June 13, 1974

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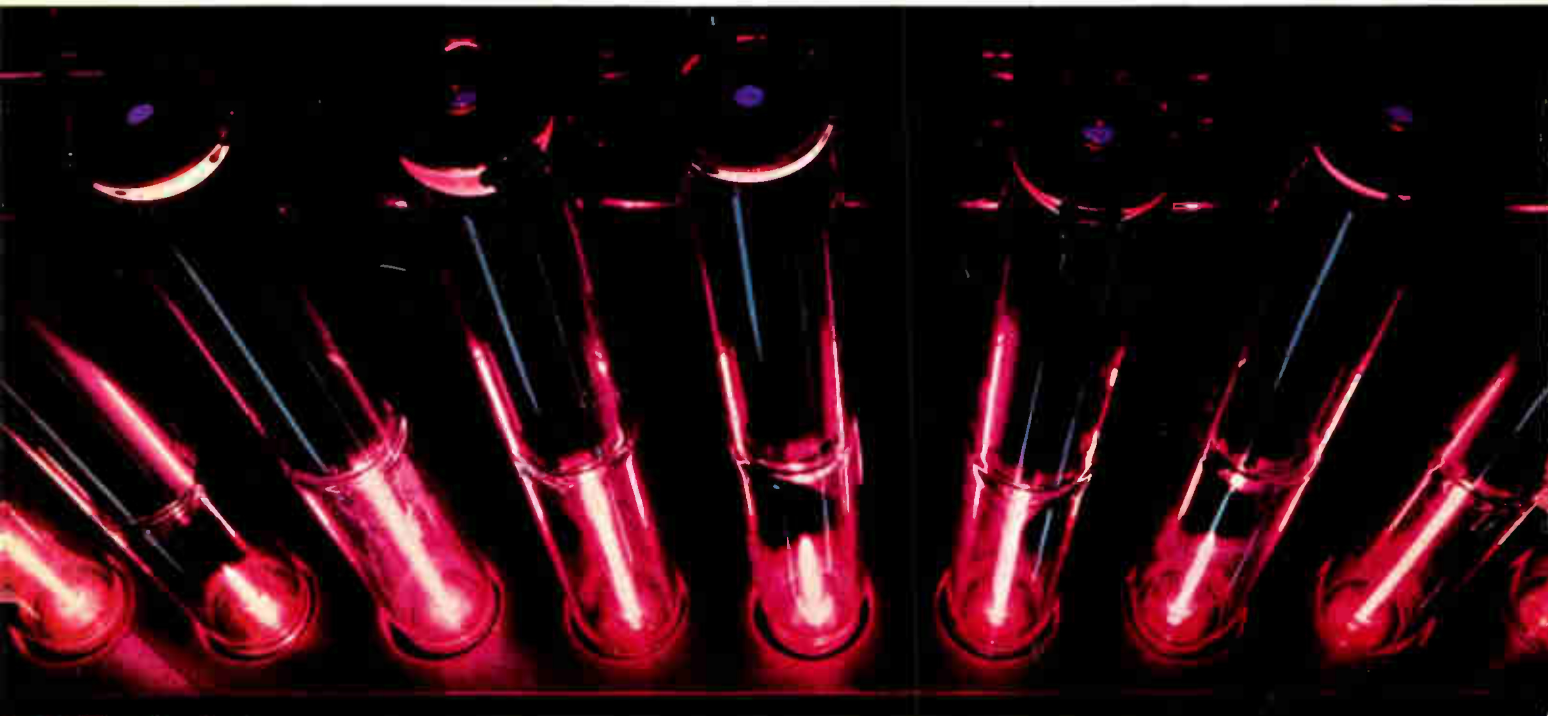
Electronics®



LOW COST LASERS LINE UP FOR NEW MASS MARKETS

Monitoring System. Means for obtaining a penumbra shadow light beam from a source and for projecting this shadow through an optical system to a motion picture film with means for vibrating this shadow in accordance with a signal to be recorded. Simultaneously a second light beam is obtained from the source coaxially with the optical axis of the optical system for the observation of the condition and position of the incandescent element which provides the light for the penumbra shadow. M. T. Schomacker, RCA. Sept. 1, 1939. No. 2,270,350. See also No. 2,270,247 to C. N. Batsel dealing with the production of beams of a predetermined shape, the light forming means providing a linear relationship between the amplitude of the sound waves and the amount of said beam passing to the film over a range of signal amplitudes of the sound waves corresponding to 80 percent of the film range and a non-linear relationship between the amplitude of the sound waves and the amount of beam passing to the film over a higher range of amplitudes of the sound waves, this higher range being recorded in the remaining 20 percent of film range.

Sound Recording System. A movable armature actuates the mirror which vibrates a beam of light with respect to a film and surrounding this armature is an inductance with the means for impressing currents having varying amplitudes and frequencies on the inductance for moving the armature and the mirror and another inductance mounted on the armature having voltages generated in it directly proportional to the movements of the armature and the mirror. W. V. Wolfe, RCA. May 31, 1939. No. 2,270,367.

ANTENNA SYSTEMS

Vehicle Antenna. A self-contained resonant antenna utilizing a continuous portion of the structure of the vehicle as the antenna for operation at frequencies substantially independent of the equivalent electrical length of the portion of the structure utilized, containing a reactance adjacent to one end of the vehicle structure and electrically exposed to space at least in part, the reactance having a value such that the equivalent electrical length of the system is substantially equal to an even number of quarter-wavelengths of the desired operating frequency. Malcolm Bruce, Plymouth, Mass. March 21, 1941. No. 2,279,130.

Directive Antenna. A conductor positioned at an angle greater than zero degrees and less than 90 degrees to a frame perpendicularly related to the path of propagation of a wave and having a length substantially equal to a half wavelength of the desired wave plus the projection of the antenna on the path of the propagated wave. Edmund Bruce, B. T. L. Inc. Feb. 28, 1933. Re-issue No. 22,051.

Ludwig Lectures.

Getting a fix on fast settling.

In numerous linear-circuit applications where the nature of the signal is pulse-like or step-like it is essential to reach a new level quickly and accurately after a large signal transition. However, we find that we cannot predict this performance from the classical specifications of frequency response and slew rate. Therefore, a direct specification — settling time — was established which defines the maximum total time required from the occurrence of an abrupt input transition until change is *satisfactorily complete.*

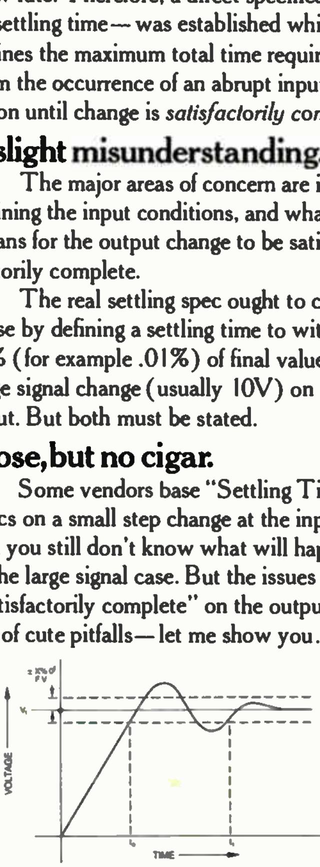
A slight misunderstanding...

The major areas of concern are in defining the input conditions, and what it means for the output change to be satisfactorily complete.

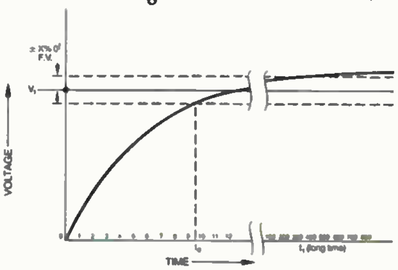
The real settling spec ought to cover these by defining a settling time to within X% (for example .01%) of final value for a large signal change (usually 10V) on the input. But both must be stated.

Close, but no cigar.

Some vendors base "Settling Time" specs on a small step change at the input and you still don't know what will happen in the large signal case. But the issues of "satisfactorily complete" on the output is full of cute pitfalls — let me show you.



Notice in the curve that the output first occurs with ±X% a full-scale-error-to-final-value at t_0 but doesn't stay within this error band. It thereafter bangs around due to the underdamped nature of the system. The real settling time should be stated as t_1.



Now look at graph B. The response is critically damped and settling seems to occur at t_0. But watch out. If we look far down scale we note that the apparent final level V_1 wasn't the final level at all. Question, how long do you wait to define what V_1 (final level) really is? You have to figure that out.

This long settling "tail" often occurs with time constants long compared to any computable electrical time constants in the system and is usually the result of less than ideal thermal management or slight pole/zero mismatch. If you're trusting your vendor's settling time measurements, make sure that you (and your vendor) understand his definition and their use of it, otherwise you're in trouble.

Who needs it?

Anyone handling signals having discontinuities needs fast settling. For example, following a multiplexer, on a PAM Bus, at the output of a DAC, in building a precision square wave, at the input to an oscilloscope, etc.

How good can you have it?

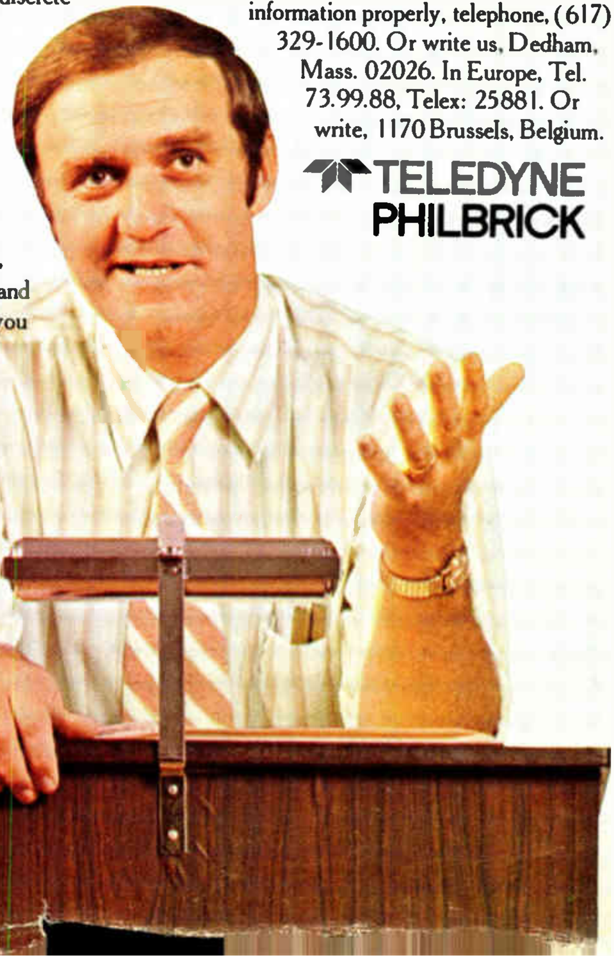
At Philbrick we give you *guaranteed* settling time because we figure your system has to always meet its spec — not just typically and that's more than just important. We offer a host of op amps, discrete modules, hybrid IC's and monolithic IC's with state of the art settling including our T099 units, 1322 (300 ns to .1%), 1324 (1 μsec. to .01%) guaranteed. The star of the show is our new DIP unit with FET inputs, the 1430, which offers 100 ns to .1% and 200 ns max to .01%. And you don't give up dc performance to get it. The 200 ns to .01% is just what you need for a fast 12 bit system and open loop gain of 200K plus, input currents of 10 pA, and offset voltage of 1mV give you the dc accuracy to go with it. The 50 mA output capability will let you drive almost anything, but you don't pay for it with high quiescent current and its attendant power consumption.

Don't settle for less.

You could have the fastest settling op amp in the world and get lousy system settling unless you're very careful. Some of the common pitfalls that catch people are things like too much load capacity, too much summing point capacity, too high a circuit impedance for the stray and input capacities, use of inductive wire-wound resistors, and not figuring on the effect of current source output capacities in current-to-voltage converter applications. You've got to handle your power supplies very carefully too, by bypassing up close to the unit with the right kind of capacitor.

In any event, to make sure you get the right story on settling time and use the information properly, telephone, (617) 329-1600. Or write us, Dedham, Mass. 02026. In Europe, Tel. 73.99.88, Telex: 25881. Or write, 1170 Brussels, Belgium.

TELEDYNE PHILBRICK



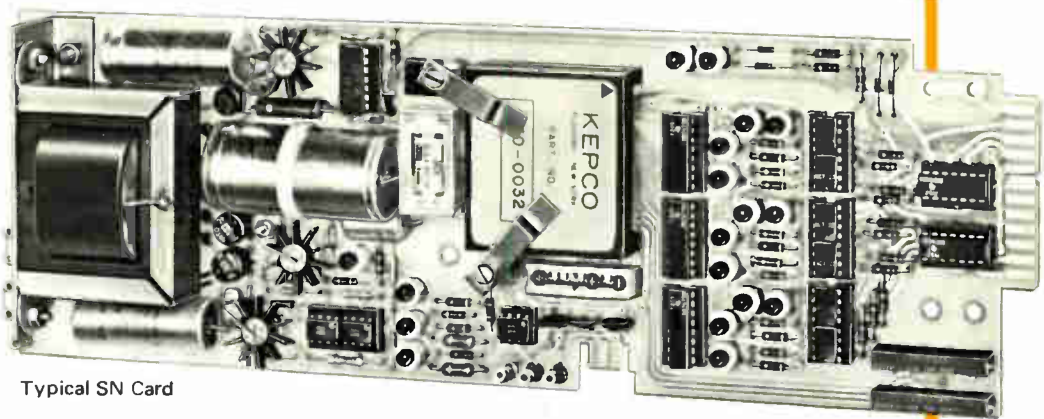
Dave Ludwig
Director of Engineering

on reader service card

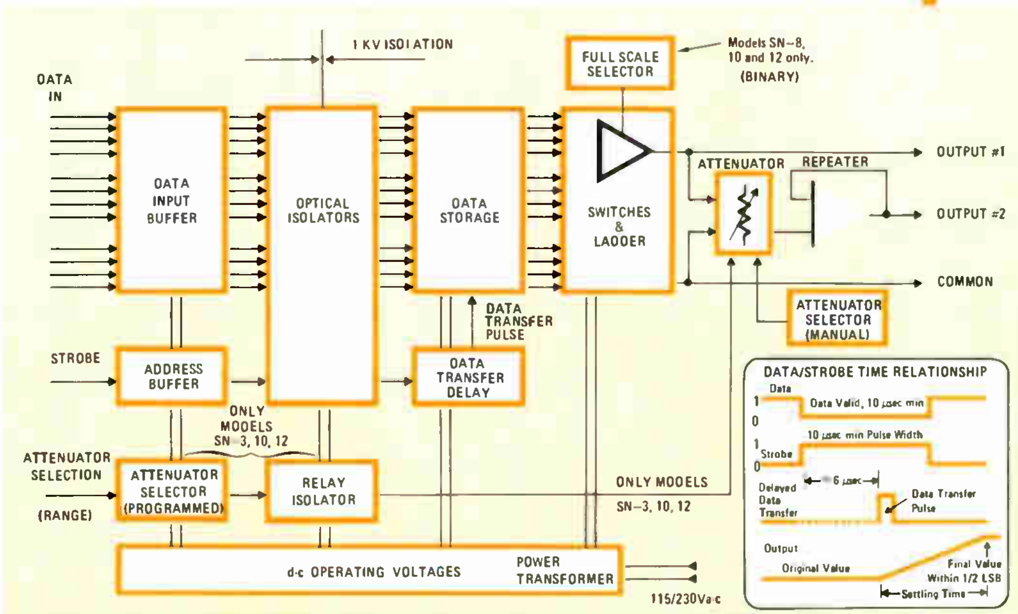
KEPCO

programming interface

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

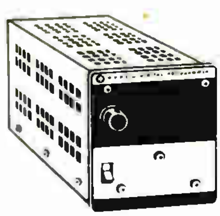


Typical SN Card



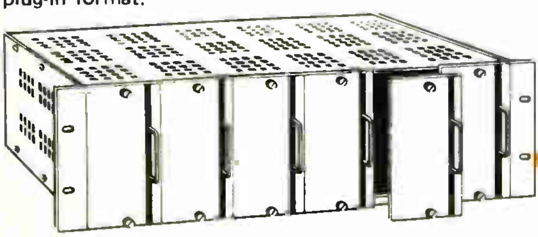
SPECIFICATIONS	MODEL SN–2	MODEL SN–3	MODEL SN–8	MODEL SN–10	MODEL SN–12
RESOLUTION	2-Digit	3-Digit	8-Bit	10-Bit	12-Bit
INPUT DATA CODING	COMPLEMENTARY BINARY CODED DECIMAL 4 LINES PER DIGIT 8–4–2–1		BIPOLAR OUTPUT: COMPLEMENTARY OFFSET BINARY UNIPOLAR OUTPUT: COMPLEMENTARY BINARY		
ACCURACY @ 25°C (% OF FULL SCALE READING) SCALE FACTOR ERROR(1)	±0.2%	±0.1%	±0.1%	±0.1%	±0.05%
ZERO OFFSET	ZEROING TRIMMER IS BUILT-IN.				
LINEARITY	±0.2%	±0.05%	±0.2%	±0.05%	±0.01%
PRICE	$370.00	$532.00	$370.00	$469.00	$571.00

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



The CA–6 enclosure accommodates 2 SN Cards.

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

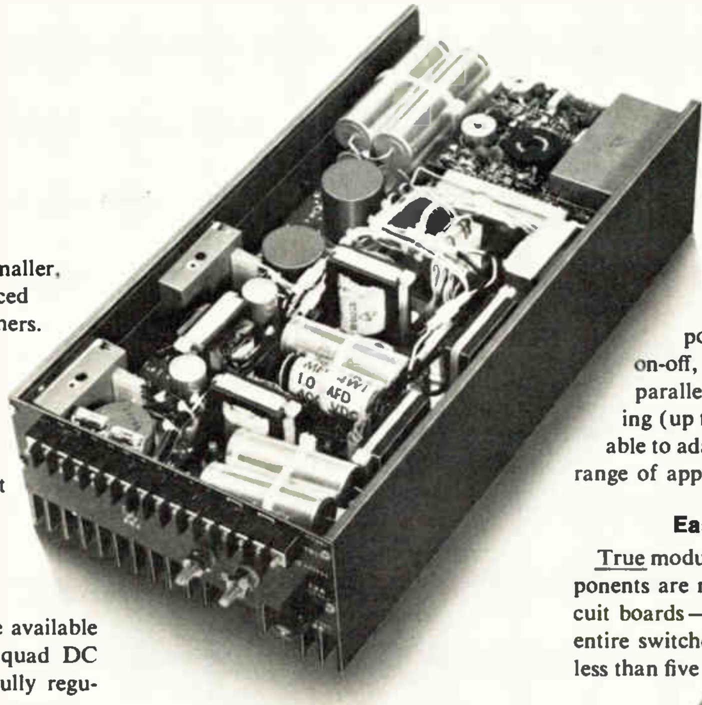


For complete specifications and applications notes, write Dept. EH–14

KEPCO

KEPCO, INC. • 131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352 • (212) 461-7000 • TWX #710-582-2631 • Cable: KEPCOPOWER NEWYORK

New! A 600-watt, 5V, 100 amps switching regulated power supply that has four outputs, measures just 3.9″ x 7.5″ x 16.12″, weighs only 14 lbs., is 75% efficient and costs only $493.*



And LH has 84 other equally exciting models to choose from — all of them smaller, lighter, more efficient and priced lower than competitive switchers.

250 to 1500 watts

LH offers 7 standard wattage ratings — 250, 300, 500, 600, 1000, 1200 and 1500** watts. This is the most comprehensive line of high-efficiency switchers available anywhere.

4 outputs

Standard LH switchers are available with single, dual, triple or quad DC outputs. Primary output is fully regulated. 2nd, 3rd and 4th outputs are semi-regulated, but may be fully regulated for $30 per output.

Low DC voltage, high power outputs

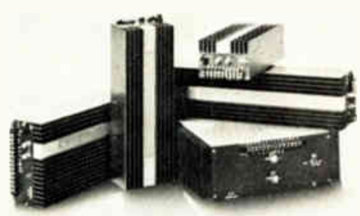
Primary voltages are at 5 VDC; 50, 100, 200 and 300** amps. 2nd and 3rd voltages are standard ±12, ±15 and ±18V at 8 amps each; 4th voltage is 24V at 2 amps. Other voltages available.

Input voltages externally selectable

110/220 VAC, 47 to 440 Hz, can be selected by simply changing a jumper on the front terminal strip. DC input, 24 to 300 VDC, also available.

6 case configurations

All LH switchers use one basic *proven* design and package it in six different case shapes — wide and short or narrow and long — for customer convenience. With a nominal power density of 1.37 watt/cu. in., LH switchers pack more power into a smaller package than any other switchers you can buy.



80% efficient

On single output models, over 80% of the primary input power is delivered to the output terminal. On models with dual, triple and quad outputs, efficiency averages 75%.

Lighter weights

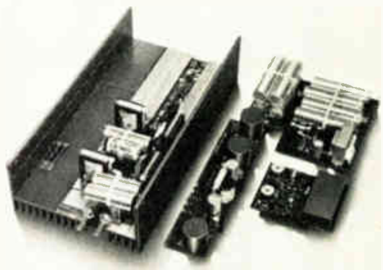
For example, LH's 250-watt single output model weighs only 7 lbs.; the 1200-watt, quad output unit, just 30 lbs.

A number of options

Over-voltage protection, power fail detection, remote on-off, thermal cutoff, DC input, paralleling, master-slave paralleling (up to 10 units) — all are available to adapt LH switchers to a wide range of applications.

Easy maintenance

True modular construction — all components are mounted on just three circuit boards — make servicing easy. The entire switcher can be disassembled in less than five minutes.



Priced as low as 63¢/watt

Watt-for-watt, LH units are the lowest priced switching regulated power supplies you can buy. In 1 to 24 quantity, a 250-watt single output model sells for $360; a 1200-watt quad goes for $1245.

Ask for full-line folder

The LH rep in your area has a new six-page folder that fully describes the 85 standard LH switchers, and discusses possible options and modifications to meet specific requirements.

Ask him for a copy today.

LH
RESEARCH

*1000 pc. qty.
**Available Sept. '74

LH RESEARCH, INC., 2052 South Grand Avenue, Santa Ana, CA 92705 · (714) 546-5279

Electronics

The International Magazine of Electronics Technology

Vol. 47, No. 12 • June 13, 1974

Highlights

The cover: Lasers penetrate big, new markets, 91
Transformation of the helium-neon laser into a safe, reliable assembly-line product has pushed the price below $100 apiece in quantity. First volume applications will probably be in label readers for the supermarket and video-disk scanners for the home.

Checkless banking is still in the balance, 75
Deterred by the high cost of computerizing every transfer of funds, banks are at present installing only partial systems. But total electronic systems will become more economical than manual processing if the flood of paperwork rises much higher.

Learning to live with FFT errors, 96
The errors that almost always accompany the fast Fourier transform are inherent in the process of digitizing an analog wave form. Being predictable, they are easy to recognize and correct.

Technology update: semiconductor RAMs, 108
Products of a technology that refuses to stand still, random-access memories on chips have expanded their capabilities enormously in the last two years. This survey first discusses the devices available today in terms of their major applications, then describes the RAMs that will hit tomorrow's market.

And in the next issue . . .
How eight European EEs view their profession . . . a two-chip analog-to-digital converter . . . speaking the microprocessor's language.

Publisher's letter

Technology Update is the name of a new series of articles that we have inaugurated with this issue. The first installment in the continuing series covers semiconductor random-access memories, one of the most active areas in all of electronics technology.

So turn to page 108 for a status report on the state of the art in semiconductor RAMs. There you'll find a summary of what's been happening recently as consumption of these memories-on-a-chip have grown from 3 million units two years ago to more than 75 million.

You'll find, too, a look into the immediate future, as Solid State Editor Larry Altman pins down the best industry estimates about near-term availability of devices, technological trends, and—most important—pricing. There's also a glossary explaining some RAM buzzwords.

This new series in *Electronics* does for our technology feature articles what another recently started column—News update (p. 54)—does for our news sections. Both are designed to bring you up to date on the wide variety of developments in the fast-moving field of electronics.

Has checkless banking bounced? That's the question we raise in the Probing the News story on page 75. The answer? No. But the pace of progress toward electronic funds-transfer systems (EFTS) has been far from rapid. Indeed, as Consumer Editor Jerry Walker indicates in the story, the "cashless society" that such systems would make possible is still a long way off.

Yet trials of such systems are under way around the country, and several aspects of the cashless society—such as direct point-of-sale credit verification and remote "convenience" terminals promoted by some full-service banks—are already catching on.

The main obstacles to electronically containing the rising flood of banking paperwork appear to be standardization and the high cost of converting from one system to another. Yet, points out Walker, "few technical problems stand in the way of EFTS. Rather its a question of organizing the computers, communications networks, and terminals into workable systems."

Thanks to the British, whose new government is reconsidering whether the United Kingdom should even be in the Common Market, component makers have won a reprieve from the terms of new European patent laws.

Dick Shepherd, McGraw-Hill World News correspondent reporting from Brussels, follows the rocky course the European nations are taking toward unity and spotted the story that you'll find on page 89. It seems that in reevaluating its own position in Europe, Britain refused, only five days before its start, to join in a meeting where a Common market patent treaty was to be signed. And, the treaty would have outlawed one of the frequently used marketing strategies of the electronic-component makers: controlling trade of their products between countries in which they have patents. But that is just one of several complaints that industry has against Europe's patent-streamlining plans. You can read about it on page 89.

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Readers comment

Overcoming waveguide noise

To the Editor: Regarding the interesting article on optical waveguides [*Electronics*, March 21, p.89], authors Thiel and Bielawski give a graph (Fig. 4, p.92) of minimum detectable signal for a photodiode-preamp combination. Ordinarily one thinks of "minimum detectable signal" as implying a noise figure on the order of 0 to 6 decibels. Their quoted figure of 10 nanowatts at 30 megahertz is about 50 dB above 300-kelvin thermal noise. I find it rather remarkable that the state of the art in this area is so poor.

Steve Smith
Quatt Wunkery
Richmond, Calif.

■*Mr. Thiel replies: The figure of 10 nW at 30 MHz is indeed much in excess of thermal noise at 300 K. Thermal noise, however, is not the relevant parameter. One must consider shot and multiplication noise in the avalanche photodiode.*

Even if followed by a perfectly noiseless transimpedance amplifier, this combination would have a noise output equivalent to a photon input at 900 nanometers of about 0.5 nW, some 36 dB above thermal noise. Photons of approximately 1.4 electronvolts of energy—and not electrons characterized by $kT = 0.026$ eV—must be detected.

To the shot and multiplication noise must be added the contributions of thermal noise within the detector and shot and thermal noise in the transimpedance amplifier.

Staking the 'wraparound' claim

To the Editor: In your article, "Energy crisis spurs development of photovoltaic power sources, "[Electronics, April 4, p. 99], reference is made to "the 'wraparound' contact technique (for solar cells) recently developed by NASA."

Ferranti Ltd. designed, developed, and produced a solar cell with a wrap-round contact (WRC) back in 1969. A number of our WRC solar cells (0,005-inch thick) are carried on the British applications satellite, Black Arrow X3, launched in 1971.

Ira S. Gewant
Ferranti Electric Inc.
Plainview, N. Y.

Now you have an alternate source for 2GHz & 3GHz microwave transistors

TRW's new 2GHz & 3GHz microwave amplifier parts are available right now, off-the-shelf, from any authorized TRW distributor. So, soon as you qualify these parts, you are no longer at the mercy of a single-source manufacturer!

And here's some more news: our transistors are **not** simply "just as good" as the originals; they're better! Gold metalized to last longer. Metal migration failure is virtually non-existent. The 2GHz parts can also withstand infinite VSWR and overdrive. Yet TRW's gold metalized parts cost the same as ordinary aluminum ones (maybe less!).

These are practically drop-in parts. You can use them right now, in your present amplifiers—and, of course, in future designs. That means instant improvement in the reliability of your amplifiers. Part for part:

	2GHz	PART NUMBERS	3GHz	
	Aluminum	**Gold**	**Aluminum**	**Gold**
1W	MSC2001	TRW2001	MSC3001	TRW3001
3W	MSC2003	TRW2003	MSC3003	TRW3003
5W	MSC2005	TRW2005	MSC3005	TRW3005
10W	MSC2010	TRW2010	—	—

For details, call Don Comm, (213) 679-4561.

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Readers comment

MIsLED Rdr RAMs Abbrs

To the Editor: The March 7 issue of *Electronics* LED me into HiNIL to improve my constitution. With this, my constitution could easily adapt to TTL, DTL, RTL, MOS, and C-MOS, all neatly packaged in DIPs.

I was sorry to hear that TI is having 4,096-bit RAM trouble, but happy to read of Motorola's CCITT modem. Perhaps I might suggest that VDO's speedometer, developed by Intermetall GmbH (an affiliate of ITT) might be used to measure the new muzzle velocity of Philips' LEP Gunn amplifier.

I let out a GaAsP when I read that RCA's Hi-Rel team can tackle my linear-IC RFQs (ouch). Now that I can change my MOS wafer in 36 hr, everyone can now mind his OEM business. It was interesting to read that T^2L has multiplied to T^3L and that 21 MPCs will now fit in a sardine can. Some of the new products, such as the static SOS/C-MOS RAM, the PS^2L, and the DAFL are great, but they are all QED and FOB Detroit. NO MOR Abbrs PLS.

Wayne M. Pope
Northern Alberta
Institute of Technology
Edmonton, Alta., Canada

■ *Abbreviations and acronyms are handy shortcuts for communicating in technical terms, but, admittedly, their over-use can become confusing to someone unfamiliar with the technology to which they refer.*

However, to minimize confusion when we use less familiar abbreviations and acronyms, we spell out the words from which they are derived the first time they appear in a story. The editors believe that it would make lugubrious reading if such terms as metal-oxide semiconductors were spelled out every time.

On dropping meter readers

To the Editor: McGraw-Edison may be dropping the meter reader because of the energy shortage [May 25, p.26], but since AT&T has no tariff structure covering the readers, we doubt that tariff is a factor.

Conrad Pologe
AT&T
New York, N. Y.

from General Instrument...

MOS KEYBOARD ENCODERS

General Instrument is now supplying N-KEY and 2-KEY Keyboard Encoders in production quantities. Each type is a single-chip MOS Read Only Memory containing all the logic necessary to encode single-pole, single-throw keyboard closures into usable codes. And each type is available as a standard pre-programmed device with a modified ASCII code. Quick turnaround is offered for custom patterns. Both encoders are supplied in 40 lead dual-in-line packages.

N-KEY (AY-5-3600)

N-KEY rollover operation, 90 keys, 4 modes, 10 bit output code, with:

- N-KEY lockout
- Output enable
- Pulse or level data ready output signal
- "Any Key Down" output

2-KEY (AY-5-2376)

2-KEY rollover operation, 88 keys, 3 modes, 9 bit output code, with:

- N-KEY lockout
- External control for selection of odd or even parity (when parity is programmed as one of the 9 output bits)

Both types also feature:

- Inputs/outputs directly compatible with TTL/DTL or MOS logic arrays
- Self-contained oscillator circuit
- Output data buffer register
- External data complement control
- Externally controlled delay network to eliminate the effect of contact bounce
- Programmable coding with a single mask change
- Static charge protection on all input and output terminals
- Entire circuit protected by glass passivation

For further information call the toll-free number below (In New York State call 516-733-3107) or write.

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A Report on the Leading Producers of Schottky/TTL:

Starting alphabetically, there's Advanced Micro Devices of Sunnyvale, California.

Advanced Micro Devices currently produces 31 different Schottky/MSI and LSI devices, making its Schottky MSI family the second largest in the world.

Of the total number of Schottky/MSI and LSI devices currently being produced by AMD, twenty-two devices are alternate source versions of the most popular designs now available, while nine devices are designs proprietary to Advanced Micro Devices.

Significantly, all Schottky/MSI and LSI parts currently produced by AMD are available to operate over the full military temperature range.

All AMD Schottky/MSI and LSI devices are built in accordance with MIL-STD-883 and MIL-M-38510.

Immediate delivery is offered on every Schottky/MSI and LSI device presently being produced by Advanced Micro Devices, the next giant.

Schottky/TTL Devices Proprietary to Advanced Micro Devices

Am25S05
4-Bit by 2-Bit Two's Complement Digital Multiplier

Am25S07
6-Bit Register with Clock Enable

Am25S08
4-Bit Register with Clock Enable

Am25S09
4-Bit Register with 2-Input — Multiplexer on Inputs

Am25S10
4-Bit Shifter used for Shifting or Scaling

Am26S12
Quad Bus Transceiver

Am26S12A
Quad Bus Transceiver

Am27S02
64-Bit Random Access Memory with Open Collector Outputs

Am27S03
64-Bit Random Access Memory with Three-State Outputs

Schottky/TTL Devices Alternate Sourced by Advanced Micro Devices

54S/74S139
Dual 1-of-4 Decoder

54S/74S151
8-Input Multiplexer

54S/74S153
Dual 4-Input Multiplexer

54S/74S157
Quad 2-Input Multiplexer; Non-Inverting Outputs

54S/74S158
Quad 2-Input Multiplexer; Inverting Outputs

54S/74S174
6-Bit Register with Master Reset

54S/74S175
Quad Register with True and Complement Outputs

54S/74S181
4-Bit Arithmetic Logic Unit

54S/74S189
64-Bit Random Access Memory with Open Collector Outputs

54S/74S194
4-Bit Shift Register; Shift Right, Left, or Load

54S/74S195
4-Bit Shift Register; JK Inputs; Shift Right or Load

54S/74S251
Three-State 8-Input Multiplexer

54S/74S253
Three-State Dual 4-Input Multiplexer

54S/74S257
Three-State Quad 2-Input Multiplexer; Non-Inverting Outputs

54S/74S258
Three-State Quad 2-Input Multiplexer; Inverting Outputs

54S/74S289
64-Bit Random Access Memory with Three-State Outputs

82S62
9-Input Parity Checker/Generator

93S10
Synchronous Decade Counter (Edge Triggered)

93S16
Synchronous Hexadecimal Counter (Edge Triggered)

93S21
Dual 1-of-4 Decoder

93S22
Quad 2-Input Multiplexer

93S48
12-Input Parity Checker/Generator

(EDITOR'S NOTE: Unfortunately, time and space do not permit us to go into additional detail on the other major producers of Schottky/MSI and LSI at this time.)

Not just a second source. But a

Introducing Harris'

Here they are—22 device types offering true alternate-source availability for 54C/74C CMOS. Combined with our existing 4000 series and custom LSI capability, addition of these new units makes Harris one of the few suppliers with total CMOS capability. So, choose from our 54C/74C series—44 devices with more on the way.

Our 54C/74C series, designed to reduce system costs, is pin-for-pin and function-for-function equivalent to T²L 7400 devices. Among their cost-saving features are low power supply requirements, less power supply regulation, fewer bypass capacitors, simpler design, and simplified power distribution. The units also offer high noise immunity—typically 45% of supply voltage, and they have a guaranteed 1V noise margin. This means that 1V of noise at the input will not cause the output to rise beyond T²L levels. As a result, logic errors are less likely.

Applications are easy, too, with industry standardized input and output characteristics. Experience acquired with the 7400 series can also be applied directly to use of the 54C/74C's. For details, see your Harris distributor or representative.

	100-999 UNITS −55°C to +125°C	100-999 UNITS 0°C to +70°C
HD-54C00/74C00 *Quad 2 NAND Gate*	2.98	.69
HD-54C02/74C02 *Quad 2 NOR Gate*	2.98	.69
HD-54C04/74C04 *Hex Inverter*	3.30	1.04
HD-54C10/74C10 *Triple 3 NAND Gate*	2.98	.69
HD-54C20/74C20 *Dual 4 NAND Gate*	2.98	.69
HD-54C42/74C42 *BCD to Decimal Decoder*	7.15	3.30
HD-54C73/74C73 *Dual J-K Flip Flop with Clear*	4.75	2.26
HD-54C74/74C74 *Dual D Flip Flop*	4.20	1.45
HD-54C76/74C76 *Dual J-K Flip Flop with Clear and Preset*	4.75	2.26
HD-54C107/74C107 *Dual J-K Flip Flop with Clear*	4.75	2.26
HD-54C151/74C151 *8 Channel Digital Multiplexer*	6.40	3.95
HD-54C154/74C154 *4-Line to 16-Line Decoder/Demultiplexer*	16.20	5.40
HD-54C157/74C157 *Quad 2 Multiplexer*	5.10	2.88
HD-54C160/74C160 *Decade Counter with Asynchronous Clear*	10.40	5.70
HD-54C161/74C161 *Binary Counter with Asynchronous Clear*	10.40	5.70
HD-54C162/74C162 *Decade Counter with Synchronous Clear*	10.40	5.70
HD-54C163/74C163 *Binary Counter with Synchronous Clear*	10.40	5.70
HD-54C164/74C164 *8-Bit Parallel Out Serial Shift Register*	11.00	4.35
HD-54C173/74C173 *Three State Quad/D Flip Flop*	9.15	3.80
HD-54C192/74C192 *Synchronous 4-Bit Up/Down Decade Counter*	10.30	5.65
HD-54C193/74C193 *Synchronous 4-Bit Up/Down Binary Counter*	10.30	5.65
HD-54C195/74C195 *4-Bit Register*	5.70	3.75

WHERE TO BUY THEM: ARIZONA: [illegible]—Hamilton, Liberty, Weatherford; Scottsdale—HAR (602) 946-3556 **CALIFORNIA:** Anaheim—Weatherford; El Segundo—Liberty; Glendale—Weatherford; Long Beach—HAR [illegible] Mountain View—Elmar; Palo Alto—Weatherford; HAR (415) [illegible] 4 6443 Pomona—Weatherford; San Diego—Liberty, Weatherford **COLORADO:** Commerce City—Elmar; Denver—Hamilton [illegible]—Weatherford **CONNECTICUT:** Danbury—Schweber; Norwalk—Harvey **FLORIDA:** Hollywood—Hamilton, Schweber; Melbourne—HAR (305) 727 [illegible] **GEORGIA:** Atlanta—Schweber; Norcross—Hamilton **ILLINOIS:** Elk Grove Village—Schweber; Schaumburg—HAR (312) 894-8824 [illegible] Park—Hamilton **INDIANA:** Indianapolis—Pioneer **KANSAS:** Lenexa—Hamilton **MARYLAND:** Baltimore—Hamilton; Rockville—Schweber **MASSACHUSETTS:** Burlington—Hamilton; Lexington—Harvey; Wellesley—HAR (617) 237 [illegible]430 **MICHIGAN:** Livonia—Hamilton; Troy—Schweber **MINNESOTA:** [illegible]—Hamilton, Schweber; Minneapolis—HAR [illegible] **MISSOURI:** [illegible]—Hamilton **NEW JERSEY:** Cedar Grove—Hamilton; Mt. Laurel—Hamilton; Somerset—Schweber **NEW MEXICO:** Albuquerque—Hamilton, Weatherford **NEW YORK:** East Syracuse—Hamilton; Melville—HAR (516) 249 [illegible] Syracuse—HAR (315) [illegible] Rochester—Schweber; Westbury—Schweber; Woodbury—Harvey **NORTH CAROLINA:** Raleigh—Schweber **OHIO:** Beachwood—Schweber; Cleveland—Pioneer; Dayton—Pioneer; HAR (513) 226-0636 **PENNSYLVANIA:** Wayne—HAR (215) 687-6680 **TEXAS:** Dallas—Hamilton, Weatherford; HAR (214) 231-9031 Houston—Hamilton, Weatherford **UTAH:** Salt Lake City—Hamilton **WASHINGTON:** Seattle—Liberty, Weatherford **WASHINGTON, D.C.:** HAR (202) 337-3170 **CANADA:** Mississauga, Ontario—Hamilton; Montreal, Quebec—Hamilton; Ottawa, Ontario—Hamilton

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source with total CMOS capability.

New 54C/74C Series

Our 4000 (S) series offers you the fastest, low-power logic devices available today. With 10-volt power supplies, speeds are typically twice that of comparable IC's. Power supply range is 3 to 15VDC, while noise immunity is typically 45% of supply voltage. Other advantages are low power dissipation and elimination of SCR latch-up problems. All units are pin-for-pin compatible with the CD-4000A series. And you have a choice of high-speed or direct CD-4000A replacement characteristics. To order a high-speed unit just add the suffix "S" to the HD-4000 part number (HD-4000S). For a direct CD-4000A replacement add an "A" to the number (HD-4000A).

In addition to the HD-4000 series, we offer the HD-4800 group of Harris proprietary devices. Among these devices are six units which together comprise the first family of three-state CMOS interface circuits available. By providing the ability to regulate the state of hard wired outputs, these interface circuits permit an extremely high level of flexibility in buss oriented systems design. These units also have buffered outputs for driving high capacitive lines and T^2L directly. When four circuits are utilized, they permit the user to perform logic translation (i.e. MOS to T^2L) directly at the buss line. For complete details on our 4000 and 4800 series, see your Harris distributor or representative.

	100-999 UNITS			
	−40°C to +85°C		−55°C to +125°C	
	A	S	A	S
HD-4000 *Dual 3 NOR Gate plus Inverter, 14 pin DIP*	.78	1.86	1.17	3.10
HD-4001 *Quad 2 NOR Gate, 14 pin DIP*	.78	1.98	1.17	3.30
HD-4002 *Dual 4 NOR Gate, 14 pin DIP*	.78	2.04	1.17	3.40
HD-4007 *Dual Complementary Pair plus Inverter, 14 pin DIP*	.78	1.59	1.17	2.65
HD-4009 *Hex Inverter/Buffer, 16 pin DIP*	1.69	3.15	2.54	5.25
HD-4010 *Hex Buffer, 16 pin DIP*	1.69	3.15	2.54	5.25
HD-4011 *Quad 2 NAND Gate, 14 pin DIP*	.78	1.98	1.17	3.30
HD-4012 *Dual 4 NAND Gate, 14 pin DIP*	.78	2.07	1.17	3.45
HD-4013 *Dual D Flip Flop, 14 pin DIP*	1.62	2.85	2.43	4.75
HD-4019 *Quad AND/OR Select Gate, 14 pin DIP*	1.91	3.03	2.87	5.05
HD-4023 *Triple 3 NAND Gate, 14 pin DIP*	.78	2.06	1.17	3.44
HD-4025 *Triple 3 NOR Gate, 14 pin DIP*	.78	2.06	1.17	3.44
HD-4030 *Quad Exclusive OR Gate, 14 pin DIP*	1.63	2.27	2.45	3.79
HD-4804 *Three State Hex Buffer with Level Translator, 16 pin DIP*	–	6.15	–	7.67
HD-4805 *Three State Hex Buffer Inverter with Level Translator, 16 pin DIP*	–	6.15	–	7.67
HD-4806 *Three State Triple True/Complement Buffer with Disable, Independent Level Translator, 16 pin DIP*	–	6.15	–	7.67
HD-4807 *Hex Buffer with Disable, 16 pin DIP*	–	6.15	–	7.67
HD-4808 *Three State Hex Buffer with Disable, 16 pin DIP*	–	6.15	–	7.67
HD-4809 *Triple True/Complement Buffer, 16 pin DIP*	1.69	3.15	2.54	5.25
HD-4810 *Three State Triple True/Complement Buffer with Disable, Common Level Translator, 14 pin DIP*	–	6.15	–	7.67
HD-4811 *Quad Exclusive NOR Gate, 16 pin DIP*	1.63	2.27	2.45	3.79
HD-4814 *Hex Inverter, 16 pin DIP*	.97	2.27	1.45	3.80

Harris

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS-INTERTYPE CORPORATION
P.O. Box 883, Melbourne, Florida 32901
(305) 727-5430

People

An official 'yes' to Loran-C agrees with John Beukers

When the U.S. Coast Guard decided last month to standardize on the Loran-C navigation system for ships sailing the coastal and inland waterways [*Electronics*, Jan. 18, 1973, p. 139], John M. Beukers breathed a sigh of satisfaction. For as president of Beukers Laboratories, a Bohemia, N.Y., manufacturer of precise navigation and communications equipment, Beukers has long propounded the view that a combination of Loran-C for navigation of coastal-confluence areas and the longer-range Omega system for the high seas would offer "the best signals available for each job."

Beukers is a charter member of the Wild Goose Association of manufacturers and users interested in the possibilities of Loran-C. As one of the association members that presented the case for Loran-C before the House of Representatives Subcommittee on Coast Guard and Navigation in April, he has done much to aid in establishing the status of the Loran-C navigation system.

The pleasant-spoken, English-born electronics engineer does not have an equipment ax to grind. Rather, with respect to navigation, at least, he practices what he preaches, applying the best attributes of both Loran-C and Omega in the equipment he designs.

This is true, for example, in Beukers Laboratories' Lo-Cate system, for tracking such objects as weather balloons, ocean buoys, small boats in distress, and helicopters. One of Beukers' several patents in the hyperbolic navigation-aid field is for a technique that applies Omega signals to the rapid acquisition and cycle identification of Loran-C signals.

In addition to navigation, Beukers has long been interested in meteorology. His compact and low-cost sondes—sensing devices that, when dropped from an aircraft or sent aloft in a balloon, radio back information on atmospheric conditions—are used almost universally by weather-forecasting and research groups in the United States. Moreover, Beukers has placed his Lo-Cate system aboard a mobile van, and it is monitoring environmental conditions at land-based sites.


Navaider. John Beukers helped promote recently approved Loran-C standard.

For the future, Beukers sees the possibility of Loran-C becoming available as a means for land-based, as well as offshore, navigation. Once the Coast Guard installs its stations, only three more will be needed to cover the entire United States.

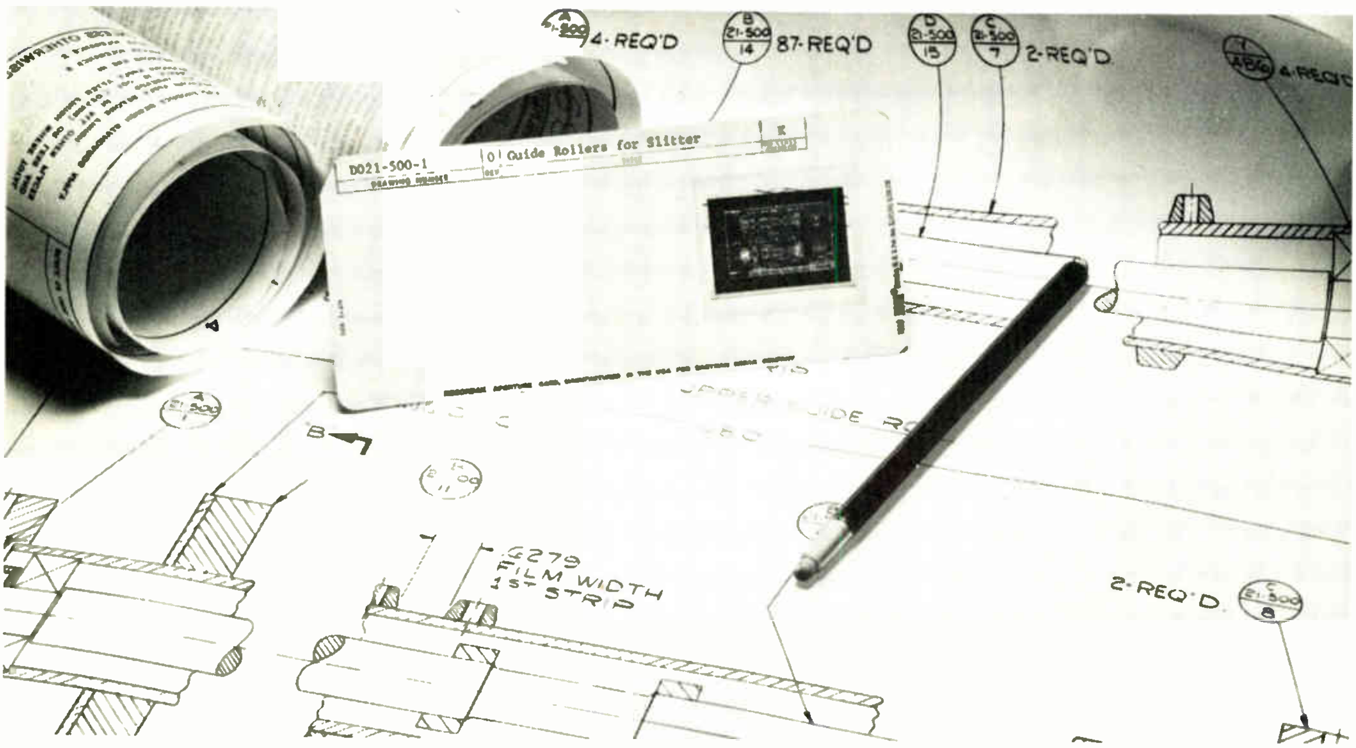
Thus, it may now be feasible to use Loran-C for locating police cars and other emergency vehicles and for its use by aircraft in area navigation. With increased use, price of the Loran-C receiver should also be decreased within four years, says Beukers, to less than $1,000 for a simpler unit from the $3,000 to $5,000 now.

At EA, Boucher hmlps carry management burden

When a company's sales nearly double in a year, and the president can't find enough hours in the day to get the job done, it's time to hire some help. Electronic Arrays Inc. did just that when the Mountain View, Calif., firm brought in Richard Boucher two months ago to serve as assistant president and share the duties that had begun to overburden the MOS LSI manufacturer's president and chief executive officer, Mois Gerson. It was under Gerson's leadership that EA's sales went from $9,756,000 in fiscal 1973 to $17,849,000 in fiscal 1974.

To free himself and Gerson from

Blowbacks. Another good reason for microfilm.



Put the flexibility of Kodak microfilm into your engineering program.

There are many advantages to microfilming your drawings. It saves space, it provides security, and it's one of the most efficient methods of filing and retrieving engineering data. And now, you can make high-quality enlargements directly from the sharp, crisp microfilm images that Kodak products have produced.

Blowing back onto Kodagraph films or papers from microfilm is a fast, easy way to make second originals. And you not only eliminate the need to use original drawings; you also save material because you can produce the exact size reproductions you require.

You'll find that you save in other ways, too! Whether the job is revising drawings or restoring them, or even making distribution prints, blowbacks from Kodak microfilm can save you time and money.

Get the details.

Find out how Kodak microfilm and drawing reproduction products can benefit your department. Write for our booklet on Engineering Document Control or ask for a sales representative to call. Eastman Kodak Company, Business Systems Markets Division, Dept. DP773, Rochester, N.Y. 14650.

Kodak products for engineering data systems. Kodak

People

Systems-oriented. Boucher helps steer Electronic Arrays to more sales by understanding OEM needs.

day-to-day operations and to "spend time on what really makes a business double or triple," Boucher plans to implement guidelines on who does what and establish management responsibilities down the line.

Systems impact. As a result of tighter management policies and "understanding OEMs' demands," Boucher expects Electronic Arrays to become an organization that can take advantage of what he calls a "fantastically growing" systems market for automobile applications, appliances, and watches, as well as its existing stake in business calculators. Expected EA sales growth is set at 45% for next year.

One of the first lessons Boucher wants to get across to his management team is that the semiconductor industry is very systems-oriented. "We can't just be component-oriented," says the former president of CMX Systems Inc., a Mountain View, Calif., firm and the former general manager at Memorex Corp., Santa Clara, Calif. Rather, he warns, "we have to know how a component fits into someone else's system."

To penetrate the systems marketplace, Electronic Arrays plans advances in LSI memories and microprocessors. It is now conducting research into an 8-bit n-channel processor on a chip, for introduction as early next year.

MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

JUNE, 1974

in this issue

New wave analyzer for precision and portability in the field

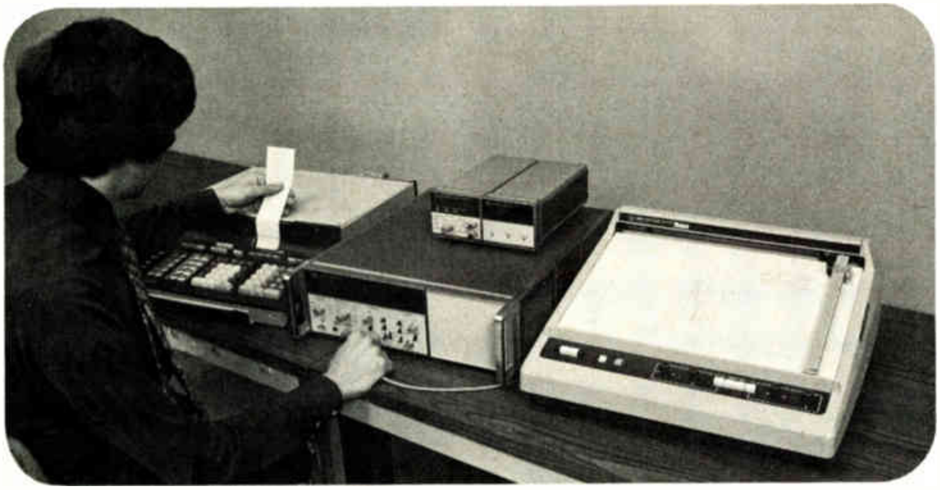
Here, the 3581A wave analyzer checks field equipment performance for the Omega navigation system, a global system that should become fully operational in 1975.

HP's new low-frequency analyzer has a built-in counter for frequency accuracy and a battery option for convenience and portability. Take the 18 lb. (8.1 kg) wave analyzer where you need it the most—out in the field—to check power or telephone lines.

Accurate single-frequency measurements are fast and easy, from 15 Hz to 50 kHz with 1 Hz resolution and 3 Hz bandwidth. The built-in counter displays tuned frequency on a 5-digit LED readout. Signal amplitude appears on a four-scale analog meter. Two scales are for log displays of 90 dB and 10 dB (expanded), and the other two are linear with 1 or 3 full scale.

(continued on page 3)

Super-counter for superb time interval measuring and easy system interface



The HP 5345A counter's unmatched capabilities in time interval measurements and automatic systems operation pay off in applications such as the time interval jitter measuring system shown above.

Precision time interval measurements are central to measuring rise time, propagation delay, slew rate, and phase. These are just a few applications that can be served better than ever by the time interval capability of HP's new 5345A electronic counter.

Compatibility with the HP interface bus makes the counter a natural for systems applications. For example, the system shown above is easily assembled using an HP 9820A calculator, 9862A plotter, and the 5345A counter to analyze time interval jitter.

The 5345A offers 2 ns single-shot time interval resolution. With an improved averaging technique, resolutions to 2 ps are achieved for repetitive signals. High sensitivity of the 500 MHz input amplifiers (better than 10 mV rms) ensures accurate trigger level settings. And for very fast pulses in 50Ω systems, you can switch to 50Ω impedance to prevent error-causing reflections.

The 5345A also makes frequency, frequency average, period, period average, ratio, totalize, and gated measurements over the dc to 500 MHz bandwidth. Plug-ins extend the counter's capability for communications and microwave measurements.

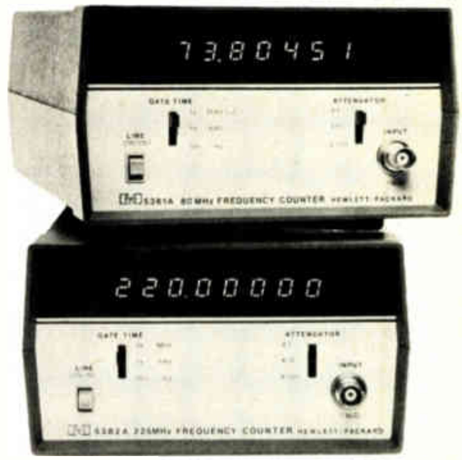
There's more. Just check the HP Reply Card.

Calculator control and HP's new ASCII programmable modules that extend the 5345A's measurement capabilities are explained in a new series of application notes. The series includes: the characterization of voltage controlled oscillators, determining probability density distribution of a series of measurements, frequency stability measurements, and the measurement of fractional frequency deviation and FM deviation. VCO characteristics covered are: the transfer function measurement, differential and integral non-linearity and dual VCO tracking error.

Each application note describes how to connect the necessary equipment, how to operate the resulting calculator-controlled system, and certain key measurement considerations that should be noted. The notes also include a complete listing of the HP 9820/21 calculator program and a flow diagram of the software.

To learn more, check the HP Reply Card.

New quality counters at surprisingly low prices



These new counters have 25 mV sensitivity, LED displays, measure ratio as well as frequency, and weigh just 4.75 lbs. (2.2 kg).

Two new electronic counters carry extremely low price tags, yet offer high-stability crystal time bases crucial to counter accuracy and usually found only in costlier models. Either new counter is ideal for production line testing, frequency monitoring, service and calibration, training classes or—at this price—even for hobbyists and radio hams.

The 80-MHz model 5381A has a 7-digit display. Model 5382A counts to 225 MHz and displays 8 digits. Resolution is 10 Hz at 0.1 sec gate time, 1 Hz at 1 sec, and 0.1 Hz in 10 sec.

Aging (drift) rate is <3 parts in 10^7 per month, reducing recalibration. Temperature-resistant and rugged, the two counters also protect against overload. Even in their wide-open settings, they'll take 200 Vdc without harm.

A three-position input attenuator lets you measure noisy or high voltage inputs. Unlike other low-priced counters, these will also operate on an external precision time base through a built-in rear connector.

For more information, check the HP Reply Card

Get 4-channel lab quality recording with portable tape recorder

The 3960A instrumentation tape recorder gives you portability along with performance and features found only in the most expensive laboratory machines. Portability is the ruggedness of the solid aluminum casting, the capability of operating from either ac or dc power sources, and a built-in dc calibrator.

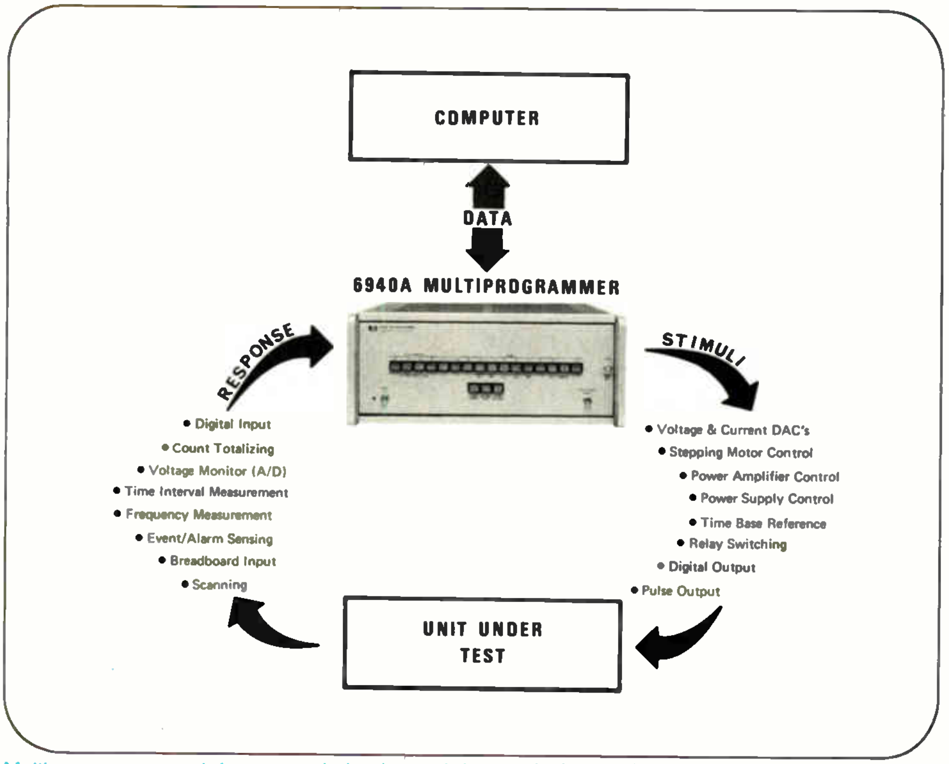
Use the 3960A in data acquisition and data reproduction applications. Tape speeds range from 15/16 ips for long-term FM recording of slowly changing phenomena to 3¾ ips for acoustic evaluation and up to 15 ips for vibration studies. The low-speed performance is outstanding, an important asset to medical researchers and others who record slowly changing variables.

The FM signal-to-noise ratio at 15/16 ips is 44 dB. At higher speeds, the FM signal-to-noise ratio is 48 dB. Data electronics for direct recording has a frequency response up to 60 kHz and up to 5 kHz for FM.

For more information, check the HP Reply Card.

The 3960A recorder uses ¼ in. (0.6 cm) tape or standard 7 in. (17.8 cm) reels.

HP multiprogrammer system expands your I/O capability to 240 channels



Multiprogrammer mainframes and plug-in cards let you design and build low-cost automatic test systems more efficiently.

You'll never run out of computer I/O slots when you design your automatic test system around the 6940A multiprogrammer. You need just one 16-bit duplex computer I/O channel to interface with the multiprogrammer. The 6940A holds up to 15 plug-in analog and digital I/O cards, mixed in any combination. Some plug-ins convert programmed data into analog and digital output signals to stimulate units under test; others convert analog and digital responses into digital data for input to the computer.

