an integrated circuit differential operational amplifier is used in a voltage reference source, two supplies usually are needed—both positive and negative. Moreover, additional circuitry is generally required to establish output polarity. But if one supply line is grounded, only one supply becomes necessary—the one that gives the desired output polarity.

So long as the non-inverting input of the operational amplifier is maintained at some positive potential, even a tiny one, the output of the reference source will also be positive. Similarly, small negative potentials at the non-inverting input will result in negative outputs.

The voltage reference source shown employs a single 15-volt supply to give a positive output. To produce a negative output voltage, the positive supply line is grounded, the negative supply line is run to -15 v, and zener polarity must be reversed.

Zener diode D_Z establishes the reference voltage (V_Z) and the reference current (I_Z) for the circuit so that a constant-current source is provided by resistor R_1 and the buffering action of the op amp. Zener current is:

$$I_Z = V_Z R_2 / R_1 R_3$$

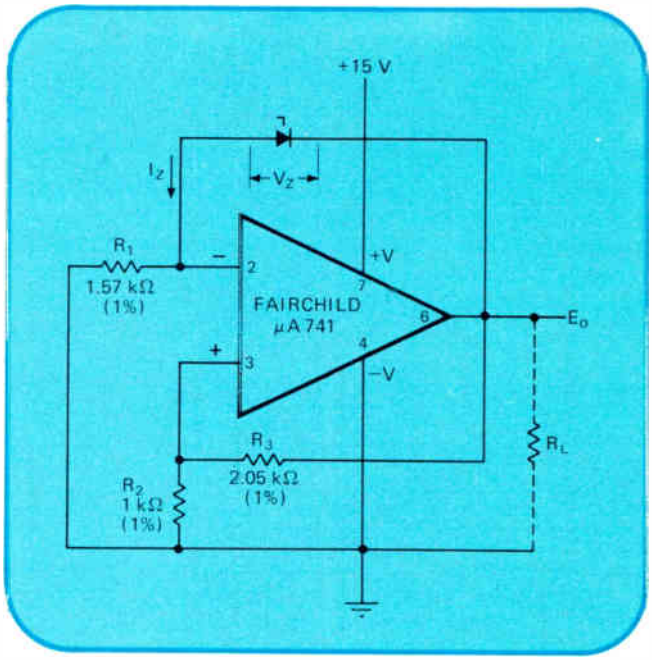
Due to the configuration of the op amp's output stage, circuit output voltage (E_o) will always be greater than 0.5 v when a positive 15-v supply is applied and the negative supply line is grounded. Therefore, a few tens of millivolts will always appear at the op amp's non-inverting input, making the output positive:

$$E_o = V_Z(1 + R_2/R_3)$$

With the positive supply line grounded and -15 v at the negative supply input, E_o will always be less than -0.5 v. The negative voltage at the op amp's noninverting input causes a negative output:

$$E_o = -V_Z(1 + R_2/R_3)$$

The reference zener voltage of 6.4 v yields a zener current of about 2 milliamperes. For a positive supply, output voltage is 9.547 v; temperature coefficient, 1.9 parts per million/°C; voltage stability, 9.5 ppm/v; and output impedance, 53 milliohms. For a negative supply, temperature coefficient remains the same; but output voltage becomes -9.560 v; voltage stability, 2.6 ppm/v; and output impedance, 21 milliohms.



Eliminating dual supplies. Voltage reference source has either positive or negative output, depending on polarity of supply used to bias op amp. Positive supply results in positive voltage at op amp's non-inverting input and, therefore, positive output. Negative supply produces negative output. In either case, final output voltage is about 10 volts. Zener diode acts as reference.

Fast-switching modulator reverses uhf signal phase

by R.N. Assaly
Massachusetts Institute of Technology, Lexington, Mass

In just a few nanoseconds, a modulator for shaping transmitted ultrahigh-frequency radar signals can switch a signal through three states. The signal can be turned on or off, and while it is on, the phase can be reversed between 0° and 180°. An off signal is attenuated by at least 35 decibels.

The modulator (a) consists of a tri-state driver and a double-balanced mixer, which allows the rf signal to be controlled by video commands. Three values of control current—-30 milliamperes, 0 mA, and 30 mA—are generated by the driver for the three modulator states—0° phase, off, and 180° phase, respectively.

The transition times of the two input logic signals, designated as code Q and gate P, are enhanced by a dual four-input AND gate. (The gate-P input turns the rf

signal on and off, performing a gating function; the code-Q input reverses the phase of an on signal, thereby coding signal phase.) A line driver then produces the outputs labeled A and B:

$A = \overline{PQ}$ and $B = \overline{P\bar{Q}}$

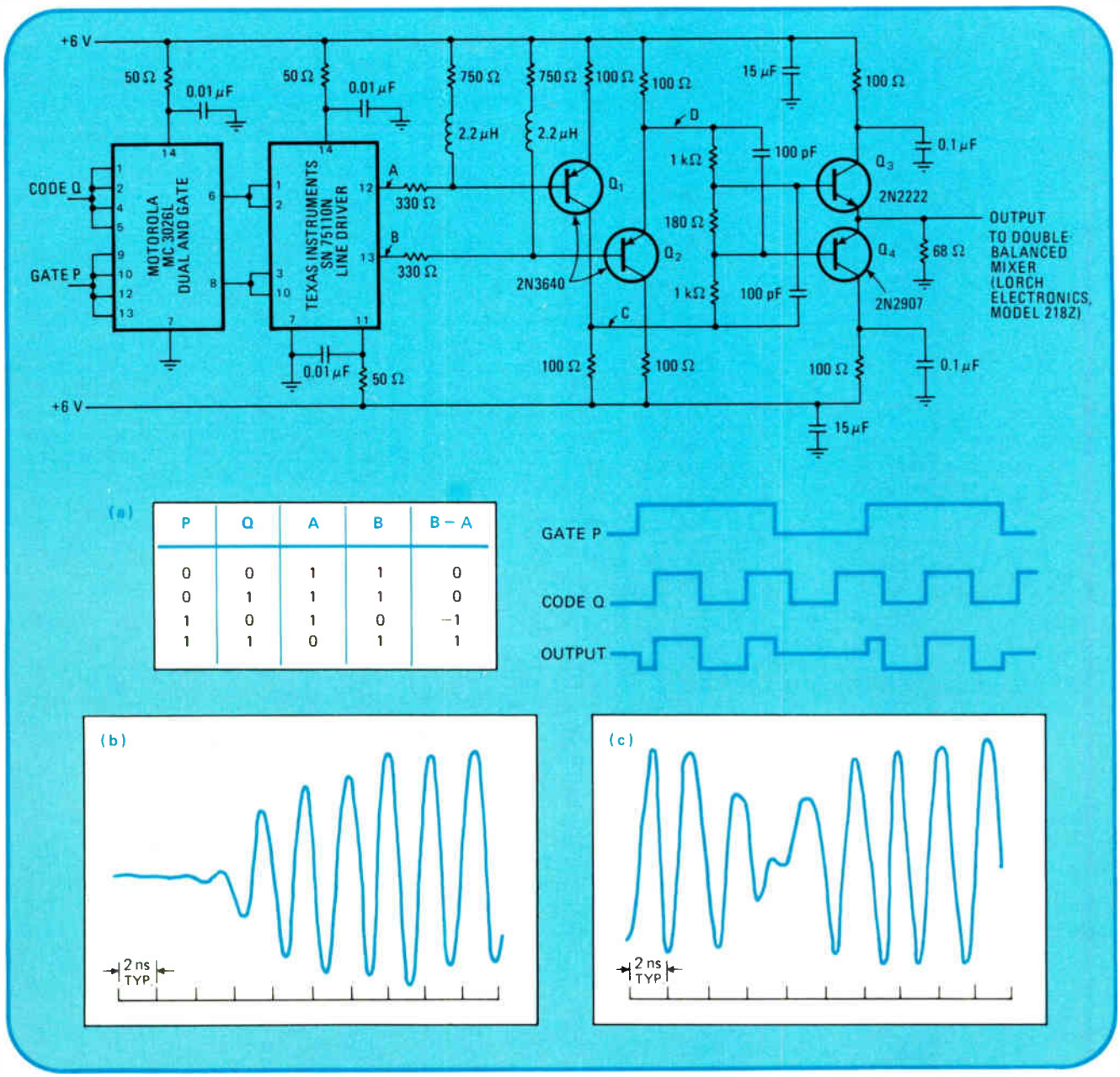
At the tri-state driver output, a difference signal, B–A, is used to provide the three desired states, as shown in the truth table.

To obtain this difference signal, transistor Q_1 inverts the A output of the line driver to produce signal C. And output B passes through transistor Q_2 without inversion, keeping the circuit balanced and resulting in signal D. A resistor network averages signals C and D, which are then applied to output transistors Q_3 and Q_4 that drive the double-balanced mixer.

Since Q_3 and Q_4 do not conduct if their base voltage is less than 0.6 volt, the resistor network holds bias voltage to about 0.5 V during the off state to reduce any delay during driver state transitions. Also, because a large base voltage must be applied either to Q_3 or Q_4 for conduction to occur, mixer current can be held to a very low value. If mixer current increases, to even just a few microamperes, the attenuation of an off signal becomes less than the desired 35 dB. For instance, attenuation degrades to about 30 dB when mixer current becomes approximately 10 microamperes.

Inductors and capacitors in the circuit are simply used to speed up state transitions. The turn-on of a 430-megahertz signal is illustrated in (b), while (c) shows a phase reversal. These transitions took less than 10 ns.

Uhf modulation. Three-state modulator (a) turns off uhf signals or reverses their phase between 0 and 180 . AND gate improves input signal transitions. To balance circuit, line driver output A is inverted by Q_1, while B passes through Q_2 without inversion. Transistors Q_3 and Q_4 drive mixer with difference signal of B–A. Turn-on (b) and phase reversal (c) traces are for 430-megahertz signal.



ECL gates stretch oscillator range

by William Blood
Motorola Semiconductor Products Inc., Phoenix, Ariz.

The frequency range of crystal-controlled oscillators can be extended easily with emitter-coupled logic gates. Selecting the proper crystal and the right number of frequency doublers results in accurate frequency signals over the range of 150 to 250 megahertz. Standard crystals are normally limited to less than 150 MHz because of the number of crystal overtones required to achieve higher frequencies.

A 200-MHz crystal-controlled oscillator that is built with only two integrated circuit packages is shown in the diagram. Two types of ECL gates, one with a propagation delay of 1 nanosecond and the other with a 2-ns delay, are used for best performance.

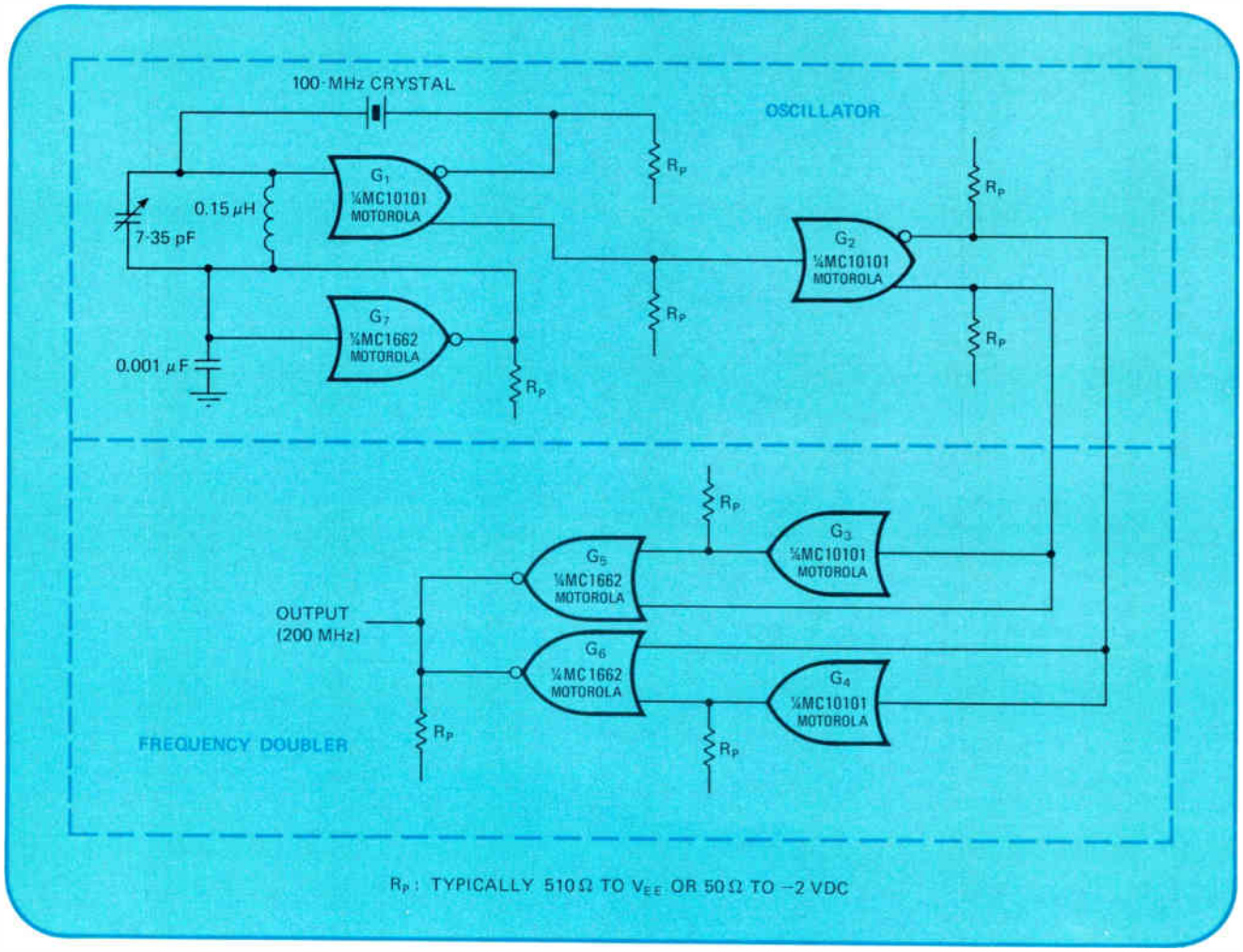
In the oscillating section of the circuit, the crystal is in series with a feedback loop from the NOR output of a 2-ns gate, G_1. The LC tank circuit tunes the 100-MHz crystal overtone, and also acts as a fine-tuner. Another 2-ns gate, G_2, from the OR output of G_1, buffers the oscillating section and provides a complementary output.

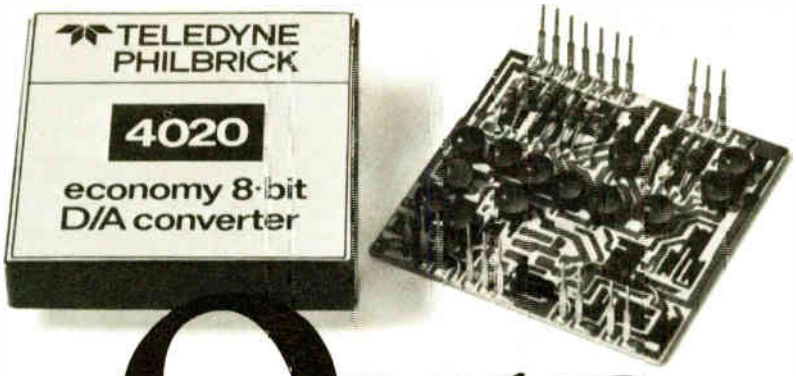
The frequency doubler section of the circuit consists of two 2-ns gates (G_3 and G_4) performing as phase shifters, and two high-speed 1-ns NOR gates (G_5 and G_6) operating as summers. For a 50% output duty cycle, the complementary 100-MHz signals should be delayed one-fourth of a cycle, or 2.5 ns. This may be done precisely with delay lines, or approximated with gates G_5 and G_6, as shown. The gating method is easier to implement and causes only a slight offset in output duty cycle. Gates G_5 and G_6 combine the four-phase 100-MHz signals, yielding a 200-MHz output frequency, when their outputs are wired-OR.

A third 1-ns gate G_7 is used as a bias generator for the crystal oscillating section. Tying the output of this NOR gate back to its input assures that the oscillating section remains biased in the center of its linear region over wide temperature and power supply extremes.

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.

Speeding up crystal oscillators. Emitter-coupled logic gates can increase the frequency output of crystal-controlled oscillators to 250 megahertz. For 200-MHz output, LC tank tunes 100-MHz overtone of crystal, while gate G_2 forms complementary 100-MHz signals. Phase shifters G_3 and G_4 and wired-OR summers G_5 and G_6 then delay and double these signals. Gate G_7 provides buffered bias supply for gate G_1.





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Functional digital ICs: devices to delight the systems man

Circuit designers consider the system builder's viewpoint to develop a new breed of integrated circuits more flexible and versatile than older designs to streamline solution of many problems now encountered

by Richard Percival and Jerry Gray, *National Semiconductor Corp., Santa Clara, Calif.*

☐ System designers are discovering that they are getting too much of a good thing in today's off-the-shelf integrated circuits. Although they were clamoring for many of these ICs just a short while ago, in the context of systems they were designing at that time, system men are finding that today's ICs often include features they can't use, or—worse yet—actually create new problems.

Dilemmas like these were pointed out recently by Bert Forbes, of Hewlett-Packard Co. [*Electronics*, Dec. 6, 1971, p. 70]. He appealed to semiconductor houses to design ICs for maximum utility, rather than for easy manufacture or a better specmanship rating.

A new approach combines the best qualities of the old ICs with the latest criteria of system design. Several semiconductor manufacturers are beginning to produce circuits that follow some of Forbes' recommendations; in particular, National Semiconductor Corp. will shortly have a specific IC he asked for, a dual circuit combining a type D flip-flop with a J-K version. Other devices in the forthcoming line include dual and quad type D flip-flops for temporary storage and four-bit digital and binary counters with an edge-sensitive hold state.

Nothing is more annoying to a system designer than, in trying for maximum speed, to find that an input must be held off for tens of nanoseconds while a previous input settles—because the IC designer included what he considered a desirable additional feature that only messes up the whole system's operation. Often, glitches like this don't show up on the data sheet because the circuit designer didn't realize that such extras could cause problems.

Clock pulses

But close attention to detail by the circuit designer avoids passing difficulties along to the system man. Both know that the shortest possible time between the leading edges of two clock pulses that the IC can handle is obviously the worst-case sum of five quantities: the propagation delay of the clock gate, the width of the clock pulse itself, the propagation delay from the clock gate input to the circuit output, propagation delay through random logic circuits driven by the circuit in question, and the data set-up time that the next clocked-synchronous element requires before the leading edge of the next clock pulse.

Clearly, if the first two quantities are eliminated and the last is minimized, the system in which the elements are used should be capable of faster performance. The third and fourth items are not dependent on clock-synchronous design, but on efficient internal logic design.

The functions performed by the new elements described here are the same as those of their predecessors—waiting, sequencing, storing, or computing. Except for the computing function, which uses clocks only indirectly, these new circuits should be faster to operate, easier to use, and less numerous in any given design than the older ones.

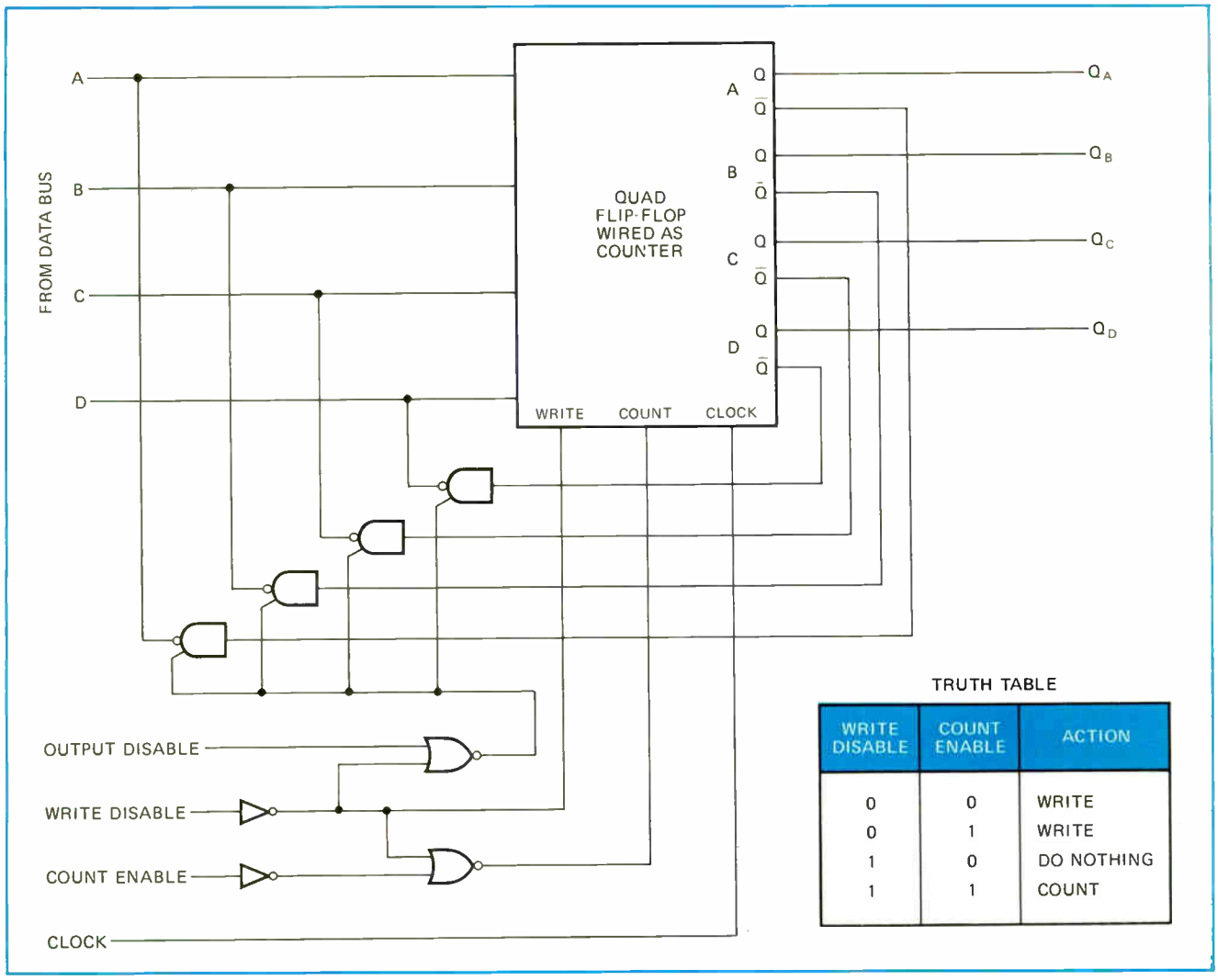
In a system with a continuously running clock, the key to effective waiting is the edge-sensitive hold state. This state is established with control signals that tell the IC, just before the clock pulse arrives, to maintain the status quo instead of changing to a new state. The control signals themselves may be the output of a hold state; although not tightly synchronized, they were generated by a ring counter—or perhaps a read-only memory—at a previous clock pulse and may change again as a result of the just-arriving pulse.

Newer devices with such a hold state coming on line include four-bit binary and decimal counters DM 8555 and DM 8556, available soon from National. In either device, the clock can increment the counter or preset it from an external bus, or the clock can be ignored.

As shown in the logic outline (Fig. 1), in each of these two devices a line called "write disable", one of three control lines, specifies whether the clock increments or presets the counter. After the presetting action, if "write disable" comes up to inhibit further presetting, the newly loaded data can appear at the same pins through which it was loaded, thus driving the same bus from which it came; an output disable line controls this section through a set of Tri-State gates. Meanwhile, the data also appears on four conventional counter output pins. If these pins are directly connected to a read/write processor memory, or a ROM containing a microprogram, either device becomes a program counter. Or, in general, the devices can perform any synchronous sequencing function.

Temporary storage

Most systems require temporary storage for both data and control signals. Temporary storage for data can be implemented with the DM 8551 quad D flip-flop, the first member of the synchronous system or bus-connectable family of parts [*Electronics*, Sept. 14, 1970, p.78].

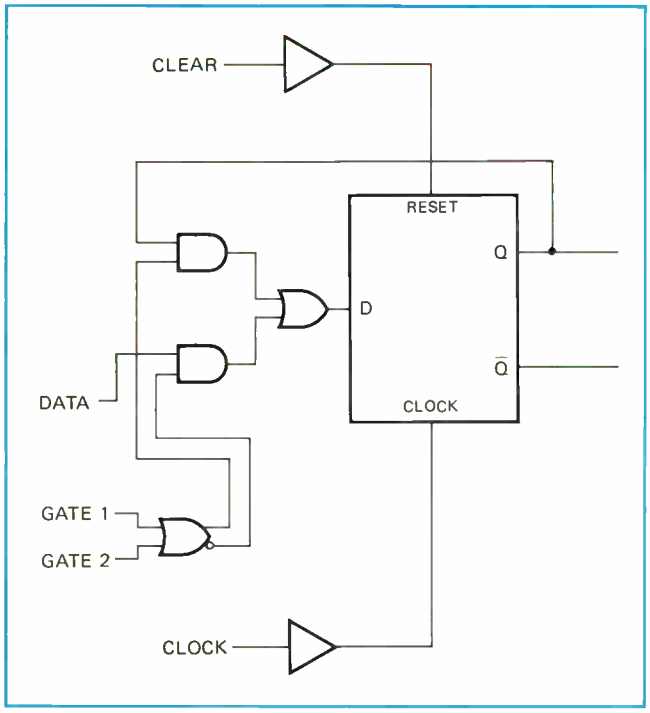


TRUTH TABLE

WRITE DISABLE	COUNT ENABLE	ACTION
0	0	WRITE
0	1	WRITE
1	0	DO NOTHING
1	1	COUNT

1. Counter. Available in either of two forms, binary or decimal, this circuit either can be incremented or preset by a clock pulse. Also, if write disable is up and count enable is down, the circuit ignores the clock pulse. It can be a computer's program counter.

2. Dual D. Two of these flip-flops are found on a single chip, the DM 7511. The circuit accepts data only when both gate input lines are down. Counters or data registers can be assembled from it. A similar circuit, DM 7613, is identical except that it has four flip-flops on a chip, and only one gate input per flip-flop; it also shares its clock and clear signals with the other flip-flops.



Bert Forbes cited this circuit in his article as an example of a well-designed device, from the system man's point of view.

But the DM 8551's input gates are common to all four sections for its intended application—storing data in a parallel-bus system. This commonality is inconvenient in a random-control environment, because a system is unlikely to have four different control signals, or even two, that require the same input gating.

Furthermore, the DM 8551 has Tri-State outputs—a capability rarely needed in a control environment. The inputs to the gates that make the third state possible and the gates themselves render the DM 8551's packaging inefficient for a control application.

However, random control does require microprogramed timing control of single bits, for which the dual gated-D flip-flop DM 7511 shown in Fig. 2 is use-

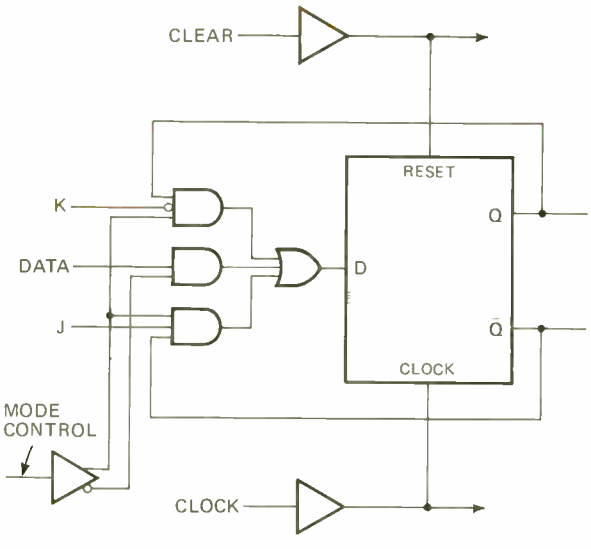
ful. It can be applied, for example, in a processor controller that must start and stop many latched functions at different times.

One gate, one input

In this flip-flop, the data can be entered in the circuit only when the circuit is enabled by the low state of both gate inputs. Otherwise the Q output is internally gated to the input, causing the bit stored in the flip-flop to be recycled with every clock pulse. (Without this feedback, a 1 would remain in the flip-flop only for one clock period.) Thus the flip-flop can be used in a counter or data register to store binary words without either internal or external gates for the clock signal. This is a valuable feature, because a system that has ungated clock lines can always run faster and with more versatility than one that uses gated clocks for any reason.

The two-input NOR gate in this circuit is just like the one that controls all four inputs of the DM 8551, except that here one gate controls one input instead of four. This feature permits the gate to be connected as part of a large X-Y array so that a minimum of control lines can select a single flip-flop. For example, one data line could be connected to the D inputs of 100 gated-D flip-flop (50 DM 7511 packages); then only two decimal decoders could select one of the 100 for loading. Each output of one decoder would drive one input of corresponding NOR gates in a horizontal row of 10; each output of the other decoder would drive the other input of the gates in a vertical column of 10.

Connecting one data line to as many as 100 flip-flops may seem to be a rather extreme fan-out. But it's no problem at all. On the contrary, the D gating is designed so that when the gate is closed, practically all the current from the gate flows out through the control line and very little through the data line. As a result, the fan-in is reduced to a point that permits one Darlington pair at the output of a TTL gate to drive up to 128 unselected inputs. (When the gate is open, no current flows out through either line.)



TRUTH TABLE

MODE	J	K	D	CLEAR	Q_{n+1}	TRANSFER IS
0	X	X	0	0	0	SYNCHRONOUS
0	X	X	1	0	1	SYNCHRONOUS
X	X	X	X	1	0	ASYNCHRONOUS
1	0	0	X	0	Q_n	SYNCHRONOUS
1	0	1	X	0	0	SYNCHRONOUS
1	1	0	X	0	1	SYNCHRONOUS
1	1	1	X	0	$\bar{Q}_n$	SYNCHRONOUS

X = DON'T-CARE CONDITION
Q_n = PRESENT STATE
Q_{n+1} = STATE AFTER NEXT CLOCK PULSE

3. Combination. A flip-flop with both D and J-K functions comes two on a chip. The mode control line is equivalent to the gate inputs of simpler flip-flops, but defines whether the circuit operates in the D mode or the J-K mode. The truth table describes the circuit's function under various input conditions. Note that the K line is inverted at the input to its AND gate.

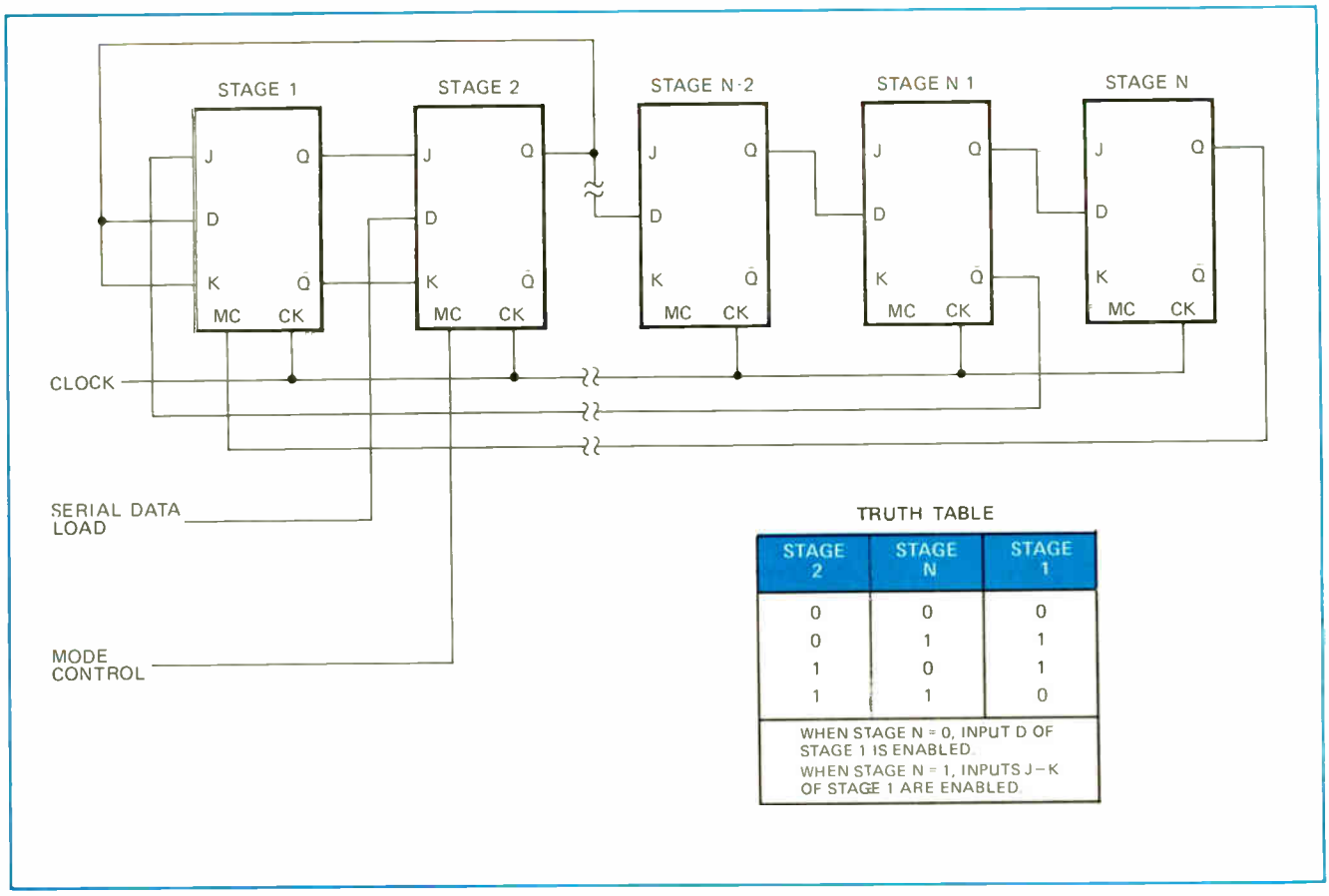
Quad gated-D

A quad gated-D circuit, the DM 7613, is similar to the dual circuit in DM 7511, except that it has only one control line instead of two per input, and its clock and clear lines are common to all four flip-flops in the package instead of being independent. The single control line makes the circuit appropriate for use with uncoded control signals, as opposed to the X-Y coding used in the example for the dual circuit.

This circuit has some advantages over its predecessor, DM 7475. First, it is edge-triggered, so that the output remains stable after the leading edge of the clock pulse, rather than responding to changes in the input all the while the clock pulse is present. Also, although the clock line is common to all four flip-flops in the package, the D-enable feature permits the clock signal to be ignored, thus eliminating clock gating and resultant clock skew. These were two of the requirements that Forbes asked for in his article.

This quad gated-D flip-flop can be used as a formatter for incoming serial data, every sequence of which begins with a 1 as a starting signal, as in the standard teletypewriter code. Two packages can be coupled together as an eight-bit shift register; the Q output of the eighth stage is fed back to the D-enable input of the first seven and the serial data line connected to the data input of the first stage. Then data is loaded into the register and shifted along its length until the data arrives at the eighth stage, when the full register shuts off further inputs. The same D-enable input also triggers other circuitry that transfers the eight bits in parallel out of the register and then clears the register asynchronously, making it available to accept more serial data.

A similar circuit with an important additional feature is the DM 7512 combination D and J-K flip-flop, a dual circuit, diagramed in Fig. 3. Forbes specifically asked for this circuit. The single mode-control line performs the same function as the D-enable line does in the quad gated-D, but when mode control disables the data input, the circuit becomes a J-K flip-flop. It turns on when it receives a J input, turns off with a K input, and changes state if J and K are simultaneous. Unlike the old master-slave J-K flip-flop, the DM 7512 is triggered by the leading edge of the clock pulse.



4. Workhorse. Connected into a feedback shift register, the flip-flop of Fig. 3 can detect and locate errors in cyclically encoded data, generate pseudo-random sequences of bits, or, with an AND gate, divide the clock frequency by $2^n - 1$.

This circuit offers several options. For example, if the J-K feature is not needed, the J and K inputs can be connected to ground and the circuit used as an ordinary gated-D flip-flop with the mode control becoming the gate. Or the D input can be connected to the Q output, creating a gated J-K flip-flop. Or, if the D input is connected to the $\bar{Q}$ output, the flip-flop becomes a toggle, changing state with every clock pulse when the mode-control line is down.

Many applications

This component has a great many applications for the system designer. For example, it can be used in a synchronously presettable counter, or as a J-K input counter that can shift its contents left through the D inputs—equivalent to multiplying a binary number by 2. Or it can be used as a counter that functions as a shift register when signaled to do so by the mode control. If the J and K inputs are connected to the Q and $\bar{Q}$ outputs respectively, the circuit becomes part of a general-purpose register that complements its outputs under program control—via the mode line.

Several of these ICs can be connected as a feedback shift register, as shown in Fig. 4, to serve as a decoder for cyclic error-correcting codes, or as a pseudo-random sequence generator, or as a modulo 2^n-1 divider.

As a decoder, the register causes an error-free code word of n bits, loaded serially and circulated exactly once through the feedback loop, to end up as a string of 0s. Had any error been present in the code word, 1s in the register after the circulation would have permitted corrections to be made to the word, held in a parallel register.[1]

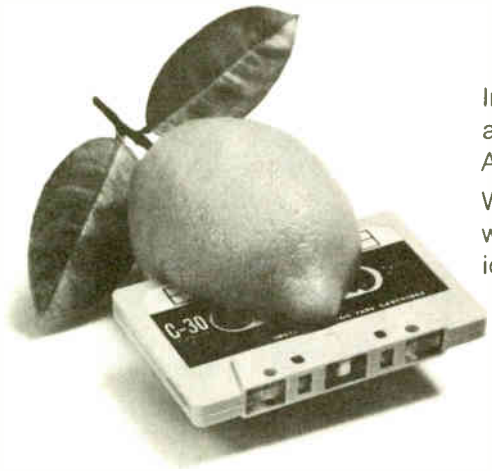
As a pseudo-random sequence generator, the register allows all n positions of the register to be loaded with an arbitrary sequence of 1s and 0s (but not all 0s) and then shifted 2^n-1 times through the feedback loop. During this shifting operation, the register has contained all possible sequences of n bits and has returned to the originally loaded sequence; the process can be repeated indefinitely.

Furthermore, the contents of any flip-flop viewed as it passes through the states of $n + 2^n-1$ of these shifts will contain all 2^n-1 possible combinations of the n bits (excluding all 0s), but will have the appearance of a random sequence of bits—hence the designation "pseudo-random." In this application the register acts like a counter, but its successive states do not represent consecutive numbers.

As a modulo 2^n-1 divider, the register operates the same as in the pseudo-random sequence generator, except that only one recurring combination is of interest—typically when all the flip-flops contain 1s. If all their outputs are connected to an AND gate, then this gate will produce an output once every 2^n-1 shifts—effectively dividing the frequency of the clock by 2^n-1. □

Reference
1. W.W. Peterson and D.T. Brown, "Cyclic Codes for Error Detection," Proceedings of the IRE, January, 1961, p. 228.

Two Years Ago, Almost

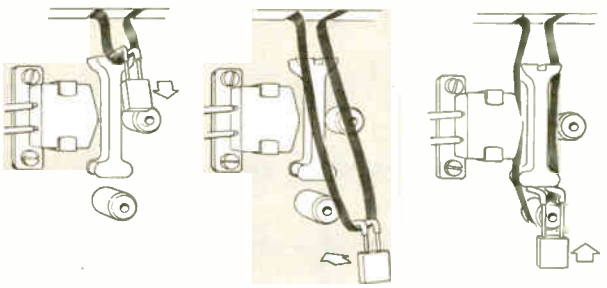


Including us. A digital cassette recorder. Seemed like a great idea at the time. But there was too much garbled info. And lousy reliability. A bumper crop of real lemons.

Well, we licked our wounds along with everyone else. But we also went back to the drawing board because we still thought the basic idea was sound. And we came up with a unit that really works.

A Whole New Concept

To get super reliability, we reasoned, you have to control that tape. So, we started from scratch. Got rid of the traditional pinch rollers, belts, solenoids, levers and mechanical linkages from the transport. Took out the head guide forks.

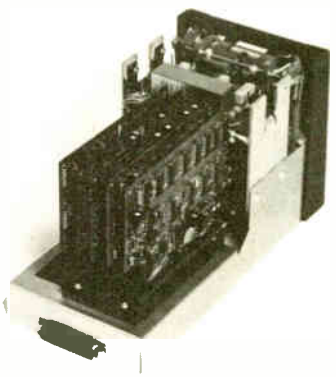


Eliminated the need for pressure pads. Those were the main cause of head and tape wear, oxide shed and dropout.

Then, instead of just pushing the head up to the tape as it rolls by, we decided to get the tape out of the cassette. (That way the cassette is just a tape holder.) So we designed two little fingers that pull the tape down past the head, over a precision guide and around a capstan. That maintains optimum head wrap angle—critical for read-after-write operation. And it's all done automatically as you load. (We've got a patent pending, in case you're interested.)

The Insides

Next, we put in three DC motors. One for the capstan and one for each reel. Servos positively control tape tension on both sides of the capstan. And tension sensors confirm proper loading to BOT—no writing on tape leader. There's no drag on the tape. Ever.



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Reel motor torque is automatically reduced when EOT or BOT is sensed to prevent pulling tape from cassette reel hubs or other possible tape damage.