If you need more than 15 programmable I/O channels, simply add 6941A extender mainframes. Each extender holds 15 plug-ins, and you can add up to 15 extenders—giving you a total of 240 plug-in cards controlled from one computer I/O slot.

Just one software driver controls any variety of multiprogrammer plug-ins. This lets you make changes and additions in the type and number of I/O cards without worrying about reconfiguring the software driver or operating system.

There's more. Just check the HP Reply Card.

(continued from page 1)

It's ideal for harmonic analysis, fm and phase noise measurements of high-frequency signals, evaluating sonar devices, and analyzing low-frequency radio transmission systems. Portability lets you check power line interference simply, accurately, on-site.

A communications version, model 3581C, analyzes telephone voice channels, both single and up to 12 multiplexed. You can also pinpoint interference on data channels, look for spurious tones, and analyze levels of transmitted tones. We even provide a loudspeaker, headphone jack, and transformer so you can patch the 3581C directly onto telephone lines. Optional rechargeable batteries run the analyzer for 12 hours.

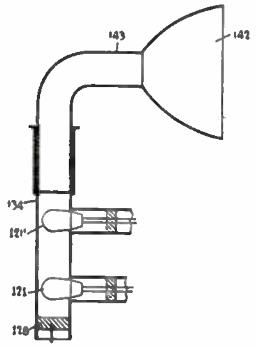
To learn more, check the HP Reply Card.

Antenna Coupling System. Coupling an antenna to a coaxial cable characterized by the fact that the antenna is formed by a conductor immersed in a tubular end portion of the inner conductor of the cable and protruding to such an extent beyond the end of the cable so that the ohmic series component of the antenna impedance at the entrance of the cable is equal to the wave resistance of the cable. The energy line formed by the inner conductor and the part of the antenna conductor which is immersed in the inner conductor is tuned by means of a movable connection to such a length that the wattless component of the antenna impedance is compensated. Werner Buschbeck, Berlin; to Telefunken. March 28, 1941. No. 2,278,531.

Multiple Antenna. Conductors arranged with their length parallel to the generatrix of the surface of a solid cone of revolution, means for energizing the conductors at their most closely adjacent ends and terminating the conductors at the other ends so that a traveling wave is set up along the conductors such that the instantaneous phase relationship of energy in the conductors progressively advances around the surface whereby a rotating field of radiation is established. Wilhelm Peters, Telefunken. No. 2,278,560. Sept. 30, 1939.

Repeater. In a repeater an antenna including a wave directive structure and means for eliminating radiation from the edges of such structure including a resonant structure tuned to offer a high impedance to the operating frequency of the antenna at the edge. N. E. Lindenblad, RCA, June 30, 1939. No. 2,281,196.

Wave Guide. Antenna comprising at least one conducting surface and serving as transmitting and receiving antenna and a conducting tube coup-



ling the transmitter and receiver to the antenna, the receiver and transmitter being placed inside this conducting tube. W. Dallenbach, Berlin, July 12, 1938. No. 2,281,274.

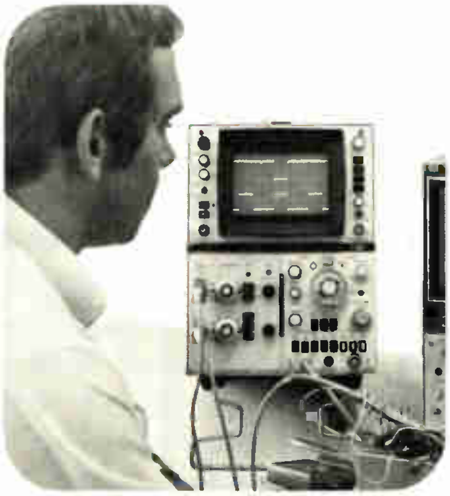
Short Wave Antenna. Antenna for decimeter wave lengths comprising several radiator systems in superposed relationship spaced a distance apart equal to a multiple of the wavelength and mounted above ground a distance equal to a large multiple of the spacing

Scope plug-in aids design and troubleshooting

Accurate measurements in digital/analog design and troubleshooting are supplied by the 1835A two-channel 200 MHz vertical plug-in for HP 183 series oscilloscopes. Wide bandwidth, coupled with the 1 ns/div sweep speed of HP's 1840A and 1841A time base plug-ins, is ideal for timing measurements in ECL and TTL circuits.

You can trigger from either channel A or B, maintaining true time relationship with the other channel. With the composite mode, each channel triggers independently in alternate or chopped displays. Either channel may be inverted, and an ADD mode lets you look at the two channels differentially (±A±B).

Integrated circuits provide 10 mV/div deflection factor, and a thick-film planar attenuator offers selectable 1 MΩ or 50Ω input impedance. The 1 MΩ (ac/dc) input has only 12 pF shunt capacitance for minimal loading. In probing applications, you can reduce this low capacitance even further by using 10:1 divider probes. The 50Ω input termination has low VSWR for pulse fidelity.



The 1835A 200-MHz bandwidth plug-in displays glitches that could cause timing problems.

Send the HP Reply Card for details and specifications.

Universal card reader inputs 300 cards per minute

HP's 300 cards-per-minute optical mark reader is flexible as well as fast: the 7260A accepts all types of punched or marked card, even specially designed forms. With appropriate clock marks, single cards may be both punched and marked, in any number of columns from 1 to 80.

This desktop serial card reader is quiet enough for the office, fast enough to keep up with your computer.

The 7260A can be used with terminals, computers or remote data systems via a modem or direct connection. Data rates are switchable from 110 baud to 2400 baud. Data is stored in bunfers so that you can optimize the card feed rate for high transmission efficiency. The 7260A transmits 7-level ASCII code, but other decoding options are available.

Quantity and OEM discounts are also available.

For more information, check the HP Reply Card.

New line printer handles calculator output

Usually line printers are considered computer system peripherals; but now HP offers a reliable line printer for your 9830 calculator system.

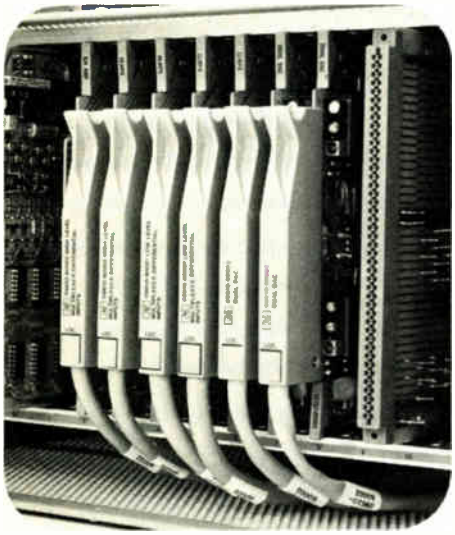
The new HP 2607A line printer prints 200 lines per minute, has a full 132 column line width, and 8-level tape control for vertical formatting. The 64 character set is standard USASCII code; characters are styled from a 5 × 7 dot matrix. The line printer is so compact, you can use it on a movable stand or keep it on a desktop or tabletop next to your calculator.

Installation is quick and easy. Simply plug an 11287A interface card into the 9830 calculator, connect the interface cable, and configure the system to your requirements. With the powerful programming capability of the 9830, it's difficult to tell where the calculator system ends and the computer system begins.

To learn more, check the HP Reply Card.

This new line printer substantially increases the through-put of the 9800 series calculators.

New multiplexer options for HP 9600 systems



Each multiplexer input circuit provides high common mode rejection from transients and noise. Drift is eliminated by an offset sampling amplifier which further improves accuracy.

Two new multiplexer options for HP 9600 series computerized measurement and control systems let you input analog signals as low as 10 mV.

The 12760 is a relay low-level multiplexer while the 12761A is a solid-state model. Either one switches low-level analog inputs to an HP 2313B A/D interface subsystem. To install the multiplexer, simply slip a printed circuit card into the subsystem.

Both multiplexers accept 16 differential analog inputs and have programmable gains. The solid-state model provides 8 low-level ranges from ±10V to ±800V full scale. Sampling rate is up to 50 Hz. The relay multiplexer provides 7 low-level ranges from ±10mV to ±400V full scale and offers protection against high common mode voltage and rejection. Sampling rate is up to 20 Hz.

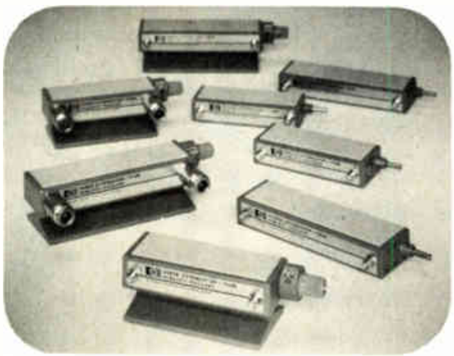
Send the HP Reply Card for details and specifications.

New low-cost microwave step-attenuators

Automated manufacturing and testing procedures enable HP to offer precision coaxial step-attenuators with outstanding performance at attractive prices. There are two attenuation ranges, 0-70 dB and 0-110 dB in 10 dB steps. The units can be specified for either dc—18 GHz or dc—4 GHz frequency coverage. The HP 8495/8496 attenuators contain thin-film (tantalum or sapphire substrate) attenuation elements that are switched in or out with extremely high repeatability (typically within 0.02 dB), even after thousands of switching cycles.

Both units have high accuracy (typically 1.6% to 4 GHz, 4% to 18 GHz) and low VSWR (1.35 at 4 GHz, 1.7 at 18 GHz). Bench models have three connector types available: type N, SMA and APC-7. Step-attenuator versions for installation within equipment are also offered.

There's more. Just check the HP Reply Card.



Compact size makes these precision attenuators ideal for beach use or installed in equipment.

Expedited entry keyboard speeds calculations

The new expedited entry keyboard for the HP-81 business calculator makes problem-solving even faster.

Thanks to a new optional expedited entry keyboard, the HP-81 business desktop calculator solves problems as fast as you can use it. The calculator stores up to 64 keystrokes while simultaneously performing your previous calculations. You can start a new problem while the calculation is solving another.

This preprogrammed business machine solves problems of investment analysis, loans, bonds, annuities, depreciation and statistics. Simply key in your figures, and the calculator prints the answer. There's no programming involved—if you can use an adding machine, you can operate the HP-81.

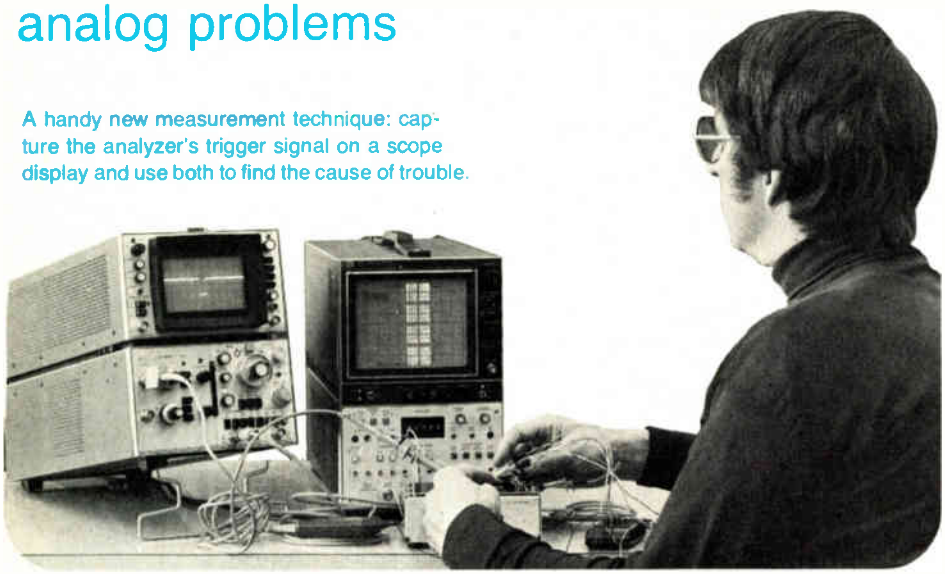
Besides the built-in financial functions, the HP-81 can compute mean and standard deviation, correlation coefficient, and a two-variable trend line. If you make an error, such as dividing by zero, an error message tells you why the operation cannot be performed.

All this computational power comes in a small 13.5 lb (6.12 kg) machine that fits easily on a corner of your desk.

For more information, check the HP Reply Card.

Digital triggering pinpoints analog problems

A handy new measurement technique: capture the analyzer's trigger signal on a scope display and use both to find the cause of trouble.



Twelve-bit parallel pattern recognition capability enables the 1601L logic state analyzer to trigger on a particular logic pattern. The unique trigger signal, available as a front panel output, is an extremely powerful tool in digital circuit analysis. By applying this trigger signal to an oscilloscope, the scope's display is positioned in the same "time window" as the digital event.

Let's look at a practical application of digital triggering. Functional checks of a two-decade BCD counter reveal that it is resetting to zero at state 89 rather than 99. A problem on the reset line is the probable cause. However, when the oscilloscope is connected to the master reset line, several pulses that could cause the problem are displayed. The one that's causing the premature reset is not readily apparent. By connecting the analyzer trigger output to the scope's external input and setting the analyzer trigger switches to state 89, the glitch is readily apparent.

Send the HP Reply Card for details and specifications.

HP solid-state sweepers deliver high power output

High power output across all bands—a value feature of HP's 8620 solid-state plug-in sweeper.

The 8620 series solid-state sweepers cover 3 MHz to 18 GHz with high power output that makes these solid-state sweep oscillators comparable to BWO-type sweepers. Standard units deliver at least 40 mW to 4.2 GHz and ≥10 mW all the way to 18 GHz.

Modular design gives you unparalleled flexibility. Start with either of two mainframes, then choose from 9 single-band plug-ins or RF module combinations to get multi-band coverage conveniently and compactly. Standard features include 1% sweep linearity, low spurious signals, high stability, fully-calibrated Start/Stop, and ΔF sweeps.

In 6 weeks or less, your 8620 sweeper will be delivered and operating.

Send the HP Reply Card for details and specifications.

New low prices for HP-45, HP-35 pocket calculators

In these days of rising inflation, powerful computation capability in the palm of your hand now costs less. Prices for the HP-45 and HP-35 have been reduced.

The HP-45 has a 4-register stack, 9 addressable memory registers, and more than 44 sophisticated functions. You can perform register arithmetic, polar/rectangular coordinate conversions, metric/U.S. conversions, logarithms, and trigonometric functions in 3 different input modes—degrees, radians and grads.

The HP-35—with 4-register stack and an addressable memory register—handles logarithms, exponents and trigonometric functions within seconds.

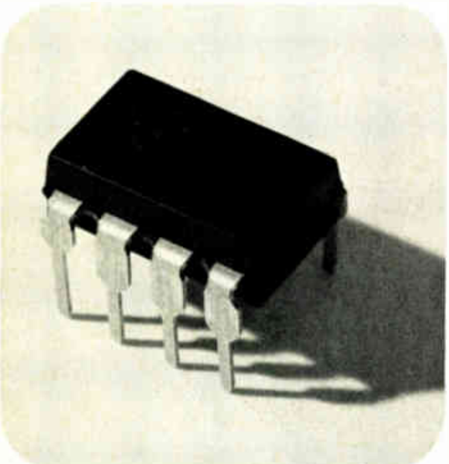
Each calculator comes with a carrying case, an ac adapter/recharger, and an owner's handbook.

For more information, check the HP Reply Card.

New lower prices for the HP-45 and HP-35 are really something to smile about.

HEWLETT-PACKARD COMPONENT NEWS

Introducing three new isolators



For maximum dc/ac isolation between each input and output, use HP's new 5082-4364 dual isolator.

HP now offers the 5082-4370 series isolators containing a high gain, high speed photodetector that provides a minimum current transfer ratio (CTR) of 300% at input currents of 1.6 mA for the 5082-4370 and 400% at 0.5 mA for the 5082-4371. The excellent low input current CTR lets you use these devices in applications that require low power consumption. Separate pin connections for the photodiode and output transistor permit high speed operation and TTL-compatible output.

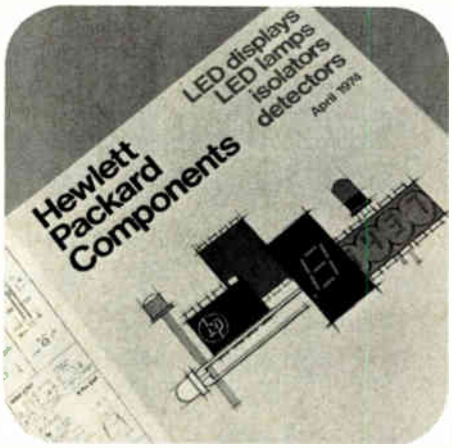
Also available is a dual version of our popular high-speed optically-coupled isolator. The new 5082-4364 consists of a pair of optically-coupled gates in an 8-pin dual-in-line package. It's completely TTL compatible and has propagation delays of 50 ns. The high speed of this device makes it ideal for use as a line receiver in high noise environments.

There's more. Just check the HP Reply Card.

Optoelectronics at a glance

HP's new short-form *Optoelectronics Catalog* describes our complete line of lamps, displays, and isolators—in just 6 pages. This concise guide contains the three latest additions to the HP optoelectronics line: the 5082-7740 common cathode LED display, the 5082-4487 low-cost LED lamp, and the 5082-7430 low-power numeric display.

For your free copy, check the HP Reply Card.



New diode and transistor catalog now available

Which diode or transistor meets your design specs? Simply refer to HP's new *Diode and Transistor Catalog*, a comprehensive reference containing complete specifications on:

- Microwave transistors
- Schottky diodes
- PIN diodes
- Impatt diodes
- Step recovery diodes
- High reliability devices

The catalog includes packaging specifications and drawings to aid the circuit designer.

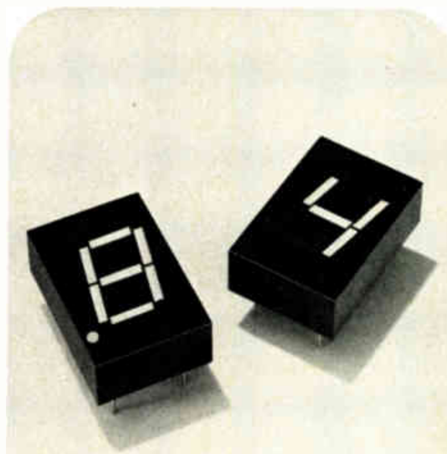
For your free copy, check the HP Reply Card.

New large-digit LED display

LEDs are growing—in size as well as popularity. Now, HP offers a seven-segment display with large .43 in. (1.1 cm) high numbers. The 5082-7750 series devices are common anode LED displays with a choice of right or left hand decimal point.

You can read these bright displays from up to 20 feet away. Distance viewing is also enhanced by the high contrast ratio and wide viewing angle. IC compatibility makes the 5082-7750 series ideal for electronic instrumentation, point of sale terminals, TVs, radios, and digital clocks.

Send the HP Reply Card for details and specifications.



Standard 0.3 in. (0.66 cm) dual-in-line package permits easy mounting on PC boards or in standard IC sockets.

New scientific minicomputer system performs maxi-computer information management tasks

Compact, streamlined, and capable: HP's new S/250 scientific information management system.

If you are in charge of an engineering laboratory or research project, your data management procedures may be inadequate for the rapid accumulation of information. You need to store growing data files yet access them quickly. Not only do your variables change, but the data sets interact dynamically. Timely reporting gets difficult. Outside services may be unreliable and costly.

Then there's the security problem—preventing unauthorized personnel from accessing sensitive data. Until now, you could find the capability that you need only in large, expensive computers.

The new HP S/250 scientific data management system solves all these problems. This compact system combines a proven minicomputer with a versatile disc operating system and powerful data base management software. You can use it in a dedicated environment or in multiple modes. You can write application programs in FORTRAN, ALGOL and assembly language. The built-in data manipulation software (IMAGE/2000) reads, updates, deletes and modifies data. Format the output for reports according to your preference, without knowledge of computer programming.

In the multiple user mode, 32 people can concurrently enter data, retrieve it and generate reports. In the data communications mode, a special telecommunications software package enables the S/250 to communicate directly with an IBM 360 or 370. And of course, the S/250 interfaces with other HP systems.

Standard hardware features include floating point arithmetic, micro-programmed fast FORTRAN processor, 48K bytes of memory, removable cartridge disc that stores 4.8 million bytes (alternately expandable to 93 million bytes), keyboard display console, 200 lpm line printer, 1600 bpi magnetic tape drive, and microprogramming capability. Like all HP computer systems, the S/250 is supported worldwide.

To learn more, check the HP Reply Card.

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- ○ ☐ A. HP-35 pocket calculator
- ○ ☐ B. HP-45 pocket calculator
- ○ ☐ C. HP-81 desktop business calculator
- ○ ☐ D. S/250 scientific data management system
- ○ ☐ E. 1601L logic analyzer
- ○ ☐ F. 1835A 200-MHz scope plug-in
- ○ ☐ G. 3581A wave analyzer
- ○ ☐ H. 3960A mag tape recorder
- ○ ☐ I. 5082-4364 and 5082-4370 isolators
- ○ ☐ J. 5082-7750 numeric display
- ○ ☐ K. 5345A counter
- ○ ☐ L. Programmable modules for 5345A counter
- ○ ☐ M. 5381A, 5382A low-cost counters
- ○ ☐ N. 6940A multi-programmer
- ○ ☐ O. 7260A card reader
- ○ ☐ P. 8495A/B, 8496A/B step-attenuators
- ○ ☐ Q. 8620 sweepers
- ○ ☐ R. 12760A/12761A multiplexers
- ○ ☐ S. 2607A line printer for calculators
- ○ T. *Optoelectronics Catalog*
- ○ U. *Diode and Transistor Catalog*

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MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

☐ I'd like Literature ☐ Please contact me about:

- ○ ☐ A. HP-35 pocket calculator
- ○ ☐ B. HP-45 pocket calculator
- ○ ☐ C. HP-81 desktop business calculator
- ○ ☐ D. S/250 scientific data management system
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- ○ ☐ I. 5082-4364 and 5082-4370 isolators
- ○ ☐ J. 5082-7750 numeric display
- ○ ☐ K. 5345A counter
- ○ ☐ L. Programmable modules for 5345A counter
- ○ ☐ M. 5381A, 5382A low-cost counters
- ○ ☐ N. 6940A multi-programmer
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- ○ U. *Diode and Transistor Catalog*

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HP-35	$225
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S/250	$59,950 and up
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1835A	$1445
3581A	$2600
3581C	$2700
3960A	$4785 to $5145
5082-4364 (1-99)	$12.90 each
5082-4370 (1-99)	$2.50 each
5082-4371 (1-99)	$1.10 each
5082-7750 (100)	$3.50 each
5345A	$3450
5381A	$249
5382	$450
6940A	$1600
7260A	$3190
8495/8496	$280 to $590
8620	$1230 and up
12760A	$1600
12761A	$1240

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For fast response, use the above reply cards. Please note that you can choose two types of HP response:

- ○ Literature (You will receive more information on a product.)
- ☐ Please contact me. (You will receive product information *and* a follow-up call by an HP field engineer.)

If both reply cards on this page have been used, contact your nearest HP field office or one of the regional offices listed on the preceding page. Or write directly to the Hewlett-Packard Company, 195 Page Mill Road, Palo Alto, California 94306.

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40 years ago

From the pages of Electronics, June 1934

Television nears reality

Describing television as being no longer around any corner, but as at the end of a long street, much of which remains to be traversed, engineers of the RCA Victor company disclosed their efforts toward developing a new system of communication to the members of the Institute of Radio Engineers at their 9th annual convention just closed. Major advances in the art were stated to be the ability to pick up and transmit outdoor scenes through the medium of a cathode ray television camera, the accomplishment of much greater detail than has been possible heretofore, and the solution of near perfect synchronization between the transmitter and receiver for both the video and the audio sidebands of the million-cycle wide carrier.

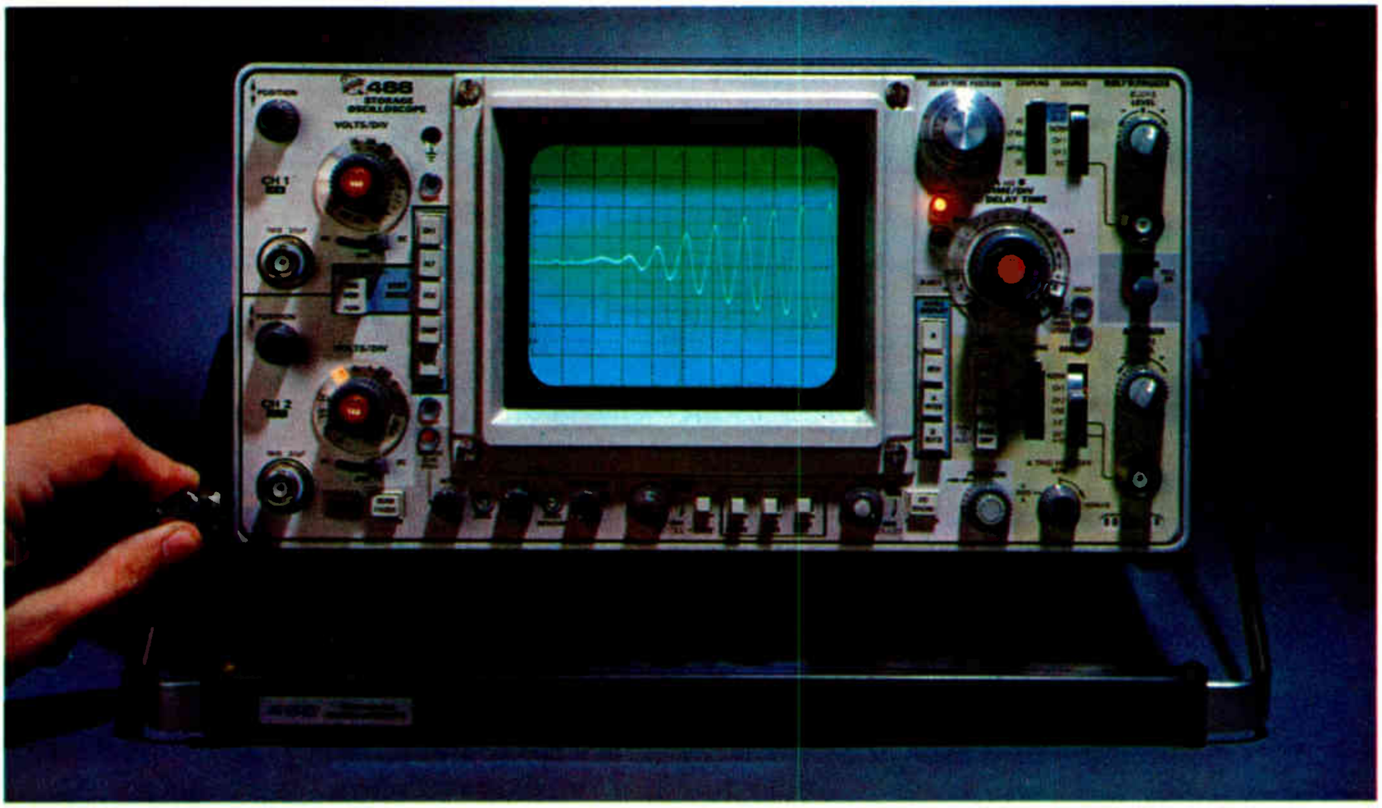
Each of the engineers who had a major share in the development of some particular phase of the research described the status of his work to date. These engineers were E.W. Engstrom, R.D. Kell, A.V. Bedford, M.A. Trainer, C.J. Young, R.S. Holmes, W.L. Carlson, and W.A. Tolson.

Prior to the reading of the technical papers describing the year's work leading to the experimental television system in operation at Camden, New Jersey, W.R.G. Baker, vice president and general manager of the RCA Victor company, spoke of the tremendous cost of establishing a national television system.

One gathered the major problem at the present time was cost, and after hearing the technical papers engineers in attendance at the convention felt that if the cost problem could be solved a saleable television system was ready.

Thus was laid to rest the old bogey of the necessity for some fundamental invention that would enable television to take place without the necessity of taking the picture apart with piece-meal transmission; perhaps this fundamental invention in the iconoscope of Dr. Zworykin has already been made.

Single-Shot Storage to 100 MHz



for DESIGN

The 466 Portable offers the fastest stored writing rate of any Tektronix direct-view oscilloscope—1350 cm/μsec throughout its 100 MHz bandwidth. (5 divisions magnitude for single shot 100 MHz sine wave.) It provides up to a 5 nsec/division sweep rate through the X10 magnifier and vertical deflection sensitivity to 5 mV/division. You can view and retain fast rise, low repetition rate, single shot, or slow moving waveforms. Here are Tektronix's reliable trigger characteristics and CRT's that minimize residual image and burn problems. Now you can display phenomena that could never before be viewed with ease on an oscilloscope.

for PRODUCTION

The 466's fast stored writing rate offers the production engineer unequalled capabilities. Stored waveforms are brighter—more visible in the high ambient light of assembly areas. Stored waveforms allow personnel to make faster, more accurate decisions and they permit study, comparison to a photo standard, and review by supervisors. Here is an oscilloscope that is essential in computer, aerospace, and many areas of communications. It is designed for minimum training of personnel. And on a dollar per MHz of bandwidth comparison, it is by far your best storage scope buy.

for FIELD SERVICE

The 466 is the answer to field troubleshooting and calibrations that require the same exacting standards as those originally specified in the lab, production, or engineering. Weighing under 30 lbs., it carries easily. And the 13-position handle provides a versatile support stand. Take an instrument with Option 7 to a missile site or into an aircraft and power it with 12-24 VDC or the 1106 or 1105 battery pack. Its 1350 cm/μsec stored writing rate can make the Tektronix 466 your most valuable test instrument.

If the high writing speed of the 466 is not required, the 464 (which is otherwise identical) features 110 div./μsec.
466 Oscilloscope, $3850.
464 Oscilloscope, $3300.

Discover what the 466 can mean to you. For a demonstration or more information, contact your local Tektronix Field Engineer, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005. In Europe write Tektronix Ltd., Guernsey, C.I., U.K.

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CONTACTS

FOR THE FIELD OF ELECTRONICS

Meetings

The Intelligent Factory, Quantum Science Corp., O'Hare Airport Inn, Chicago, June 21.

1974 Government Microcircuit Applications Conference, DOD, NASA, AEC, U. of Colo., Boulder, (clearance required), June 25–27.

Precision Electromagnetic Measurements Conference, Royal Society, IEE, London, July 1–5.

Electromagnetic Compatibility Symposium, IEEE, Hilton Hotel, San Francisco, July 16–18.

Electromagnetic Compatibility Symposium, IEEE, San Francisco Hilton Hotel, San Francisco, July 16–18.

Circuit Theory and Design Conference, IEEE, IEE, London, England, July 23–26.

Summer Computer Simulation Conference, IEEE, Shamrock Hilton Hotel, Houston, Texas, July 24–26.

The Second Jerusalem Conference on Information Technology, The Jerusalem Economic Conference and its Computer Committee, Jerusalem, Israel, July 29–Aug. 1.

Computer Communications International Conference, IEEE, Stockholm, Sweden, Aug. 12–14.

National Electronics Conference of New Zealand (Nelcon), New Zealand Section, IEEE, University of Auckland, Auckland, Aug. 26–30.

Compcon Fall, IEEE, Mayflower Hotel, Washington, D. C., Sept. 10–12.

Western Electronic Show and Convention (Wescon), IEEE, Los Angeles, Sept. 10–13.

Fourth European Microwave Conference, Microwave Exhibitions and Publishers Ltd., Maison des Congres, Montreux, Switzerland, Sept. 10–13.

European Solid State Devices Res. Conference, Inst. of Phys., IEEE, Univ. of Nottingham, England, Sept. 16–19.

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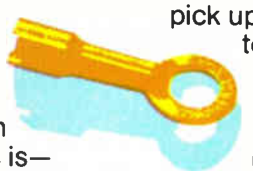

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3207A-1	75450	NE501	LM308	NE556	PA239
		NE592	MC1456		MC1496

signetics

From CPU
8080 Microcom

Intel's new 8080 n-channel microcomputer is here—incredibly easy to interface, simple to program and with up to 100 times the performance of p-channel MOS microcomputers.

Best of all, the 8080 is real—in production at Intel and available in volume quantities, today. It's also available through distributors along with a growing line of peripheral circuits and a new version of the Intellec 8, a program and hardware development system for the 8080, all supported with software packages, design documentation and manuals, and backed by more than 100 man years of microcomputer expertise.

The 8080 is the inevitable successor to complex custom MOS and many large discrete logic subsystems. It is the industry's first general purpose n-channel microcomputer and the first high performance single-chip CPU, with extremely simple interface requirements and straightforward programming. It runs a full instruction cycle in 2 microseconds.

As such, the 8080 extends the economic benefits of Intel's p-channel microcomputers to a new universe of systems that need fast, multi-port controllers and processors. These systems include intelligent terminals, point of sale systems, process and numeric controllers, advanced

to software, the
puter is here.

calculators, word processors, self-calibrating instruments, data loggers, communications controllers, and many more.

You can use 256 input and 256 output channels, handle almost unlimited interrupt levels, directly access 64 kilobytes of memory, and put many satellite 8080 processors around a single memory.

Interfacing is minimal and design is easy with the 8080 because all controls are fully decoded on the CPU chip itself and inputs and outputs are TTL compatible. There are separate data, address and control buses.

INTEL 8080			
RAM MEMORIES			
8101	256 x 4 STATIC	AVL:	3RD Q
8111	256 x 4 STATIC WITH COMMON I/O	AVL:	3RD Q
8102	1024 x 1 STATIC	AVL:	NOW
8107	4096 x 1 DYNAMIC	AVL:	NOW
ROM MEMORIES			
8308	1024 x 8	AVL:	3RD Q
8316	2048 x 8	AVL:	NOW
PROM MEMORIES			
8702	256 x 8	AVL:	NOW
8704	512 x 8	AVL:	4TH Q
8604	512 x 8	AVL:	4TH Q
PERIPHERAL CIRCUITS			
8205	1 of 8 DECODER	AVL:	NOW
8210	4K RAM CLOCK DRIVER	AVL:	NOW
8212	8 - BIT I/O LATCH	AVL:	NOW
8216	BI-DIRECTIONAL BUS DRIVER	AVL:	3RD Q
8201	COMMUNICATIONS INTERFACE	AVL:	4TH Q

INTEL 8080 PRODUCT FAMILY

The 8080 microcomputer has 78 basic instructions, including the 8008 set plus new ones that make possible such features as vectored multi-level interrupt, unlimited subroutine nesting and very fast decimal and binary arithmetic.

Program development for the 8080 can be done either on a large computer using the Intel software cross products (PL/M systems language compiler, macro-assembler and simulator), or on an Intellec 8 development system with a resident monitor, text editor and macro-assembler.

The new 8080 product family includes performance matched peripheral and memory circuits configured to minimize design effort and maximize system performance. Large, low cost RAMs, ROMs, PROMs and I/O devices are available now and we will soon announce other 8080 LSI support circuits.

The 8080 is easier to use and more economical than any high performance microcomputer in sight. It's here now, in volume, from the inventors of the microcomputer and the people who lead the industry in production and design support.

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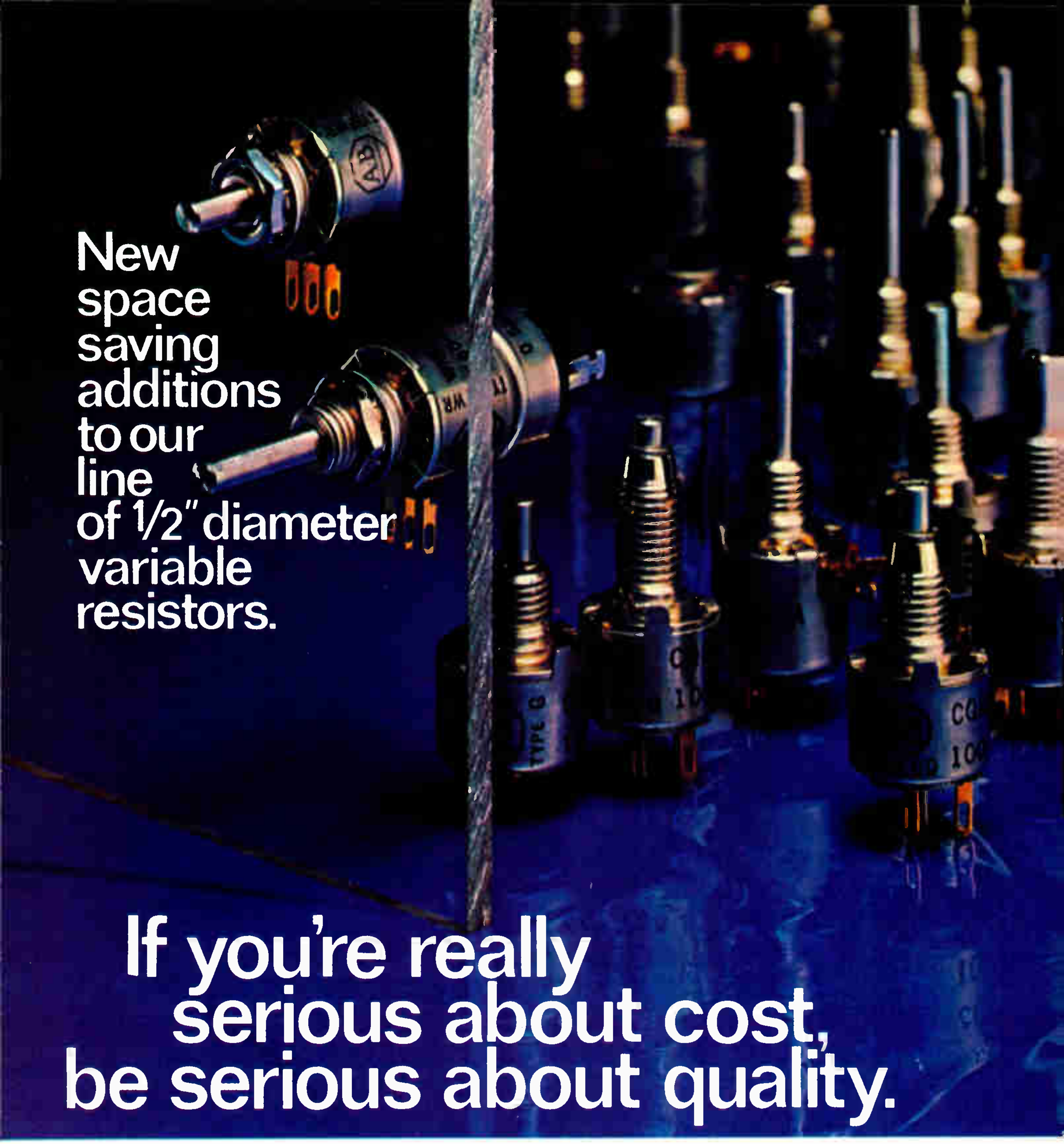

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Small N. J. firm selling $99 digital watch

While the old hands in the watch business race to get under-$100 digital watches to the market, **a small liquid-crystal house affiliated with Sprague Electric Co. has stolen their thunder.** Princeton Material Sciences, Princeton, N.J., is selling its timepiece through Alexander's department-store chain in New York City, which in two weeks sold or took orders for 5,000 units at $99. Princeton Material won't comment on the development.

Timex, which is test-marketing a digital watch that it reportedly will introduce in the fall for $85, refuses to comment. But a spokesman for Waltham says that **the digital-watch industry "has been turned upside down"** by Princeton Material's action; an official at Gruen agreed. And to add to the turmoil, Utah's Cox Electronics says it's going to introduce a $99 liquid-crystal model at the end of the year.

Inselek working on microprocessor with 300-ns cycle

Look for a C-MOS-on-sapphire microprocessor with a cycle time of 300 nanoseconds—**nearly seven times faster than Intel's recently announced model.** Being developed by Inselek Corp. of Princeton, N.J., the device will be ready early next year if all goes according to plan. Joseph Burns, president of the company, which specializes in silicon-on-sapphire ICs, divulged the timetable and confirms that work is under way, but he is reluctant to disclose details of the microprocessor.

By comparison, the new Intel n-channel MOS 8080 cycles in 2 microseconds, which itself is an order of magnitude faster than the same company's groundbreaking 8008 and 4004 microprocessors.

UK artillery control system interests U.S. Army

The U.S. Army may go to Britain to get an automated field artillery fire-control system that works. Plagued by continuing development problems and rising costs of Litton's highly automated Tacfire system, **the Pentagon is seeking a field test of the less-computerized field-artillery computer equipment** (FACE) made by Marconi Space and Defense Systems Ltd. and used by the British Army since 1969. Requests for the field test are to be made through a U.S.-Commonwealth Defense Committee, which including Canada, Australia, and New Zealand, all users of FACE, sources say.

Tacfire, under development since 1967, is facing continuing Congressional budget pressure and is considered in the UK as too ambitious and unwieldy. FACE units, in keeping with British practice, **control only one battery and cost about the same as Tadac,** in U.S. service since the late 1950s. Meanwhile, Marconi is actively seeking sales in Africa and South America for the system, which fits into the back of a Land Rover, a Jeep-like vehicle.

RFPs for DAIS due in July

The Air Force Avionics Lab at Wright-Patterson Air Force Base will request proposals next month **for the digital processor in the anxiously awaited Digital Avionics Information System.** DAIS is a multi-aircraft, general-purpose system that interconnects a variety of on-board avionics.

Among the 45 companies surveyed for the computer RFP are IBM, Univac, Control Data, Autonetics, Honeywell, TI, and Rolm. **The Air Force is interested in off-the-shelf technology,** though such minor modifications as substituting semiconductor memory for core could be handled. Sixteen machines will be purchased initially for delivery from March to June 1975, with each having a capacity of at least 24,000 words of 16 bits.

Motorola working on EFL design

Emitter-follower logic, that old workhorse of the 1960s, may be making a comeback in a new streamlined form. Motorola Semiconductor's Integrated Applied Research Laboratory is building **two different triple-diffused emitter-follower logic LSI chips for a government agency.** And, according to Robert Jenkins, director of the lab, Motorola is seeking to determine if the technology is a viable one to add to its processes.

The EFL, which has been under primary development at TRW Systems in Redondo Beach, Calif., for military computer and communications applications, **is a very high yield, simple technology capable of relatively high density and good speed** performance—40 megahertz. It's also adaptable to computer design techniques. Jenkins says the process is a good one but does have limitations, notably that it's most adaptable to combinational logic rather than memory circuits. He adds that Motorola is not looking for additional business in EFL.

Static RAM accesses in 145 ns

Designers of peripheral equipment will soon be able to design with a static memory that accesses in only 145 nanoseconds. The usual access time for such devices is 500 to 1,000 nanoseconds. **However, the speed is obtained at a price:** static memories are generally easy to handle because they use only one power supply, which is what makes them slow. But the new device, a 1,024-bit n-MOS part from the SEMI subsidiary of Electronic Memories, uses three power supplies—the same as a dynamic memory.

SEMI will offer two parts: the 145 ns model 1217 and the 260 ns model 1216. They'll be interchangeable, but won't be plug compatible with other RAMs. **And the company expects to complete a second-source agreement soon.** The parts will be priced at $11 and $13 in 100 to 999 quantities.

Addenda

Matsushita will buy $1.75 million worth of TV tuners and $1 million worth of flyback coils and deflection yokes this year from General Instrument, **the first time Japan's largest TV and components maker has gone aboard for any parts except semiconductors.** The company cites better prices and a shortage of tuners meeting the U.S. uhf-vhf equality rules as reasons for the move. . . . Experimental fiberoptic material has been fabricated at Bell Laboratories, Murray Hill, N.J., **with losses of only 1.2 decibels per kilometer.** The fibers are made with chemical vapor deposition techniques familiar to the semiconductor industry. Lowest losses so far were measured at the infrared wavelength of 1.06 micrometers with fibers consisting of a pure fused-silica core with a borosilicate cladding. . . . Motorola's $220 million suit against Fairchild, filed in 1968 after C. Lester Hogan left Motorola to head Fairchild, **has been dismissed.**

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		POSITIVE OUTPUT			
PIC600 PIC601	5A	60V 80V	85% @ 2A	30nSec	50nSec
PIC625 PIC626	15A	60V 80V	82% @ 10A	45nSec	70nSec
		NEGATIVE OUTPUT			
PIC610 PIC611	−5A	−60V −80V	85% @ −2A	40nSec	50nSec
PIC635 PIC636	−15A	−60V −80V	82% @ −10A	50nSec	65nSec

*Measured with V_{in} = 25V, V_{out} = 5V, f = 20 KHz, Input pulse width = 10μSec

See Electronics Buyers' Guide Semiconductors Section for more complete product listing

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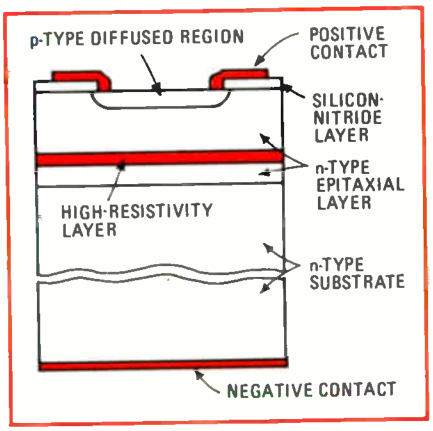
LED with storage makes feasible large displays

Ferranti has developed a means of multiplexing LED matrixes without diminishing emitted brightness.

Providing internal storage for light-emitting diodes may make LEDs practical for large arrays, and a new development from Ferranti, Oldham, England could hold the key. Although multiplexed LED displays are widely used because they simplify interconnections and drive circuitry, each additional multiplexed point or segment reduces the brightness of the image. This is generally not a problem in common seven-segment readouts, but it becomes increasingly serious in large matrix displays, especially those used in bright environments.

The alternative to multiplexing, direct addressing, requires large and complex interconnection arrays, plus substantial external storage circuitry to keep the points lit. Some designers have proposed using either four-layer, or Shockley, diodes or p-i-n diodes, but both of these diodes are difficult to reproduce uniformly with low switching voltage and bright light output.

Thyropter structure. Once turned on, Ferranti-made LED remains lit.



The new approach to a storage diode by researchers at Ferranti was described at the 1974 Society for Information Display conference in San Diego, Calif., last month. The diodes, called Thyropters, depend on optical feedback within the device structure. Ferranti's Victor Pastore says the devices thus far fabricated have turn-on currents of about 1 milliampere at potentials between 8 and 11 volts, and holding voltages can be in the 2- to 4-V region.

Thus, for normal operation, the diodes are forward-biased at approximately 7 V, below the turn-on threshold, and are turned on and off with pulses of ±5 V of over 1 microsecond duration. The nominal device current is 15 milliamperes with a brightness of 400 foot-lamberts at a wavelength of 5,650 angstroms in the green spectrum.

The device is similar, except in one regard, to a LED with a p-type region diffused into an n-type epitaxial layer grown on an n-type substrate. The difference is a high-resistivity layer incorporated in the epitaxial layer; this, in effect, forms a photosensitive region. This layer restricts current flow through the device at low voltages, but as current increases with higher voltages, light is emitted at the pn junction.

Turned on. This light causes current flow at the barrier between the epitaxial layer and the high-resistivity layer, resulting in a negative-resistance characteristic that keeps the device on, even when voltage is reduced somewhat. At present, the current must be limited by external resistance of about 180 ohms because of the difficulty of integrating this high resistance value.

The devices have been designed into a small hybrid matrix display, and work is proceeding toward a monolithic array with much higher density, which is scheduled to be available commercially in two years, Pastore says. The optical isolation required between cells has been demonstrated, but many problems in uniformity and contact resistance remain.

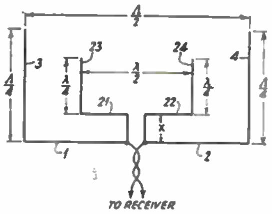
Interestingly, since the individual device elements are sensitive to light at approximately 5,650 Å, they can be turned on by an optical pen. Thus, because the elements can be sensed electronically, data can be entered, as well as retrieved. Normal room lighting is not a problem if the usual contrast-enhancement filters are used; a 5,145-Å argon laser has been used for addressing the display. □

Displays

Thin film lights matrix TV panel

Electroluminescent panels, which have never appeared to be practical for commercial markets in their 15 years of development, may now be headed for a new life. Researchers at Sharp Corp.'s Central Research Laboratories in Japan, have developed a sealed ac-coupled display that offers high light output and between the systems, the systems being energized in an opposing phase relationship. W. Ilberg, Telefunken, April 12. 1941. No. 2,280,235.

Antenna. A short wave antenna comprising a pair of L-shaped con-



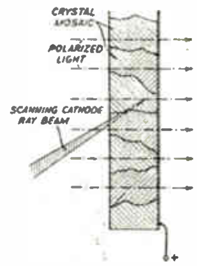
ductors like the illustration. De Witt R. Goddard, Nov. 26, 1938. No. 2,281,-429.

TELEVISION

Receiving System. A picture scanned sequentially at a certain frame frequency, the receiver comprising a cathode-ray set-up for reproducing the picture and a second cathode ray for reproducing the picture in superimposed relation to the first picture utilizing a picture storage tube comprising a double-sided mosaic. G. L. Beers, RCA. Feb. 23, 1940. No. 2,273,172.

Electron Image Amplifier. An apertured insulated grid and a means to project a flood of electrons through the grid, means to produce on the grid electrostatic charges representative of a picture and a target element located on the side of the apertured grid opposite the source of electrons. P. T. Farnsworth, July 6, 1937. Re-issue No. 22,009.

Projection System. The target area in a cathode-ray tube is scanned electrically and cyclically with a modulated beam of electrons at a predetermined rate. Polarized light is intermittently projected against the unscanned surface of the target, the intermittent rate of projection being greater than the scanning rate and bearing a whole num-



ber ratio with respect thereto. Means including a projection lens for directing the light reflected from the target upon an observation screen. Manfred von Ardenne, Berlin. March 18, 1940. No. 2,276,750. See also Nos. 2,277,007–2,277,008, inclusive on projection apparatus, also to von Ardenne.

long life. The lack of these properties are the two major problems with present electroluminscent displays. With its thin-film approach, Sharp has already made a 120-by-90-dot matrix TV display measuring 36 by 48 millimeters.

According to Sharp, the panels have operated more than 10,000 hours with outputs of 1,000 foot-lamberts. The light, at 5,800 angstroms, is yellow-orange. The color is a result of the 5% manganese-doped zinc-sulfide layers forming the emitting material. Other colors are possible. For example, green can be obtained with a tellurium-fluoride activator.

Device structure. The structure of the device is a sandwich of a 5,000-Å thin-film of manganese-doped zinc sulfide with a 2,000-Å insulating layer above and below. These two layers seal the emitting material. An aluminum electrode is fixed to the back of the device, and a transparent tin-oxide layer to the front.

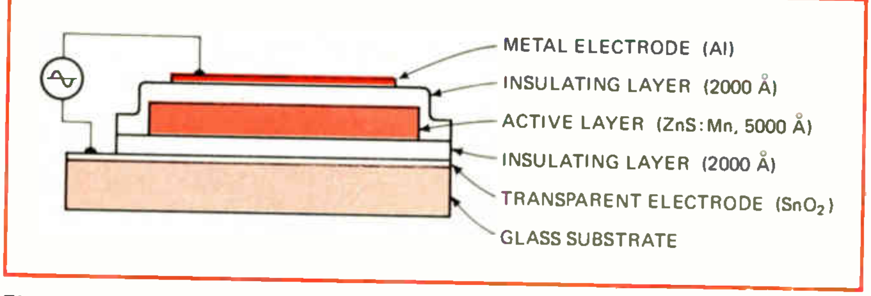
This unit is constructed on a glass substrate. The two insulating layers between the active layer and the contact areas appear to represent the major change from the previous short-lived devices, which have the metal in contact with the zinc sulfide. The insulators are composed of yttrium oxide, evaporated from an electron-bombarded source, silicon nitride, or alternate layers of silicon nitride and aluminum oxide. Protection from moisture is provided if the outer layer is silicon nitride.

The device gets brighter as it is used—at least up to a plateau. This brighter value can be accelerated by a two-hour operating bake at 200°C.

The drive for the device consists of ac pulses at approximately 250 volts. The display brightness depends on the applied voltage, a dependency the earlier powder-type electroluminescent displays did not exhibit. The brightness is also highly dependent on pulse width, making it possible to obtain TV-type gray-scale displays.

TV-display mode. The Sharp researchers developed the TV display by depositing a large sheet of emitting material between insulating layers, with vertical and horizontal conductors arranged over and under in the familiar parallel strips. By this means, any crossover could be addressed separately. A contrast ratio of more than 50 to 1, with 50 foot-lamberts average brightness, has been achieved at a scan rate of at 60 fields per second.

Eight gray scales are available, and the driving voltages are 130 V peak vertical and 130 V horizontal. One line at a time is addressed out of every three lines. The firm expects to have an 8-inch display within a year and a half. □



Electroluminescent sandwich. Using a matrix of these devices, Sharp has already fabricated a TV-type display measuring 36 by 48 mm.

Commercial electronics

OCR unit reads hand-printing

Of all the efforts to speed up entry of raw data to computers, perhaps none has proved more complicated than direct reading of standard hand-printed text. But the complications are neatly negotiated in some new software that Information International Inc. developed to enable its Grafix I optical-character-recognition system to read conventional hand-printing, as well.

Other firms—including Scan-Data Corp., Norristown, Pa., Recognition Equipment, Dallas, Texas, and IBM, Armonk, N.Y.—have developed optical character readers that read either numerals only or alphanumerical characters carefully copied from the American National Standards Institute standard set. The program by the Los Angeles, Calif., firm, however identifies normally hand-printed alphanumerics in any sequence, the only requirement being that an I have bars at top and bottom and a Z have a slash through it. The system processes about 200 characters a second.

The program, which was developed by Steve Gray and Arnold K. Griffith, senior members of the technical staff, begins with a relatively conventional, algorithmic "filter," which recognizes about 70% of the characters very rapidly by following a fixed pattern of analysis. This is followed by a more novel "verifier," which is slower but more thorough. The operation of the verifier is based on heuristic principles—its route to recognizing most of the remaining characters is not fixed, but varies with what it discovers along the way.

The large and complex Grafix I, of which the program is an extension, is a medium-scale time-shared computer system that combines a sophisticated flying-spot scanner and a very-high-speed specialized computer, called the binary image processor, with a DEC PDP-10. The PDP-10 has 150,000 36-bit words of core memory, plus a full range of peripherals.

The scanner and binary image processor are built by Information International. The scanner accepts microfilm images of individual characters normalized to a 31-by-36-dot matrix at a rate of one position per microsecond. The binary image processor, a special-purpose slave processor with a pipeline organization, uses TTL circuitry to achieve a speed of 40 megahertz—up to 1,000 times faster than many other computers.

With the software, this system was tested for its ability to read 10,000 characters printed by clerks

Growing crystals in space spurs study for speed, higher quality

Some of the basic ideas about the physical processes involved in crystal growth may be upset when studies of semiconductor crystals grown aboard Skylab II are completed at Rensselaer Polytechnic Institute, Troy, N.Y. The major result is likely to be a means of growing higher-quality crystals faster.

That is the opinion of Heribert A. Wiedemeier, professor of chemistry at RPI's Materials Research Center, who prepared ampules containing source material of germanium selenide and germanium telluride for growth by means of vapor-phase, a widely used technique for growing epitaxial layers for semiconductors.

For the Skylab experiment, Wiedemeier expected that the crystals would have fewer imperfections, but that the transport rate of materials would be slower. He found, however, that the crystals not only had fewer imperfections, but that the rate of growth was much faster than on earth. The next step is to isolate the factors causing the increased growth.

The major environmental change in the Skylab experiments was the lack of a gravitational field. According to the traditional diffusion-convection model of crystal growth, turbulence caused by gravity during the convection phase results in imperfections in crystal structure.

If convection is minimized (it cannot, of course, be eliminated on earth) by keeping the pressure low in the sealed ampule containing the source material, crystal quality is improved. This procedure usually results in slower growth; not so in Skylab, however.

Because it is unlikely that a chemical reaction is fundamentally different in space than on earth, Wiedemeier reasons that the predominance of gravity-driven convection in crystal growth may veil other mechanisms at work during diffusion. He has postulated that there may be a previously unsuspected transport mode that has not been considered in the present diffusion-convection model.

Whatever the mechanism, it must be understood physically in order to control it and apply it to industrial methods of crystal growth. Analysis of the Skylab crystals may be sufficient, but even more data may be supplied by a similar experiment Wiedemeier is now readying for the Apollo-Soyuz mission next year. □

with only 5 minutes of training and 5 minutes of practice. It rejected 4% of the characters and mixed up 0.05%, or five characters out of the 10,000.

Information International is looking first to the Government for use of the hand-print-reading capability, says Daniel Forsyth, vice president for advanced systems. Social Security is a prime candidate because of the tremendous number of forms it processes, and even more growth is expected as medical programs increase. The company has already sold one of the $1.25 million Grafix I systems to the Navy for reading conventional printing, but the same hardware could handle hand-printing. □

Fiber optics

Thin-film layer cancels polarization

The information-carrying capacity of optical transmission lines could be doubled if the components of optical-waveguide systems were not polarization-dependent. And they need not be, says Leonard Bergstein, professor of electrical engineering at the Polytechnic Institute of Brooklyn, N.Y. A thin-film technique can modify the reflection coefficient at the interface of two optical media to allow matching of the phase velocities of two perpendicularly polarized signals.

In a polarization-independent waveguide, two perpendicular polarizations, like the TE and TM modes, could be independently modulated and demodulated by only one coupling at the input and output, Bergstein explains. In a polarization-dependent waveguide, however, perpendicular polarizations will propagate with different phase velocities, so that only one of the two can be demodulated with any feasible input/output coupling.

Clad and unclad. There are two major sources of polarization dependence in cylindrical waveguides: polarization-dependent reflection coefficients at dielectric interfaces, and birefringence within the fiber. The former dominates in low-loss clad fibers, where multiple reflections between the core material and the cladding occur. The latter becomes important in long lengths of unclad fibers.

According to Bergstein, there is a practical solution that is essentially the same in both cases—the insertion at the critical dielectric interfaces of thin-film phase-matching layers. For clad fibers, this critical interface between the cladding, the core glass, and the phase-matching layer must therefore run the full length of the fiber. For unclad fibers, coating the ends of the fiber is sufficient. The thin-film material has an index of refraction that is the geometric mean of the refraction indexes of the two surrounding media, since this is what cancels the polarization-dependent components of the reflected waves.

Bergstein has applied the same techniques to filters and wave-splitters, thus making feasible a complete set of polarization-independent components for an optical communications system. □

Production

Microprocessors add new twist to torque-monitoring

Since Federal auto-safety regulations now extend to the amount of torque applied to tighten fasteners during assembly, a Flint, Mich., company has put together a microprocessor-based system for monitoring torque at remote assembly-line locations. And the system is already earmarked for several General Motors plants.

Process Computer Systems Inc. designed its Torque Certification System to monitor, control, and provide hard-copy documentation for the 30 to 50 critical fasteners installed in a vehicle. Although each remote unit can stand alone, high-speed data links can connect as many as 256 remote microprocessor terminals to a host minicomputer to obtain factory-wide information.

Each microprocessor terminal, in turn, can handle up to 25 torquing tools so that a single 16-bit minicomputer—a Hewlett-Packard 2100—and 256 small satellite processors can accommodate some 6,400 tools. Moreover, the builders of the system say it has uses, not only in the defect-conscious auto industry, but in other industries faced with excessive field repair, replacement of fasteners, or new Federal quality and safety standards. In the auto industry, for example, assembly plants must employ additional personnel to check and often to retorque critical fasteners.

Each satellite terminal, sealed in an environment-proof enclosure, is built up of standard modules, also developed by Process Computer, in what is called a Plant box. The company's CM4400 microprocessor module uses the 8-bit Intel 8080 chip and includes six 8-bit registers, 8-bit accumulator, 8-bit parallel arithmetic unit and 16-bit stack pointer. Four different memory modules may be used in any combination for up to 64 kilobytes of read-only and random-access memory for storing data, data tables, and application software.

Also included in the Plant box is a teletypewriter that prints torque readings and out-of-tolerance messages, along with summary reports for all tooling connected to the stations. The date and time of day can be included, as well. At the option of the user, an alarm light or buzzer may be substituted for an out-of-tolerance printout. A general-purpose interface at the host minicomputer matches each Plant box to the computer via the high-speed serial communications lines.

Stripped threads seen. The data itself comes from dc strain gages on each torquing tool. These gages send over a shielded cable low-level dc analog voltages that indicate the actual torque characteristic of each fastening operation. Equivalent torque voltages are stored in memory, and the processor is able to calculate actual torque applied to a fastener. The system also includes a special tool-controller module that provides excitation for the transducer, as well as transducer-signal amplification, peak-torque detection, an automatic tool shut-off signal when maximum torque is reached, and 10 bit analog-to-digital conversion for output to the microprocessor card.

In addition, a timer determines how long it takes the transducer signal to get from the threshold where torque is first applied to peak. This enables a fault such as crossed threads on a fastener to be detected immediately—the fastener would be torqued to a final value in only 50 milliseconds, when it should have taken 100 to 300 ms. Moreover, stripped threads might show up when a relatively long time is taken for torque to build up—say 400 ms.

Communications between the host minicomputer and each Plant box are serial at 40,000 to 160,000 bits per second, using the company's high-speed serial input/output controller modules. A standard interface module—PCS series 2000—is used as well.

Originally, Process Computer had thought of using Hewlett-Packard minicomputers at each of the remote stations, says chief engineer Richard Barnish. However, the microprocessors offer several distinct advantages, he points out. The systems cost less and also allow the company to boost the value that it

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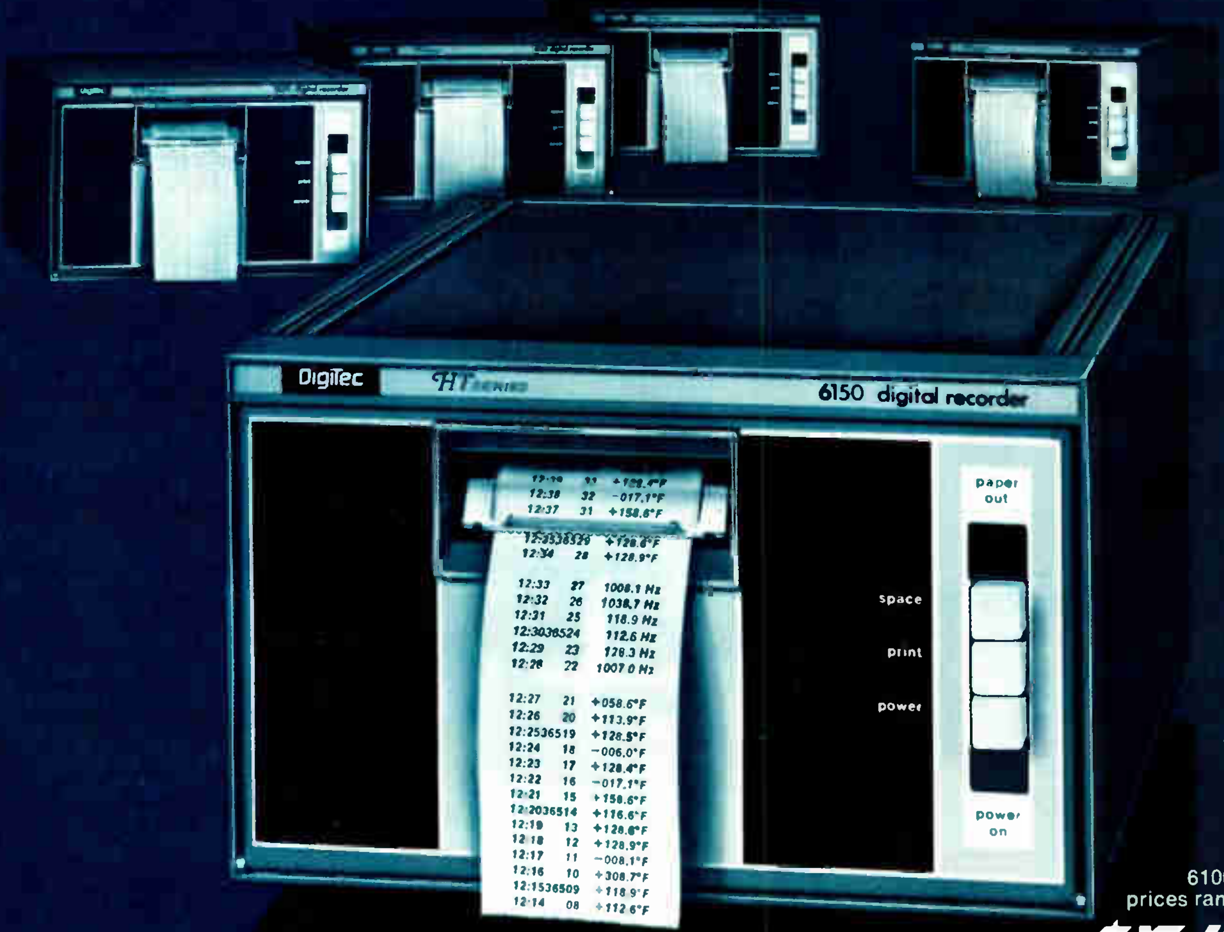

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Medical electronics

Hospital speeds up ultrasonic diagnosis

Ultrasonic devices have been gaining ground as new weapons against artery disease. The ultrasonic technique is a safe, noninvasive way of monitoring a patient's organs [*Electronics*, Sept. 13, 1973, p. 103]. But the results often take hours to assemble and require skilled interpretation. Now, researchers at Guy's Hospital Medical School, London, have designed and built their own system, in which doppler signals are monitored by specially designed circuitry—plus a Texas Instruments calculator chip. The result: an analysis now takes 10 minutes.

Real time. The principle underlying this and other ultrasonic angiology systems is that the red blood cells will backscatter 5-megahertz doppler signals with enough accuracy to indicate blood flow and condition of the arteries. But to achieve the faster analysis, the researchers at Guy's combined a real-time spectrum analyzer with a data collector containing the doppler-signal generator, probes, and a cassette tape recorder for recording the signals.

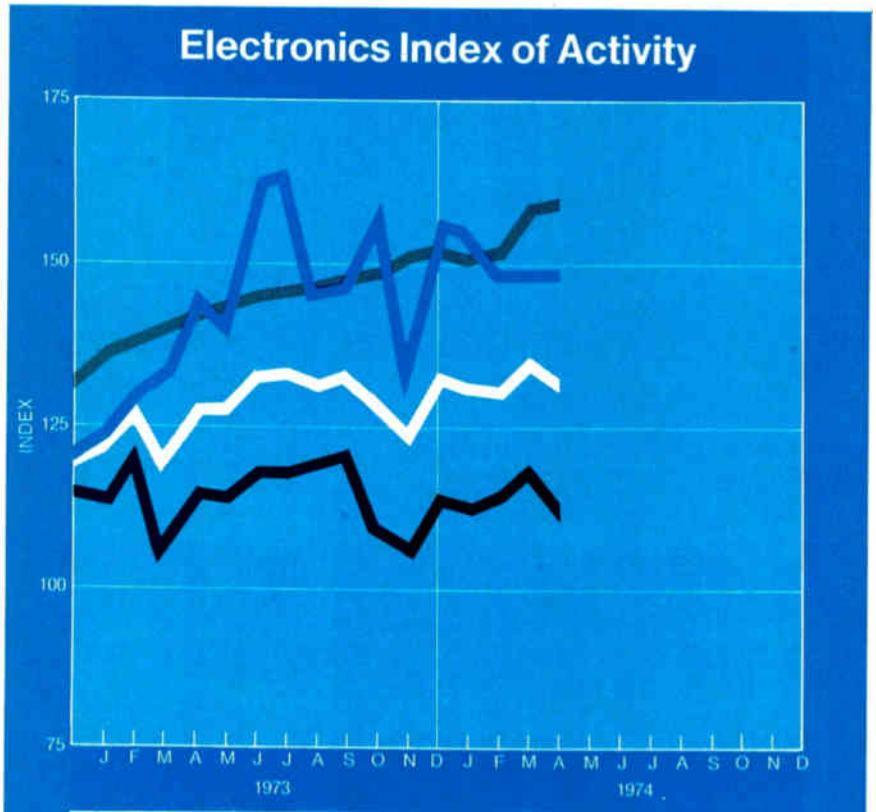
The spectrum analyzer converts the cassette's signals into waveforms, which it prints out as hard copy. Inputs from a pen tracing the waveform are then used by what the hospital calls a pulsitivity-index meter. This computes pulsitivity (or ripple), damping factor, and transit time of a signal, normalized for a patient's blood pressure. The TI chip is the heart of the meter.

The researchers are concentrating on leg arteries. By placing two doppler emitter/receiver probes along a leg artery, clinicians determine, from the system's analysis, whether an artery is normal, or whether and where it is narrowing, or clotted. Five readings are usually taken along each leg.

A key part of the system is the real-time spectrum analyzer, called a Spectrascribé, says David H. King, an electronics engineer who is a research assistant at the hospital. The more commercial type of time-compression analyzer may have up to 1,000 channels and is biased for frequency, rather than time-analysis, because it is often used to monitor vibration. And the vast number of channels slows it up.

From 1,000 to 80. The Guy's Hospital group dropped the number of channels to 80 per doppler channel for quick response, which, since they also optimized the time-frequency bias, got them the required precision. Hybrid analog-digital circuitry, using an MOS shift register, for example, made possible some data-sharing within the unit, also saving time. The analyzer synthesizes with the equivalent of 80 parallel filters, King explains.

The pulsitivity-index meter takes the tracing of the analyzer's wave



Segment of Industry	Apr. '74	Mar. '74*	Apr. '73
Industrial-commercial electronics	148.6	148.6	163.6
Consumer electronics	112.9	118.8	117.0
Defense electronics	159.8	158.8	141.7
Total industry	133.0	135.9	132.4

The over-all index fell 2.1% in April, leaving it 0.5% ahead of last year's level. The only decline was in the defense sector, down 5.0% from March and down 3.5% from a year ago. Consumer electronics remained the same for the third straight month. Industrial-commercial electronics, which rose 0.8% over March's level, caused the index to be 12.8% higher than a year ago.

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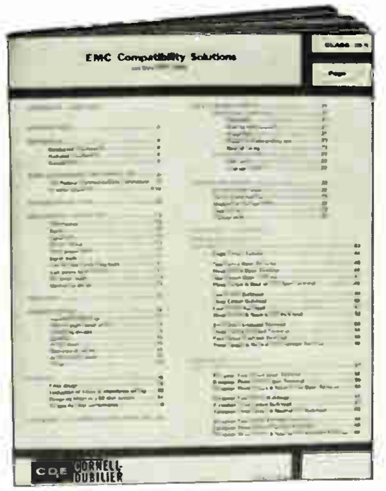

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forms and produces "three parameters of interest," says King: the pulsitivity of the waveform, or ripple; the damping factor, the ratio between the upstream and downstream doppler probes; and the time delay between them, which is relative to a drop in pressure in the artery.

The system will be especially important for patients recovering from an artery-bypass operation, in which continuous monitoring is necessary and dye-tracing methods are inadvisable. Moreover, since the computation of the pulsitivity-index meter comes from a simple tracing, adding a graphic display to it means that less specialized hospital personnel can be used, thus freeing specialists for other duties.

Also, a data base of healthy persons' profiles can be used by doctors to pinpoint the degree of artery disease more precisely. In fact, the staff at the teaching hospital already has established threshold values for the system data, according to Dr. Raymond G. Gosling, reader in physics applied to medicine, who says that a large data base could lead to automated, objective diagnosis of artery disease.

From preliminary work in the hospital, the system is about to become part of a three-year trial sponsored by Servier Ltd., a drug company.

The group estimates that the whole system could be made commercially for about $25,000, considerably less than anything remotely comparable. □

News briefs

TI wins $40 million Navy award
The U.S. Navy has selected Texas Instruments to develop its new air-to-ground High-Speed Anti-Radiation Missile, known as HARM, at an estimated cost of $40 million. With the award of the first $1.4 million for preliminary design, the Dallas-based company becomes the winner in competition with General Dynamics, Hughes Aircraft, and Lockheed Missiles & Space Co.

RCA dropping audio-product line
RCA's Consumer Electronics division, Indianapolis, is phasing out the company's line of home audio products in order to concentrate on TV-related home electronic products. The 1975 line will be the last for radios, audiotape players and recorders, and phonograph equipment. William Hittinger, executive vice president of the division, said the reason for the decision is that the audio product line has not been profitable in recent years.

National shifts executives
National Semiconductor Corp.'s marketing organization now has a new marketing director, Gene Carter, former director of integrated-circuit marketing. Carter replaces Floyd Kvamme, who has become manufacturing vice president, the post recently vacated by Pierre Lamond. Lamond, in turn, left National to become president and chief executive of Palo Alto-based Coherent Radiation.

Textron may invest in Lockheed
Textron Inc. may help to overhaul Lockheed Aircraft Corp.'s shaky financial situation through a top-level management switch. If approved, Textron will invest $85 million in Lockheed stock, and G. Wilson Miller, the lawyer who heads Textron, will also become chairman and chief executive of Lockheed. Lockheed's present chairman, Daniel J. Haughton, will become vice chairman. Textron and Lockheed have tentatively agreed on the deal.

Second Westar launch delayed
Trouble in NASA's Delta launch vehicle has delayed the launch of Western Union's Westar II communications satellite, which had been scheduled for June 10. NASA said "anomalies" that appeared on recent Delta launches will delay the launch—perhaps until August—pending results of a review of the Delta launch program.

Burroughs adds to Series L line
Burroughs has added higher-performance models to its L-Series business minicomputers. The new machines are the L 6000H series, which includes three accounting minis and a magnetic-record mini. Also added are the even more powerful L 8800H accounting mini and L 8900H magnetic record mini.

Radar market to reach $5.5 billion
Government spending on the total ground- and ship-based radar market is predicted to reach $5.5 billion for fiscal years 1974 through 1978, says Frost and Sullivan Inc., New York City market researcher. In addition, says the firm, annual funding will be about $1 billion.

Trade with Taiwan rises
A new trade center in Taipei, Taiwan, is aiding a "substantial rise in U.S. sales" to the Republic of China, says the U.S. Department of Commerce. Upswings are expected particularly in electronic test equipment, nuclear-test instruments, analytical instruments, and industrial process instruments and controls. The Commerce Department attributes the boom to a growing economy in Taiwan, coupled with its government's recent decision to encourage a more equitable trade balance with the U.S.

Memories

8-kilobit CCD memory runs fast

Getting around the inherently slow serial nature of CCD memories has been a major problem. But Bell-Northern, Ottawa, Canada, has organized an 8,192 bit CCD chip into recirculating tracks to boost its speed, and the company is now assembling a 1-megabit memory that

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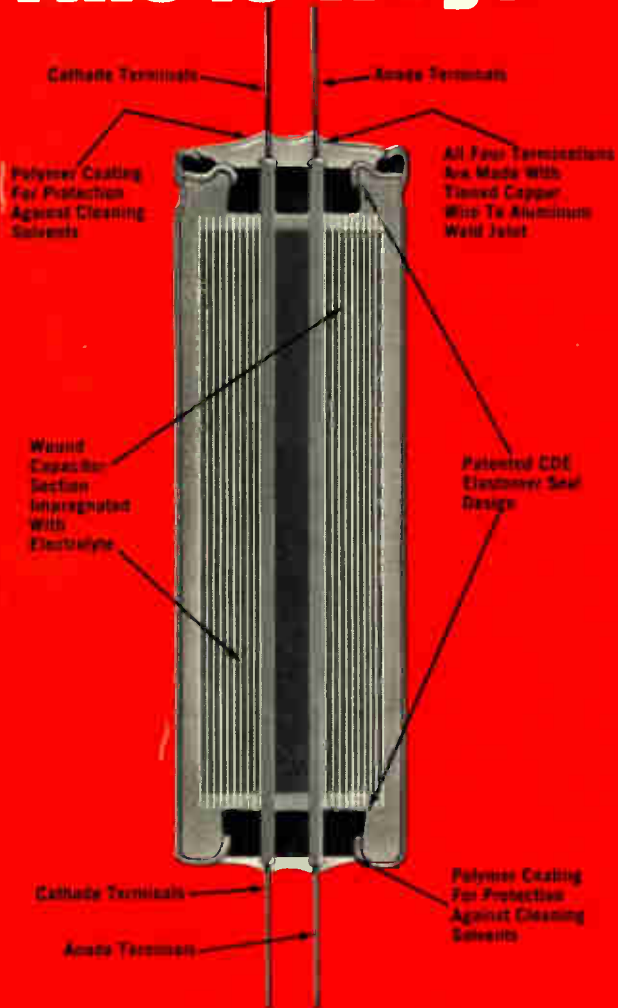

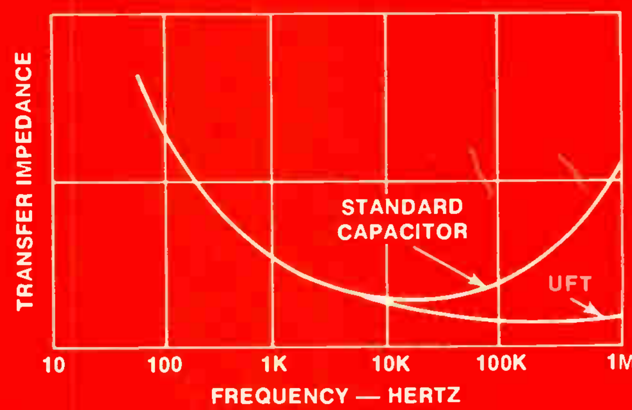

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could rival the performance of electromechanical disk memories.

The device has been operating satisfactorily in the laboratory at least since early February. And with the recent revelation that Signetics Corp., Sunnyvale, Calif., is readying a 16,000-bit CCD chip for introduction next winter [*Electronics,* March 7, p. 26, *Electronics,* April 4, p. 120] the advent of CCD memory appears to be a step nearer. In fact, Bell Northern is building an experimental system, consisting of 128 of the devices, to deliver 1 megabit of 16-bit-word storage, which will operate at speeds to 1 megahertz [*Electronics,* April 4, p. 35].

The Bell Northern 8,192-bit unit operates at a 1-megahertz clock rate and has an access time, or latency, of 128 microseconds. Such a relatively fast latency is achieved by organizing the array into 32 recirculating serial memory tracks of 256 bits each. Thus, the waiting time for access to data is shorter by a factor of 32 than with a conventional 8-kilobit shift register that has a single "track."

Moreover, when data is not being accessed, the CCD chip is designed to have a 10-kilohertz idle rate for refreshing data. This means that power dissipation, with 8-volt clocks, is only a milliwatt; during data transfer at 1 MHz, it is 15 mW on-chip, plus a capacitive drive power of 90 mW dissipated off the chip. Bell Northern has also operated the chip at rates above 2 MHz.

Random access to any track is provided by on-chip decoding of a five-digit address. Data is read out nondestructively, except while the input terminal is enabled, in which case each input data bit replaces the bit readout during the previous half-clock period.

Sequential read/write operation is achieved by including a 1-bit CCD register between the output and input nodes as part of each recirculating 256-bit track.

Over-all chip dimensions for the 8-kilobit array are 178 by 168 mils. This works out to 3.6 mil^2/bit, including 1.2 mil^2/bit for peripheral circuits, interconnections, and bonding pads. The CCD elements themselves are two-phase, two-level, overlapping, silicon-gate structures that permit a simplified CCD-electrode layout providing transfer in one direction only. End-of-row refresh amplifiers drive metal return lines back to the input side of the array. In-row or end-row refresh is carried out every 32 storage bits.

As far as manufacturability is concerned, a Bell-Northern spokesman says that the process is similar to those used for standard n-channel silicon-gate MOS devices. Bell Northern could produce the devices, but, as a research arm of the Canadian telephone company, Bell Canada, is legally restrained from entering into manufacture.

In the long run, CCD memories have a good chance of replacing rotating memories such as disks. Fabricated in systems, the CCDs would offer savings in power, weight, and space, and would likely offer increased reliability. The CCD structure promises at least a 2:1 and even as much as 4:1 lower cost than a comparable MOS RAM, the Bell Northern spokesman says. □

Military electronics

French and U.S. fighters compete for NATO sales

Representatives of four NATO countries—Belgium, Holland, Denmark, and Norway—are visiting France and the U.S. this month to select a replacement for their aging F-104 Starfighters. The main contenders for the business are the General Dynamics YF-16, the Northrop YF-17, and the French Mirage 1E. The four countries will require about 350 to 400 aircraft—roughly a $2 billion deal. About 40% of the total will go for electronic equipment.

In addition, there are prospects of overflow business with non-NATO nations, such as Iran, Spain, Greece, Turkey, the oil sheikhdoms, and certain South American countries. Total sales outside the U.S., including the four NATO partners, could run from 1,000 to 1,500 planes.

Representatives of the four NATO countries will be in the U.S. June 24 for three weeks, visiting Washington, D.C., General Dyanmics and Northrop plants, and Edwards Air Force Base. Their reports may not be ready before their parliaments go on vacation, however, and the outlook for the first action is when parliaments return in September.

Both the French and the U.S. firms have offered a variety of deals to potential buyers that call for production of up to half the number of the planes now flying in their countries. Government representatives will primarily be looking at economic aspects of the arrangements, having previously examined the technical advantages of the various craft. What is also important is the willingness of France and the U.S. to pick up future research and development costs of the aircraft.

The General Dynamics plane has

General Dynamics contender. The YF16 is one of three fighters competing for NATO buys.

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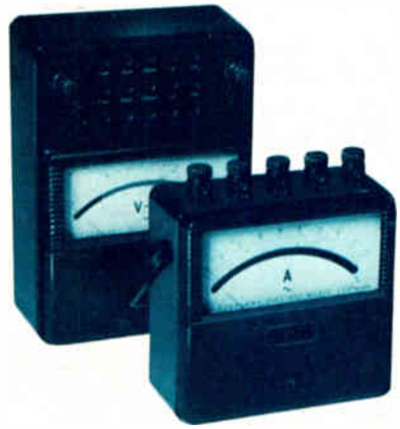

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Supersonic System. A supersonic wave light modulating device and a light source for illuminating the device plus means for applying picture signals to produce in this device a train of moving supersonic waves modulated in amplitude in accordance with the signals with means for forming optical and electron images. A. H. Rosenthal, New York. No. 2,270,232. Jan. 12, 1939.

Television and Cathode-ray Circuits

Signal Producing System. In a television system, a cathode-ray image-reproducing tube having an apertured grid with one surface of dielectric material and an opposite surface of secondary electron-emissive material. The surface is scanned with a signal-modulated beam to produce a charge image on the surface, and upon the other surface of the grid is directed an electron stream for developing a source of low voltage electrons of uniform density and of a cross-sectional area comparable to the area of the grid. Means for physically blocking the direct path of electrons of the stream through the grid, whereby the density of the electron stream through the grid is space-modulated by the charge image on one surface, and means for utilizing the modulated electron stream to produce a visible image. R. C. Hergenrother, Hazeltine Corp., Sept. 30, 1939. No. 2,280,191.

been flying since February, and the Northrop aircraft was to be flown for the first time this month. Testing on the two projects should be wound up by next spring, and then the U.S. Air Force is to consider the purchase of the planes, subject to budget approval. The selection by the U.S. might boost sales, since it might help to lower production costs, provide spare-parts back up, and furnish other support.

The U.S. has been touting the General Dynamics and Northrop planes on their technical superiority over the French Mirage, which is being called a redo of an existing plane. The Mirage, being redesigned around a new engine, is expected to fly by the end of this year. But the French are aggressively selling also and urging European countries to "buy Europe."

The Belgians and Dutch will probably be the first to decide on replacement of the Starfighter, probably this fall. With strong electronics capabilities, both countries will probably get a lion's share of the avionics business. □

Congress favors defense spending

Although there are still critical cost overruns in some military programs, Congress doesn't appear to dislike any program very much. That is the opinion of one knowledgeable House military-appropriations analyst.

Even the Air Force's long-controversial Airborne Warning and Control System with its look-down radar is expected to be funded for production of at least six planes. This represents a cut by the House of half the number sought, but Senate tactical-air-power specialists are pushing for the full dozen. The USAF request for $769.5 million in fiscal 1975 is for the Boeing/Westinghouse program, the service's third largest. It is exceeded only by the $1,076 million sought for the McDonnell Douglas F-15 fighter and the $918.5 million requested for Minuteman missiles, improvements, and site defense.

Although the Awacs procurement was chopped by the House, the $219.7 million for R&D has been left intact by both chambers thus far. One new and still unresolved threat to Awacs is a recent General Accounting Office report to Congress that its radar is vulnerable to enemy jamming with relative ease. The Air Force denies this, yet the Senate wants Schlesinger to name a panel of "disinterested experts" to evaluate the charges.

Of two new tactical air programs for the 1980's—the Navy's VFX lightweight follow-on to the costly Grumman F-14 and the similar Air Force air-combat fighter, proposed successor to the F-15—both House and Senate are near agreement thus far on the $30-odd million sought by USAF. The House, however, has scrubbed the $36 million sought by the Navy. Some Navy money could be restored later, but Congressional sentiment is growing for a commonality study to see if one plane could do both jobs.

The Army's Advanced Attack Helicopter, follow-on to the cancelled Lockheed AH-56 Cheyenne, could be in trouble. The service acknowledges that unit costs for a buy of 472 aircraft would be $4.2 million, or close to the $5.1 million figure for Cheyenne at the time of cancellation.

Defense outlays to rise past 1975

The Pentagon's fiscal 1975 spending request is now nearly halfway through the congressional mill, and the funding outlook for the country's largest spending agency and its electronics programs is good for the short term and even better for the years ahead. The congressional mill this year is grinding quickly and not very fine.

In the two-step process, an authorization bill fixing a spending ceiling is followed by an appropriation. The House has now passed a $22.6 billion authorization for procurement, research, and development after its Armed Services Committee had cut the Department of Defense request by only $500 million, a tiny 2% of the total. Procurement outlays represent approximately 27% of DOD's proposed expenditure total of $85.8 billion in fiscal 1975 [*Electronics*, Feb. 21, p. 69].

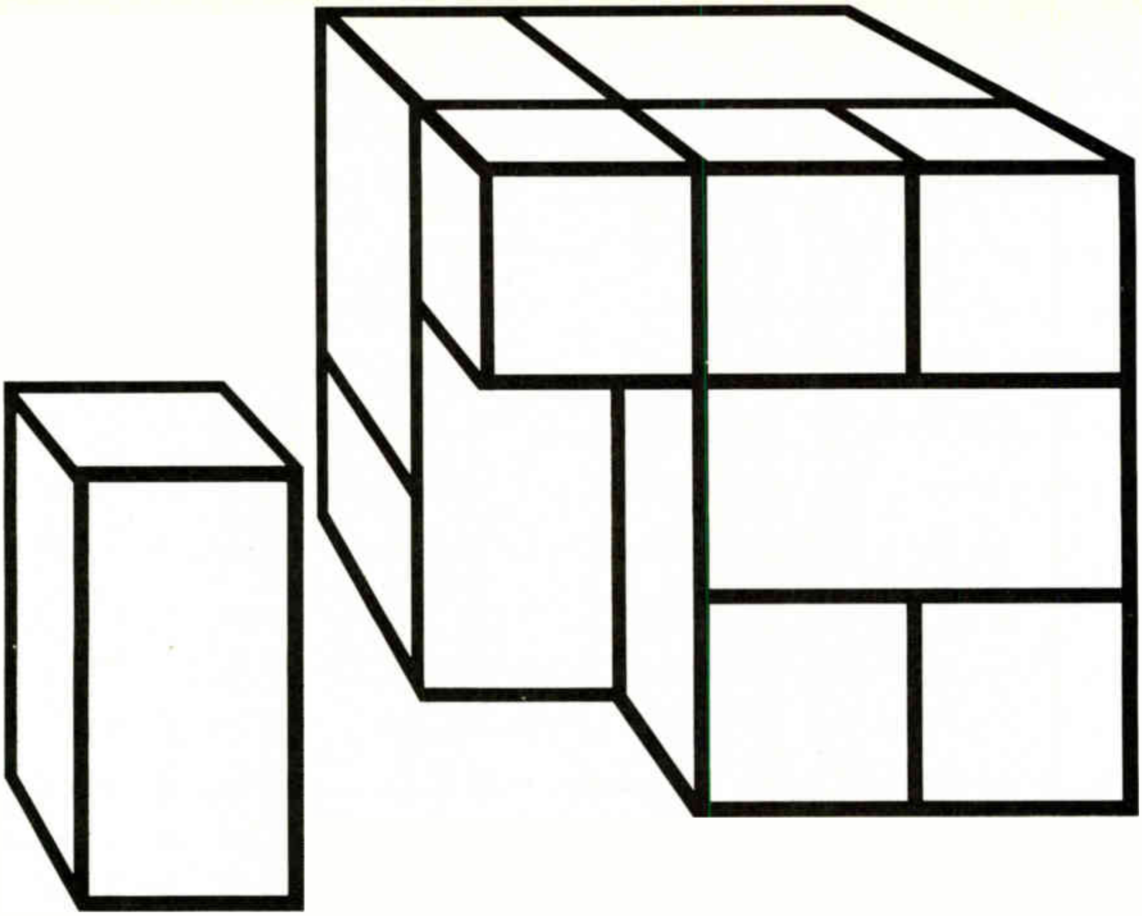
The Senate, known for making larger cuts than the lower chamber, has until now reduced the procurement and R&D money request by only $1.3 billion to $21.8 billion. If the House of Representatives and Senate decide to compromise as they have in the past by splitting the difference, Defense Secretary James Schlesinger will wind up with an authorization approximating $22.2 billion, or only $800 million less than he asked for.

This cut is only 3% compared with reductions in prior years of 5% or more. DOD would be authorized to spend about $2 billion more than it got a year ago for hardware and studies in the new fiscal year that begins July 1.

Reductions limited. While legislative analysts in DOD, the Congress, and industry agree that somewhat bigger reductions may come in the more important appropriations bills later this year, they also concur that these are unlikely to exceed a billion dollars, even though they may severely impact a few individual programs with high electronics content.

The future. In a new and detailed forecast of defense spending in fiscal 1975 and beyond, the Brookings Institution foresees a likely need for a supplemental defense appropriation in the coming year to counter $1.4 billion in unanticipated inflation. It predicts that in five years, the nation will require nearly $111 billion annually for defense to achieve Secretary Schlesinger's goal of a more efficient, combat-ready force [*Electronics*, Feb. 21, p. 12]. The Washington-based research institution predicts that figure could soar to as much as $142 billion if its estimate, based on 1975 dollars, is inflated by 5% a year. In any event, the Brookings Institution analysis—"Setting National Priorities: The 1975 Budget"—forecasts that defense spending will break through the $100 billion mark by fiscal 1978.

Schlesinger's approach to defense



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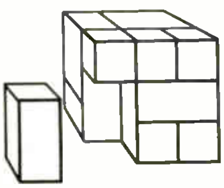

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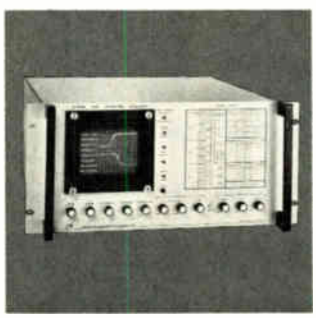

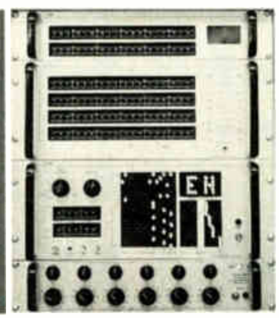

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spending and force structures is premised on the possible need to fight a short, intensive European war of a few weeks, rather than the 90-day conflicts envisioned by prior administrations. This strategy is viewed by Brookings as leading to "the most far-reaching changes since 1961," when the Kennedy Administration brought in Robert S. McNamara as Secretary of Defense to reshape military goals and forces.

Considering probable Soviet battle tactics in Europe, say the Brookings Institution analysts, Schlesinger's goals are probably all valid: to exchange military-support manpower for more combat units, modernize existing weapons, and increase tactical-force stockpiles of relatively low-cost systems, as well as expand airlift and seapower capabilities. □

Computers

DEC forms group to market peripherals

In a major departure from its previous strategy for marketing small peripheral devices and some other relatively simple products, Digital Equipment Corp. has decided to sell this equipment in quantity to all comers, as well as to buyers of its minicomputers. To this end, its manufacturing and marketing operations for these products have been transferred to DEC's new Components group, which will occupy part of the former RCA computer plant in Marlboro, Mass. Heading the new group is Andrew Knowles, previously vice president for small computers at DEC.

Peripherals for the large DECsystem 10 are included in the move. The group will market the TU-60 tape-cassette drive, the RT-01 and RT-02 remote data-entry terminals, and a few other small peripherals, a stripped version of the PDP-8/A minicomputer (the new two-board model of the venerable PDP-8 line), its new MPS microprocessor board, all non-core memories, and logic products.

The newest product from the group is a low-cost alphanumeric cathode-ray-tube terminal, called the VT-50 DECscope, with an optional printer for hard copy. DEC says the VT-50 will be the lowest-priced such terminal on the market at less than $900 in quantities of 100 without the printer.

The key offering under the new marketing effort will be what DEC calls "pure iron." Products will be sold in minimum quantities of 50 right off the production line, unassembled, untested, and without inclusion at any field service, software, or training. □

MOS 1974 sales are forecast to hit $800 million

The most bullish forecast for 1974 MOS sales comes from Benjamin M. Rosen, of Coleman and Co., New York securities firm. Rosen surveyed 13 semiconductor manufacturers and came up with a projection of $800 million, up from $482 million in 1973. The total includes $290 million in MOS-memory sales. Rosen predicts total semiconductor sales for the year at $2.8 billion.

He also ranks semiconductor firms in MOS sales. Rosen's projected top five for 1974 are Intel, with an estimated $120 million; Texas Instruments, $90 million; American Microsystems, $87 million; Rockwell Microelectronics, $80 million, and Mostek, $60 million.

In MOS-memory sales for 1974, Rosen projects Intel as the leader with $118 million; Mostek, $36 million; American Microsystems, $26 million; National Semiconductor, $20 million, and Advanced Memory Systems, $12 million.

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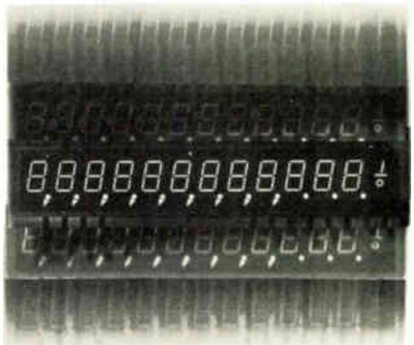

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News update

Go slower and make it simpler. This is the essence of the guidelines delivered by the director of Defense Research & Engineering earlier this year to Army's SAM-D program and its prime contractors, Raytheon Co. and Martin-Marietta. The policy follows a stinging criticism last year of the air-defense-missile system's rising costs and complex technology [July 19, 1973, p. 74]. Since the review by the General Accounting Office, economic watchdog for the Congress, SAM-D has been slowed, even though its R&D funds are about unchanged from Pentagon requests. Budgeted at $194.4 million for fiscal 1974, which ends June 30, the project is expected to get about $100 million of the $111.2 million sought by the military for fiscal 1975. How much the program is altered and how quickly it resumes speed on its new course are to be determined by the Defense Systems Acquisition Review Council.

Remember Viatron Computer Systems Corp. and its $40 terminal? The bankrupt Burlington, Mass., manufacturer, which bet heavily on MOS at a time when the technology was not yet mature [Oct. 14, 1968, p. 193], is still having financial problems. The latest turn of bad fortune came when Viatron's Chapter 10 bankruptcy trustee said he couldn't sell the company as a going concern after bids were sought in February. Proceeds of the sale were to be used to pay off Viatron's creditors, whose claims come close to $20 million—$15 million of that in convertible subordinated debentures. At the same time, a group of debenture holders presented their own reorganization plan in a Boston Federal court. The plan provides for nearly all creditors to receive a new issue of Viatron common stock as payment. "Priority" creditors—including the Government—would receive cash payments; "nonpriority" creditors—including the debenture holders—would receive one share of a new common stock at 1 cent par value for each $10 of indebtedness.

"Installed and growing" is the way U.S. Customs Service officials describe the anti-smuggling computer network it calls TECS—for Treasury enforcement communications system [July 21, 1973, p. 36]. Now more than 400 terminals, made up of visual displays for baggage inspection at U.S. international airports and automatic send/receive teleprinters at U.S. entry points along the Canadian and Mexican borders, have been installed. They're linked by telephone lines to the TECS duplexed Burroughs 5500 computers at the Customs data-processing operation at San Diego, Calif.

Two years ago, semiconductor makers were digging in for the first laps of the great bipolar RAM race [July 3, 1972, p. 65]. There were almost as many processes designed to pack as many bits as possible on the smallest possible chip as there were contending manufacturers. However, there were two basic ways to handle the 1,024-bit TTL devices: oxide-isolation and the standard process. Of the companies announcing oxide-isolated devices, only Fairchild, with its Isoplanar technique, appears to be shipping in volume [Feb. 21, p. 114]— in fact, says the company, the 1,024-bit bipolar RAM is one of its best sellers. Another oxide-isolation version called V-ate, was announced by Raytheon. That company will say only that its process and run rates are the same as they were a year ago—but industry observers hint that Raytheon is experiencing problems with its V-ate process.

With the People's Republic of China now displaying a distinct coolness to almost anything American, last year's cautious assessment by the Electronic Industries Association's John Sodolski that new electronics trade with the Chinese would develop slowly seems to be borne out [July 5, 1973, p. 73]. Sources at the State Department acknowledge that the potential for trade in technology has not blossomed as they had hoped following President Nixon's historic visit to Peking. But, as the EIA staff vice-president observed after his mission last year to Kwangchow and the Canton Trade Fair, the Chinese, renowned for their patience, seemed even then to be in no great hurry to acquire American hardware, despite their potentially vast market.

The big, fast ECL computers developed by Gene Amdahl's Amdahl Corp. [March 29, 1973, p. 51] will be produced solely by Fujitsu Ltd. in Japan. The company has been one of the financial backers of Amdahl. Deliveries are expected to start in 1976. However, Fujitsu doesn't plan to sell any of the machines in Japan, because they will compete with Fujitsu's own (jointly with Hitachi Ltd.) top-of-the-line computer— roughly three times the speed of IBM's System 370/168. Meanwhile, in Sunnyvale, Calif., Amdahl maintains that a small number of computers will be produced domestically, as will parts that don't involve excessive labor or inventory cost. Fujitsu has already committed $6 million to Amdahl, and may chip in as much as $7 million more. Amdahl's other angel is Heizer Corp. of Chicago, whose share is roughly the same size as Fujitsu's.

—Howard Wolff

Intended to bring *Electronics* readers up to date on news stories of the past months.

Centralab perspective:

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- Epoxy sealed terminals.
- Interlock/lockout variations.
- 25 button styles and 18 colors.

Write Centralab for Bulletin 1550.

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Circle 122 on reader service card

Centralab perspective:

Miniature pots at a mini-price.

Centralab gives you more to choose from in miniature potentiometers. Take the 1/5 watt, 45/64″dia. **Model 9** for example. Typical pricing, in production quantities of 1000, is 34¢. That's economy because you also get:

- **Rotational life in excess of 25,000 cycles.**
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- **Adjustability — Knob edge or screwdriver slot.**
- **Tolerance — ± 20%**

For quantities under 250 contact your local Centralab Distributor.

Three other miniature potentiometers in the Centralab line of standard controls are:

- **Model 1 — 5/8″ dia. 1/5 watt (Available with switch)**
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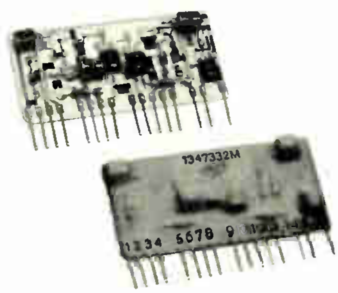
Get complete specifications on all four. Write Centralab for Bulletin No. EP2184.

Circle 123 on reader service card

Centralab perspective:



Two thick film hybrid systems. PEC and MEC.

Centralab offers the flexibility to design and fabricate thick film modules to fit virtually any application and cost parameter.

Low-cost silver/carbon or PEC® systems for consumer applications:

- Resistor Range........10 ohms to 10 megohms
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- Ratio Matching...............±5% minimum
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Circle 57 on reader service card

Washington newsletter

Sea tests planned for laser weapon against missiles

In an apparent effort to develop a ship defense against attacks by such low-flying cruise missiles as the Soviet Styx, the U.S. Navy plans to take a high-energy laser weapon to sea in fiscal 1975 for development testing. Some details of the classified R&D program were disclosed in heavily censored Navy budget testimony published late last month by the House Armed Services Committee. **Assistant Navy Secretary for R&D David S. Potter and Navy R&D boss Vice Admiral W. J. Moran indicated some details in their testimony, however, including plans to test the laser aboard a 10,000-ton utility vessel.**

The requirement for ocean-testing, rather than in a laboratory simulator, was justified by a variety of reasons. These include the need to accurately determine the effects of shipboard motion, as well as the high humidity, dense atmosphere, and other weather conditions "right on the surface of the sea" that could produce "thermal blooming . . . all sorts of things that could distort the path" and break up the laser beam, Potter explained. **Industry sources estimate program cost to be about $20 million in 1975. Most will go for ship operations if the project is approved in upcoming appropriations.**

Saving claimed for electronic switch at ECC hearings

Federal Communications Commission hearings on Phase II of its AT&T investigation covering the company's performance are expected to continue into mid-July, say commission sources. Examination before Administrative Law Judge David Kraushaar is proceeding at a slow pace. **The phone company seems to have successfully rebutted FCC trial-staff claims in the latest hearings that Bell acted with undue haste and incurred unnecessary expense** by pushing ahead with installation of its electronic switching systems (ESS) in central offices without performing extensive field trials first.

AT&T Long Lines president Richard Hough claimed that installations of ESS hardware, developed at a cost of $400 million, are already producing direct annual savings of some $220 million through automation of telephone traffic. Moreover, Hough cited uncounted indirect economies from the elimination of construction costs that would have been incurred in building new space for the larger and older No. 5 crossbar equipment that ESS is replacing.

FCC staff criticisms were developed "without standards or guideposts" and offered only *ex post facto*, observed Judge Kraushaar. No denial of AT&T's development costs as part of its rate base is expected.

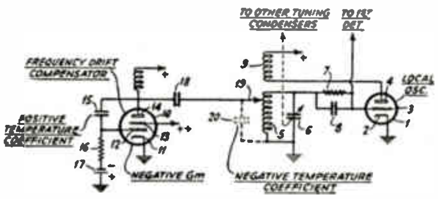
Addenda

General Electric Co., engine supplier for the USAF B-1 bomber now being built at Rockwell International Inc., is disheartened by DOD's acknowledged $1.7 billion overrun in the first R&D models: **GE planners are forecasting fewer B-1 engine sales than the 244 planes the service says it wants to buy,** even though the first B-1 flight has now slipped to late fall and the plane is still overweight. . . . **DOD's cost estimates say inflation in the last half of 1973 was responsible for $2.5 billion of a $7 billion increase** in 55 key weapons systems that pushed their total price up 5.5% to $134.2 billion. Of 15 weapons individually identified in DOD's list of six-months' cost increases, the Army's SAM-D air-defense missile being developed by Raytheon Co. showed the biggest inflationary gain—more than double—to $417 million.

Synchronizing-Signal System. In a synchronizing-signal separating apparatus energized by a composite signal including line-synchronizing and field-synchronizing pulses for each field-underlap interval of the same polarity as, by having a greater duration than the line-synchronizing pulses, an integrating circuit responsive to a predetermined one of the field-synchronizing pulses of each field-underlap interval and unresponsive to the line-synchronizing pulses means for deriving a sensitizing signal initiating at the trailing edge of each predetermined field-synchronizing pulses, plus means responsive jointly to the sensitizing signal and to the field-synchronizing pulse for deriving a control signal. J. C. Wilson, Hazeltine Corp., July 13, 1940. No. 2,280,181.

Generator. System for producing deflection voltage variations for a magnetically deflected cathode-ray beam having saw-tooth wave characteristics. E. L. C. White, E&MI, Ltd., May 15, 1940. No. 2,280,990.

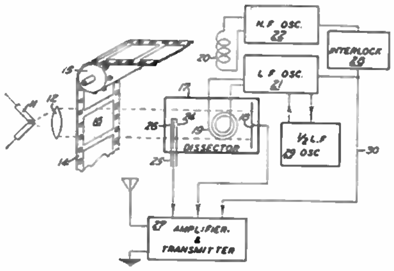
Oscillator Drift Compensation. In combination with a resonant circuit varying in frequency by virtue of temperature effect on the circuit reactance and an electron tube having a cathode and two cold electrodes, an alternating voltage is applied across the circuit between the cathode and one electrode and a phase shifter connected with the other cold electrode develops



from this voltage a second voltage in phase quadrature with the first. The phase shifter includes a reactive element has a temperature coefficient of predetermined signal so related to the mutual conductance of the tube that a reactive effect is produced between one electrode and cathode which has a temperature coefficient compensating frequency variation. C. N. Kimball, RCA. No. 2,280,527, Sept. 7, 1940.

Electron Device. An electrical condenser comprising conducting elements separated by an insulating gap, and an electron beam normally separated from contact with the gap and at times moving the beam to such a position as to render the gap conductive. V. K. Zworykin, WE&M Co., Nov. 26, 1938. No. 2,280,877.

Scanning System. A cathode-ray beam scans a picture field, means for deflecting the beam in two directions, a high frequency oscillator supplying one of the deflecting elements, a low frequency oscillator supplying the other of the deflecting elements, said oscil-



lators having commensurable frequencies, means for interlocking the frequencies, with an additional oscillator operating at a frequency lower than the said low frequency oscillator connected to the output of the low frequency oscillator. P. T. Farnsworth, 1934. No. 2,280,572.

Negative Transconductance Device. Two stages having a common source of anode voltage, control means connected to the grid of the first stage, and a direct connection from the grid of the second stage to a junction between the load resistor and the source of voltage. W. B. Roberts, RCA, Dec. 20, 1939. No. 2,280,987.

Response Adjustment. A multi-section filter having a rising frequency response characteristic, and a load circuit having a response characteristic complementary to the filter response connected intermediate to the ends of the filter. D. E. Foster, RCA, June 29, 1940. No. 2,280,695.

Washington commentary

How industry views TV-set fires

Reports of an increasing number of fires in television receivers caused the Consumer Product Safety Commission to put TV near the top of its priority list and schedule testimony on the issue late this spring. Manufacturers sought to rebut some of the reports with an analysis prepared by the Electronic Industries Association's Consumer Electronics Group. The industry position has some interesting points, so here are some excerpts from that report by EIA/CEG's special counsel, J. Edward Day. **—Ray Connolly**

There are approximately 117 million TV receivers in use in the United States at the present time. Of these, approximately 64.5 million are black and white and approximately 52.6 million are color. Statistics on numbers of fire or shock incidents claimed to be attributable to TV receivers [88 per million 1970-71 models sold, of which EIA verified 40; 56 per million 1971-72 models sold, of which EIA verified 26; 44 per million 1972-73 models sold, of which EIA verified 20] must be placed in context by relating them to total sets in use: 110 million in 1972; 100 million in 1971; 92 million in 1970. The number of color sets in use was only 10 million in 1966 and in 1972 was up to 45.4 million.

We do not claim that we have reached perfection. We have been ready ever since this commission was appointed to sit down and discuss any ideas this commission might have to still further improve television safety. We have never needed repeated waves of scare publicity and sensationalizing of this complex problem to make our industry concerned and active about safety on a priority basis.

The events chain

When this commission issued its priority list last summer, TV receivers were well down the line and were not scheduled for early action. Then, two things happened: First, several fires took place, by coincidence all in northern New Jersey, where it was claimed that the source of the fire was a TV receiver. These tragic incidents gave rise to extensive and frequently repeated waves of publicity. The first of these fires took place in New Jersey Jan. 1, 1973. Here is what the report of this commission's staff said about that fire: "We established the exact identity of the set (it was not an 'instant-on' type); however, we were unable to determine the repair history or to prove that this TV set started the fire."

The second thing that happened in our situation was that, pursuant to the (Consumer Product Safety) Act, various companies began filing with the commission reports of potential defects in particular models. In many of these cases, as a result of having time for more thorough investigation after the report was filed, the actual number of potentially defective sets turned out to be much lower than the larger number originally reported.

As a result of these developments, the commission put TV near the top of its priority list.

The statistics

We realize the commission is still new and is still in the process of developing and improving its statistical and investigatory methods.

For example, in the Federal Register [hearing] notice you include a list of "17 consumer complaint letters on TV-related accidents." In one of the so-called "accidents," identified as happening in San Jose, Calif., all that happened was that a man from San Jose wrote to the Federal Communications Commission, said that he had seen an ad for a TV-tube tester, and questioned whether such a tester was safe.

As another example, the notice refers to a survey of TV-related fire reports by your field offices. We visited one of these offices to see how the survey was made. We found that in not even one of the cases reported by this particular field office could your investigators locate any information at all to indicate the TV set was the cause of the fire. The local fire department reports had merely said a fire "began near the TV," but said nothing as to the cause of the fire. But in the commission's notice this was escalated into a "TV-related fire."

In the notice you refer to data on what is labeled "TV-related accidents" collected through your National Electronic Injury Surveillance System. In the case of one of these incidents, here is what the commission's staff report shows: "Victim had placed a kitchen knife on top of TV set and cut his right arm on the knife while adjusting the antenna."

But aside from such questions about the statistics, the really important thing is to realize that in considering TV safety we are dealing with a dynamic, evolving technology. It is not a situation where absolute perfection can be easily and immediately achieved.

We have never objected to having a Federal mandatory standard for TV receivers. We have urged and do urge that procedures for formulating such a standard be started without delay. We also urge that such standard include uncomplicated procedures for revision to recognize the fact that achieving maximum safety for a complex product is not a static process.

SGS-Ates packs 20 watts into IC audio amplifier

With the ease of a soprano trilling up the scale towards high C at Milan's famed La Scala opera house, Italy's leading performer in semiconductors—SGS-Ates—keeps running up the power ratings for its audio integrated circuits.

SGS-Ates' latest audio IC package—which is, as far as the company's market watchers know, the power pacesetter at the moment—puts out 20 watts typically, with supply voltages of ±17 volts and a load of 4 ohms. And it's not just raw power. At the 20-W output, harmonic distortion is only 1%. At 10 W, the distortion drops to 0.1%.

"We are trying to push power levels for low-cost hi-fi phonographs up from 5 W to between 10 and 15 W," says Raimondo Paletto, the company's technical director. SGS-Ates has set a quantity price of $3 for the new package, designated the TDA 2020, and Paletto expects it will help open a new market—quality sound at 10 W or so from unit audio sets with manufacturers' price around $100. The company has started pilot production of the IC and figures to get into full-scale production during the second half of 1975. Later, there'll be an industrial version, the LO 68, for such applications as small-motor drives.

To reach high IC power, SGS-Ates parlayed its plastic packaging expertise with a slick layout for elements on the chip. Crucial to the package concept is the technique used to solder the chip—100 by 70 mils—directly onto a copper-slug heat sink running the length of the package.

Paletto won't say what the composition of the solder is. But at the late-May Internepcon/Europa meeting in Brussels, the company's top packaging development man, Walter Fumagalli, said that gold-based solder preforms pointed the way to a "two-fold improvement" on the number of on/off thermal cycles that plastic packages for 20 W or even 50 watts could withstand.

Other key considerations for the package are the copper for the lead frame and the encapsulating resin. It must have thermal expansion as close as possible to that of the chip-to-frame wire connections, withstand temperature to 150°C, and shrink enough when cured to leave the heat-sink slug's surface slightly above the rest of the package.

It's the package, then, that let SGS-Ates boost power to a guaranteed rating of 15 W, with 20 W typical. The hi-fi-quality distortion characteristics, though, come from the chip layout— largely the work of Bruno Murari, head of linear IC design for the development department at SGS-Ates. □

Great Britain

BBC experiments with digital TV recording

The British Broadcasting Corp. is experimenting with digitizing another link in television broadcasting in what may become the digital revolution of the medium. Having recently developed its own analog-to-digital converter for video waveforms [*Electronics*, Jan. 24, p.53], the BBC now is developing a digital color-TV recorder to store program material on magnetic tape. Results are very good, but the big problems are determining how much digital data need be stored and storing it so that it requires the minimum amount of magnetic tape—all economically and without impairing picture quality.

However, even if these problems can't be solved satisfactorily the recorder experiment will have its benefits. BBC engineers will be able to apply the signal and information processing techniques they develop to eventual optical storage techniques, should these laser and holographic approaches prove competitive with analog tape storage and overtake the development of digital tape storage. And, it should lead to improved error detection and correction.

Among the advantages of digital recording are the use of reliable and rugged machines that are self-monitoring, says A.H. Jones, head of the storage and recording section of the BBC's research department, Kingswood Warren, Surrey. Also the technique would facilitate copying of programs, aid in program editing, and make for better archival storage.

The digital recorder uses a standard instrumentation tape transport in sampling up to 13 million times per second, using eight-bit words to describe each signal sample while recording 16,000 bit per inch along each of 42 tracks on 1-inch tape. Backing up the transport is some sophisticated circuitry. Each parallel track has its own printed-circuit board to process its signal. Each 7-by-10-in. board carries 49 integrated circuits and six shift registers. The high sampling rate is necessary because of the UK's 5.5-megahertz bandwidth.

For comparison, it would take 400 compatible IBM tape decks to handle the machine's data rate, explains Alan Bellis, who designed the recorder. The recorder may be locked to an external clock, with automatic timing and slew correction. And, most of the disturbances caused by tape dropouts are detected and concealed by processing circuitry.

In a sense, the recorder is two in one because it can replay the signal and then record back again on the same tape a little further on, Jones says, instead of playing from one recorder to another. However, "if something happens in between, you're lost, as you wouldn't have the master tape," he adds.

To achieve high-grade TV recording, the machine uses four times as much tape as an analog system, Jones explains. The big question is whether the digital packing densities can be brought down to where they're competitive with analog. Some improvements can be expected from manufacturers of heads and tapes, but "they may not be good enough," he says.

Another approach is to reduce the data rate in the signal, Jones explains. "We're trying to look for redundancy in the signal itself." This way, a two-to-one reduction is conceivable, Jones estimates. □

Japan

Sony colors its TV gas-discharge panel

Japan's Sony Corp. has developed a prototype flat-screen color television set using gas-discharge matrix panels operating on direct current. When research is completed, the company envisions wall-hung 40-inch TV receivers incorporating circuitry that is simple enough to keep production costs below current levels.

The color prototype was developed after Sony succeeded in building two monochrome sets [*Electronics*, Electronics International, Dec. 6, 1973]. The display panel is 0.25-inch thick and measures 7 in. diagonally. The front and rear sections of the panel are glass plates, and the inside surface of the front plate is coated with 60,000 phosphor elements.

The color prototype has a peak luminance of 5 foot-lamberts, a 20:1 contrast ratio, and 48 digitized brightness levels, while monochrome sets thus far developed have a peak luminance of 25 foot-lamberts, a contrast ratio of 40:1, and 32 brightness levels.

Yoshibumi Amano, who is heading the research, says that a number of approaches have been taken by various firms to develop flat panel displays, with most of them employing ac or dc plasma panels. Sony decided on a dc gas-discharge panel because, among other reasons, of the simplicity of the driving circuitry, ease in fabricating large-area displays, and development of a full color display through the use of phosphors.

The two glass plates of the display are separated with barrier ribs, which are formed by means of silk-screen printing techniques. The ribs, which provide a barrier to prevent crosstalk that could be caused by the diffusion of electrons and metastable ions, are made of a black dielectric material, in order to help increase contrast. The 282 anodes and barrier electrodes on the front panel are made by vacuum evaporation, followed by photo etching. The 212 cathodes on the base panel are made by silk-screen printing and electroplating. The space between the glass plates is filled with a gas mixture, predominant components of which are argon and mercury for the color display. Spacing of the two glass plates is 0.1 millimeter.

Display elements are 0.2 by 0.4 mm, and have a 0.5-mm center-to-center separation. There are, in all, 94 color trio stripes and 20,000 stripe elements in the prototype model. Circuitry volume is about twice as large as the monochrome sets, and power consumption is doubled, to 200 watts, with 15 W dissipated in the panel. □

Around the world

System speeds telephone ordering of medicine

Although the average German pharmacy has up to 25,000 drugs and medicines on hand, it still must order specific articles from pharmaceutical wholesalers. And all too often clerks make mistakes in noting down the complex terms of medicines, or misunderstandings occur when ordering drugs, especially those that have similar sounding names, over the telephone. Now, equipment that the ITT subsidiary Standard Elektrik Lorenz AG is offering pharmacists may ease those headaches. Tied to the telephone network, the equipment transmits the article's designation, the amount wanted and the pharmacist's address in coded form to the wholesaler. There, the information is punched out either on tape or cards, put into a computer for processing and used to prepare the shipment to the retailer.

The information originating at the retailer is contained on small punched cards that are inserted into the equipment. Information is transmitted, over regular telephone links, by a "two times one-out-of-four" code at 20 characters per second. The equipment, an information terminal no larger than a normal slide projector, was developed at SEL's private communications and data systems group in Stuttgart. The key unit in SEL's approach is the KKL 300 terminal, a card reader available as a non-automatic type at roughly $1,130 or as an automatic version that costs about $130 more. The terminal connects to the telephone network via a modem, which rents from the German post office for $10.50 a month.

The ordering process is relatively simple and largely automated. Assigned to each article and package size are two small, differently colored punch cards, a yellow and a white one, for example. These item cards are kept with the stock of a particular article, the yellow card behind the white one. When the supply runs low, the clerk takes out the white card and puts it into the card reader's cassette. The yellow card alerts other clerks that the article is being ordered. The cards measure 1 by 2 inches and are 0.4 millimeter thick. Their punched-hole codes identify the article, its form, and the weight or amount per package. Up to 180 cards can be inserted into the cassette, which is about 10 in. in diameter and similar to those used in some slide projectors.

UK companies join scramble for Marisat market

Scrappy Redifon Telecommunications Ltd. and established Marconi are getting set to square off for the British share of the potential shipboard terminal market for Marisat, the U.S. maritime communications satellite system to be launched by Communications Satellite Corp. in 1975 (see p. 78). Redifon has concluded an agreement to sell radio communications terminals made by AII Systems, Moorestown, N.J., which has performed terminal work for the U.S. Maritime Administration. Marconi is readying its own antenna system, called Arion, for entry when Marisat becomes operational. Both companies peg their prices in the $50,000 region.

But the British competitors could face European resistance. The European Space Research Organization, developing its own Marots maritime satellite for 1977 launch, is highly displeased over the U.S. Marisat effort. It is grumbling over lack of U.S. interest in an internationally-based system, aside from long-standing U.S.-European bristling. However, the UK contributes a healthy share towards Marots, and London is the world's leading shipping center.

Scandinavian patrol-boat order spawns hefty sales for electronics firms

Swedish and Norwegian military electronics firms will share orders totalling an estimated **$40–50 million for fire control, navigation, and ship-to-ship missile systems that will go aboard 16 patrol boats being ordered by the Swedish navy.** The patrol boats, weighing 140 tons, will be built at Bergens Mekaniske Verksteder in Norway and will be equipped with the Norwegian-developed Penguin ship-to-ship missile system, made by Norway's Kongsberg. The patrol boats will also be equipped with a new 57-mm anti-aircraft cannon developed by Bofors of Sweden, and Swedish fire control systems will be used.

Japan's computer subsidies breed new machines

New computers developed with government subsidies have been announced by two of Japan's three groups of computer manufacturers. The subsidies were offered by the Japanese government in 1971 to induce the six major computer companies to form groups **as part of a plan to permit liberalizing computer and integrated circuit imports, as well as their manufacture by foreign-capital companies, while maintaining competitiveness with IBM and other American manufacturers.**

Nippon Electric Co. and Tokyo Shibaura Electric Co. have announced a small computer and two medium computers, with first shipments scheduled for October. These computers are competitive with IBM's 370/115, 125, and 135. The group's large through ultralarge computers will be announced sometime in the future. The group's new computers feature virtual memory and ring protection. They also make extensive use of firmware. **Much of the software uses techniques developed by Honeywell, but the companies emphasize that the hardware was independently developed by the two Japanese firms.** The machines use TTL and 1-kilobit or 4-kilobit n-MOS devices in main memory.

The Mitsubishi Electric Corp.-Oki Electric Industry Co. group has announced its Cosmo-700 computer, with deliveries to start this December. The machine features virtual memory and set-associative memory with 512-word capacity. It is more a scientific and control computer rather than a general-purpose machine like the other group's.

Sonab takes over mobile-communications arm of Sweden's AGA

Sonab, the Swedish state-owned company that got started in business with an omni-directional stereo loud-speaker for hi-fi systems, takes over the mobile-communications division of AGA on July 1, **paving the way for expanded activity in international markets.** The take-over will mean that Sonab will have about half the land-mobile communications market in Sweden, and will double Sonab's total sales. It will mean that Sonab will expand its product range in communications—today covering primarily land-mobile systems—to include aviation radio. AGA's communication radio equipment sales last year were about $7 million, while Sonab's total sales—a majority of which is in entertainment electronics—were $10 million. **Sonab has a well-established international sales operation with 11 sales and services subsidiaries abroad, the latest one being in U.S.** Along with the take-over, Sonab gets a new managing director, Staffan Haakansson, who has been managing director of the AGA mobile-communications subsidiary, AGA Mobilradio AB.