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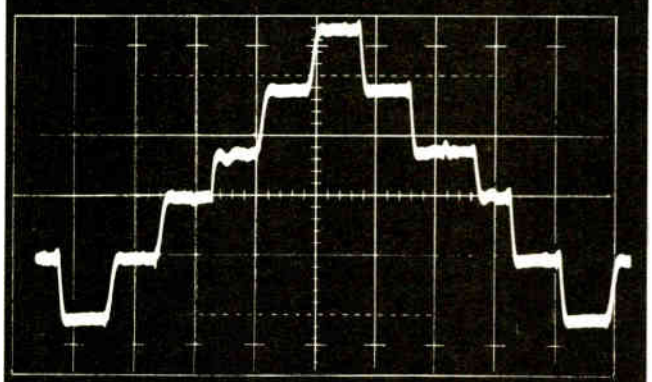
Digital-to-analog converters: trading off bits and bucks

A multiplicity of makers, plus a dearth of standards, creates a bewildering array of options. But the engineer who can define his needs will find there is a d-a converter to match them

by Harry R. Karp,
Special Issues Editor



☐ What electronics device has proven so cost-effective over such a range of applications that six times as many are in use today as there were three years ago?

What device is widely accepted without makers having any common agreement about how to produce them and without benefit of any industry standards? Nor has a single maker developed a clearly superior design, nor is there one user large enough to dictate specifications.

Finally, what device, with estimated sales of 120,000 units this year and more growth expected, has moved into the market with low-cost models to anticipate volume requirements and competitive pressures—yet given rise to products with marginal performance? (Or so say some makers about some competitors).

The answer is the digital-to-analog converter (DAC) module.

Once exclusively a measurement and control systems component, the DAC now goes more into such products as X-Y plotters, cathode ray tube display terminals, programable power supplies, and analog-to-digital converters. But lack of electrical, packaging and terminal-connection standards, poor definition of real costs in terms of performance, and technical complexities of the module put the electronics engineer at risk in determining DAC parameters and selecting the proper unit.

All this means that price alone is no guide to the selection of a DAC. By and large, two DACs of the same bit length usually differ in many electrical and performance parameters and options, as well as terminal arrangements, whether they come from different vendors or from two families of DACs made by the same vendor.

Consequently, choosing a DAC module—and so opting to deal with a particular vendor—means the system designer has to lay out the circuit board for a sole-source unit. However, if he is concerned about continued availability or long-term performance of the sole-source DAC, the designer can go to the expense of adding extra conductors and holes to his circuit board to make it compatible also with a "second-source" DAC. Or he can search out another vendor who can adapt his unit to be compatible with the first selection.

While competition has little effect on pricing, therefore, the major price determinants are completeness and freedom from error. By completeness of DAC modules is meant whether all of the electronic niceties required to convert a digital data word into a usable analog signal are actually in the package or whether outboard components—an input register or an output amplifier are examples—must be added and paid for by the user.

Six performance parameters

There is a very sharp increase in price as DAC performance improves. The major performance parameters are resolution, accuracy, linearity, temperature stability, settling time, and freedom from switching transients.

In performing conversion, the DAC turns a parallel n-bit data word into 2^n discrete levels of analog output. Thus, a 10-bit DAC has 2^{10}, or 1,024, output levels. The reciprocal of the number of output levels is the DAC's *resolution.* Thus, the resolution of a DAC is implicit in the number of input bits (see table of Resolution Equivalents). Because the smallest change in analog output results from the binary change (from a **1** to an **0**, for example) of the least significant bit (LSB) in the data word, the term "1 LSB" is a customary way of stating resolution, since it is independent of the bit-length of the data word. The LSB is equivalent to stating the percent of full scale for the analog output.

The DAC's *accuracy* refers to net error in the analog output for a given input code. For example, if a 10-bit DAC ought to have a 10-volt output for a full-scale digital word but yields only 9.5 volts because of poor calibration, the error is 5%. While the DAC will provide the necessary 1,024-step resolution, each step will be correspondingly inaccurate. Customarily, accuracy is specified in terms of ±½ LSB error, meaning the accuracy remains consistent with the DAC's resolution capability. Practically speaking, accuracy cannot be better than resolution, but it can be worse.

Linearity defines the constancy of the input-output ratio of the full range of values. A DAC can be linear, but inaccurate.

Changes in the DAC's operating temperature create output error. The better the *temperature stability*, the wider the temperature range that it is possible for the

DAC to tolerate without producing excessive error.

Settling time expresses the delay between introduction of the data word and the analog output reaching some final value. The shorter the settling time, the faster the throughput rate for data conversion.

Switching operations inside the DAC cause transient spikes known as *glitches*. For some applications it's necessary to add a deglitcher circuit to remove them.

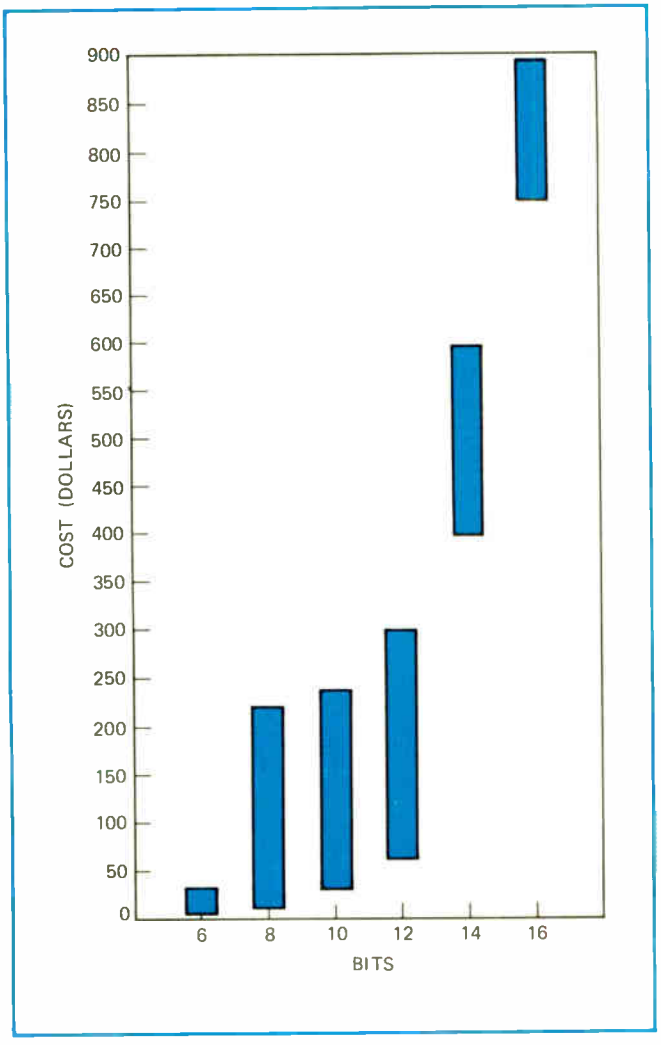
An indication of how the parameters relate to price can be gained from Fig. 1, which is based on information obtained from many manufacturers and charts the lowest and highest prices for DACs ranging from 6 to 16 bits. This price structure reveals the cost to the user of the technological demands placed on the maker to satisfy specific applications. The lowest price for each DAC size can be interpreted as the basic cost of obtaining conversion and resolution. The top of each bar can be construed as the maximum cost of providing maximum completeness, nominal accuracy, temperature stability, deglitching, and so forth. It is interesting to note that this extra cost, about $200, is almost independent of the DACs bit size—except for 6-bit DACs.

The cost trend for increased resolution is clearly demonstrated in Fig. 2, which uses the data of Fig. 1 to plot cost per bit vs bits from the data. As expected, the cost per bit goes up with the number of bits—first gradually, then sharply—reflecting both the increased cost of higher-quality components and more exacting manufacturing and testing procedures.

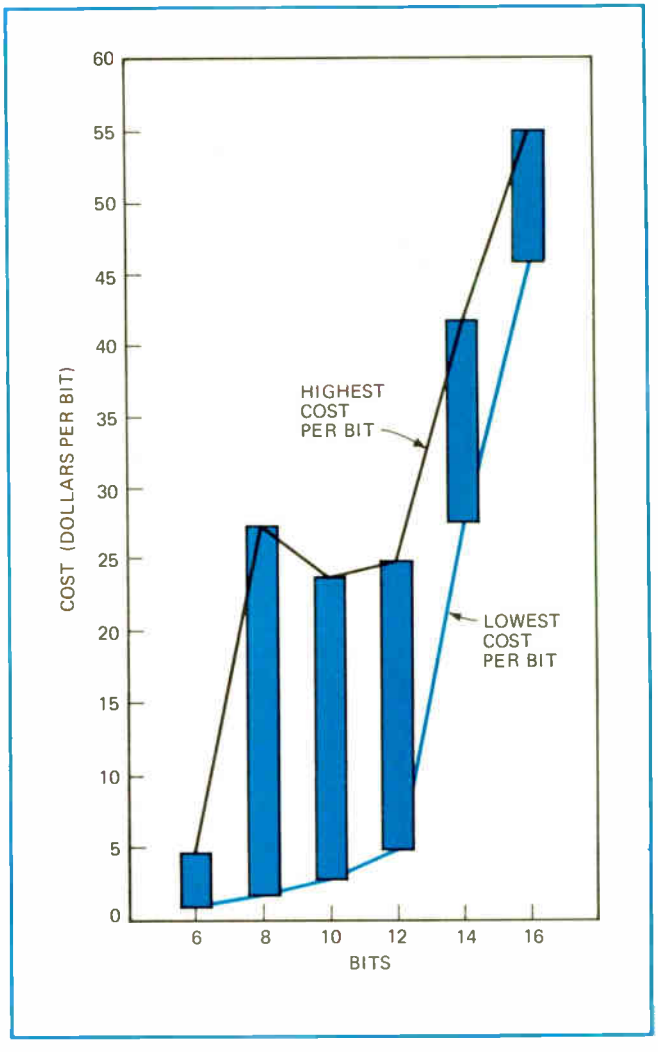
Figures 1 and 2 also show that 6-bit, 14-bit, and 16-bit DACs are each in a class by itself, while 8-bit, 10-bit, and 12-bit DACs together form another class. In fact many makers offer 8-, 10-, and 12-bit DACs in the same family of devices, having started with a 12-bit design and then modified the design to make lesser-bit units.

DACs having 14 and 16 bits provide so much resolution that they are most often used in exotic laboratory and scientific investigations and for applications having a wide dynamic range of digital values—65,536-to-1 for a 16-bit DAC.

The accuracy of a 10-bit DAC, equal to 0.05% of full-scale, equals or betters many types of analog meters and recorders. Such a unit is suited to drive, for example, a strip-chart recorder with outputs from a computer or other digital source. A 12-bit DAC provides sufficient resolution to match the accuracy of an X-Y plotter. And



1. Insight. Price structure for digital-to-analog converters, based on bit-length, or resolution, reveals sharp rise in cost for more resolution and precision. Height of bar reflects cost-range for performance features over and above that for basic conversion.



2. Premium. Cost-per-bit data, based on Fig. 1, emphasizes the cost increment for attaining and maintaining DAC precision. The gradual price increase for lesser-bit DACs results from volume production and less stringent demand on component tolerances.

an 8-bit DAC could be used to drive a low-accuracy analog meter whose purpose is, for example, to give a test operator a quick but not too accurate look at ongoing results.

The 6-bit DAC produces an analog output having only 64 discrete steps, or a resolution of 1.6%. Because of this low resolution, the 6-bit DAC is not normally used in measurement and control applications as are the higher-bit DAC's. Instead, the 6-bit DAC programs the output of power supplies, provides multi-level outputs for modems in data communications links, and so on.

For each application, the system designer must develop a set of specifications for such major parameters as resolution, linearity, accuracy, and settling time. And this means answering such questions as: over what temperature range must the DAC operate satisfactorily? For example, a 10-bit DAC required to have 10-bit resolution *and* 10-bit accuracy could degenerate to yield 10-bit resolution but only 9- or 8-bit accuracy—but 10-bit resolution with 8-bit accuracy might be adequate.

Does the application require a current output or a voltage output from the DAC? If voltage, is the performance of the output amplifier supplied with the DAC good enough, or should the user provide a higher-performance outboard amplifier?

The infrastructure

There is a wide enough range of DACs and options available from about 20 manufacturers to meet almost any user requirements. Choosing a DAC wisely, though, involves an understanding of how they operate and how they're made.

The kernel of any DAC is a set of switches and a resistance network, as shown by the colored blocks in Fig. 3. Two popular configurations are shown in some detail in Figs. 4 and 5. Each transistor switch is opened by a **0** level or closed by a **1** level at a corresponding bit-position of the input digital data word. (Or the logic convention might of course reverse this correlation.) Thus, in the case of a 6-bit DAC, the input binary word

1 0 1 0 1 0 **Binary**
1 2 3 4 5 6 Bit number

would mean the switches for bits 1, 3, and 5 are closed and 2, 4, and 6 open. Here bit 1 is the most significant bit (MSB) and bit 6 the least significant bit (LSB).

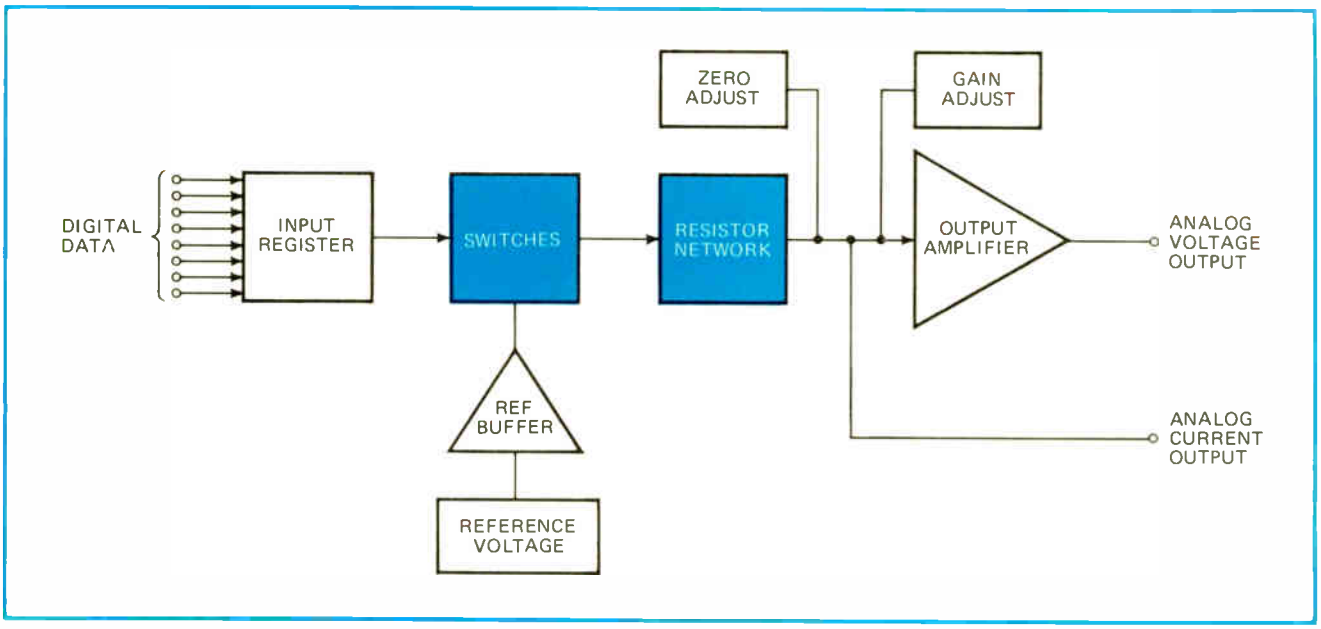
The analog output corresponding to **101010** is $\mathbf{1}\times2^{-1} + \mathbf{0}\times2^{-2} + \mathbf{1}\times2^{-3} + \mathbf{0}\times2^{-4} + \mathbf{1}\times2^{-5} + \mathbf{0}\times2^{-6}$ or 21/32 of full-scale value. Here, the MSB contributes one half the analog output.

Basic circuits

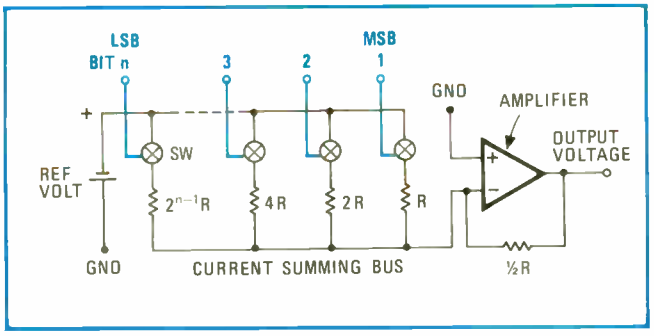
One common way of converting a binary input word to an equivalent analog output is shown in Fig. 4. When the bit-1 switch closes, the reference voltage creates a current through R of, say, 1 milliampere. Since the resistor associated with bit 3 is 4 R, then its current contribution is ¼ milliampere. And so on. The sum of these currents goes to the input of an operational amplifier which in turn produces an output voltage equivalent to the value of the applied digital word.

RESOLUTION EQUIVALENTS

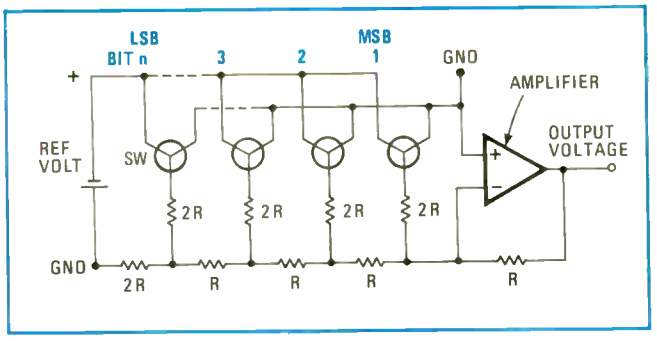
1 LSB RESOLUTION		BITS	½ LSB RESOLUTION		ANALOG OUTPUT STEPS
%	PPM		%	PPM	
6.25	62,500	4	3.125	31,250	16
3.125	31,250	5	1.563	15,563	32
1.563	15,630	6	0.781	7,810	64
0.781	7,810	7	0.391	3,910	128
0.391	3,910	8	0.195	1,950	256
0.195	1,950	9	0.0977	977	512
0.0977	977	10	0.0488	488	1,024
0.0488	488	11	0.0244	244	2,048
0.0244	244	12	0.0122	122	4,096
0.0122	122	13	0.00610	61	8,192
0.00610	61	14	0.00305	31	16,384
0.00305	31	15	0.00153	15	32,768
0.00153	15	16	0.000763	8	65,536



3. Necessities and niceties. Every DAC contains switches and resistors (colored blocks) essential to conversion process, as well as other functions and features selectable for the performance required for the application.



4. Adding up. Binary input either opens or closes transistor switches, thereby producing binary-weighted currents that are then summed to equivalent current output or voltage output.



5. Network. A common d-a conversion method uses the R-2R network to produce binary currents. This technique needs only two values of resistances, but takes two resistors per bit.

This configuration features one resistor for each bit. However, since each resistance is related to its neighbor by a factor of 2, a DAC with a large number of bits requires a very wide range of resistance values. In a 12-bit DAC, for example, the range is over 4,000-to-1.

Furthermore, if linearity and accuracy are not to fall short of ±½ LSB, the tolerance of R—including a resistance variation due to temperature change—must not be allowed to exceed $2^{-(n+1)}R$. In other words, any variation in the current through R (for the MSB) due to a change in the nominal design-value of R should not exceed half the current through the LSB resistor. This is why the allowable tolerance of the resistors decreases rapidly as the number of bits increases in the DAC.

To reduce the number of resistance values for higher-bit DACs, the quad circuit has been developed. The quad is essentially a 4-bit DAC requiring four different resistance values, as in Fig. 4. An 8-bit DAC is obtained by connecting two quad units, with a suitable current-attenuating resistor in the summing bus. In this case, the attenuating resistor reduces the contribution of the quad containing the LSB by 16 (or 2^4) relative to the quad containing the MSB. The two quads are similar, except that the tolerance of the resistors in the MSB quad must be correspondingly tighter than the tolerances in the other unit.

Another way of performing digital-to-analog conversion uses the R-2R network (Fig. 5). This conversion circuit also yields binarily weighted analog contributions when each bit-position switch is closed. While it needs two resistors instead of one for each bit, it also requires only two different resistance values. But again, tolerances are important.

A heating problem

During conversion, single-pole double-throw transistor switches connect each resistor to the reference voltage or to ground. Some voltage drop occurs across the transistor and, ideally, this can be accounted for in the basic design so that the actual current through the resistors remains binarily related. However, the transistor's sensitivity to temperature variations can have an effect on the actual current. As with the resistors, transistor-switch performance becomes more critical as the bit-length of the DAC increases. For this reason, makers often include temperature-compensation in the transistor-switch circuits.

Irrespective of the kind of resistor network, the addition of an internal zener reference, driven by a power supply, provides a regulated voltage to develop the summed currents (see Fig. 3). If the power supply rejection ratio (PSRR) (in percent output change per percent supply voltage change) isn't satisfactory, a reference buffer amplifier helps to stabilize the zener's operating point further, making the DAC even more immune to changes in power supply voltage.

Some DACs come without a zener reference, allowing the user to add his own when he wants a reference common to the whole system or when overall system performance requires a better regulation than ordinarily provided in the DAC package.

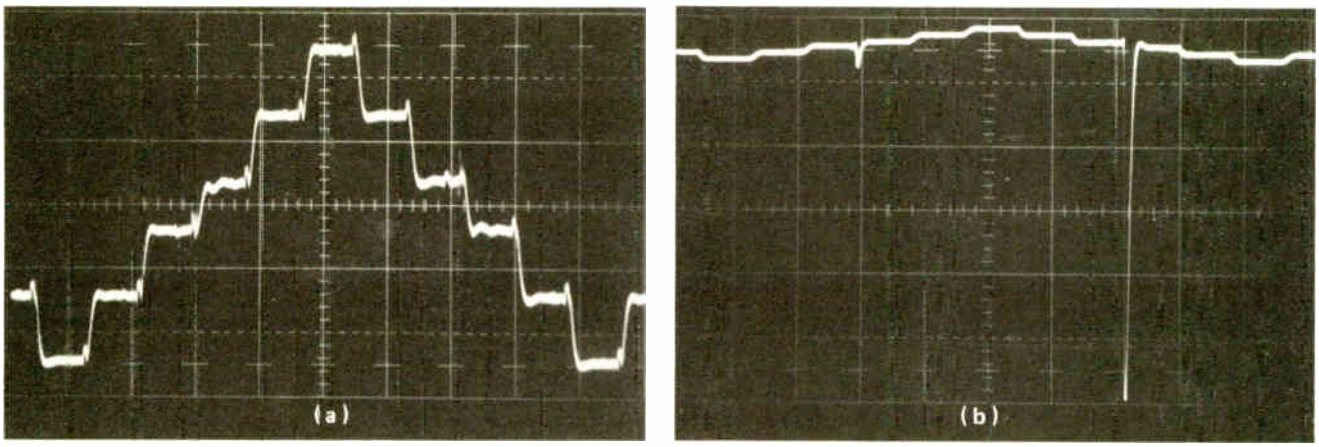
As the switches open and close as the data word changes, the difference in transistor turn-on and turn-off times and the resulting shifts in analog signal level, together with residual capacitance, create spikes called glitches (Fig. 6). The maximum amplitude of the spike, 50% of full-scale value, occurs when all the bit-positions switch simultaneously—as when an input data word changes from **0111** to **1000**. Such a code change occurs when a DAC having a bipolarity output—for instance, from +5 V to −5 V—goes through zero.

The glitch can last for several hundred nanoseconds. If the DAC is driving a relatively large time-constant device, such as a d'Arsonval meter for a quick-look display, the effect of the glitches will go unnoticed. However, in a fast-response application—a CRT display—such a spike can be disturbing to the viewer since the glitch energy will "rattle around" in the tube and cause jitter in the displayed characters. For such high-speed applications, makers provide, for a price, a deglitcher that cuts the spike to about 0.02% of full scale value.

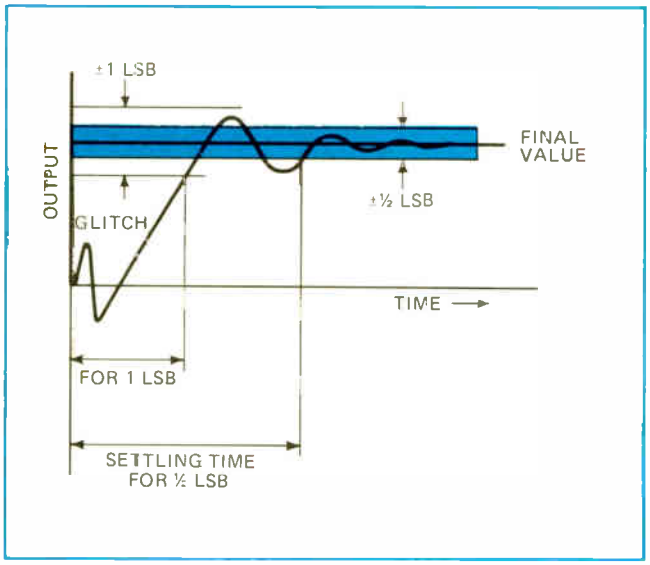
When bits in the parallel-bit data word do not actually arrive at the DAC at the same time, each transistor will then switch at a different time. This nonsimultaneous switching can also cause glitches. The situation can be ameliorated by adding a register in front of the switches. The data word is loaded into the input register, and then a strobe command connects the data word in the register to drive all switches simultaneously.

The register also serves as a data hold. Here, the computer loads the register and goes on to other tasks. At a later time, determined by system needs, a strobe command initiates the conversion.

Settling time, one of the DAC's major parameters, de-



6. Deglitching. Oscillogram A shows spikeless output when deglitcher circuit is added to a 10-bit high-speed DAC. In oscillogram B the vertical gain has been reduced by a factor of ten, revealing magnitude of the glitch. Photos, courtesy Analog Devices Inc., have been retouched.



7. Settling time. The time interval between initiation of switching operations and attainment of some prescribed final value of analog output is called the settling time.

termines the fastest rate at which successive data inputs can be converted without losing accuracy due to premature cutoff of the transient analog output. By definition, it's the interval between the loading of a new data word into the switches and settling of the output to within some error band bracketing the final value (Fig. 7).

Its actual duration depends on the magnitude of the change between successive data words, the presence (or absence) of major code transitions that may create glitches, and the slewing rate and damping of the output amplifier (if any).

Plus and minus an amplifier

This amplifier, as Fig. 3 shows, is not necessary in DACs with a current output, which is available directly from the current summing bus. When a voltage output is needed, an output amplifier transduces the output current to an equivalent voltage. Staying with current output means the settling time is shorter, and the DAC will probably cost less because there's no amplifier in the module. However, analog devices driven by a DAC often require voltage inputs, so it may be more convenient to buy a DAC with the internal output amplifier at the slight additional cost.

By and large, the settling time stated by makers is based on a full-scale change in the input data word and an error band of ±½ LSB. This value would be much smaller, and therefore appear better, if the error band were ±1 LSB, because of the exponential approach to final value. Thus, to compare settling times, the user must make sure the error bands are within same tolerances.

For current-output DACs, the times quoted range from about 100 to 1,000 nanoseconds, due primarily to switching delay. However, with an integral amplifier the net settling time stretches to many microseconds.

This increase arises from the amplifier's inherent rise time, which occurs in response to the step change in current resulting from a change in the input digital word. Despite its duration, the settling time of most voltage DACs is generally adequate. But when the application needs it to be shorter, the user can add a higher-performance amplifier, one having a wider bandwidth, to speed up the output response.

The output amplifier also contributes to the error budget of the overall DAC. Therefore, a high-performance outboard amplifier can be employed not only to improve settling time, but also to reduce zero drift and changes gain in with time and temperature. High-performance amplifiers add appreciably to the overall cost of performing fast, accurate, and repeatable digital-to-analog conversion.

Sources of error

Besides the operating functions available in or with a DAC, the other aspect of DAC performance is the error budget. Some error is left in during manufacture, as indicated by the values on maker's spec sheets for various parameters. Additional error can show up during operation—particularly when the DAC is mounted in a warm or cold environment.

Changes in component values cause several types of error, which may be more or less important in different applications. Suppose it were possible to have an ideally linear and accurate DAC (Fig. 8). Here, the "transfer function" would be a straight line that started at true zero and finished at true full scale. As a result, when the digital input was stepped 1 bit-value at a time, the digi-

tal-to-analog conversion process would produce a uniform-incremental-step staircase output. Figure 8 shows the effect on this output when the transfer function becomes nonlinear, which can occur, for example, when temperature change modifies component values so that the summed currents are no longer related in a binary fashion. The resolution remains, but accuracy decreases: the staircase steps are no longer uniform.

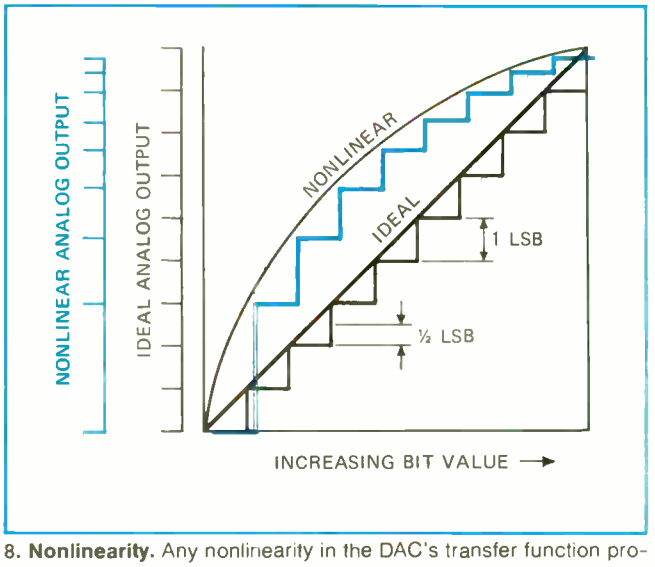
The nonlinearity in Fig. 8 is monotonic, in that increasing bit values yield an increasing-value staircase output and there is a unique analog value corresponding to each digital word. However, the transfer function could degenerate into a non-monotonic nonlinearity, as shown in Fig. 9. Here, the nonlinearity reverses direction. The presence of an excessive non-monotonic nonlinearity means that two different input codes produce the same analog output—which could have serious consequences. For example, it could cause a digital servo to hunt (oscillate) continuously, because of the servo's inability to settle on a single-valued null point. (The nonlinearity in Figs. 8 and 9 has been exaggerated for graphic contrast).

Two other kinds of error, gain error and offset error, are shown in Fig. 10. The former, in which the slope of the transfer function changes and does not go through the ideal full-scale point, is caused by changes in reference voltage, amplifier gain, and resistor values. Offset error, in which the slope does not go through the ideal zero point, is caused by resistor changes and amplifier drift. Some higher-resolution DACs include extra terminals for connection of resistor trimmers, to permit outboard recalibration of offset and gain functions when the DAC ambient is of high or low temperature.

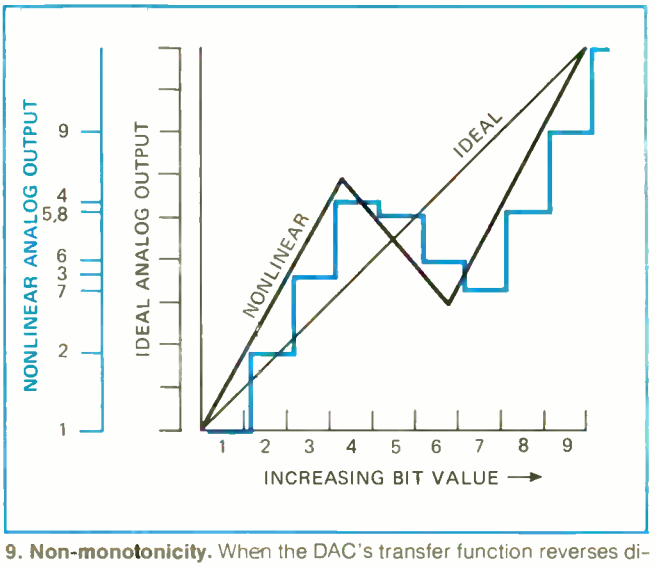
While the effect of temperature change on individual components is to alter nonlinearity, gain, and offset errors, the important thing to the user is the net effect of temperature on the overall unit. This effect on accuracy is specified by the maker as a temperature coefficient (tempco) in parts per million per °C (or as its equivalent percent per °C, see table of Resolution Equivalents). The impact of temperature change on DAC accuracy can be determined from the three charts in Fig. 11. Here, a DAC ambient temperature different from nominal temperature (usually 25°C) results in a certain ppm error—depending on the DAC's tempco—and this in turn is translated into the equivalent ½ LSB error for each DAC size from 6 to 16 bits.

Suppose a 12-bit DAC has a 100 ppm/°C tempco and must operate at 35°C (or a Δ°C of 10). Figure 11b shows the resulting error is 100 ppm. Since 100 ppm falls within the colored band for the ½ LSB for 12-bit DAC, the DAC retains its ½ LSB accuracy under these conditions. However, in the case of a 14-bit DAC with a 10 ppm/°C tempco (see Fig. 11c), a change of only 4°C is enough to push accuracy past the ½ LSB limit, so that the DAC has 14-bit resolution but only 13-bit accuracy under these conditions. And a change of 10°C would reduce the DAC to 12-bit accuracy.

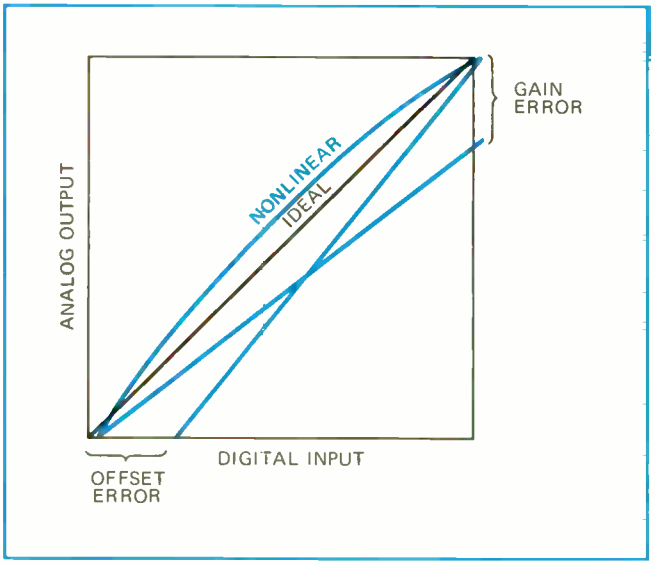
All this brings the user right back to the cost information in Fig. 1. Does he really need a 14-bit DAC that must operate with 14-bit accuracy and, if so, can he maintain the unit's temperature within a relatively narrow band? If yes, the cost is about $500. If, however, 12-



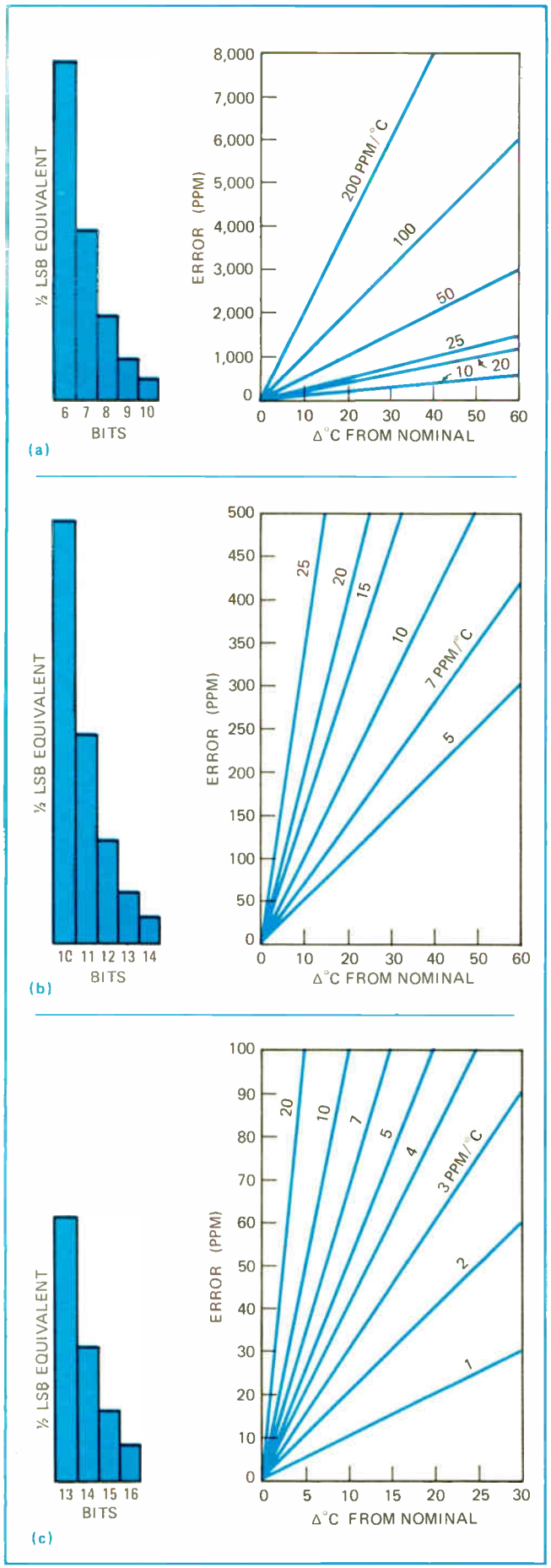
8. Nonlinearity. Any nonlinearity in the DAC's transfer function produces non-uniform steps in the analog output.



9. Non-monotonicity. When the DAC's transfer function reverses direction, output steps will go down when they should go up.



10. Erroneous. Two causes of reduced accuracy in a DAC are gain error and offset error. External correction is possible in some DACs.



11. How temperature affects DAC accuracy. When a DAC operates at a temperature different from the nominal design temperature, an error in parts per million may result. Its value depends on the DAC's temperature coefficient and ambient temperature. Here, the error is related to the corresponding ½-least-significant-bit criterion for each DAC size. If the temperature-induced error falls within the appropriate colored bar, the DAC retains nominal accuracy.

bit accuracy is satisfactory and he can also settle for 12-bit resolution, the cost drops to about $200.

In some applications accuracy less than equivalent resolution can be a definite specification, not a compromise. For example, suppose a wide range of digital values requires the code combinations available in a 16-bit word for their representation, but the analog output need only be accurate to 0.05%, equivalent to the ±½ LSB accuracy of a 10-bit DAC. Asking the manufacturer for a 16-bit DAC with a 10-bit accuracy eases his production and testing problems since acceptable ±½ LSB error can be within 500 ppm rather than less than 10 ppm; the cost drops from about $750 to $200.

Method of manufacture

Interpreting the information on spec sheets, however, is just one factor in coming up with a performance rating. The second factor—design and manufacturing method—may weigh heavily in the ultimate selection because it could affect the long-term performance of the relatively low-cost DAC in an expensive electronic system. As the plethora of hybrid, discrete-component, and monolithic DACs reveals, manufacturers themselves have not agreed in the best way to make a DAC—and at the present there may be no single way that's best for every application. The user should add his own judgment, in the light of his particular needs, and then relate the outcome to price.

Many interrelated considerations go into the way the maker chooses to produce his unit. Among these are the DAC's bit length, the conversion method, the expected selling price, and production volume. The bit length sets the accuracy requirements and this in turn determines, for example, whether thick-film resistors can provide the required range of resistance values and tempco for the bit-length of the DAC, or whether the unit should use more precise, discrete wirewound resistors. The conversion method determines, among other things, the parts count of the resistors, and thus affects the decision of whether it's less costly to buy discrete resistors or to deposit them at one time as a thin-film or thick-film network. Production volume can affect whether the maker wants to invest in a hybrid or semiconductor facility, or save on capital investment but opt for higher labor cost in assembling discrete-component DACs.

In general, higher-bit DACs don't enjoy a high volume but do require high precision, and so they are produced from discrete, high-accuracy, low-tempco resistors. Lesser-bit DACs, with higher production volume, are made in a variety of hybrid or discrete designs. The latest innovation in DACs, the 100% monolithic design, may eventually pose a threat to other methods, but so far this approach has resulted in a 6-bit DAC on one chip in a dual in-line package. However, 8- and 10-bit monolithic DACs should be announced soon. □

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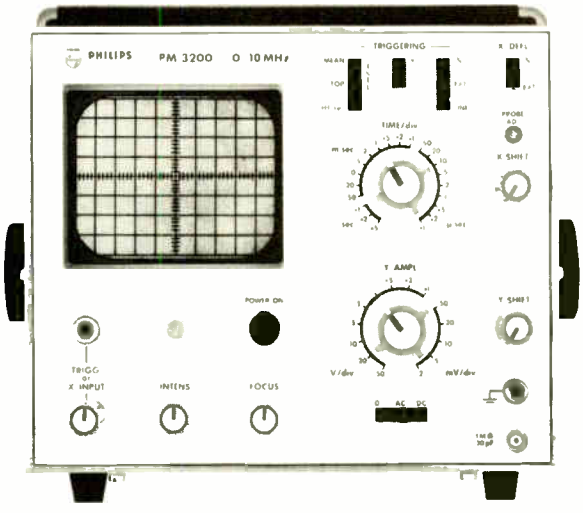

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The T-box: a low-cost software-based interface

A low-cost connector module and easily installed cable can use idle minicomputer time or a dedicated machine to substitute for the major functions of a peripheral device controller with minimum preparation

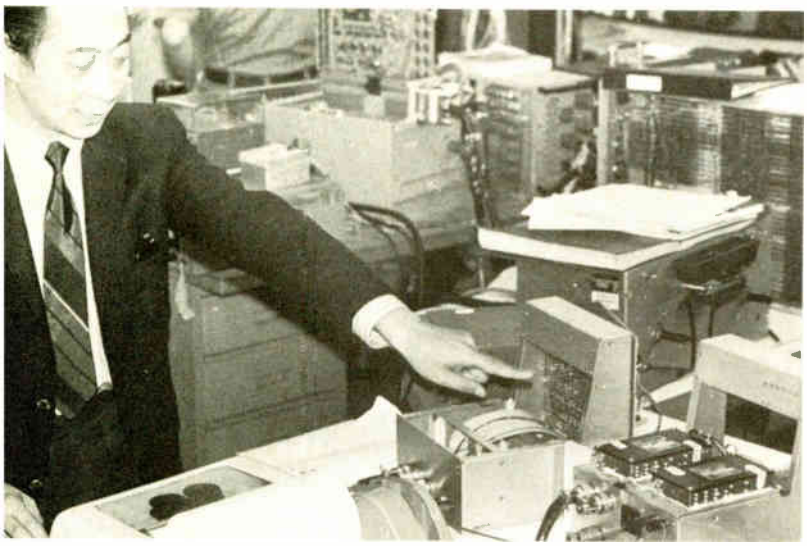
by David H. Chung and Don B. Hay, *United Technology Laboratories, Garland, Texas*

☐ Each peripheral device connected to a minicomputer normally requires its own unique controller or adapter to generate the required operating signals. This controller usually translates and buffers the signals and data flowing back and forth between the device and the computer. But controllers are expensive and take up valuable space in the processor frame.

However, an inexpensive generalized interface, called the T-box, is available for many applications, allowing the minicomputer itself to control the peripheral equipment through software. The T-box takes up little or no space in the processor, and—best of all—the same type of T-box can be used for many different kinds of peripheral devices.

The T-box reduces hardware design to laying out a cable to connect it to the peripheral—a task usually requiring two to three hours, compared to the days or weeks necessary to design a controller. Design of the necessary software to operate the T-box can be completed in weeks, at most.

As in all technological developments, the T-box involves trade-offs. It must be used with a minicomputer in an application that allows the processor to take over some of the functions normally performed by a peripheral controller. This implies that the processor can spare some time from its basic tasks; or equivalently, that the processor can be dedicated to input-output operations—perhaps as a controller in a network.



1. Small and simple. Author Chung points at some prototype T-boxes on a bench at United Technology Labs. The boxes plus computer software replace large, expensive input-output controllers.

Table 1
CONTROLLERS VERSUS T-BOXES

Device	Conventional interface		T-box method	
	Interface	Cost	T-box	Cost
Mag. tape unit	Formatter	$ 1,500	2	$ 800
Modem	Modem interface	2,250	1	400
Line printer	Printer controller	11,500	1	400
CRT terminal	Terminal controller	2,000	1	400
Card reader	Reader controller	850	1	400
Plotter	Plotter controller	1,500	1	400
Totals		$19,600	7	$2,800
Dedicated minicomputer				3,000
Software				1,200
Grand Total		$19,600		$7,000

With the already low and continuously decreasing prices of minicomputers, such dedicated use becomes feasible. An example of savings possible with the T-box is shown in Table 1. But the T-box is suitable only for smaller systems or for large networks of peripherals that have very low duty cycles for each peripheral.

The device can handle data formats from one to 16 bits per word. The time interval between words must be sufficient to permit bits to and from the minicomputer to be spaced at least 50 microseconds apart, corresponding to a maximum data rate of 20 kilobits per second. This rate would permit the T-box to control nearly any peripheral device, except high-speed disk files or magnetic tape drives.

Although two T-boxes have been combined to control a magnetic tape unit, the usual functions of a formatter in a conventional system, such as computing parity bits, checking characters, monitoring tape motion, and the like, are transferred to the minicomputer. These functions would probably prevent it from doing anything else while controlling the tape unit.

Two versions built

Two versions of the T-box have been built—one for use with transistor-transistor logic levels, and one with signal specifications of the Electronic Industries Association's RS-232 interface. Synchronization and timing ca-

pabilities are defined by those of the minicomputer with which it us used. The T-box depends on the minicomputer's interrupt capability (assuming that the minicomputer can accept interrupts—most can) and the execution time of a single instruction, which establishes a lower limit on the smallest time increment that the T-box can resolve. This is not a constraint on most peripherals used with minicomputers.

Starting with a single minicomputer and the memory modules appropriate for a particular application, the options are to attach the necessary peripheral units to the minicomputer through a series of conventional controllers or to set up a dedicated minicomputer in parallel with the parent machine and attach the peripherals through T-boxes. In the Table 1 example, seven T-boxes are necessary—two for the magnetic tape unit and one each for all others; to this expense, the cost of the extra minicomputer and the software is added. The cost difference is clearly in favor of the T-box.

The T-box is currently in use in all of the computers being marketed by United Technology Laboratories [*Electronics*, Aug. 30, 1971 p.28]. As implemented in these computers, it is not really a "tee" but consists of about 70 integrated circuits, two thumb-wheel switches, and a connector—all mounted as part of the system. If it were built as a separate single unit, it would have three connectors and could be contained in an ordinary printed-circuit board with a small housing for the connectors and switches (see Fig. 1). One implementation houses eight T-boxes in a box 3½ by 19 by 20 inches. But logically, the box has the configuration of the letter T (see Fig. 2), hence its name; it is plugged in between two lengths of cable (the top of the T) with a peripheral unit connected to the side (the stem of the T).

The ICs are relatively simple; the design appears to be amenable to being integrated on a single chip, in which form it could fit inside a modified conventional BNC T-connector. The three connectors are called "in," "out," and "drop." The in and out connectors each carry 10 twisted-pair signal lines and three dc power lines; at the in connector, these come either from the minicomputer or the preceding T-box, and at the out connector they are passed along to the next T-box or to an impedance-matching terminator plug at the end of the line. Through the drop connector pass the signal lines to and from the peripheral unit. There is a maximum of 39 of these lines. Sometimes a single T-box can service more than one peripheral unit, and sometimes a single peripheral unit will require more than one T-box to handle its communications with the minicomputer. Some typical examples appear in Fig. 3.

T-box shown

A block diagram of the T-box and its electrical signal lines is shown in Fig. 4. Two amplifiers serve every signal line passing through the T-box—five lines from in to out, four from out to in, and one both ways. Each of these signals is transmitted in a balanced mode on a twisted pair; the amplifiers are differential line drivers and receivers.

The individual lines are defined in Tables 2 and 3. Serial/parallel conversion, which requires the clock line, is performed on data when a peripheral unit accepts or generates several bits in parallel; the T-box in and out connectors have only one data line, which is used for serial transmission.

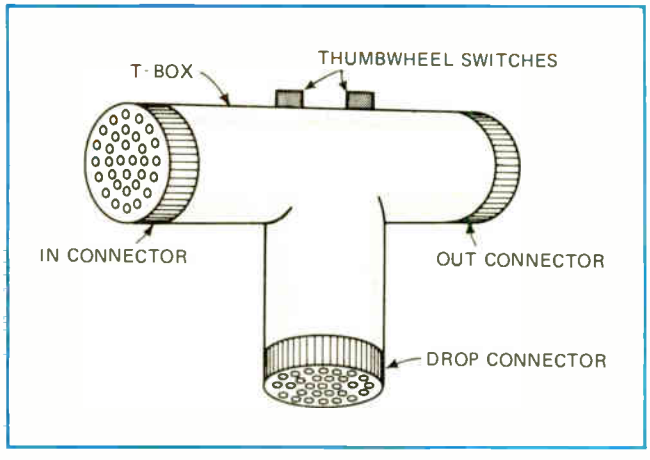
Three dc power lines pass through the T-box along with the signal lines. They carry a positive and a negative voltage and ground for the logic circuits in the T-box; voltage regulator circuits in the T-box adjust the voltage levels if necessary, particularly along long cables. These power lines do not supply the peripheral device itself.

Only the fastest peripheral units would use all 32 data lines available at the drop connector; slow devices, such as teletypewriters, would use only one line each way.

One of the four output strobe lines carries an unconditional pulse. It is used after a read operation to acknowledge receipt of the character from the peripheral unit, or before a write operation as a signal that the character to be written is available. The other three strobes are conditioned by bits 0, 14, and 15, respectively, in the T-box output buffer. By setting and resetting these bits at appropriate times, the computer can use them for any purpose. All four strobe pulses are nominally 500 nanoseconds in duration, but can be varied over a considerable range by adjusting a monostable circuit in the T-box.

The thumb-wheel switches define the address of each peripheral unit on the bus by translating the numerical address into an eight-bit binary address. Three bits define one of eight groups of units; four define a particular one of 16 units in the group; and the eighth defines whether the operation that follows the address concerns a data transfer or an interrupt inquiry. This eighth bit isn't strictly an address bit, but goes out with the address in the same operation. As many as 128 peripheral units can share a single input-output channel of the minicomputer, each with its own T-box, within the constraints of the addressing scheme. Electrical or operational considerations, such as the computer's bandwidth, may impose a lower maximum number of peripheral units in particular cases.

When an address, identified by the rise of the address gate, is sent out on the data line at the beginning of an operation, it automatically goes to every T-box, regard-



2. Simplicity. This schematic representation emphasizes the T-box's simple nature. A cable common to many peripherals passes through it, between the "in" and "out" connectors. Internal logic processes signals to and from peripheral via "drop" connector.

less of the setting of the thumb-wheel switches. When the eighth bit has been set into the output register of the T-box, the entire address is compared with that T-box's thumb-wheel switch settings. If the address doesn't match the setting, the T-box ignores the following instruction, the end of which is signaled by the fall of the data gate line. Only one T-box should be set to a matching address.

The eighth bit—actually the first bit to go to the T-box—defines whether the operation to follow concerns data or an interrupt. If this bit is 0, the operation will transfer data to or from the minicomputer, as specified by the input-output line. If it is 1, the minicomputer is either inquiring about the interrupt status of the T-box, or it is supplying a mask bit to disable that interrupt, again as specified by input-output. When a particular T-box has had its interrupt disabled, but the interrupt line is still up, the computer knows that the interrupt is coming from a different T-box.

The computer can query or mask the interrupts from 16 T-boxes at once. If the first address bit indicates an upcoming interrupt query or mask, all the T-boxes in a particular group—up to 16—stay on line; the four address bits that identify them are not checked for match or mismatch against the thumbwheel addresses. Then when data transfer begins, each T-box transmits its interrupt status bit or accepts a mask bit during a time slot identified by these four address bits. The 16 bits travel along the data line, just as in normal data transfer, but each one comes from or is destined for a different T-box.

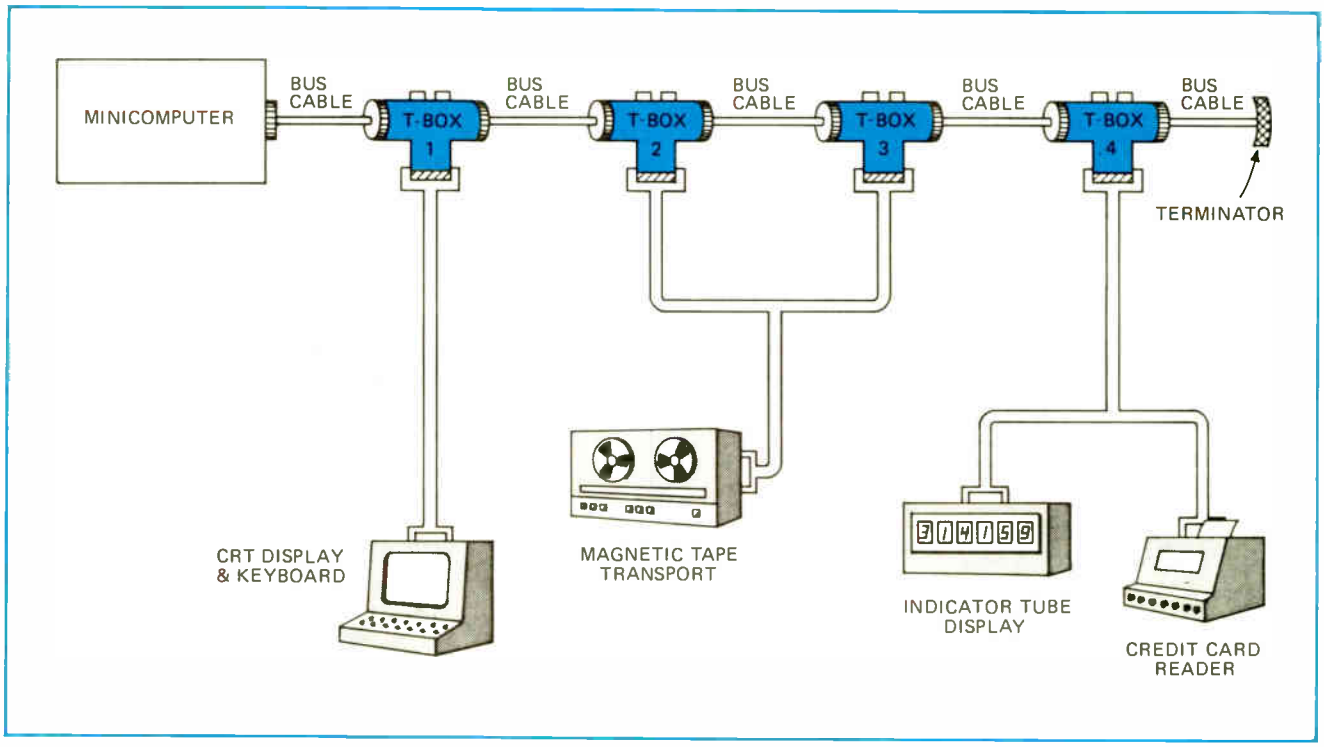
The data gate and clock signals, unlike the others in

Table 2
T-BOX IN AND OUT LINES

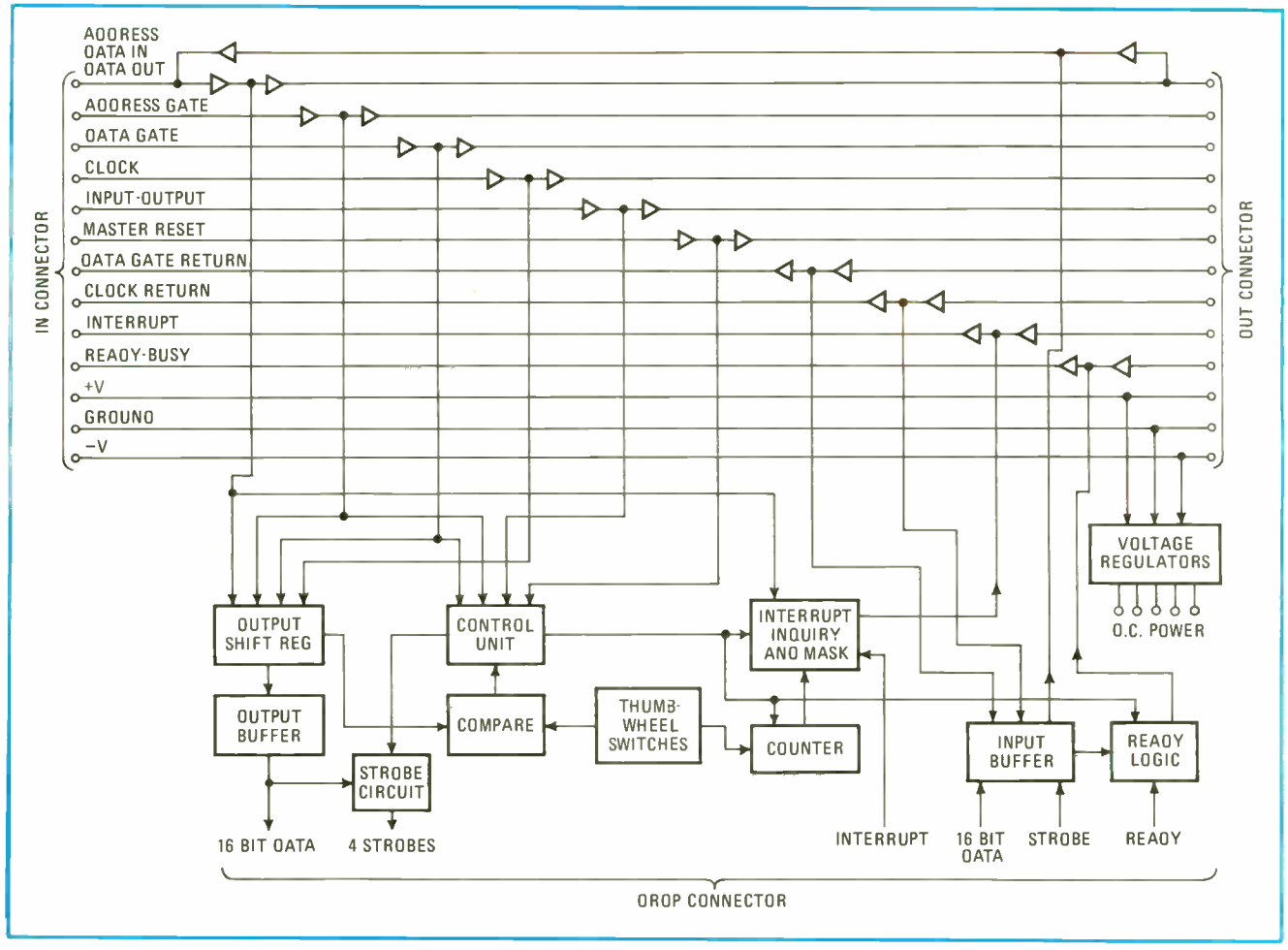
Line name	Definition
Address/Data	Bidirectional line for serial transmission of address or data bits
Address Gate	Indentifies address bits on Address/Data line
Data Gate	Identifies data bits on Address/Data line
Clock	Timing pulses for serial/parallel conversion in T-box
Input/output	Defines direction of data flow
Master reset	Clears all data and status bits in T-box to initialize it
Data Gate Return	Return path for Data Gate signal
Clock Return	Return path for Clock signal
Interrupt	Requests unscheduled or asynchronous operation
Ready	Addressed unit is available for use

Table 3
T-BOX DROP LINES

Line name	Definition
Input data	Up to 16 lines, carrying data from peripheral unit to T-box
Input strobe	Advises T-box that data is on input bus, sets T-box input buffer
Interrupt	Advises T-box of exceptional condition in peripheral unit
Ready	Peripheral unit is available for use
Output data	Up to 16 lines, carrying data from T-box to peripheral unit
Output strobe	Four lines for signaling the peripheral unit



3. Anything and everything. Any kind of low-speed peripheral device can be connected to a minicomputer through a T-box. The more complex ones, like magnetic tape units, may require two T-boxes; whereas one T-box can sometimes handle two very simple devices.



4. Lines and logic. Amplifiers boost the bus signals so they can be used on long cables, if necessary. Between receiver and driver, signals are tapped for local manipulation and for forwarding to the local peripheral unit, attached through the "drop" connector.

the bus, are not terminated at the end of the cable but are short-circuited to data gate return and clock return, respectively, which are terminated at the minicomputer. If the cable is very long, a great many microseconds may elapse at a T-box near the computer between the passage of these signals out and back. No T-box can put data on the data line until the data gate signal has passed both ways.

To understand why this restriction is designed into the T-box, suppose that two widely separated peripherals, with addresses 0 and 1, interrupt the computer at the same time. Suppose further that unit 1 is closer to the computer and that the propagation delay between unit 0 and unit 1 is 10 μs. Unit 0 correctly inserts its interrupt status bit on the data line during time slot 0, and unit 1 does likewise during time slot 1. If these responses occurred immediately upon the rise of data gate, unit 1, being closer to the computer, would respond 10 μs ahead of unit 0, and the computer would receive unit 1's status bit 20 μs early. But by responding upon the rise of data gate return, the bits are inserted on the data line in the proper order and are so received at the computer. The only timing requirement for these proper responses is for the skew between clock, gate, and data to be less than one clock period. As long as this time relationship is maintained, the propagation delay of the cable is not a factor.

The ICs in the T-box include amplifiers for every signal passing between the in and out connectors. The devices permit lengthy cabling between successive T-boxes so that peripherals may be strung out over a distance of several miles, if desired.

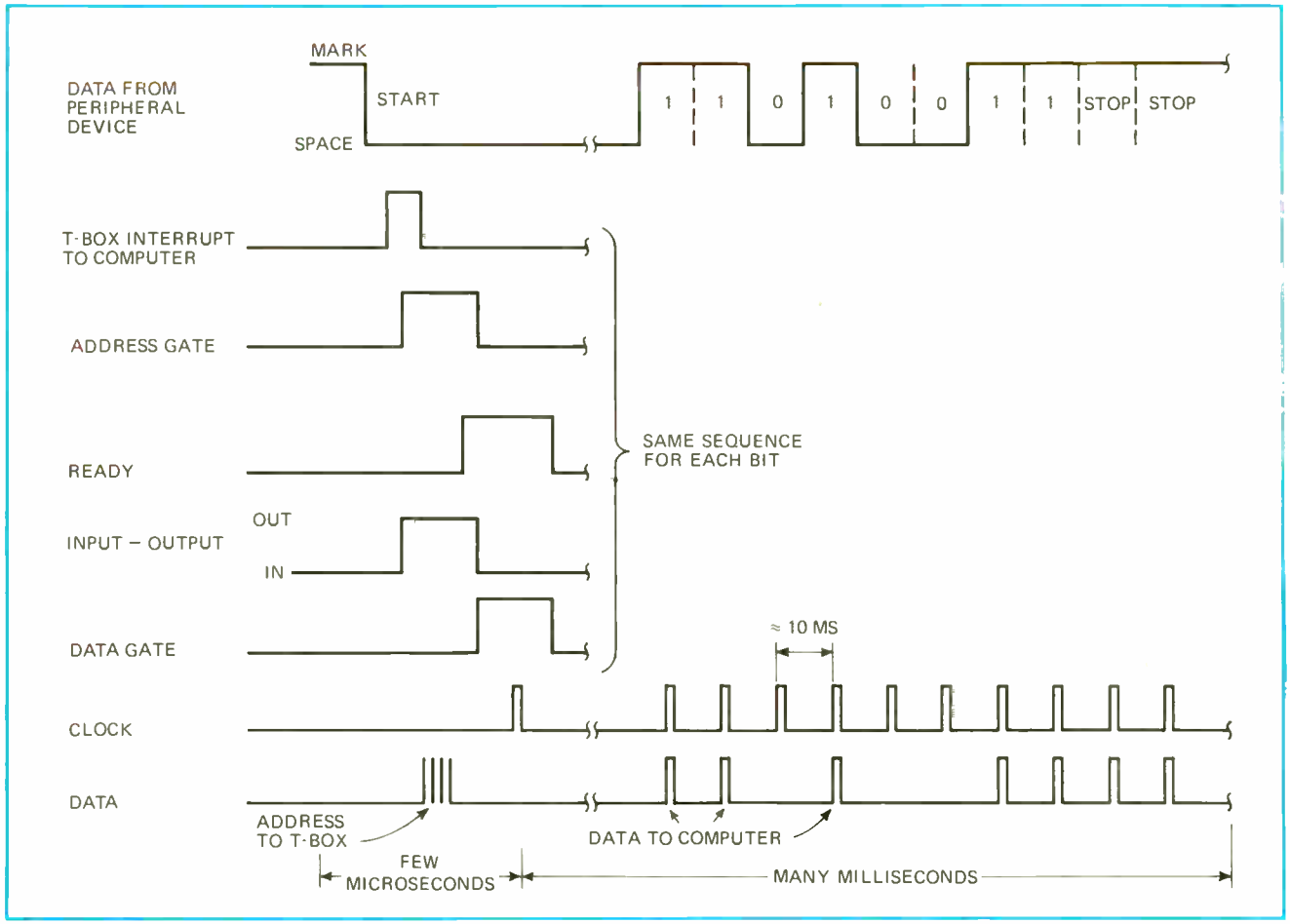
Teletypewriter control

Suppose the T-box is used with an asynchronous data transmitter, such as a teletypewriter. Each character from the teletypewriter arrives at the T-box in the form of a series of pulses, perhaps similar to that shown in Fig. 5. The T-box responds to the negative transition—representing the character's start pulse—by generating an interrupt signal to the minicomputer, which in turn responds by starting its internal timer.

At prescribed intervals, the minicomputer interrogates the T-box for each incoming bit. For machines such as the standard ASR-33 Teletype, which transmits 10 characters per second, the sampling interval is 9.09 milliseconds.

One character comprises 11 pulses—namely a start pulse, eight data bits, and two stop pulses. Start pulses and 0 bits are both negative or "space" levels; stop pulses and 1 bits are positive or "mark" levels. Each bit is transmitted into the minicomputer, where it is assembled into a complete word and placed in memory.

This software overhead may take five to 10 times as



5. Slow and asynchronous. Signals between T-box and computer in typical low-speed application show sequence for each bit transferred. Left side of timing chart represents periods of 10 to 100 μs; but bits are perhaps 10 ms apart, so time scale at right is condensed.

long as the actual bit-fetching, which is only a few microseconds. If the servicing of each bit, including the fetching and overhead, takes 100 μs, but bits arrive only once every 9.09 ms, then only a little more than 1% of the minicomputer time is taken up by this operation, and the need for special interface hardware is avoided.

However, this example shows one of the limitations of the T-box. If as many as 100 peripherals were connected with T-boxes strung out along a single bus, all of them capable of transmitting at the same rate as the teletypewriter and all of them going at once, the minicomputer could not keep up with them without the assistance of an external controller.

Tape drive control

But the T-box is not limited to teletypewriters and similar devices. It has been used successfully with a magnetic tape unit transferring data at 10 kilobytes per second, corresponding to 80 kilobits per second—about four times the maximum mentioned earlier. This was achieved by using a formatter with the tape unit and by cutting the software overhead to the bone.

Ordinarily, manufacturers of tape units also supply those formatters or even control units to go with the mechanical tape drives. Minicomputer manufacturers are usually obliged to build interface units to match these formatters to their own machines. The combined cost of the formatter and an interface unit is likely to be $2,500 or more. But the two units can be replaced by two T-boxes, as shown in Fig. 2 and in Fig. 5.

Since the tape unit is a more complex device than a teletypewriter, at least in the sense of using more instructions, it requires a more complex interconnection with the minicomputer. This is why two T-boxes are required. One of them is devoted primarily to forwarding data to and from the tape unit in much the same way the T-box is used with the teletypewriter. The other takes care of control instructions to the tape drive, such as backspace, rewind, or unload, and status information from the tape drive such as ready, end of file, or file protect (a status assignable to individual reels or cassettes that prevents writing and therefore prevents destruction of vital information by writing over it).

There is more of this control and status information than the 32 data lines of a single T-box can handle. Therefore, from the addressing point of view, control and status information is related to a different peripheral unit than read and write information. Functions that the formatter usually performs in conventional systems, such as computing parity bits, checking characters, and monitoring tape motions, such as backspacing and rewinding, are transferred to the minicomputer. These functions would keep the minicomputer considerably busier than receiving data from a teletypewriter and probably would prevent it from doing anything else while controlling the tape unit. □

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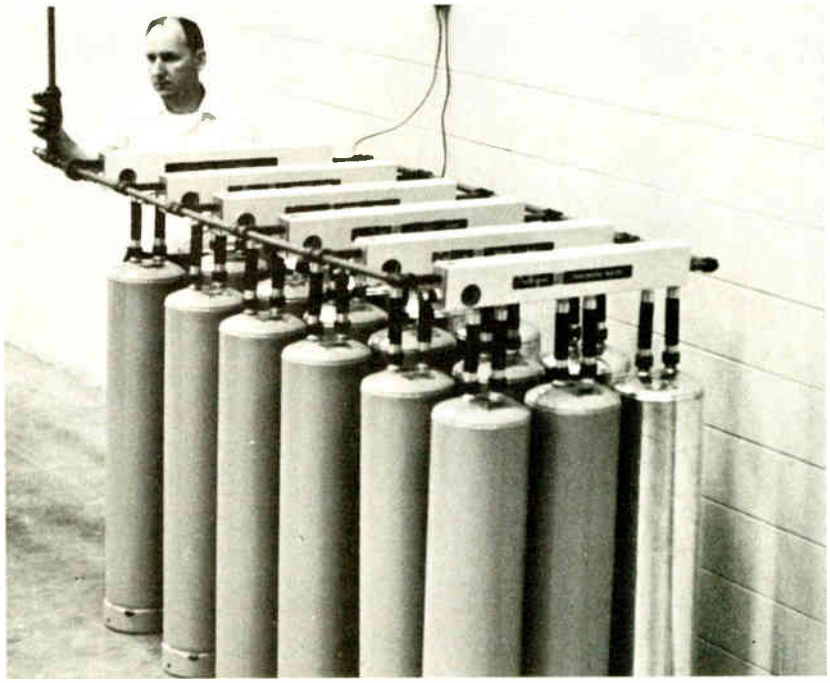

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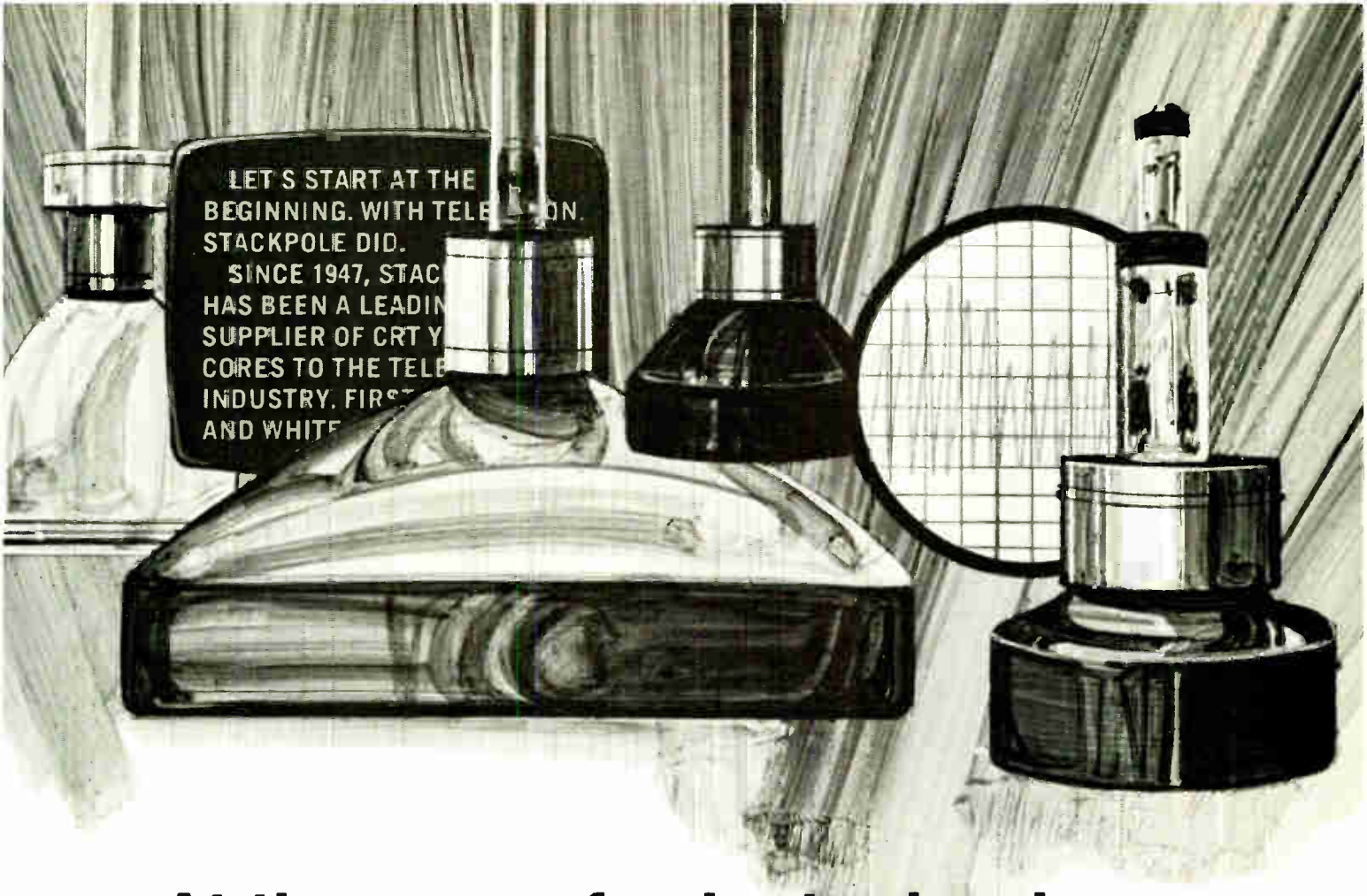

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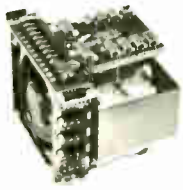

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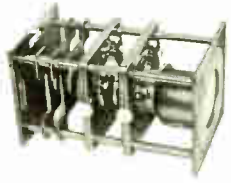

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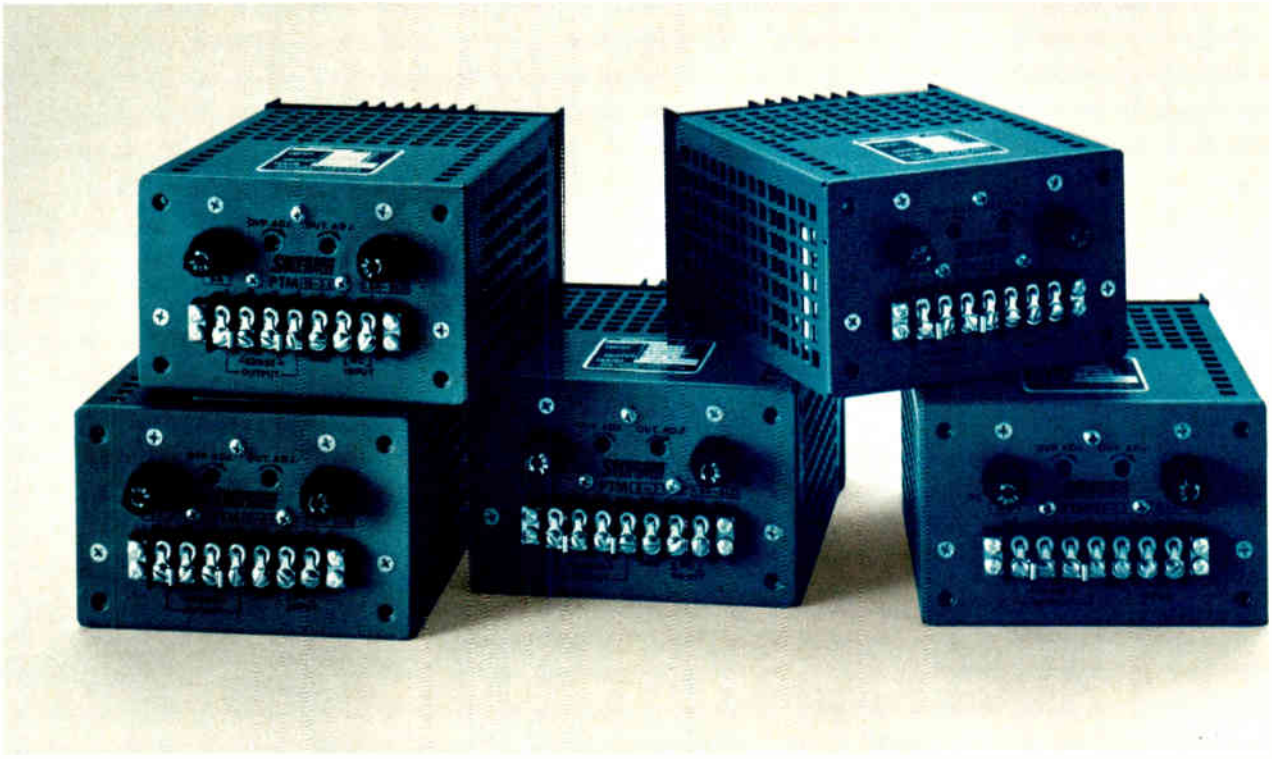

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PTM15-3.5	14.25	15.75	3.5	3.1	2.5	1.6	$119
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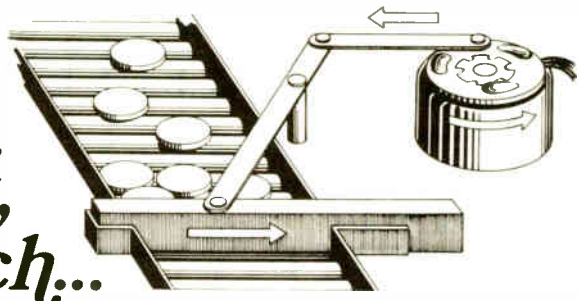

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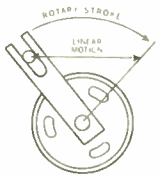

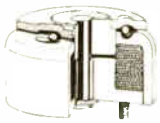

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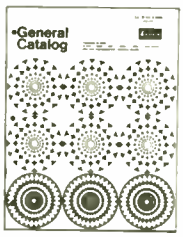

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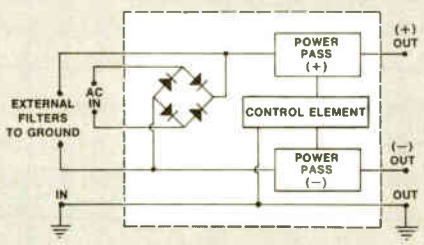

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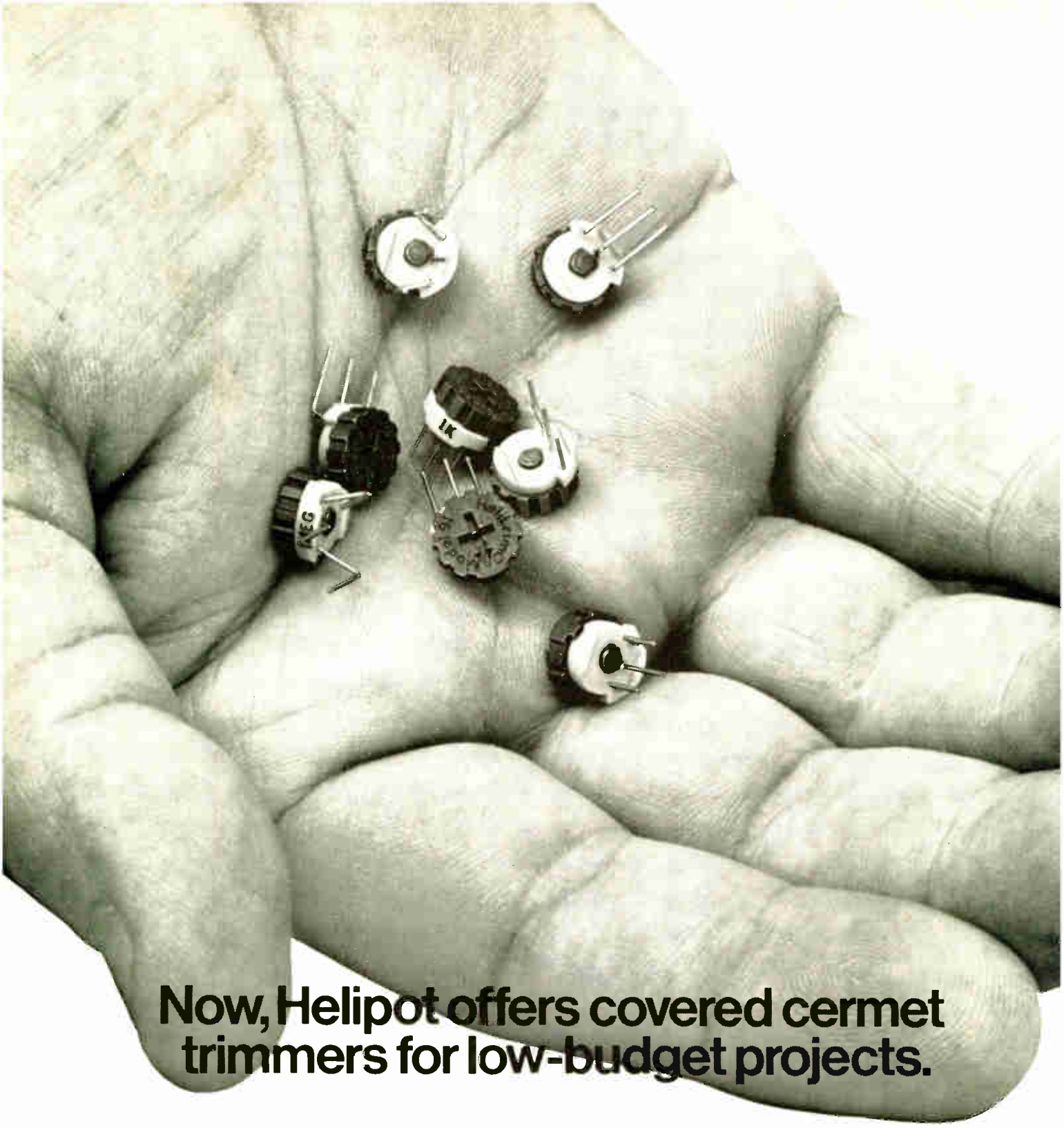

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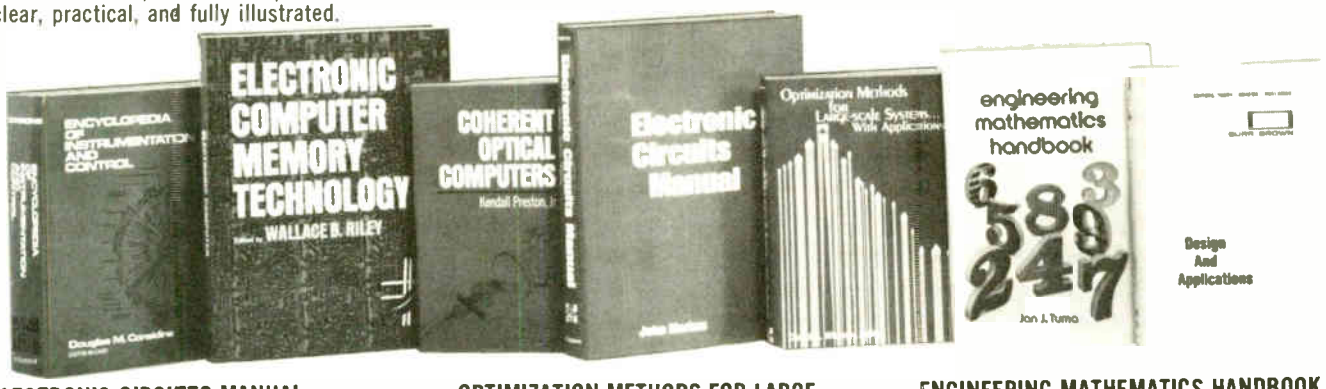