Siemens leads in microcomputer systems development

Siemens AG apparently is the frontrunner among European electronics producers to develop microcomputer systems. **First samples of an eight-bit commercial version based on n-channel silicon-gate technology will become available towards the end of this year or early next,** says Erich Gelder, the company's marketing manager for integrated circuits. The system, from Siemens semiconductor facilities in Munich, is for applications in small office computers and includes read-only and random-access memories, latches, decoders, and a central processing unit similar to and compatible with the 8080 n-channel CPU from Intel Corp., the pioneer in the microprocessor field. Two more systems, a four-bit and another eight-bit version, are also in development, but these, Gelder says, **will be custom-tailored and are intended strictly for Siemens-made EDP and telephone communications equipment.**

Addenda

The small Swiss company Laser Technik AG is off to a strong export start with its new numerically controlled machining laser. LT expects to deliver in June a first unit with a 50-watt carbon-dioxide laser to the French company Lignes Télégraphiques et Téléphoniques, an ITT subsidiary. The second NC laser is also destined for France. It will have a 50-watt YAG laser and go to LCC-CICE, a Thomson-CSF subsidiary. Both companies will use the machines for hybrid-circuit production. . . . Nippon Electric has received U.S. orders for 20 low-noise uncooled parametric amplifiers for communications satellite ground stations. Total price is in order of half a million dollars. Sixteen were ordered by Philco-Ford, and four by Comsat, with Comsat also taking options on additional amplifiers, which have noise temperature of only 55K without the maintenance problems of cooled amplifiers. Nippon Electric earlier exported amplifiers of this type to the Soviet Union. . . . The European Space Research Organization will award a $226 million contract for the design and development of Spacelab, a reusable manned orbital laboratory, to a German group—ERNO-VFW-Fokker. The six-year contract calls for one Spacelab flight unit, fully qualified and ready for the installation of experiments, by April 1979. Spacelab is due to be launched by the U.S. space shuttle in the 1980s.

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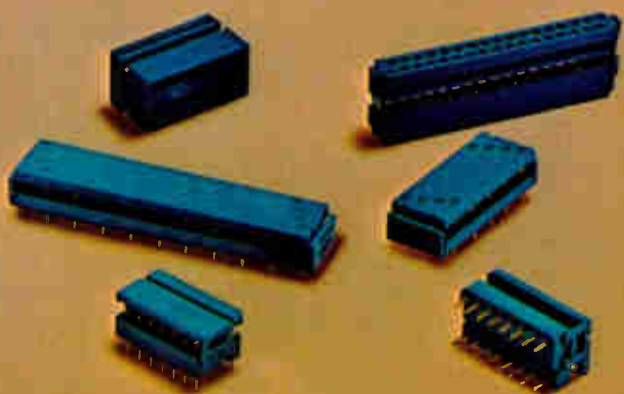
New cable connector system...It's designed to lower your installed costs.



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Circle 67 on reader service card

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P&B is the industry's largest producer of solid state/hybrid time delay relays. Types and styles range from low-cost economy models to sophisticated units with excellent performance characteristics.

For precision and versatility, P&B's CD Series is an obvious choice. Within the CD Series are models which feature 7 timing ranges from 0.1 second to 180 seconds, temperature range of −40°C to +55°C, recycle time of less than 60 ms and repeatability of ±1%. And, some models can control up to 25 amperes when used with an external relay.

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1—PARTS, ACCESSORIES, MATERIALS

Basic commodities used in the fabrication, assembly and maintenance of electronic devices

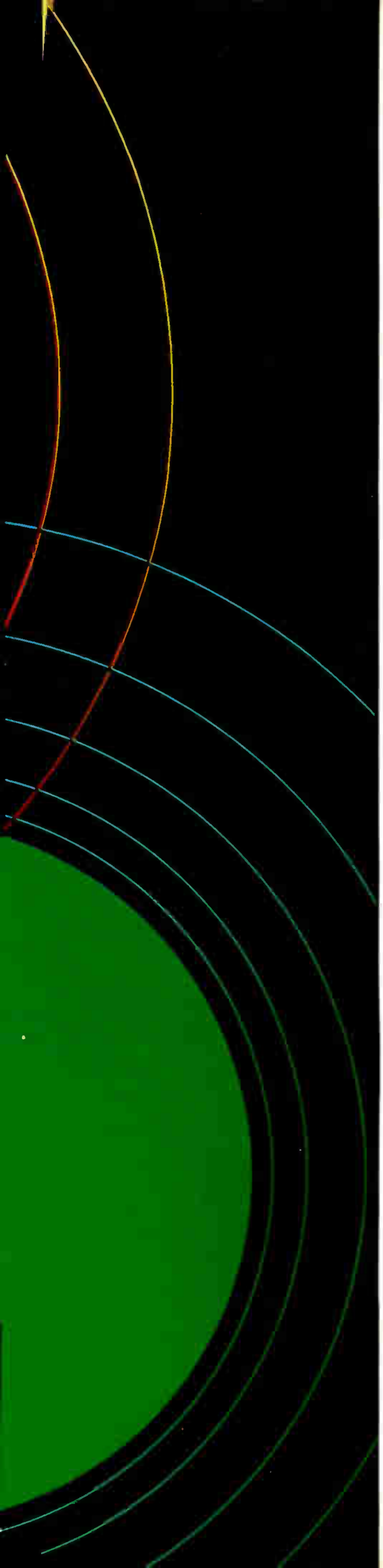
2—ELECTRICAL INSTRUMENTS

Test and measurement items used in the design, production and adjustment of electronic devices

3—ELECTRONIC EQUIPMENT

Devices having electronic operating principles, used by other fields as well as by the electronic industry itself

In each of these three sections products are listed under the noun or principal word. Certain products, not readily classified, have been arbitrarily included in the third section. The index following immediately after this title page serves as a general key to all three sections.



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Circle 71 on reader service card

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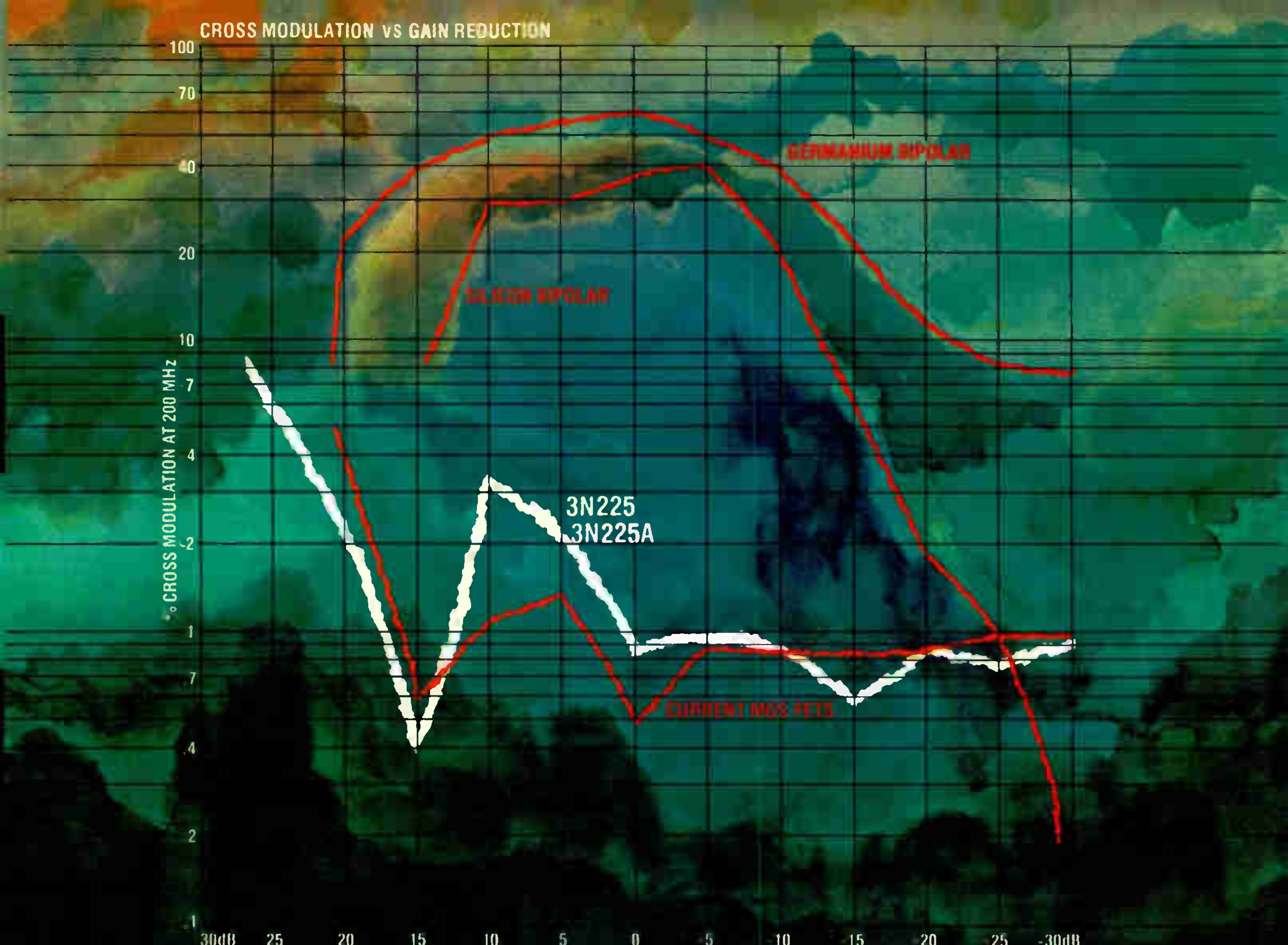

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...and there's lots more uses for them than just TV.

900 MHz noise figure – 4.5 dB typical. 900 MHz gain – 15 dB typical. That's what the 3N225 and 3N225A deliver – consistently and reliably. Virtually nothing in the industry comes close to this capability.

The 3N225 and 3N225A need no special handling procedures either. Integrated back-to-back diodes between gates and source protect against excessive voltage.

And designers also get high stage gain and excellent stability without neutralization – because feedback capacity is so extremely low.

Right now, leading TV manufacturers are designing with 3N225 and 3N225A in a big way. Especially in tuners, IF strips and UHF pre-amplifiers where linear, low noise is really an important requirement. A requirement that includes more applications than just TV, however.

Comparative Performance Data

	45-MHz		200-MHz		450-MHz		900-MHz	
	Gain	Noise Figure	Gain	Noise Figure	Gain	Noise Figure	Gain	Noise Figure
3N201 series	25	1.8	24	2.7	–	–	–	–
3N204 series	30	1.8	24	2	18	3.2	–	–
3N211 series	33	1.8	28	2.2	21	5	–	–
3N225 series	32	1.8	28	2	21	3	15	4.5

For instance 3N225 and 3N225A can be designed into CATV. Detection alarm systems. Medical electronic devices. Measuring instrumentation. Plate-wire memories. Video signal processors. And all types of mobile and fixed receivers.

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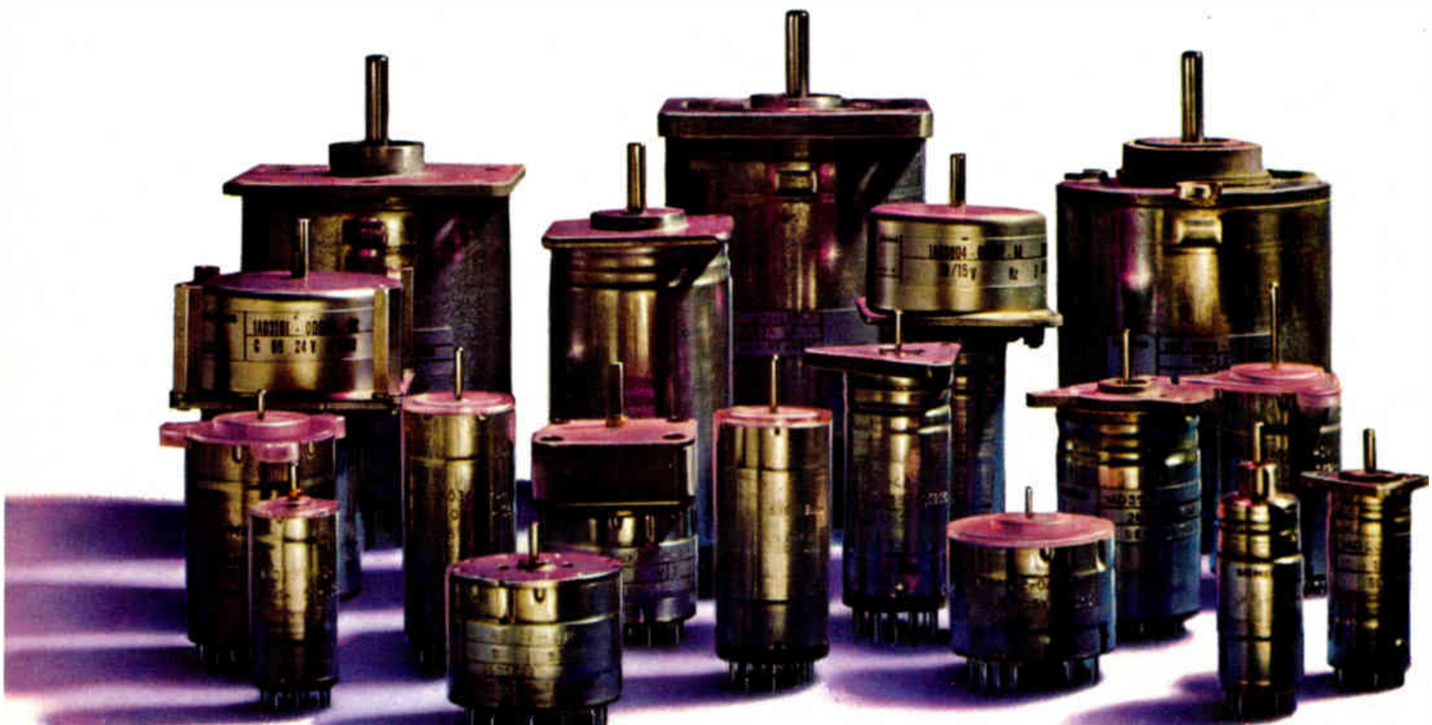

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Circle 74 on reader service card

Has checkless banking bounced?

Dream of total electronic funds transfer is coming true in bits and pieces, but the big investments in complete systems have yet to be made

by Gerald M. Walker, Consumer Editor

A cashless society—that dream of electronic funds-transfer systems (EFTS) so popular in the late 1960s—is still a long way off. Instead, the banking establishment has been nibbling away piecemeal at the task of installing electronic funds-transfer systems. The bankers' euphemism for this less-than-total approach, "evolution rather than revolution," is another way of saying that they're still unprepared to devise total EFTS plans.

Experiments are under way around the country, and some equipment is being installed in an effort to make a dent in the paperwork that accompanies banking transactions (see "That human touch," p.76). To date, those installations have involved mostly simple terminals for such services as:

- **Direct pay.** Employees' net wages are paid directly by the employer to the bank by means of a single check for all employees banking with that institution. Social Security checks also will be paid in this manner. However, a certain amount of consumer resistance may develop over the practice, since many workers like to feel something tangible in a pay envelope before depositing it. In addition, many workers in the country still do not have bank accounts.
- **Verification/authorization.** Direct links to retailers and branch institutions verify adequate balances or validity of charge purchases within the limits of credit authorizations. Being the easiest to implement, this service is probably the fastest growing "front-office" feature.
- **Transfers.** Terminals at locations remote from the computer transmit funds-transfer directives entered by

Going slowly. Banks are going electronic a little at a time. They are adding such equipment as credit-verification terminals, above, and self-service terminals, left.

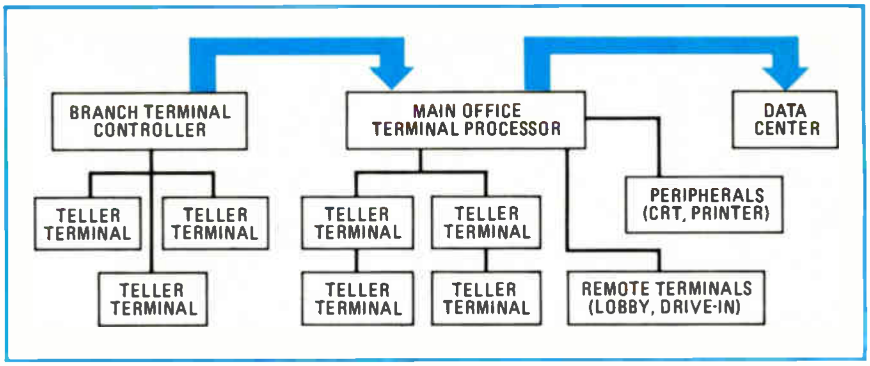
depositors and tellers. Unattended tellers are used for check deposits, savings deposits, cash-dispensing, and other transfers. The jury's still out on these. While the full-service banks have actively promoted remote terminals, there's some belief that consumers use them avidly for a brief time for the novelty, then revert to rather infrequent use.

■ **Bill-paying.** Mortgage, utilities, and other fixed-amount payments are made monthly by the bank, and checks are returned to each depositor after recipients endorse and return them. A variety of variable-amount bill-paying systems are being tested, as well, and all involve pre-authorization. In addition, there's still paper flying around, so some EFTS benefits are lost.

■ **Point-of-sale.** Customers of retail establishments give merchants debit cards (not credit cards) to be used in on-line terminals that record amount and nature of sale, transfer funds to merchants' accounts, and update merchants' inventories, purchasing, and sales accounting records. This is pretty much what's being evaluated in Lincoln, Neb., and is receiving considerable attention from different types of savings banks as they attempt to move in on services offered by full-service banks.

■ **Billing, collection.** Charge accounts, accounts receivable, and credit-card charge-collection systems already are in use in many banks. Eliminating the paperwork and check-processing by such systems would result from conversion of these to on-line, terminal-oriented systems. This, of course, was supposed to have happened some time ago because the paper generated by the credit-card system is about to smother the card issuers. As a result, both National BankAmeriCard and Interbank have set up new systems to help speed communications and reduce the lag between credit purchases and payments.

■ **Automated clearing houses.** Checks are processed totally on magnetic media. Magnetic tapes are then exchanged instead of paper. This is the most promising "back-office" move into EFTS, although there have been problems.



Mainstream. This diagram of a typical bank transaction-processing system is one envisioned by a Florida company, Financial Data Sciences Inc. of Orlando.

Alternatives. All of these services are viable alternatives to the traditional means of funds-transfer, and yet they are not fully electronic systems. The reason for the piecemeal effort is essentially the high cost of conversion, and an industry in which full-service banks, savings and loan banks, and mutual savings institutions don't see eye to eye.

Nevertheless, a few simple facts about today's checking system alone foretell the inevitable shift to EFTS. For instance, from the time it is written until it is returned and filed, a check is handled at least 26 times—10 of these times in the bank. It travels by mail, and one man must deliver the check personally. What's more, this check then joins a stream of paper so enormous that, if placed in line with all other checks processed in a single year, the string would make 11 round trips to the moon at about the same cost. In other words, the cost of the present system will soon outstrip the investment in the radical change.

To cash in on the conversion, several dozen hardware companies are vying for market positions with equipment ranging from plain credit-verification terminals (telephone-communications gear) and remote tellers to back-office computer centers. Few technical problems stand in the way of EFTS. Rather, it's a question of organizing the computers, communications networks, and terminals into workable systems.

In the meantime, the disunited banking industry needs to get some of the Federal regulations governing operations changed significantly in order to realize the ultimate EFTS. And before that happens, a lot more consumers will have to be convinced that electronic solutions are better than today's paper mess. □

That human touch

When a new branch of a New York bank opened recently in Grand Central Station, large signs outside proclaimed "six live tellers to serve you." The message was not lost on many of the thousands of commuters who can choose to patronize two electronic tellers at two other bank branches in the same railway station. It was a sort of anti-automation pitch that caused more chuckles than concern: to have a bank knock electronic tellers nowadays is about like having a publisher grouse about computerized typesetting or a garment manufacturer grumble about being forced to cut his cloth by laser.

A far more indicative sign of the times is what took place earlier this year in Lincoln, Neb., where a savings and loan association was granted temporary approval to experiment with cashless purchasing at two Hinky Dinky supermarkets. There, a "debit" card was used to transfer funds from the purchaser's account to the supermarket's account with no service charge for customer or merchant. Results of the experiment are being evaluated.

A similar experiment has been under way in Delaware, and, while participants evaluate the results, other banks across the country may soon follow suit.

Why Parylene works where other microelectronic protection fails:

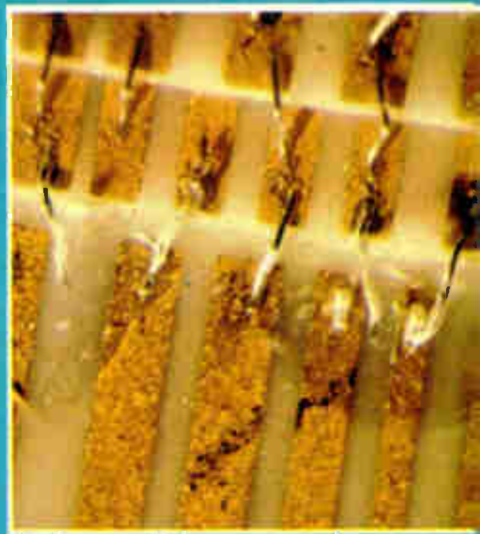
Crevice penetration in hybrids

This beam lead has a 0.3 mil parylene coating all the way to the weld. Parylene penetrates deep within small crevices, maintaining clearance while putting a coherent coating under beam leaded chips and air bridges. No area is left unprotected, preventing shorts and allowing the designer great latitude in component spacing and sizing. And parylene secures loose debris while preventing breakoff of pigtails during shock and vibration loadings.

Controlled conformality

There's a uniform coating of parylene all the way around the half-mil tip of this phonograph needle. That's true conformality, and only parylene gives it, in precisely controlled thicknesses from .002 to 3 mils, in one step. Unlike spray or dip coatings, parylene won't bridge or puddle, or thin out at sharp edges, creating potential failure points. The parylene coating is completely uniform, no matter how dense or intricate the module. And because it's applied at room temperature, there's no component discomfort.

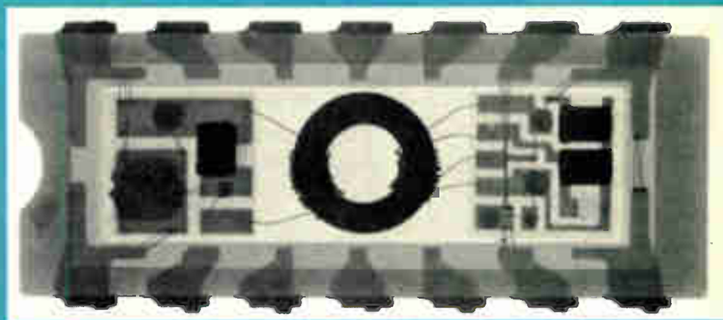
Lead Strengthening



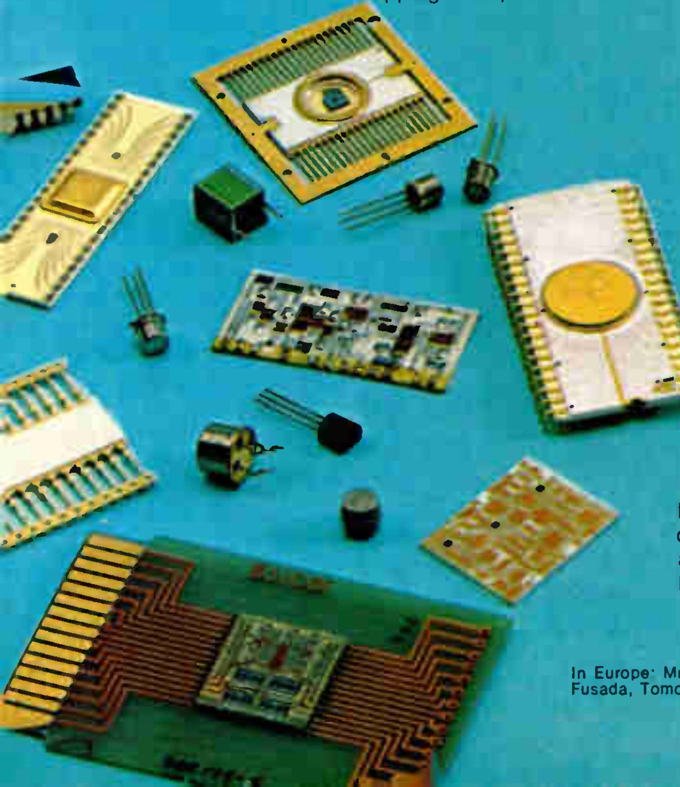
It took up to 75 grams pull to break these 1 mil wires Bare 1 mil aluminum wires, for instance, exhibit bond strengths of 3-5.5 grams; coated with 1 mil of parylene, pull strength increases by 60-70 grams. So wire and bond are stronger, and sideward shorts and loop collapse during extreme g-loads are prevented. Parylene coatings will penetrate the less than 1 mil clearance between beam lead bonded chips and the substrate, giving such strong coating coverage that the chip cannot be lifted without destroying it.

△200 C thermal shock protection

This hybrid microelectronics relay has undergone 200 45-minute cycles from −120 to 80°C, simulating earth-orbiting conditions. This X-ray shows all leads remain intact. Parylene protection was at work, on the transformer core and then the whole assembly before packaging (TO-116). There was no appearance of corona up to 5000 V_{dc} ; leakage was reduced from 10μA to <.001μA at 1000V. RTV encapsulation suffered dimensional mismatch, straining and snapping leads, with 500 V/mil bulk breakdown.



X-ray courtesy NASA Lewis Research Center and Sterer Eng. & Mfg. Co.



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Circle 77 on reader service card

Communications

Marisat partners seek accord

Commercial partners in maritime satellite disagree on plan for use of voice channel on each of two craft to be launched in six months

by Stephen E. Scrupski, Communications Editor

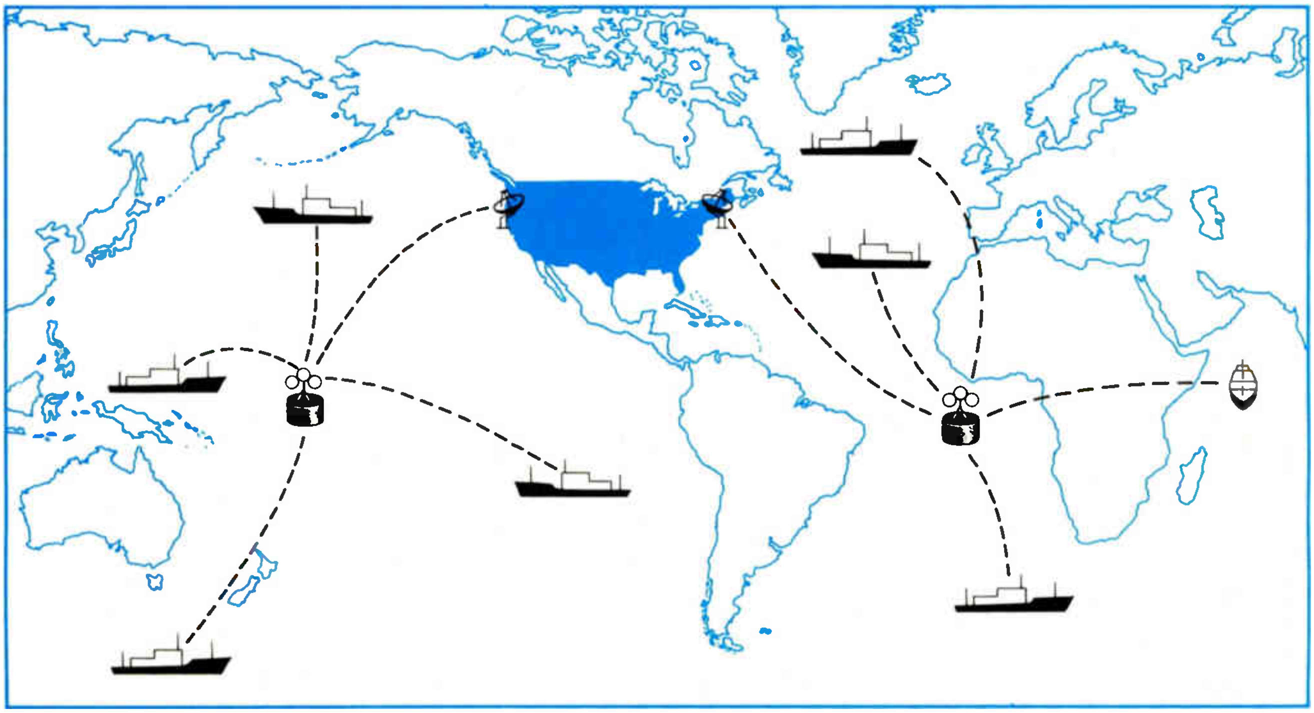
The partners in Marisat are squabbling. Marisat, which consists of two maritime satellites intended to provide reliable, high-quality communications to U.S. Navy and merchant ships, will be launched six weeks apart in a little more than six months—the first on Jan. 9, 1975.

But the consortium partners are still meeting weekly to decide how to divide the small portion of the satellite's facilities that initially will be available for commercial use. Despite their differences, they expect to work out an agreement shortly—even though they don't know if shippers will buy the service.

The controversy centers on access to the satellite's single voice channel. Will the majority (80.2%) owner, Comsat General, have exclusive rights to offer it to users, or will the others—RCA Global Communications (12.5% ownership), Western Union International (4%), and ITT World Communications (3.3%)—have access to the voice channel for a percentage of time equal to their ownership interests? The FCC has issued an order that tends to back Comsat General's view, but the other partners can still suggest alternate plans.

At least one thing is settled: For the first two years, the U.S. Navy will use at least half, and possibly almost 90% of the satellites' facilities for ultrahigh frequency links to its ships. If the Navy does exercise its full option, the satellite's remaining 10%, which will operate in L band, will consist of about 99 full-duplex, 50-baud teletypewriter channels per bird; it takes about 55 of these channels to make up one voice channel. Comsat General has said that the 99 channels will be allocated according to percentage of ownership. Thus, Comsat gets 79 channels; RCA, 13; WUI, 4; and ITT, 3. With this arrangement, only Comsat could assemble a voice channel; the others would be able to offer only teletypewriter service.

Understandably, the other partners are not enthralled by Comsat General's proposal. In fact, Robert Angliss, RCA Globcom executive vice president, has another plan. Noting that even the 99-channel figure may not be final, he says that RCA would prefer to apportion the total channel-hours by the month so that the minority owners would have access to the two voice chan-



nels at least part of the time. And, if one partner sells more voice time than its allocation calls for, it would compensate the partner that had been short-changed that month.

WUI executive vice president Robert Conn characterizes his company as the "peacemaker" in the dispute, although he notes that he has tended to agree more frequently with ITT and RCA than with Comsat General. "The others are adamant," he says. Conn traces the history of the partnership this way: When the Tacsat and LES-6 satellites expired, the Navy needed a new one quickly and asked for bids from commercial carriers. Comsat General was awarded an exclusive contract. But the FCC stepped in, and, when WUI suggested that the commission order joint ownership, the FCC agreed and told the new partners to work out the details of the system management.

The FCC ruled in late April that capacity should be allocated according to investment and that Comsat General, as the majority owner, should be the system manager. But the agency told the partners to report back in six weeks on the results of their negotiations.

Terminals ordered. Meanwhile, a contract for 100 terminals at $20,000 to $30,000 each has been awarded to Scientific-Atlanta.

RCA's Angliss says that his company also requested bids on shipboard terminals and received five responses. However, RCA will not make awards until the system's operating philosophy has been settled—if then. The company is holding open its options and may go along with Comsat General's designs "if that proves to be the most cost-effective way," says Angliss.

All the partners agree on one thing, however—the controversy will not affect the Navy's use of the satellite. The Navy has its ground stations and shipboard terminals ready to go as soon as the satellite is up and checked out. The Navy also has the say as to where the first satellite is positioned—over the Atlantic or the Pacific. One satellite, over the Atlantic at 15° west longitude, will be able to cover an area ranging from the Persian Gulf to the eastern U.S. seaboard. The other, at 176° east longitude will cover from the western U. S. to the straits of Malacca.

The Navy needs the satellites, but will the merchant shippers use the service after the satellite is launched? This is the next big question facing the partners. Comsat General's Keyes points out: "This is a completely new service, and there's a tremendous amount of risk capital involved here. We have $70 million invested now, and we will approach $100 million with the ship terminals. And we haven't got a customer yet, except the Navy, who's in for $29.6 million."

Anticipation. What confidence there is, says Keyes, is based on the belief that if good communications are available for merchant shippers, the market will develop itself, But, he says, if the satellite were only to replace the communications carried by present high-frequency radio,

"we would probably lose our shirt."

Keyes credits the Navy with being the key customer in getting the service started. "If the Navy thing hadn't happened, it would probably be 10 or 15 years before this got off the ground."

Angliss tends to agree with Keyes: "I suspect that any assessment made of the maritime-communications market itself would not have been such as to prompt anyone to launch a satellite for maritime-communications services. I don't think the economics are there, and this is borne out by our market assessments."

The economics of bad communications can be based on the cost of running a ship—$1,000 to $2,000 an hour. Any time lost in getting a message to a ship to tell it, say, to divert to another port, costs money. And since it now takes an average of 12 hours to get a message through and acknowledged, users are facing costs of $12,000 to $24,000 an hour for bad communications.

To demonstrate how valuable state-of-the-art communications could be for ships, Exxon Corp. and General Electric performed a series of experiments between July 1973 and February 1974, using NASA's ATS-1 and ATS-3 satellites for one hour each day. Teletypewriter, voice, facsimile, and slow-scan television were transmitted to the ship, and the satellites also were used for position-fixing with a General Electric system.

Teletypewriter turned out to be the most useful transmission vehicle for normal messages, but facsimile was found to be useful to send such information as layouts of ship facilities and equipment to help in making repairs. Teletypewriter-traffic quality was good—about 90% of the messages were received with error rate of less than 1 in 10^4.

Position fixes were made to within an average of 1.3 nautical miles of actual positions, determined by radar and visual sightings. However, the frequencies used were in the vhf range, and the accuracy could be improved to within only 0.1 nautical mile at the L-band frequencies used in Marisat. ☐

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Solid state

LSI testing: a three-way street

General-purpose, special, and combination systems all have place in checking memories, calculators, microprocessors

by Howard Wolff, Associate Editor

What kind of instrument is needed to test large-scale integrated circuits—the general-purpose tester, the specialized tester, or both? The answer is all of the above. It all depends on the application.

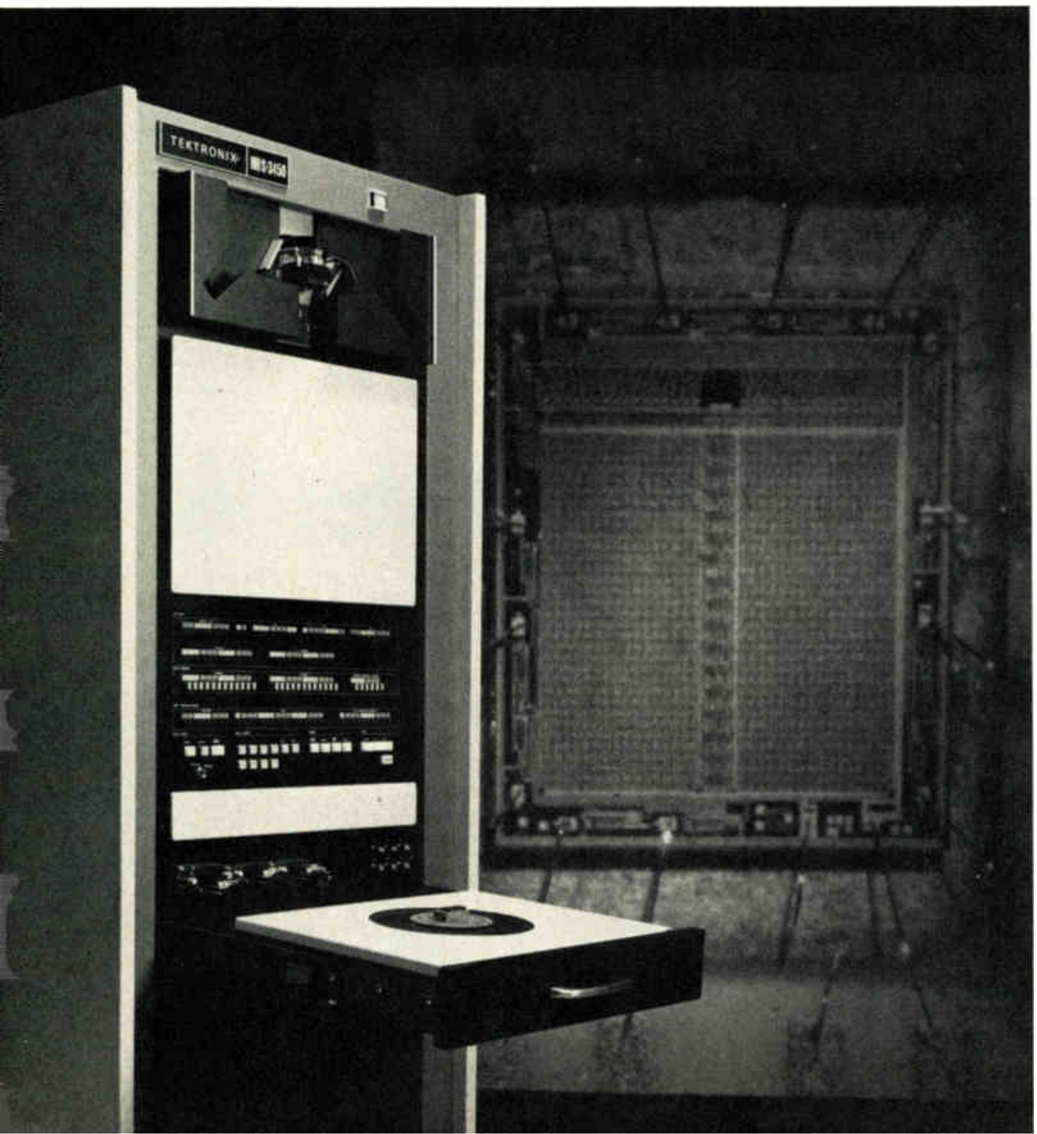
Some makers of test systems maintain that some of the requirements for LSI testing can be handled best by a big, general-purpose machine; others prefer specialized ones. And still others like a combination, or modular, approach. A prime supporter of that last view is William C.W. Mow, president of Macrodata Corp. of Woodland Hills, Calif., a tester manufacturer, who says he can supply both types through his system of "cascading" testers.

Mow breaks the market into the system house, the large computer company, and the semiconductor maker. The first, he says, needs a versatile large-scale tester because it must test memories, random logic, and microprocessors. Only if memory-testing requirements escalate considerably would such a house be forced to add dedicated memory testers, says Mow.

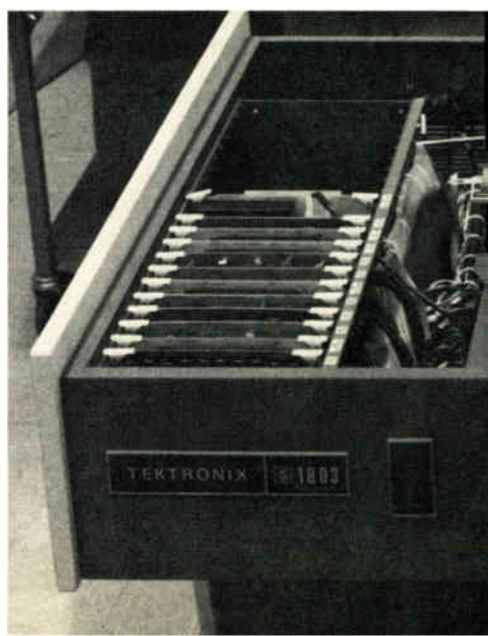
On the other hand, he adds, the computer manufacturer requires only a memory tester, while the semiconductor manufacturer has yet a different need: separate memory and microprocessor testers.

Another California tester maker, Teradyne's Digital Systems division in Chatsworth, believes that specialized testers are the answer for the needs of the memory, calculator chip, and microprocessor markets. Jack G. Salvador, vice president and general manager, says, "The 'DME'—diagnose and measure everything—machines are too large, too complex, and too expensive to be justified at this time. They're not optimum for anything." The big machines leave too much room for error, he adds. "The operator has enough complexity in the devices without having the complexity of the tester added to it." So the answer, according to Teradyne, is to offer specialized testers in each area.

That's also the philosophy at Tektronix in Beaverton, Ore. James Fischer, marketing manager for automated test systems, is loathe to compare special with general-purpose testers because, he says, neither



Ready. Tester maker Tektronix is marketing the S-3400 series for semiconductors, left, for $80,000 to $150,000. Below is a test station, the 1803, also from Tek.



will do all the jobs, and neither will dominate the other. But in its marketing plans, which include both types, Tektronix will tilt slightly toward the general system because it is adaptable.

Deciding factors. "The determining factors in whether or not a specialized LSI tester will be used are volume, throughput time, and the kind of testing to be done," says Fischer. For example, he says: "In memory, the market is characterized by a volume in the millions of devices yearly. On the production line, this means short throughput time and getting them out the door as fast as possible. In this kind of environment, you test to determine whether the device works or not. It's not necessary or economical to try to characterize the failures. So you test to first failure."

A relatively new entry in the LSI-testing race is another Chatsworth company, Xincom Corp., which supplies a complete memory-test system that Tektronix markets as the 3400. Since Xincom's product line is modular, it's not surprising to find that the company's marketing vice president, John W. Coons, advocates assembling a test system for a specific job.

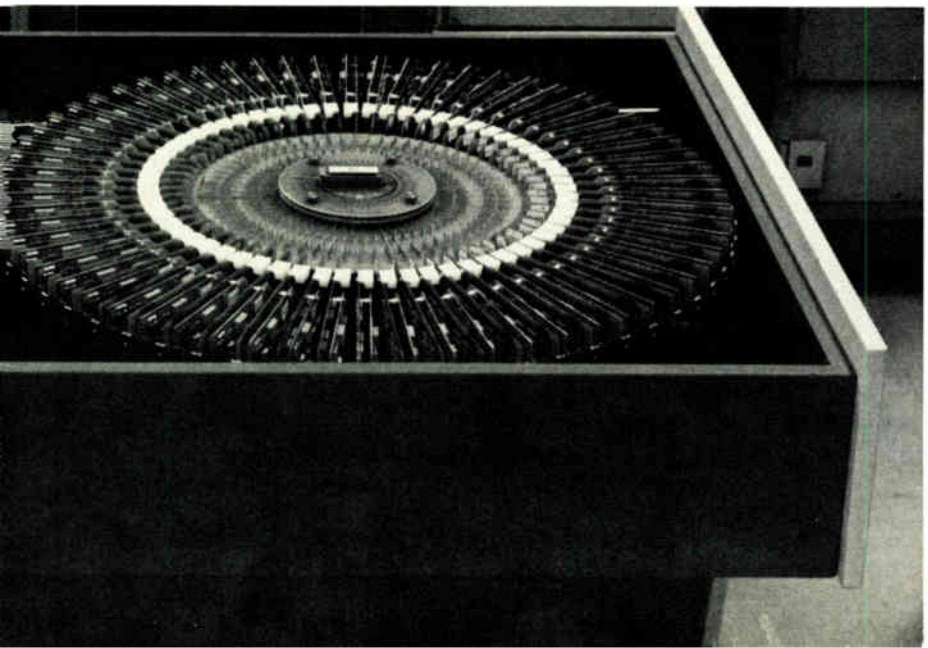
Xincom uses a "mother-daughter" arrangement for its 5500 series, a concept labeled by Macrodata's Mow as the wave of the future. This consists of an internal controller as the "daughter" that can be loaded from an external "mother" computer instead of with paper tape. With this arrangement, up to eight terminals (four testers, two stations per tester) can be slaved to one computer, which develops programs, keeps track of results, does housekeeping, and so on.

Versatility. In a unique position is Western Digital Co. of Newport Beach, Calif., which makes both an MOS and a general-purpose test system called the Spartan. The system is used by other device makers, such as Burroughs, Microsystems International Ltd., American Microsystems Inc., and Solitron Devices. Ron Griffin, test-systems marketing manager, says that, while a specialized tester may look more economical than a general version, it sometimes doesn't work that way. "In engineering development," he says, "it's necessary to have a more versatile tool."

National Semiconductor's Tony Mandia disagrees. He thinks that specialization is the best thing that ever happened to LSI testing. Mandia, manager of MOS-test engineering, says, "Specialized testers make a lot of sense from the point of view of throughput, performance, and economics. If you have a dedicated tester, life is a lot simpler. For one thing, the logic in the tester can be designed for a specific job, which means you can take a lot of shortcuts on the production line that you couldn't take with a general-purpose tester."

Interestingly, though, Mandia also seems to agree with the module makers when he says, "What would be ideal would be to have dedicated testers doing a variety of jobs, each controlled by its own microprocessor and all tied together into a single system by a central computer that does all the book work." □

Reporting for this article were Bernard C. Cole and Paul Franson.



Communications

U.S. and Soviets ready space link

Hot Line, to avoid damage by humans, will use European and Soviet communications satellite; Moscow earth station causes delay

by Howard Wolff, Associate Editor

Something had to be done about the Hot Line linking Washington and Moscow. Soviet and American officials agreed—after a Danish bulldozer operator cut the line near Copenhagen, a Finnish farmer plowed it up, and a fire in a Baltimore manhole put it out of service—that the system had to be separated as far as possible from humans.

The answer is a new arrangement that provides for two parallel satellite-communications circuits—one utilizing the Russian Molniya, and the other the European Intelsat satellites. The hookup was to have been completed by the time President Nixon visits Moscow this summer, but the target date is now between August and the end of November. The delay, say American officials, is in getting the Soviet earth station on stream; the American one, operated by the Army Satellite Communications Agency at Ft. Detrick, Md., is already operating and is busily tracking the Russian birds.

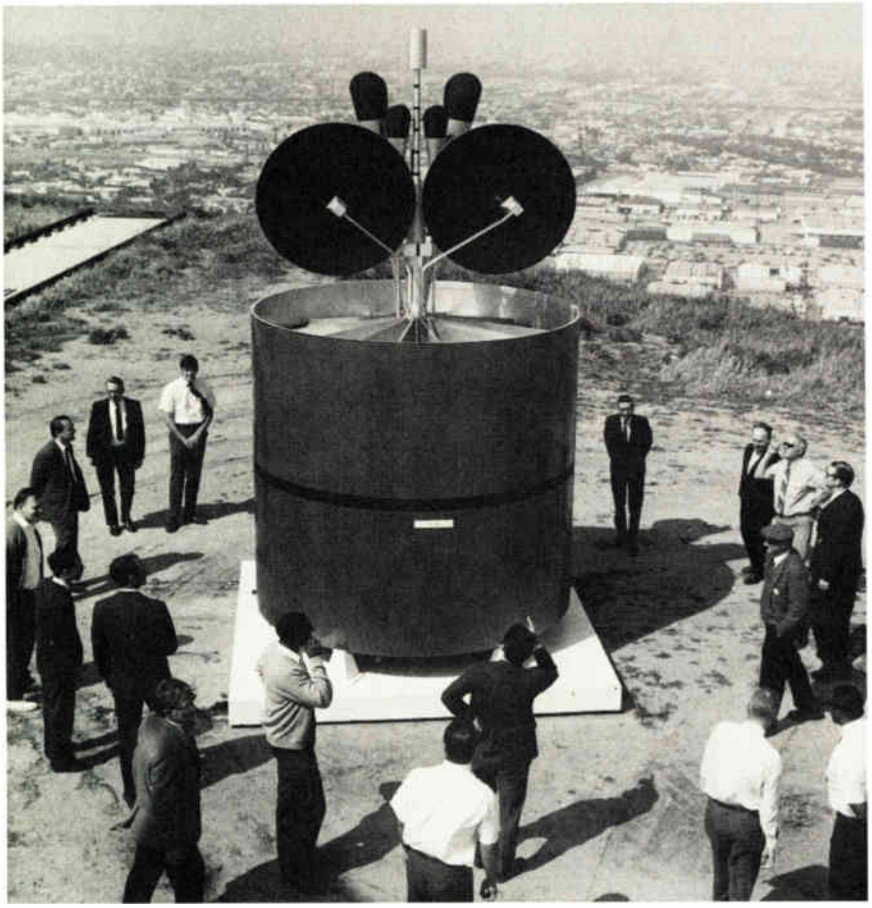
The U.S. satellite portion is a leased full-duplex voice-bandwidth circuit from a Comsat station at Etam, W. Va., through an Intelsat-4 to a Russian earth station being built by ITT some 10 miles from Moscow.

The Ft. Detrick Molniya earth station was supplied under a $7.5 million contract by the Harris Electronic Systems division (formerly Radiation division) of the Harris Corp. It consists of identical communications systems that will be providing C-band signals through 60-foot tracking and communications antennas.

Tracking is a particular problem because, unlike the Intelsat and other synchronous satellites, which appear to remain in fixed position, the Molniya satellites travel in a highly eccentric and highly elliptical orbit. Their path will bring each of the three or four Molniyas forming the operational system over the Hot Line's U.S. earth station in a high looping arc once a day.

Both the antennas will track each satellite, ensuring uninterrupted operation in case one malfunctions. Then, just before the active satellite moves out of range, one of the antennas will swing away and lock in on the next Molniya coming into view in the sequence.

Eccentric. The Molniyas travel this way because the northern portions of the Soviet Union aren't visible to a satellite located over the equator. The Russians, therefore, have their satellites follow an ex-



Hot bird. Intelsat 4 will be one satellite used in redundant spaceborne communications link between Kremlin and Washington. The other will be Soviet Molniya. The link is scheduled to be completed this autumn when the Soviet earth station turns on.

tremely elliptical orbit: the apogee is 25,000 miles and the perigee is 300 miles. Each craft makes two complete orbits around the earth each day, making two North American apogees. Each time it reaches this North American high point, each Molniya is visible to both the Russian and American earth stations for a period of about eight hours.

Redundancy is the watchword for the communications systems, as well as for the antennas. Dual uplink and downlink chains are provided in on-line/standby pairs so that single failures in either system will cause only a momentary loss of signal.

Each of the two baseband information channels frequency-modulates a carrier; each is up-converted and amplified within redundant transmitting chains. The output of one of the two power amplifiers is then selected for radiation to the Molniya satellite via the antenna subsystem.

Received signals are sent from the antenna subsystem to one of the two low-noise amplifier channels in the receiver subsystem. Four down-converter/demodulator channels then move the band signals to a signal processor. Two of the four channels normally provide redundant paths for the Moscow-link communications traffic. The other two, not directly in the communications path, give the signal processor auxiliary inputs for the earth frequency and power control and for automatic tracking.

Ironically, despite all the technology and expertise designed into the system way, it won't get much use. While ordinary communications between the Kremlin and Washington will continue to travel back and forth via closed-circuit Telex machines, the Hot Line is reserved for top-priority communications between the two governments in the event of crises such as last October's Middle East war and what William E. Naeher, deputy assistant secretary of state, refers to as "other emergencies."

In any event, Russian and American diplomatic communication officials no longer will have to worry about bulldozers, plows, and fires in Baltimore. □

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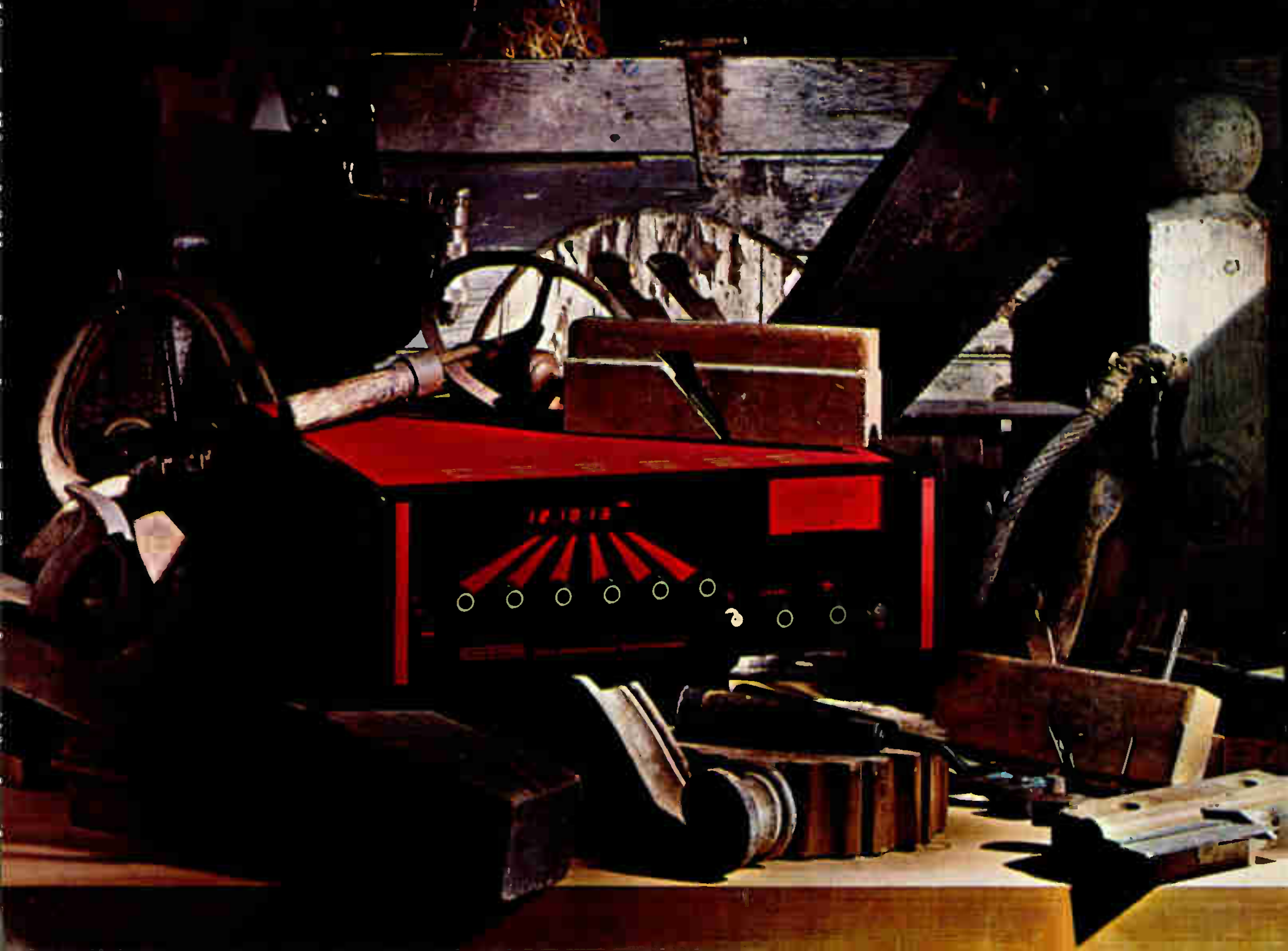

Patents

Europe delays patent changes

New treaty would end right of holder to control trade in all Common Market countries, a provision used frequently by components manufacturers

by Richard Shepherd, McGraw-Hill World News

Some of the world's big component manufacturers are breathing a sigh of relief. The reason: a potentially troublesome piece of European patent legislation has been stalled just short of agreement. It would, among other things, remove the right of a patent holder to control trade of his product between countries in which he has obtained a patent. And that, say European patent experts, is a favorite marketing strategy of the electronic-components industry.

What saved the day was British refusal to participate only five days before delegates were due to arrive in Luxembourg last month to sign a European Common Market patent treaty. The stay may be only a short one, since the project was put off until the fall. But it may last longer because the British are supporting a protocol to the draft treaty that calls for a delay in application of the patent for five or even 10 years. Meanwhile, supporters of the treaty hope the Common Market's Court of Justice will hand down decisions that can get the whole project moving again.

The row is over the last of three big international patent agreements designed to speed and rationalize the slow and often varied procedures for establishing an inventor's rights for his discovery in as many corners of the world as he chooses. The three agreements, though separately negotiated, go hand in hand.

The first, the Patent Cooperation Treaty, signed in Washington in 1970, provides a single patent-filing application to cover as many as 40 separate national patents. The second, the Munich Convention, signed last October, sets up a single patent-granting mechanism, including a joint patent-examination facility, previously only available to three or four countries.

The third would create a single Common Market patent. But the complicated diplomatic haggling over all three means that the failure of any one could foul up the others.

One for all. As it stands now, the draft Common Market patent treaty will insist that the patent-holder or his licensee no longer can intervene to protect his market in any member country after he has introduced his product in any one of the member states. In other words, once the product is launched in one country, it must be allowed equal access and treatment in any of the other eight.

At the same time, the draft treaty blocks another potential loophole by ruling that patents filed on a purely national basis in any one country will automatically have the same status and effect as the European version. Thus, the inventor cannot escape the free-trade principle by filing in one country alone.

International patent officials figure that the British government sees the new convention as yet another tool for European integration. And in its present hostility to that principle, the Wilson administration is in no mood to accept a tightened rein on British companies. Yet on the surface, these experts say, the British government is expected to disguise its basic motives with a demand for more time to study the draft treaty.

Right now, the British delegation to the EEC is talking about an October reply to its initial examination of the draft treaty, and there are still hopes that an agreement can be reached by the end of the year.

A more serious complaint, some European experts concede, is that, for many companies, the patent would be more expensive than their current national coverage in the European community. British patent agents figure that for 16-year coverage for all nine member countries, the European patent would cost $7,200, compared with $16,800 for each country separately covered.

But the agents point out that, in many cases, the company does not require complete coverage. For example, patent coverage on the same basis in Britain, Germany, and France alone would cost $1,440 less than the European patent if calculated at current fees. □

Too much too soon?

As the patent chief of one of Europe's largest electronics companies explains it, the Common Market patent, combined with the Munich Convention and the Patent Cooperation Treaty, would "put too much weight on our shoulders. I am very much in favor of the Munich Convention, but we need to gain experience with the European Patent Office and then tackle the EEC patent later on."

But even that opinion isn't unanimous. One official who's involved in patent work for a major semiconductor company says the problem is too complex to say whether or not a delay would help. However, for the moment, it appears that the people favoring delay are going to get their way.

INDEX

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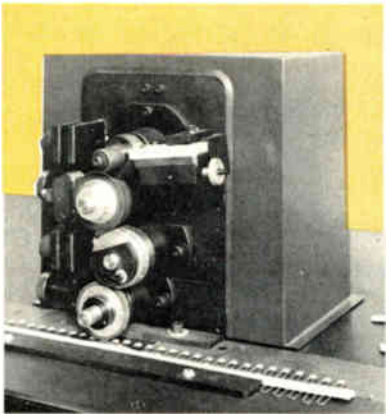
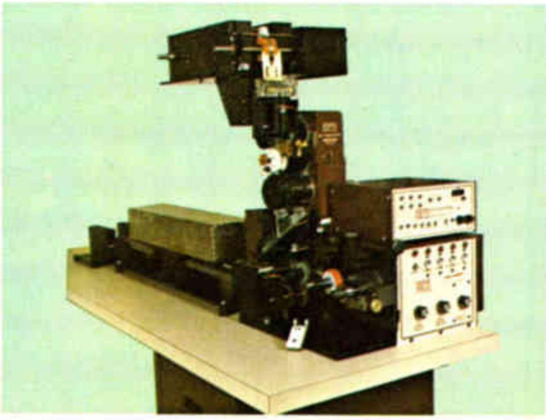


Radial Lead Print N Mark



Print N Mark

Laser becomes a component for mass-market applications

Helium-neon lasers priced below $100 are being aimed at volume usage in supermarket point-of-sale systems, video-disk players, and other equipment that require safe, low-power scanning for operation.

by David L. Wright and Dale Crane,
Spectra-Physics Inc., Mountain View, Calif.

☐ The helium-neon laser, once relegated to the scientist's laboratory, is finally becoming inexpensive enough for use in supermarkets and homes. Not that supermarkets will sell lasers to housewives, but reading labels in stores and playing video records on television sets will probably soon become the two most widespread laser applications.

Moreover, the laser has become safe and reliable enough for extensive use in commercial and consumer products. It is now practical to mass produce a low-power laser with an operating life that exceeds the useful life of most electronic products, allowing the laser to be used as a component, rather than a subsystem that requires expert maintenance.

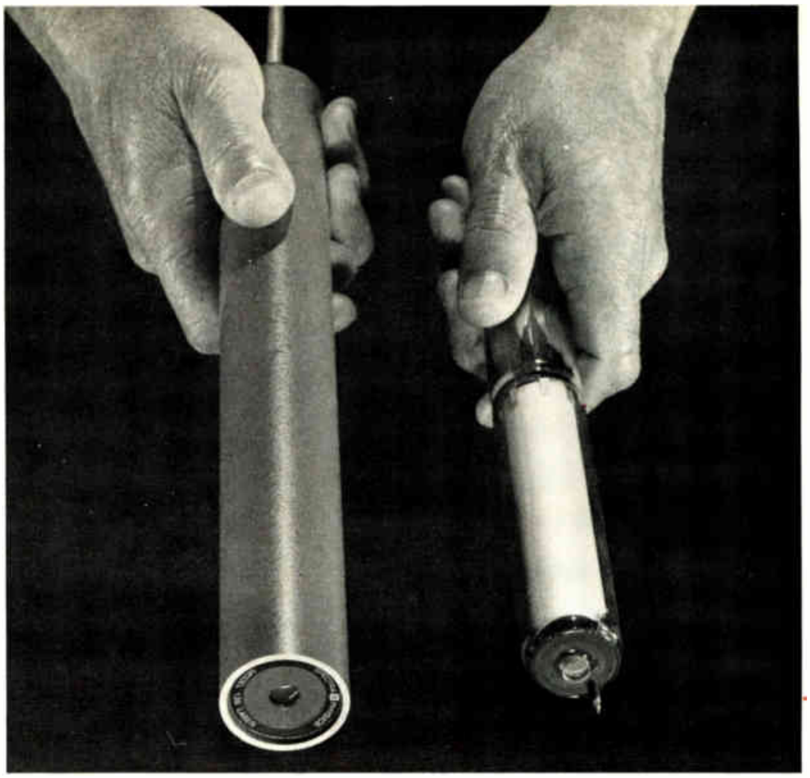
So even before label readers and video players become commonplace in the next five years, as often predicted, the laser will probably become a high-volume component for many other applications.

Indeed, a new laser has been developed specifically for mass production as a general-purpose component. This laser, the Spectra-Physics model 136, sells for less than $100 now in volume and is expected to drop in price in the future. In the past, prices under $100 generally applied only to unmounted plasma tubes—the part that generates the light beam—rather than assembled, fully operational lasers.

Tests indicate that a continuous operating life of more than 20,000 hours can be expected, or almost twice the reliability of older designs of comparable beam power (1 to 2 milliwatts). The expected life is twice the MTBF (mean time between failures) of most electronic products and is equivalent to some 10 years of use at 40 hours a week. Also, power efficiency has been doubled and beam pointing accuracy increased some 5 to 10 times by the new design.

The cost reduction is a result of a novel plasma tube design that can be manufactured from easily fabricated piece parts by automated production equipment. Since conventional plasma tubes are largely handcrafted by highly skilled workmen, the new design sharply cuts labor costs. Major cost savings include:

- A 40% reduction in the number of parts-fabrication and assembly operations
- A 60% savings in materials costs through the use of readily available, lower-cost materials
- A 33% cut in the number of tube piece parts (from 60 in the conventional design to 40 in the new design).



1. Savings. This new He-Ne laser tube requires 33% fewer parts, 40% fewer manufacturing operations, and 60% less money for materials than previous models.

Reducing tube costs made it possible to package the laser as a general-purpose subsystem and still keep below the $100 figure that appears to be the cost threshold for volume applications. It is believed to be the only non-laboratory laser with a beam-power control. This control, with a range from less than 1 mW to more than 2 mW, allows the equipment manufacturer to set the beam level as needed to comply with eye-safety standards. The laser itself is designed to meet electrical safety codes.

The rise in performance is largely the result of a change in the optical mode that generates the beam in the plasma tube. The new mode has a diameter that is smaller than before, thereby raising the optimum gas pressure and reducing the required gas volume. In turn, tube diameter was reduced some 20%, to 1.2 inches, from the 1.5 in. of conventional designs. The net effects were a 60% reduction in required operating power, since the excited gas is utilized more efficiently, and minimal "gas-eating" (degradation caused by absorption of gas by tube elements).

Assaulting the mass market

The public still views the laser as a laboratory instrument, although lasers have actually had many practical applications in the past decade. In fact, laser systems have become commonplace tools in the construction industry. The visible red beam of a low-power helium neon laser is used as a long, perfectly straight "string" to set ceiling and floor levels and to establish grade angles for sewer-pipe installation, bulldozing, and the like.

At present, such alignment and surveying systems constitute the only volume laser market—a few thousand systems a year. Some small-volume applications include spectrometers, eye-retina stitchers, silicon-wafer positioning, industrial-dimensioning controls, computer mass-memory recorders, interferometers, and metrology, as well as laboratory research.

In addition to label-readers and video-disk scanners, the emerging, potentially high-volume markets for low-cost lasers include pollution-monitors, copiers, optical memories, communications, facsimile, and target designation, such as gun sights. In fact, one of the first uses of the model 136 is in the Electronic Label Reader for supermarkets (see "Laser speeds checkout," p. 93).

All past uses have involved a few tens of thousands of lasers while the expected mass markets will probably require hundreds of thousands. In particular, video players and label readers must be mass-produced. Enough video players must be sold to create an attractive market for a variety of video disks, to encourage further purchases of players. Likewise, the use of label readers in many stores will make commonplace the use of optically readable labels on merchandise.

Simply reducing laser prices is not enough to open a mass market. Components of consumer and commercial products are expected to have average operating lives longer than the warranty period; otherwise, replacement costs become intolerable. And a system's primary and most expensive component, whether the laser in a video player or a picture tube in a TV set, should have a life much longer than the warranty period. If it does not, the manufacturer may be driven from the market by a reputation for "cheap," unreliable products.

Therefore, Spectra-Physics' basic objective at the outset of the tube development program in 1970 was to lower cost and improve performance. The plasma tube was the prime target, since it is the most expensive part of a laser to make. The other objective, making a generally applicable laser, could be achieved in the package-design phase. Luckily, no revolutionary changes in tube design were required. Instead, a combination of evolutionary changes in conventional helium-neon tube technology proved suitable.

Evolutions from lab to market

An evolutionary design was sought in order to make use of the hard-won advances of the 1960s. Although helium-neon lasers had started out as laboratory curiosities conceived and studied by physicists, their commercial production dates back to 1962. Spectra-Physics began marketing helium-neon lasers through the Perkin-Elmer Corp. at that time, and their practical use in instruments soon followed.

However, the early He-Ne tubes were expensive, had short lives, and were difficult to use. They required expertly assembled external optical cavities (the resonators in which the coherent, monochromatic beams are formed). A succession of developments from 1966 through 1969 largely corrected those problems.

The use of mirrors permanently assembled as parts of the tube, forming permanently aligned cavities, and semiautomatic alignment and sealing machines reduced laser prices from more than $1,000 to several hundred dollars. Meanwhile, lifetimes were extended from hundreds of hours to several thousands of hours by development of cold aluminum cathodes, hard dielectric mirrors, and moisture-resistant seals.

The latter developments opened the construction-laser market, which supported the tooling developments. But it became obvious by 1969 that the tubes of the day could not be produced at low cost in the huge volumes projected for potential consumer and commercial markets. Furthermore, refinements of conventional tube designs would not assure cost and reliability improvements as great as those in the past.

Redeveloping the tube

Its origin as a product of the laboratory glassblower's art caused the conventional plasma tube to retain a complex, rather fragile shape with pin seals and many protrusions. In contrast, the geometry developed for the model 136 laser's tube is simple and suitable for mechanized production and rapid packaging (Fig. 2).

Besides the new glass-envelope geometry, which resulted in a clean cylinder, the major innovations in mechanical design are the stamped metal end plates and the use of a metal, rather than glass, pinch-off tube. The end plates replace the parts formerly used as mirror seats and electrical feedthroughs. They are hermetically sealed to the glass body. The pinch-off tube forms the final seal after the tube is evacuated and filled with the helium-neon gas mixture. Combined with other less notable redesign, these changes eliminated 20 tube parts.

Much of the development effort went into finding proprietary combinations of economical materials that were easy to fabricate and had compatible thermal-ex-

Laser speeds checkout

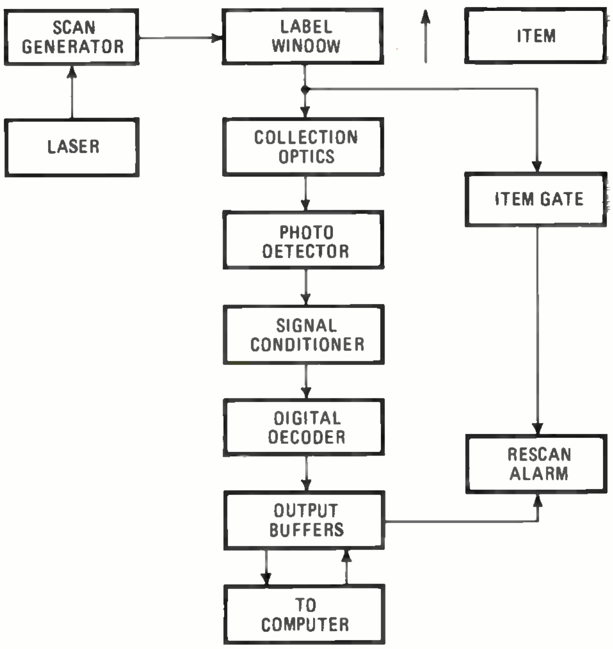
Food canners and other suppliers of merchandise to supermarkets have started to print on labels and packages the Universal Product Code, a family of optoelectronically readable bar codes that identify each product and its manufacturer. The UPC was adopted recently as a Super Market Institute standard so that many store operations, from inventory-control to product-pricing and customer-checkout, could be automated with electronic point-of-sale systems.

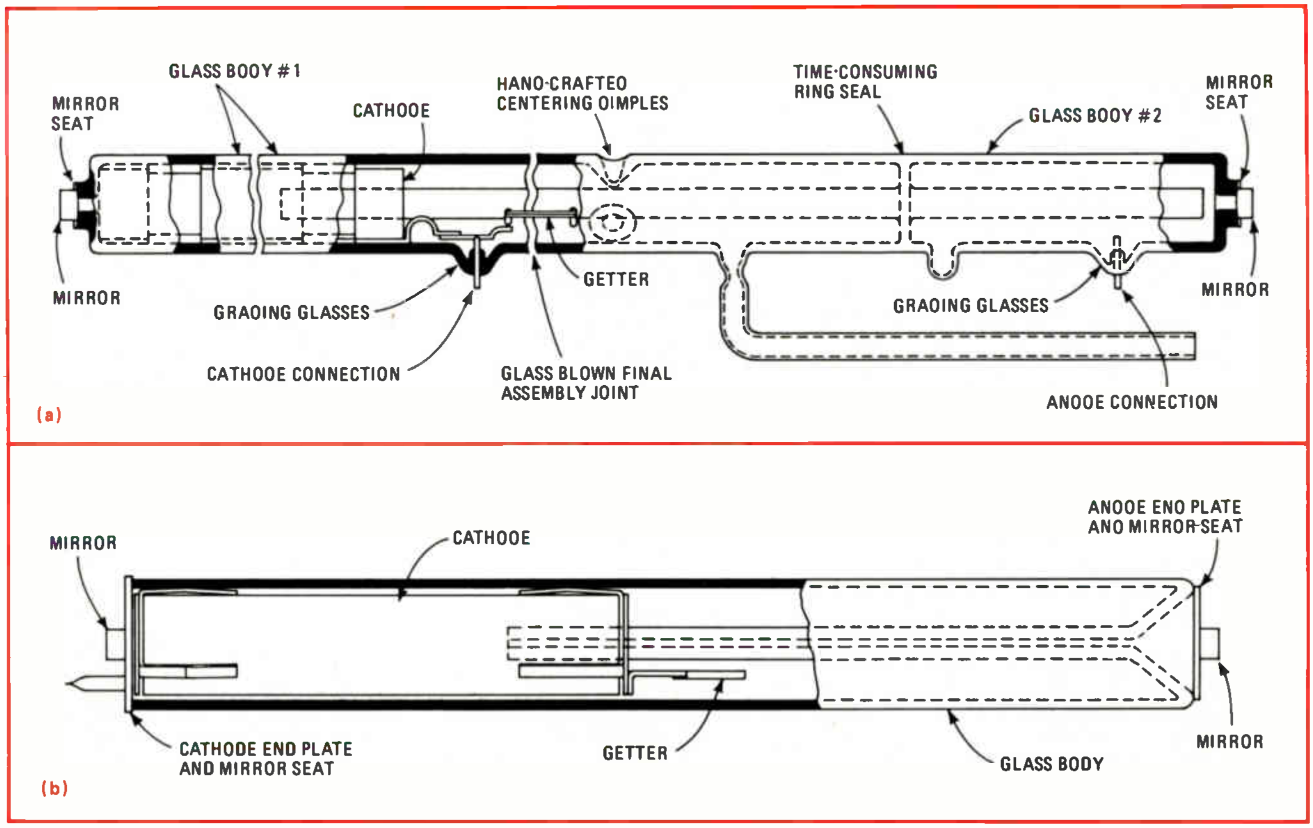
When read and decoded by symbol-scanning peripherals in the checkout counters, the UPC makes it possible for the POS system's computer to look up prices and operate the store's electronic cash registers. The checker simply pulls the packages across a scanning window in the counter and puts them in a bag. And the POS computer also can replace manual price-marking, inventory-checking, accounting, and the like.

Spectra-Physics' Electronic Label Reader, one of the initial applications of the laser described in this article, is such a peripheral. The laser beam goes through focusing and routing optics to a high-speed scanner that projects a multibeam scanning pattern toward oncoming packages. In cross-section, the pattern is a horizontal line bisecting a series of vertical scans.

Projected upward and forward for several inches beyond the counter-top scanning window, the pattern allows UPC symbols printed on the sides of boxes, cans, and bottles to be read when most packages are upright. Conventional fan or X-shaped laser scans would require labels to be placed face-down on the scanning window. Also, since UPC code bars are usually printed horizontally or vertically, a conventional scan would cross the bars at a 45° angle.

The stitch-bar pattern is more efficient, since one of the orthogonal scan lines will usually cross the code bars at 90°, the crossing angle that represents the shortest scanning distance. That allows packages to be read while moving through the scan pattern at speeds to 500 inches per second. Maximum speed drops to 100 ips if a checker twists a package to a 45° orientation.





2. Evolution. The most important improvement on an older He-Ne laser (a) is the use in the new one (b) of stamped-metal end plates that serve as both electrical feedthroughs and mirror seats. The new model also eliminates protrusions and fragile pin seals of previous designs.

pansion coefficients at processing and operational temperatures.

The resonant optical cavity is formed by two spherical mirrors. Most other low-cost plasma tubes employ one spherical mirror and a flat mirror, an arrangement called a hemispherical resonator. The hemispherical design is generally used because the mirrors are relatively easy to align. However, that resonator's optical mode is cone-shaped while the tube is cylindrical, so much of the light energy generated by the excited gas cannot be collected within the optical cavity and does not contribute to beam energy.

In contrast, the new tube's optical mode is almost cylindrical along the entire length of the tube. There are only small variations in the diameter of the beam oscillating within the tube, so nearly all the excited gas is utilized, providing the high power efficiency. The mode is slightly more sensitive to angular shifts (e.g., warping of the tube body) but has the compensating advantage of being insensitive to changes in tube length. That gave additional tolerance in the long direction.

In addition to reduced costs, the chief benefits are:

- Lifetime approximately doubled to 20,000 hours or more (indicated by tests to date).
- Power efficiency more than doubled, an important factor for supply economy and battery life. It approaches that of high-power lasers. An unballasted tube generates about 3 mW of beam power with an input of 1,200 volts at 3 mW.
- Tight, repeatable beam-positioning so that little or no alignment is needed to mate the laser to system optics. When the tube is packaged, the beam is within ±0.05 mm of the center line of package mounts, compared with the ±0.5 mm typical for low-power He-Ne lasers.
- Small beam diameter—0.51 mm, compared with a normal range of 0.5 to 1.5 mm.
- Smaller, more readily assembled package. The final package is a hermetic cylindrical metal "can" 1.37 in. in diameter and 11.5 in. long, or 22% smaller than a conventional tube's package would be.

The tube is placed in mounts in the package. The beam is concentric with two precision system-alignment reference surfaces machined on the can. The package also contains stress reliefs that allow the tube to expand and contract without warping during temperature variations, as well as installation of shock mounts, power-supply ballast, safety-ground circuits, and the beam-power control.

Using the laser

The package eliminates the difficulties normally encountered in applying laser tubes. It converts the tube to a component that can be installed without numerous auxiliary electrical and mechanical parts, protects the tube and its high-voltage components from adverse environments, makes the laser an electrically safe device.

A variable attenuator is built in as an output-power control to allow the laser to be stocked as a general-purpose device. Precise beam-power tolerances have always been difficult to meet in tube production, necessitating either tube selection or adjustments in using systems. The control allows the model 136 power to be specified "from less than 1 mW to more than 2 mW."

The equipment manufacturer simply adjusts to the power desired by means of a fitting on the package, while observing beam power on a conventional optical power meter. To prevent end users from tampering with the setting, the fitting is hidden, requires a special tool, and can be sealed.

More power is required by the laser than the bare tube, primarily because the tube is ballasted by 62 kilohms. All He-Ne tubes must be ballasted with a positive resistance to compensate for the gas discharge's negative resistance. Unballasted tubes oscillate and drop out. They may operate beyond their drop-out point, but they will be inefficient and may be noisy.

The laser needs less than 7 kV starting voltage and about 6 W of operating power (1.5 kV at 4 mA). Two power supplies, also sealed, have been developed. One draws less than 8 W from a battery, and the other less than 12 W from an ac outlet. Both use the laser's ground circuit as part of a safety-monitor circuit that shuts off all high-voltage power unless all grounds are complete. Such circuits avoid subjecting personnel working with active lasers to potentially lethal high voltages and short-circuit currents that could reach 30 mA or more.

Mounting lasers requires a feel for the fine angles involved in beam positioning and familiarity with the effects of thermal and mechanical stress on positioning. A bare tube can be mounted in simple holders only when environments are benign and accuracy requirements low. But a packaged laser with internal stress reliefs and precision mounts can usually go into simple external mounts—compliant mounts (holders with rubber "O" rings around the "can") in less-critical applications, or rigid rings at each end of the can in precision uses.

The system-mounting structure's thermal warping or twisting should be considered. For example, 10 thermal W across a stainless-steel bar 1 by 1 by 20 cm creates a thermal gradient large enough to cause 2 milliradians of angular shift—greater than the beam's diffraction-limited divergence. Pointing accuracy could be preserved better in poorly cooled systems by mounting on aluminum or other high-conductivity materials.

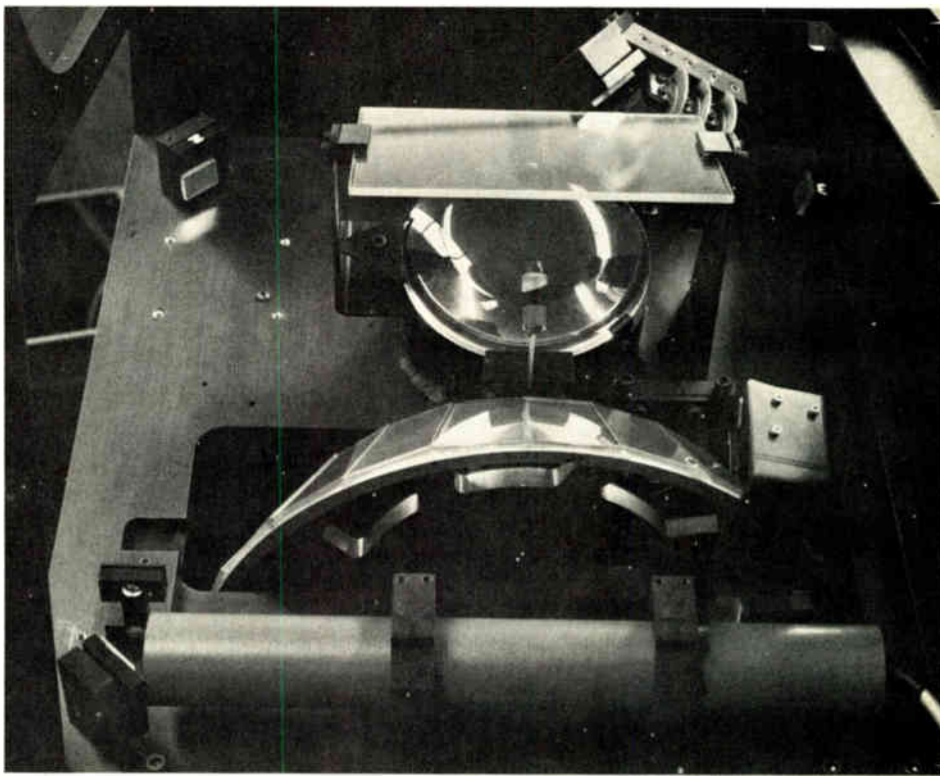
Eye safety depends on how much beam energy enters the eye in a given exposure time. If the beam is scanned, modulated or pulsed, greater beam power is allowable, since average power or exposure time is less than when a continuous-wave beam is seen. Pertinent standards are "American National Standard for Safe Use of Lasers," (Z136, 1-1973), American National Standards Institute, New York, and the proposed "Performance Standards for Laser Products," Bureau of Radiological Health, Bethesda, Md.

The model 136 is applicable to the three least-hazardous equipment classes defined in these documents: Class I (exempt products requiring no precautionary labeling), which expose the eye to up to 0.4 microwatts average power; Class II, 0.4 μW to 1 mW; and Class III, 1 mW to 5 mW. Powers above 5 mW are considered definitely hazardous.

By itself, this cw laser is a Class II or III product, but beam modulation or scanning (or a light-tight housing) can exempt the end equipment. For example, the Electronic Label Reader qualifies for Class I because the beam is split into multiple beams that are scanned at very high speed. Even if a beam should reach the eye of a customer or checker, it would move too fast to be hazardous.

Electrical safety is also important. If the laser is used with a system power supply, safety circuits like those in the optional supplies are strongly recommended. Also, sealed packages avoid hazards from spills or high humidity, as well as protect the tube and its connectors. The laser and the supplies can operate even when submerged in water. □

3. In action. The laser must scan omnidirectionally the product-code symbol, shown on package labels (a). To do so, it's mounted inside an electronic label-reader (b) which focuses a cross-hatch scan pattern.



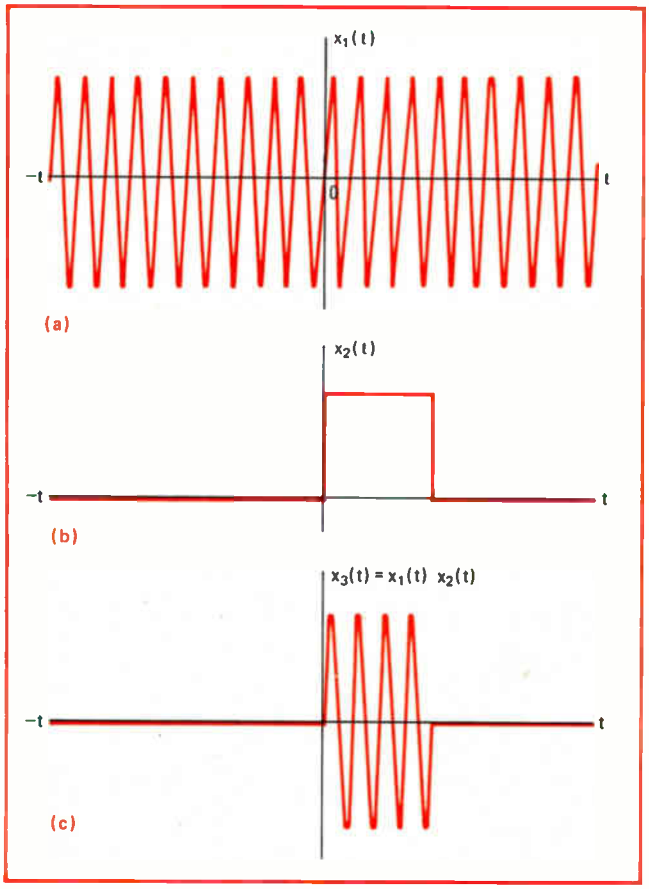
The fast Fourier transform's errors are predictable, therefore manageable

By limiting itself to a digitized segment of a continuous waveform, the FFT makes waveform analysis practical at the cost of introducing aliasing and leakage errors; but these errors, once understood, are easy to counter

by Robert W. Ramirez, *Tektronix Inc., Beaverton, Ore.*

☐ One's first brush with the fast Fourier transform (FFT) is often disconcerting because turning the classical Fourier transform into the FFT practically always introduces errors. Known as leakage and aliasing, these errors almost invariably occur when continuous time-domain waveforms are subjected to finite-time-windowing and sampling—both of them operations that are fundamental to the FFT.

But the engineer who understands why leakage and aliasing occur will fairly soon be able to spot many cases on sight. Also, several methods for combating them become very obvious.

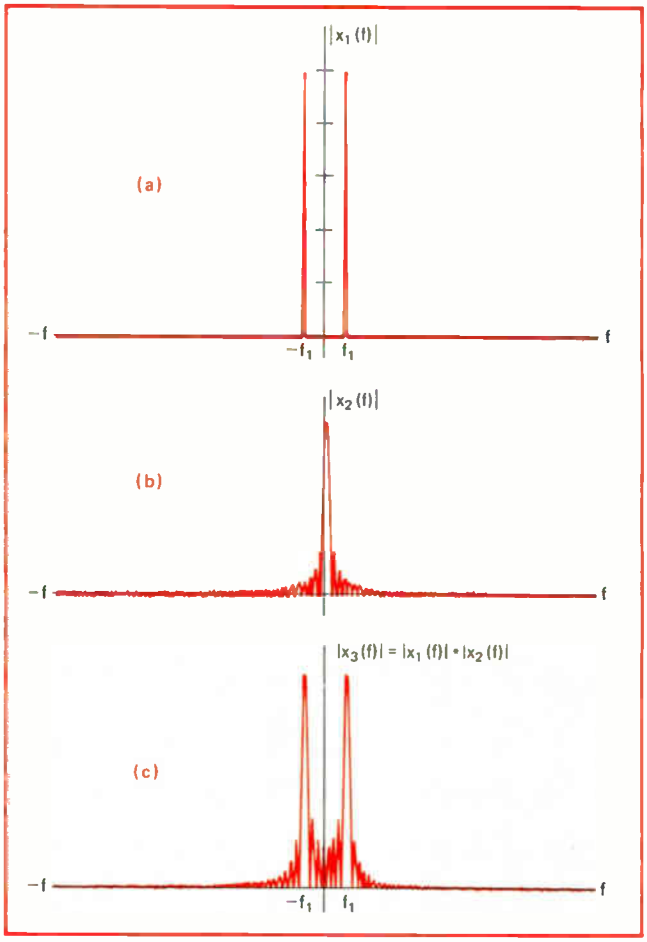


1. Windowing. Mathematically ideal sine wave extends over entire time domain (a). It must be multiplied by window of finite duration (b) to yield a signal that can be handled by a computer for processing into the frequency domain (c).

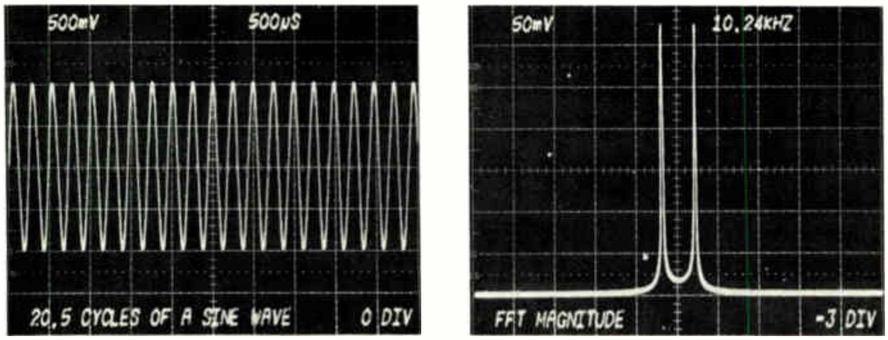
Let's first recall the integral Fourier transform:

$$X(f) = \int_{-\infty}^{\infty} x(t)e^{-j2\pi ft}dt$$

where x(t) is a continuous time-domain function, and X(f) is the corresponding frequency-domain function for which the integral transform is to be evaluated. To transform x(t) digitally, the Fourier transform must be

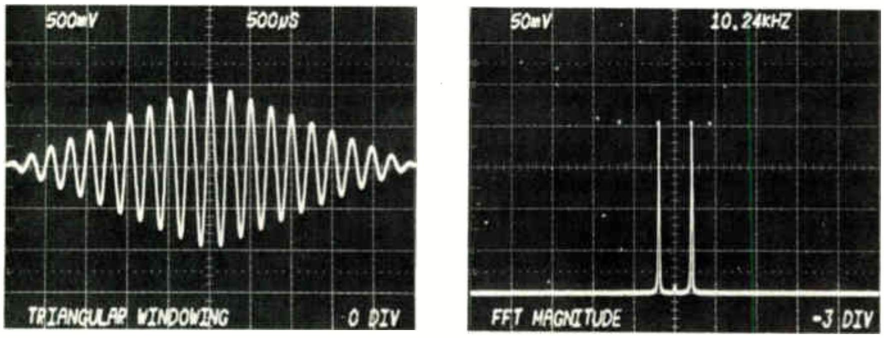


2. Effect of windowing. Fourier transform of an ideal sine wave is a pair of impulses in the frequency domain (a). Transform of a rectangular pulse is a (sin x)/x function (b). Convolving these two functions produces transform of a sine wave windowed by a rectangular pulse (c). Note the leakage. (All transforms shown here are magnitudes only; hence, negative values are shown as positive.)



(a) (b)

3. Leakage. CRT photos of sine wave (a) and its transform (b) show actual "leakage," due to windowing. Effect only fails to occur when frequency of sine wave and inverse of window duration happen to be harmonically related.



(a) (b)

4. Reducing leakage. Using a triangular window (a) on the sine wave of Fig. 3 cuts frequency-domain leakage (b). Note, however, that it also cuts amplitude of the frequency-domain impulses.

restated as the discrete Fourier transform (DFT):

$$X_d(k\Delta f) = \Delta t \cdot \sum_{n=0}^{N-1} x(n\Delta t)e^{-j2\pi k\Delta f n\Delta t}$$

or, letting $\Delta f = 1/N\Delta t$,

$$X_d(k\Delta f) = \Delta t \cdot \sum_{n=0}^{N-1} x(n\Delta t)e^{-j2\pi kn/N}$$

where k and n = 0,1,...,N−1; Δt is the time-domain sampling interval, and N is the number of samples taken over the interval of $(N-1)\cdot\Delta t$.

Now the FFT is nothing more than a time-saving computer algorithm for evaluating the DFT, so its mathematical properties are completely analogous to the DFT's. Similarly, the errors associated with the FFT derive from the DFT. Leakage arises from the fact that the waveform is studied over only a short period (or window) of time. Aliasing arises if the waveform is sampled at too slow a rate.

The view through the window

In the integral transform, time is considered in its infinite totality. In the discrete transform, only the time interval covering the N discrete samples is considered (Fig. 1). In Fig. 1a, a continuous function of time—a sine wave—is assumed to exist over the time interval from $-\infty$ to $+\infty$. When this sine wave is transformed into the frequency domain by an FFT algorithm, a data window (Fig. 1b) must be defined, and a segment of the wave-

How to read the CRT photos

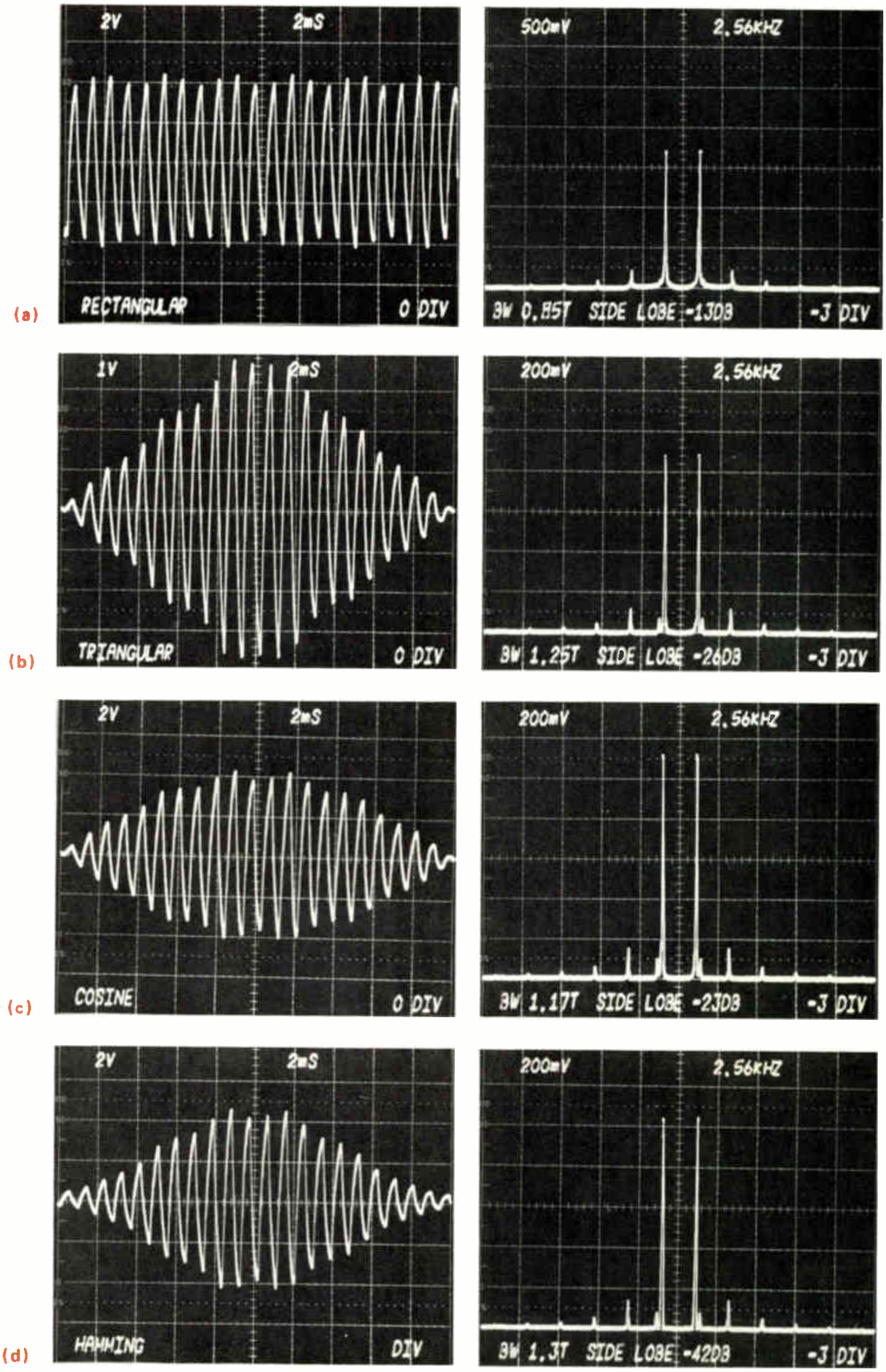
The many photographs in this article ware taken from the CRT display of the Tektronix digital processing oscilloscope (DPO). To benefit fully from this article, therefore, the conventions used in the display for both time- and frequency-domain information must be understood.

The CRT display has eight vertical and 10 horizontal divisions. The scale factors giving quantity and units per division appear at the top of display, the vertical scale factor on the left, the horizontal on the right.

In the bottom right-hand corner of the display is information on the position of the zero reference for vertical information. A 0 DIV indicates the zero reference is on the center horizontal line of the graticule; a −3DIV indicates it is three divisions below that line.

Time-domain displays are distinguished from frequency-domain displays by the units associated with the horizontal scale factors. S is time in seconds, HZ is frequency. In time-domain displays, time zero coincides with the leftmost graticule line, and positive time proceeds to the right in accordance with the displayed horizontal scale factor. In frequency-domain displays, zero hertz coincides with the center vertical line of the graticule, negative frequency is on the left, and positive on the right.

Where it's needed to explain the display or add information, computer-generated text appears in the lower left area of the display.



5. Other windows. These eight pairs of photographs each show a windowed time-domain function and its corresponding frequency-domain magnitude spectrum. The various windowing functions have all been applied to the same signal—a low-pass-filtered square wave to which a low-amplitude sine wave has been added. The frequency of the added sine wave is very close to the fundamental of the square wave.

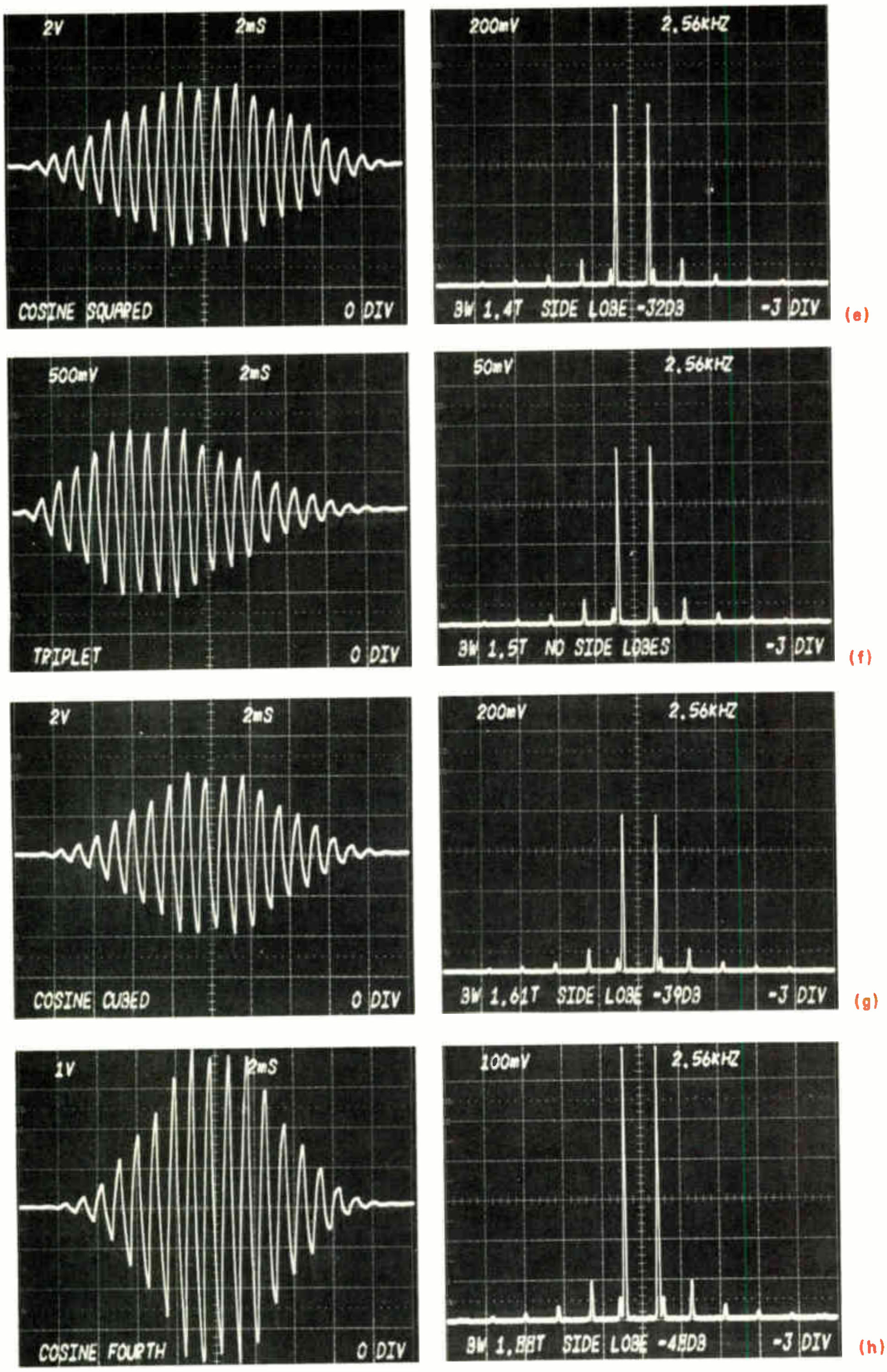
Included in the photos of the frequency-domain spectra is information on the more important characteristics of each windowing function. Specifically, the bandwidth figure (BW), indicates the theoretical bandwidth of the windowing function's major lobe at

form viewed through the window. Thus, all knowledge of the waveform's behavior before and after the window is lost.

In effect, the window of Fig. 1b is a unity-amplitude pulse. The sine wave is "viewed through the window" when the two are multiplied together. The result of this time-domain multiplication of Figs. 1a and 1b is shown in Fig. 1c.

Obviously, the act of windowing in the time domain must also affect the signal in the frequency domain (Fig. 2). Figures 2a, 2b, and 2c are the magnitudes of the Fourier transforms of the time-domain waveforms of Figs. 1a, 1b, and 1c, respectively. Since multiplication in the time domain corresponds to convolution in the frequency domain, Fig. 2c is produced by convolving the magnitude plots of Figs. 2a and 2b.

Figure 2 clearly shows the effect of windowing in the frequency domain. The original concentration of energy in the two impulses of Fig. 2a has been smeared or "leaked" into the major lobes and side lobes that appear in Fig. 2c. The same amount of energy is present o both cases, but it has been redistributed in Fig. 2c in



the 3-decibel point. The "T" factor appearing with these bandwidth figures is the reciprocal of the window length in the time domain. (For example, the window length of the triangular window shown in (b) is 10 divisions times 2 milliseconds, or 20 ms, and the resulting theoretical bandwidth of the triangular window's major lobe at the 3-dB point is 1.25/20 ms or 62.5 Hz.) Also given are theoretical figures showing the level of each window's highest side lobe relative to the major lobe.

The Hamming window of (d) is a cosine squared function on an 8% pedestal, and the triplet window of (f) is a cosine squared function multiplied by an exponental function. All the other windows are self-explanatory.

such a way as to decrease peak magnitude. This redistribution of energy is what's called "leakage" and is a direct result of data windowing.

In practice, the leakage may not be as pronounced as in Fig. 2c. In Fig. 3, for example, the major lobes represent the frequency-domain magnitude of the windowed 20.5 cycles of a sine wave, and they are so positioned that the frequency-domain sample points of the FFT algorithm occur on the peaks of the side lobes. Consequently, instead of individual side lobes, all that's visible is the exponentially decaying peaks of the side lobes. This form of leakage looks like, and is often called, "skirts."

Very rarely, the number of cycles of a periodic waveform acquired within a rectangular data window is an integer, and then no leakage at all occurs. In this situation, the frequency of the time-domain signal is harmonically related to the inverse of the duration of the window, and the zero crossings of the (sin x)/x function (which is the Fourier transform of a rectangular window) coincide with the frequency-domain sample points of the FFT algorithm. (In the case of nonrecurring

PARTS, ACCESSORIES and MATERIALS

Aluminum

see Metals

Anodes

CARBON ANODES

Keystone Carbon Co., St. Marys, Pa.
National Carbon Co., Carbon Sales Div., Cleveland, Ohio
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Pure Carbon Co., St. Marys, Pa.
Speer Carbon Co., St. Marys, Pa. (See p. 24.)
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
Superior Carbon Products, Inc., 9115 George Ave., Cleveland, Ohio
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.

METAL ANODES

Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Tungsten Mfg. Co., 502 23d St., Union City, N. J.
Goldsmith Bros. Smelting & Refining Co., 58 E. Washington St., Chicago, Ill.
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.

Antennas

AUTO ANTENNAS

ABC Radio Laboratories, 3334 N. New Jersey St., Indianapolis, Ind.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Amy, Aceves & King, Inc., 11 W. 42d St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Fishwick Radio Co., Colorado Bldg., Washington, D. C.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Kraeuter & Co., 585 18th Ave., Newark, N. J.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Premax Products Div., Chisholm-Ryder Co., College & Highland Aves., Niagara Falls, N. Y.
Radiart Corp., 3571 W. 62d St., Cleveland, Ohio
RCA Mfg. Co., Camden, N. J.
Snyder, Inc., 813 Noble St., Philadelphia, Pa.
Superior Tube Co., Norristown, Pa.
Ward Products Corp., 1523 E. 45th St., Cleveland, Ohio

HOME ANTENNAS

ABC Radio Laboratories, 3334 N. New Jersey St., Indianapolis, Ind.
Alden Products Co., 715 Center St., Brockton, Mass.
American Communications Corp., 306 Broadway, New York, N. Y.
Amy, Aceves & King, Inc., 11 W. 42d St., New York, N. Y.
Andrea Radio Corp., 4820 48th Ave., Woodside, N. Y.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Fishwick Radio Co., Colorado Bldg., Washington, D. C.
Fleron & Son, M. M., 113 N. Broad St., Trenton, N. J.
Fowler Mfg. Co., 9 Rutger St., St. Louis, Mo.
General Electric Co., Bridgeport, Conn.
General Television & Radio Corp., 1240 N. Homan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jefferson-Travis Radio Mfg. Corp., 380 2nd Ave., New York, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Norwest Radio Laboratories, Blaine Ave. & Hill St., Shelby, Mont.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Premax Products Div., Chisholm-Ryder Co., College & Highland Aves., Niagara Falls, N. Y.
Radex Corp., 1328 Elston Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sparks-Withington Co., Jackson, Mich.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Technical Appliance Corp., 516 W. 34th St., New York, N. Y.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Vertrod Mfg. Co., 132 Nassau St., New York, N. Y.
Vogue Co., 8134 Vincennes Ave., Chicago, Ill.
Ward Products Corp., 1523 E. 45th St., Cleveland, Ohio

TRANSMITTING ANTENNAS

American Bridge Co., Frick Bldg., Pittsburgh, Pa.
Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa. (See page 102.)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hardner Corp., George H., 602 Hamilton St., Allentown, Pa.
Harrell Co., D. H., 10640 Buffalo Ave., Chicago, Ill.
Hartenstine-Zane Co., 225 Broadway, New York, N. Y.
Hoke Vertical Radiator Co., 135 S. Market St., Petersburg, Va.
International-Stacey Corp., 875 Michigan Ave., Columbus, Ohio
Isolantite, Inc., 343 Cortland St., Belleville, N. J.
Lehigh Structural Steel Co., 17 Battery Pl., New York, N. Y.
Lingo & Son, John E., 28th St., & Buren Ave., Camden, N. J. (See page 168.)
Mims Radio Co., Texarkana, Ark.
Superior Tube Co., Norristown, Pa.
Truscon Steel Co., Albert St., Youngstown, Ohio
Western Electric Co.—see Graybar Electric Co.
Wilcox Electric Co., 3947 State Line, Kansas City, Mo.
Wincharger Corp., 2700 Hawkeye Drive, Sioux City, Iowa. (See page 140.)

Attenuators

see Controls

Baffles

SPEAKER BAFFLES

Adler Mfg. Co., 2901 W. Chestnut St., Louisville, Ky.
Art Specialty Co., 3245 Lake St., Chicago, Ill.
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Castlewood Mfg. Co., 12th & Burnett, Louisville, Ky.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Hadley, Robert M., 711 E. 61st St., Los Angeles, Cal.
Hawley Products Co., St. Charles, Ill.
Illinois Wood Products Corp., 2512 S. Damen Ave., Chicago, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laobratories, 1617 N. Damen St., Chicago, Ill.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Ray Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Ballasts

see Tubes

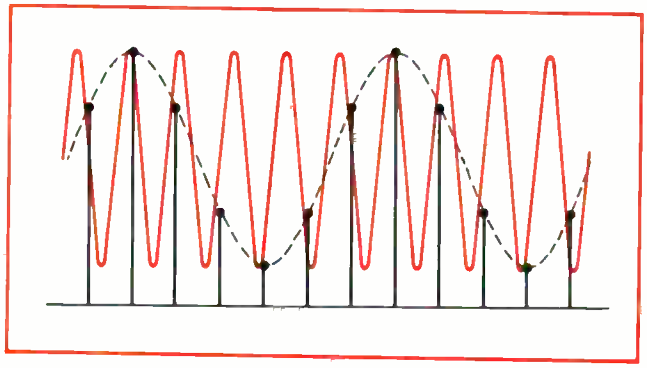
Batteries

DRY BATTERIES

Acme Battery Corp., 59 Pearl St., Brooklyn, N. Y.
Bright Star Battery Co., 200 Crooks Ave., Clifton, N. J.
Burgess Battery Co., Freeport, Ill.
Deal Electric Co., 338 Berry St., Brooklyn, N. Y.
Edison Storage Battery Div., Thomas A. Edison, West Orange, N. J.
General Dry Batteries, Inc., 13000 Athens Ave., Cleveland, Ohio
Le Carbone Co., Myrtle Ave., Boonton, N. J.
National Carbon Co., 30 E. 42d St., New York, N. Y.
Philco (Battery Division), Philadelphia, Pa.
Ray-O-Vac Co., Madison, Wis.
Southern Battery Co., Appomattox, Va.
United States Electric Mfg. Corp., 222 W. 14th St., New York, N. Y.
Western Cable & Light Co., Baldwin, Wis.
Winchester Repeating Arms Co., New Haven, Conn.

STORAGE BATTERIES

American Battery Co., 208 W. Kinzie St., Chicago, Ill.
Am-plus Storage Battery Co., 425 W. Superior St., Chicago, Ill.
Bowers Battery Mfg. Co., Reading, Pa.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Edison Storage Battery Div., Thomas A. Edison, Inc., West Orange, N. J.
Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.
General Lead Batteries Co., Chapel St. & Lister Ave., Newark, N. J.
General Storage Battery Co., 2005 Locust St., St. Louis, Mo.
Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis.
Gould Storage Battery Corp., 35 Neoga St., Depew, N. Y.
Jumbo Battery Mfrs., Ellsworth, Iowa.
K. W. Battery Co., 3705 N. Lincoln Ave., Chicago, Ill.
Monark Battery Co., 4556 W. Grand Ave., Chicago, Ill.



6. Aliasing. Insufficient sampling of high-frequency sine wave (solid line) leads to low-frequency aliasing (dashed line). To prevent it, sampling rate must be at least twice highest signal frequency.

pulses, too, leakage will not occur if the pulse rises from and returns to zero within the window's confines.)

Unfortunately, this harmonic relationship seldom happens. Leakage generally occurs and just has to be lived with—though it can be diminished if the window's shape does not exhibit as harsh a time truncation as the rectangular window.

Reducing leakage

For example, take triangular windowing. In Fig. 4a, the same 20.5 cycles of sine wave as appear in Fig. 3a have been multiplied by a unity-amplitude triangular pulse. The spectrum of this triangularly windowed waveform (Fig. 4b) reveals significantly less leakage into the skirts than does the spectrum of the rectangularly windowed waveform of Fig. 3b. Amplitude is also lower, because a unity-amplitude triangle contains less energy than a unity-amplitude square pulse of the same duration.

Now, the windowing function is in essence a time-domain pulse of fixed energy, and any change in that pulse's shape must be reflected in a redistribution of the energy in the pulse's frequency domain. It follows that, if the shape of a windowing function is changed to reduce side-lobe size, the energy normally associated with those side lobes must go elsewhere. In general, the energy is forced into and widens the major lobe.

Besides the rectangular and triangular windows so far mentioned, there are many more windowing functions available for preconditioning acquired signals. Also called weighting functions and convolution kernels, eight of the more common and useful windows are illustrated in Fig. 5.

Examination of all these windowing functions reveals a general trend of increasing bandwidth for decreasing side-lobe level. The implication here is that the resolution—the ability to distinguish adjacent frequencies of equal amplitude—decreases as bandwidth increases. On the other hand, the selectivity—ability to pick out adjacent frequencies of unequal amplitude—is increased as the side-lobe level is decreased. An extreme of the selectivity-resolution dilemma is shown in Fig. 5h, where a cosine fourth window has widened the fundamental lobe so much that it threatens to encroach upon the domain of the adjacent, low-level frequency component. Had this low-level component been closer to the fundamental, cosine fourth windowing would have caused the component to be absorbed in the widened lobe of the fundamental.

Aliasing

To evaluate the FFT, the data viewed through a window must also be digitized. But the process of obtaining discrete samples of the windowed time-domain waveform may give rise to aliasing, or foldover, errors.

Digitizing an analog waveform requires that the waveform's amplitude be sampled often enough to define the waveform completely. The number of times that any waveform is sampled in a fixed period is referred to as the sampling rate. The well-established sampling theorem (Nyquist criterion) states that the sampling rate must be at least twice the highest frequency present in the wave form for the wave form to be defined completely. Failure to use a sufficiently high sampling rate is the source of aliasing errors.

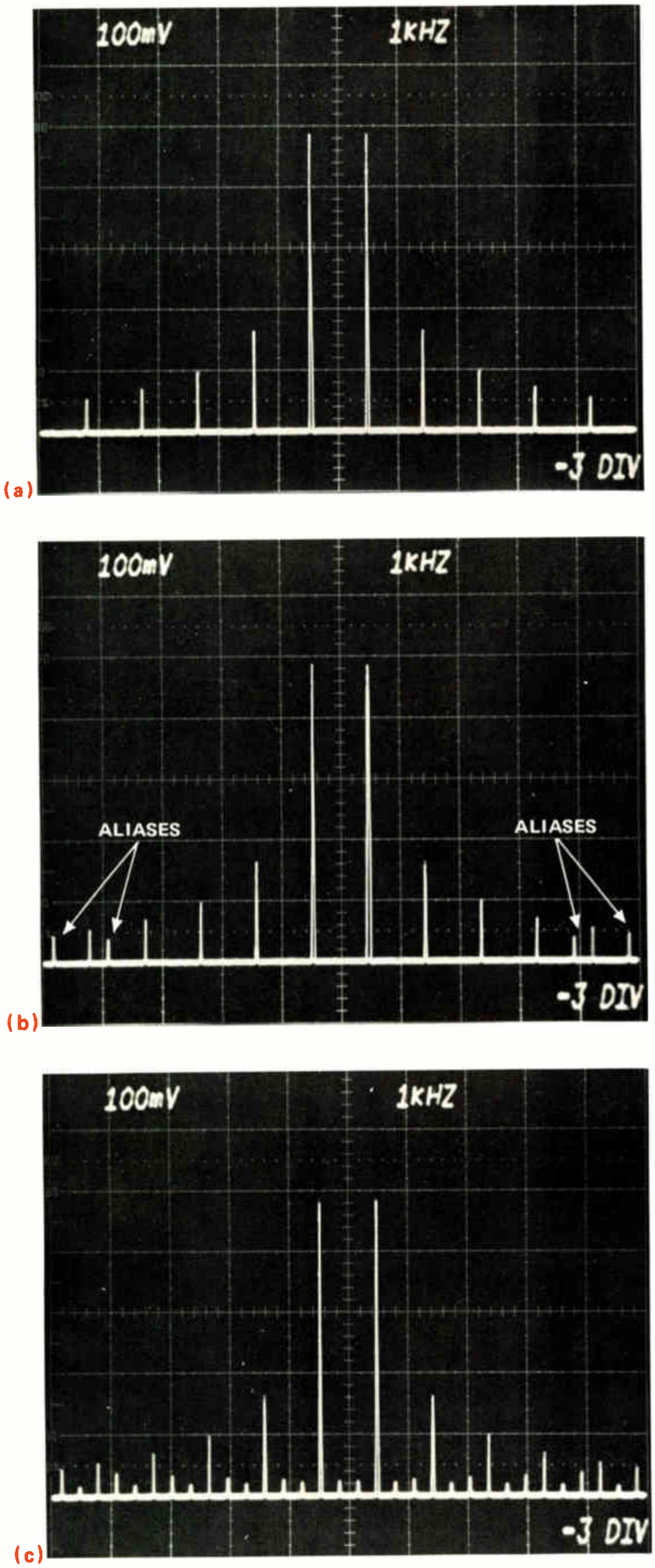
Fig. 6 diagrams the impersonation of low-frequency waveforms by aliasing or foldover. Assume that the 10 cycles of sine wave shown by the solid line represent a

Refresher on FFTs

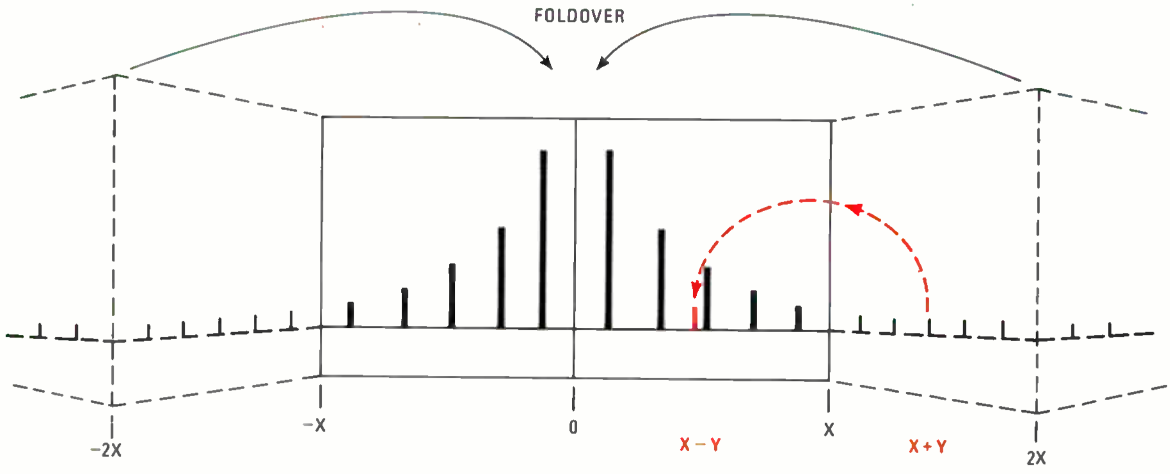
The Fourier transform has been described as both one of the most useful and one of the most useless mathematical tools available to the electronics engineer. The usefulness of the tool is evident: it provides a method for calculating the frequency spectrum—both magnitude and angle—for any function of time. However, for almost all signals, except the very simple ones found in textbooks, the evaluation of the Fourier integral is so difficult and time-consuming as to have been impractical before computers were widely available.

Computers substitute brute-force number crunching for the elegance of analytic solutions. Any time-domain waveform that can be described as a sequence of discrete values can be transformed into the frequency domain by a computer. But even with a computer, the process was rather lengthy until James W. Cooley and John W. Tukey, deciding to exploit the various symmetries inherent in the definition of the Fourier transform, produced "An algorithm for the machine computation of complex Fourier series" (Mathematics of Computation, April 1965, p. 297). This algorithm and its successors are what are known today as fast Fourier transforms (FFTs).

As reasonably priced, accurate, analog-to-digital converters, and low-cost minicomputers and microprocessors become more widely used, the examination of a signal's frequency spectrum may become as commonplace as the study of its time-domain behavior. Though communications engineers have traditionally thought in terms more of frequency bands than time functions, the advent of instruments like the digital processing oscilloscope [*Electronics*, March 15, 1973, pp. 98–103] is giving them the hardware to look at signals the way they've always wanted to. But engineers who have no experience of the FFT do need to be aware of the important differences between this practical tool and M. Fourier's mathematical abstraction.



7. Recognizing the impostors. These three photos show the effect of adding high-frequency components to an input signal while keeping the sampling rate fixed. In (a), the sampling rate is more than twice the maximum input frequency, and all is well. As additional frequency components are added, foldover occurs around the edges of the screen and two low-frequency aliases appear (b). They are easy to recognize because they destroy the monotonicity of the spectrum. When many more components are added, the impostors reach the center of the screen, fold over there, and proceed out toward the edges again (c).



8. Relation to foldover. Aliasing occurs systematically as a result of foldover. If sampling rate is 2X, then the foldover frequency is X—the limit set by the sampling theorem. Frequency components below X in the waveform being sampled will appear as they ought. A component Y hertz above X will actually appear as an alias Y hertz below it, hence the spectrum display is said to fold over at X.

high-frequency component, say 100 kilohertz, of a waveform that is being digitized, and that the heavy dots on the sine wave represent 12 digital amplitude samples. However, a 100-kHz sine wave sampled only 1.2 times per cycle yields a sampling frequency of only 120 kHz—too low for complete definition of the 100-kHz component. The frequency that corresponds to the Nyquist criterion is 120 kHz/2 or 60 kHz—40 kHz below the 100-kHz component. The low-frequency impersonation or alias caused by insufficient sampling of the high-frequency component is shown in Fig. 6 as the dashed sine wave. Note that the alias has a frequency of 20 kHz—40 kHz below the 60 kHz defined by the Nyquist criterion. Since a frequency component 40 kHz above the 60 kHz frequency winds up as a component 40 kHz below it, the 60-kHz frequency is sometimes called the foldover frequency.

The spectra of Fig. 7 demonstrate how aliasing can sometimes be recognized by inspection. The square waves that were transformed for these frequency-domain displays were generated by a computer by the successive addition of odd harmonics. Thus, for the sake of the demonstration, the band limiting of the waveform was controlled very precisely.

In Fig. 7a, the waveform has been limited to components existing below the ±5-kHz folding frequency chosen for this case, and no aliasing is apparent. (The ±5-kHz folding frequency corresponds to the left and right edges of the display.)

If the next higher harmonics are added to the time-domain waveform, undersampling will occur. The aliasing that arises from the undersampling of frequency components above the folding frequency is shown in Fig. 7b, where the additional harmonics have folded about the left and right edges of the display to appear as low-frequency aliases. Their nonsymmetrical placement in the frequency domain and their lower-than-normal amplitudes are clues that aliasing has occurred.