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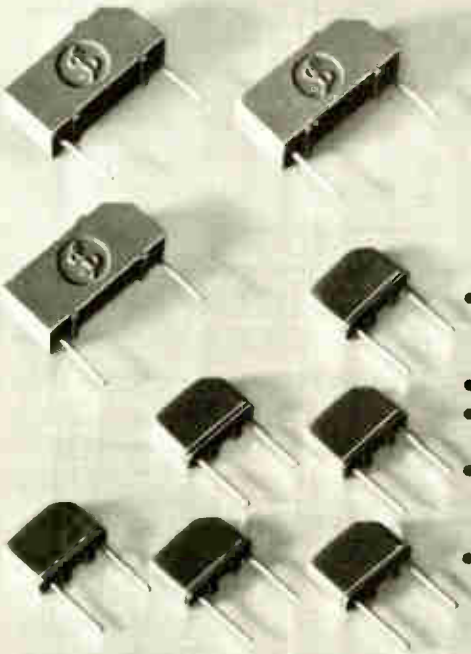

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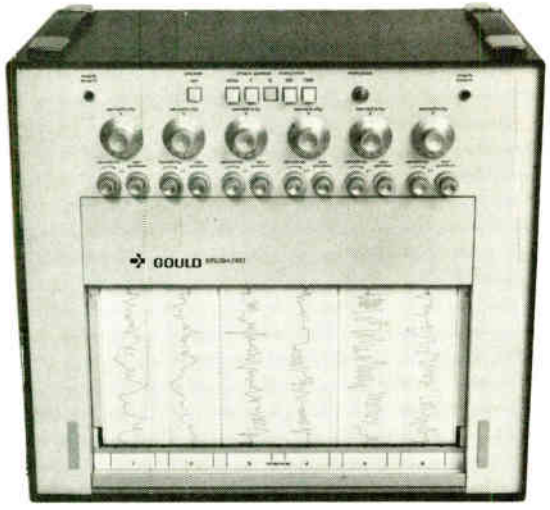

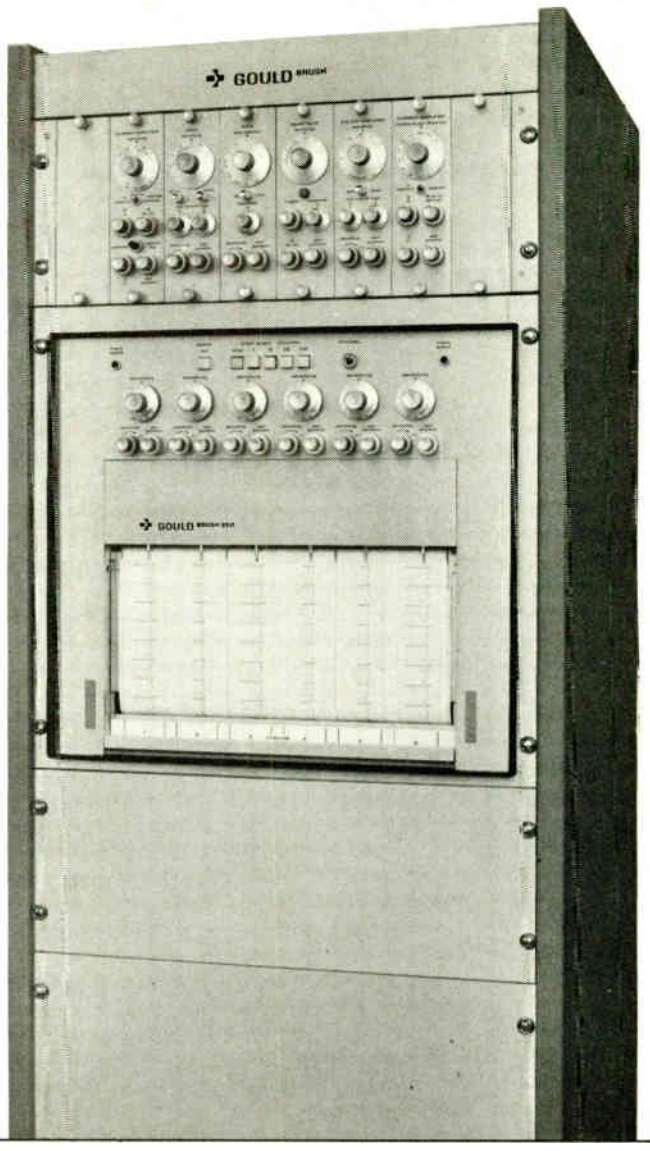

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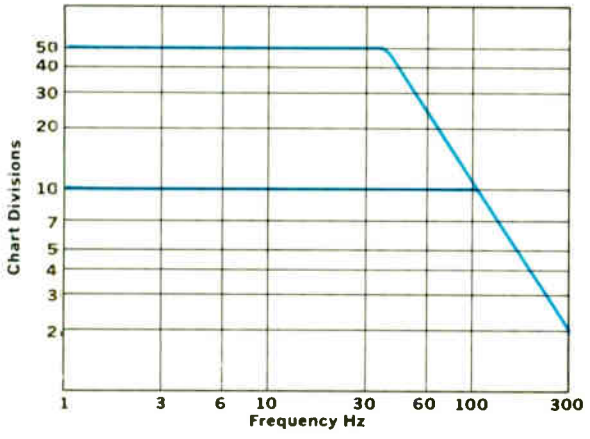

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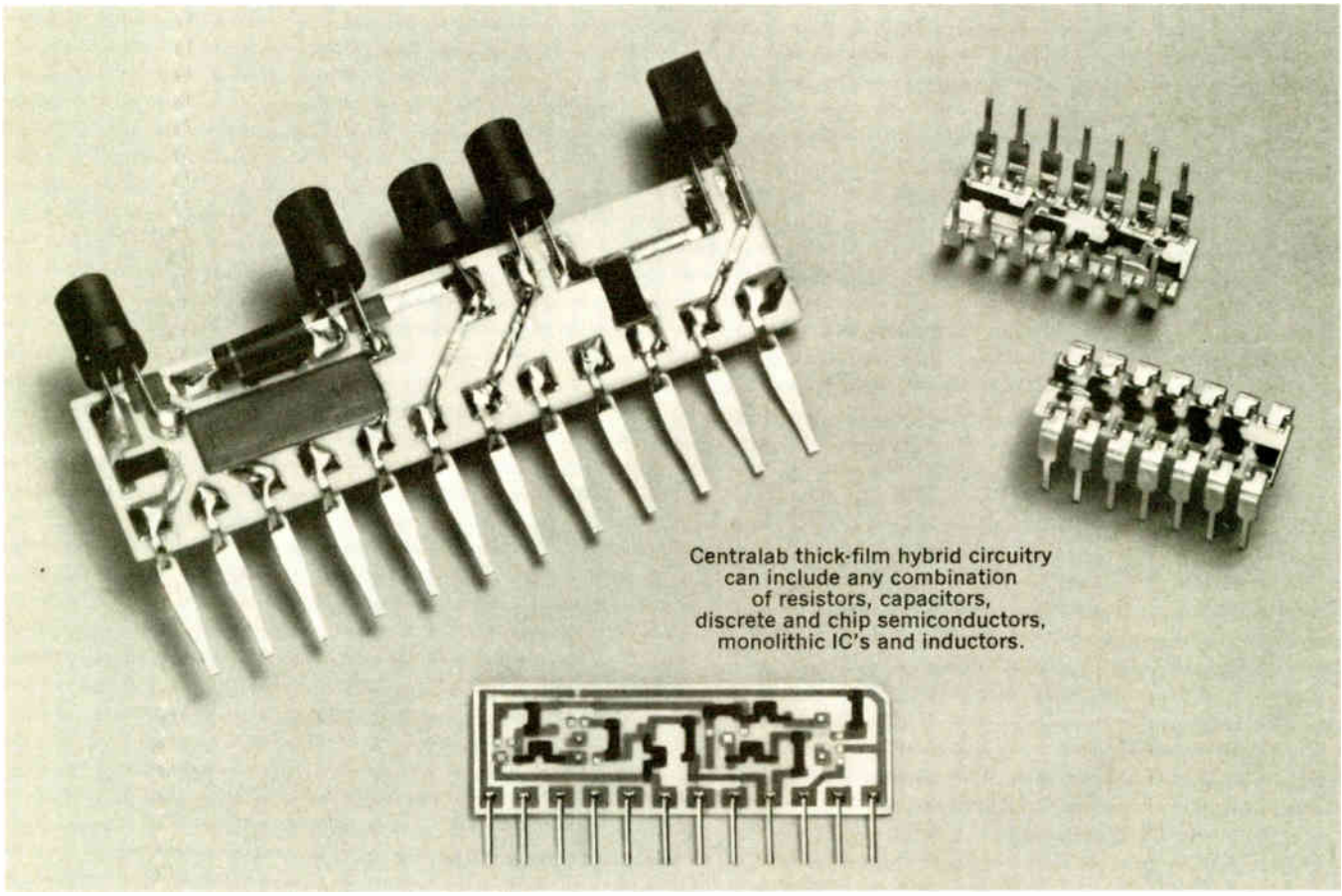

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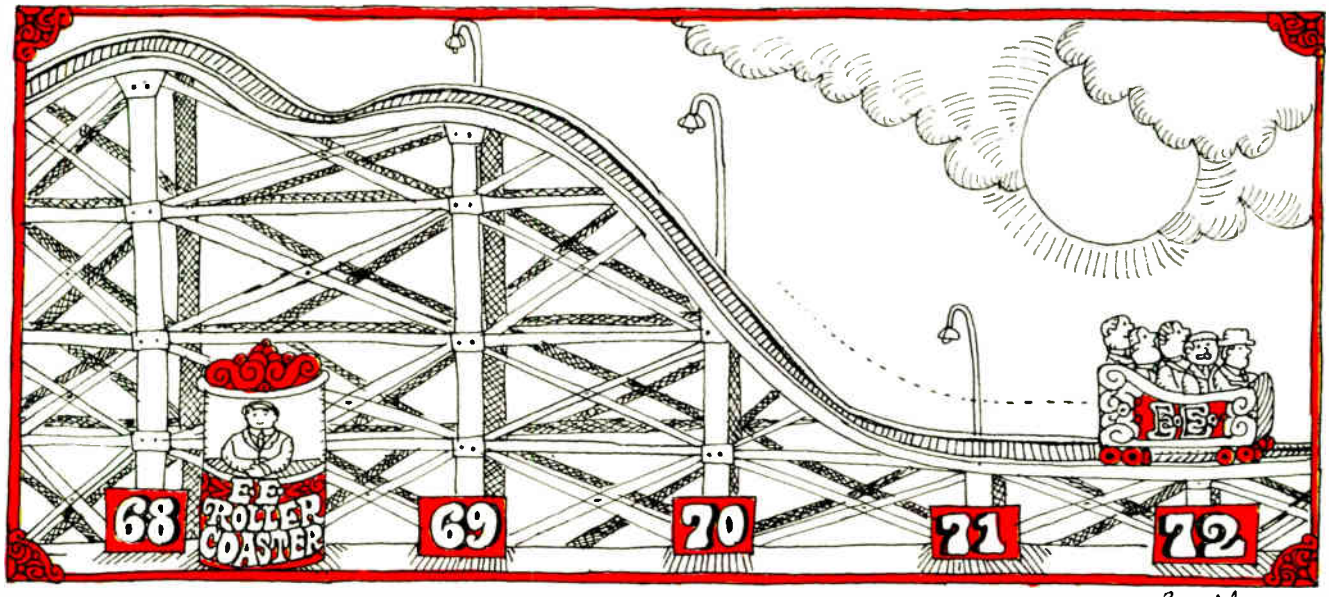

Job roller coaster starts climb

More openings may end downhill plunge; but new graduates land jobs while many unemployed engineers are stalled

by Gerald M. Walker, Consumer electronics editor

Vivid in the memories of many engineers at IEEE show time are the buses hauling loads of eager job hoppers from the exhibit hall to recruiting offices where they would pick among new employers begging for their services. But times have changed, and at showtime 1972 (March 20-23), EEs can expect only a slight improvement in a three-year job drought. In fact, unemployed IEEE members, who will be able to enter the show free, are likely to be looking more carefully for employers than for products, despite a ban on "repeated solicitations" and circulation of resumes.

Now that companies are picking and choosing, the EEs are taking what they can get. The rub for many is that while the recession—led by the aerospace/defense sector of the industry—caused layoffs, the improvement in business expected in this recovery year has not yet triggered a rash of hiring.

The job situation is mixed, partially because many companies are not confident enough about the strength of their recovery and partially because sales improvements do not automatically call for more engineers. Appearances indicate that new graduates will have less trouble finding jobs; that salaries have remained unchanged; and that the greatest demand is for communications, microwave, and power specialists. While aerospace EEs may continue to be out of work, few companies dispute the contention that there will be another shortage of engineers in the second half of this decade, which confounds placement officials and employment agents, not to mention concerned EEs.

From Boston. From the electronics concentration around Boston, for example, Thomas Heffernan, placement manager for the Administrative and Technical division of Dunhill of Boston, Inc., says the job market has been very quiet, except at Raytheon Co., Bedford, Mass. He reports openings there "in radar and over-the-horizon sensor systems, shipboard electronics systems, traffic control, radar displays, ballistic missile guidance systems, aerospace data systems, and military communications."

By comparison, Nelson Gildersleeve, head of Professional Placement Consultants, Waltham, Mass., paints a brighter picture. "In the last three months I've definitely seen more jobs," he states. Microwave equipment and system engineers are in demand, he says. "Overall, communications equipment is the largest area of activity," particularly for engineers with three to five years of experience.

Though mentioned as a company in a hiring mood, Raytheon says only that it is doing the same amount of recruiting this year as last—113 visits to 89 schools. On the West Coast, Edward Shaw, dean of placement and the career planning center at the University of California at Los Angeles, says that the number of job orders "has increased significantly over the past six to eight months"—well over 10% ahead of last year. Yet two aerospace em-

ployers in the area, the Autonetics division of North American Rockwell Corp. and Hughes Aircraft Co., indicate only slight increases for working level designers and little interest in managerial EEs.

At the Consumer Products division of Motorola Inc. in Chicago, which had booming sales during 1971, the engineering department hardly changed, and only a slight increase is expected this year. Robert B. Hansen, manager of consumer products engineering, explains that mass producing products has little effect on EEs; it is the emergence of new technology—such as color TV or the integrated-circuit chassis—that creates jobs.

Further in the vanguard of technology than consumer goods, the Texas Instruments Components group, Dallas, is busier on campus this year, hiring more candidates for master's degrees than for baccalaureate degrees, says group staffing manager James J. McKeen. "As master's programs become more and more sophisticated, the EE gets closer and closer to what we really need. They also seem to be more available," he explains.

TI will be hiring three to four times as many engineering grads this year as they did last year. But McKeen points out that this doesn't reflect a change in basic need, but a realization that the components group must be increased.

Like TI, employment at Fairchild Camera & Instrument Corp., Mountain View, Calif., is higher than in 1970 for EEs, but not booming. Fairchild will hire at least 35 new graduates this year, compared to six last year; will cover 33 schools around the country, compared to only 18 in California and neighboring states during 1971; and raise starting salaries slightly to $890 per month for EEs.

For the MSEE, starting salary will be $1,000 to $1,050 a month. The emphasis in recruiting will be on solid state, and Fairchild leans toward the engineer with a graduate degree. Raises, which come after a year, are 5½% to 6% on the average, but vary depending on merit ratings. As for the experienced engineer, Leo L. Contois, group director industrial relations, estimates that 100 to 125 will be needed this year, compared with 75 hired last year. Contois comments, "This has been a disappointingly slow turnaround, but we expect a moderately steady increase in business and employment."

Other electronics firms across the country report similar hiring intentions—a slight increase for beginning-level engineers and virtually

EE grads do better in job scramble

According to a special survey of 835 employers, including the Federal Government, engineers graduating this year have a better job outlook then either business majors or liberal arts students.

Engineering school placement has also increased over last year, according to the College Placement Council. This situation contrasts with the scare started by engineering placement officials two years ago when they interpreted a decline in the number of on-campus interviews as a decline in the number of jobs.

Although there were 26% fewer job offers for all 1971 graduates, EE graduates were absorbed without difficulty. However, they did not have the luxury of choosing from among several offers as in past years.

The council expects a 10% increase for engineers to 12,250 new jobs. Business administration will climb 9%, but liberal arts majors will find 3% fewer jobs waiting.

For each degree category, the council reported that engineers can expect a 1% increase for bachelors, no change in masters, and a 61% jump for Ph.Ds.

Among the company types represented by the 835 employers, electronics and instruments firms revealed a 34% increase in openings. This contrasts sharply with metals, down 41%, and both utilities and transportation, down 15%.

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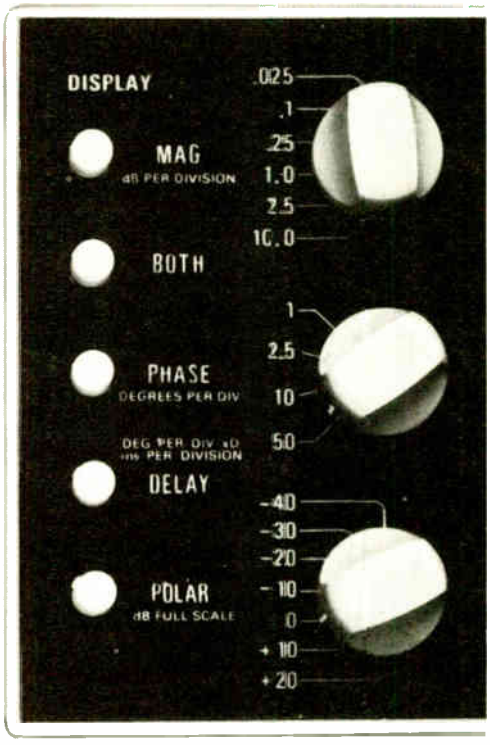

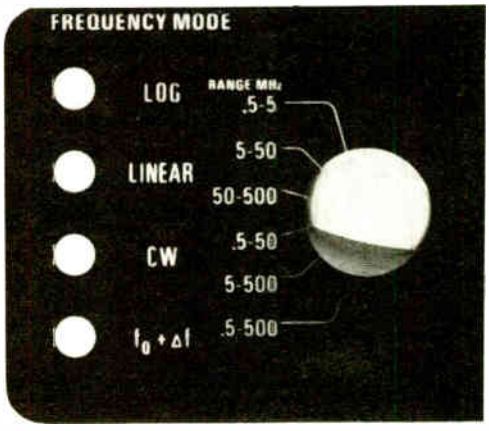

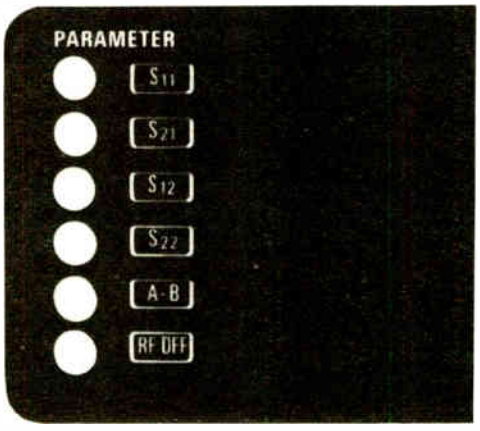

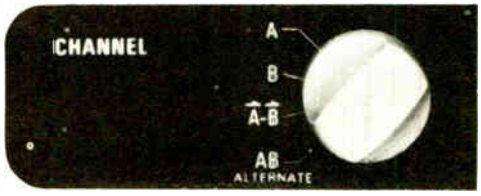

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no interest in managers, coordinators, and the like. This situation bodes ill for many middle-aged engineers unemployed by previous cutbacks. Generally, these EEs have come from supervisory positions and cannot easily return to designing at the bench. As a former department head, aged 50, complains, "Engineering is almost impossible to start over, once you've moved into managerial slots and away from day-to-day designing. We're also finding out that aerospace experience doesn't equip us for any other industry."

Federal failures. The problem of middle-aged unemployment has thus far resisted Federal efforts, such as retraining, partly because the Government's efforts have been largely superficial. At the heart of the matter is the unanswerable question: what can the Department of Labor do for jobless engineers if the Department of Defense, NASA, and other agencies are not generating new employment?

Self-help programs, both Federally and privately supported, have unearthed a startling lack of understanding among the unemployed about how to find a job or even write a resumé. Yet once the job applicants learned the ropes and undertook retraining, they found that few jobs were available through the self-help organizations. The result has been that a significant number of EEs are leaving engineering entirely.

The Engineering Manpower Commission of the Engineers Joint Council last fall reported that of the unemployed pool in 1970, 18% (mostly aerospace and electrical engineers) remained unemployed in 1971, 11.7% went into non-engineering jobs, 4.9% took up management and business administration, and 4% entered computer, mathematics, or science positions. In short, almost 39% of all engineers not practicing in 1970 were still not practicing in 1971.

This trend prompted the Council to issue a rather stern blast at Washington earlier this year. It states, "In the commission's judgment, corrective action in order to be more effec-

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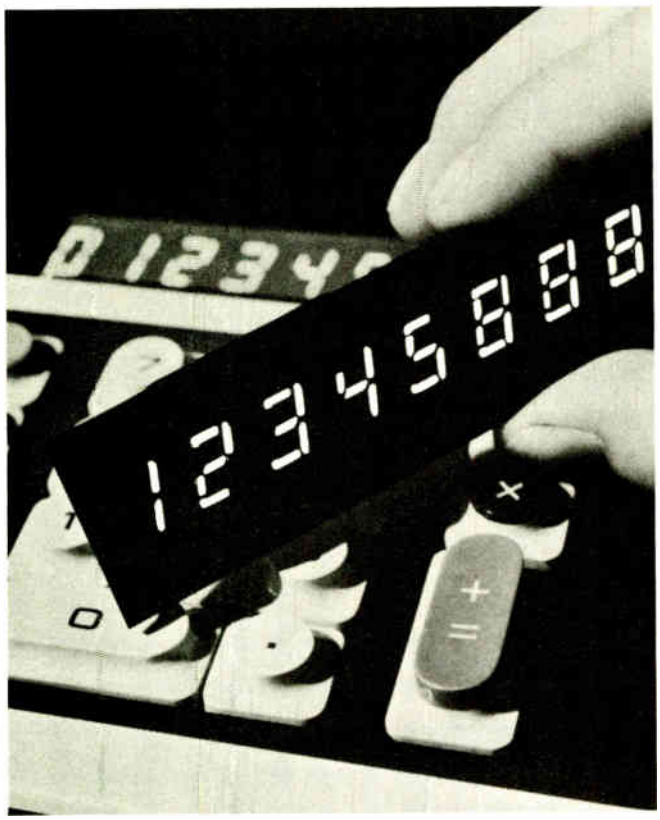

A 7-segment, multi-digit plasma display device employing thick film IC techniques, its unique features make it ideal for electronic calculators and various instrumentation indicators.

Now in production, the LD8026 (shown left) is a 12 digit unit, 0—9 and decimal point per digit. Its dimensions are 149mm x 30mm x 5mm. Future models will include 8, 10 and 16 digits ranging in size from 50mm x 20mm to 500mm x 500mm. In every case, thickness is a startlingly thin 5mm (excluding exhaust pipe).

Regardless of size, all models share the same, practical advantages. *Lower installation cost* through fewer digit connections (only 24 in the 12-digit model). *Easy to read* even under unfavorable ambient light conditions and extreme visual angles. *Thin and compact* for vital space economies and new styling opportunities. *High reliability with long life* . . . over 10,000 hours!

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tive should be directed more toward the creation of job opportunities and the reorientation of personnel within their broad fields of competence and less to retraining personnel in new and differing fields. Retraining engineers for jobs that turn out to be nonexistent is a waste of resources and a source of frustration to the trainee."

Companies scheduled fewer college campus calls for recruiting in order to cut hiring costs, and apparently this year there will also be fewer interviews scheduled at colleges. Reflecting this trend, the number of companies recruiting EEs at the Massachusetts Institute of Technology has been declining for the past few years, says director of placement Robert K. Weatherall. In 1969-70, 198 companies visited the campus, in 1970-71 the number dropped 17% to 164, and thus far this school year, it has dropped another 33% to 110.

Off with the old. Weatherall adds that the type of company interviewing is also changing. "Firms in the old manufacturing areas that used to come have dropped out because the students are less interested in them. They are interested in state-of-the-art technology, and companies in this category draw well." In all, Weatherall says, "the signs are that we have hit bottom, and things are getting better. We have had some new firms sign up, taking the place of those who have cancelled, and we're glad to have them."

Joseph Bruns, director of engineering assistance at the University of Texas, Austin, sums up the placement situation as "confused," but says it looks better than last year. "We have 10% to 15% more companies scheduled than last semester.

At one time, we had about 30% more, but many have cancelled, and many of those were electronics firms," he points out. Companies are more choosy in the recession, says Bruns. "They are looking only at the straight-A students, although many of them don't have the types of jobs that would keep a straight-A student interested." □

Government

Coast Guard to direct harbor traffic

First system in San Francisco will test semiautomated ship monitoring provide basis for other port systems, and spark new electronics market

by William F. Arnold, Aerospace Editor

The U. S. Coast Guard is on its way toward becoming a maritime counterpart of the Federal Aviation Administration. Congress, concerned over the hazards of collision and oil spillage created by huge tankers and freighters navigating the nation's harbors, has initiated legislation to increase the Coast Guard's authority to direct marine traffic. And the Coast Guard has turned to automated radar systems to provide the tools for this control.

That's why the service will begin to install a semiautomated vessel monitoring and control system this summer in San Francisco harbor. The system, which will include radars, computers, and displays, is expected to be the forerunner of greater sophistication in harbor safety.

Ports in other parts of the world also are meeting harbor traffic problems with electronic systems. Tokyo, Osaka, Rotterdam, London, and Hamburg use radar-radio networks, and the latter three are considering computerization of their systems, the Coast Guard says.

The service claims it has the power, by executive order, to control water traffic, and pending legislation in Congress would expand the Guard's authority to "establish, operate and maintain vessel traffic services and systems" [*Electronics*, Jan. 17, p. 43].

Test bed. The 9.4-to-9.5-gHz computer-driven San Francisco harbor radar complex, called the Marine Traffic System (MTS), is intended "to find out what we need in traffic systems," says Lt. Andrew F. Hobson, Coast Guard research & development project officer. "MTS is the test bed for everything the Coast Guard is doing," he adds. Particularly, the service wants to look into requirements for radar surveillance integration (between antennas, computers and scopes), communications, graphics, and displays.

The MTS consists of two shore-based radars—one outside and the other inside the harbor—video processors, three computers and various display consoles. With computer processing, the full system will determine every ship's course and speed, as well as predict possible collisions, Lt. Hobson says. This way, a traffic operator will be able to alert ships by radio that they may collide or run aground. Keeping inbound and outbound traffic in proper lanes will be easier, too, he says.

Key to the full system is the traffic computer, which will give the MTS operator information similar to that which an FAA air traffic controller sees on his displays. Besides potential collisions and congestion, an operator can also request such computer analyses as relative position, closest point-of-approach, and traffic projections.

Each of the two operator stations will have a 17-inch primary cathode-ray tube display produced by Imlac Corp., Waltham, Mass.; four Imlac 14-inch satellite CRTs; and two 10-inch ship status alphanumeric CRTs made by Ann Arbor Displays Inc., in Michigan. The Imlac equipment consists of combined alphanumeric and graphic displays refreshed from a minicomputer with a vector generator.

Each station will also have a keyboard to query and direct the computer and a trackball, used to posi-

The marine traffic system

As the test bed for future harbor traffic systems, MTS is a simply conceived but sophisticated design employing two marine radars, three small computers, and electronic display consoles for ship monitoring.

Each of the two MTS radars sends data to its own radar video pre-processor (RVP), which, with a radar computer, combine to spot ships automatically, follow their progress, and keep track of their location, speed, and course. The RVP separates the ships from clutter for subsequent computer processing. Each Honeywell radar computer, with an 8,192-word memory, not only correlates scan-to-scan information, but performs such tracking functions as range and bearing, track updating, ship length computations, and coast logic, which estimates a ship's progress when it becomes obscured by a bridge or an island.

The third Honeywell DDP-516 computer analyzes the data from the radar units and displays the results to the MTS operators through the terminals. Its automatic alert functions include warning operators of potential collisions, anticipating traffic congestion in critical areas, detecting vessel departures from designated traffic lanes, spotting possible groundings, and showing the drift of buoys or anchored ships from their assigned stations.

The two AIL radars were specifically designed for MTS. Their features include switchable antenna polarizations, 50 nanosecond pulses, and logarithmic i-f amplifiers.

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Price is a big feature too: $1545 for the 150 MHz version, $1795 for the 512 MHz. With Monsanto's 2-year warranty, that's the lowest cost of usership in the counter field. Ask for complete data. United Systems Corp., a subsidiary of Monsanto Co., 918 Woodley Road, Dayton, Ohio 45403.

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Probing the news

tion an electronic symbol over a blip so that the computer can analyze the blip. The two stations will share two backup radar plan position indicators (PPIs) and a radar console with five PPIs—all built by AIL.

The working display, highlighting one of seven coverage areas, will show such symbols as buoys, ship size in one of three categories, traffic lane center lines, and tags on identified ships. Satellite displays will show other coverage areas, and ship status displays will provide the operator with an alphanumeric list of identified ships in the system.

Installation of the $3.2 million system will begin this summer, with a semiautomated system operating by January 1973 and the full system scheduled to come on line in July 1973. Johns Hopkins University's Applied Physics Laboratory is performing the systems integration, including the displays, radar video processor and the automatic tracking, says Lt. Hobson. AIL division of Cutler-Hammer Inc., is building the high-precision radar. The computers are Honeywell DDP-516s.

Problems. In designing the system, APL had to overcome the effect of sea clutter caused by false returns from whitecaps that confuse the radar. Using high-resolution radar with vertical polarization proved "the basic approach to beating clutter," says APL systems engineer Alfred J. Cote. Because ships appear differently, depending how they face a radar antenna, APL has had to devise beam interpolation studies to decipher ship sizes. APL solved this by establishing a profile word that would be a preliminary estimate of the ship's size, he says. Subsequent sweeps of the radar further fix the ship's true tonnage.

The Coast Guard "will develop MTS on a modular basis" says Lt. Hobson. Each harbor is unique, and each system will be tailored to that harbor, he explains. Two areas the Guard is looking at now are the Houston, Texas, ship channel and New York harbor, he says. MTS itself is an outgrowth of a "patchwork" system used in San Francisco for the last two years, he comments. □

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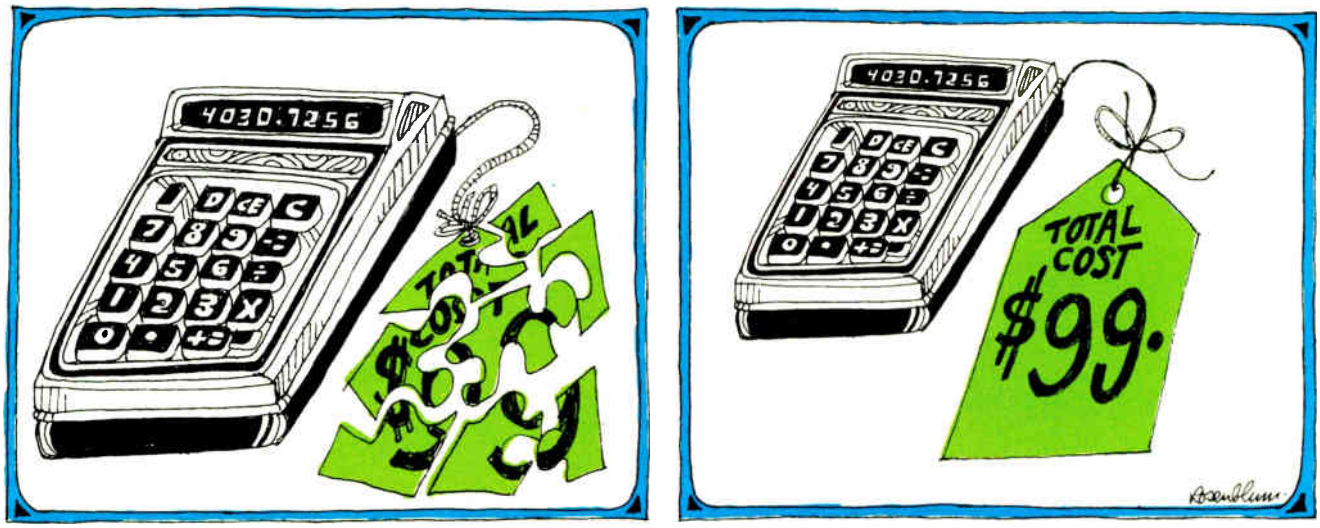

Consumer electronics

New calculator firms favored

Odds for success in under-$100 machines give edge to small companies that adapt latest electronics technology and marketing strategies

by Stephen Wm. Fields, San Francisco bureau manager

The great consumer calculator race is underway, and several agile companies have leaped to the forefront with electronic machines that have already dipped below the $100 consumer price milestone. The pace set by the contenders is so fast that some of the old-line business machine companies—handicapped by organizational inertia and overhead—are finding it difficult to get out of the starting gate. And, as advanced technology cuts components costs further and the market expands, most manufacturers look to see the price of calculators drop to $70 in the not-too-distant future.

Much of the thrust behind cheaper electronic calculators comes from the higher levels of MOS LSI integration and the lower cost of such chips. But better MOS yields and reduction in four-function machines from between four and six chips to one aren't the only factors driving calculator prices down. Keyboard and display costs also are being reduced, although it isn't clear now that any single display technology—gas discharge tubes, light emitting diodes, or liquid crystals— will become dominant.

Larger firms handicapped. It is apparent that more startup companies or smaller firms are finding it easier than the larger business machine companies to move up fast with new technologies. Indeed, the simple $99 calculator seems to be the divider between the upstart low-overhead technology opportunists and established firms in the electromechanical business machine market. Some of the latter will participate in the low-price market only with imported machines.

But as fewer parts are required for calculators, there's less reason to assemble them overseas. The bigger companies counting on imported machines to win them a piece of the consumer market may be deluding themselves as U. S. competition heats up. L. J. Sevin, president of Mostek Corp., the Carrollton, Tex., MOS supplier, thinks the Japanese "will be hard-pressed" to compete in the consumer market, (which he calls the toy market) because there's so little labor in the low-priced machines. He adds that the realignment of the monetary system will also mitigate against the Japanese because of the new import duties they'll have to pay. Sevin says flatly that the consumer calculator "will be a $25 toy in a year or two."

And Charles Kovac, vice president-marketing at North American Rockwell Microelectronics Co. Anaheim, Calif., further underscores the shift away from Japanese dominance of the U. S. market for calculators selling for less than $150. Although the Japanese had a lock on the multichip calculators when they sold for more than $300, Kovac looks for most of the single-chip machines to be made here.

He predicts that 1.5 million calculators will be sold in this country this year, of which 500,000 to 700,000 will be consumer machines. Of the latter total, Kovac believes American companies will sell 300,000 to 400,000. He looks for the Japanese to remain strong in industrial calculators, however. And Kovac goes further: he predicts that some 9 million consumer machines,

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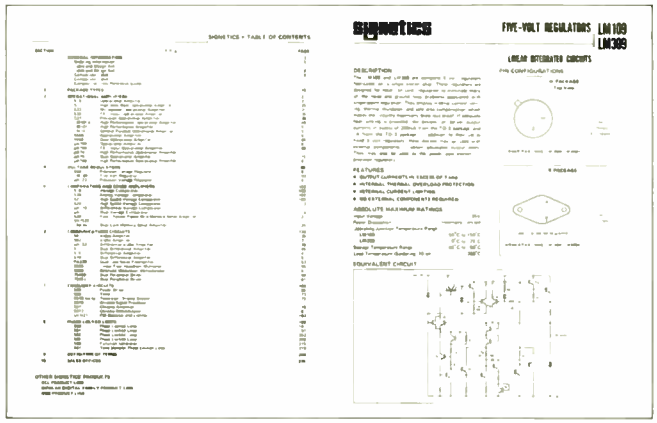

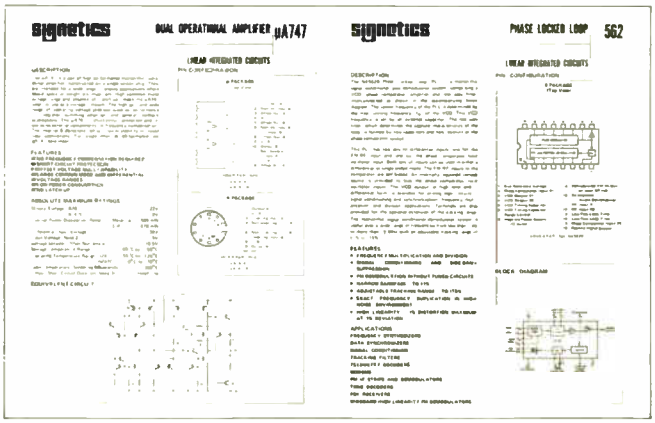

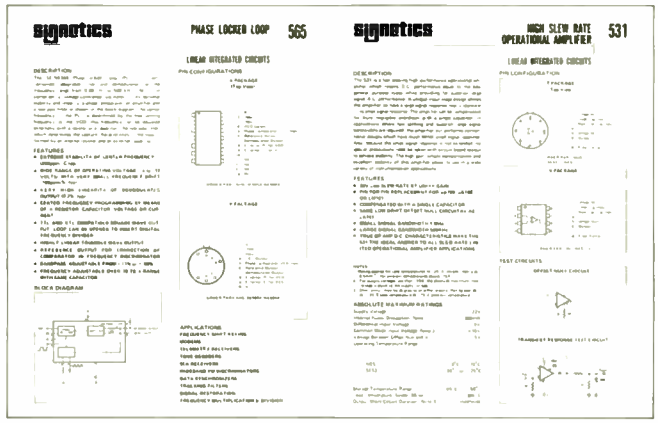

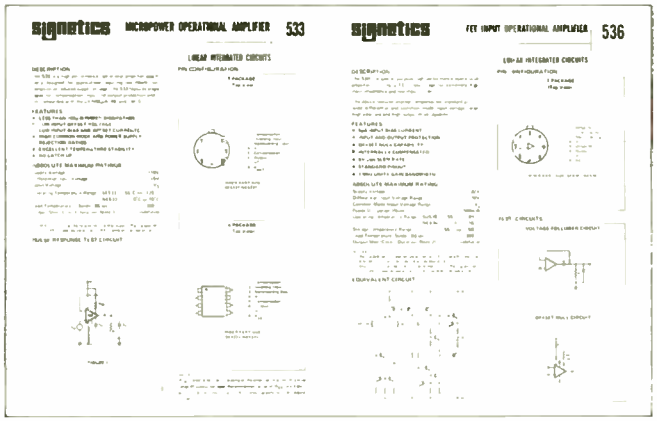

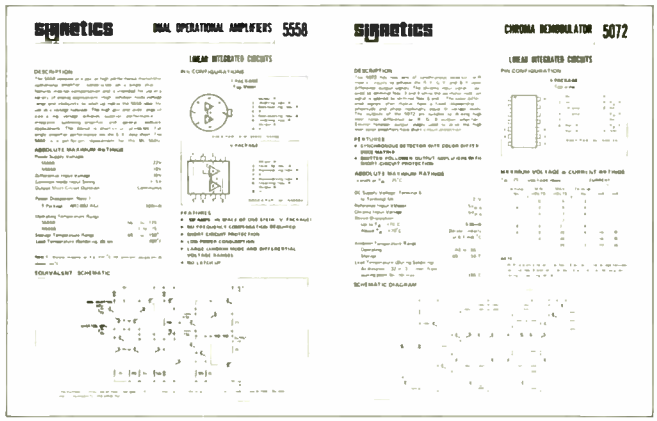

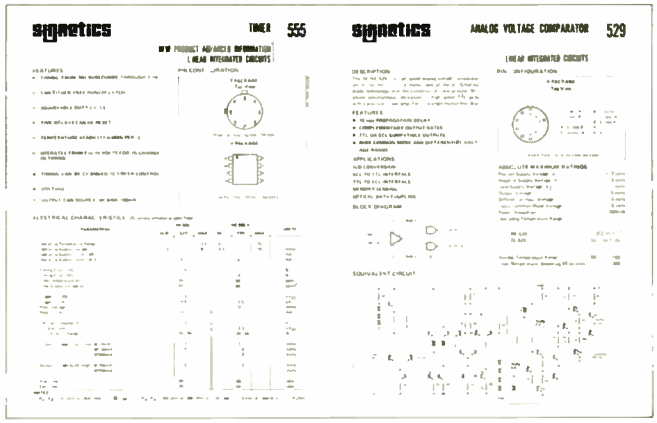

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Probing the news

including simple teaching machines and true calculators selling for about $100, will be sold in this country in the next three years. That's almost a $1 billion market.