As more and more harmonics are added in the time domain, more and more frequency impostors are found, as shown in Fig. 7c. There, aliasing has progressed from the left and right edges of the display to fold about zero hertz in the center of the display and then work back out toward the edges again.

Figure 8 shows another way of looking at the folding action that characterizes aliasing. Note that aliasing is not limited to the bounds delineated here, but in theory goes on to infinity.

If components higher than the Nyquist frequency are known to exist in the time-domain waveform being sampled, then aliasing is bound to happen, and a foldover of high-frequency components in the frequency domain should be expected. If the frequency components of a waveform are not known, then a simple test for aliasing is to sample the waveform, transform it to the frequency domain, and check to see if the frequency-domain function appears to go to zero and remain at zero before the edges of the window are reached. If it does not, aliasing has probably occurred.

Since aliasing arises from insufficient sampling of the original waveform, an obvious cure for the problem is to assure sufficient sampling. But unfortunately, a well-defined high-frequency limit is lacking in some waveforms, for instance, in those with fast rise times or in the responses from high-pass filters.

Here, aliasing can be prevented if the high frequencies are filtered out before the waveform is digitized. Filters used for this purpose are referred to as anti-aliasing filters and are designed to limit the high-frequency content of the filtered waveform to a known and acceptable cutoff frequency.

Probably the most important thing to remember in using the FFT is that certain errors are inherent in the application of digital techniques to analog waveforms. Once the errors and their sources are understood, action can usually be taken to reduce the error. Indeed, all that's needed with some measurements is the ability simply to recognize bad data and then ignore it. □

WANTED

for not impersonating an op amp

Unlike most other comparators, these MC3430-33 high-speed quads don't don the usual op amp spec disguise. We've combined a conglomeration of specs into one helpful parameter that treats the MC3430 series like digital devices rather than op amps. This revealing new spec is called "input sensitivity" (V_{IS}).

Traditional comparator specs are a heritage from the early "op amp" development days of linear. But these parameters don't adequately describe comparators with their notably different applications. Like the MC3430-33 quads. They're at home as sense amps in 1103 type MOS memory systems, other computer interface applications, or even control systems. That's where input sensitivity comes to the rescue.

Input sensitivity blends the effects of voltage gain, input offset voltage and input offset current. This provides you with the comparator's differential input requirements to guarantee a given logic state at the output. In short, input sensitivity gives you your worst-case design at a glance.

And just so there are no unexpected surprises, we've even included some usually ignored influences in conventional specing. Like the effects of ±5% power supply variations, a ±3.0 V common-mode voltage range and temperature changes from 0° to 70°C.

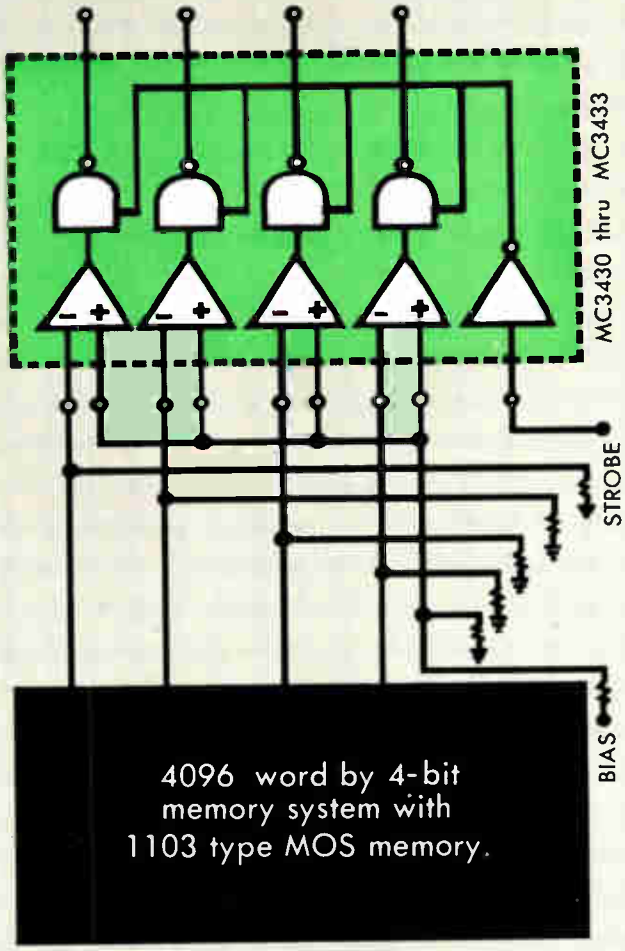
It all adds up to a ±7 mV or ±12 mV total sensitivity, depending on how stringent your requirements. Both versions are available in either open-collector or three-state TTL compatible configurations. And prices for these 10 fan-out comparators start as low as $4.00 (100-up) with off-the-shelf delivery.

So just how good is the MC3430-33 series compared with other popular industry standard comparators? The table tells all.

WORST CASE COMPARISONS

Type Number	$T_A = 0$ to 70°C					
	V_{IO} mV Max	A_{vol}* V/V Typ	Differential Input Voltage Required for 3.0 V Output Change	I_{IO} $R_s = 200\Omega$ µA Max	Error Voltage Generated Into 200Ω Source Resistors	Input Sensitivity mV
MC3430, MC3432	—	—	—	—	—	7.0
MC3431, MC3433	—	—	—	—	—	12
MC1711C	5.0	1000	3.0 mV	25	5.0 mV	13
MLM311	10	100 k	0.030 mV	70**	0.014 mV	10.04
MNE521	10	4000	0.75 mV	12	2.4 mV	13.15

*Typical values given, as minimum gain not always specified.
**I_{IO} measured in nA.



Hopefully, your curiosity is peaked. Satisfy it by capturing the MC3430-33 comparator data sheet which details our unique new parameter. Correspond to P.O. Box 20912, Phoenix, Arizona, 85036, or circle the reader service number below.

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Circle 103 on reader service card

Synchronous noise blanker cleans up audio signals

by M.J. Salvati
Sony Corp. of America, Long Island City, N.Y.

Fluorescent lights, gas rectifiers, neon lamps, SCRs, and triacs all produce a substantial rf signal that often radiates through their power-line connections and interferes with nearby communications receivers. This type of radio interference desensitizes the receiver and makes the recovered audio signal very difficult to understand.

The circuit shown here significantly improves the audio intelligibility of a receiver by eliminating the noise pulses generated by a single dominant nearby noise source. The noise pulses are removed from the audio signal with only slight distortion. Moreover, since this noise-blanking circuit is not internally connected to the receiver, it can be moved from one receiver to another as needed.

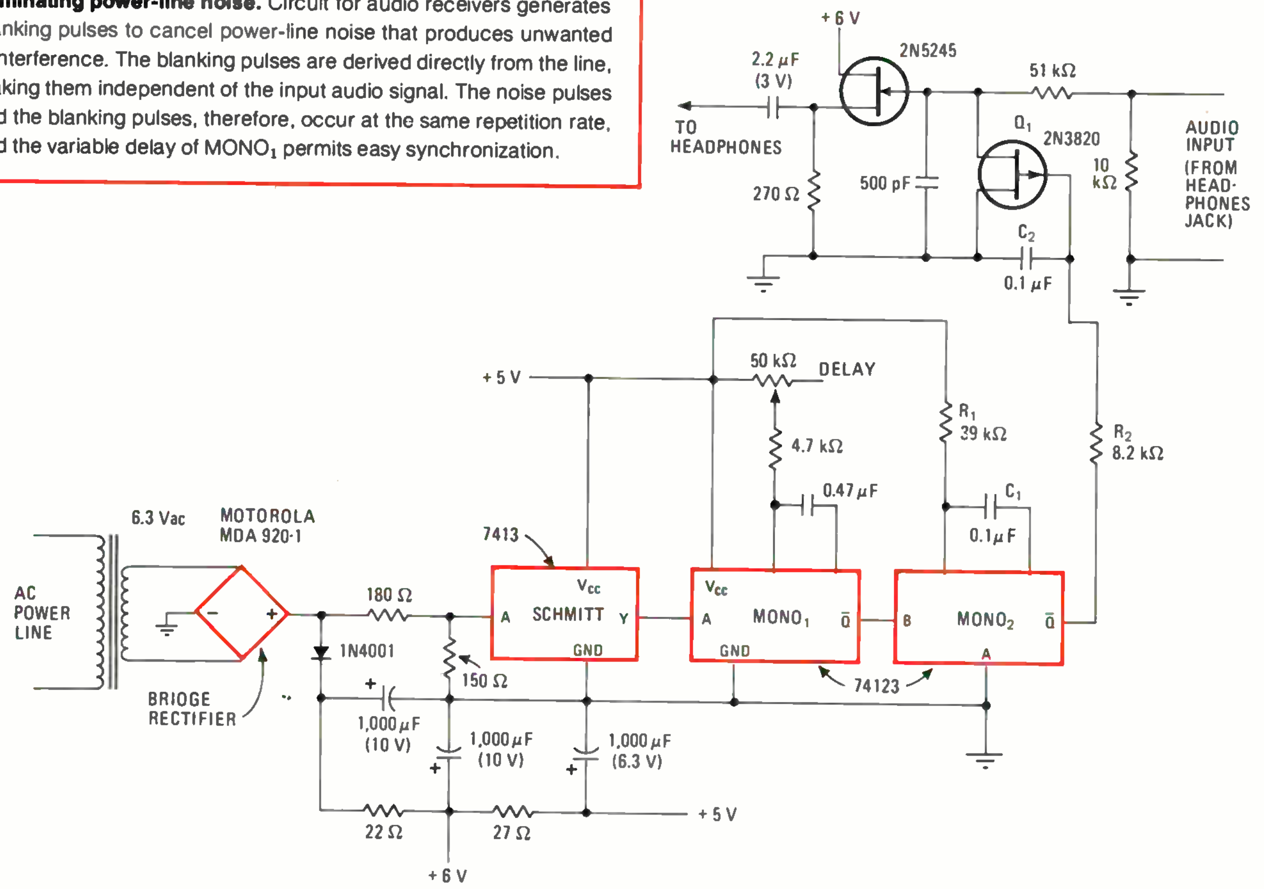
The noise pulses produced by power-line radiation occur at a repetition rate of twice the local power-line frequency. Since the noise-blanking circuit is driven by the same power utility as the noise source, the output signal from the bridge-rectifier section of the noise blanker will have the same rate as the noise pulses.

The source of the blanking pulses, therefore, is independent of the input audio signal. The blanking pulses cause the FET gate (transistor Q_1) to conduct to silence the receiver. Since the blanking pulses are not derived from the input signal, their timing does not depend on the snape and rise time of the noise pulses, nor is it affected by the modulation characteristics of the desired signal.

The output from the bridge rectifier is shaped by a Schmitt trigger that drives a dual monostable multivibrator. The first monostable ($MONO_1$) delays the blanking pulse, which is produced by the second monostable ($MONO_2$), relative to the rectifier's output. The delay is variable so that the blanking pulse can be positioned to coincide with the noise pulse.

The width of the blanking pulse is determined by resistor R_1 and capacitor C_1. The fast rise time of the blanking pulse (from $MONO_2$) is slowed down by the low-pass filter formed by resistor R_2 and capacitor C_2, thereby minimizing the distortion of the recovered audio signal □

Eliminating power-line noise. Circuit for audio receivers generates blanking pulses to cancel power-line noise that produces unwanted rf interference. The blanking pulses are derived directly from the line, making them independent of the input audio signal. The noise pulses and the blanking pulses, therefore, occur at the same repetition rate, and the variable delay of $MONO_1$ permits easy synchronization.



Variable voltage source has independently adjustable TC

by Nathan O. Sokal
Design Automation Inc., Lexington, Mass.

A reference voltage source, which is built around a suitably stable general-purpose operational amplifier, offers an adjustable output-voltage magnitude, as well as an adjustable output-voltage temperature coefficient. Both the voltage magnitude and the temperature coefficient may be varied independently of each other.

The output voltage can be positive or negative, and it is continuously variable from 0.7 to 13 V. The temperature coefficient is also continuously variable, from −0.3%/°C to +0.3%/°C. For the circuit shown in the figure, the output voltage is positive. To obtain a negative voltage, the polarities of all the diodes and the supply (except to the op amp) are simply reversed.

The temperature coefficients of the zener-diode voltage, the resistance values, the op-amp input offset voltage, the op-amp input bias and offset currents, and the power-supply voltage need not all be zero. Rather, their values as functions of temperature must be stable with time and retrace well with temperature cycling. This is also true of the V-I characteristics of diodes D_1 and D_2. Moreover, these two diodes do not have to be matched.

If a narrower range of output voltage is adequate, part of resistance R_1 should be a stable fixed resistor. Likewise, if a narrower temperature-coefficient range is satisfactory, part of resistance R_2 should be a stable fixed resistor. Resistances R_1, R_2, and R_3 should be multi-turn potentiometers if both wide-range adjustment and high resolution are desired. Or they should be combinations of potentiometers and fixed resistors if a narrow adjustment range will do. Or they should be only fixed resistors when the desired output voltage and temperature coefficient need not be adjusted.

The fixed resistors used in this circuit should be film or wire-wound types for good long-term stability. A reference-type zener diode, such as the 1N4894, will improve voltage stability still further. All the resistors and semiconductor devices should be thermally coupled to each other for a good transient response to changes in ambient temperature.

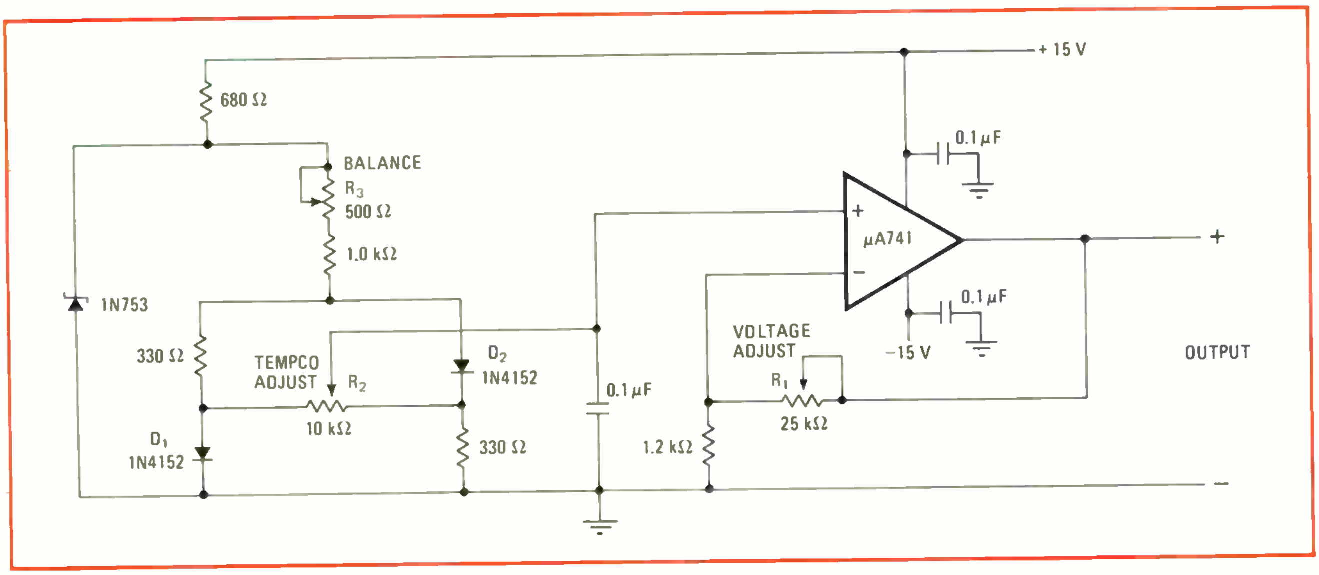
A simple procedure can be followed to adjust the circuit to desired operating conditions. First, set potentiometers R_1 and R_2 approximately at their mid-range positions. Then adjust potentiometer R_3 until the voltage across R_2 is zero at the reference temperature. This is the temperature at which it must be possible to adjust the temperature coefficient without changing the output voltage. Next, position potentiometer R_1 to give the desired output voltage at the reference temperature.

The last step is to adjust potentiometer R_2 for the desired temperature coefficient. This adjustment, which should not affect the output voltage at the reference temperature, can be made by heating or cooling the entire circuit to some temperature other than the reference temperature and then adjusting R_2 to obtain the desired output voltage at that temperature.

As a precaution, the circuit's output voltage should be checked for changing temperature. If it is not within the desired tolerance, repeat all the adjustment steps but the first one. Usually no such repetition will be needed.

More output current can be obtained from this reference voltage source by adding an npn power transistor, wired as an emitter-follower, at the circuit's output. The output from the op amp goes to this transistor's base, and resistor R_1 is then connected to the transistor's emitter, which becomes the circuit output. If the output voltage is negative, a pnp emitter-follower should be used. Without an emitter-follower, the output current can be as large as 10 milliamperes for most general-purpose op amps. □

Stable voltage source. The output voltage of this reference voltage source can be adjusted from 0.7 to 13 volts. And the circuit's output-voltage temperature coefficient is also adjustable, from −0.3%/°C to +0.3%/°C. These two adjustments are independent of each other. Potentiometer R_1 sets the output voltage, potentiometer R_2, the temperature coefficient, and potentiometer R_3, the reference temperature.



Switched frequency doubler provides multiple outputs

by Michael F. Black
Texas Instruments, Systems Analysis Section, Dallas, Texas

Frequency doublers that operate in the vhf/uhf range typically consist of complicated arrangements of saturated amplifiers, tuned circuits, and harmonic-suppression traps. With these circuits, a constant input impedance is usually difficult to sustain with changing temperature. Also, if the doubler must be switched, it is difficult to maintain circuit simplicity and high isolation ratios.

The switched frequency doubler shown here, however, provides high harmonic rejection, as well as constant input impedance, and it requires a minimum of adjustment. The circuit, which consists of a double-balanced mixer followed by a linear amplifier, accepts a 50-megahertz input of 5 dBm. In addition, it has provision for fast on/off switching and multiple 100-MHz outputs to 50-ohm loads.

The input power is split by the two-way power divider, HY1, and applied to the RF and LO ports of the mixer, M1. The mixer output, of course, is made up of several frequencies: twice the input frequency, the input frequency itself, the difference frequency (between the input and the local oscillator), and harmonics.

The difference frequency, which is dc, is shorted by the rf choke (L_1), and the input-frequency component is attenuated by the LO/i-f and rf/i-f isolation of the mixer. Transistor Q_1 is tuned to the doubled frequency, and the high-Q circuit in its collector loop further attenuates the unwanted frequencies to about 50-dB down. Through inductor L_2, the matching structure of this collector loop provides the only circuit adjustment.

Only three 50-ohm outputs are shown here, but more can be added. For each output, two capacitors (C_1 and C_2) transform the 50-ohm load up to a resistance value that output transistor Q_1 can drive satisfactorily. The reactance of inductor L_2 then tunes out the capacitance to present a high-value real load to Q_1's collector at the doubled frequency.

The value of L_2's reactance is:

$$X_{L2} = (1/3)(R_P/Q)$$

where R_P is the load resistance that transistor Q_1 sees, and Q is the circuit's figure of merit. The reactances of the transformation capacitors, C_1 and C_2, are also dependent on R_P and Q. They can be expressed as:

$$X_{C1} = [R_P/(1+Q_2)][Q - [(50/R_P)(1+Q^2) - 1]^{1/2}]$$
$$X_{C2} = 50/[(50/R_P)(1+Q^2) - 1]^{1/2}$$

Circuit Q is selected according to the harmonic rejection required. The higher the value of Q is, the higher the harmonic rejection will be, but the more difficult some component values may become to obtain. For the circuit given here:

$Q = 6$
$R_P = 1.5$ *kilohms*
$X_{L2} = 83$ *ohms at 100 MHz = 0.13 microhenry*
$X_{C1} = 222$ *ohms at 100 MHz = 6 picofarads*

and:

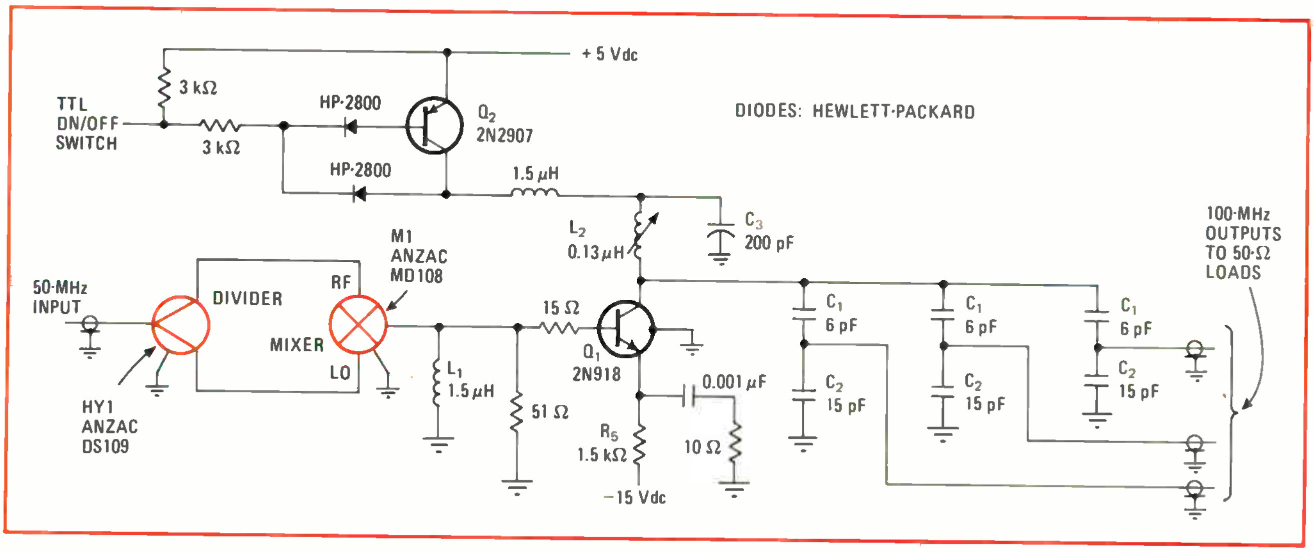
$X_{C2} = 104$ *ohms at 100 MHz = 15 pF*

Each output of the circuit supplies a power level of +3 dBm at a frequency of 100 MHz.

Transistor Q_2 is a nonsaturating switch that is compatible with a TTL open-collector input. Together with its associated circuitry, transistor Q_2 switches transistor Q_1, providing the mutiple gated outputs. Switching times of well under 1 microsecond can be realized when an appropriate value is chosen for capacitor C_3. The circuit's on/off isolation is better than 50 dB. □

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.

Rf frequency doubler. From a 5-dBm input at 50 megahertz, this switched frequency doubler develops multiple 3-dBm outputs at 100 MHz, seen by output transistor Q_1 so that the circuit can handle 50-ohm loads with relative ease. The doubler's only adjustment, inductor L_2, is used to tune out this added capacitance. Transistor Q_2 is used to switch transistor Q_1.



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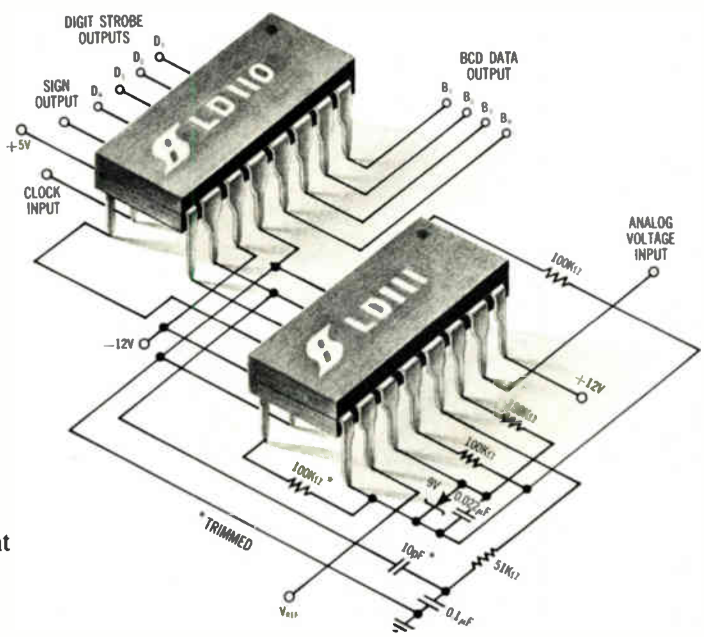

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The unique conversion technique uses a single reference and a single full-scale adjustment to achieve a highly-accurate strobed 3½-digit output of up to 3100 counts plus sign. LD111 analog processor employs monolithic PMOS/bipolar construction and interfaces directly with the LD110 digital processor, which has a monolithic PMOS structure. For further information

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Semiconductor random-access memories

Which of the many RAMs spawned by a fast-changing semiconductor technology is best for which application? This survey relates the capabilities of available and soon-to-be-available device types to the needs of today's memory systems

by Laurence Altman, *Solid State Editor*

☐ No segment of the semiconductor market has grown faster in the last few years than semiconductor random-access memories.

For every RAM-on-a-chip being used in 1972, 50 are being used today. Consumption has gone from 3 million units to over 75 million, adding up to nearly 75 billion bipolar and metal-oxide-semiconductor bits.

Available device types have multiplied from just two—the 1,024-bit dynamic p-channel MOS RAM and the small (64-bit and 256-bit) bipolar array—to at least six distinct RAM types based on a dozen different bipolar and MOS techniques (see table).

Where core once reigned, 70% of new memories are now being designed with semiconductor devices. Applications span every kind of memory system, from the microsecond, micropower requirements of today's terminals and portable memory equipment, through the 100- to 500-nanosecond mainframe and peripheral controller applications, right down to the fastest 20-ns computer buffer and scratch-pad functions.

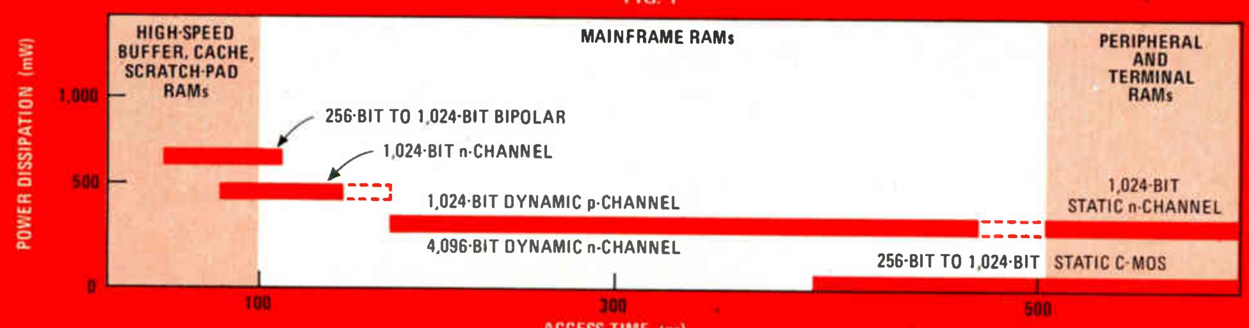
Figure 1 shows the three functional categories:

- Static bipolar and dynamic n-channel 1,024-bit RAMs for very fast scratch pads, buffers, and mainframe memories.
- The old 1,024-bit dynamic p-channel RAMs and the new 4,096-bit dynamic n-channel RAMs for low-cost, medium-speed main memories and as alternatives for peripheral, terminal, and microprocessor applications.
- The new static RAMs—easy-to-use 1,024-bit n-channel MOS and 256- and 1,024-bit complementary MOS arrays—for the small peripheral and terminal systems that often need low power dissipation but almost never high speed.

Scratch pad, buffer, and cache

Only bipolar arrays have a short enough access time to handle the fastest (20 ns) scratch-pad requirement. Moreover, their read time cycle time equals their read access time and does not handicap system speed.

FIG. 1



But for most buffer and cache memory, the 50- to 80-ns reach of n-channel dynamic MOS devices is good enough. Their problem is not access time, which may be as short as in some bipolar RAMs, but cycle time, which is three times as long as the access time and may slow up over-all system speed. Bipolars are therefore better for those cache memories that are cycle-time-limited, as well as for those scratch-pad memories that perform a read/modify/write cycle.

Also troublesome in n-channel RAM system designs is managing the large current transients of about 20 milliamperes caused by power and clock pulses during the memory cycle. These transients are absent in the static, clock-less bipolar devices, and their presence in the n-channel MOS RAMs may require a looser layout that uses up more board space and more design time.

High clock voltage is another n-channel system overhead, and so too are interface logic circuits, whereas bipolar RAMs, being TTL or ECL designs, are automatically compatible with logic. These factors, together with the increasing availability of Schottky TTL, oxide-isolated TTL, and ECL 1,024-bit RAMs, must be weighed against the generally lower power consumption and component costs of n-channel RAMs.

Main memory

As the cheapest way of satisfying medium-speed mainframe and large peripheral controller needs, the new 4,096-bit n-channel RAMs far outdo the 1,024-bit p-channel types. (The very fast mainframe will probably stay with the speedy 1,024-bit n-channel RAM.) Packing four times as much memory as the same size of chip and operating at about the same speed as the p-channel devices, the newer type potentially offers a 4:1 cost-per-bit advantage. The n-channel device also cuts system costs a lot, since its address and data lines interface directly with TTL, it has simple clocking, and it consumes no more power per chip.

Although availability is likely to be spotty till 1975, 4,096-bit chips have already been designed into microcomputers, minicomputers, and add-on systems. At present, the situation is changing almost daily, but three types are vying for industry dominance. To classify them by the company of their origin:

- Intel/TI's 22-pin package, announced by Intel and then modified by TI, uses TTL voltage levels for all address, data-in, and data-out lines; it requires only one high-voltage clock level but needs three power supplies.
- Motorola/AMI's 22-pin package differs in having an extra reset pin, which must be energized when power is first applied.
- Mostek's 16-pin package takes up less board space than the other two, at the cost of some added system complexity in clocking and interface logic, since the device must be multiplexed; it is also TTL-compatible at all inputs, including the clock input.

Perhaps the biggest surprise has been the static

THE RAM FAMILIES

Type	Typical speeds, access/cycle (ns)	Power per chip active/standby (mW)	Applications
Bipolar: 64-to-256-bit ECL / TTL 1,024-bit ECL / TTL	20 – 50 / 20 – 50 60 – 90 / 60 – 90	350 / 350 500 / 500	Computer scratch pads. Buffer memories. Accumulator registers. Control stores. Caches.
1,024-bit dynamic n-channel (7001 and 2205 types)	60 / 180	450 / 60	50-ns caches. Add-on mainframe memory. Buffer memories. In high-speed controllers.
1,024-bit p-channel (1103 or 6002)	300 / 600	450 / 60	Medium-speed mainframe. Add-on mainframe memory. Minicomputer memory. In terminals. In small controllers.
4,096-bit n-channel	200 – 350 / 400 – 700	350 / ≅ 30	Major core replacement. Computer mainframe memory (micro, mini, and 360 types). Also large mainframe, add-on, and fast peripheral memories.
1,024-bit static n-channel (2102 types dash versions)	1,000 / 1,000 500 / 500	350 / 90 350 / 90	Small memory systems. In peripherals. In terminals. Display memory.
C-MOS static 256-bit 1,024-bit	350 / 350 600 / 600	20 / 0.2 (μW) 30 / 0.3 (μW)	In peripherals. In point-of-sale units. In minicomputers, microcomputers, and calculators. In medical instruments, avionics, and portable equipment.

National Battery Co., First National Bank Bldg., St. Paul, Minn.
Philco (Battery Division), Philadelphia, Pa.
Prest-O-Lite Battery Co., 4500 W. 16th St., Indianapolis, Ind.
Solar Corp., 944 W. Bruce St., Milwaukee, Wis.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
USL Battery Corp., 1725 Highland Ave., Niagara Falls, N. Y.
Western Cable & Light Co., Baldwin, Wis.
Willard Storage Battery Co., 246 E. 131st St., Cleveland, Ohio

Belts

DIAL BELTS—see Cable

Breakers

CIRCUIT BREAKERS (for electronic applications)

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Burlington Instrument Co., Burlington, Iowa
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Fenwal, Inc., Ashland, Mass.
General Electric Co., Schenectady, N. Y.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J. (See page 121.)
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Penn Electric Switch Co., Goshen, Ind.
Roller-Smith Co., Bethlehem, Pa.
Spencer Thermostat Co., Attleboro, Mass. (See page 111)
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

Cabinets

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American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio. (See page 163.)
Columbia Metal Box Co., 260 E. 143rd St., New York, N. Y.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
Erie Can Co., 816 W. Erie St., Chicago, Ill.
Falstrom Co., 7 Falstrom Court, Passaic, N. J.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y. (See page 163.)
Karp Products Co., 129 30th St., Brooklyn, N. Y.
Lewyt Metal Products Co., 60 Broadway, Brooklyn, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Par Metal Products Corp., 32-62 49th St., Long Island City, N. Y. (See p. 146.)
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y. (See page 150.)

PLASTICS CABINETS—see Plastics

RECORD CABINETS

Chicago Sound System Co., 2124 S. Michigan Blvd., Chicago, Ill.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
RCA Mfg. Co., Camden, N. J.
Schloss Bros. Corp., 801 E. 135th St., New York, N. Y.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.

WOOD CABINETS

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Castlewood Mfg. Co., 12th & Burnett, Louisville, Ky.
Caswell-Runyan Co., Huntington, Ind.
Chicago Novelty Furniture Co., 1750 N. Campbell Ave., Chicago, Ill.
Churchill Cabinet Co., 2119 W. Churchill St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Illinois Cabinet Co., Rockford, Ill.
Illinois Wood Products Corp., 2512 S. Damen Ave., Chicago, Ill.
Ingraham Co., Bristol, Conn.
Steger Furniture Mfg. Co., Steger, Ill.
Tillotson Cabinet Co., 1775 Broadway, New York, N. Y.
Waters-Conley Co., 501 First St., Rochester, Minn.
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.

Cable

see also Wire

COAXIAL CABLE and LINES

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Communications Products Co., 363 Cator Ave., Jersey City, N. J.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Insulated Wire Corp., 53 Park Pl., New York, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole distributor for Western Electric Co., New York, N. Y.)
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J. (See page 105.)
Lektra Laboratories, 30 E. 10th St., New York, N. Y.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Radex Corp., 1328 Elston Ave., Chicago, Ill.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Simplex Wire & Cable Corp., 79 Sidney St., Cambridge, Mass.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
Western Electric Co.—see Graybar Electric Co.

DIAL BELTS and CABLE

J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Schott Co., Walter L., 5266 W. Pico Blvd., Los Angeles, Cal.

Capacitors

FIXED CAPACITORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass. (See page 122.)
American Condenser Corp., 2508 S. Michigan Ave., Chicago, Ill.
Art Radio Corp., 115 Liberty St., New York, N. Y.
Atlas Condenser Products Co., 548 Westchester Ave., New York, N. Y.
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis. (See page 8)
Condenser Corp. of America, 1000 Hamilton Blvd., South Plainfield, N. J.
Condenser Products Co., 1375 N. Branch St., Chicago, Ill.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J. (See page 19.)
Cosmic Radio Co., 699 E. 135th St., New York, N. Y.
Crowley & Co., Henry L., 1 Central Ave., West Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Electric Co., 34 Hubert St., New York, N. Y.
Eitel-McCullough, Inc., San Bruno, Cal.
Electro-Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Fast & Co., John E., 3123 N. Crawford Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
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General Radio Co., 30 State St., Cambridge, Mass.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
Glyco Products, Inc., 230 King St., New York, N. Y. (See page 134.)
H. R. S. Products, 5707 W. Lake St., Chicago, Ill.
Illinois Condenser Co., 3252 W. North Ave., Chicago, Ill.
Industrial Condenser Corp., 1725 W. North Ave., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Magnavox Co., 2131 Beuter Rd., Fort Wayne, Ind.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Scintilla Magneto Engrg Co., 379 Phillips Ave., Toledo, Ohio
Sickles Co., F. W., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J. (See page 131.)
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

COMPRESSED GAS CAPACITORS

Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.

VARIABLE RECEIVER TUNING CAPACITORS

Alden Products Co., 117 Main St., Brockton, Mass.
American Steel Package Co., Squire Ave., Defiance, Ohio
Barker & Williamson, Ardmore, Pa. (See page 138.)
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio. (See page 163.)
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y. (See p. 21.)
De Wald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass. (See page 158.)

1,024-bit n-channel MOS RAM, sales of which are growing fastest of all RAMs. Introduced by Intel two years ago, it is now supplied by several other manufacturers, and 10 million units could well be sold this year.

The static MOS RAM comes to life

MOS memory designers originally switched to dynamic cells to escape the slowness and largeness of static memory. But silicon-gate n-channel processing raised speeds and reduced size enough to revive interest in simpler-to-use static designs.

That interest has swelled, because the 1,024-bit statics operate from single 5-volt supplies, are directly compatible with bipolar logic, and dissipate relatively little power when operating (though dc power drain is fairly high). Also, the latest designs are getting faster—down from 1 microsecond to 500 ns and below—and this will increase penetration into some small mainframes. Primarily, though, the static n-channel RAMs are for small (16-kilobyte) peripheral memories, where high speed is not needed but low system overhead is.

The newest RAMs are C-MOS devices, today generally at the 256-bit level of integration, by year's end possibly at the 1,024-bit level. Their chief attractions are low power dissipation (particularly their microwatt standby power), high noise immunity, and high power-supply tolerance, all of which makes them useful outside the traditional computer market in industrial and portable equipment. At 10 cents a bit, they're expensive, but cost will drop with experience and volume.

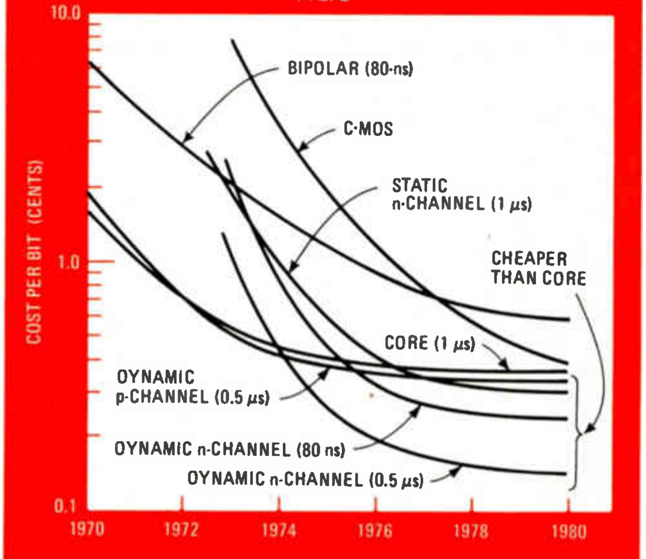
Moreover, many foresee the C-MOS RAMs proliferating throughout the computer memory hierarchy as they're improved by, for example, the use of insulating substrates like sapphire, which boost speed and increase chip packing density. And the prospect of power-supply-insensitive, noise-immune 1,024-bit and 4,096-bit static C-MOS-on-sapphire RAMs, operating off 5 V at speeds below 100 ns, is very appealing.

What it all costs

Finally, what's happening to that all-important parameter—cost? Figure 2 charts the trends in semiconductor memory costs (core cost is included for comparison). Clearly, today's semiconductor memory products are in the high-growth sharp-cost-reduction part of their cycle. Even so, the 1,024-bit n-channel statics and the just introduced 4,096-bit RAMs are already priced below core, and the 1,024-bit n-channel dynamic products should join them in 1975.

Indeed, the 4,096-bit devices are expected to approach 0.1 cent per bit in the next few years—an encouragement to designers, who have been watching the fraction of total system cost due to memory climb steadily and so far irreversibly to about 40%. □

FIG. 2



MEMORY-SYSTEM COST PER BIT FOR VARIOUS TECHNOLOGIES

Source: Intel

Glossary

A random-access memory, or *RAM*, is one in which any data word of information may be accessed in any order. Semiconductor RAMs are always *read/write*—you can enter or remove data in any cycle. Semiconductor read-only memories, or *ROMs*, on the other hand, may or may not be read/write, but they are always random-access. Both should be distinguished from *serial* memories, like shift registers, first-in first-outs, and so on, where bits can be accessed and recycled only serially. *Cycle time* is the time it takes to complete an operation. In a cycle you can *access* data (read), *enter* data (write), read and write, and *update* or *modify* the state of a memory location. While cycle times of *dynamic* MOS memories are always longer than access times, a bipolar memory's cycle time is about the same as its access time, because it is *static* and requires no *refresh*—a program is entered only once and can be updated but need not be refreshed. Static MOS memories have the same advantages but are much slower than dynamic MOS memories, which, however, must be refreshed about every 2 milliseconds and therefore need *refresh clocks*, as well as additional power supplies.

SOME MORE READINGS

For an in-depth look at where and how LSI RAMs are being used in systems, see two *Electronics'* Special Reports by L. Altman, Solid State Editor (Aug. 28, 1972, p. 63) and W. B. Riley, Computers Editor (Aug. 2, 1973, p. 75). Economic advantages are analyzed in an IEEE Intercom '74 paper by Intel Corp.'s A. C. Markkula Jr., "Semiconductor Memory Costs: Present and Future," while the system designer is helped in another Intercon '74 paper, "Perspectives of Semiconductor Memory from the System Viewpoint," by Burroughs Corp.'s J. Reese Brown Jr. Finally, several chapters in "Large- and Medium-Scale Integration" deal with RAM processing and applications. Edited by *Electronics'* Executive Editor, S. Weber, the book has just been published by McGraw-Hill Book Co. for $15.

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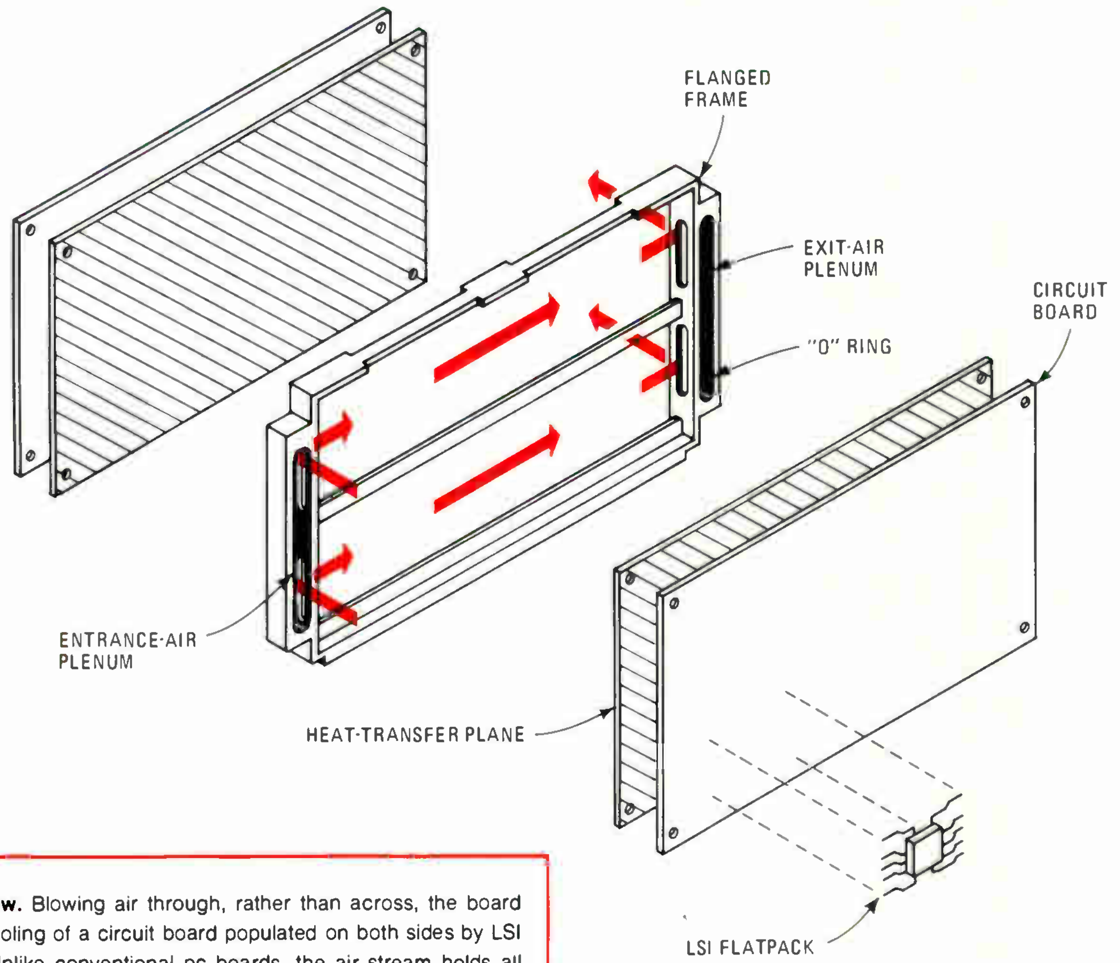
ANALOG DEVICES

THERMAL DESIGN PART 7

Air through hollow cards cools high-power LSI

Providing parallel flow through hollow-core cards and wafer-mounted heat exchanger can cut temperatures at no cost in space

by Lou Laermer, *Singer Co., Kearfott Division, Wayne, N. J.*

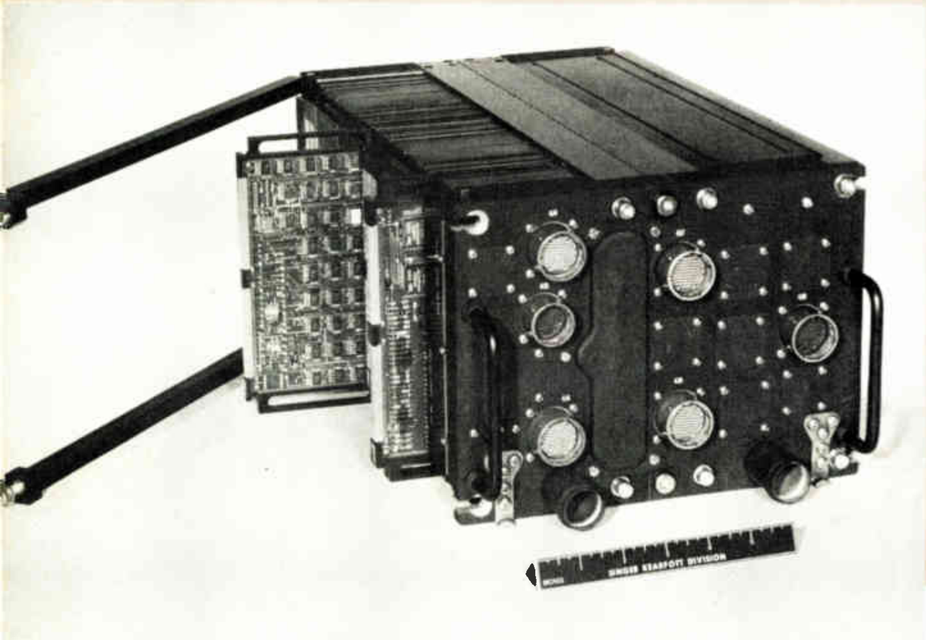


1. It's hollow. Blowing air through, rather than across, the board optimizes cooling of a circuit board populated on both sides by LSI packages. Unlike conventional pc boards, the air stream holds all components near the same temperature.

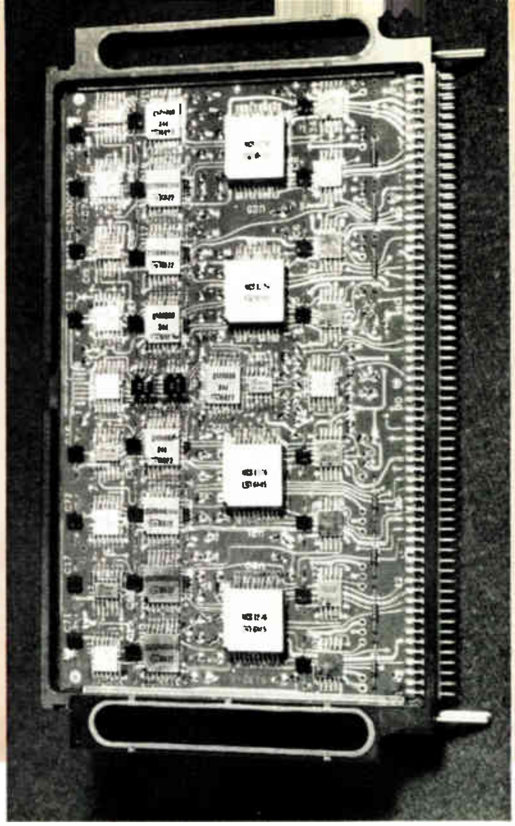
☐ Circuit designers are excited about the tremendous functional capability of LSI, and they are constantly trying to increase the number they can pack on each printed-circuit board. However, dense packing of thousands of active, heat-producing devices on a square inch of circuit card places an awesome burden on the packaging engineer.

Traditional cooling methods are becoming increasingly inadequate, especially with densely packed high-power LSI devices, because power density, in watts per cubic inch, is much higher, and thermal paths from the heat-producing devices to the cooling medium are too long. It's not unusual for a logic card of 25 square inches, which once dissipated 2.5 watts, to dissipate 20 W when mounting LSI and MSI devices.

However, thermal paths can be shortened and temperatures of device junctions held well below safe values by using a patented hollow card so that the heat exchanger becomes an integral part of the circuit card. Air circulates through a channel between the two circuit



2. **Potent package.** Airborne computer packs 35 hollow cards containing over 2,500 flatpacks. Total power dissipated is over 400 watts, but device temperatures never climb above 75°C, thereby enhancing long-term reliability. Slots shown in the top and bottom of the cards form the entry and exit air plenums.



3. **Anatomy.** Packing over 60 LSI flatpacks, this card dissipates over 20 watts, almost 10 times more than its conventional printed-circuit-card ancestor. Cool air enters at left and exits from the plenum at right.

cards mounted back-to-back, and results are truly astounding. What's more, the hollow configuration weighs no more than a conventional card cooled in a conventional way.

Better still, thermally, is the basic building-block module (B^3M), which Singer-Kearfott has designed for the U.S. Naval Air Systems Command. The module, which has eliminated the circuit card altogether, lowers the temperature of the IC junction from 141°C to a safe 68°C, while the ruggedized package is easily accessible and easy to interconnect.

Design objectives

Clearly, two factors discourage the conventional design approach: component temperatures are highly dependent upon card location in the chassis, and the temperature rise across the horizontal span of each card is too great because ICs near the center of the card build up intolerable temperatures. (See "LSI turns up the heat," p. 115).

True, a designer could use heat pipes, but they are expensive. A better and cheaper solution is to introduce cooling air at a common temperature to each card and then circulate the air directly through each card. This can be done most effectively by circulating air through a hollow-core card.

The configuration of the hollow-core card provides improved cooling by:

- Eliminating the thermal conducting path across the breadth of the circuit card.
- Replacing series air distribution with parallel air distribution.
- Increasing convection area per circuit card.
- Increasing convection effectiveness.

A design for a hollow-core card that satisfies design objectives for a high-power, high-density system is illustrated in Fig. 1. The assembly is actually a sandwich of two cards, mounted back-to-back on a flanged frame, which separates the cards to create a channel that allows cool air to flow across their rear surfaces. Bonded to the back of each card is a conductive heat-transfer plane, which serves as the convective interface.

The air enters a plenum on the left side of the frame and exits at the right. The reason that cooling air entering the inlet plenums of cards positioned at increasing distances from the air source does not get hotter is that the temperature gradient along the main air-cooling stream, perpendicular to the cards (the left side of Fig. 1), is virtually zero. The transverse flow rate at the entrance to each card is determined by careful selection of the cross-sectional area of the entrance and exit air plenums.

The hollow cards are clamped together by straps between their front and rear panels. The upper pair appears in Fig. 2. The lower straps (not shown) serve as a subchassis that supports the motherboard and the mating connectors for each card.

A close-up of a hollow-card assembly that mounts LSI flatpacks is shown in Fig. 3. Note that gaskets line the edges of the cooling-air entry and exit plenums to prevent air leakage. Besides assuring a uniform temperature at each card-inlet plenum, parallel cooling maintains a virtually constant air-pressure drop, regardless of the number of cards. In the traditional chassis-type heat exchanger, the card interface temperatures increase as cards are added so that the cooling effectiveness falls off

LSI turns up the heat

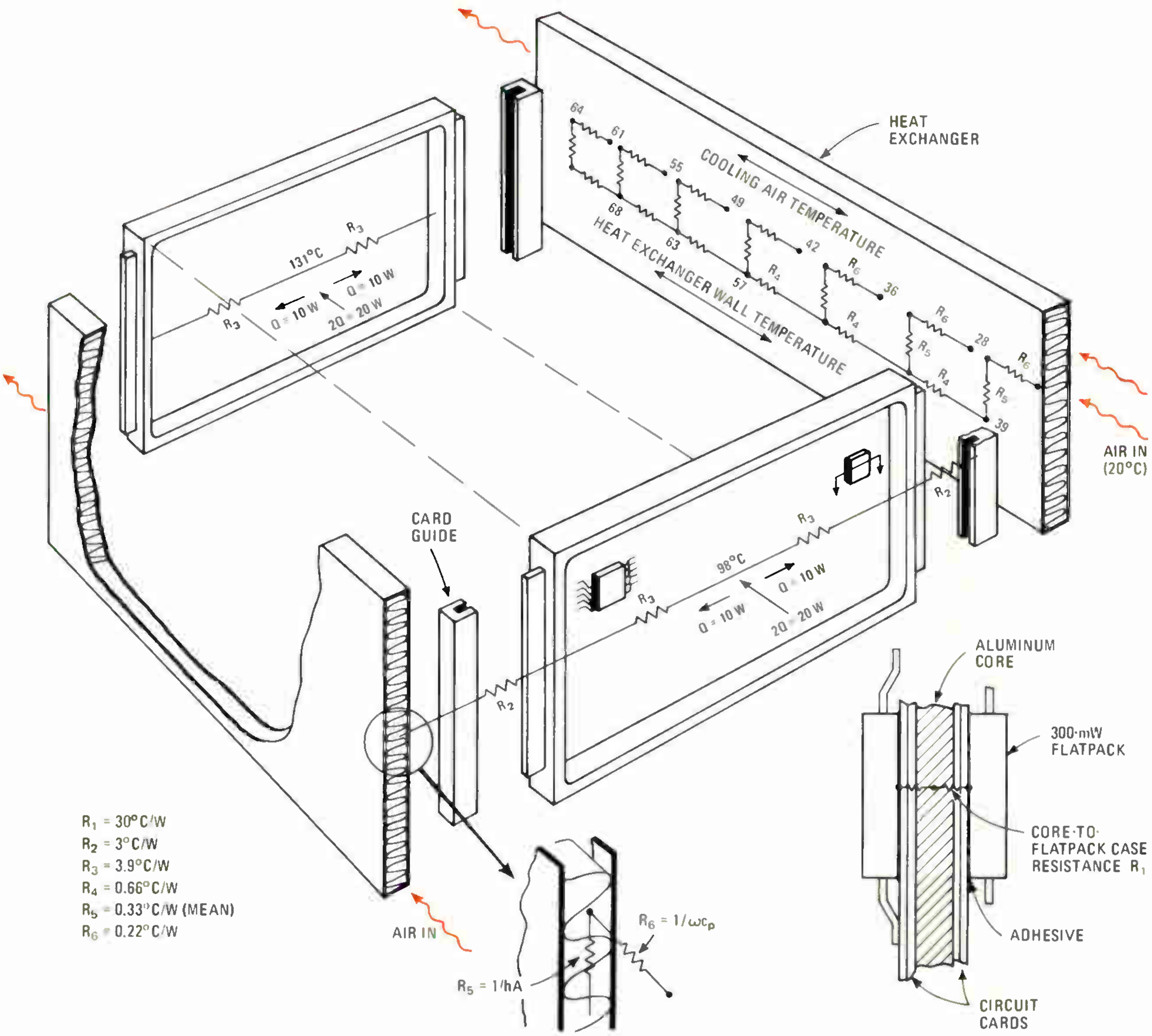
When it was populated by discrete components, the card shown below cooled the circuits on it admirably. But when large-scale integration multiplied the power density to as much as 500 milliwatts per square inch, this configuration could no longer fill the bill. Originally designed for an airborne computer, the chassis contained 35 cards that dissipated a total of 85 watts. A power supply raised the burden of thermal dissipation by another 65 W.

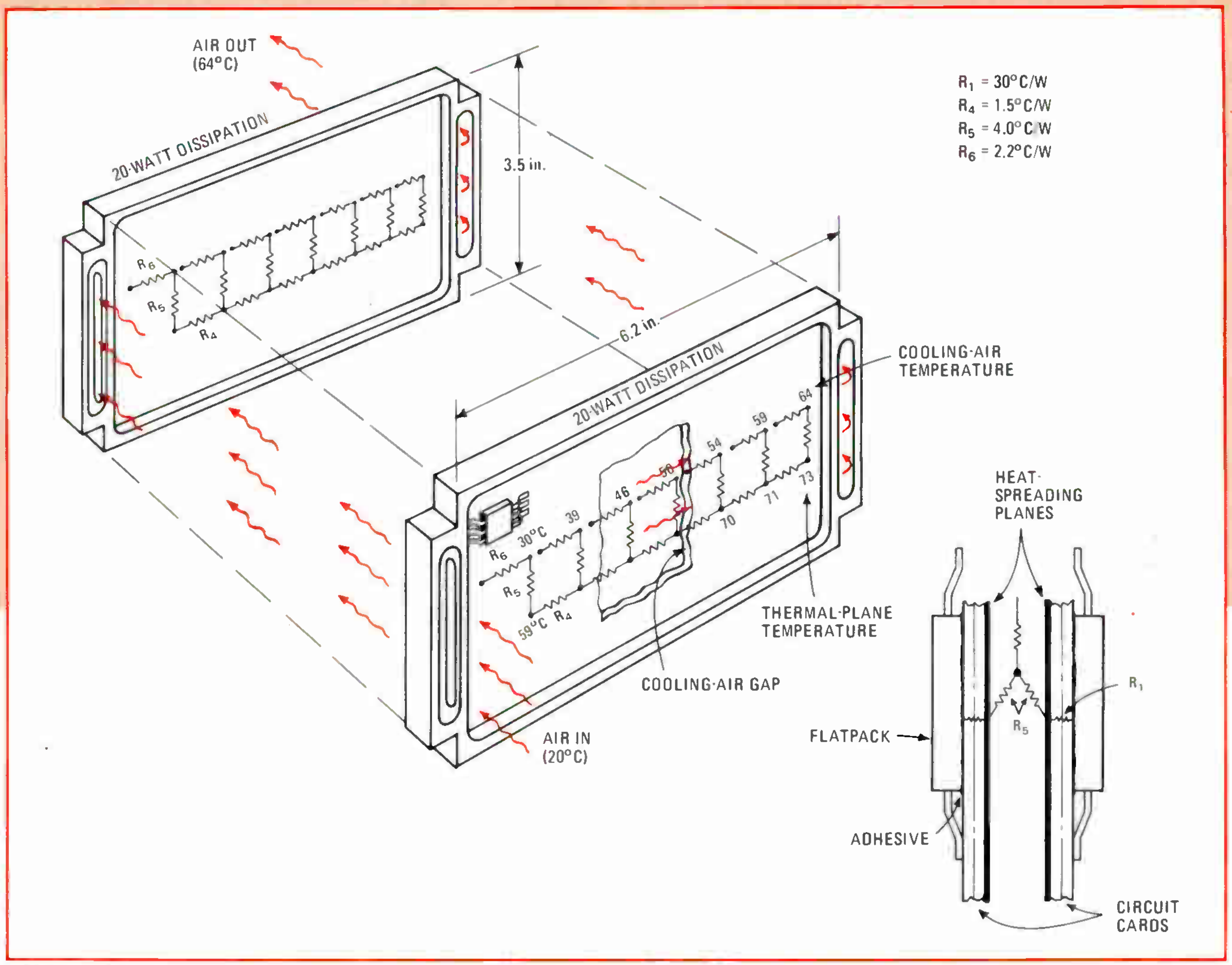
Circuit cards, some built on aluminum cores, conduct heat left and right to the air-cooled heat exchangers, which double as chassis walls. The card guides also serve a vital secondary role—carrying heat from the card to the exchangers. When each card dissipated 2.5 W, the cooling air could keep temperatures below a safe 75°C. However, when each card is packed with 60 LSI flatpacks, each measuring 0.25-inch square, the power on each card is boosted to 20 W, which drastically increases the amount of heat that must be dissipated.

If cooling air at 20°C is forced through the exchangers at three pounds per kilowatt, the temperatures at various points in the chassis will reach the temperatures assigned to the node points in the illustration. There is a colossal rise of 49°C laterally across the card. Although the edge temperature is only 39°C, the center of the near card is 98°C. The temperature of the last card at the rear, near the outgoing air, rises to 131°C—well above the tolerable levels for long-term IC reliability.

A designer could improve heat flow in the existing design by increasing the card-core thickness and by using a wedge-type card clamp, which would improve thermal conductivity. But this effort won't lower IC temperatures very much. Even a tripling of the card-core thickness fails to lower maximum IC temperatures below 92°C— too high for long-term reliable operation. Moreover, thickening the card is a costly tradeoff because it doubles the card weight and enlarges its volume by 30%.

Fortunately, the hollow-core card and the basic module with its integral exchanger are breakthroughs in thermal architecture. They both enable cooling air to circulate effectively and thereby provide the parallel air to hold densely packaged LSI devices at low operating temperatures.





4. Flow path. Entrance air at 20° C distributes to each of the cards and exits at 64° C. Air temperature at entrance plenums of all cards is virtually the same. Circuits depict thermal paths. Resistor R_5 accounts for the thermal resistance of the convective interface.

as the distance from the air intake increases.

The hollow card successfully lowers component temperatures below what is obtainable in conventional designs. Using a design rule of three pounds per minute of cooling air per kilowatt, a card dissipating 20 W is allocated 0.06 lb of cooling air. As shown in Fig. 4, the air's exit temperature is 64°C if the inlet temperature is 20°C. The circuit card's thermal-plane temperature range is from 30°C to 64°C, and maximum and average component-case temperatures are 82°C and 74°C, respectively.

Table 1 compares case temperatures and indicates that the hollow card provides significantly lower component temperatures because the hollow region assures that cooling air is brought within close proximity of the heat-dissipating devices.

Convection efficiency increased

As an additional benefit, the geometry of air-core cards boosts convection efficiency. The convection coefficient, which is a function of air speed, rises because the shortened cooling path speeds air flow through the hollow card and also prevents buildup of a static boundary layer, which hinders heat transfer. The path in the air-core card is 6 inches long, compared to 15 in. for the conventional card.

Finally, the surface area of the hollow card presents 20% more convective area to the moving air stream than does conventional designs. If cooling is still inadequate, a designer can furthur enlarge the convective area by adding fins along the surface. A finned exchanger becomes practical when the power dissipation per card exceeds 25 W, not unusual in power supplies.

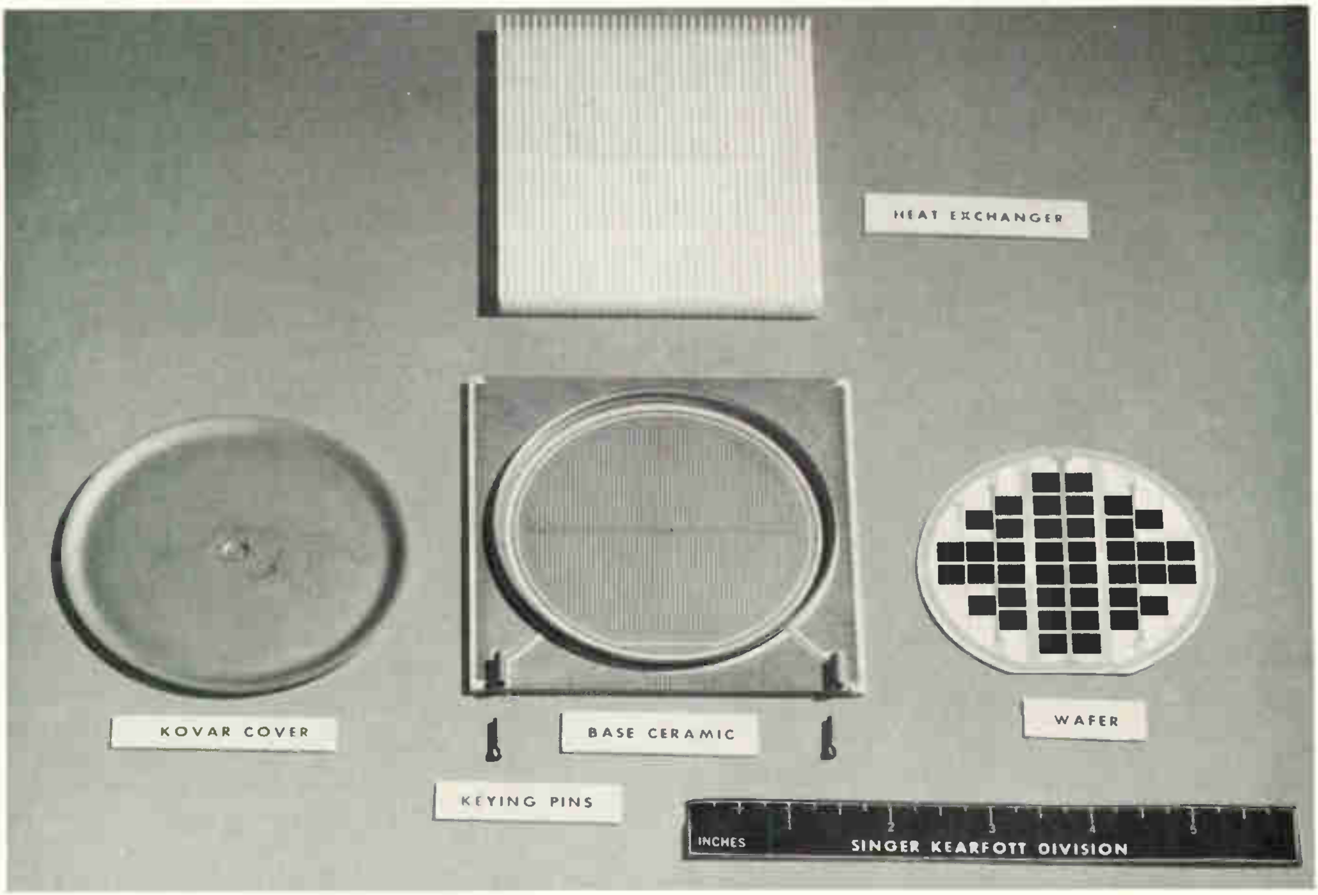
A system approach

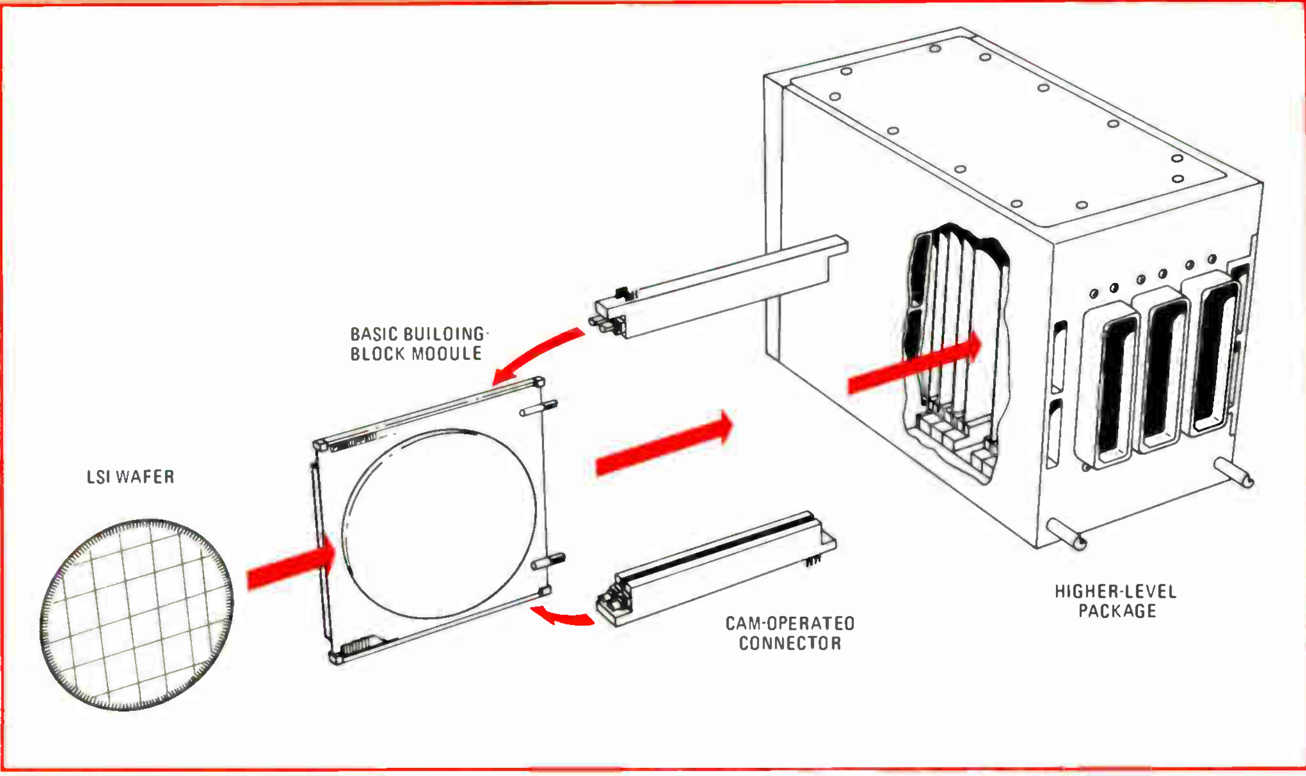
Efficient as the hollow card is, one more improvement can be made. That's to reduce the resistance of the path from the chip to the thermal plane of the card.

In the LSI flatpack, junction-to-case thermal resistance ranges from 20°C/W to 75°C/W so that if a package dissipates 300 milliwatts, the junction temperature rises 6°C to 22°C above the case temperature. Junction-to-case thermal resistance is a major contributor to temperature rise, and if not lowered, can be a significant factor in loss of reliability.

Improving the thermal path within the flatpack is difficult because effective heat transfer depends heavily on a lateral spreading effect as the heat moves from the device junction toward the interface between the package and the circuit board. Attempts to improve heat flow by selecting a better thermal conductor or a thinner sub-

5. A cool wafer. Efficient thermal package houses a 3-inch LSI wafer (a). Component parts (b) include an alumina or beryllia heat exchanger that fastens directly to the base ceramic, optimizing cooling. Substituting more costly beryllia enhances thermal conductivity by a factor of 12.





6. Full-wafer packaging. This airborne computer houses modules containing 3-inch wafers, doing away with the printed-circuit-card construction and holding device junctions below 68° C. Cam-operated connectors eliminate engagement force. At 400 W, higher-level package dissipates almost three times the power of an earlier computer—with no increase in package volume.

COMPONENT CASE TEMPERATURES – 20 WATT CARD		
	Hollow card (°C)	Conventional card (0.05-in. aluminum core) (°C)
Maximum IC case temperature	82	131
Average IC case temperature	73	115
Cooling-air temperature rise	44	44
Flow rate 3 lb/minute per kW — 20°C inlet air temperature		

strate material seldom lower thermal resistance very much. The problem requires a novel solution.

Extraordinarily potent in its ability to lower junction temperatures is the structure shown in Fig. 5(a). This package, the B³M, offers junction temperatures 23% lower than even the hollow card, and it can dissipate as much as 50 W. What is so unusual about this package is that it does away with the circuit board by marrying a heat exchanger directly to the active IC devices.

The (B³M) stems from a development program sponsored by the U.S. Naval Air Systems Command for the all-applications digital computer, designed to fulfill military and space requirements that are now anticipated for the latter part of this decade.

The module is designed to hold an LSI wafer 3 inches in diameter that has a complexity equivalent to more than 5,000 gates. Alternately, it can house a hybrid substrate 3 in. in diameter that contains a multiplicity of LSI chips and passive devices mounted on a multilayer thick-film substrate.

The key to the excellent thermal capability of this module is the ceramic heat exchanger shown in Fig. 5(b). The heat exchanger cements directly to the alumina-base ceramic, ensuring a very short thermal path from the chip to the cooling air stream. Interrupted fins can also be used to prevent static air boundaries from forming, and the reward is a high film-convection coefficient.

Substituting more-costly beryllia for alumina in the heat exchanger lowers thermal resistance still more—by a factor of 12—thereby lowering junction temperatures another 8°C. The combination alumina-beryllia heat exchanger lowers the lateral resistance so that hot spots are less likely to develop on the chip.

Singer-Kearfott's higher-level package, made up of basic building-block modules, is shown in Fig. 6. Airflow paths are much like those shown in Fig. 1. Air flows from left to right through the heat exchanger channels on each module. Again, flow rates and inlet-air temperature are independent of card placement, offering the designer great flexibility in arranging the configuration.

The basic module circulates cooling air where it belongs—in intimate contact with the IC. Doing away with the circuit card lowers IC-junction temperatures approximately 20°C. If one applies the rule of thumb that each 10°C of lower temperature doubles the mean time between failures, the life of each IC has been lengthened by a factor of 4. Such an enhancement clearly supports the role of sound packaging design in the development of high-power-density electronic systems. □

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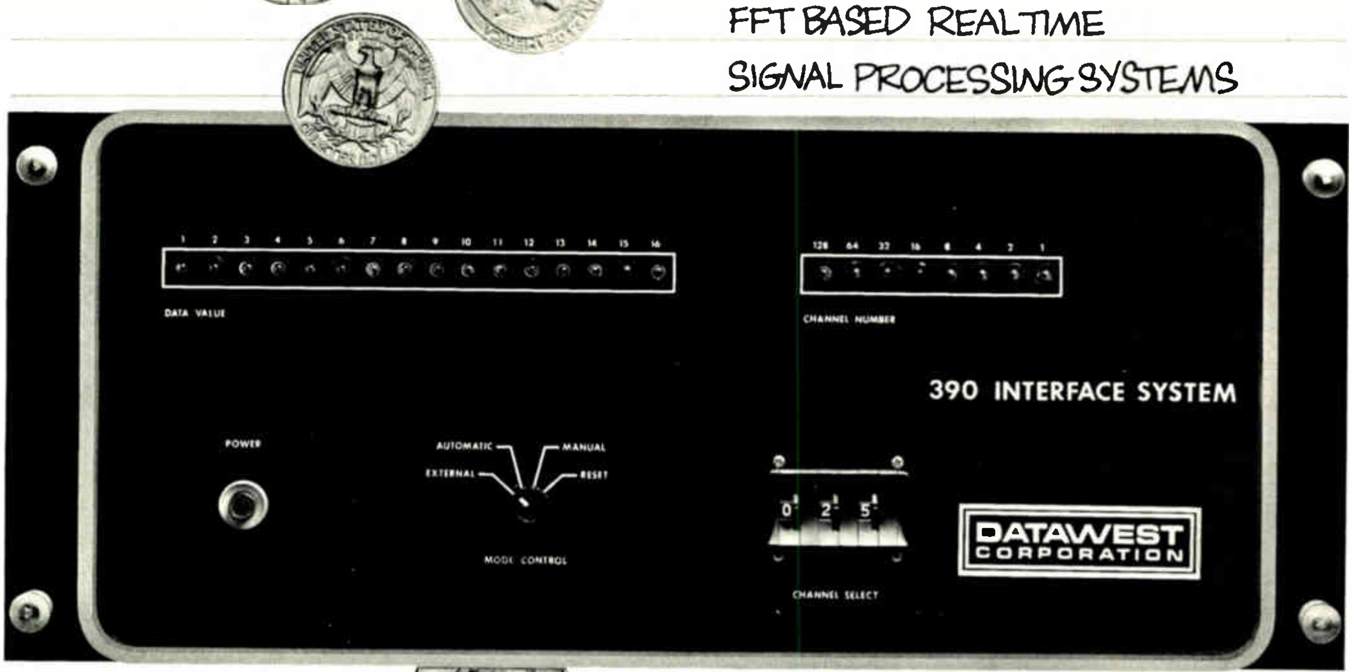

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Circle 121 on reader service card

Probing system noise from hertz to megahertz

By Clarence Lundy
California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.

Since an electronic system is often an assembly of interconnected subassemblies, unplanned noise-coupling paths that degrade the performance of the system are frequently created. The engineer who tries to trace these unwanted noise paths needs some way to measure unbalanced currents in signal cables.

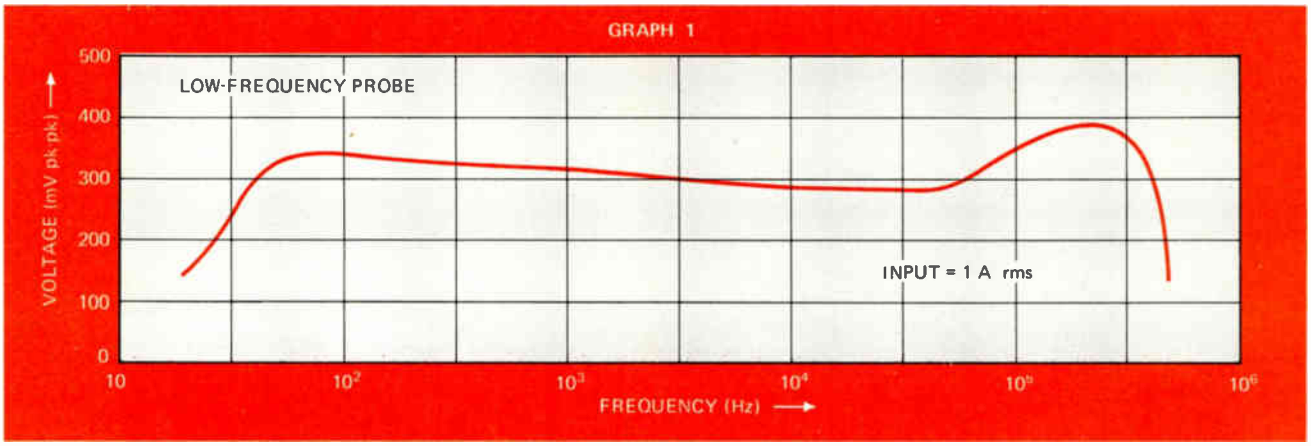
Three probes make it easy to measure the wide frequency range of noise signals that may plague the operation of an installation. One probe is useful from 30 hertz to about 400 kilohertz, another probe discriminates against power frequencies and operates from a few kilohertz to about 400 kHz, and the last probe is sensitive in the megahertz region. None of these probes responds to balanced currents, which generally do not cause any noise.

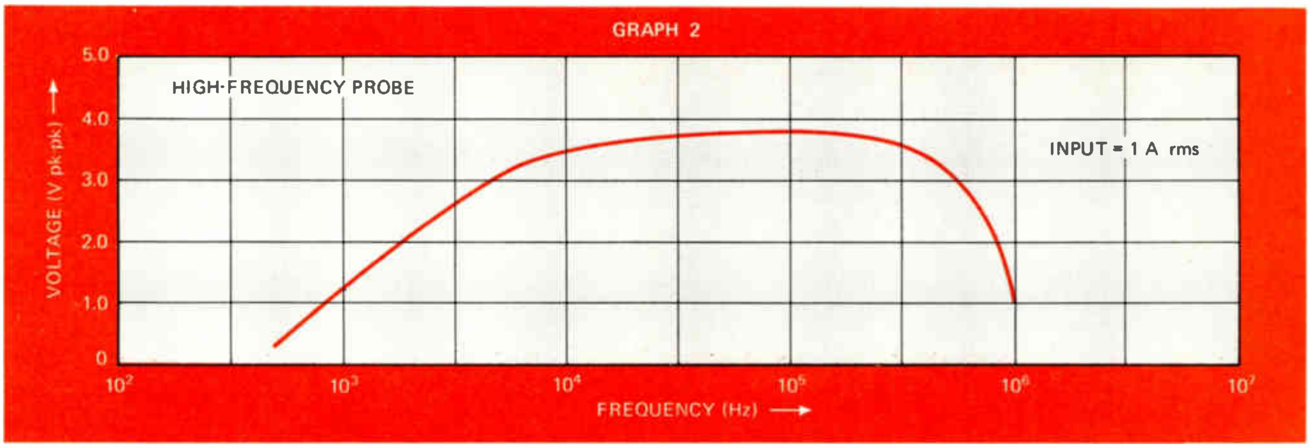
The low-frequency probe is a modified clip-on ammeter—in this case, the Amprobe RS-1, which is a direct-reading ammeter for measuring currents from about 2 to 100 amperes. Auxiliary scales enable the unit to read voltage when a pair of test leads is added, but these scales are not used after the modification. The modified ammeter gives a satisfactory oscilloscope display of any current from 1 milliampere to 100 A, and its own current scales can still be used when the ammeter is employed for normal service.

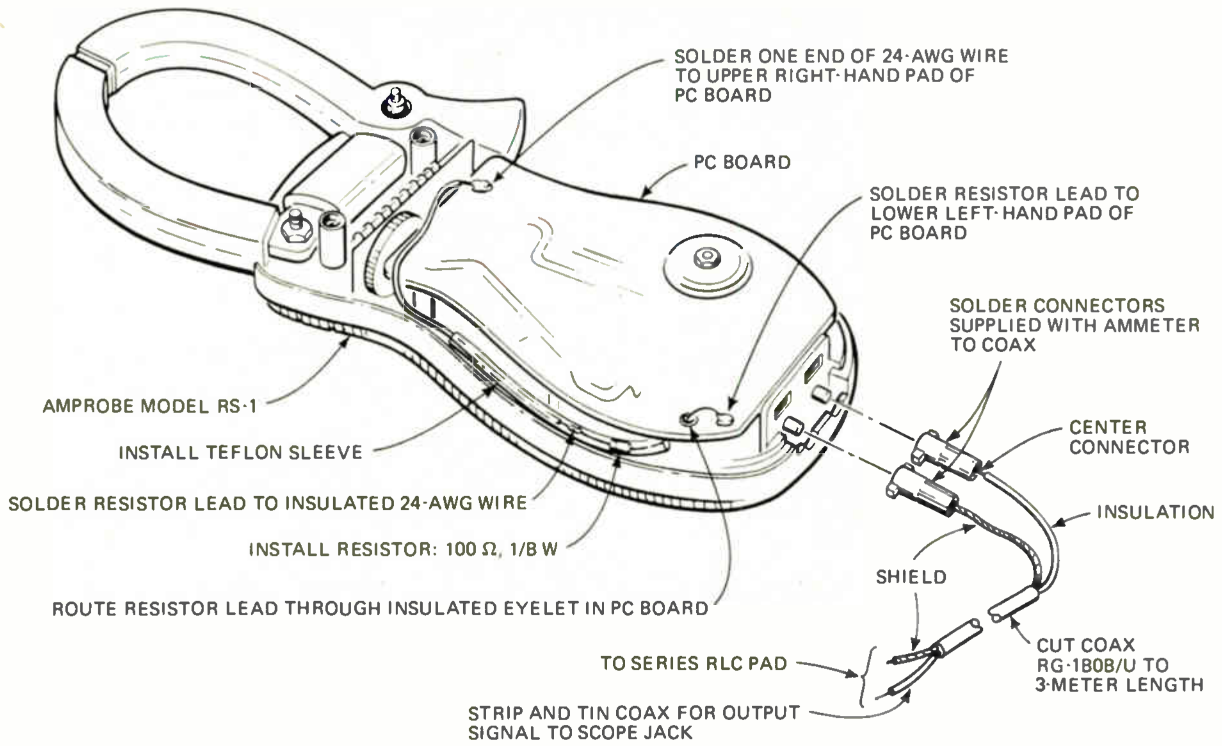
Figure 1 shows the modified ammeter. First, remove the back of the unit by taking out the two deeply countersunk plastic screws. These may be removed by cutting a screwdriver slot in each or making a thin-walled deep socket wrench by forming a piece of tin around a quarter-inch Allen wrench, fastening it with a twist of wire, and sliding it down to project a quarter-inch beyond the end of the wrench.

Next, add a 100-ohm ⅛-watt resistor to the instrument's printed-circuit board. This resistor is used only as a fuse; it will burn out and save the instrument from damage if someone tries to use the meter to read voltage. If this precaution is not considered necessary, a wire can be run directly from the upper right-hand pad of the pc board to the lower-left-hand pad on the pc board. Now, the cover can be put back on. But be sure to mark the instrument plainly to show that it can no longer be used to read voltage.

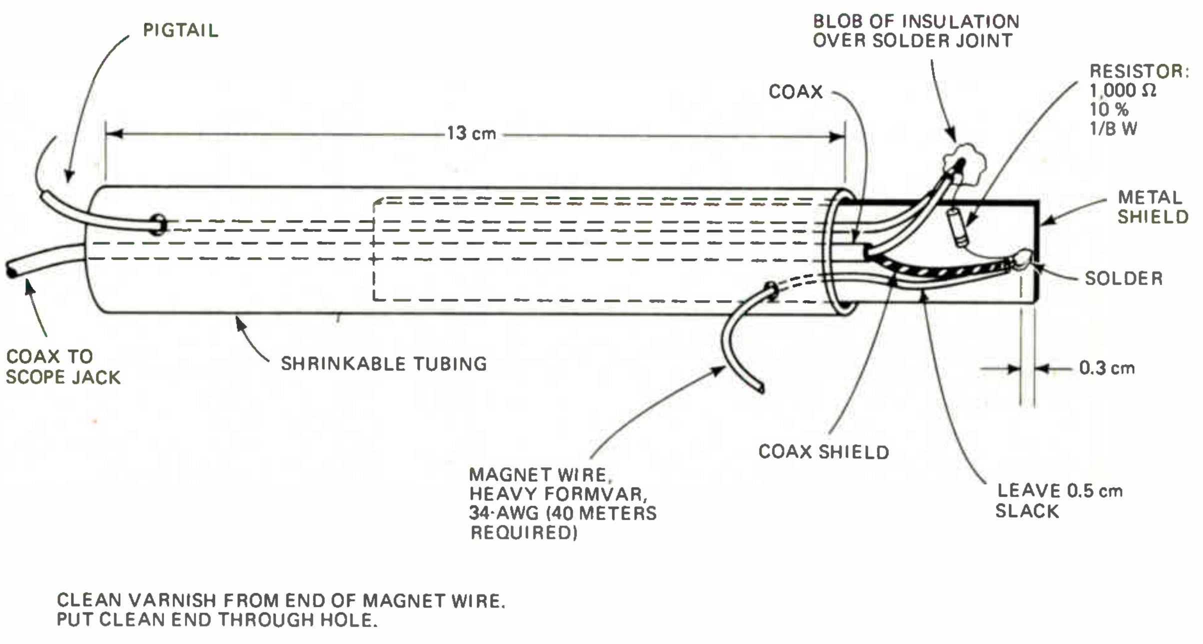
The ammeter comes with a pair of voltage-test leads that are terminated with connectors. Remove the fe-







1. Low-frequency probe. When set on its voltage scale, a modified direct-reading ammeter makes an excellent probe for tracing noise signals occurring at frequencies from about 30 hertz to 400 kilohertz. The voltage response curve of this unit is shown in Graph 1.



2. High-frequency probe. Operating from a few kilohertz to around 400 kHz, this probe is particularly good for sensing high-frequency noise, even if it is buried amid large-level power frequencies. The probe consists of a long 1,000-turn coil wound on a thin soft-iron core. A damping resistor spoils resonances, and a coaxial cable brings the signal to an oscilloscope. The final assembly is bent into a U-shape. Graph 2 shows this probe's voltage sensitivity. For noise signals having even higher frequencies—from approximately 300 kHz to 10 megahertz—an ordinary flat ferrite-core radio antenna can be modified slightly for use as a noise probe.

male connectors and attach them to one end of about 3 meters of miniature coaxial cable. On the other end of the coax, attach a pad made up of a series RLC network—a 2.2-millihenry inductor coil (such as the J.W. Miller 70F223A1), a 470-ohm resistor, and a 4.7- or 5-microfarad capacitor.

One end of the coil goes to the coax's center conductor, and the free end of the capacitor is grounded to the coax's shield. (A miniature electrolytic capacitor is adequate.) The three parts used for the pad, along with an appropriate oscilloscope jack, can be conveniently placed in a separate compact box. The voltage response of the finished probe is shown in Graph 1.

The second probe is about 10 times as sensitive as the low-frequency probe, but only to higher-frequency signals. This probe is especially useful when a large-level power-line signal obscures a high-frequency signal.

Figure 2 shows the first stage of construction. A metal core measuring about 12 by 2 centimeters is cut from 0.15-cm-thick magnetic foil. The preferred stock is Hypernom, an alloy that is similar to Permalloy, but sustains less damage from bending. If handled gently, Permalloy can serve as well, or a piece of a tin can is equally good for measuring signals from 10 kHz to 400 kHz.

The next step is to solder to one end of the core a 1,000-ohm resistor, the shield of a piece of miniature coaxial cable about 3 meters long, and the start of approximately a 40-meter length of magnet wire. A pigtail of hookup wire (15 cm long) is laid beside the coax, and one end is soldered to the center conductor of the coax and to the free end of the resistor. This solder joint must be insulated from the core.

A piece of shrinkable tubing or a layer of vinyl tape is now used to form a cushion over the core. The free end of the pigtail of hookup wire must be left exposed. Then 1,000 turns of the magnet wire, one end of which is already grounded to the core, is bank-wound in one pass over the plastic. This can be done by hand. The other end of the magnet wire is soldered to the pigtail.

Finally, a plastic jacket is added, and the entire assembly is bent into a U-shape. The far end of the coax is provided with a connector that matches the input of the oscilloscope being used. When the core is Hypernom, the finished probe has the voltage-sensitivity characteristic shown in Graph 2. The curve droops more sharply on the left if the core is fabricated from part of a tin can.

The third probe, for tracing signals with frequencies from 300 kHz to 10 MHz, is simpler to build. It is an ordinary ferrite-core antenna, shunted by a 1,000-ohm resistor. A little flat antenna, like one for a pocket-size transistor radio and intended to be tuned with a 365-picofarad capacitor, is best (for example, J.W. Miller 2001 or 2004). The probe can be connected to either an oscilloscope or a high-frequency voltmeter by means of short open leads. To test for signal radiation, with this probe is simple—just hold the probe against the cable being checked. □

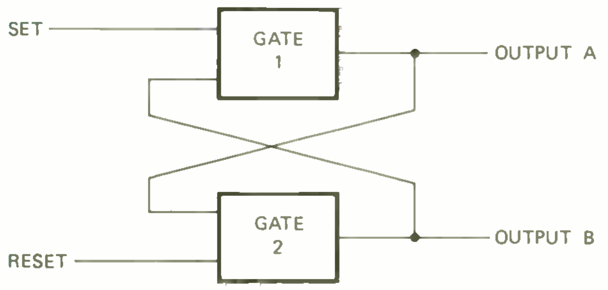
Another way to build a two-gate flip-flop

by Donald P. Martin
Martin Research Ltd., Chicago, Ill.

Most logic designers know that a flip-flop may be built with two NAND gates or two NOR gates, but few seem to realize that one AND gate plus one OR gate may often do just as well. This simple substitution can be helpful in minimizing the IC package count for a complex design.

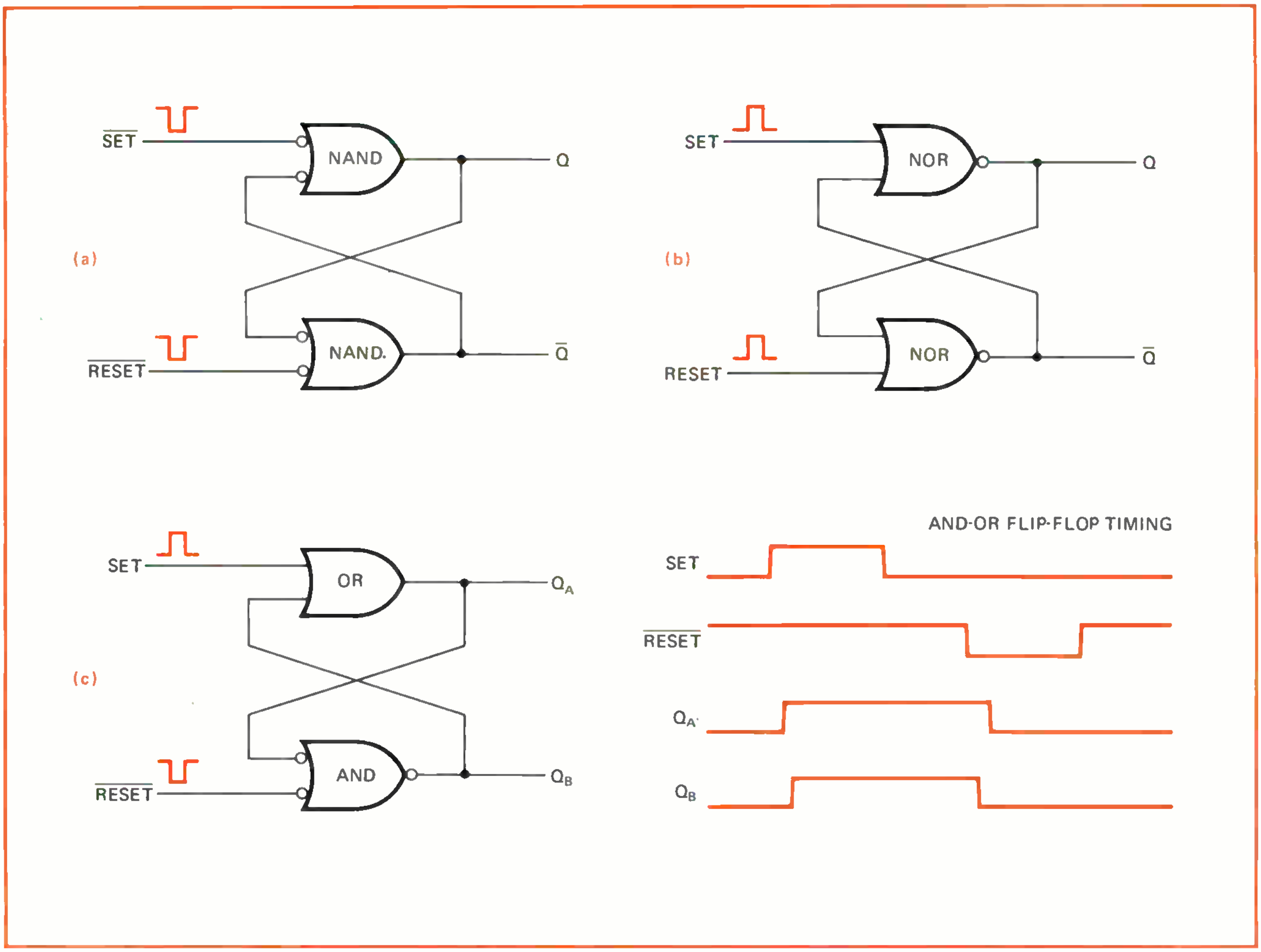
In general, a flip-flop is constructed by taking two two-input gates and connecting one of the inputs of each gate to the output of the other gate (Fig. 1). For proper flip-flop operation, each gate's exceptional input state must be the complement of the other gate's exceptional output state. (A gate's exceptional output state is the logic state that occurs with only one combination of inputs; the exceptional input state is the logic state at both inputs that creates the exceptional output state.)

Figure 2 illustrates the three ways to build a flip-flop—with NAND gates (2a), with NOR gates (2b), or with



GATE	EXCEPTIONAL INPUT STATE	EXCEPTIONAL OUTPUT STATE
NAND	1	0
NOR	0	1
AND	1	1
OR	0	0

1. By definition. For the two-gate flip-flop, one gate's exceptional input state must be the complement of the other gate's exceptional output state. A gate's exceptional output state is that logic state produced by only a certain combination of (exceptional) inputs.



2. Three choices. A flip-flop can be made from two NAND gates, as in (a), or from two NOR gates, as in (b). A third alternative—one that is particularly handy if you're trying to use leftover gates—is to wire up an AND gate and an OR gate. The resulting flip-flop does not have complementary outputs, nor same-polarity set and reset inputs, but it can help avoid undesirable race-prone situations.

AND and OR gates (2c). (The AND gate is drawn here as an equivalent negative NOR gate so that the operation of the AND-OR flip-flop will be clearer.)

The NAND flip-flop requires negative set and reset inputs, while the NOR flip-flop needs positive set and reset inputs. Each of these flip-flops provides complementary (Q and $\bar{Q}$)outputs. Needless to say, the designer who is trying to use leftover gates can employ an AND gate, followed by an inverter to get a NAND gate, or he can put together an OR gate and an inverter for a NOR gate.

Unlike in the NAND and NOR flip-flops, the set and reset inputs of the AND-OR device have opposite polarities—often very conveniently—and the outputs of this flip-flop are not complementary—sometimes quite inconveniently. Of course, an inverter can be added at one of the outputs to change its polarity.

It should be noted that the AND-OR flip-flop can be particularly useful in race-prone applications. During the set pulse of this flip-flop, the Q_A output rises to logic 1 before the Q_B output even starts to rise. □

Polynomial expansion beats calculator display limits

by Charles Lotterman
Northrop Corp., Electronics Div., Hawthorne, Calif.

Occasionally, when you're multiplying or dividing two large numbers, you will exceed the display capacity of your calculator—even if you have a machine as sophisticated as Hewlett-Packard's HP-45, which rounds off the answer. But, by taking advantage of the way polynomials are multiplied or divided, you can get around this problem.

Any number can be expanded as a polynomial whose base is 1,000. For example, the number 123,456,789 can be written as:

$$123 \times 1{,}000^2 + 456 \times 1{,}000^1 + 789 \times 1{,}000^0$$

Now this number can be manipulated as a polynomial, with the three-digit significant figures of the number being treated as the coefficients of the polynomial.

To multiply two such polynomials:

- Multiply each three-digit group of one number by each three-digit group of the other number in an orderly manner. (Your calculator's constant storage capability will be convenient to use during this operation.) For each multiplication, the digits that fall to the left of the three least-significant digits are carried into the next higher-order term.
- Sum the three-digit terms that produce the corresponding power of 1,000, including all the carry factors from the lower-order terms.
- Arrange the results in ascending order of powers of 1,000 to obtain the answers.

As an illustration of this technique, let's multiply 123,456,789 by itself. The carry terms will be enclosed by parentheses. The problem is:

$$[123\ 456\ 789] \times [123\ 456\ 789]$$

First, each three-digit group of the multiplicand is multiplied by the least-significant three digits of the multiplier:

$$789 \times 789 = (622)\ 521$$
$$456 \times 789 = (359)\ 784$$
$$123 \times 789 = (097)\ 047$$

Then, each three-digit group of the multiplicand is multiplied by the next-most-significant three digits of the multiplier:

$$789 \times 456 = (359)\ 784$$
$$456 \times 456 = (207)\ 936$$
$$123 \times 456 = (056)\ 088$$

Finally, each three-digit group of the multiplicand is multiplied by the most-significant three digits of the multiplier:

$$789 \times 123 = (097)\ 047$$
$$456 \times 123 = (056)\ 088$$
$$123 \times 123 = (015)\ 129$$

The results of each of these multiplications are arranged so that the three-digit groups belonging to the same power of 1,000 can be added together:

			123	456	789
		×	123	456	789
				(622)	521
			(359)	784	
		(097)	047		
			(359)	784	
		(207)	936		
	(056)	088			
		(097)	047		
	(056)	088			
(015)	129				
		(1)	(2)		
15	241	578	750	190	521

The answer, therefore, is: 15,241,578,750,190,521.

A similar technique can be used for division:

- Set up the numbers in the format used for long division.
- Perform a trial division using your calculator's divide function.
- Round the results to a three-digit integer and multiply by the divisor.
- Subtract the results of the multiplication from the dividend. The high-order term of the resulting polynomial must be zero.
- Continue this process—dividing, multiplying, and subtracting, as in long division—until you obtain the desired number of places for the quotient.
- Sum the results for the answer.

A numerical example will make the procedure clearer. We will divide 123,456,000 by 456,000. To keep the computations neat, let X = 1,000. The problem is:

$$\frac{123(X^2)+456(X^1)+000(X^0)+000(X^{-1})}{456(X^1)}$$

The trial division produces:

$$\frac{123{,}456{,}000}{456{,}000} = 270\,(X^0)$$

Proceed now as in long division. Multiply:

$$270(X^0) \times 456(X^1) = 123(X^2)+120(X^1)$$

Subtract:

$$\begin{array}{r} 123(X^2)+456(X^1)+000(X^0) \\ -\ 123(X^2)+120(X^1) \\ \hline 000(X^2)+336(X^1)+000(X^0) \end{array}$$

Divide:

$$\frac{336(X^1)+000(X^0)}{456(X^1)} = 737(X^{-1})$$

Multiply:

$$737(X^{-1}) \times 456(X^1) = 336(X^1)+072(X^0)$$

Subtract:

$$\begin{array}{r} 336(X^1)+000(X^0)+000(X^{-1}) \\ -\ 336(X^1)+072(X^0) \\ \hline 000(X^1)-072(X^0)+000(X^{-1}) \end{array}$$

Divide:

$$\frac{-072(X^0)+000(X^{-1})}{456(X^1)} = -158(X^{-2})$$

Continue in this way until you obtain the accuracy desired. The complete long-division array looks like this:

$$\begin{array}{r} 270(X^0)+737(X^{-1})-158(X^{-2}) \\ 456(X^1)\ \overline{)\ 123(X^2)+456(X^1)+000(X^0)+000(X^{-1})+000(X^{-2})} \\ -\ 123(X^2)+120(X^1) \qquad\qquad\qquad\qquad\qquad \\ \hline 336(X^1)+000(X^0) \qquad\qquad\qquad \\ -\ 336(X^1)+072(X^0) \qquad\qquad\qquad \\ \hline -072(X^0)+000(X^{-1}) \qquad \\ -\ -072(X^0)-048(X^{-1}) \qquad \\ \hline +048(X^{-1})+000(X^{-2}) \end{array}$$

The answer is found from the quotient:

$$(270 \times 1{,}000^0)+(737 \times 1{,}000^{-1}) - (158 \times 1{,}000^{-2})+(106 \times 1{,}000^{-3})$$

or, 270.736 842 106, with a small negative remainder. □

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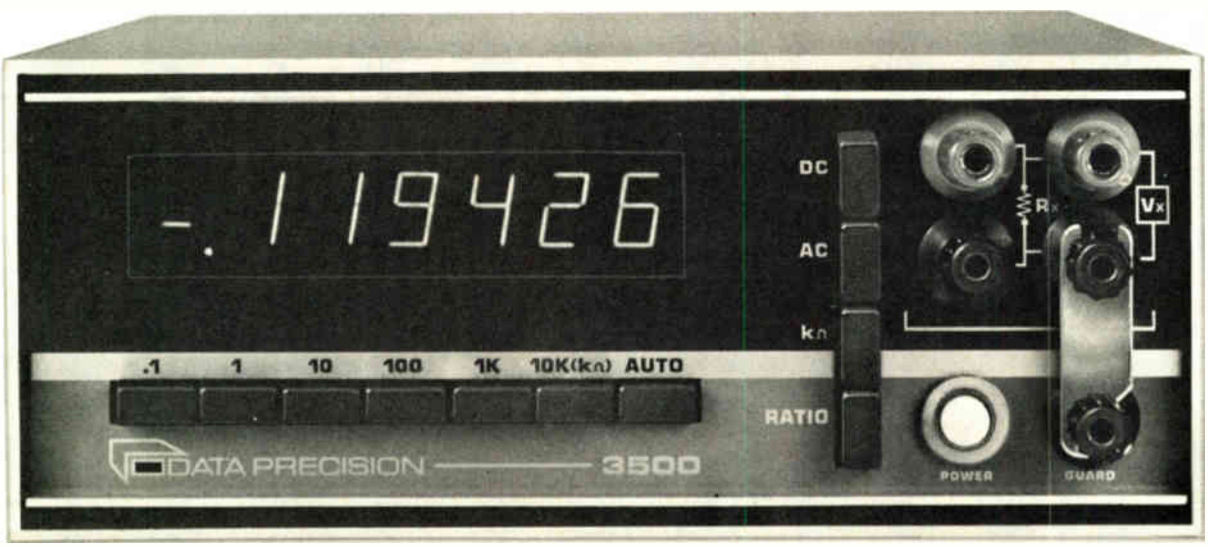


Engineer's newsletter

Microprocessor designs demand tighter logic

Besides cost-saving benefits, microprocessor-based designs have another, less obvious, advantage over equivalent systems built with hardwire logic. Because they need software control, microprocessor designs require the whole system to be analyzed before any portion of the design can be attacked. **The old hardwire cut-and-try piecemeal logic design tricks won't work any more. This forces a designer into more rigorous, iterative methods, with their attendant flowcharts and optimization techniques**, which in the end results in a tighter logic design. The only problem: **you must learn to implement software.**

Etch process pinpoints pinholes

Gaining currency is a chemical etch process for increasing the visibility of pinholes—those tough-to-detect IC yield killers that cause electrical shorts in MOS structures. The wafer's first bathed in a metalization and oxide etch, **then left to soak for 20 seconds or so in a silicon etchant,** basically until the silicon at the bottom of the pinhole is quite clean and will **contrast clearly with the color of its surroundings when viewed under an optical microscope. But some silicon etchants work better than others,** and, according to M. Narayanan, a fabrication specialist at GI's Microelectronics Laboratory, the best he's developed consists of **40 parts nitric acid, 13 parts acetic acid, and 4 parts hydrofluoric acid.**

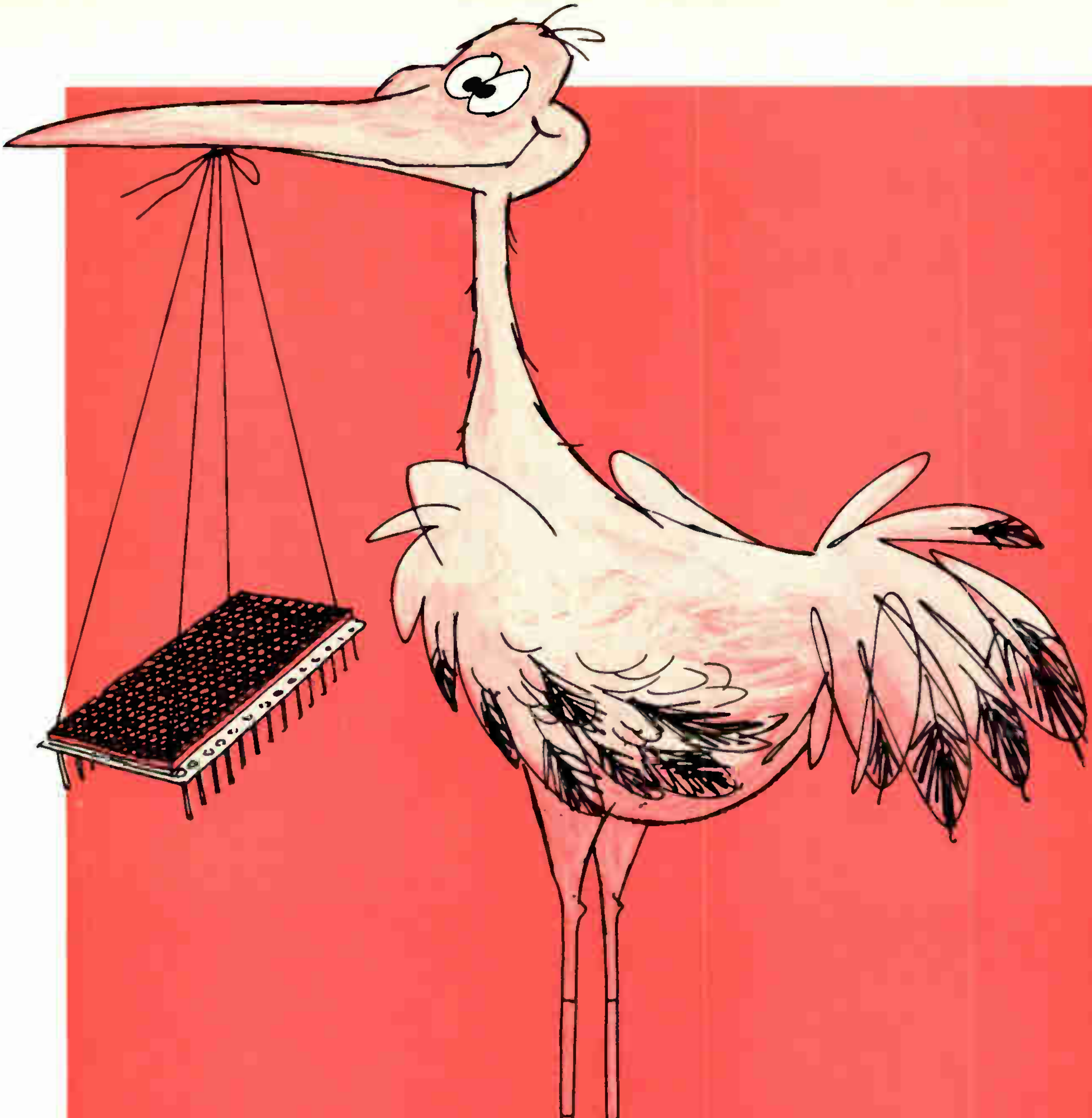
Keep your printed-circuit boards dry

Having unexplained failures with circuits built on glass-epoxy circuit boards? Beware of air-borne moisture, cautions Dale Hileman of Sphygmetrics Inc. in Woodland Hills, Calif. **Moisture is drawn to the matte surface of a glass-epoxy board, where it gives rise to stray conductive paths that can disable any high-impedance circuit.** This not-so-apparent fault can be especially insidious because the equipment may operate normally for months until the weather turns humid and everything suddenly stops working. On a damp day, leakage between adjacent conductors is typically 500 kilohms. Virtual shorts can be created even by condensation produced, say, when a board is brought into a warm room from outside.

A protective coating of rosin, or better yet, of polyurethane will help, but remember to heat the board first to ensure it's dry. Otherwise, moisture trapped between the board and the coating will migrate about the board's surface, making all kinds of mischief in different places at different times. **Also, apply the coating after the components are mounted,** so that adjustable mechanical parts like potentiometers won't become clogged.

New SIPs can be assembled automatically

The newer dual in-line package, because it can be inserted automatically, has long overshadowed the single in-line component for off-chip assemblies. Well, the SIP is making a comeback. **New manufacturing techniques are producing a closer dimensional control over the single in-line package tolerances by allowing the SIP to be molded (like the dual in-line) instead of dipped.** The result: an automatically insertable SIP. In fact, if they hadn't needed hand assembly, SIPs would always have been better than DIPs for most pc board applications—they've **twice the packing density, half the lead length, and take up half the board space.**



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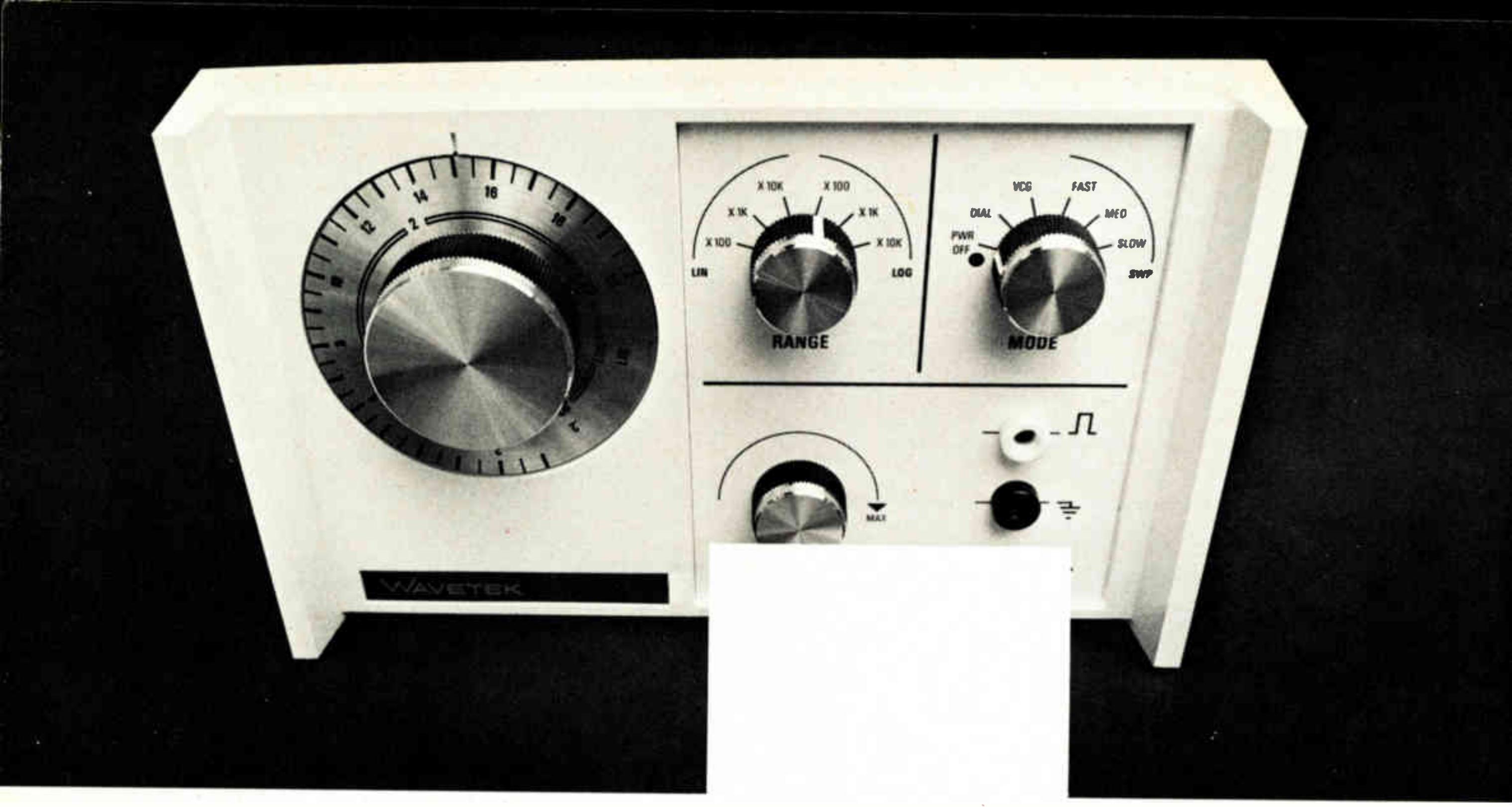
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Multimeter rides piggyback on scope

It not only adds digital measurement capability, but enhances time-interval measurements between points on displayed waveform

by Stephen E. Grossman, Instrumentation Editor

By combining digital and analog functions in highly innovative ways, manufacturers are significantly enlarging the capabilities and the power of instrumentation systems. An instance is one of the latest Tektronix developments. The company has connected a low-profile (1.1 inch high) digital multimeter to its line of portable dual-trace oscilloscopes and thereby added the accuracy and resolution of a DMM to the scope's waveform-display capability.

The 3½-digit (2,000-count) multimeter comes in two versions—with and without temperature-measuring capability—and is offered as a built-in option on the 200-megahertz model 475 and the widely used 100-MHz model 465, as well as on the newer 464 and 466 scopes.

Just as a navigator uses a pair of dividers to measure distances on a chart, the engineer can put the Tektronix piggyback digital multimeter to work measuring time across the screen between selected points on a displayed waveform. Accuracy is within 1%, and resolution is substantially better than that of the bare scope, which provides an excellent technique for measuring critical timing in digital circuits.

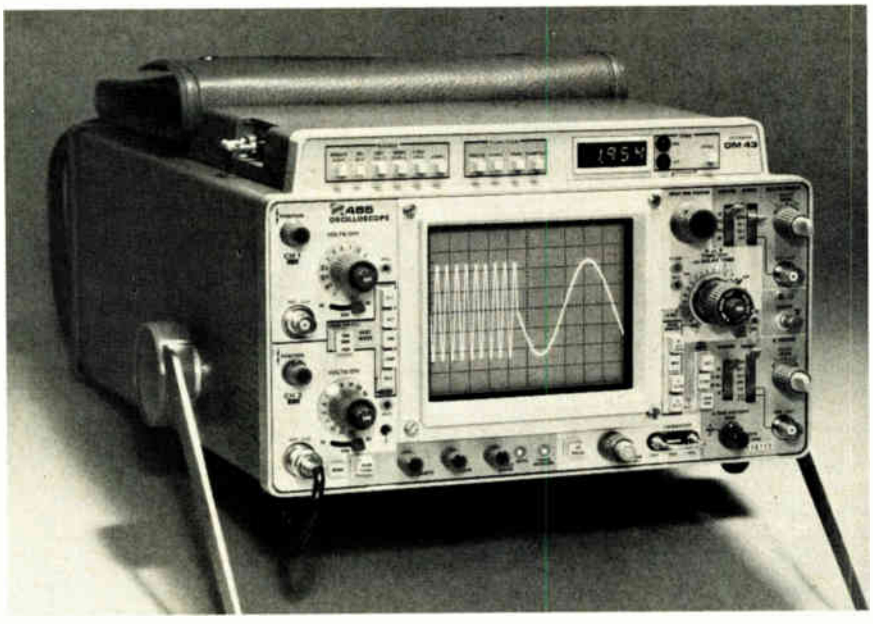
To perform a time-span measurement, the user advances the delay-time control until the intensified spot coincides with the beginning of the time interval on the waveform he wants to measure. Then he presses the zero button on the DMM and again advances the control to the end of the desired point on the waveform. The time interval appears on the 3½-digit light-emitting-diode display. Accuracy is the same as that of the scope plus or minus one count. Either the millisecond or microsecond lamp lights up.

The combined instrument also measures temperature, a frequently ignored parameter that is a vital indicator of circuit performance. This adds an important capability to the engineer's kit of diagnostic tools. While the scope is displaying a signal for visual study, the temperature probe, which covers the range from -55 to +150°C and is connected to the DMM, can be monitoring the temperature of critical devices. Maximum error is ±1.1°C up to 125°C, and is ±2.1°C from 125° to 150°C. As an example, an engineer can monitor the case temperature of a device for various signal levels.

The instrument package enables engineers to add normal temperature ranges to schematics—not only of transistors, but also of transformers and motors. Among other benefits, specification of case temperature on schematics would help in trouble-shooting in the field.

Equipped with its own power supply and test leads, the DMM has a stand-alone capability for measuring dc voltage in five ranges from 200 millivolts to 1,200 volts. The common terminal may be floated 500 V dc above ground. Six resistance scales range from 200 ohms to 20 megohms.

The multimeter adds 1 inch to the height of the portable scope and a little less than 4 pounds to its weight. Price of the DM43 multimeter, which has the temperature-measurement capability, is $475, plus the price of the scope. Model DM40, which does not include the temperature-measurement capability is priced at $390 plus the cost of the scope.



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Optical waveguide spans 500 meters

Electrical-to-optical signal converter uses input data to modulate LED source in system marketed for prototype and developmental work

The promise of fiber-optic waveguides in various telecommunications applications [*Electronics*, March 21, p. 89] comes a step closer to fruition with marketing of a complete optical data link, including a low-loss multimode optical waveguide bundle, by Corning Glass Works.

Although the system is available off the shelf, the relatively high price is likely to restrict its use in the immediate future to prototype and developmental applications.

The optical data link consists of the 19-fiber bundle with an electrical-to-optical signal converter at one end and a reconversion unit at the other. To enhance compatibility with existing hookups, the input and output signal connections are provided by BNC connectors. Power is externally supplied via receptacles included in the transmitter and detector package. Links are available in lengths up to a maximum of 500 meters.

The electrical-to-optical signal converter uses the input data to modulate a light-emitting-diode source. The reconverter at the output uses an avalanche photodetector and amplifier electronics to produce a replica of the input electrical data. The LED source and avalanche photodiode detector are specially packaged by Texas Instruments to be compatible with the waveguide-bundle terminations and connector bulkheads jointly developed by Corning and the Deutsch Company.

The optical fiber bundles consist of 19 multimode step-refractive index optical waveguides jacketed in polyvinyl chloride. They have maximum signal attenuation of 30 decibels per kilometer at a wavelength of 820 nanometers. The choice of 19 fibers per bundle was made, according to Corning, to allow the waveguide bundle to be compatible with commercially available LEDs.

Terminations for the waveguide bundle without the transmitter-receiver modules are either a closely packed hexagonal-array termination that is compatible with the source and detector of the data link or a general-purpose glass ferrule.

The waveguide bundle has a numerical aperture of 0.14 and therefore accepts light rays incident on the waveguide fiber cores at angles of 8° or less. The attenuation in the fiber bundles is minimum between wavelengths of 800 to 900 nm, which corresponds to gallium-arsenide diodes and around 1060 nm, which is the primary wavelength of the neodymium-YAG glass laser.

The usable bandwidth is determined by a complex set of factors involving the LED source, the fiber length, and the avalanche photodiode detector and its associated electronics. Currently usable bandwidth is about 30 MHz. Initial applications will include process control and communications.