The U. S. calculator makers say, however, that they can't build and market machines profitably unless the selling price is about four times the cost of components—assuming that they're selling through business machine dealers or direct salesmen. Going to low-overhead operations and selling directly to retail outlets lowers the price to three times the components cost.

Early last year, MOS chip sets for four-function calculators consisted of three to five arrays that sold for a total of about $40. The other principal part costs broke down this way: keyboard, $20; display, $20; power supply and other electronics, $10; and case, key caps and other external hardware, about $5. This adds up to about $95, dictating a selling price of $395.

Most calculator makers agree that to produce a machine designed to retail for $99, it must have a parts cost of $25. This means that in quantity the single MOS LSI chip must cost about $5; the keyboard, $2; display, about $8; power supply and other electronics, about $5; and case and other hardware, about $5. Labor and overhead boosts the cost to between $36 and $40. Calculator manufacturers say such a machine can be sold to chain stores for $65 and can retail for $99. One East Coast department chain, Alexander's, has gone so far as to buy a machine for $94 (parts cost of $50, which should boost the retail price to $150), and sold it by mail order for $99.

Prices continue downward. That doesn't leave much profit margin, but there are signs that the $25 parts cost goal is reachable, which would boost the profit. The companies talking about a $99 calculator agree that $5 or $6 LSI can be had. Texas Instruments and Mostek, Dallas, General Instrument, Hicksville, N.Y., and Caltex, Santa Clara, Calif., are the only announced suppliers of one-chip calculator circuits. The chips are publicly priced at $12 to $15 in large quantities. But at least five other LSI makers are vying for business, and at least one of these has signed a multi-million dollar contract to deliver one-chip calculator circuits this year at $5 each.

North American Rockwell is building a circuit for Sharp Electronics Corp. in Japan (and is reportedly building a complete machine for Sears); American Microsystems Inc., Santa Clara, Calif., is building a chip for Unicom, an AMI subsidiary; Nortec Electronics Corp., Santa Clara, Calif., is building one for Omron Tateisi Electronics Co., in Japan, a newcomer; Standard Microsystems is building a chip for Commodore; and Caltex is fabricating a chip for Eiko. With this competition, most suppliers will probably be willing to sell four-function-plus-constant and either fixed- or floating-point calculator chips for $5 or $6 in high volume. And TI, now supplying Eldorado Electrodata Corp., Concord, Calif., and Bowmar/Ali, Inc., Acton, Mass., with chips, will probably meet the $5 price.

This leaves the maker of a $99

A calculated market. The Eldorado model 8M is aimed to fill mass consumer needs. It is a four-function machine with a floating decimal point and an eight-digit display.

calculator the task of finding a manufacturer of 10¢-per-switch keys and $1-per-driven-digit displays, or finding the technology to build them in-house. One well publicized example of the latter is Ragen Precision Industries, North Arlington, N.J. Their machine, with its complementary MOS logic and liquid crystal display, has progressed to a model that turns on the display, but doesn't do any calculating.

As of the end of February, Alexander's, had not seen a working model. "If they send them, we'll sell them," says Alexander's vice president, Jerome P. Germain. For its part, Ragen promises to have calculators "on the shelves" by the first week in April.

In the meantime, Germain, shopping around for another pocket calculator, has ordered 20,000 from a Toronto, Ont., company, Rapid Data Systems & Equipment Ltd. Its Rapidman 800, somewhat larger than Ragen's machine, is expected to sell for under $100. Ragen is the only low-priced calculator producer that makes everything except the mercury power cells. However, the company won't reveal what percentage of the total cost each part represents.

Another company that is counting on in-house technology to launch a $99 calculator by this summer is Omron Tateisi. This Japanese company has an American partner called Omron R&D, headed by Bernard Jacobs. Omron R&D has developed a keyboard that Jacobs says will cost about 8 cents per key, which he is counting on to bring keyboard costs down from $10 to $2. And like Ragen, Omron has developed a liquid crystal display for its low-cost machine. While Jacobs won't comment on the display, sources at Omron in Tokyo imply that their cost target is $5 to $8. One of Omron's present machines, being marketed by Unicom and Commodore, is retailing for $138. It's a three-chip machine employing display tubes made by ISE in Japan. But by changing to an in-house liquid crystal display and an in-house keyboard with a single calculator chip, Omron should make its $99

Sperry explodes the LED myth

There has been a lot said in recent months about LED's representing the most significant advance in display technology and how they are destined to dominate the digital display market. We feel it's time to explode the myth and set the record straight. So, here's a direct, point-by-point, comparison of Sperry seven segment gas discharge planar displays* vs LED displays.

COST
For the price of a single ¼" LED digit you can buy three ½" or three ⅓" Sperry display digits*. And in the future, the Sperry displays should continue to be less expensive than LED displays. Gives you something to think about, doesn't it?

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Have you tried to read a ⅛" or even a ¼" LED display at 20'? On the other hand, the Sperry ⅓" display is easy to read at that distance and the ½" mocel can be read at up to 40'. See the difference?

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With LED's, you have the choice of red, red or red. Not so with Sperry. They come in an eye appealing orange — with amber and red available with filters. If you like red, why pay more for a LED?

APPEARANCE
Which do you prefer — looking at individual red dots on LED devices or at continuous unbroken Sperry figures. The choice is yours.

BRIGHTNESS
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For complete technical information on Sperry displays, use this publication's reader service card or phone or write:
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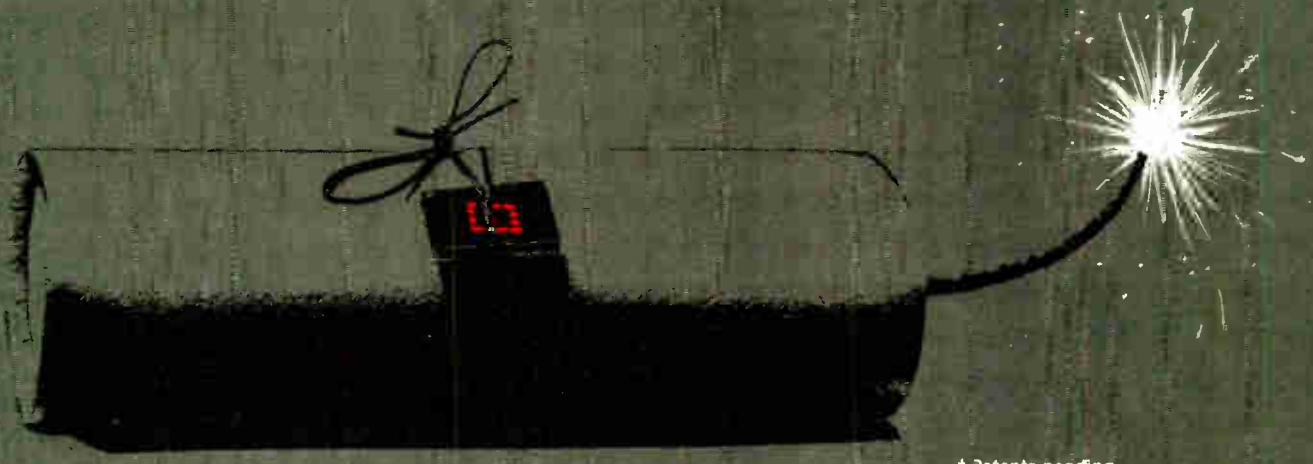


† Patents pending

*based on 1,000 digit quantity, and above. Sperry displays are available in 3 digit, 2 digit, and 1½ (7 segment character and a 1 with + and − digit models in both ⅓" and ½" sizes.

SPERRY RAND

Circle 125 on reader service card

target. As for quality, Jacobs says that, out of a lot of 200,000 machines, the failure rate, including field repairs and cosmetic rejects, has been only 0.3% with the $138 machine.

Elastic keyboard. But there is also hope for companies that want to buy rather than build inexpensive keyboards and displays. For example, Alps Electric Co. of Japan has just announced a low-cost, elastic keyboard that is expected to sell for around 13 cents per key, including key top. The switch has a piece of conducting rubber that makes a connection between two contacts on a printed circuit board when a key is depressed. Another piece of rubber returns the key when pressure is removed.

While other low-cost keyboards are sure to follow the Alps development, the display competition is still up in the air. Most of the publicity has centered around light emitting diodes and liquid crystal displays. But there's still no machine on the market with a liquid crystal display. Ragen's may be the first. The Monroe division of Litton Industries, Orange, N.J., gets around the problem of high cost in its Royal Digital III pocket calculator by providing only a four-digit readout.

The Royal Digital III was intended to retail for $139, but is selling for $99. It employs four General Electric Co. vacuum fluorescent display tubes. Instead of a keyboard, the operator uses a stylus to tap labeled squares—gold contacts in the printed circuit board—to close each circuit. A single chip made by General Instrument provides the logic.

The magic number in displays is about $1 per driven digit—the display plus the driving circuitry. And while LED makers and the liquid crystal proponents fight it out, the gas discharge people are slipping in and taking the business. As one major U.S. calculator maker puts it, "Burroughs says that they will match any realistic display price with their Panaplex" [see p.136] In volume, this calculator maker continues, the display can be bought for $1 per digit (not driven), and Burroughs reportedly has something new in the works that should come out at $1 per driven digit.

Liquid crystal. Liquid crystal advocates say that, since the display can be driven directly from an MOS chip [*Electronics*, Jan. 31, p.66], the cost per driven digit will be the lowest. But LED backers such as Ian S. McCrae, TI's optoelectronics marketing manager, say that, since the material cost is still the most significant cost of the display, "LEDs could be made even more attractive by reducing the character size from 0.1 inch to 0.07 inch and using a 1.2× magnifier." Hewlett-Packard Co., Palo Alto, Calif., did this in its new display [*Electronics*, Jan. 17, p.64]. The H-P digit is 0.08 in. high; a 1.4× magnifier brings it up to 0.112 in. high. H-P says that, although the display is now $2.25 per digit in quantities of 100,000, the price is expected to drop to $1 per digit as "demand reaches the millions of digits." □

SAINT LOGIC

The best thing to come along since sliced bread

The state-of-the-art has not permitted any significant break-through in DVM logic until now. In the present DVMs on the market, certain trade-offs or sacrifices are necessary. For example, accuracy is given up for speed in many cases; speed is given up for accuracy; accuracy and speed have been given up for a lower price; accuracy and speed are given up for noise rejection.

The new Cimron DMM 50 is a five digit digital multimeter and is first in a family of multimeters to be introduced by Cimron this year. The Cimron DMM 50 offers high quality, high accuracy, high noise rejection and high speed at the same time.

In order to provide such a meter Cimron has employed a logic we call "SAINT." We've taken two logics and combined them resulting in one very powerful instrument. We use Successive Approximation (SA) logic for speed and integrating (INT) logic for its inherent noise rejection.

Each reading on the Cimron DMM 50 starts with an "Automatic Set Zero," then we examine the most significant of the five decades. Any part of a digit from zero through eleven is subtracted. This is called our "subtractive digit" operation. The most significant decade can be zero through eleven. Next we integrate the four least significant decades.

The four operations of the "SAINT" technique are (1) automatic zero set; (2) subtractive digit; (3) integrate compare "one"; (4) integrate compare "two." This means the DMM 50 can operate at greater than 20 readings per second with a rejection of 60 dB at 60 Hz. An additional 60 dB of noise rejection may be switch selected.

Multimeter capabilities include: 5 ranges of DC and DC/DC ratio; 4 ranges of AC; 5 ranges of resistance; optical coupled data output and remote programming. Priced from $1200.

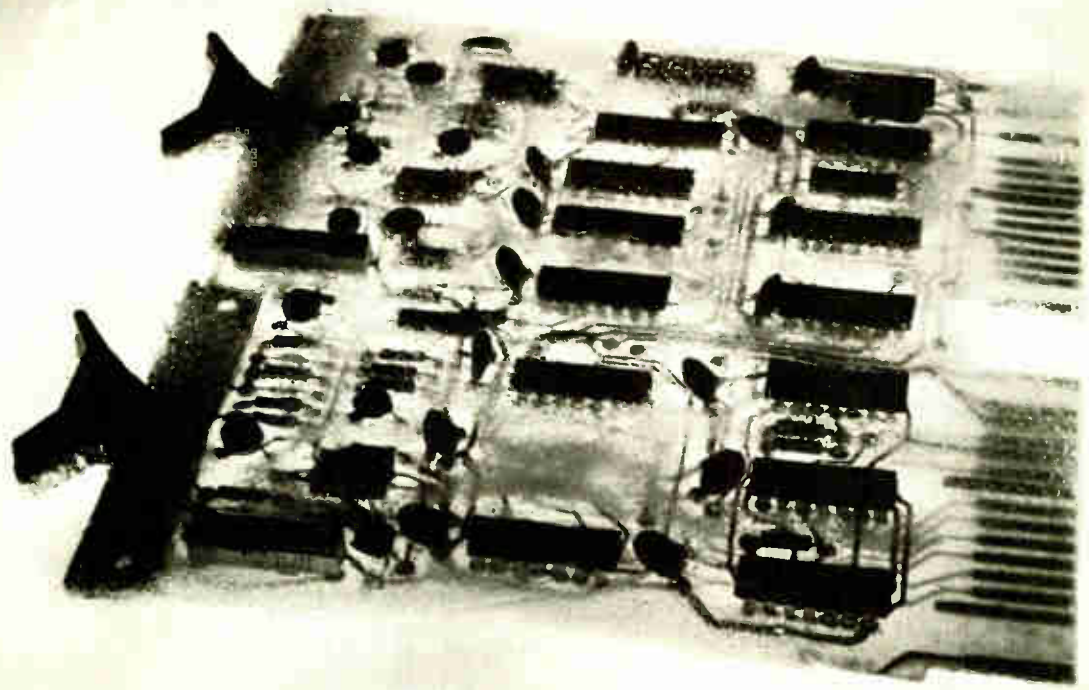
Other Cimron products include AC Power Sources and Line Conditioners; Data Acquisition Systems; Pulse Generators; and a complete line of high performance DVMs.

For detailed specifications and demonstration contact your local Cimron Representative or Chuck Hasley at 714-774-1010, Lear Siegler, Inc., Cimron Instruments. 714 North Brookhurst Street, Anaheim, California 92803.

LEAR SIEGLER, INC. / *CIMRON INSTRUMENTS*

IEEE Booth #2101

Circle 127 on reader service card



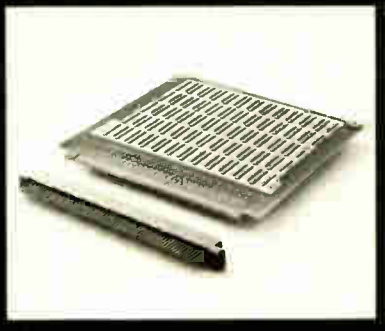
Augat asks: are you freezing your circuits in a block of ice?

Consider the printed circuit board. Cheap. Reliable. Compact. So where's the fuss?

It's simply that soldered PC boards are terribly expensive and time-consuming to change . . . less reliable, and *far* less compact than wire wrapped socket panels. It's enough to start you wondering about your commitment to printed circuit boards.

Augat's dual-in-line wire wrapping panel is leading a revolution in another direction. No wonder. The plug-in flexibility of an Augat panel gives you the chance to make component and wiring changes in minutes. In breadboarding. Prototypes. Production. With Augat you get a big competitive edge because at a time when changes are happening faster than ever, you're not forced to freeze a design.

But flexibility isn't all you get. Our exclusive (tapered-entry) socket gives you integrity unsurpassed by any other interconnecting method, including solder. And our high density pattern arrangement gives you up to three times the density of planar P.C. boards.



All of which are some of the reasons why Augat sales have zoomed to thousands of panels a week. Call us today at (617) 222-2202. Or write. We have a new brochure that gives you the facts on panels versus P.C. boards: *Augat Challenges The P.C. Board.* We'll also send you literature on our complete product line. Augat Inc., 30 Perry Avenue, Attleboro, Massachusetts 02703. Our representation and distribution is international.

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Circle 128 on reader service card

Management

Teledyne Semi profits from change

By reorganizing the product lines to aim at the industrial market, top management has revitalized the company

by Stephen Wm. Fields, San Francisco bureau manager

The new sense of direction felt at Teledyne Semiconductor these days normally goes with a sign in the window proclaiming "under new management." But the triumvirate responsible for the change at the Mountain View, Calif., company has been in place for almost a year.

In that time, Eugene A. Blanchette, president, Robert F. Graham, vice president and director of marketing, and A. Gene Ladomato, vice president operations, looked hard at their existing product lines, decided there were some losers mixed in with the strong families, and reordered priorities at the former Amelco Semiconductor. Blanchette is a veteran of the semiconductor wars at Fairchild and Motorola. Graham came to Teledyne via Intel and ITT Semiconductor. Ladomato is a former Motorolan who came to Teledyne from Fairchild with Blanchette.

Definite goal. The result is a newly integrated product plan: the company is going after the industrial semiconductor market with a line built around its HiNil family of high-noise-immunity logic. HiNil is a DTL-based logic that works with a 12-volt supply. It offers a 3.5-v noise margin, can tolerate a 1-v ripple in the supply, and has a voltage swing of 8 v. To complement it, new products are to be introduced in all lines including silicon gate MOS designed for compatibility with 12-v operation and linear ICs with high noise immunity. The one thing HiNil lacks is speed—but that, says Graham, works in Teledyne's favor in an industrial environment.

"We presently have about 25 Hi-Nil circuits in our catalog, and we will soon add 16 new ones," says Graham. "These include some MSI parts such as up-down counters, multiplexers, and multivibrators."

There will also be a series of Hi-Nil interface circuits. Graham points out that at any interface, whether it is between people and machines or machines and machines, there is something analog to be sensed and something analog to be driven. "And we will have the parts so that our customers can sense, calculate, and drive with Hi-Nil logic."

Teledyne includes the former Amelco product lines, plus those of the former Continental Device Corp. The latter has long been a diode and transistor manufacturer in Hawthorne, Calif. Amelco was

First person. Teledyne's president, Eugene Blanchette, believes the firm's DTL know-how is an invaluable asset.

Probing the news

the chip producer for the hybrid MEMA (microelectronics modular assembly) module for military avionics systems and also had discrete and IC product lines.

Before formulating a five-year plan, Blanchette has been intent on maximizing short-term returns on the best "inherited" product lines, while also pruning marginal product areas.

"We're a good house in diodes," he asserts. Teledyne makes double-plug computer switching diodes, whisker diodes and zeners. "But the computer switching-diode market dried up in the last few years," he notes, "and prices are very low. The whisker diode business is better, as is the zener business." In zeners, he figures his only competitor is Motorola's Semiconductor Products division. Generally, Blanchette characterizes Teledyne Semiconductor's diode line as solid and profitable, and he intends to retain it.

FETs favored. In transistors, Teledyne was in everything from rf power to small signal and switching devices. Blanchette has retained the logic transistor business with duals, quads, and hi-rel parts. And he hasn't tampered with the field effect transistors, either. He calls them "the most successful line in Mountain View." His house cleaning elsewhere, though, has done no harm: "the transistor line is selling more now than five to six months ago on far fewer products," Blanchette notes.

The hybrid facility has remained untouched, being almost all high-priced, high-reliability military work. But among the monolithic products, which include both digital and linear ICs, Blanchette shut off an MOS line he says was in trouble. He plans to get back into the field this summer, however, and expects to go with a silicon-gate, p-channel process, even though he thinks that the future is in ion-implanted n-channel and silicon gate n-channel. "The only way for Teledyne to go is with a proprietary MOS line," he says. It will probably be one that's easily compatible with the company's HiNil voltage supply and input-output levels. □

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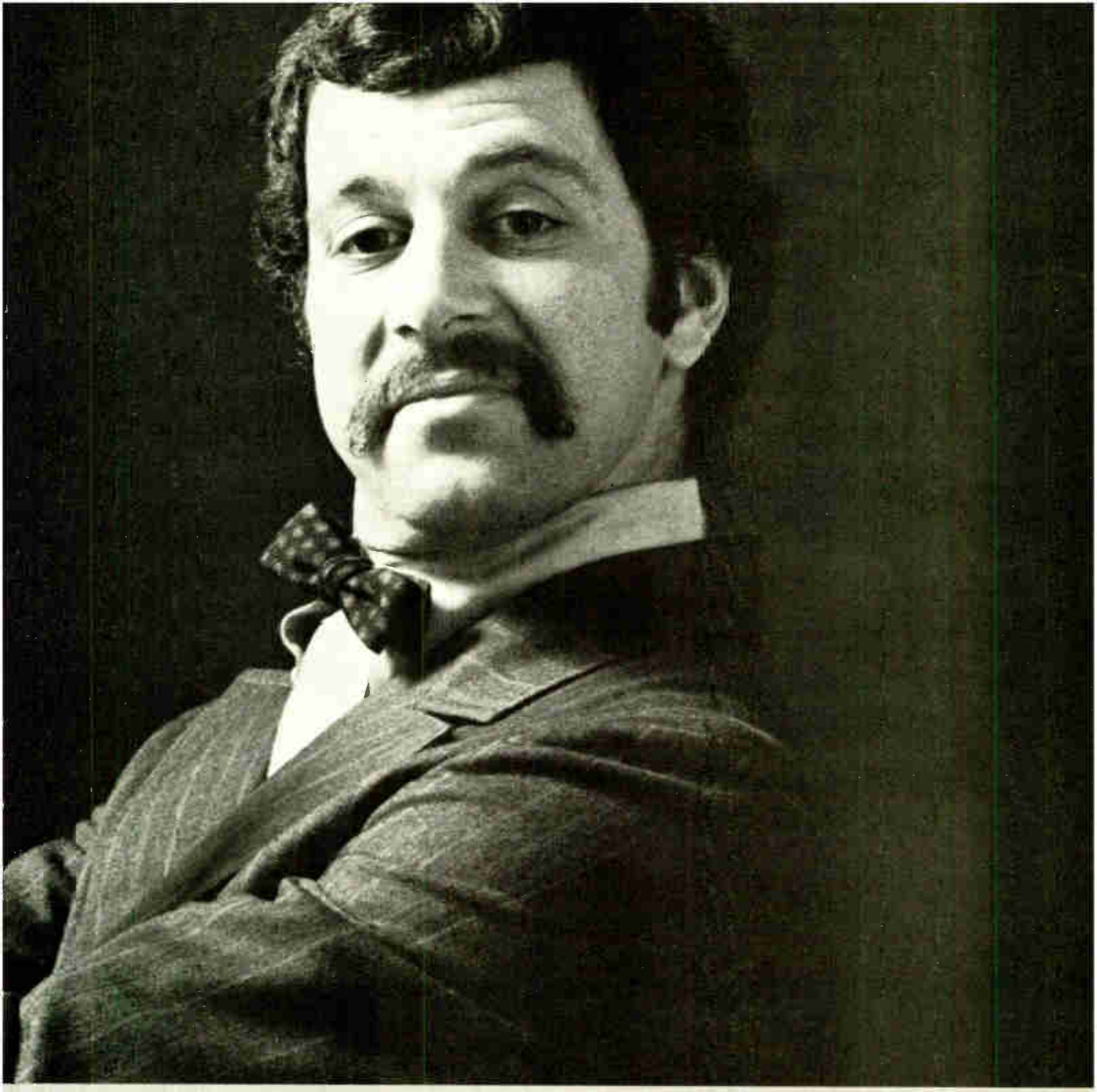

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IEEE '72 showcase: the theme is new industrial markets

Instruments and components have traditionally dominated the product exhibits at the IEEE International Convention and Exposition. They do it again this year—but with a difference. Visitors to the New York Coliseum, March 20-23, will find that many of these products—along with data processing, production and other equipment—are neatly tailored to demands of the industrial and commercial marketplace: they offer low price, adaptability to automatic production and testing, and reliability without gold-plating. Further, the visitor will notice that electronics industries are expanding their horizons to include applications in virtually every non-electronic segment of industry and commerce.

In the pages that follow are some of the more significant products that will be introduced at Intercon '72.

Tantalum capacitors are packaged in plastic

Plastic transistors were a boon in commercial applications: with their inexpensive packaging and adaptability to automatic insertion, they not only lowered the cost of many electronic subassemblies, but broadened the transistor market as a whole.

Now the Sprague Electric Co., North Adams, Mass., has developed a similar packaging scheme for solid electrolyte tantalum capacitors that may offer many of the same advantages, especially in parts cost and manufacturing savings. The new series is the Econoline Tantalex type 198D, and just as plastic transistors are molded in a shape that assures location of base emitter and collector, the Sprague capacitors are molded with a flat side and a notch at the top. This makes polarity unambiguous and speeds visual quality-control inspection on the production line.

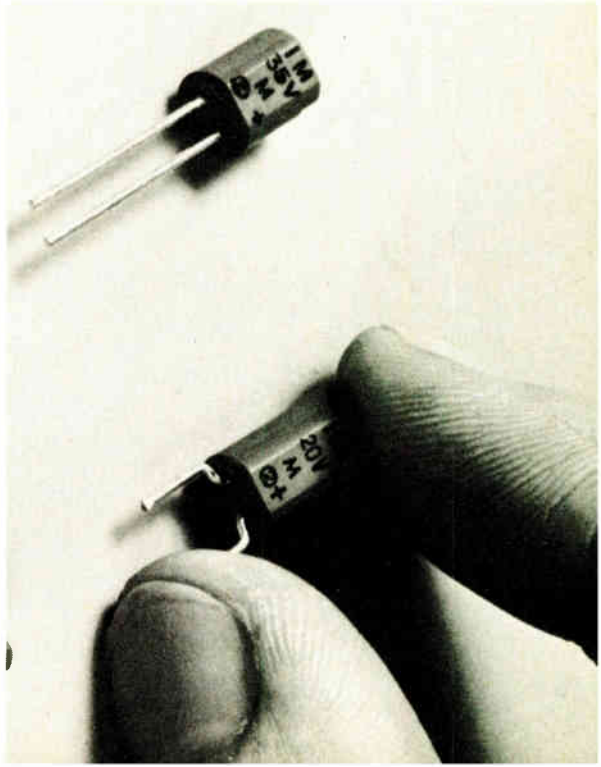
The case also has 0.02-inch standoffs on its underside to prevent moisture, dirt, or other foreign material from collecting during assembly; but most importantly, the standoffs permit complete defluxing after assembly. Rosin flux especially collects moisture during assembly procedures, often causing almost untraceable short circuits in the equipment.

The new package shape is designed to do more than compete with the dual in-line packages now available.

Its very packaging material, a flame-retardant epoxy, is said to have no discernible temperature coefficient over a temperature range of -55° to +85°C. Spokesmen say, though Sprague doesn't advertise it, that the package could meet environmental requirements of military specifications.

And because both leads emerge from the same end, unlike simple axial capacitors, there is less self-inductance in tightly packed circuit-board installations—normally, axial capacitors are mounted perpendicular to the board with one lead bent and led 180° to a board contact point beside its brother, adding an often pesky inductive reactance to the desired capacitive reactance designed into the device itself.

Two case sizes are available, one with straight leads 0.1 in. apart, the other with crimped leads spaced 0.2 or 0.25 in. apart. High-quality tantalum pellets and solid electrolyte are used to assemble capacitors with working voltages from 4 to 50 volts dc and capacitance ratings of 0.1



microfarad to 100μF; tolerances are ±10% or 20%.

The type 198D capacitors are now being delivered in sample quantities, and they soon will be available from stock. Price varies with quantity ordered. IEEE booth 3500.

The Sprague Electric Co., North Adams, Mass. 01247 [341]

200-MHz generator also shapes pulses

One trouble with high-speed logic circuits is that they're difficult to test. Hewlett-Packard's Model 8008A pulse generator should make that job a little easier since its repetition rate is variable all the way from 10 Hz to 200 MHz.

The pulser has two complementary outputs, each of which can supply up to 4 volts into 50 ohms. In its normal mode of operation, the pulser is triggered by its internal rate generator at any rate from 10 Hz to 200 MHz. Front-panel controls allow the operator to vary the delay between the trigger and the outputs from 25 nanoseconds to 0.5 millisecond. Similarly, the pulse width can be varied from 2.5 ns to 0.5 ms. The pulse's rise and fall times are fixed at less than 1 ns.

In addition to its normal mode, the instrument can operate from an external trigger, in a gated mode (produces pulses as long as an externally applied gate signal is present), and as a pulse shaper (where it controls the pulse output, polarity and transition time, but the external source controls the timing and the pulse width).

The generator also has a double-pulse mode in which each trigger signal generates two pulses; the interval between pulses is controlled by the instrument's delay control. In this mode, the maximum triggering rate is 100 MHz.

Each output of the 8008A has its own amplitude and offset controls, with the offset of each output variable from −2.5 V to +2.5 V.

H-P will also introduce, at IEEE Island 2400, a digital gain-phase meter, an 18-GHz automatic counter, and four new oscilloscopes.

Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304 [342]

Gas-discharge display nears dollar-a-digit mark

A gas-discharge display for handheld calculators that offers large characters in a small, inexpensive package should give light-emitting-diode displays a run for their money. At least that's what Burroughs Corp. hopes to do with the latest addition to its Panaplex II line, an eight-digit model with each digit measuring 0.2 inch—twice the size of the most popular LED display, says Burroughs' Electronic Components division.

These latest models in the Panaplex II line, which includes panels with 0.25-, 0.4-, and 0.7-in. digits, comes close to the magic dollar-a-digit figure—Burroughs quotes a price of $1.10 per digit in quantities of 50,000 eight-digit monolithic displays.

This eight-digit panel, furthermore, measures 2.65 in. long, 0.69 in. high, and is only 0.197 in. thick—not including the tubulation projecting from the rear, a relic of the process of evacuating the individual digit tubes and filling them with neon gas. Connectors for energizing the segments of each digit are along the bottom edge of the display.

The panel is also quite economical in its power dissipation. It requires only 0.35 to 3.0 milliwatts per segment, depending on the brightness needed, and typically will use less than 1 mW per segment. This corresponds to a maximum of 7 mW per digit or 56 mW for the entire panel, when everything is lighted; but on the average, perhaps no more than five digits of five segments each are on, reducing the average dissipation to 5 mW per digit or 25 mW for the panel. At this rate,

four standard carbon-zinc batteries, AA size, would last about 200 hours.

In one test, Burroughs engineers purchased a small calculator and replaced its LED display with the new Panaplex unit. This reduced the calculator's total power requirements for display and computation from 800 mW to 350 mW.

In most hand-held calculators made with metal-oxide-semiconductor circuits, no interface drivers are necessary. Even though the Panaplex II panels are 170-volt gas-discharge devices, their anodes can be driven with voltage swings and current that conventional MOS circuits can provide—sometimes even through passive components instead of transistors.

Panaplex technology is basically the same as that of the old familiar Nixie cold-cathode tubes, differing primarily in their low-cost mode of construction. Their life is expected to be as good—some Nixie tubes are known to have operated continuously for over 120,000 hours, or 14 years. They contain no wire bonds—the interconnections that are most likely to fail first in some LED designs.

Like Nixies, the Panaplex panels emit an orange-red light, which is spread over a relatively broad part of the visible spectrum and is centered near the middle of the perception range of the human eye. Therefore, the panels can be viewed continuously for long periods without discomfort, and are not difficult for color-blind persons to read, as are some bright-red LED displays, which cover a narrow spectral range.

Production quantities of the new 0.2-inch-digit panels will be available in June. IEEE booth 2711.

Burroughs Corp., Electronic Components Division, Mt. Bethel Road, Plainfield, N.J. 07061 [343]

C/MOS cuts data system's size, power drain

As more industrial operations lend themselves to computer control, the so-called data-acquisition systems market is growing. The latest entry comes from Datel Systems Inc. Called the N-series of data-acquisition systems, it's aimed at applications where space, power requirements, and cost must be minimized.

While the N-series' small size is due in great part to careful packing of modular subassemblies on and between its two dual-sided printed circuit boards, credit also is due the use of complementary MOS and other integrated circuits. The C/MOS is said by Datel's Ronald P. Petrelli, an applications engineer, to be especially important in low-power applications, such as remote monitoring of operations like drilling or pipeline equipment. The C/MOS makes it possible to power the data-acquisition system with a dc-to-dc converter and a battery.

Datel spokesman say that the N-series systems are, among the smallest of their type. "Most of them are built for rack mounting, and thus generally are about 19 inches wide; the N-series is contained on only two glass epoxy printed circuit boards about 6 by 6 inches. The whole 28-cubic-in. assembly plugs directly into dual pc board edge connectors," says Petrelli.

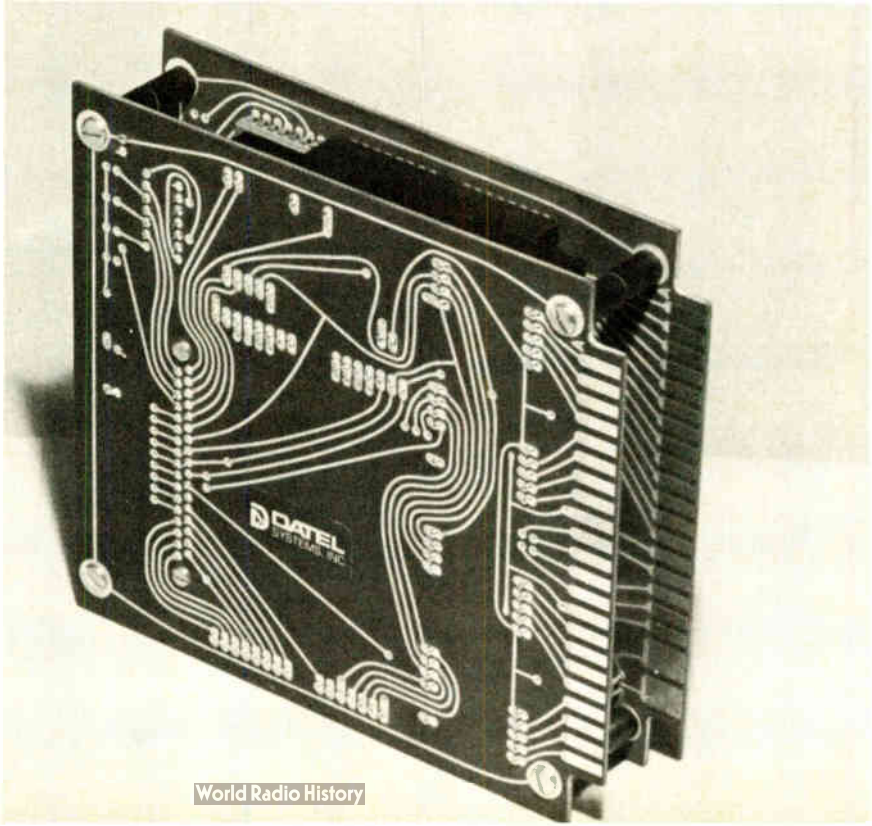
Into that 28 cubic in., Datel has managed to cram an 8- or 16-channel multiplexer, sample-and-hold electronics, a 12-bit analog-to-digital converter, and—for control and interface logic—a system sequencer. Petrelli notes that most of these elements are in module form, so that they can be removed and replaced for on-site maintenance. He thus expects the N-series to move well in markets where low down-time is important.

The devices take inputs in any one of four voltage ranges: 0 to +5 volts, 0 to +10, ±5, and ±10. Output coding is either three-digit BCD, or 8-, 10-, or 12-bit binary words; throughput is a function of word length with the highest rate achievable with the shortest words—100 kilobits per second at 8 bits; a 16-bit module has a potential throughput of 50 kb/s.

Since the N-series is expected to find its way into some fairly primitive applications, the needed control signals may not be as sharply defined in rise time and amplitude as those a minicomputer would yield. Thus, Datel has designed a "front end" to regenerate control signals, even though they may come from a pushbutton, an approach that should simplify system interfacing.

Petrelli claims that here is no competitor to the N-series in size versus price. An eight-channel, 12-bit version is priced at $595.

Other features of the N-series in-



clude random or sequential access of channels by user command, an input impedance of 100 megohms, a ±30 ppm/°C temperature coefficient that is maintained over its operating range of 0 to 70°C, and TTL-compatible control inputs and outputs. IEEE booth 2108

Datel Systems, Inc., 1020 Turnpike St., Canton, Mass. 02021 [344]

Ratiometer measures to 1 ppm

It is time-consuming to test a line of digital-to-analog converters by using a manual bridge, but there hasn't been an alternative because digital multimeters weren't accurate enough.

Now Julie Research Laboratories has developed a digital ratiometer, the DM-1000, with accuracy and linearity errors that are less than 0.0001% (1 ppm) of full scale. And it's a completely automatic (self-balancing) unit that requires only 1.5 seconds to make a measurement at its rated accuracy. The instrument's display consists of seven digits: six significant digits plus a seventh for 20% over-ranging.

The key to the instrument's long-term accuracy and stability is use of high-quality electromechanical switches and stable wire-wound resistors in its automated divider. A high-performance unbalance detector and the necessary logic control circuitry complete the ratiometer.

The price of the basic ratiometer is $5,995. However, by itself it cannot measure voltage or resistance. Thus a reference voltage source is needed to convert the unit into a digital voltmeter and a resistance add-on is needed to convert it into an ohmmeter. A two-range (0 to 1.2 V and 0 to 12.0 V) voltmeter add-on is available for $490, and a combination of the voltmeter and a 1.0-milliohm to 1.2-megohm resistance-measuring add-on costs $990. Current, of course, can be measured by measuring the voltage drop across a precision resistor. Thus, a complete digital multimeter costs about $7,000.

A valuable feature of the DM-1000 is its ability to be self-calibrated without the need for expensive auxiliary equipment. A few simple checks are all that is needed to permit the user to calibrate the unit against NBS-certified standards.

The ratiometer is available in both bench and panel-mounting styles, and weighs 40 pounds. Its dimensions are approximately 19 by 10½ by 8⅜ inches. Delivery time is 30 days.

Julie Research Laboratories, Inc., 211 West 61st St., New York, N. Y. 10023 [345]

Analyzer is programable

A fully programable waveform analyzer developed by Automated Measurements Corp., a subsidiary of E-H Research Laboratories, is a high-speed, 1-gigahertz-bandwidth instrument capable of making digital time and amplitude measurements on pulse, rf, or complex waveforms. Designated the AMC system 1010, it is designed for applications in automatic test systems.

In time measurements, the 1010 is accurate to within 1% over full-scale ranges from 2 nanoseconds to 1 second. In voltage measurements, it is accurate to within 2% of full scale, with ranges from 20 millivolts to 2 volts.

System 1010 offers programing capability from a variety of data

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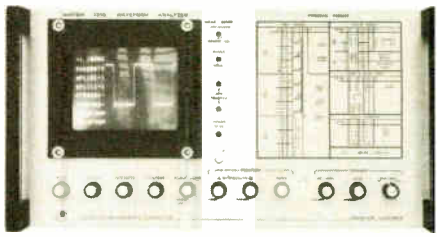


provisions for multiplexed probes to give 100-channel capability. IEEE booth 2732.

E-H Research Laboratories Inc., 163 Adeline St., Oakland, Calif. [346]

5-digit meter

First in a new line of digital multimeters from Lear Siegler's Cimron Instruments, the 5-digit DMM 50 uses a combination of analog-to digital conversion techniques to provide sampling rates as high as 20 times per second, even in the presence of noise.

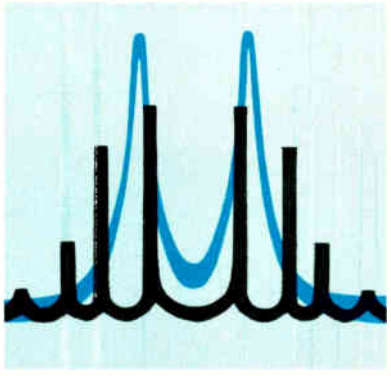
Successive approximation is used for the most significant decade (including overrange, 0 to 11), with dual-slope integration providing the other four digits. Charles N. Hasley, product manager, says this approach was taken to avoid heavy filtering or integration of all digits, with slower speeds resulting. Cimron's approach gives 60-dB common mode noise rejection at 20 readings per second.

Maximum dc voltage reading and input is 1199.9 V; on ac, the limit is 750 V. Maximum resistance is 1199.9 kilohms. Accuracy is to within 0.001% of full scale plus 0.005% of reading for 30 days minimum.

The instrument uses light-emitting diodes as annunciators to indicate function ranges, and Sperry gas-discharge readouts. Prices start at $1,200. IEEE booth 2101

Lear Siegler Inc., Cimron Instruments, 714 Brookhurst St., Anaheim, Calif. 92803 [347]

Near and far-sighted Spectrum Analyzer.

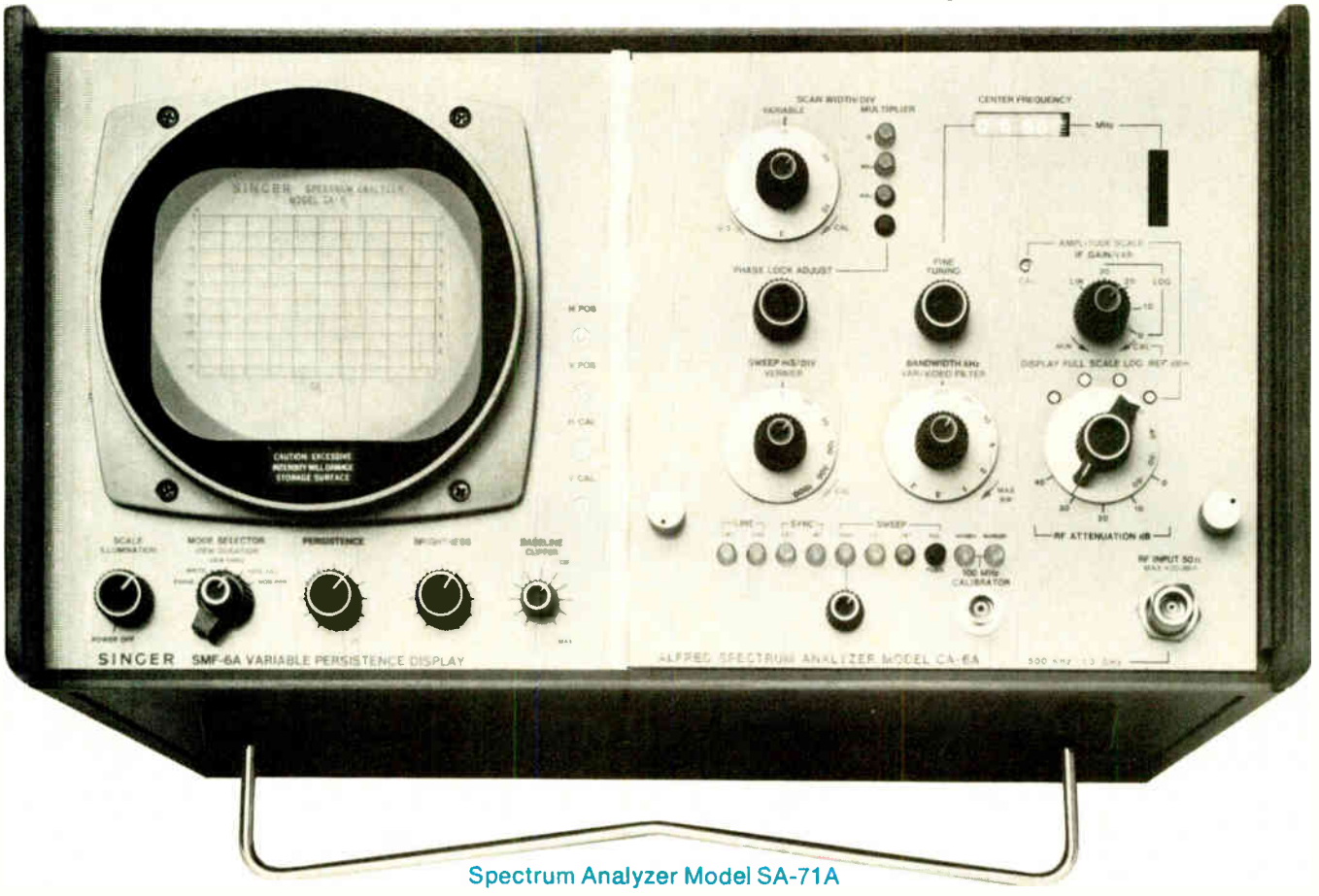


Whether you need a bay-window scan or a microscopic display of two very closely spaced signals, the SA-70 series provides near-perfect vision between 500 kHz and 1300 MHz. And it does it over a 141 dB range with signal levels down to −121 dBm!

This instrument offers a unique combination of performance, ease of operation, and low cost:

- Phase lock for stable displays; indicator light for unambiguous amplitude measurement; 300 Hz resolution for close-in side-by-side signal analysis.
- Internal markers every 100 MHz for precise frequency determination.
- Additional plug-ins for frequency coverage over 20 Hz to 27.5 MHz range.
- Priced to make others seem expensive.

If you need variable persistence and display storage, ask for the SA-71A, otherwise, select the SA-70A. Both are described in our data bulletin. Send for one. It's the far-sighted thing to do.



Spectrum Analyzer Model SA-71A

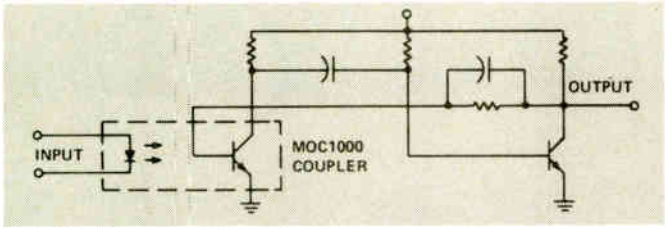
SINGER
INSTRUMENTATION

The Singer Company, Palo Alto Operation • 3176 Porter Drive, Palo Alto, Calif. 94304 • Telephone (415) 493-3231

Isolate It Optically

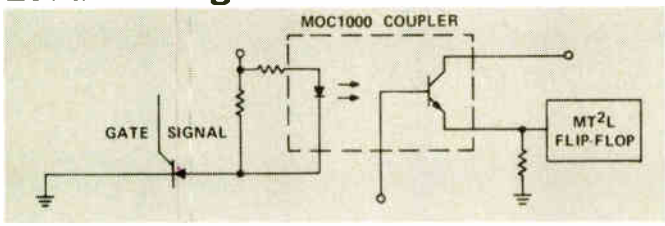
...solid-state lights on using the ideal switch — optoelectronic couplers

Pulse Stretcher



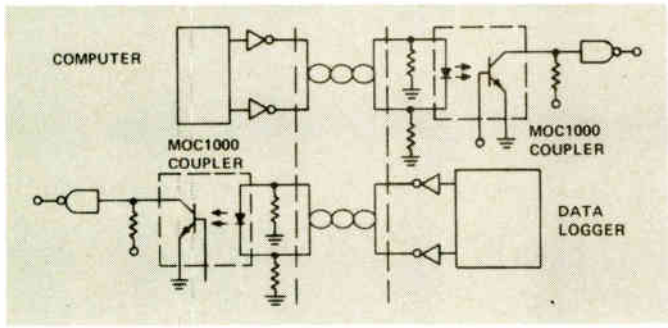
Very short input pulses can be adjusted to any desired pulse width in this circuit with the output completely independent of the input.

Load-To-Logic Translation



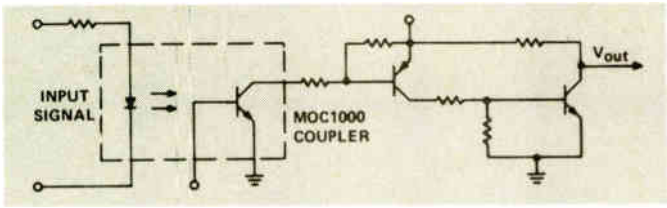
Monitoring an SCR-controlled load with an optical coupler provides a count of load operations each time the flip-flop is toggled through load activation.

Computer/Peripheral Interconnect



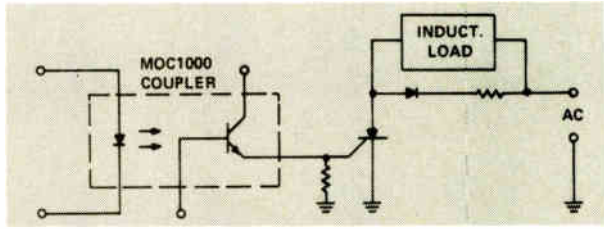
Couplers detect differential signals from twisted-pair lines and translate to single-ended output which provides complete ground-loop isolation.

Power Amplifier



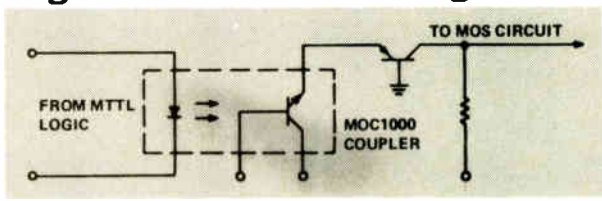
Couplers amplify low-level logic to drive large loads and accomplish interfacing between logic power supplies and load power supplies.

Logic-To-Load Translation



When the T²L gate input goes high, the SCR is activated and logic-to-load translation is achieved through optical coupling.

Logic-To-MOS Interfacing



Easy interfacing between various logic forms (in this case T²L-to-MOS circuitry) can be achieved through optical coupling without regard to differences in logic swings.

Lights on: switch on. Lights off: switch off. Quickly. Simply. Reliably.

Optoelectronic couplers give you nearly perfect input/output isolation . . . 100 billion ohms. They afford 1,500 V minimum dielectric isolation. They provide 300 kHz typical frequency response and 60% typical transfer ratios. They furnish complex signal transmission without RFI at microsecond speeds. They offer low coupling capacitance: 1.3 pF typical.

They don't wear out, they don't use much power and they're immune to bouncing, arcing, shock and vibration. They're light, compact and have closed construction. They're IC-compatible and cost as little as $3.35, 100-999.

They're obvious replacements for mechanical relays.

Use them in interface and coupling systems, phase and feedback controls, amplifiers and general purpose switching.

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See your Motorola distributor or factory representative for prototype or production needs.

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MOC1000 — the optoelectronic coupler

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Semiconductors

8-bit parallel processor offered on a single chip

by Stephen Wm. Fields, San Francisco bureau manager

P-channel silicon-gate CPU for intelligent terminals is designed around data bus and housed in 18-pin DIP

The concept of replacing many small-scale and medium-scale integration devices with one or two large-scale chips has been proven with the electronic calculator. Now, Intel Corp. is trying to prove it with the new 8008, a complete central processing unit for use in any arithmetic, control, or decision-making system, such as a smart terminal.

The p-channel silicon-gate metal-oxide semiconductor chip, which measures 125 by 170 mils and is mounted in an 18-pin dual in-line package, can be interfaced with up to 16,384 bits of semiconductor memory of any type or speed, including read-only memories, random-access memories, and shift registers. All inputs, including the clocks, are transistor-transistor-logic-compatible, and all outputs are low-power TTL-compatible.

Internally, the 8008 is organized around an 8-bit data bus. All communications within the CPU and with external components go through this bus in the form of 8-bit bytes of address, instruction, or data. The processor determines when the bus sends or receives data.

Hal Feeney, customer applications engineer and one of the designers of the 8008, says that a complete system employing the 8008 would contain the CPU, memory, and interface circuits to allow the CPU (which talks in 8 parallel bits) to communicate with the memory, which could be serial or parallel. A typical machine cycle consists of five states—two in which an address is sent to memory, one for the instruction or data fetch, and two for execution of the instruction.

This CPU contains six 8-bit data registers, an 8-bit accumulator, two 8-bit temporary registers, four flag bits, and an 8-bit parallel binary arithmetic unit that implements addition, subtraction, and logical operations. A memory stack containing a 14-bit program counter and seven 14-bit words is used internally to store program and subroutine addresses. The 14-bit address permits the direct addressing of 16,384 words of memory.

Two separate dynamic memories are used—the pushdown address stack and the scratch pad. The address stack contains eight 14-bit registers providing storage for eight lower and six higher order address bits in each register. The scratch pad contains the accumulator and six additional 8-bit registers. All arithmetic operations use the accumulator as one of the operands. All registers are independent and may be used for temporary storage.

All arithmetic and logical operations are carried out in the 8-bit parallel arithmetic unit, which includes carry-look-ahead logic. Two temporary registers are used to store the accumulator and operand for arithmetic-logic-unit operations. In addition, the registers are used for temporary address and data storage during intra-processor transfers. Four control bits are set as the result of each arithmetic and logical operation. These bits provide conditional branching capability through call, jump, or return on condition instructions. In addition, the carry bit provides capability to do multiple precision arithmetic.

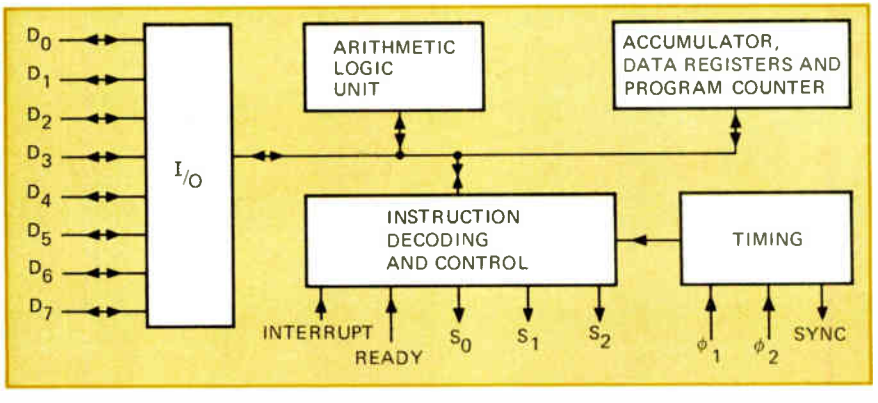
The input-output buffer is the only link between the processor and the rest of the system. Each of the eight buffers is bidirectional and under control of the instruction register and state timing. Each of the buffers is low-power TTL-compatible on the output and TTL-compatible on the input.

To help systems designers work with the 8008, Intel has designed a prototyping board, the SIM801.

The 8008 is available now in sample quantities at $200 each. Production quantities will be available in May. The SIM8-01 board will cost from $750 to $1,000.

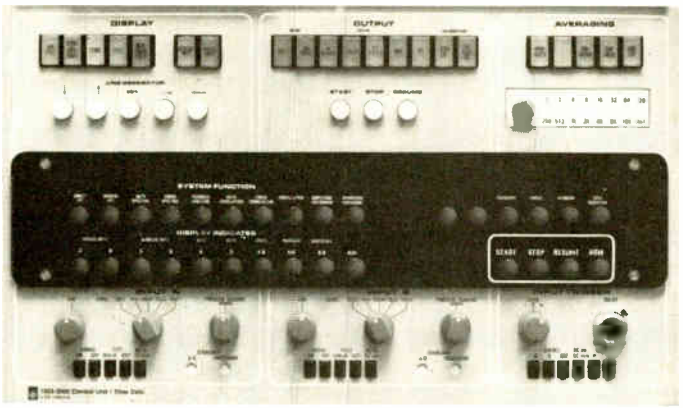
Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [339]

All together. Central processing unit on a chip performs the functions that formerly required 300 devices. Addition of a memory and interface circuits completes a system.



Be in command of your time-series analyzer

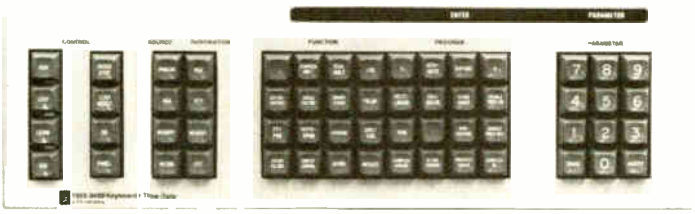
Time/Data saves you valuable time with single, pre-programmed pushbuttons for all widely used functions. No program. No keyboard. No human error. Just a button.



Single, pre-programmed pushbuttons for all these functions:

Direct Fourier Transform	*Auto Spectral*	*Waveform Averaging*	*Spectral Averaging*
Inverse Fourier Transform	*Cross Spectral*	*Auto Correlation*	*Linear*
	Transfer Function	*Cross Correlation*	*Exponential*
	Coherence Function	*Hanning*	*Normalized*

Full, calibrated 24, 48, or 96 dB display (pushbutton selectable)



Of course, if you wish to construct additional functions or a program of your own, use our plug-in keyboard. It utilizes a high-level language for time-series functions, arithmetic functions, and digital processing. It can even call the pre-programmed control panel functions for added speed and simplicity.

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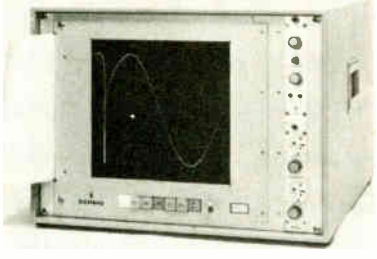
Instruments

X-Y recorder uses laser pen

Unit has frequency response up to 250 MHz, can project data onto wall 15 feet away

It's not unusual when a company develops still another X-Y recorder that writes on paper. But when the same machine also uses a gas laser as a writing implement, has a frequency response that goes up to 250 hertz, and can project data onto a wall 15 feet away or onto a luminescent screen for direct see-through viewing like an oscilloscope—that's something else.

These unusual features are incorporated in a new X-Y recorder built by Siemens Corp., and designated Oscilloreg MO 2017. The



unit's fast response—X-Y recorders ordinarily are limited to only a few hertz—is possible because it writes with the laser's zero-mass light beam, instead of the conventional pen-and-ink stylus. And the laser beam's deflection system is inherently fast and sensitive. Writing speed is almost 2,400 inches per second over a 10-by-10-inch writing area. This compares with the tens of inches-per-second maximums of conventional recorders.

The new recorder doesn't replace or compete directly against any other single piece of equipment, says Lane Gorton, marketing manager of Siemens' Scientific Measuring division. Conventional X-Y recorders are much too slow, and light-beam galvanometers—operating upwards of 1 kilohertz—record in one dimension only.

"With the Oscilloreg, Siemens has combined the function of the usual X-Y recorder with features of a low-frequency oscilloscope and a moving-light-beam galvanometer," Gorton points out. The new machine opens the low-frequency dynamic measurement spectrum to real-time display. This area involves measuring, for example, dynamic mechanical phenomena, such as shock, vibration, resonance, and stress-strain relationships. One recorder has been sold, Gorton reports, to a German automobile manufacturer who is using it in testing the design of shock absorbers and leaf springs.

In addition, the recorder can be used in the research laboratory for such things as investigating and analyzing closed- and open-loop servo systems. For these applications, the recorder makes a hard copy of the input waveform on ultraviolet-light-sensitive paper.

Alternatively, the waveform can first be displayed for a "quick look" on the luminescent screen. When the waveform is in position, the paper can be substituted to produce a hard copy. The Oscilloreg also can be used like a movie projector, focusing the input waveform over a 6-foot-square area in technical presentations for customers and staff.

For writing, the low-power laser beam is deflected by a pair of galvanometer-driven mirrors. The X-axis deflection mirror is controlled either by the input, via an amplifier, or from a plug-in time-base generator. This adjustable generator moves the beam over the full recording area in sweeps of 5 milliseconds to 1 minute.

Price of the Oscilloreg 2017 X-Y recorder, which measures 20 by 14 inches by 23 inches deep, is $6,600. The 78-pound unit can be supplied with either of two twin-channel amplifiers. A 1-millivolt full-scale unit is priced at $800; a 100 MV unit is $250. The 1-mV amplifier has an input impedance of 2 megohms and a measuring range of ±1 mV to ±100 V in 10 ranges. The 100-mV range has an input impedance of 100 kilohms. In addition, a time-base generator plug-in costs $750.

The Oscilloreg can be operated from 220 to 120 V on 60 Hz ac.

Siemens Corp., 186 Wood Avenue South, Iselin, New Jersey, [351]

Voltmeter remembers peak value of transients

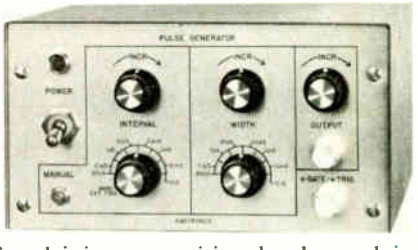
A four-channel transient voltage recorder has a response from dc to 50 nanoseconds on all channels. It is used in systems work for multiphase power line applications. The strip-

chart recorder circuitry permits detection of spikes and transients. Peak amplitudes of transients are held in the memory circuits, permitting the recorder to respond. They are then periodically cleared from the memory. Price of the model 5205 is $3,900.

Micro Instrument Co., 12901 Crenshaw Blvd., Hawthorne, Calif. 90250[353]

Generator's interval, width are independently controlled

A pulse generator with a range of 50 nanoseconds to 0.1 second provides independent control of both interval and width. The output is short-circuit protected, has an active pull-up



for driving capacitive loads, and is adjustable from 0 to +7 volts into 50 ohms (or +9 volts into an open circuit). A manual trigger provides a single-pulse capability. The instru-

ment is suitable for use in the laboratory. Price is $150.
Bartronics, 10507 S.E. 30th St., Bellevue, Wash. 98004 [354]

Modulator provides pulses, square waves, and ramps

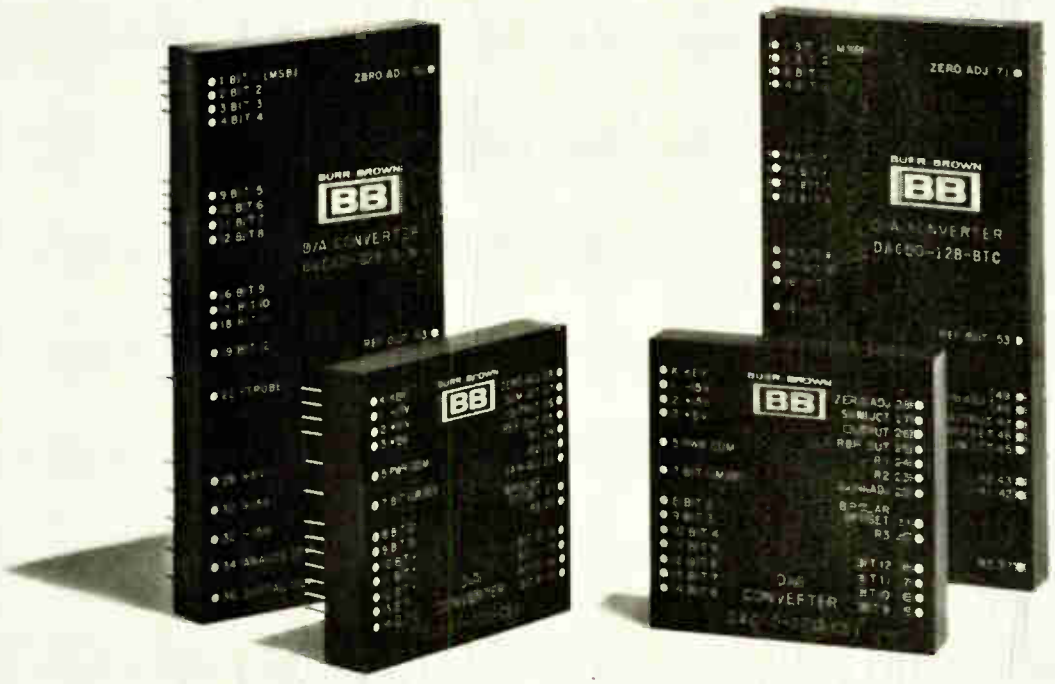
A modulator, called the model 1020, provides pulses, square waves, and ramp waveforms. It is intended as an accessory to the company's line of microwave signal generators in the range of 0.95 to 21 gigahertz.

Adjustable pulses, square wave, a-m, and sawtooth fm are provided from 10 to 10,000 hertz, and pulse widths range from 0.2 to 20 microseconds. Sync pulse delay is up to 2,000 μs. Price is $475. When ordered as an accessory to the microwave signal generator, the price is $240.
Polarad Electronic Instruments Div., 5 Delaware Dr., Lake Success, N.Y. 11040 [355]

Sweep generator covers 220-to-1,000-MHz range

The model 2361 sweep generator, when used with the company's model MT9694 ultrahigh-frequency plug-in accessory, covers the range of 220 to 1,000 megahertz. Features of the complete sweeper system are high spectral purity and flatness of better than ±0.1 decibel at 25

New D/A converters from Burr-Brown



just a little bit better!

Premium performance combined with Burr-Brown quality make the new DAC-40 and DAC-50 digital-to-analog converters just a bit better. The optimum performance comes from the use of Burr-Brown monolithic current switches designed for tight temperature tracking and Burr-Brown thin film resistor networks developed for tight ratio tracking.

Burr-Brown quality is evident in the comprehensive specifications which include test details. All critical specs are fully-tested over the standard 0 to +70°C specification temperature range — including gain, offset, and linearity.

A variety of optional features are available in these competitively priced series; Binary or BCD codes, optional input buffer register, +5V, +10V, ±2.5V, ±5V and ±10V output voltage ranges and current output options. The DAC-40 series offers 8-, 10-, and 12-bit resolutions and accuracies. The DAC-50 is available in 10- and 12-bit models.

NEW BURR-BROWN BOOK "Operational Amplifiers — Design and Applications", over 470 pages, 300 illustrations. Written by Burr-Brown application-engineering staff, published by McGraw-Hill. U.S. price, 15.00 dollars. **Order from Burr-Brown.**

GUARANTEED MAXIMUM SPECIFICATIONS

	DAC-40 Series	DAC-50 Series
Low Temperature Coefficient		
Linearity (8-, 10-bit)	± 3 ppm/°C	± 5 ppm/°C
Gain 12-bit	± 5 ppm/°C	± 10 ppm/°C
Gain 8-, 10-bit	± 7 ppm/°C	± 12 ppm/°C
Linearity (over 0-70°C range; 12-bit)	± ½ LSB	± 1 LSB
Conversion speed	5 μsec to .01%	5 μsec to .01%
Power Supply Rejection	0.002%/%V_S	0.002%/% V_S
Resolution	8-10 or 12 bits	10 or 12 bits

Models available with Input Buffer Register.

For complete information on the DAC-40 and DAC-50 series digital-to-analog converters, use this publication's reader service card or contact your Burr-Brown Representative.

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Circle 147 on reader service card

New products

kilohertz to ±0.25 dB at 1,000 MHz, which with the differential facility enables measurements to be made to within 0.01 dB.

Marconi Instruments, Englewood, N.J. 07631 [356]

Modular pulse generator is priced at $55

A pulse generator, designated the model PG1, provides a pulse rate of 1 pulse per second to 400 kilopulses per second, adjustable by decade and vernier. The main output has adjustable amplitude, optional inversion, and either zero-volt or −6-volt baseline. Outputs are DTL-TTL-compatible. The PG1 can also be expanded to produce pulse trains of any required complexity. Price is $55. Delivery is from stock.

Scientific Instruments Inc., 2945 Central, Wilmette, Ill. 60091 [357]

Active filter's cutoff tunable over wide range

A digitally tuned, variable active filter designated the series AF-400 features a cutoff frequency from 0.001 hertz to 99.9 kilohertz, with an accuracy to within ±2% on all ranges. Other specifications are high-pass, low-pass, bandpass, band-reject, and bypass functions, and hum and

noise below 100 microvolts rms maximum. The unit also has close phase tracking between independent channels and input impedance of 100 megohms. Output impedance is 50 ohms, and attenuation is 80 decibels minimum to 1 megahertz.

Multimetrics Industries, 120-30 Jamaica Ave., Richmond Hill, New York 11418 [358]

Teradyne's L100 Automatic Circuit Board Test System speaks for itself.

```
        PASSED

   GOOD: 43
   BAD:  8
```

```
              FAILED
FAILURE COUNTERS (BAD/TOTAL):
          FTEST  0/36
          MTEST  5/83
          BTEST  0/1
          TTEST  0/2
```

```
MT44  D8
THIS  TEST  PASSED

MTEST  ON  PINS:  M

        LIMIT  :+  500.  MV
        ACTUAL:+  248.  MV
```

```
TT39
THIS  TEST  FAILED

TIME  FROM  PIN   18  TO  21
   ACTUAL:      00.195  US
     TMIN:      00.050  US
     TMAX:      00.190  US
```

```
FT35
THIS  TEST  FAILED
<ALARMS>S1
FAILING  PINS:  20  Z  K
```

```
FT15
THIS  TEST  FAILED

FAILING  PINS:  S  R  P  N  M  L  J
```

If you test circuit boards, you get the message. The L100 doesn't just tell you a bad board is bad. It helps you find out why. And in a fraction of the time you'd usually spend trouble-shooting. We'd like to send you a brochureful of reasons why the L100 is the most money-saving system you can buy.

Write: Teradyne
183 Essex Street
Boston, Mass. 02111

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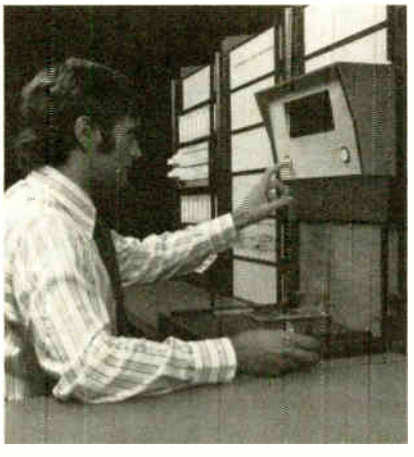
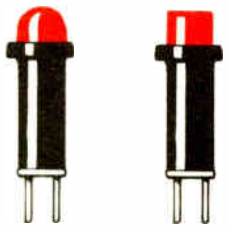


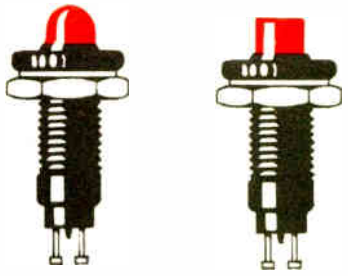
See the L100 at the IEEE Convention, New York Coliseum, Booth 2332, March 20-23.

Circle 149 on reader service card 149

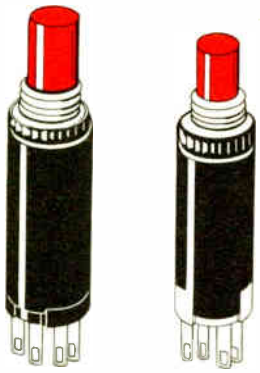
DIODE-LITEs



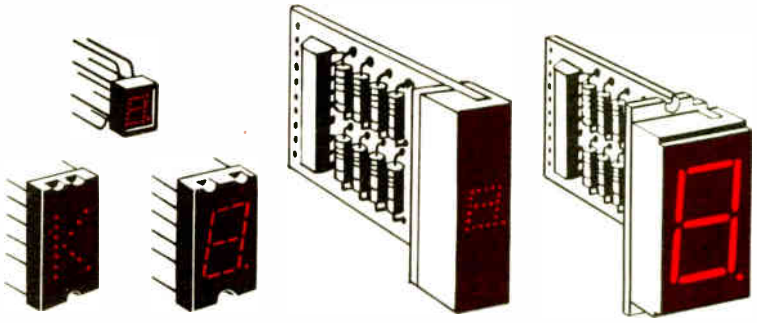
Cartridges



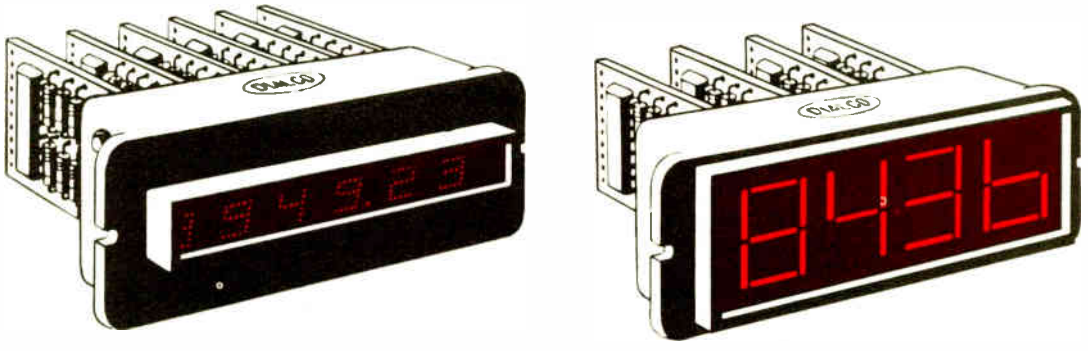
Indicator lights



Lighted push button switches



Readout modules and packages



Readout assemblies

LED displays?

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Whether you're looking for LEDs as light sources for build-your-own displays or for a variety of products that utilize LEDs, bring your requirements to us. Dialight is a major supplier of both LEDs (we call ours DIODE-LITE™) and of indicator lights, readouts and lighted push button switches that incorporate DIODE-LITEs. We can even give you a contactless solid state switch that uses a DIODE-LITE in the circuit to provide cleaner, faster switching than any mechanical switch. Dialight can help you do more with LEDs than anyone else because we've done more with them. Write for LED Data File.

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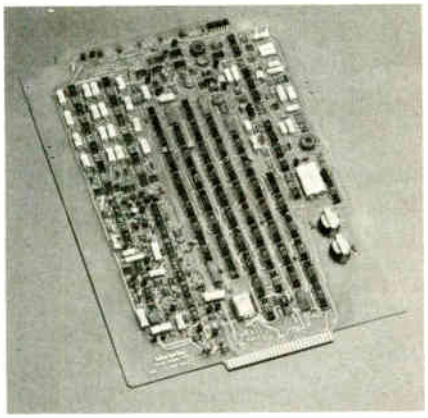
Data handling

Modem packed into pc board

Three Bell-201 types aimed at OEM market; error rate is less than one bit in 10^6

The market for independent modem makers has been growing rapidly since the Caterfone decision in 1967 opened public telephone networks to private suppliers. Independent manufacturers cornered an esti-



mated 25–35% of the $100 million modem market in 1971, and Intertel Inc. hopes to capture 10–12% of the independent market this year with its three series IN201 modems.

The model 2010, designed principally for unconditioned private lines, transmits at 2,400 bits per second, and is fully compatible with Bell's 201B. The other two modems are for switched network use; the 2011 can transmit at 2,000 b/s and is compatible with Bell's 201A. The 2012 is the same as the 2011, but can perform at 2,400 bps.

Alvin L. Polinsky, marketing support manager, claims that the IN201 is the only Bell 201 type available on a printed-circuit board; other makers design them in a box. The modems are also available in single rack-powered enclosures with either single or multiple modems.

Polinsky says the units can transmit or receive data from any other 201-type modem. "We transmit the total signal exactly as Bell transmits it," he claims, "So we are compatible with all 4-phase differential phase-shift-keyed type modems."

The company claims its error rate—less than one bit in 10^6 at a signal-to-noise ratio of dB over an unconditioned line with 20° peak-to-peak phase jitter at a rate from 0 to 180 hertz—is superior to that of any other 2,400-b/s modem available. Intertel says this accuracy is attained by what it calls data-derived timing. Other modems carry timing information on the sidebands, where noise, delay distortion, and phase jitter are at a maximum. Intertel reads both timing information and data from the central bandwidth, although timing information is also transmitted on the sidebands to insure compatibility.

The received sidebands are removed by what Polinsky claims are "the narrowest and sharpest narrow-band filters being used for this purpose," restricting the incoming signal to between 1,200 and 2,400 Hz. Active filters are used throughout.

To lessen error further, Intertel uses coherent demodulation, which compares incoming signals with a stable reference carrier. However, Intertel uses a Cartesian-coordinate approach that it says is simpler and less expensive to implement than existing methods. Fixed statistical equalization is employed to allow maximum versatility in the types of transmission lines used. The IN201 series also has an optional 150 reverse channel.

The 2010 is $1,050 in small quantities, and models 2011 and 2012 are $1,125. Powered enclosure for a single modem is $200 extra.

Intertel Inc. 6 Vine Brook Park, Burlington, Mass. 01803 [361]

Cassette recorder aimed at remote-terminal jobs

Tackling the data acquisition terminal market on a new front, Memodyne Corp. has beefed up its model 101 cassette recorder with a version that has higher capacity, packing density, and price tag. The 101E sells for $389.

Battery-powered, it uses 2 microamperes at 12 volts on standby and 52 mA when recording, compared to the earlier model's 1 A at 5 V or 0.5 A at 12 V [*Electronics*, July 5, 1971, p. 87]. Packing density is 615 bits per inch, versus 120 b/in. for the 101, and capacity is 4 million bits instead of 432,000. Because of its low power requirement, the 101E's top speed is 200 bits/second compared to 300 b/s for the 101.

The new unit is specifically designed for off-line data logging and storage for environmental and industrial systems, and it is compatible with analog instrumentation.

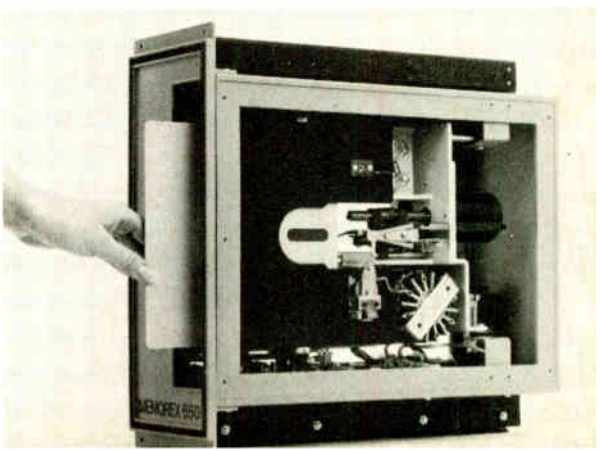
The 101E's electronics, consisting of C/MOS logic, is packaged in a flat module on a pc board attached to the rear of the tape transport.

By slowing clock rate and running two bits per step, the recorder's density can be doubled to 1,230 b/in. and the capacity to 8 million bits. Memodyne recommends, however, a speed of 200 b/s. Error rate is one bit in 10^7.

Memodyne Corp., 369 Elliot St., Newton Upper Falls, Mass. [362]

Direct-access disk file reads, writes interchangeably

A direct-access disk file, called the model 650, is designed for digital applications, and can read and write disks interchangeably from unit to unit at a transfer rate of 200 kilobits per second. In the file is incorporated a cartridge that is composed of 7½-in. Mylar coated with magnetic oxide and encased in a flexible plastic envelope. Primary use is the distribution and loading of microcode or diagnostic programs. Others in-



New products

clude remote terminal data acquisition, data logging, and key-entry recording.

Memorex Corp., San Tomas at Central Expressway, Santa Clara, Calif. 95052 [363]

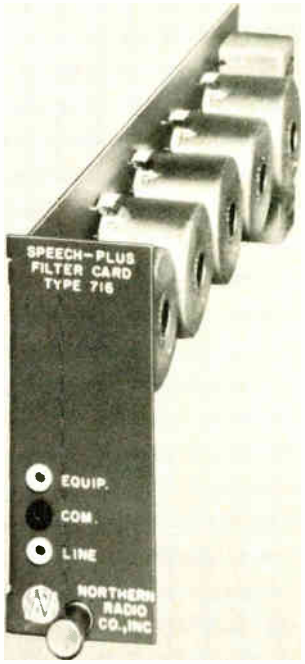
Punched-tape reader-spooler has self-cleaning read head

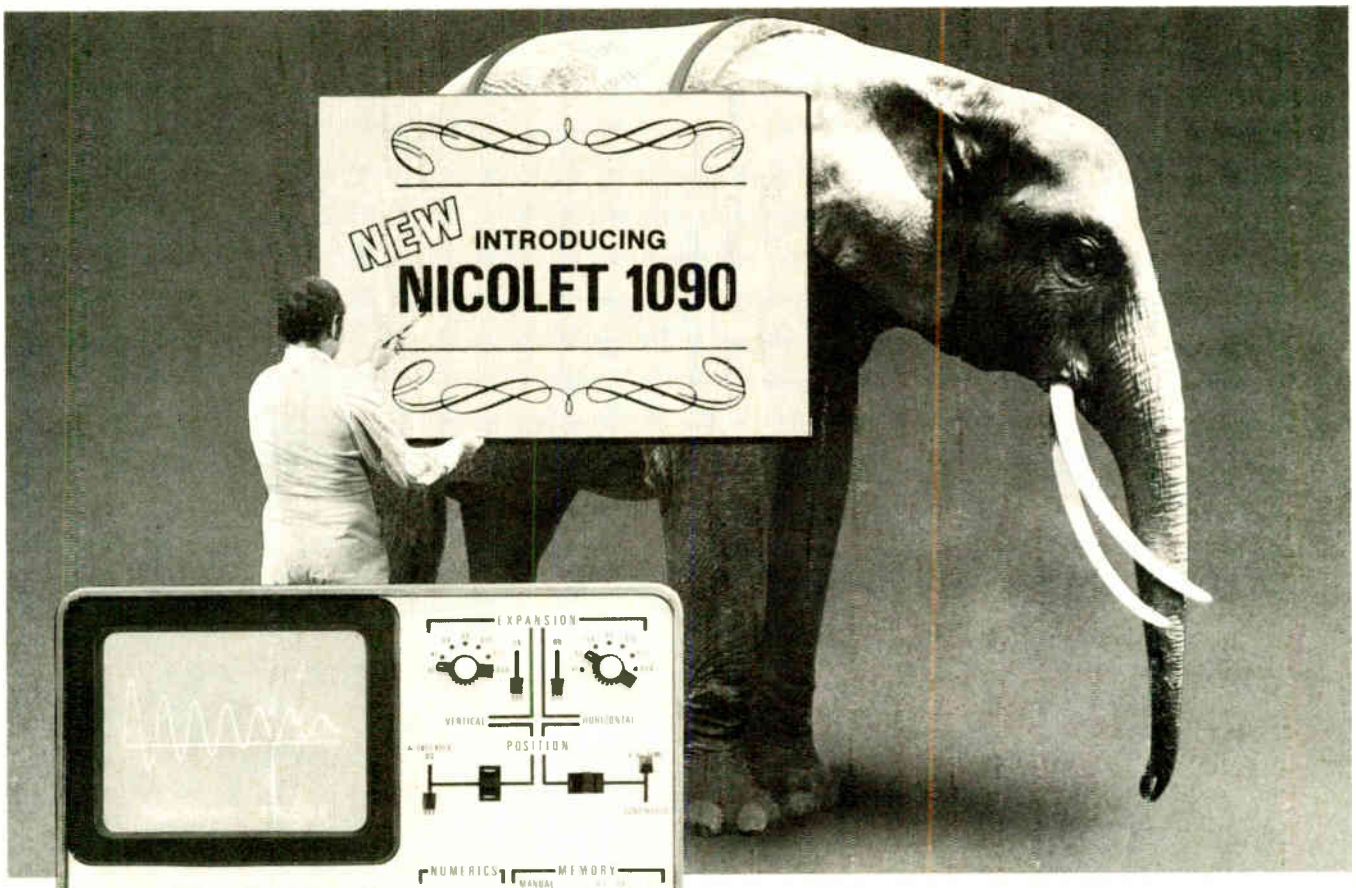
The model TRS9300BB punched-tape reader-spooler incorporates a proportional servo, stepping motor, phototransistor sensing and a self-cleaning read head. Search and rewind speed is 700 characters per second, and stop-on-character reading is at 300 characters per second. The 5½-in.-diameter reel accommodates up to 150 feet of tape of any standard 5-, 6-, 7-, or 8-level type with as low as 40% opacity. The unit is DDT, RTL, and TTL compatible.

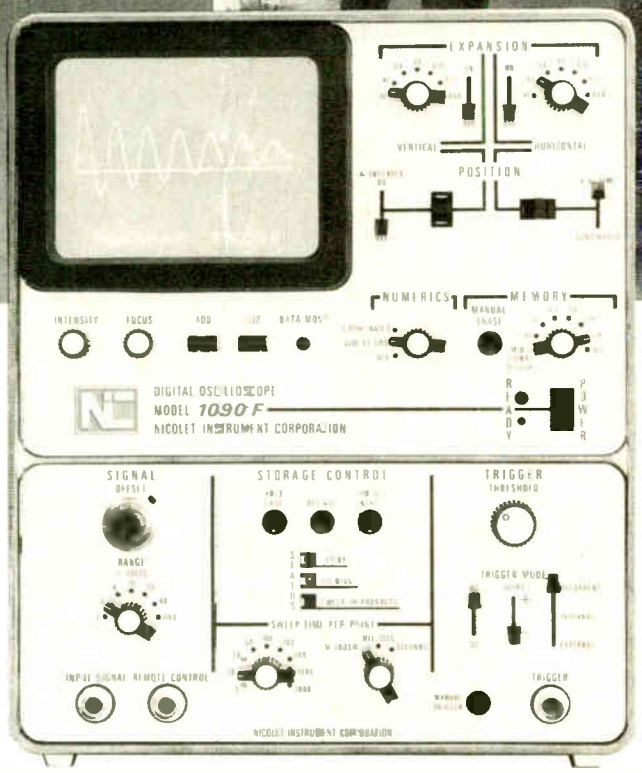
Electronic Engineering Co. of Calif., Electronics Products Div., 1441 E. Chestnut Ave., Santa Ana, Calif. 92701 [364]

Speech/filter unit permits voice, data on same line

A new speech-plus-filter assembly permits transmission and reception of voice and data on the same tele-







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World's Highest Precision Oscilloscope

This is the first digital instrument specifically designed as an oscilloscope. More than a digital recorder, it is a direct replacement for low-frequency, general-purpose oscilloscopes and storage oscilloscopes. It is much easier to use, has almost two orders of magnitude greater accuracy in both time and voltage, and is far more versatile.

Comprised of a main frame and plug-in unit, it has a 100 kHz real-time bandwidth with 12-bit precision, with sweep times that range to as long as several days per sweep.

The 4096 x 4096 storage resolution makes it possible to record as much information about a single waveform as 160 storage oscilloscope screens, with higher equivalent real-time writing speeds, without loss of information with time, without need for an erase operation, and without enhancement adjustments. A touch of a button allows the present, preceding, or following signal to be held (whichever is desired) and another touch returns the operation to real time. Several waveforms may be stored and superimposed, with digital scale magnifications up to 64 times in both dimensions. Stored waveforms may be adjusted vertically for more accurate comparisons.

The numerical readout shows both time and voltage values for any selected point, normalized for sensitivity and sweep speed settings.

But this is only part of the story. Write for complete information about this revolutionary oscilloscope.

NICOLET INSTRUMENT CORPORATION

5225 Verona Road, Madison Wisconsin 53711
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See the 1090 at Booth 2643 at the IEEE Conference in New York City starting March 20, 1972.

New products

phone line. The unit is designed for use with the company's series 700 frequency division multiplex equipment, and for equipment utilizing a type 3002 dedicated line and applications involving switching. Two models offer different bandpasses. The model 1 has a speech band from 300 hertz to 2,200 Hz ±3 decibels and a data band from 2,325 hertz to 3,000 Hz. Model 2 has a speech band from 300 Hz to 2,700 Hz ±3 dB and a data band of 2,825 Hz to 3,000 Hz. Price is $150. Delivery of the assembly is from stock.
Northern Radio Co., Melbourne, Fla. 32901 [365]

CRT computer terminal has on-site editing capability

A message-oriented CRT computer terminal is compatible with teletypewriters and has on-site editing capability. Features include stand-alone operation, a full alphanu-

meric keyboard, numeric key pad, a 40- or 80-character-per-line display, switch-selectable transmission control, and a multiple interface capability. The model 4390 can also be used for on-line data entry and retrieval systems, regardless of size or complexity.
Bendix Corp., Bendix Center, Southfield, Mich. 48060 [366]

Cassette tape transport has only two moving parts

A bidirectional, reel-to-reel-drive cassette tape transport has two moving parts, dc motor-tachs. The de-

A CAMBION® Double "QQ" Product Line

Coils with high "Q" values have always been available from CAMBION. You've probably come to expect them as a matter of course.

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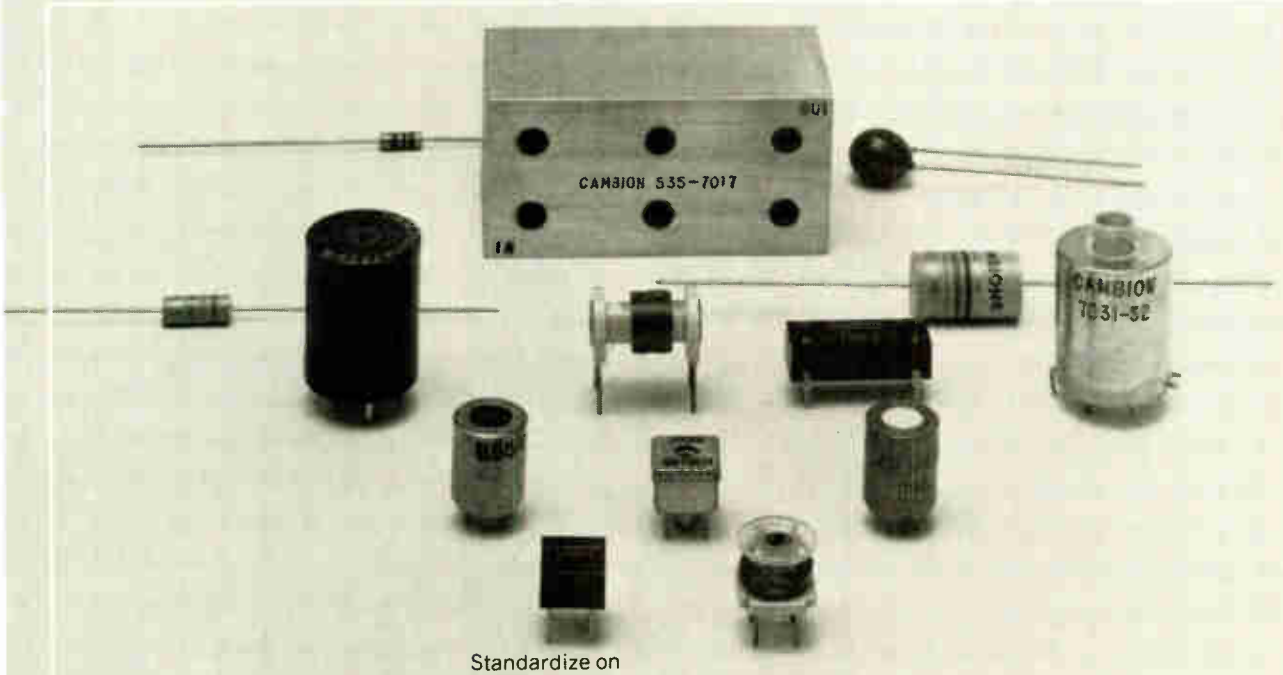

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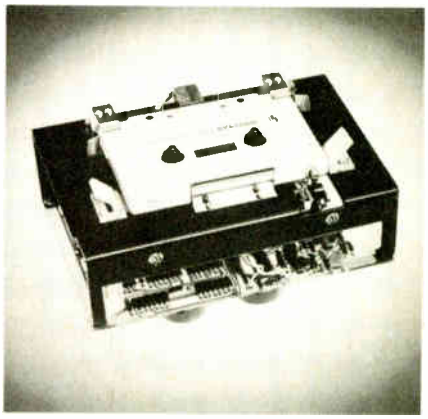
sign eliminates capstans, belts, solenoids, pinch rollers, and mechanical clutches. The model 260 offers cassette interchangeability between transports and uses cassettes complying with ANSI, ECMA or ISO stan-



dards. Tape speed variation from transport to transport is less than ±1%, and read and write speeds are between 5 and 40 inches per second. The recording method is single-track phase-encoded, with densities to 800 bits/second. OEM price is less than $300 in 500 lots.

Computer Access Systems, 2645 E. Buckeye Rd., Phoenix, Ariz. 85034 [367]

Precision power source is computer-controllable

A computer-controllable voltage standard and power source called the CSC-701 Compu-Dac is designed for automatic test, laboratory, and manual setup applications. The unit

is relay-free, and settling time is 100 microseconds. As a voltage standard, it provides six-decimal-digit resolution on ±100-volt ranges, organized to provide useful linearity to within ±0.5 ppm. Price is $2,795.

Compu-Systems Co., Audubon Rd., Wakefield, Mass. 01880 [368]

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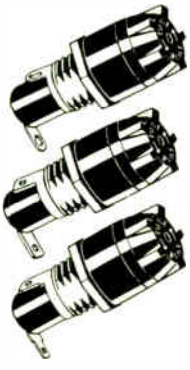

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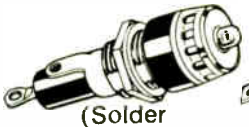
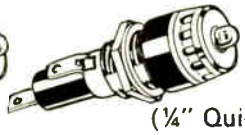
HKP (Solder Terminals) **HKP-HH** (¼" Quick-Connect Terminals)
The Fuseholder for All-Purpose Applications





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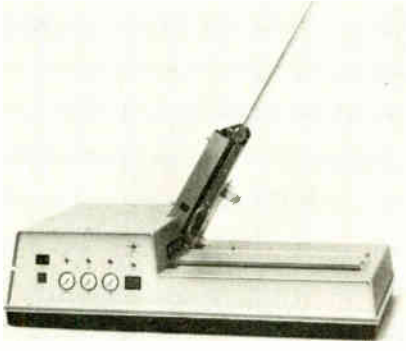
Circle 158 on reader service card

Packaging and production

Handler sorts 5,000 DIPs/hr

Simultaneous test-sort operations speed process; fluidic logic minimizes rfi

A redesigned contact assembly and provisions for mechanical sorting while testing has raised the speed of a handler for dual in-line packages from 4,000 devices an hour to 5,000. The handler, built by International



Production Technology and designated the model 600C, provides Kelvin contacts to DIPs with 0.300-inch lead-row spacing and up to 18 leads. The 600C works from stick carriers and sorts devices into two or three categories under instructions from the automatic tester that would be used with the sorter.

Pneumatically driven fluidic logic is used in the sorter shuttle to improve mechanical reliability and minimize electrical interference. In an earlier version of the machine, devices were tested and sorted individually from a contactor assembly on the base plate. In the new version, sorting is performed on one device while the next one is being tested in a contact assembly on the input tower, where it is readily accessible for more rapid changes.

The beryllium-copper spring contacts, of a new design, close with a slight scrubbing action on each side of the DIP lead just below the neck. Other contact assemblies grip the shoulder, which sometimes is covered with plastic flash from the molding operation, preventing electrical contact.

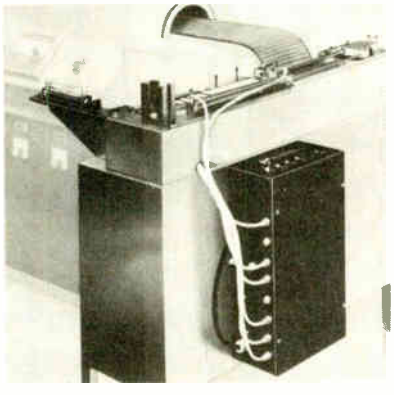
The machine also is available with up to seven sort positions for use in a semiconductor plant. Owners of the company's earlier model 600 can have that handler updated to 600C specifications for a nominal charge. Price of the 600C machine is under $8,000.

International Production Technology, 185 Evelyn Ave., Mountain View, Calif. 94040 [391]

Magazine reloader handles 3,000 substrates an hour

One of the bottlenecks in the manufacturing of thick-film hybrid circuits is at the output end of the drying oven or firing furnace. The substrates leave there neatly laid out next to one another, but for further screening they often must be stacked in a magazine to be fed back into the automatic screen printer. For such applications, Weltek division of Wells Electronics Inc. has built a magazine reloader that attaches to the end of the oven or furnace and, handling each piece so that there is no abrasive action, reloads them in the magazines at a rate of 3,000 pieces per hour.

Any size substrate from 0.5 by 1



inch up to 3 by 3 inches can be accommodated; the basic machine price of $4,800 includes one set of tooling. Design of the delivery system from furnace or oven belt to handling mechanism also requires matching to the diameter of the

New products

roller on the end of the belt, so Weltek asks for dimensions of the furnace or oven.

Weltek Division, Wells Electronics Inc., 1701 S. Main St., South Bend, Ind. 46623 [392]

System generates pc artwork masters automatically

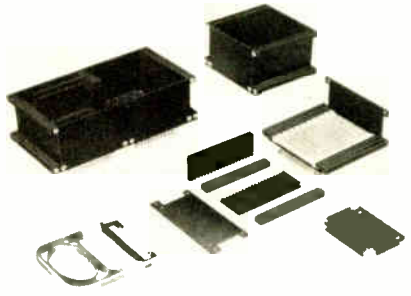
A self-contained system for the generation of pc artwork masters is designated the PC-740. The machine enables the user to produce finished masters, starting with only a rough-gridded layout of the circuit board. All processing is done within the

minicomputer. The system consists of a digitizer connected to a customer-supplied card punch, a stored-program model 700 control unit, a high-speed photoelectric card reader, and a model 400 precision plotting table. Price is $75,000.

The Gerber Scientific Instrument Co., 83 Gerber Rd., South Windsor, Conn. 06087 [394]

Packaging system fits Navy standard hardware program

A set of basic hardware pieces for assembly of electronic packages is for almost any piece of electronic equipment being configured in accordance with the Navy's standard



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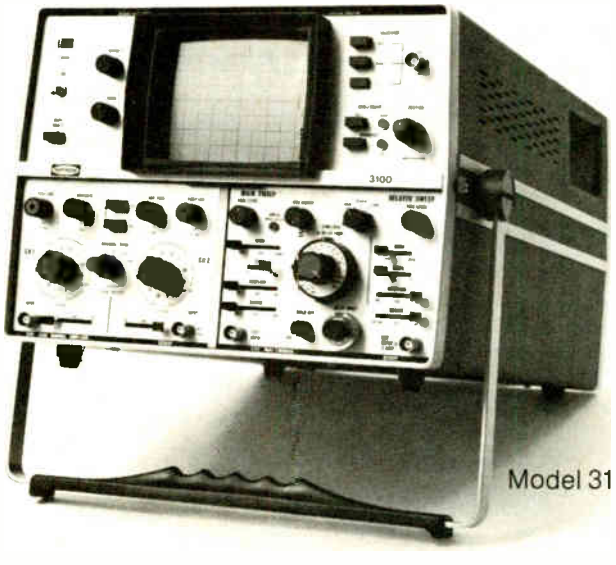


Model 3100

72 IEEE Booth 2602

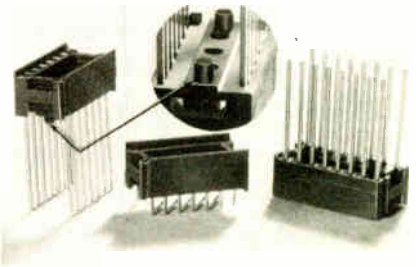
New products

hardware program. The system is designed to hold any circuit module in any number and is said to cost less than custom-packaged electronics. The packaging system is made up of six basic hardware pieces, from which the user selects proper quantities. Assembly is accomplished with a screwdriver.

International Electronics Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91504 [395]

DIP socket has press-in attaching buttons

A line of 14- and 16-pin soldered and wire-wrapped dual in-line sockets features tapered, press-in molded buttons for assembly simplification. The sockets are pushed into the mating holes in the board and the buttons hold them in place prior



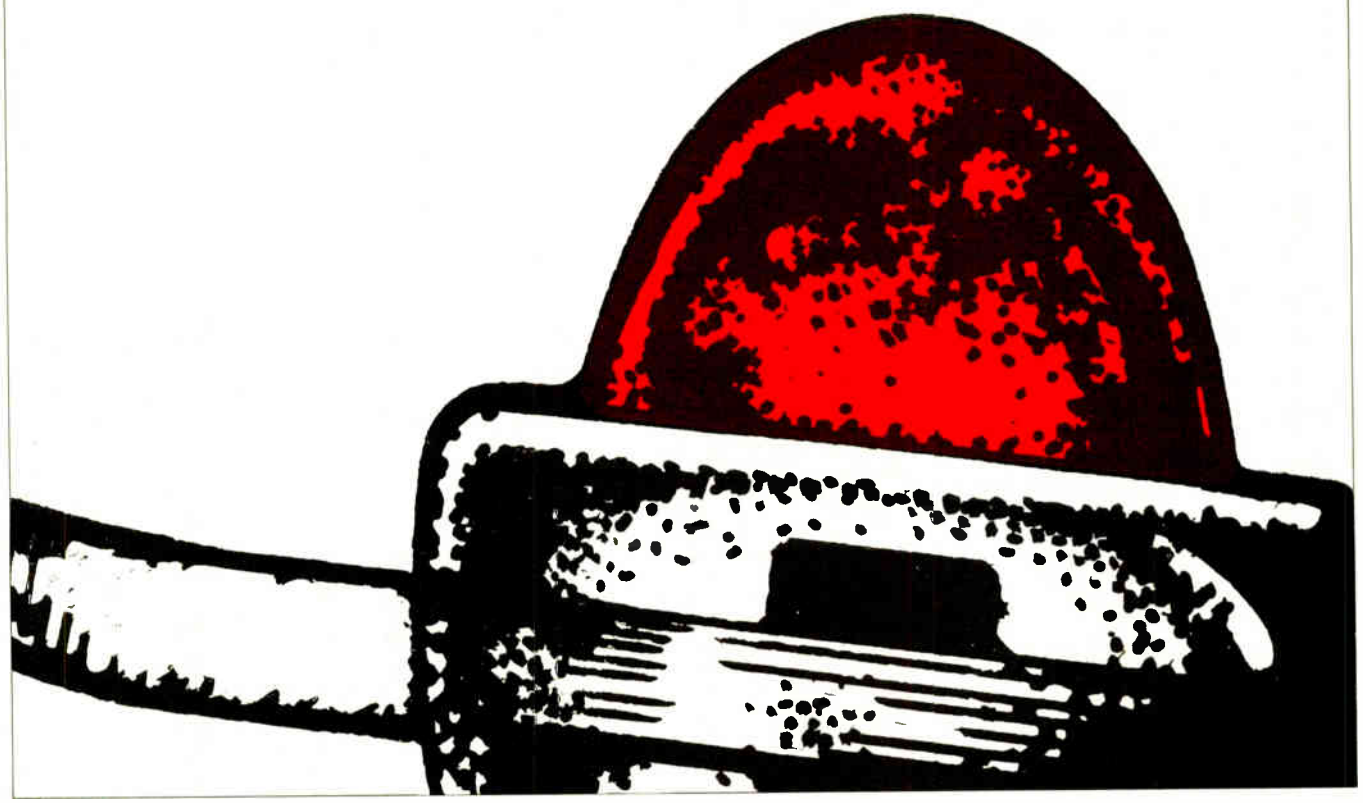
to wave or dip soldering. This eliminates screws, rivets or other attaching hardware. The sockets are molded from glass-filled nylon, and the bronze, gold, or tin-plated contacts are bifurcated. Price is from 29 cents to $1 depending on quantity and plating type.

Aries Electronics Inc., P.O. Box 231, Frenchtown, N.J. 08825 [396]

Tester automatically identifies wire loops in cable

A cable tester called the Maze Master identifies, on a light-emitting diode display, the source and termination points of wire loops in cable harnesses. Identification is made in less than one second per termination. The unit is capable of identi-

The 19¢ GaAsLITE



The million-part buyer can now get the first under-20¢ GaAsLITE, the MV50, with a red lens for high contrast. And there will be a lot of million-part buyers at this price. People who are looking for a bright new unit for diagnostic and other applications. Designers who want scintillating arrays. Automotive guys who want dashboard flashers that keep flashing. And many more.

19¢ each, for a lamp with the long life and reliability of solid-state? Quite a milestone. And an indication of the way things are going in the solid-state light bulb business. At Monsanto volume is up, so price is down. You can even try us on a quote for larger quantities.

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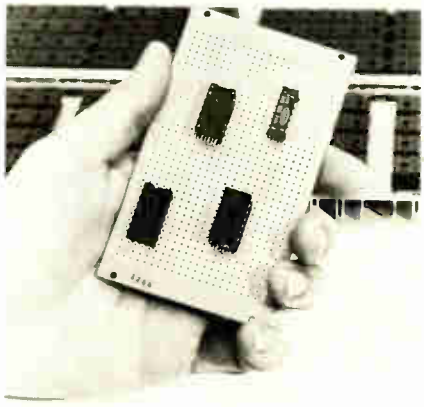
fying 99 single-ended or 49 double-ended wire terminations, and a verify mode identifies connector terminations at both ends of wired-in ca-

bles. A visual and audible short circuit alarm operates during random identifications. Price is under $600.

Addison, 1101 Bristol Rd., Mountainside, N.J. 07092 [397]

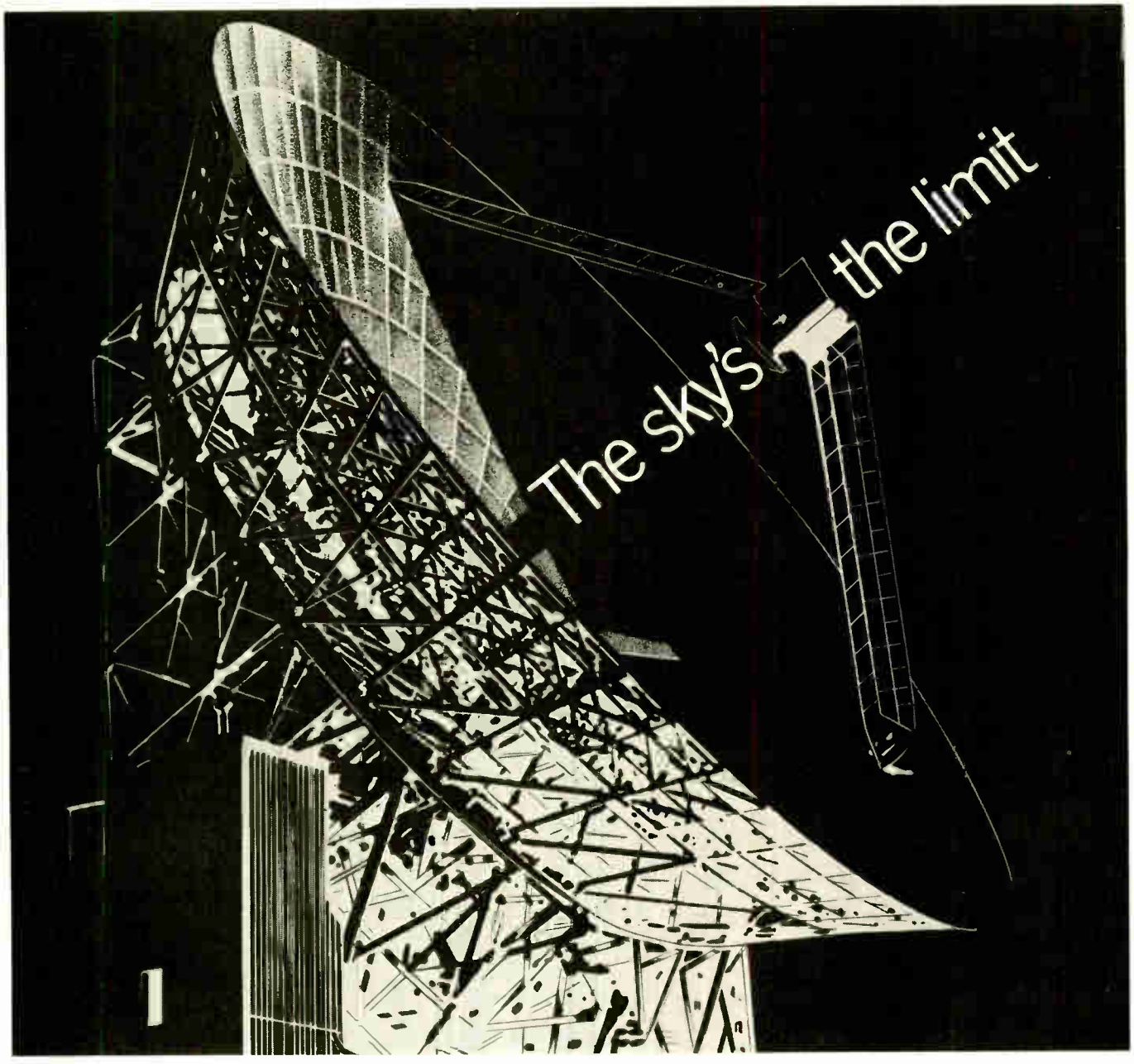
IC component mounting board is universal

A line of modular boards for dual in-line packaging assemblies accepts any socket strip or components having standard wire-wrapped pins.



Called the H-2939 series, the glass epoxy boards have through-hole plating over etched copper rings so that components and sockets can be soldered in position. The board measures 0.062 in. thick by 2.45 in. wide by 4.14 in. high

Electronic Engineering Co. of Calif., Electronic Products Div., 1441 E. Chestnut Ave., Santa Ana, Calif. 92701 [398]



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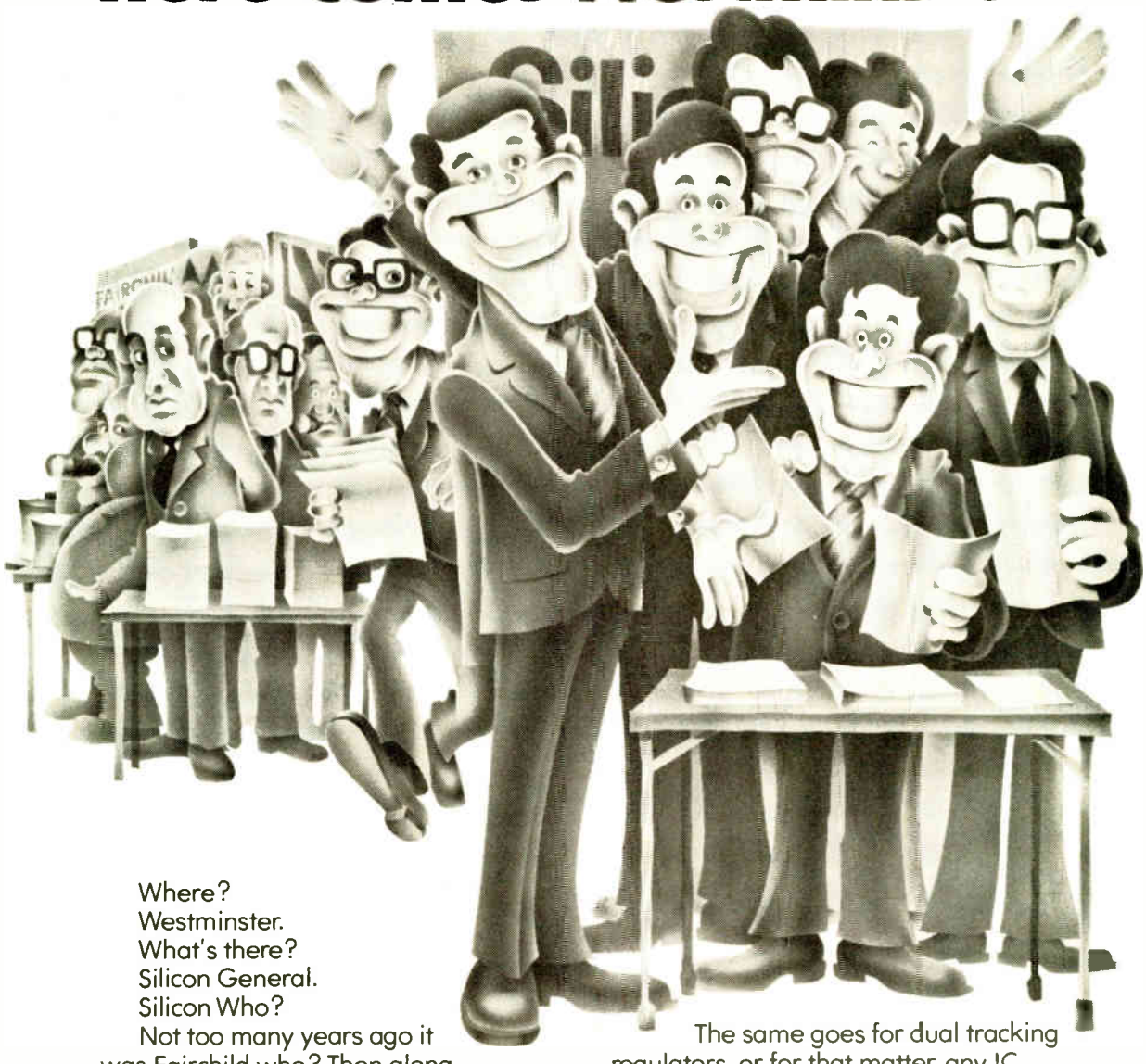
Number of persons

London office/local agent.

Look out Mountain View, here comes Westminster.



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Semiconductors

ALU and latch put on chip

Bipolar MSI device allows designers to save power and get increased speed

Monolithic arithmetic logic units, such as the 54/74181 and the 9341, have been widely accepted by designers because they're easy to use—and they work. In most systems, the unit is used with a latch circuit; the unit and the latch, with an accumulator generally, are combined in a loop so that the result of a calculation can be stored temporarily in the latch for use in the next calculation.

But the latch requires power and introduces a delay of about 20 nanoseconds. That is why circuit designers at Advanced Micro Devices have combined the arithmetic logic unit and latch into one bipolar MSI device. The result is the Am2506, the first such device in the industry. The four-bit arithmetic logic unit section of the 2506 is functionally identical to the Am54/74181, but has the four-bit latch on the device outputs. Thus, where a latch is required for temporary storage in arithmetic functions, an external package isn't needed.

Because the two functions are combined on one chip, the latch portion offers essentially zero propagation delay as well as zero power dissipation. The designer thus saves power as well as getting increased speed. For example, in a 16-word configuration the 16-bit arithmetic register slice would require 13 packages if it had external latches. With the Am2506, 11 packages do the job—with 20% more speed and 15% less power. And the built-in latch adds only $1 to the cost of the logic unit at a price of $17.50.

The 2506 performs two functions commonly used together. It is a four-bit ALU with a four-bit latch on the outputs.

Like the 9341 and 74181, the device performs addition, subtraction, or any logic function on two four-bit words. The operation is determined by the mode control line, and the four select lines. The chip produces the carry look-ahead functions as well as a carry-out signal, and all signals are located on the same pins as the corresponding signals on the 9341 or 74181.

Also provided is a latch-enable pin: as long as it is high, data from the arithmetic logic unit appears directly on the output pins, and operation is identical to the Am9341's in all respects including switching speeds. The only difference is that the A=B output of the 9341 has been replaced by the latch-enable pin in the 2506. But when the enable goes low, the data on the outputs latches and no further changes occur. This allows the inputs to the device to change without destroying the output data from the previous operation.

Because of the built-in latch, the 2506 can help designers save time in many configurations. For example, when the Am2506 is combined with the Am2505 2's-complement multiplier circuit [*Electronics*, Sept. 13, 1971, p. 125], the time required to multiply two 16-bit numbers can be reduced from, typically, 275 nanoseconds to 95 ns.

The Am2506 is available from stock in small quantities. The commercial version, in an hermetic dual in-line package, is priced at $17.50 in quantities of 100.

Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. 94086 [412]

Line driver features internal inhibit and slew control

A line driver called the 9616 links DTL-TTL data terminals and communications equipment. The triple line driver is implemented by an and/or/invert function instead of a positive NAND function, eliminating the need for external gating to perform the inhibit function. The unit also features an internal slew rate control that eliminates the need for

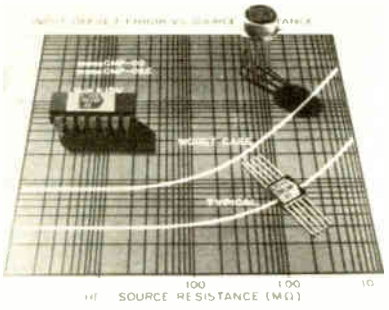
New products

an external capacitor for each driver. Price in 100 to 999 quantities in a 14-pin ceramic DIP is $4.50

Semiconductor Component Group, Fairchild Camera & Instrument Corp., 464 Ellis St., Mountain View, Calif. 94040 [413]

Precision IC comparator offers low offset current

A low-input current comparator called the CMP-02 can maintain total input errors of less than ± 1 millivolt in circuits with up to 2.0 megohms of source resistance, without the requirement for offset nulling. The unit operates from ± 5-volt to



±18-V supplies or from a single +5-V logic supply. The output is capable of driving eight TTL loads without requiring an extra pull-up resistor, and has wired-OR capability. Price, depending on quantity, temperature range and packaging, varies from $3.15 to $23.25.

Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050 [414]

FET operational amplifier requires bias of only 10 pA

An operational amplifier incorporating a dual-FET front end and packaged in a TO-99 case is designed for applications requiring accuracy in fast or high-impedance circuits. The model 1421 offers a bias current of 10 picoamperes, and a common mode voltage of ± 12 volts. Output current is 10 milliamperes, and unity-gain bandwith is 1 megahertz. The unit is directly interchangeable with the company's models 741 or 740, and incorporates

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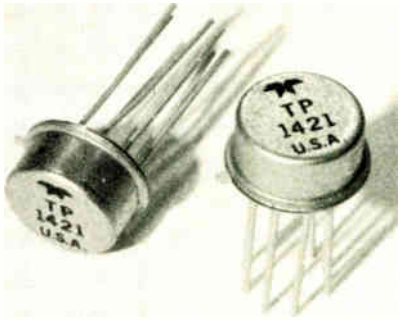


output short-circuit protection and input fault protection.

Teledyne Philbrick, Allied Dr. at Rte. 28, Dedham, Mass. 02026 [415]

Vhf-uhf power transistor delivers 30 W cw at 400 MHz

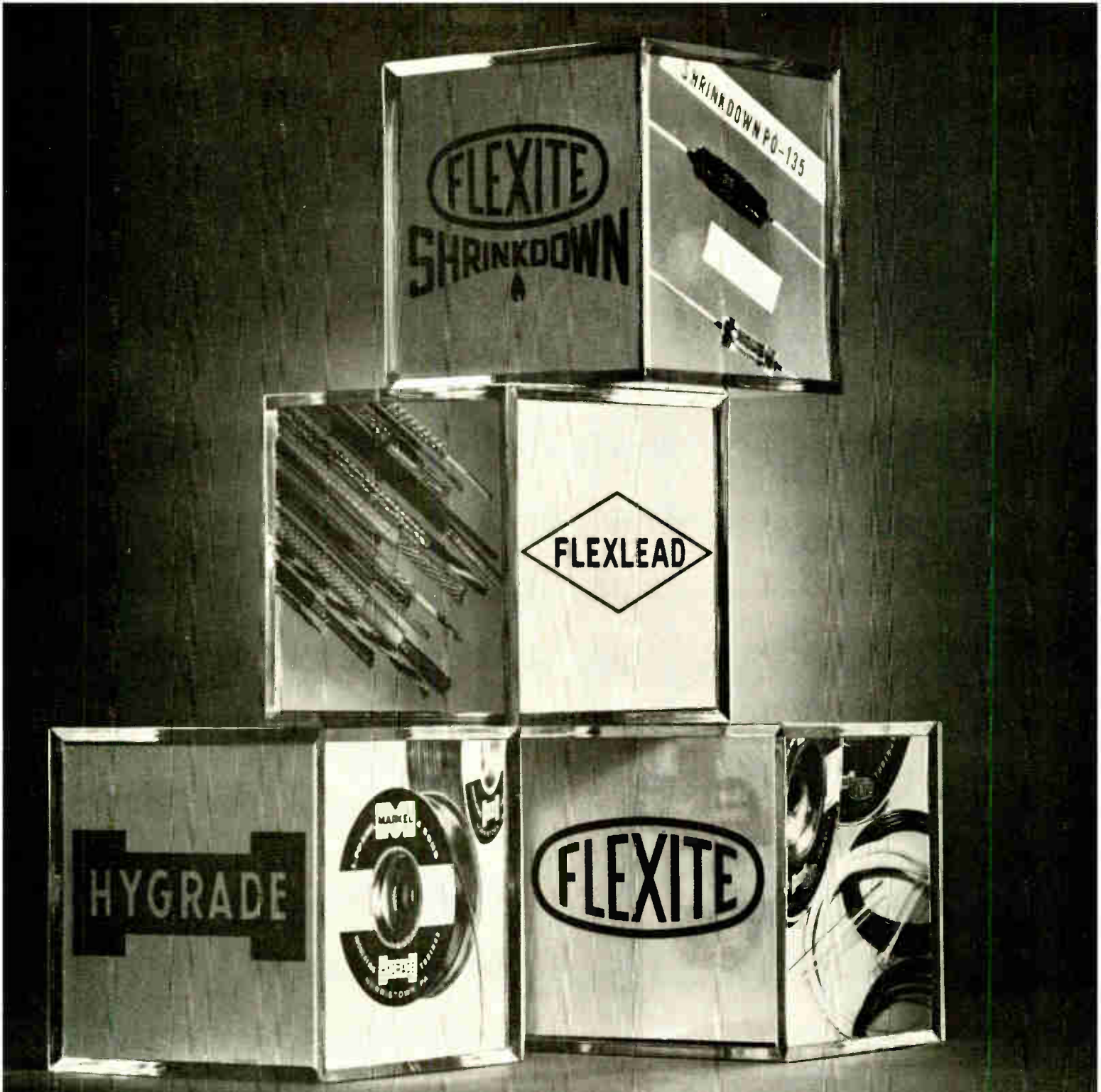
A vhf-uhf power transistor, designated the 2N6104, delivers 30 watts continuous-wave with a 5-decibel gain at 400 megahertz. It is designed

for use in large-signal, high-power cw and pulsed amplifiers at frequencies from 200 to 600 MHz, and operates from a 28-volt supply. The unit also features overlay multiple emitter site construction and emitter ballasting resistors. Price is $33 in 1,000-unit quantities.

RCA Solid State Div., Box 3200, Somerville, N.J. 08876 [416]

Thin-film ladder networks track within 1 ppm/°C

Eight-, 10-, 12-, and 14-bit R-2R thin-film resistor ladder networks feature a tracking characteristic of



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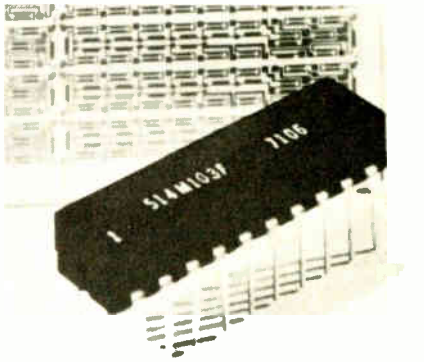
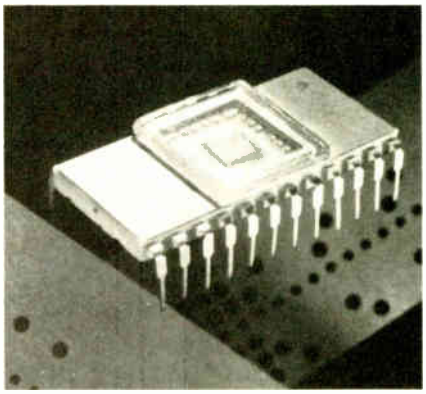


less than 1 ppm/°C. Ladder transfer linearity for the 8-bit network is 0.05%, for the 10-bit, 0.03%; for the 12-bit, 0.01%; and for the 14-bit, 0.005%. Characteristic resistance of all networks is 1.0% at −55°C to +125°C maximum. Settling time to 0.1% of full scale is less than 50 nanoseconds typical. Delivery of the units is from stock.

Hybridyne Inc., 3150 Pullman St., Costa Mesa, Calif 92627 [417]

MOS read-only memory is electrically programable

A metal oxide semiconductor read-only memory is electrically programable and, in one version, erasable and reprogramable. Called the model MM5203, the 2,048-bit static device is made with silicon



gate technology and has a maximum access time of 1 microsecond. Other characteristics include bipolar compatibility, three-channel outputs for high-speed operation on data buses, and chip-enable output control.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [418]

How to live within your budget!

Money for new test equipment is tight. If you're looking for a 15 to 50-MHz scope — like the 422, 453A or 1700 — you owe it to your company to try Hickok. Because, with a Hickok scope, you get quality performance while saving money.

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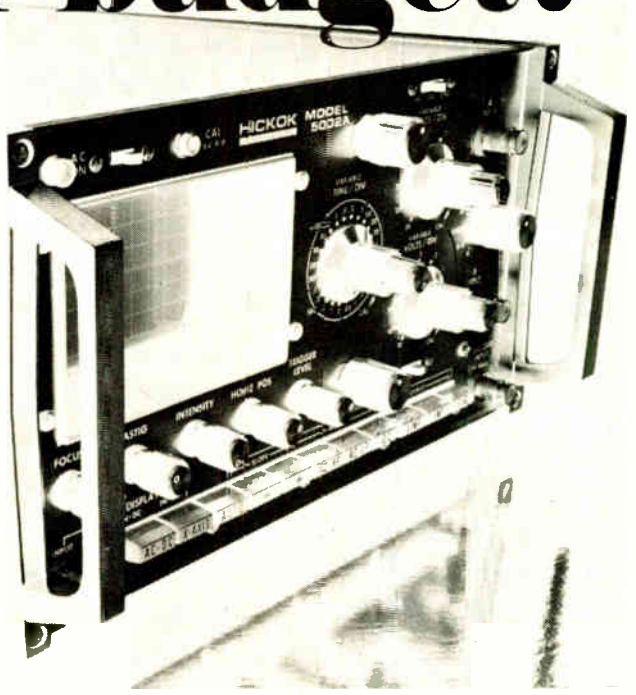
These are features usually found on models costing up to $2100. And this brings us back to economy — the 5000A single-channel scope is $595 and the 5002A dual channel is $845. Call Hickok to take a look at these scopes in your lab.



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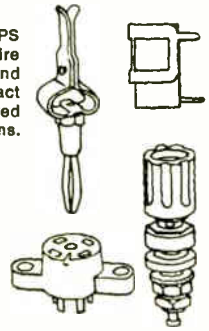

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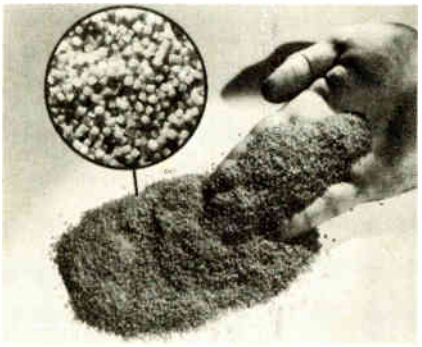
New Products/Materials



Alloyed plastic material is for deburring metal and plastic parts and for cleaning electronic connectors and circuit boards. Called Blas-Tic, the material has high tensile, compressive and flexural strength, combined with comparatively low hardness. It is dust-free and rounds rapidly into an operating mix. Blas-Tic is sold in 50-pound bags and 250-pound drums.

Media Technology Corp., 4916 Leafdale Blvd., Royal Oak, Mich. 48073 [476]

Thermally conductive adhesive can increase the efficiency of high-wattage semiconductors by providing a low-heat-resistance bond to heat sinks. Designated type 341, the material is a two-part adhesive that can be used where glue lines of 0.001 in. or less are required. Price is about $15 a gallon.

Castall Inc., Weymouth Industrial Park, East Weymouth, Mass. 02189 [477]

Silicone material acts as a moisture barrier in electronic applications and is designed to stabilize semiconductor junctions and surfaces of diodes, transistors, integrated circuits, and thick- and thin-film circuit modules. Price is $12 per pound.

Transene Co. Inc., Route 1, Rowley, Mass. 01969 [478]

Silver-filled silicone adhesive called 190-3 is formulated especially for rf shielding applications. It contains both pure silver and silver composite filters and is a ready-to-use one-component material that cures at room temperature. The material is also noncorrosive to metals, and is available in squeeze tubes or plastic cartridges.

Ablestik Laboratories, 833 W. 182nd St., Gardena, Calif. 90248 [479]

New literature

Power switch and pilot light. Airpax Electronics, Cambridge Div., Cambridge, Maryland 21613, has published an 11-page bulletin describing the type 203 electromagnetic circuit protector power switch and pilot light. The comprehensive information includes diagrams and charts. Circle 421 on reader service card.

Optical systems. General Electric, Semiconductor Product Dept., Electronics Park, Syracuse, N.Y. 13201, has available an application note on how to evaluate light emitters and optical systems for light sensitive silicon devices. [422]

Broadband oscillators. Two backward wave oscillators are described in a four-page technical paper available from the Siemens Corp., 186 Wood Ave. South, Iselin, N.J. 08830. [423]

Printed-circuit board equipment. Electrovert Inc., 86 Hartford Ave., Mount Vernon, N.Y. 10553. A four-page brochure includes the company's line of wave soldering, infrasoldering, cleaning, pc board assembly, soldercoating and fusing, solderability testing and armature soldering equipment. [424]

Instrumentation. The Singer Co., 3211 S. La Cienega Blvd., Los Angeles, Calif. 90016, has published a 16-page brochure describing the company's line of 33 products. They include several signal generators, antennas, rf current probes and meters. [425]

Microminiature indicators. A four-page brochure describes the line of microminiature indicators available from Shelly Associates, 1562 Reynolds Ave., Santa Ana, Calif. [426]

Component networks. An eight-page brochure from Corning Glass Works, Corning, N.Y., highlights a line of resistor-capacitor-diode networks. Included are advantages in design flexibility, component density and pc board space requirements. [427]

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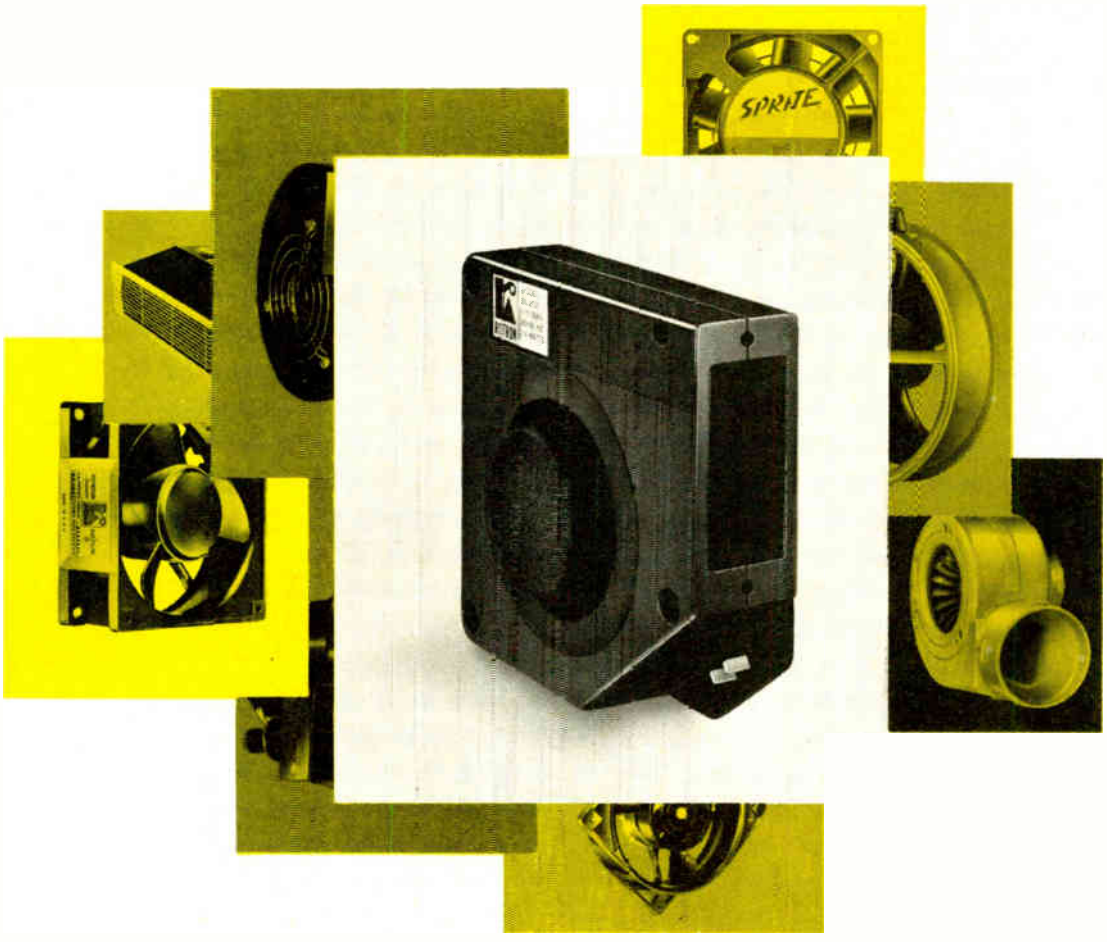

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New Literature

Recorder. Kontron Inc., P.O. Box 702, Princeton, N.J. A laboratory-type strip chart recorder is described in a product brochure. [428]

Pc terminal boards. A design guide is available from Kulka Electric Corp., 520 S. Fulton Ave., Mount Vernon, N.Y. 10551, covering technical data on four series of terminal strips for use with printed-circuit boards of the type designed for wave soldering. [429]

Inductive components. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138. A 20-page bulletin includes design advice on the selection of filter types and a glossary of filter terms in addition to specifications of inductive components. [430]

Keyboards. Sixty-six-key and 53-key ASCII coded keyboards are detailed in a bulletin from Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085. Included are legends, formats and panel cutout dimensions. [431]

Light beam recorder. Gulton/Tecni-Rite, Rte. 2, E. Greenwich, R.I. 02818. A data sheet details the model TR-180 LB portable 18-channel light beam recorder. Information includes specifications, charts, and data on accessories. [432]

Panel meters. A handbook of digital panel meters is available from Digilin Inc., 1007 Air Way, Glendale, Calif. 91201. The comprehensive manual contains 60 pages of specific information on how to use DPMs, pitfalls related to common applications, and various forms of analog-to-digital conversion. Add-on options are also shown, including amplifiers, active filters, and linearizers. [433]

Pollution monitor. Theta Sensors Inc., 1015 North Main St., Orange, Calif. 92667. A technical data sheet is available describing the model SP-1000 source emission sample conditioning system that can be used as a fixed or a portable unit in air-pollution monitoring. [434]

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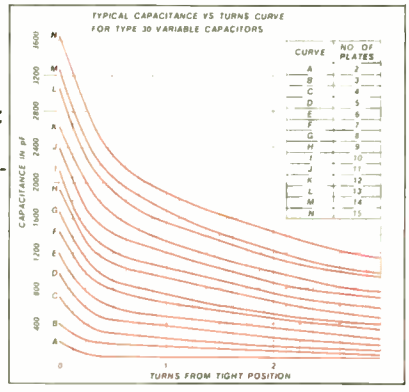

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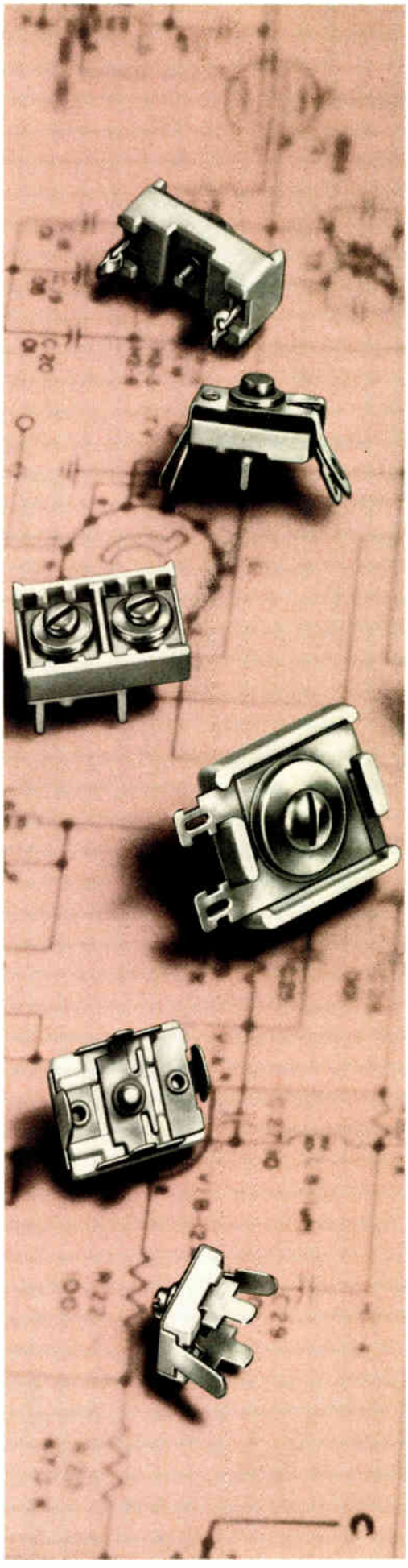


International Newsletter

March 13, 1972

IBM reduces prices in Germany, Japan

IBM heated up the competition in Japan and Germany by decreasing prices in effect since September 1969 on System/370, 3, and 7 mainframes and peripherals. **In Germany, prices were reduced 3.8%, effective March 1 for purchases and April 1 for rentals.** In Japan, reductions were effective March 1, for both rentals and purchases of the System/370 mainframe and some attachments, the System 3/6 mainframe and a number of peripherals, the System/7, and the model 129 data recorder. **Reductions in Japan averaged 1.3% for the System 370 CPU and 8.6% for I/O devices,** a spokesman said, with variations according to the equipment. Reductions on a complete System/370 average 3%, he added, although prices abroad are still higher than they are in the U. S.

Thin film used for alterable memories

Another avenue to alterable holographic memories has been paved by development of a thin film of arsenic selenium germanium glass by the Musashino Electrical Research Laboratory of the Nippon Telegraph & Telephone Public Corp. Information can be stored in holograms or in any other format possible with ordinary photographic plates at about the same resolution. The thin film is composed of glass evaporated on a substrate as a 0.5- to 1-micrometer-thick layer. In its annealed state, it has fairly high light transmission capability. **For writing, a light beam with energy density of about 0.1 joule per square centimeter darkens the material to a contrast ratio on the order of five or six to one, also changing the refractive index slightly.** Holograms thus produced are brighter than those based on density difference. **A light beam with energy density of several joules per square centimeter can erase selectively, or an entire plate can be erased by heat annealing.**

Japanese to buy Philips computers

Philips has received the largest single foreign computer contract in its history. Worth nearly $2.4 million over the next three years, the order came from a Japanese electric company, a spokesman in Germany says, but he declined to identify the customer. The order is for 200 small programable models, P850, P855, and P860, to be used primarily for technical-scientific problem solving, process control, and intelligent terminals. **The P800 computers are built by Philips Electrologica,** a subsidiary of the Dutch Philips Gloeilampenfabrieken.

Facsimile uses compression. . .

Subscribers using a new high-speed digital facsimile system between Tokyo and Osaka, Japan, will save enough on leased-line charges in a year to pay for the new equipment, says the developer, Fujitsu Ltd. **The system uses bandwidth compression on ordinary telephone lines with a bandwidth of 0.3 to 0.4 kilohertz, rather than the 48-kHz bandwidth required with present high-speed analog systems.** The company, now taking orders, plans to begin shipping equipment in June or July. The new system sends data at 4,800 bits per second, with resolution of six lines per millimeter.

Using a so-called run-length system, a digital signal indicates distance along a scanned line from the last previous change. Two lines are scanned at a time, with pick-up of two picture elements on each line.

International Newsletter

. . .to transmit on telephone lines

Three of these elements are considered references, and the fourth element is a check to assure that it has the value predicted by the algorithm from the other three. If the value differs, that signal is sent.

Information sensed in excess of transmission capability is stored in memory until it can be sent. The system uses a one-line n-channel MOS buffer memory of about 8 kilobits and a supplementary memory of several tens of kilobits to store data in excess of a modem's transmission capability. **Transmission time averages 40 to 50 seconds for an ordinary printed page of book size.**

International group to build ESRO satellite

West Germany's Messerschmitt-Boelkow-Blohm GmbH will head a consortium to develop and build the $23 million gamma ray research satellite, COS B, for ESRO, the European space research organization. Members of the consortium are the U.K.'s British Aircraft Corp., Spain's Construcciones Aeronautica SA, Belgium's Etudes Techniques et Construction Aerospatiale, Italy's Selenia, and France's Société Nationale d'Industrie Aerospatiale.

COS B, weighing 280 kilograms, is to be launched into orbit Sept. 1, 1974, from Kouru, French Guiana, aboard a Europa 2 launch vehicle. The main objective of the satellite is to study gamma radiation, especially energy spectrum, intensity, and distribution of direction of incoming radiation. The scientific payload weighs about 120 kg.

Philips Plumbicon is Toshiba target

Toshiba, taking dead aim at the color TV vidicon market now dominated by Philips Plumbicon tubes, has launched its Hisensicon E5040 series, made with a lead oxide photoconductive layer. **Toshiba says its tube is a plug-in replacement for the 30-mm Plumbicon, but does not infringe on Philips patents.**

New computers due from East Germans

Watch for the East German electronics industry to unveil the initial model of a third-generation computer family and a third-generation process computer March 12-20 at the Leipzig Spring Fair. The new series from state-owned VEB Kombinat Robotron, will succeed the country's workhorse Robotron R300 second-generation machine. Western experts say the new computers have been developed at the urging of the East German government. **Development is said to have been coordinated with other East-bloc countries to avoid duplication of designs.**

IR vidicon operates at room temperature

Infrared TV Vidicon tubes that operate at room temperature are being offered by English Electric Valve Ltd. in sample quantities for $2,600 each. The company, seeking to overcome the requirement for nitrogen-cooled point detectors with mechanical scanning, has been working for many years on the development [*Electronics,* International, Nov. 9, 1970].

The tube, 6¼ by 1⅛ inches, is said to achieve thermal resolution near 1°C in the 8-14-micrometer waveband, producing a 100-line TV picture at standard frame rates. For static scenes, the tube needs a chopper in front because the pyro-electric target gives an output only when the radiation incident on it is changing.

Laser link hops 3.4 miles, even in poor weather

Siemens connects two Munich plants with a 14-inch beam that diverges to 6 feet

Scrapping the popular image of a laser beam as a pencil of light with a nearly uniform diameter from one end to the other, engineers at Siemens AG have deliberately widened the beam to build a virtually all-weather communications link.

Over an experimental 3.4-mile link connecting two Siemens facilities in Munich, researchers have achieved excellent communications even at atmospheric attenuation levels of 8 decibels/kilometer—much higher than the level at which other laser links falter.

The most striking physical feature of the Munich link is its unusually thick laser beam. More than 14 inches in diameter when it leaves the transmitting station, the beam diverges to nearly 6 feet at the receiver. This divergence, together with the use of a carbon dioxide laser, accounts for the link's high immunity to atmospheric conditions.

Window. The infrared ray of the CO_2 laser is far less weather sensitive than is the visible beam of a helium-neon laser because its wavelength falls within an atmospheric "window." The link's laser has a wavelength of 10.6 micrometers, and output power is 5 watts.

The large beam divergence insures that even under unfavorable conditions at least part of the transmitted laser energy arrives at the receiving terminal, where the beam may shift as a result of disturbances by as much as three feet before it misses altogether.

Only when atmospheric disturbances cause an attenuation exceeding 8 dB/km has the present setup failed to function satisfactorily. Above that level, Siemens says, even a CO_2 laser beam is subject to meteorological factors, such as absorption of water vapor and carbon dioxide in the air, scattering of light by minute water or dust particles, or air turbulences resulting from lateral wind currents or solar radiation. These factors cause the beam to bulge out, to shift, or to vary in intensity.

More to come. The Siemens researchers are confident, however, that with certain system refinements, the limiting atmospheric influences can be made to have a less critical effect. They are considering the use of heterodyne principles together with optical narrow-band filtering. Another idea is to employ a higher powered laser. Such design factors should result in a five-fold improvement in performance, making possible laser communications through the free atmosphere at attenuation levels of 40 dB/km, or 200 dB over the 3.4-mile link.

At its present state of development, the experimental system allows communications at visibility distances as small as 1,000 yards—in other words, communications are possible even through heavy haze, moderate rainfall, fog, or snow. The link which is set up between two Siemens facilities in Munich's Obersendling and Giesing sections, crosses one river, two heavily-used traffic arteries, and three streetcar lines. Most other experimental links, a Siemens man says, are set up in flat terrain and in more favorable environments.

The 3.4-mile experimental link consists of two terminal stations using Cassegrain telescopes in their optical antennas. Each telescope is made up of a concave objective mirror lens about 14 inches in diameter and a convex ocular lens measuring roughly 1.25 in. in diameter. The distance between lenses is 70 in.

Path. The modulated laser beam goes through an axial opening in the objective lens to the ocular lens, which reflects and at the same time fans out the beam. It then bounces off the objective lens and is finally radiated from the telescope.

The information to be transmitted is modulated at the sending terminal onto the CO_2 beam by way of a gallium-arsenide modulation crystal, which converts the electrical signals into intensity-modulated laser signals. At the receiving end, a small focusing lens projects the beam coming from the receiving telescope onto the detector. This detector, a germanium semiconductor type doped with gold atoms and cooled by liquid nitrogen, changes the received laser signals back into electrical signals using its inherent photoconduction effect.

Great Britain

Automating check-out of mobile radio transceivers

With its output of mobile radio transceivers expanding at a 10% to 15% annual rate—and demand rising at least as fast—Pye Tele-

communications Ltd. had a hard time finding enough trained personnel for its check-out staff. So it decided to find another answer.

Now on line is completely automatic test gear that can check out transceivers all the way up to transmission frequencies, which in Britain can reach 470 megahertz. The old check-out routine called for automatic testing at dc and low-frequency ac—up to 450 kilohertz. But all radio frequency tests were done manually or semiautomatically. Pye's new equipment, developed with Marconi Instruments Ltd. and Honeywell Ltd., relieves a bottleneck in production, which last year totaled about 70,000 transceivers.

Marconi has supplied two complete auto-testers and Honeywell one. All are designed to process between 7,000 and 8,000 printed circuit boards or about 800 complete sets in a 60-hour week. So far, one Marconi tester is fully operational, checking out about 400 transceivers and 3,000 boards a week.

Two-way improvement. John Churcher, Pye's quality assurance manager, says its performance so far indicates a rate of return on investment of about 30% from two improvements alone—a reduction in final test time for a complete set from 30 minutes to 3 minutes, and a much lower defect rate at final test due to vastly improved printed circuit board testing.

The fault rate at final test has dropped from an average of approximately one per transceiver to one per six transceivers. This rate of return on investment does not count spin-off benefits such as fewer warranty service claims due to more accurate testing or the improved feedback from production to design because full test result print-outs are available.

Churcher says that as far as he knows no mobile radio maker has automated testing above 10.7 MHz—a common i-f frequency. At the final test stage, auto-testing means that approximately twice the number of tests can be applied—about 45—with an order of magnitude greater accuracy, and in an order of magnitude less time. For board tests it's not so easy to generalize, but roughly speaking Pye has doubled the number of tests per board, which can be done in 25% less time. Both time comparisons include loading and unloading.

Because auto-testers can be operated by relatively unskilled workers, it has been possible to move the small number of more highly skilled testers up from testing to fault diagnosis, easing one of Pye's other labor problems. These men use the auto-test print-out to locate faulty components.

Some handwork. Alignment of transmitter and receiver is still carried out manually, because it's not possible to automate that function completely and semiautomation wastes a disproportionate amount of autotester time. Thus, Churcher says, the best economic tradeoff is to do it entirely manually.

Churcher cautions that anybody wanting to automate testing ought to do some deep thinking to determine where best in the production process to do the tests—and how many to do—to get the best return on the large capital outlay involved.

The best distribution of tests, says Churcher, is ultimately determined by the incidence of statistically random component failures, which the test systems engineer must know. Pye started off applying a blanket check involving about 40 tests to an average board, but by re-arranging the tests into a graded sequence based mostly on probability, Churcher has cut the average to about 15 without increasing defects in assembled equipment.

Multiplexing cuts error rate as channels decrease

Two electronics teachers, applying what they teach, have built a digital data multiplexer working on a new principle. They've taken up an idea proposed by a German engineer, Henning Harmuth of Leopoldshafen, that information can be carried in modulated code words.

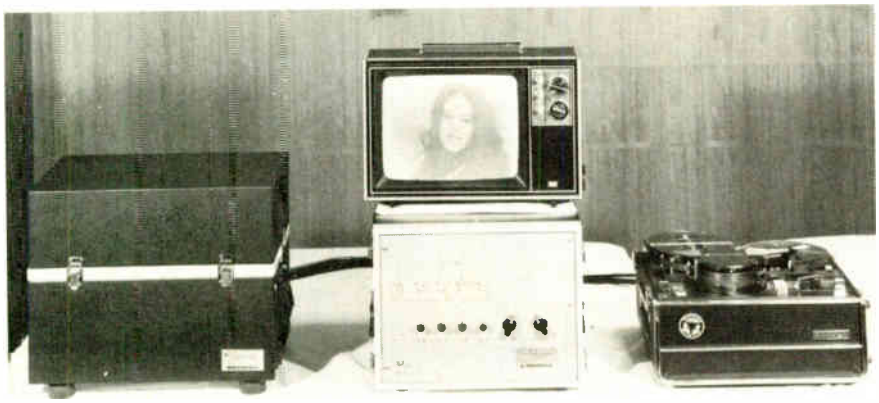
The way the two men—Robert Barrett and John Gordon of Hatfield Polytechnic at Hatfield, Hertfordshire—have worked it out, the system has an advantage over time-division and frequency-division multiplexing. Its transmission error performance improves automatically, without any manipulation or extra circuitry, as the number of channels in use falls off from the maximum available. If a system is built for standard error performance with all channels in use—which will cost no more than for TDM or FDM, according to Gordon—there is a bonus of free extra reliability during off-peak periods.

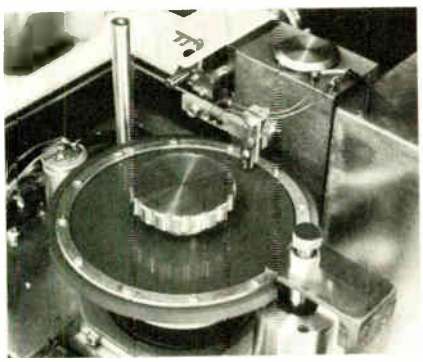
The work has been financed by the Defence Ministry's Signals Research and Development Establishment (SRDE), which may take it up at some future time. For the military, the potential advantage is that deliberate suppression of some channels could provide a very high degree of freedom from errors, if that were necessary. On the snag side, an individual system is at present limited to seven channels, so that there may be problems in fitting it in with conventional 12-channel systems

In code. Basically, a digital code word transmitted unaltered represents a 1 and transmitted inverted represents a 0. The received signal is demodulated by comparing it with the original code word. Obviously, transmitting a whole code word of several bits to represent a single data bit is grossly wasteful.

The achievement of the two researchers is in working out how to reduce the number of transmitted bits to equal the number of data bits, plus an allowance for synchronizing bits. They claim the data content of the pulse stream is the same as for tdm, and they lose nothing in obtaining better error performance at part capacity, at least in a seven-channel system.

Each of the seven channels has its own individual code word, seven bits long, which is repeated indefinitely together with an eighth synchronizing bit. The seven words are exactly parallel, in the same time slot. Each is a combination of three 0s and four 1s, which is reversed when the word is inverted to trans-





Black box. Two-speed magnetic sheet recorder is the heart of narrowband telephone TV system. Both transmitting and receiving station (above) have one.

mit a data 0. The code words are generated in parallel in a function generator, pass through a modulator where they are inverted or left alone, and then, still in parallel synchronism, pass bit by bit into a majority voting gate.

This gate scans the first bit of all seven words, and puts out a 1 if there are more 1s than 0s in the seven leading bits, and a 0 if there are more 0s than 1s. Because there are seven channels, there must always be a clear majority. This action is repeated for the second bits, third bits and so on. Thus, the majority gate puts out a seven-bit word representing the seven parallel data bits in the seven channels. It is this word that is transmitted.

At the receiving end, the transmitted word is compared, bit by bit, with all seven unmodulated code words. If the transmitted word is more like a code word than it is unlike, a transmitted data 1 is registered. If it is more unlike than it is like, a data 0 is registered.

The demodulation is done by feeding the transmitted word into a seven-bit parallel-output shift register and comparing it with the code word hard-wired into a majority gate. The gate produces an output if there are more like characters than unlike. Hence there are seven demodulation gates, one per channel.

Gordon has a laboratory setup to demonstrate that this system of multiplexing by majority vote and demultiplexing by comparison and majority vote works accurately. However, he can't find more than seven code words that give unambiguous results. And he hasn't worked out a theory of why the error self-correction properties of the system improve as the number of channels in use decreases.

But by introducing deliberate random errors, he shows that performance improves until, when only three channels are in use, all single-bit errors in received seven-bit frames are corrected automatically in demodulation. When only one channel is being used, incoming frames can have up to three bits wrong and the demodulated data is still correct.

Japan

Video sheet recorders drive narrow-band TV telephone

While telephone administrations the world over debate on the future of television telephones and the required bandwidth, engineers at Matsushita Electric Industrial Co.'s Wireless Research Lab have developed an efficient method of transmitting television pictures over ordinary telephone lines.

The limited information transmission capacity of the telephone line restricts the system to still pictures, but there is no requirement that the object or diagram being televised be stationary because the still picture can be an instantaneous snapshot of the moving image picked up by a camera.

A single field extracted from a camera signal is stored in a video sheet recorder at the sending end. After the field has been recorded, its time scale is lengthened from the normal 1/60 second to 30 seconds by slowing down the recorder. This conversion decreases the maximum frequency sufficiently so that a signal can be transmitted over a normal 0.3- to 3.4-kilohertz telephone channel.

Fields. At the receiver, another sheet recorder records the incoming signal at the slow time scale and then reproduces it in the normal time scale. The signal is then recorded on a video tape recorder that has had its mechanism modified for intermittent motion of the tape. The tape, stationary for the recording and playback of individual fields, advances between fields. This permits continuous reproduction of individual fields, which appear as stationary images on the monitor until the next field has been completely received and transferred from the sheet.

The tape recorder acts as a file memory for the fields that have been received. Fields are displayed continuously for about 50 seconds, which includes the 30 seconds required for transmission of each succeeding field and the 12 seconds needed to accelerate the sheet recorder up to the normal-time-scale speed.

The system only transmits one of the two fields making up each frame of the television picture. This is a compromise between resolution and shorter transmission time. The bandwidth of the video signal is lim-

ited to somewhat more than half that of the original signal, both to give equivalent resolution in horizontal and vertical directions and to achieve a further saving in transmission time.

Retaining resolution. Overall resolution of the transmitted picture is at least 200 lines horizontally and 170 lines vertically. The signal-to-noise ratio of received pictures is at least 30 decibels, which is more than sufficient for transmissiion of head images of individuals or even groups of several persons, large letters, and even not too complex diagrams.

Scan conversion is performed by a newly developed video sheet recorder. In this unit, the head remains at the same location until the track underneath it becomes worn out, and then the head is advanced to the next track manually. However, track life is extremely long because the head merely rests on the sheet, with a force of several grams supplied by gravity. When all tracks become worn out, replacement of the magnetic sheet is simple.

The sheet provides the required scan conversion by rotating at 3,600 revolutions per minute for recording or playback of standard television signal, and 2 rpm for playback or recording of the narrow-band video signal.

Two-motor drive system. The turntable is mounted directly on the shaft of an induction motor used for high-speed drive. A sheet with a magnet embedded at one point rotates on the same shaft and operates a reed switch, which senses both speed and phase of the turntable to control motor slip. Low-speed drive consists of a brushless dc motor, which drives a rubber tire on the turntable rim.

A single field signal is initially recorded as a frequency modulated carrier that has frequency of 3.5 megahertz at sync pulse peaks and 5 MHz at white peak. Because the original video signal has frequency components up to about 3 MHz, there are sidebands that make the spectrum of the modulated signal extend from about 0.5 MHz to about 6.5 MHz. However, much of the upper sideband is cut off because it exceeds the frequency capabilities of the recorder.

When the turntable is switched to low, reproduced frequencies become 1/1,800 of their original frequency, reducing the white peak to 2.78 kilohertz and the sync pulse tips to 1.94 kHz. The lower sideband—which extends down to about 278 Hz—is almost completely transmitted, but much of the upper sideband exceeds the capability of the telephone transmission line.

France

TI harvests technological crop of ideas in Europe

Texas Instruments is reaping unexpected bonuses from its widespread European operations as its own foreign employes contribute technology that can be applied in other TI plants. Two recent examples are a new process for automatic gate alignment originated by the French staff and a new highly-automated bonding machine designed and built by the German staff of TI-Deutschland, with an assist from U.S. specialists.

And the French are especially proud that TI's new SATO process, for self-aligned thick oxide, [*Electronics*, Jan. 3, p. 89] for use in large-scale integration MOS circuity was developed in large part from work done in the laboratory at Villeneuve-Loubet, just up the French Riviera from Nice. "Admittedly, the reverse is more often true," says one Frenchman who helped conceive the process. "Usually we are the beneficiaries of advancements made on the American side."

The French R&D team spent about three years working out its so-called Samnos method, for self-aligned metal nitride oxide semiconductor. TI in Dallas followed the French work closely as it was reported in the regular monthly technical reports that foreign plants make to the home office. U.S.-based TI engineers also looked in on Samnos progress on their periodic visits to the French plant.

The American researchers took up a parallel project and emerged with SATO, which was put into production commercially a few months ago. Exactly how much the Americans borrowed and how much they developed on their own remains a delicate subject in the atmosphere of rivalry that resulted between the two contributing teams.

The French say the two techniques are "very similar" except that the French were using metallic masking techniques. "Our work was valued by Dallas," one researcher says, "and there's no doubt we were ahead much of the way and played a key role in SATO's development."

SATO is being promoted as a process that beats the other three standard methods of MOS LSI gate self-alignment—silicon gate, molybdenum gate, and ion implantantion. In SATO, the gate electrode overlaps the source and drain region but is separated from the diffusion by thick oxide. TI says its "significant departure" from the other three self-alignment methods was the use of silicon nitride as a diffusion and oxidation mask. The high density of silicon nitride makes a 1,000-angstrom layer sufficient to serve as an effective mask.

Bonder. On the mechanical side, TI's German staff came up with plans for a new bonding machine. Dallas liked the idea well enough to provide special development funds for the project about a year ago. The result is a still-secret bonder that, according to TI-France production manager Bernie Yurin, increases production 260% on 14-pin circuits. It is being built in Germany, Italy, France, Formosa, and Singapore and machine installation already is well under way.

Stewart Carrell, TI's vice president in charge of European operations, is a believer in multinational input in the electronics industry. Aside from technical benefits, Carrell says, he likes individual plants to have a mixture of "nationalities and mentalities" in management. "It enhances communications immensely," he says.

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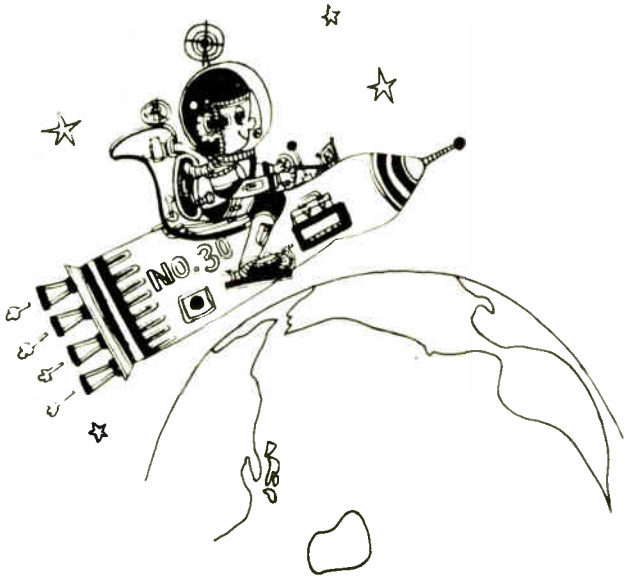

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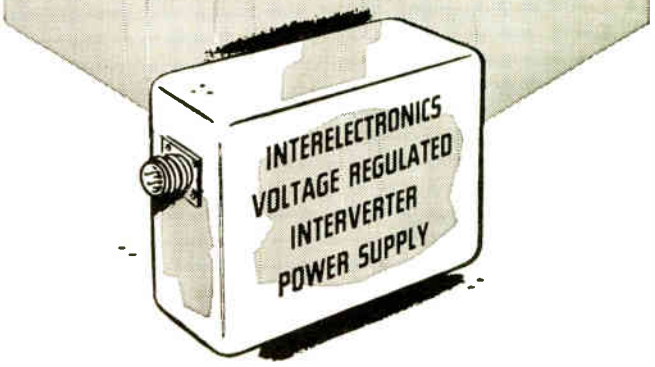

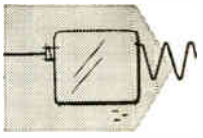

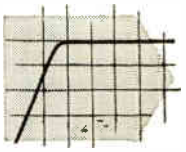

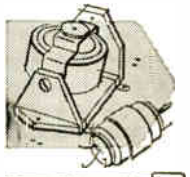

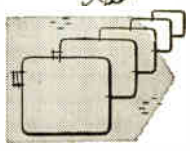

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21	46	71	96	121	146	171	196	221	338	363	388	413	438	463	956
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23	48	73	98	123	148	173	198	223	340	365	390	415	440	465	958
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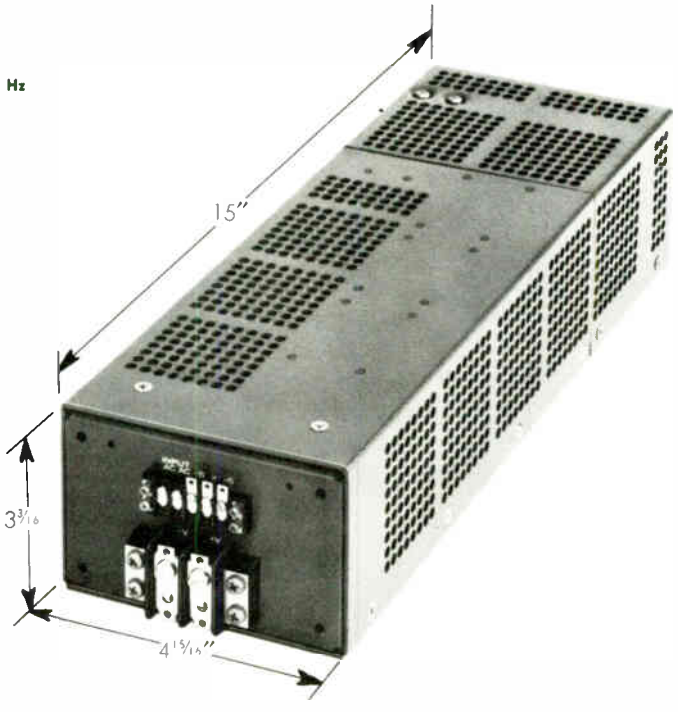

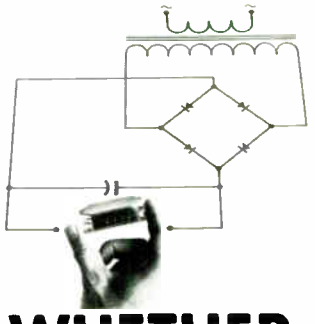

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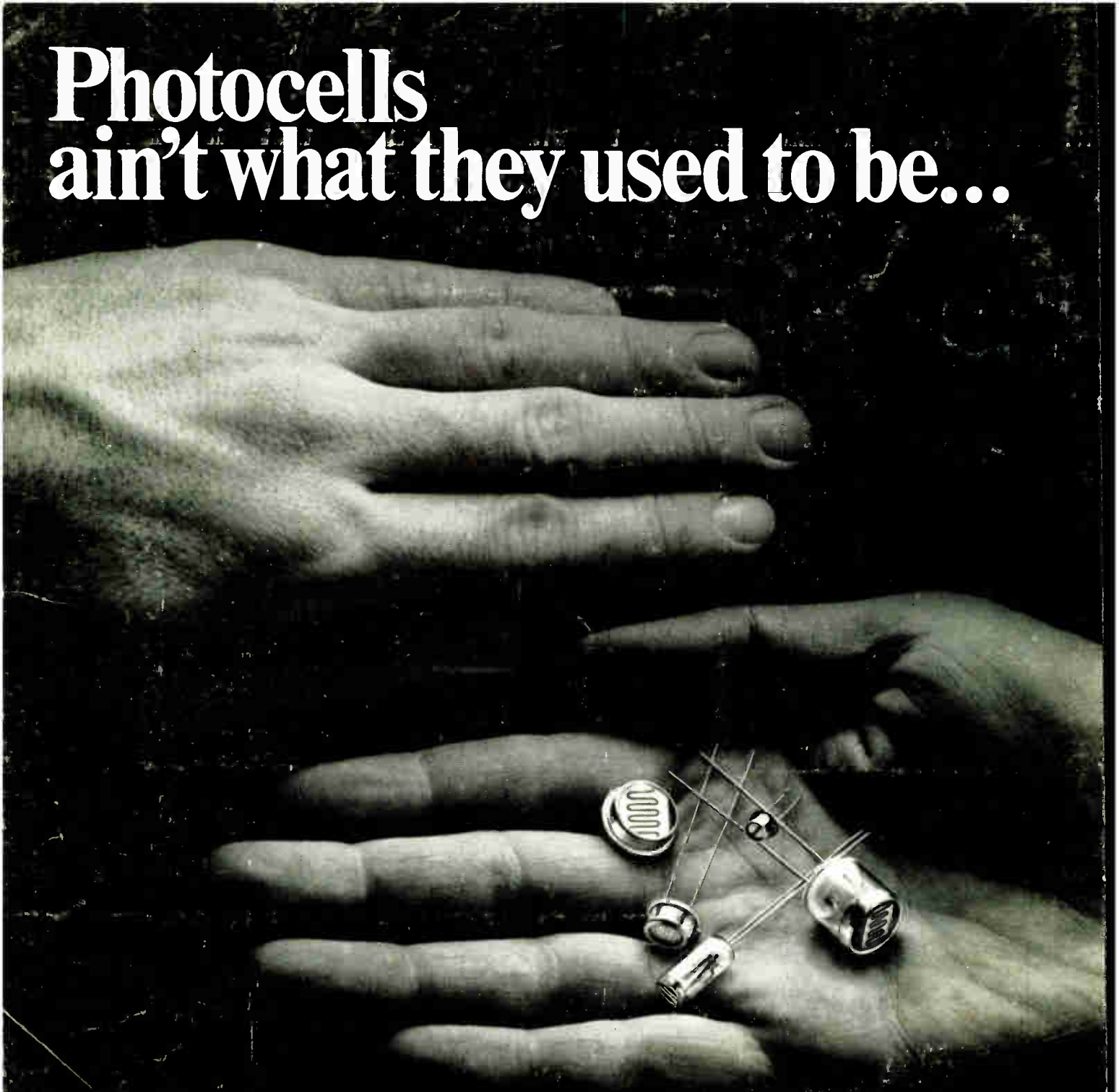

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