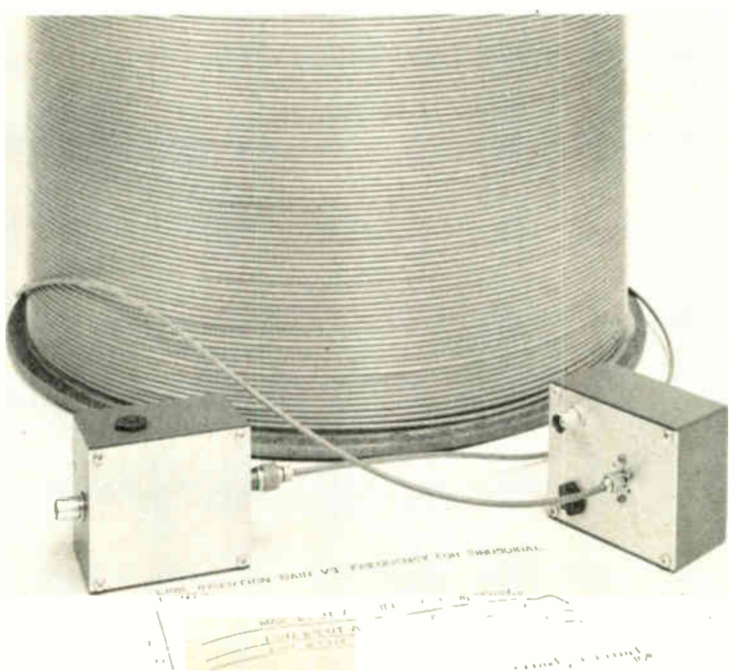
The key advantages of waveguide links lie in high dielectric isolation, extremely high immunity to electromagnetic interference, and lighter weight than comparable wire bundles.

Waveguide bundles are available in maximum lengths of 500 meters. Cost is $57 per meter for orders of less than five kilometers and $28.50 per meter for orders of five or more kilometers. A minimum order of $1,000 is required.

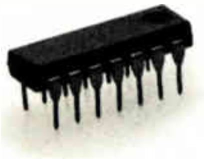
The price of the entire link consists of the cost of the connecting waveguide plus $1,000 for the transmitter and receiver modules.

Telecommunication Products Department, Corning Glass Works, Corning, N. Y. 14830 [339]

Telecommunications system. Optical-waveguide link includes 19-fiber bundle and, in foreground, input and output units. Chart shows performance curves of prototype system.



All those little wires have been pushed around long enough.



Until now, all those wires have been at the mercy of packaging materials that expand when things get hot.

So we developed new Dow Corning® 480 semiconductor molding compound.

Dow Corning 480 has a low coefficient of thermal expansion.

So it virtually eliminates the hot intermittent open. And moisture penetration.

Which means that an integrated circuit stays integrated. Through all sorts of temperature and atmospheric extremes.

But that's not all that's different about 480 molding compound.

Its resistance to salt spray is excellent.

And it reduces your packaging costs because it saves time. Molding times are short—less than one minute for some components. Post curing is unnecessary.

Of course, Dow Corning 480 molding compound also has the advantages of our other silicones. Consistency. Long shelf life. Less cleaning downtime because there's no buildup. Non-flammability. And, because it doesn't irritate skin, there's no need for special handling.

Dow Corning 480 semiconductor molding compound is the kind of improved product you can expect to keep getting from Dow Corning. Our Technical Service and Development Department has more manpower and greater technical facilities than any other in the industry.

If you want to know more about 480, call us at 517 636-8000, or write Dow Corning Corporation, Dept. B-4334, Midland, Michigan 48640. **DOW CORNING**

DOW CORNING

Crystals

QUARTZ CRYSTALS and HOLDERS

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Bellefonte Engineering Laboratories, Bellefonte, Pa.
Bliley Electric Co., Erie, Pa. (See p. 154.)
Burnett, Wm. W. L., 4814 Idaho St., San Diego, Cal.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co. New York, N. Y.)
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Hipower Crystal Co., 2035 W. Charleston St., Chicago, Ill. (See page 181.)
Hollister Crystal Co., Merriam, Kan.
Hunt & Sons, G. C., Carlisle, Pa.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Miller, August E., 9226 Hudson Blvd., North Bergen, N. J.
Petersen Radio Co., 2800 W. Broadway, Council Bluffs, Iowa
Precision Crystal Laboratories, 1211 Liberty St., Springfield, Mass.
Precision Piezo Service, 427 Asia St., Baton Rouge, La.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Scientific Radio Service, 4301 Sheridan St., University Park, Hyattsville, Md.
Standard Piezo Co., W. Louther & Cedar Sts., Carlisle, Pa.
Universal Television System, 114 W. 18th St., Kansas City, Mo.
Valpey Crystals, Holliston, Mass.
Western Electric Co.—see Graybar Electric Co.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

ROCHELLE SALT CRYSTALS

Tibbetts Laboratories, 179 Fifth St., Cambridge, Mass.

TOURMALINE CRYSTALS

Fuess, Inc., R., 39 W. 60th St., New York, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

Dials

See also Knobs, Pointers

Alden Products Co., 117 Main St., Brockton, Mass.
American Emblem Co., Utica, N. Y.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Flock Process Corp., 17 W. 31st St., New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mount Carmel, Ill.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass. (See page 158.)
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., Western Ave. at 35th St., Chicago, Ill.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sillcocks-Miller Co., 10 Parker Ave., W. South Orange, N. J.

Discs

BLANK RECORDING DISCS

Advance Recording Products Co., 36-12 34th St., Long Island City, N. Y. (See page 177.)
Allied Recording Products Co., 21-09 43d Ave., Long Island City, N. Y. (See page 160.)
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Devices, Inc., 1600 Broadway, New York, N. Y. (See page 176.)
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Electrical Industries Mfg. Co., Red Bank. N. J.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Federal Recorder Co., Elkhart, Ind.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago, Ill.
Gould-Moody Co., 395 Broadway, New York, N. Y. (See page 168.)
Hammermill Paper Co., Erie, Pa.
Home Recording Co., 9 E. 19th St., New York, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Presto Recording Corp, 242 W. 55th St., New York, N. Y. (See page 144.)
Radio Specialties Co., 1956 S. Figueroa St., Los Angeles, Cal.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Talking Devices Co., 4451 Irving Park Rd., Chicago, Ill.
United States Record Corp., 1780 Broadway, New York, N. Y.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Wilcox-Gay Corp., Charlotte, Mich.
Zephyr Products Co., 160 E. 116th St., New York, N. Y.

Dividers

VOLTAGE DIVIDERS—see Resistors

Dynamotors

see Generators

Enamels

see Finishes

Equalizers

see Filters

Escutcheons

see also Dials, Scales

Alden Products Co., 117 Main St., Brockton, Mass.
American Emblem Co., Utica, N. Y.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Dual Remote Control Co., 31776 W. Warren St., Wayne, Mich.
Erie Resistor Corp., Erie, Pa.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Liberty Engraving & Mfg. Co., 2911 S. Central Ave., Los Angeles, Cal.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind .
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago, Ill.
Syracuse Ornamental Co., Syracuse, N. Y.
United Motors Service, 3044 W. Grand Blvd., Detroit, Mich.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.

Fibre

see Insulation

Filters

ELECTRIC WAVE SECTION FILTERS

Audio Development Co., 2833 13th Ave., S., Minneapolis, Minn. (See page 170.)
Bliley Electric Co., Erie, Pa.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
United Transformer Co., 150 Varick St., New York, N. Y.
Western Instrument Co., 5115 Kinsie St., Los Angeles, Cal.

EQUALIZER FILTERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill. (See p. 130.)
United Transformer Co., 150 Varick St., New York, N. Y.

NOISE FILTERS

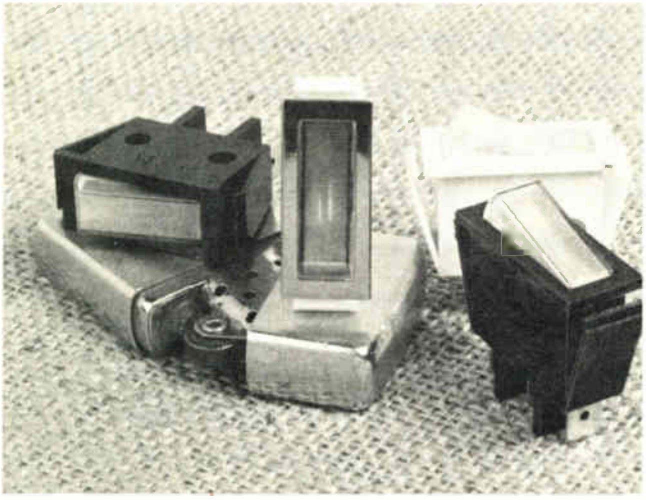
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Atlas Condenser Products Co., 548 Westchester Ave., New York, N. Y.
Bendix Aviation, Ltd., North Hollywood, Cal.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Electronic Transformer Co., 515 W. 29th St., New York, N. Y.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Winding Co., 254 W. 31st St., New York, N. Y.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Slayter Electronic Div., Owens-Corning Fiberglas Corp., 26 W. Market St., Newark, Ohio.
Solar Mfg. Corp., Bayonne, N. J.

Components

Switches aimed at metric design

Applications for rocker units seen in new and redesigned test, data-handling equipment

As more and more equipment manufacturers begin to convert to metric dimensions in the design phase of their product cycles, component manufacturers can be expected to follow suit. They will begin supplying standard product lines in "hard metric" specifications instead of English units with metric dimensions added parenthetically.



Oak Industries' Switch division is introducing a line of all-metric rocker switches, said to be the first available from a domestic manufacturer.

"By designing for the metric market, we realize that we're bypassing opportunities in the retrofit market," says product manager Dean Bach, so we're aiming at new products and totally redesigned products."

The rocker switches, representing a new market for Oak, are designed for test and measurements, as well as computer and peripheral-equipment markets, although Bach expects to see some applications by appliance manufacturers.

The line consists of single-pole, single-throw and single-pole, double throw snap-action switches with silver contacts, an illuminated SPST type with snap action, and unlighted momentary SPST and SPDT models, normally closed. All are rated at maximums of 16 amperes at 120 volts or 8 A at 240 V ac (inductive). They use a common black or white housing that measures 33.4 by 33 by 15 millimeters. The switches, which accomodate a maximum panel thickness of 1.42 mm, are available in versions with or without chromium trim.

Actuators are either flat or concave, and the lighted versions have red, amber, or clear lenses. Price of the unilluminated switches is about 50 cents each in production quantities, and delivery time is eight to 10 weeks.

Small off-the-shelf quantities will be available from stock in July.

Oak Industries Inc., Switch Division, Crystal Lake, Ill. 60014 [341]

Time-delay relay works from 0.1 s to 10 minutes

A solid-state time-delay relay that allows independent adjustment of off-on and on-off time intervals is offered in seven combinations that include: factory-fixed, dual concentric knobs on top, and remotely adjustable. The series FDR, available with eight-pin or 11-pin plug-in sockets, also provides five time ranges from 0.1 second to 10 minutes in ±5%, ±10% and ±20% time tolerances. Repeat accuracy is to within ±2%. The relay has a built-in transient protector and a life of more than 1 million operations under load and 100 million mechanical operations. Price ranges from $35.11 to $49.50 each, depending on tolerance and quantity.

Omnetics Inc., Box 113, Syracuse, N.Y. 13211 [343]

Slide switches aimed at calculators, test equipment

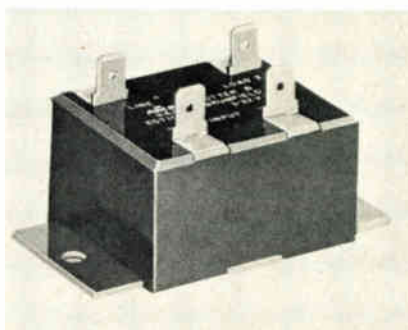
Using a ball-and-spring detent mechanism and contacts with wiping action for low resistance, a line of subminiature slide switches is designed for calculators, test instruments, communications equipment, and sound systems. The basic switch measures 0.433 inches long, 0.213 in. wide, and 0.197 in. high. Rating is 0.3 ampere at 125 volts ac.

Alco Electronic Products Inc., 1551 Osgood St., Andover, Mass. 01845 [363]

Optically coupled relay can handle 20 amperes

An optically coupled, 20-ampere solid-state relay with zero-crossover switching is designated the model EOT. Because of zero crossover, the single-pole, single-throw, normally open switch has minimal electromagnetic interference, and its expected life is in excess of 100 million operations.

The EOT comes with two basic control circuits: constant current and constant impedance, with inputs from 3 to 32 volts dc. Each type offers output-current ratings of 2, 4, 5, or 7 amperes, 120 V ac, 50 to 60 hertz, at 25°C. With factory-recommended heat-sinking, these ratings increase to 4, 8, 12, and 20 A, respec-



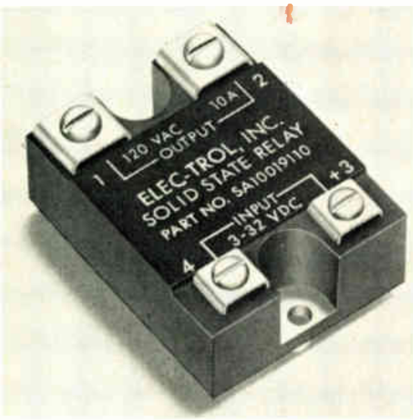
tively, the company reports.

A dv/dt network across the switch provides protection against false triggering by all but the fastest voltage transients. A metal-oxide varistor, available on one model, prevents false triggering by transients that exceed the switch blocking voltage. Operating ambient temperature is from -10°C to +55°C. Isolation is 1,500 v rms at 60 Hz.

Potter & Brumfield Division, AMF Inc., Princeton, Ind. 47670 [345]

Solid-state relays feature zero-crossover switching

Solid-state relays, which provide zero-crossover switching of high-power ac reactive loads, are available with either of two input voltage

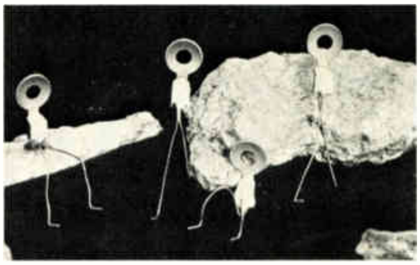


ranges and with 6- or 10-ampere outputs at 140 to 280 v rms. The zero-crossover function applies to the load ac voltage that is free of electrical noise and transient surges that cause radio-frequency interference. Photo isolation between input and output is 1,500 v rms.

Elec-Trol Inc., 26477 N. Golden Valley Rd., Saugus, Calif. 91360 [344]

Resistor provides overload protection

A positive-temperature-coefficient resistor that can sense case temperature of a high-power semiconductor and reduce power dissipation when dangerous current or power limits are approached is called the Posistor, model PTH 487A. In a typical application, the resistor is mechanically affixed to the semiconductor case and electrically connected in series with the base-biasing circuit. The resistance of the unit is nominally 500 ohms at normal operating temperatures. This resistance increases rapidly when the protective temperature threshold is reached.

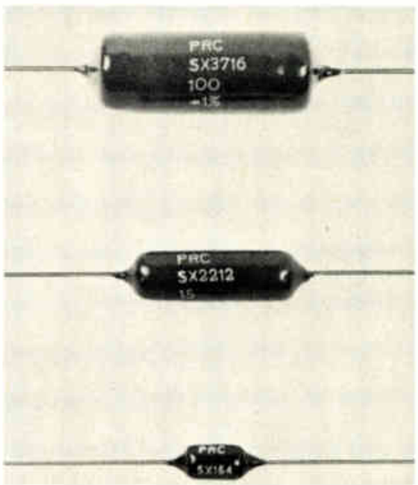


This is 2,000 ohms at 176°F and 3,000 ohms at 194°F. Maximum voltage and current ratings are 12.5V dc and 0.1A respectively. Maximum external withstanding voltage is 15V dc.

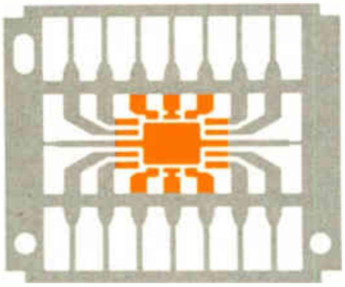
Murata Corp., 2 Westchester Plaza, Elmsford, N.Y. 10523 [346]

Resistors are rated from 40 mW to 5 W

A line of resistors, called type SX, is available in 100 physical sizes, from 40 mw through 5 watts, and in thousands of variations in resistance values and tolerances to fit particular applications. All type SX resis-



We spot a way to save you up to 60% in gold costs.



Apply gold precisely—and only—in places where it's absolutely needed. That's the Plessey difference in spot-plating. And it makes one enormous difference in your operating costs—considering the price of gold today.

Our application system is golden. It allows us to have extremely accurate control of size, shape and registration. So you never end up paying for gold applied to the base metal when it's not required.

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Plessey can do a quality job for you in ribbon and wire plating, too. We've got the people, the goods, and 14 solid years experience to tailor our plating to your environmental, temperature and solderability requirements. Including "on-line" testing while your material is being plated.

And in this business, that's as close to a gold-plated guarantee as you can get.

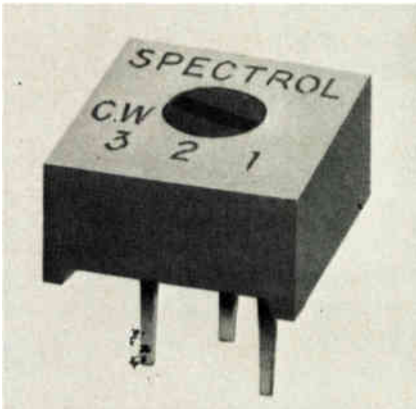
tors are encapsulated in a solvent-resistant, silicone protective coating that withstands high temperature for wave-soldering processes.
Precision Resistor Co., 109 Rte. 22, Hillside, N.J. 07205 [347]

Switch is activated by very little pressure

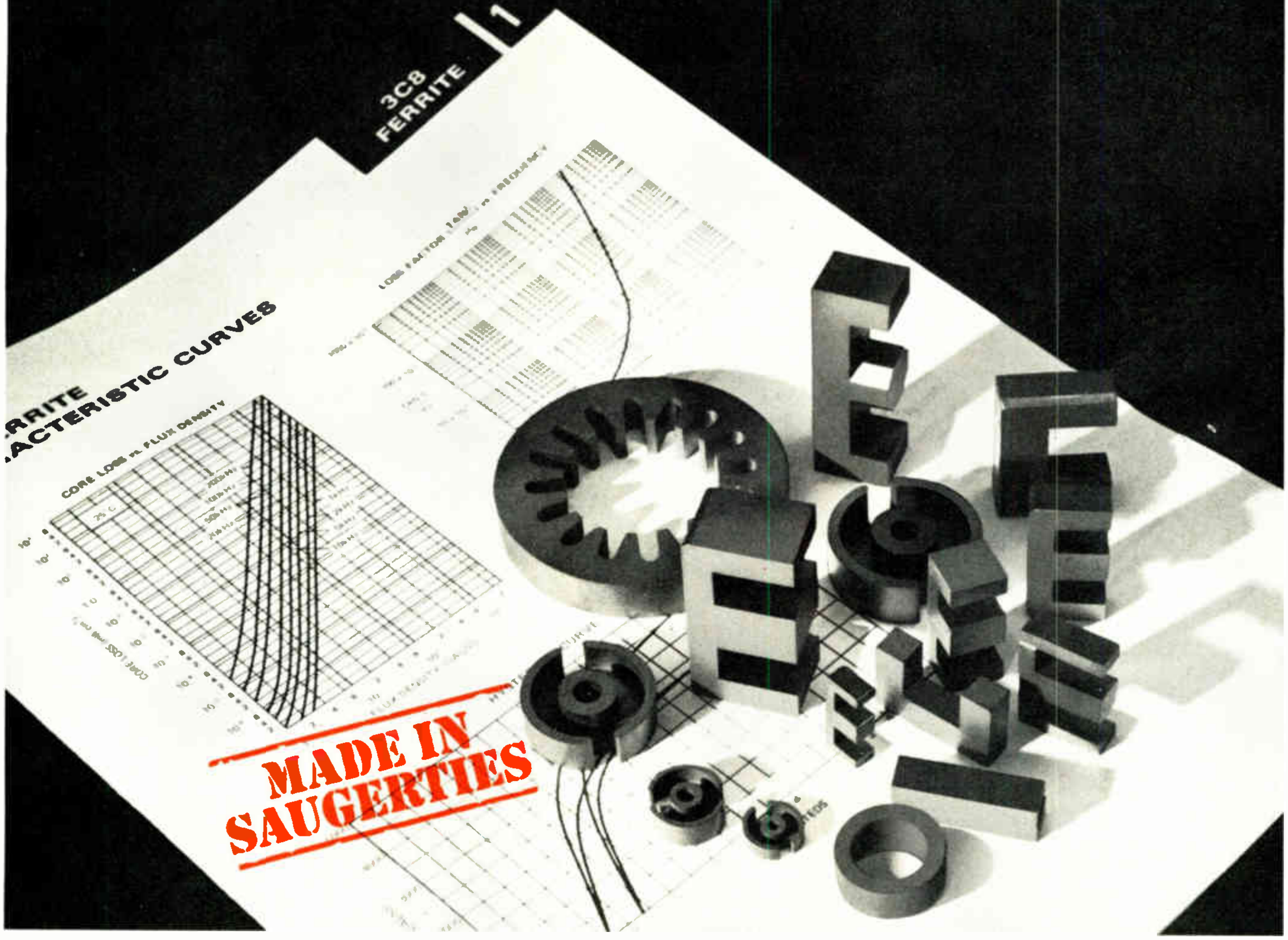
For applications in copy machines, programers, paper sensors and timers, a miniature switch, the V3, needs very little pressure for activation. The low-force device offers fine silver or gold-alloy crosspoint contacts and accepts pin plunger operating forces as high as 15 and 25 grams. Solder, screw, and quick-connect terminals are also available. Versions in the line handle 3 or 5 amperes at 125 v through 250 v ac from −65 to +185°F.
Micro Switch, 11 W. Spring St., Freeport, Ill. 61032 [348]

Cermet trimmer designed to eliminate springback

A new single-turn, ⅜-inch-square, cermet trimmer, the model 63, has been designed to almost eliminate springback problems and provide reliable setability. Offered in both top-adjust and side-adjust configurations, the trimmer plugs into models 362, 3389, and 72 sockets. The model 63 is priced at 60 cents in quantities of 100.
Spectrol Electronics Corp., 17070 E. Gale Ave., City of Industry, Calif. 91745 [349]



Dramatic new product opportunities... yours with new 3C8 ferrites



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

And the key to still *more* efficient, high-frequency power conversion is Ferroxcube's new 3C8!

This important new ferrite material gives significantly higher flux densities at higher temperatures, and lower losses at high excitation levels than any other magnetic core material. It is available in practical size cores for use up to kilowatt power levels.

3C8 is already being used with great success in: inverters, battery chargers, fluorescent lamp ballasts, strobe light devices for highway markers and harbor buoys, power oscillators, power amplifiers, ultrasonic generators.

In all of these circuits Ferroxcube's 3C8 material has led to greater efficiency, lower cost, less weight, and smaller sized units. In one power supply, for example, the size of the core was reduced from 13 lbs. at 60Hz to 4 lbs. at 20,000 Hz and the volume from 35 to 9 cu. inches —savings of 70 to 75%!

Can 3C8 improve your present products or suggest new products and markets for your company? If you've got the imagination, we've got the core! Call 914• 246-2811, TWX 510-247-5410 or write today.

Ferroxcube linear ferrites—made in Saugerties, N.Y. and stocked in seven U. S. locations.

FERROXCUBE CORPORATION, SAUGERTIES, N.Y. 12477
A NORTH AMERICAN PHILIPS COMPANY

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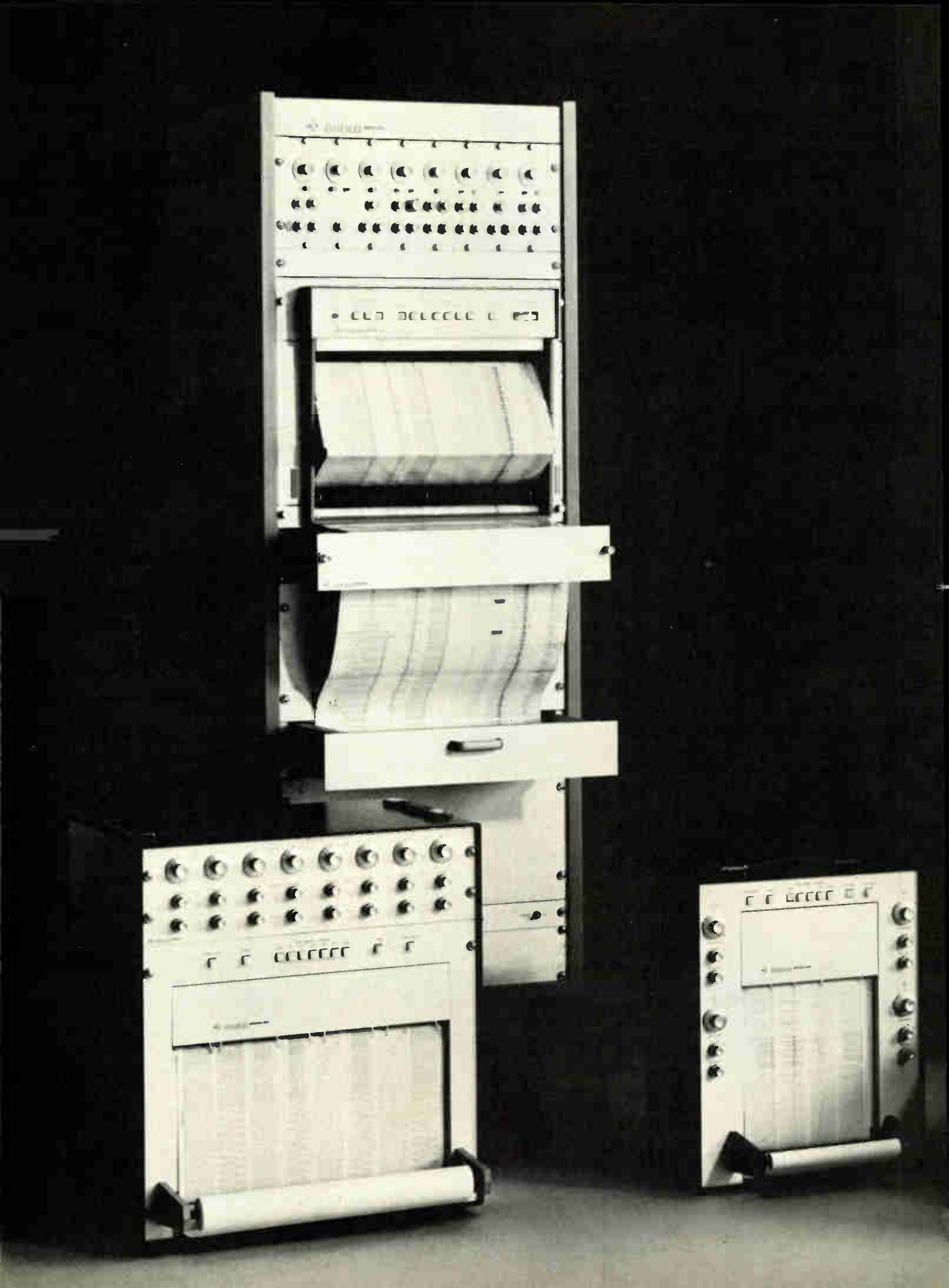
16404



Six good reasons why Brush recording systems are your best buy.

1. Brush has the broadest line in the industry.

We make a recorder/signal conditioner to meet just about any industrial or scientific application.

Choose from 1 to 8 channel direct writing recorders with or without built-in preamps; full scale frequency responses from 35 Hz to 55 Hz; 40 mm, 80 mm and 4½" wide channels; portable and rack mounted models.

2. Brush guarantees better than 99.5% linearity.

There are two reasons why we can guarantee such a high degree of accuracy. First, our Metrisite non-contact servo-loop feedback device. Second, our recorders have a rectilinear presentation which eliminates geometric errors.

3. The Brush pressurized inking system gives you the highest quality traces.

For twelve years, Brush traces have been the standard of the industry. Our pressurized inking system writes dry. It eliminates smudges, smears, skips and puddles. The record you get is crisp, clear and permanent.

4. Brush recording systems give you trouble-free operation.

All of our instruments require minimal maintenance. For example, our disposable ink supply usually lasts more than a year. And all of our electronics are solid state.

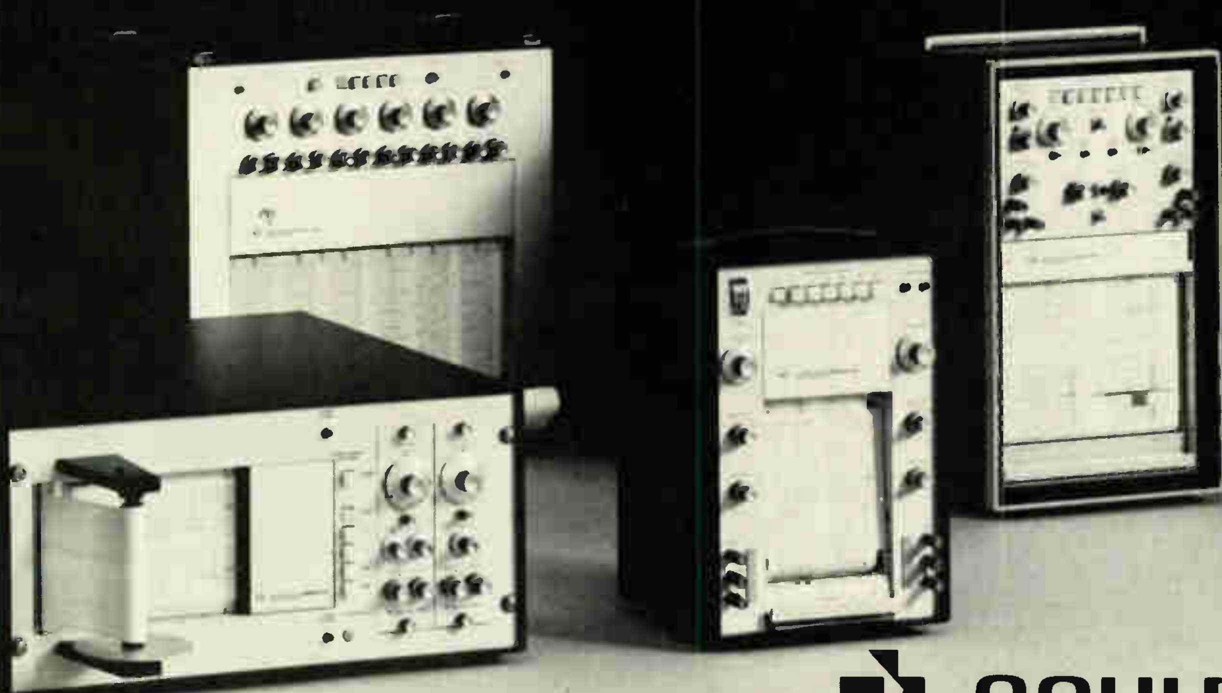
5. A Brush system is easy to operate.

All of our systems are self-calibrating. Controls are conveniently placed to give you maximum flexibility. Chart paper can be replaced in seconds. Switching signal conditioners is a snap.

6. Brush is a single source for everything you need.

We offer custom financing and leasing plans. Our installation, training, and maintenance programs are geared to your needs. And our warranty and replacement parts packages are two of the best in the industry.

If you'd like to find out more, contact your nearest Gould Sales Engineer or Representative. Or write for detailed performance information and specifications. Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114. Or Kouterveldstraat Z/N, B 1920 Diegem, Belgium.



GOULD

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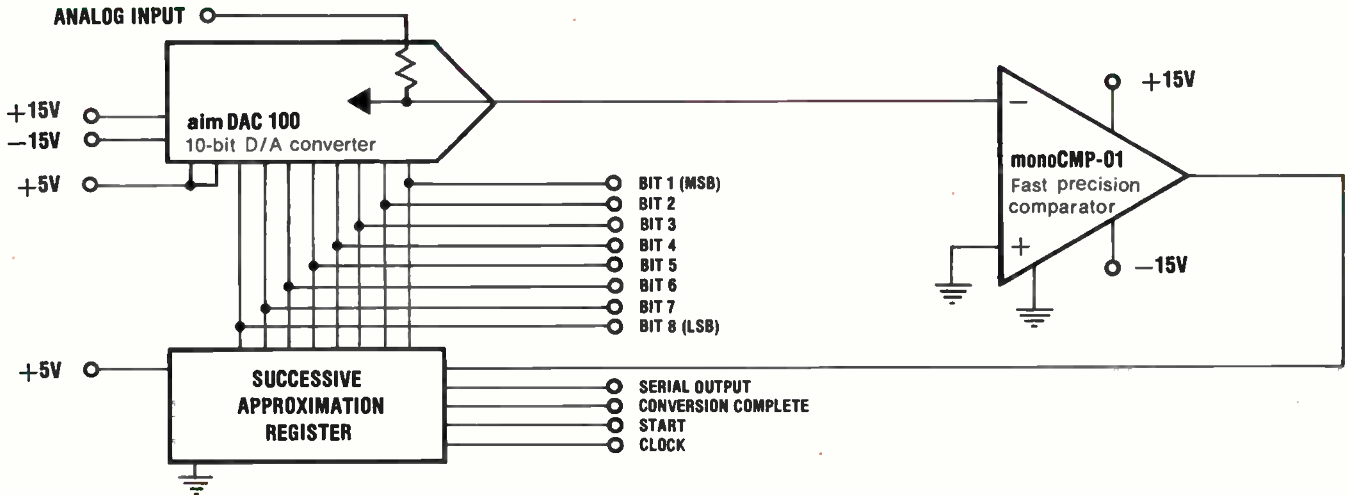

THREE IC's BUILD A FAST A/D CONVERTER – FOR UNDER $25!

It's easy with high performance analog components from Precision Monolithics—start with PMI's aimDAC100 Low Cost *D/A Converter*—with its internal precision reference voltage, 10-bit resolution, choice of linearities and high speed current output, it's ideal for all D/A and A/D applications. Next, add the PMI *monoCMP-01 Precision Comparator* with its fast 90ns response, low Vos, drift and superior stability—complete your converter with a successive approximation logic chip and that's it! Sound easy? You bet—and 10-bit versions can be built for under $40! Circuit construction and performance are fully detailed in our new Application Note: pre-drilled demonstration circuit cards are available *free* by contacting your local PMI rep or stocking distributor—call him today and find out how easy A/D conversion can be!

SPECIFICATIONS		PRICES
aimDAC 100 DDT1*	0.30% Linearity Max-0/70°C	$ 9.95 @ 100 pcs.
aimDAC 100 CCT1*	0.20% Linearity Max-0/70°C	$12.00 @ 100 pcs.
aimDAC 100 BCT1*	0.10% Linearity Max-0/70°C	$17.00 @ 100 pcs.
aimDAC 100 ACT1*	0.05% Linearity Max-0/70°C	$26.00 @ 100 pcs.
*Specify T1 for 0 to 10 Volt usage; T2 for 0 to 5 Volt usage.		
monoCMP-01CJ	Vos 2.8 mV Max	$3.25 @ 100 pcs.
monoCMP-01EJ	Vos 0.8 mV Max	$7.50 @ 100 pcs.

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New Jersey, South	(609) 966-4070
New Mexico	(505) 265-5655
New York, New York City	(516) 567-5900
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Industrial

Panel meters cover wide range

Digital process indicators read out temperature, voltage, current, resistance

The variety of sensors used in industrial processes today, and the accuracy required in many systems, create a need for a wide range of digital panel instruments. Voltage, current, resistance, thermocouple and resistance-temperature-detector indicators are used for process and quality control in conjunction with strain gauges, thermocouples, analytic instruments with bridge detectors, and nonlinear sensors, to cite just a few examples.

The LFE Corp.'s Process Control division has introduced a line of panel meters, the 4358 series, designed specifically to work in these applications.

The highly sensitive voltage/current indicator, is available in 11 ranges—five voltage and six current. The voltage ranges go from 39.99 mV full scale to 399.9 V, with an input resistance of 100 megohms on the lower three ranges and 10 megohms on the top two. The current scales go from 3.999 μA full scale to 399.9 mA, with an input resistance of 10 kilohms on the two most sensitive ranges, dropping to 1 ohm on the top range. Significant overload protection is provided, especially for the more sensitive ranges. For example, the 40-mV range can tolerate 250 V, and the 4-μA range can withstand 5 mA.

Long-term accuracy is within either 0.1 or 0.25% full scale, depending on range. Temperature coefficient is 0.008% full scale/°C in all but two cases where it is 0.02% full scale/°C. Each unit costs $225.

The four-terminal resistance indicator, which provides resolution to 0.1 ohm, is designed for sorting, adjustment and inspection tasks, such as resistance trimming. It covers four ranges from 0 to 399.9 ohms to 0 to 399.9 kilohms, with sample currents ranging from 1 mA to 10 μA. In all ranges, long-term accuracy is within 0.1% of reading ±0.2% full scale. Temperature coefficient is 0.01% full scale/°C. Price of the instrument is $245.

Curve-fitting 10-segment linearization is standard on the thermocouple indicator, and the linearization points can be rearranged for special applications. High input impedance permits the instrument to tolerate source resistances up to 2,000 ohms with no reduction in accuracy. The unit includes internal cold-junction compensation and flashing indication of thermocouple burnout. It can accommodate copper-constantan, chromel-constantan, iron-constantan, and chromel-alumel thermocouples, and in each case has input impedance of 100 megohms, maximum bias current of 1 nanoampere, and maximum voltage of 250 volts. Eight temperature ranges are

Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Technical Appliance Corp., 516 W. 34th St., New York, N. Y
Tefft Radio Co., Plymouth, Mich.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Whisk Laboratories, 145 W. 45th St., New York, N. Y.

Finishes

INSULATING ENAMELS

Alden Products Co., 117 Main St., Brockton, Mass.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J. (See page 148.)
Roxalin Flexible Lacquer Co., Elizabeth, N. J.
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.

INSULATING VARNISH

Arco Co., 7301 Bessemer Ave., Cleveland, Ohio
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Benolite Corp., Manor, Pa.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
Dielectric Corp., 5520 Clemens St., St. Louis, Mo.
Dolph Co., John C., 168A Emmett St., Newark, N. J.
Electric Power Construction, Inc., 569 S. Main St., Akron, Ohio
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
George Co., P. D., 4153 Bingham Ave., St. Louis, Mo.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Impervious Varnish Co., Rochester, Pa.
Industrial Paint Co., Haysville, Pa.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insualtor Co., 10 Argyle Terrace, Irvington, N. J. (See page 106.)
Kay & Ess Co., Leo & Kiser Sts., Dayton, Ohio
Lastik Products Co., American Bank Bldg., Pittsburgh, Pa.
Maas and Waldstein, 438 Riverside Ave., Newark, N. J. (See page 148.)
Makalot Corp., 262 Washington St., Boston, Mass.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
Ohmlac Paint & Refining Co., 6540 S. Central St., Chicago, Ill.
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Schenectady Varnish Co., Congress St., Schenectady, N. Y.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island, N. Y.
Sterling Varnish Co., Haysville, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zophar Mills, Inc., 118-26th St., Brooklyn, N. Y.

LACQUER FINISHES

Alrose Chemical Co., Providence, R. I.
Arco Co., 7301 Bessemer Ave., Cleveland, Ohio
Ault & Wiborg Corp., 75 Varick St., New York, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Berry Bros., Inc., 211 Leib St., Detroit, Mich.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
du Pont de Nemours & Co., E. I., 626 Schuyler Ave., Arlington, N. J.
Durez Plastics & Chemicals, Inc., 1922 Walck Road, North Tonawanda, N. Y.
Egyptian Lacquer Mfg. Co., 1270 Sixth Ave., New York, N. Y.
Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Glidden Co., 11100 Glidden Ave., Cleveland, Ohio
Haynes Laboratories, Inc., C. W., Chandler St., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Jones-Dabney Co., Smith & Proback Sts., Louisville, Ky.
Kay & Ess Co., Leo & Kiser Sts., Dayton, Ohio
Larkin Co., 680 Seneca St., Buffalo, N. Y.
Lily Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Brothers Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N J. (See page 148.)
Makalot Corp., 262 Washington St., Boston, Mass.
Masury & Son, John W., 50 Jay St., Brooklyn, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
New Wrinkle, Inc., Mutual Home Bldg., Dayton, Ohio
Pierce & Stevens, Inc., Swing St., Buffalo, N. Y.
Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.
Pratt & Lambert, Inc., 92 Tonawanda St., Buffalo, N. Y.
Roxalin Flexible Lacquer Co., 802 Magnolia Ave., Elizabeth, N. J.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio
Stanley Chemical Co., East Berlin, Conn.
Walker Co., H. V., 714 Division St., Elizabeth, N. J.
Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

Forms

COIL FORMS

Alden Products Co., 117 Main St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Fast & Co., John E., 3101 N. Pulaski Ave., Chicago, Ill.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. I., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Paramount Paper Tube Co., 801 Glasgow Ave., Fort Wayne, Ind.
Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Fuses

INSTRUMENT FUSES

Bussmann Mfg. Co., University at Jefferson, St. Louis, Mo.
Chase-Shawmut Co., Newburyport, Mass.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill. (See page 155.)
Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio

Generators

DYNAMOTORS, ROTARY CONVERTERS

Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Carter Motor Co., 1608 Milwaukee Ave., Chicago, Ill. (See page 158.)
Delco Appliance Div., General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Diehl Mfg. Co., Trumbell & First Sts., Elizabethport, N. J.
Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Eicor, Inc., 1060 W. Adams St., Chicago, Ill. (See page 168.)
Electric Specialty Co., 211 South St., Stamford, Conn.
General Electric Co., Schenectady, N. Y.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
United Engineering Co., 655 N. May St., Chicago, Ill.

ELECTRIC POWER PLANTS

Delco Appliance Div., General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Eicor, Inc., 1060 W. Adams St., Chicago, Ill.
Electric Specialty Co., 211 South St., Stamford, Conn.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Midco Mfg. & Distributing Co., S. 13th & Kentucky Ave., Sheboygan, Wis.
Onan & Sons, D. W., 43 Royalston Ave., Minneapolis, Minn.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago, Ill. (See page 152.)
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Wincharger Corp., Sioux City, Ia. (See page 140.)

Geophones

see also Geophysical Apparatus

Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Globe Phone Mfg. Corp., Reading, Mass.
Heiland Research Corp., Club Bldg., Denver, Col.

Graphite

COLLOIDAL GRAPHITE

Acheson Colloids Corp., Port Huron, Mich.
Asbury Graphite Mills, Asbury, N. J.
Grafo Colloids Corp., Sharon, Pa.
Superior Flake Graphite Co., First National Bank Bldg., Chicago, Ill.

Harnesses

WIRE HARNESSES

Alden Products Co., 117 Main St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
Lewyt Metal Products Co., 60 Broadway, Brooklyn, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
R. B. M. Mfg. Co., Div. Essex Wire Corp., Logansport, Ind.
Rupp's Assembling & Mfg. Works, 2341 N. Seminary Ave., Chicago, Ill.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.

Headphones

CRYSTAL HEADPHONES

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio. (See p. 22.)
Connecticut Telephone & Electric Co., 70 Britannia St., Meriden, Conn.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

available, spanning a range from –80 to +2,000 degrees on the fahrenheit scale, and from 0 to plus 1,200 degrees on the Celsius scale. Accuracy and temperature coefficient vary with temperature range, and all the units in the series are priced at $345.

The industry-standard 100-ohm/3,850-ppm/4-wire platinum probes are used with the RTD indicator, which provides 0.1° resolution. Temperature ranges vary from -80 to +399.9°F to 0 to 750°C. Probe current is 1 mA, and maximum input voltage is ±10 volts. Long-term accuracy is within 0.1% of reading ±0.2% full scale. Temperature coefficient varies from 0.0099% full scale/°C to 0.01% full scale/°C. Price is $295. The unit can accommodate other types of probes as well because the 10-point linearization gives it flexibility, according to the company.

All four versions of the 4358 series have a 4½-digit display, with an optional hardwired zero digit in the least significant place to provide readout ranges to 39990. The curve-fitting linearization, standard on all temperature indicators, is optional on voltage, current, and resistance meters.

Price of the 4358 voltage/current indicator is $225, the resistance indicator costs $245, the thermocouple indicator is priced at $345, and the RTD indicator is $295. Delivery time is 8-12 weeks.

LFE Corp., 1601 Trapelo Rd., Waltham, Mass. 02154 [351]

Gas, smoke detectors have high output sink current

Consisting of a gas-sensing semiconductor, an operational amplifier, a stable trigger circuit, and a high-output-current final stage, the models MXE 50812A, N & S and 70812 A, N & S gas and smoke detectors handle a wide variety of gases. The units also contain gold-plated connector strips spaced 0.1 inch apart, which allow them to be mounted horizontally or vertically. The models N and S feature high-output-current final stages, while the A model has an analog-output stage.

Metronix B.V., Box 74, Harderwijk, Holland [353]

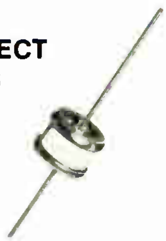
Infrared thermal imaging system is portable

The model 510 portable thermal imaging system scans the naturally emitted infrared radiation of objects, converting the radiation into an electronically displayed heat picture. Temperature differences of the picture can also be seen and measured. Frame rate is 30 frames per

it takes more

than a spark gap to solve surge voltage problems like these...

COMM GAPS PROTECT COMMUNICATIONS EQUIPMENT



Voltage surges from lightning and its secondary effects have very fast rise times which are hazardous to equipment and personnel. Signalite COMM GAPS are used in telephone, CATV, telegraph and other communications lines to protect against these hazards.

POWER SUPPLY PROTECTION

Supply transformers are subject to line surges. Signalite COMM GAPS are used across transformer secondaries to prevent these surges from affecting power supply components or load circuits. COMM GAPS protect both laboratory and modular types.

ELECTRICAL ENERGY TRANSFER

In circuits using capacitors and flash tubes, such as photoflash and strobe applications, it is necessary to dissipate large amounts of energy in a short time period. Low cost, miniature Signalite COMM GAPS provide increased speed of circuit function and improved reliability.

It takes application help from a group of surge protection specialists...

...yours for the asking.

SIGNALITE TRANSIENT VOLTAGE PROTECTION KIT—includes 28 page illustrated technical manual on the applications of gas discharge devices in transient protection and energy transfer. Also detailed specifications bulletins and an applications engineering worksheet. Available from your Signalite representative or by contacting Signalite, 1933 Heck Ave., Neptune, New Jersey 07753, (201) 775-2490.

CG-3

SIGNALITE DIVISION
GENERAL INSTRUMENT CORP.
Circle 151 on reader service card

second, which provides a flicker-free cathode-ray-tube display of continuous real-time action. A detachable optical module is also offered. Price is less than $10,000.

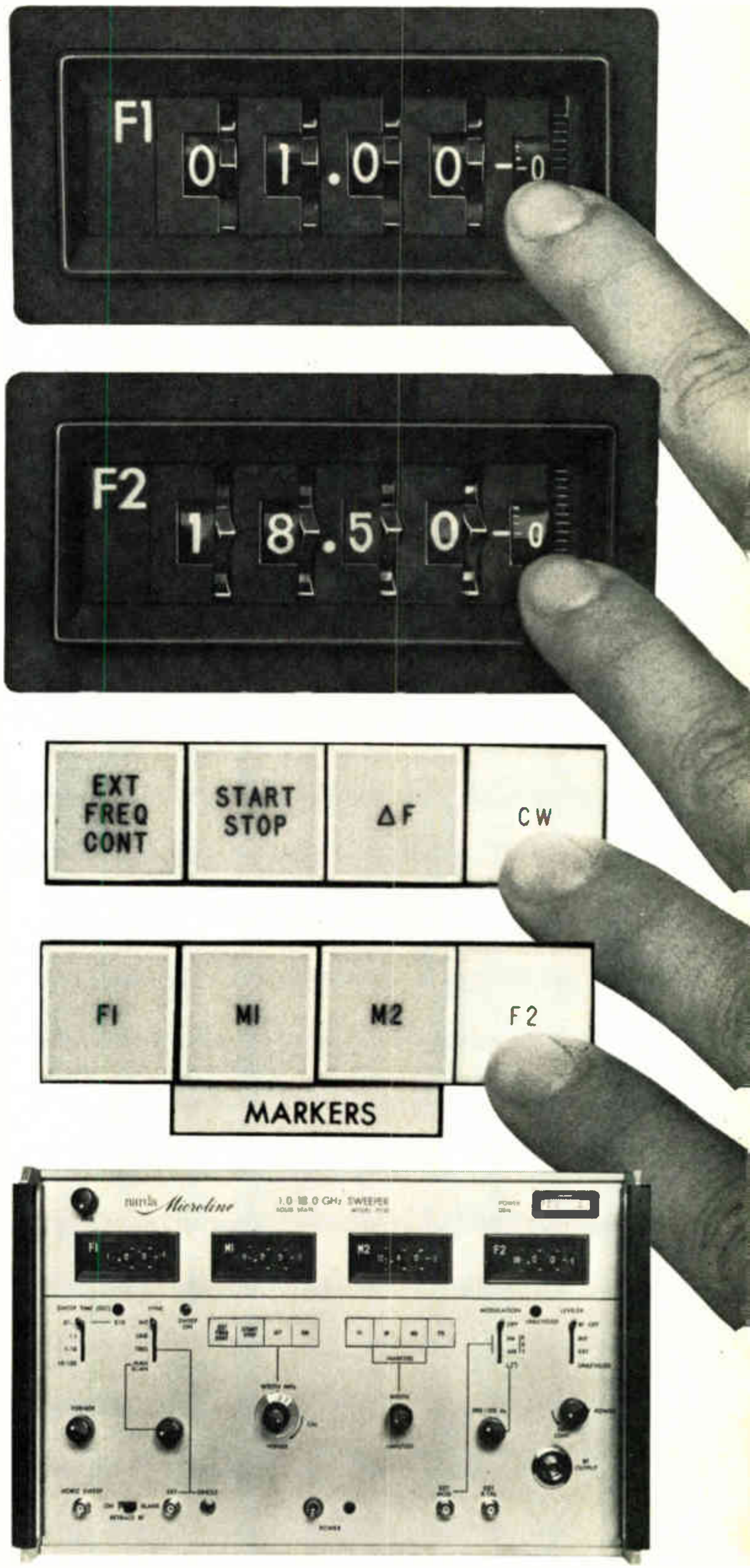
Dynarad Inc., 19 Strathmore Rd., Natick Industrial Park, Natick, Mass. 01760 [355]

Low-voltage monitor reduces damage, downtime

Priced at $30, a low-voltage monitor, called the type LVS, is available in adjustable or nonadjustable 3- or 10-ampere versions. The unit helps prevent equipment damage and reduces downtime caused by low voltage. In operation, a relay de-energizes and automatically shuts down equipment when voltage drops to a dangerous level. After voltage returns to normal, the unit reconnects power to the system. A built-in 5-

Sweep from 1 to 18.5 GHz this easy

select and read with six choices



Replace 6 Klystron Signal Generators with one Model 9535 — from 1 to 18.5 GHz.

Narda's newest generator/sweeper, Model 9535, is easy and quick to use —

- 0.5% accurate frequency digi-wheels — calibrated output power
- Provide 200 KHz resolution with excellent reset-ability
- Calibrated internal power meter
- Distance viewing provided—no mistaking frequency
- Push-button functions are illuminated for optimum visibility
- Calibrated controls with human engine... benefits

It eliminates the octave-band l... nd the associated cost and accur... dinary sweepers and signal ... sible to test at all p... Hz. Because o... for military an... e- quency rang... e of interest st... changing rang...

Save man hours ... and warm-up tim... ment budgets, p... with phase-lock capabil...

Write for the full det... ...here are a lot more benefits to know abo...

NOW -

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- Flicker-Free Display

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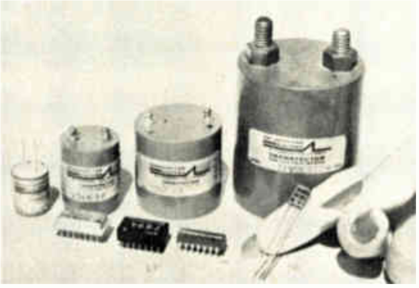
Circle 153 on reader service card

second delay prevents turnoff due to momentary voltage surges.
Logitek Inc., 42 Central Ave., Farmingdale, N.Y. 11735 [356]

Module protects against transients and overvoltages

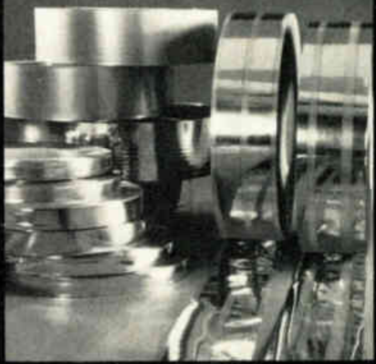
An overvoltage/transient protector features a high-speed transient suppressor for continued operation of loads during short-term low-energy transients, plus an overvoltage protector for long-term high-energy overvoltages. This dual feature helps eliminate both tripping and the unexplained circuit failures associated with slower protection



methods. The suppressor works by clamping and absorbing the energy of the transients. If the transient persists, the overvoltage protector shunts the line to a safe level within 500 nanoseconds. Price starts under $4 in quantity.
Transtector Systems, 532 Monterey Pass Rd., Monterey Park, Calif. 91754 [357]

Quality-control monitor includes digital display

The new series 5 digital monitor/control instrument packages are available for discrete-part inspection or quality-control applications. These instruments use the model SCA-5 strain-gage signal-conditioner amplifier power supply and the model TPST-5 logic function card with additional set-up adjustments per application. The logic function card performs a programed inspection sequence through "hi," "lo," or accept level comparisons



Only one of these synchronous motors

is a genuine Synchron® Motor.

Look alikes aren't perform-alikes.

Not by a mile. And once a motor is installed in your product, who cares what it looks like? As long as it does its job, is trouble-free and lasts a specified time.

But how do you know which of the three will perform the best? Do you gamble and just pick one, assuming they're all about the same? Hardly. You specify the one that's made by a company that's just as interested in how well the motor performs as you are . . . who will stand by it 100% . . . who will deliver it when you need it . . . at a fair price.

But most of all, from a company dedicated to helping you solve your problems with the best product made. The motor on the left is the one we're talking about. It's the genuine Synchron.

Call or write for complete Synchron motor specifications and the name of your Hansen representative.

Synchron motors are made in five major styles. Speeds from 900 rpms to one revolution per week. Torque from 8 through 98 oz-in at one rpm. Hundreds of output options.

MALLORY

HANSEN MANUFACTURING CO.
a division of P. R. MALLORY & CO. INC.
Princeton, Indiana 47670

We make every Synchron motor as if *our* name were on *your* product.

with output logic and an auto-reset for unattended operation. Production information in logic form is available for computer interface. The digital display holds the last inspection value until a new cycle is initiated. Price is $1,400.

Sensotec Inc., 1400 Holly Ave., Columbus, Ohio, 43212 [358]

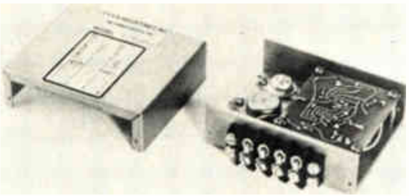
Controller sets temperature to within ±0.001° centigrade

The model 72 proportional temperature controller is designed to maintain temperature as closely as ±0.001°C over a range of 0° to 120°C. Three dials are provided to set the control point. As temperature drops below this point, a triac continuously varies power applied to a heat source from 0 to full load, according to need. The heaters receive only the amount of power required to maintain exact temperature. Price is $390.

Yellow Springs Instrument Co., Box 279, Yellow Springs, Ohio 45387 [359]

Temperature controller handles up to 200 watts

A 1,200-watt dc time-proportioning temperature controller is designated the model 4C4-200. This on-off unit, which has a factory-set bandwidth



of approximately 0.25°C, also has a set-point stability of +0.025°C/°C for ambient changes from -20 to +70°C and +0.01°C/volt for an input voltage change from 24 v dc to 30 v dc. TP series sensor probes are used for control over temperature ranges from -20° to +250°C.

Oven Industries Inc., Box 229, Mechanicsburg, Pa. 17055 [360]

BOURNS®

SPACE SAVER CERMET CONTROLS

ARE–

INTERCHANGEABLE WITH CTS 550 and 600 — Series 3852 is an exact CTS 550 replacement with less space required; Series 3859, ordered with a plastic bushing, also is interchangeable and costs even less. Series 3862 is interchangeable with the CTS 600 and is a better ½ inch diameter control.

THIN — Cut the bulk out of your new design . . . try the controls with the thinnest back-panel profiles in the industry — ¼".

QUIET — CRV is conservatively specified at 3% of total resistance. Actually it's substantially less on most units.

CERMET — This provides the designer with BETTER STABILITY, HIGHER POWER-RATING, AND A ±150 ppm/°C TEMPCO.

COMPETITIVELY PRICED

SERIES	100 piece quantity*	2000 piece quantity*
3852	$1.56	$ .81
3859	1.27	.66
3862	2.20	1.18

AVAILABLE — All three Series, including their various shaft, bushing, and shaft-end styles, are stocked in-depth at each of 73 Bourns distributor locations. Delivery on standards is 24 hours.

LOOK AT THE SIGNIFICANT SPECS —

	MODEL 3852/3859	MODEL 3862
Power Rating	2 watts at 70°C	1 watt at 125°C
Temperature Coefficient	±150 ppm/°C	±150 ppm/°C
Diameter	¾"	½"
Depth Behind Panel	¼"	½"
Resistance Range	50Ω to 5 megohms	100Ω to 5 megohms
Resistance Tolerance	±10%	±10%
Bushing	metal and plastic, locking and non-locking, plus snap-in	metal; locking and non-locking

* Prices are U.S. Dollars, F.O.B., U.S.A.

FOR A COPY OF OUR COMPREHENSIVE 22-PAGE BROCHURE, OR TO ENTER YOUR ORDER, CONTACT YOUR LOCAL BOURNS SALES OFFICE, DISTRIBUTOR, OR THE FACTORY-DIRECT.

BOURNS INC

TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

Circle 157 on reader service card

We're doing everything we can to keep on top of your needs.

Shortages. Crises. Delays. At times like these they're a fact of life.

At Brand-Rex we're doing something about them. We've instituted a company-wide program to foster a "Yes We Can" attitude to supply problems. And we've taken dozens of steps to make our problems less burdensome to our wire and cable customers.

Here's a sampling of what we're up to:

Production. We're minimizing waste and scrap by grouping orders using the same materials. We're modifying existing equipment to make it operate more efficiently. And we're keeping tabs on critical customer needs, giving them preference as far as possible.

Purchasing. To get maximum utilization from available resin and plasticizer, we've eliminated special purpose and low usage PVC compounds. We've raised our sights to include the world — we're searching out new supply sources overseas. At the same time, we're working with our long-term vendors to coordinate their production schedules with ours.

Product Engineering. Our engineers have come up with acceptable substitutes for hard-to-get PVC compounds — without compromising performance or service life. They're constantly evaluating new available insulations and developing new manufacturing techniques for those showing promise.

Shipping. We're using new packaging methods that virtually eliminate damage in transit. And where possible, we're consolidating shipments for better delivery service.

Sales and Marketing. We've given our salesmen an additional responsibility: calling on our vendors in their territories to keep materials moving. We're using computers to keep track of customers' behind-schedule orders and giving them the extra attention needed to get them out on time.

What you can do. We're asking our customers to call us before new wire and cable specifications are finalized so that "tight" materials can be avoided or alternates provided for. And doing everything else that will help us help you.

We're not deluding ourselves. None of these steps is going to bring an end to the problems we all face. But they can make a difference — if we all work at it. After years of providing the best possible wire and cable service, we're not about to quit now.

Brand-Rex
Willimantic, Conn. 06226

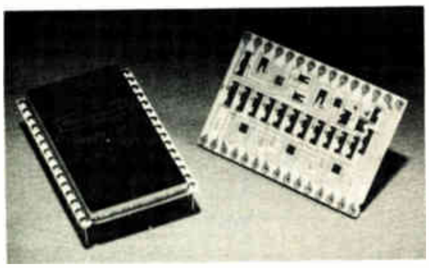
Yes we can.

Subassemblies

D-a converter uses C-MOS

12-bit unit for military, industrial jobs also has low-power op amp

Increasing use of low power C-MOS circuitry in industrial equipment has led to the need for compatible ancillary equipment. Beckman Instruments is providing one example in a standard hybrid 12-bit digital-to-



analog converter using C-MOS digital circuitry and a low-power operational amplifier. The series 872 is designed for demanding industrial and military applications, says Lyle F. Pittroff, product manager for standard microcircuits at Beckman's Helipot division. The d-a converters are specified for linearity as good as ±4.88 millivolts over −55 to +125°C, the military temperature range, with ½-bit resolution.

The 1- by 1½-inch parts include the 4000 series C-MOS switches (also compatible with 74C C-MOS), precision R-2R cermet thick-film ladder networks, micropower 4250 output buffer amplifier, and internal precision voltage reference. The ceramic package is sealed with a polymer that Pittroff says meets military specifications. The part is a 28-pin, dual in-line package with 0.9-inch pin-row spacing, three times that of common IC packages, for convenience in laying out circuit boards.

Power drain of the circuit is 4.5 milliwatts for the converter and 40 mW for the reference source. The +10-volt reference is normally connected externally to the converter's reference input, but can be used separately or disconnected. For applications requiring minimum power drain and numerous converters, the reference can be supplied from a common source. Voltage required is ±15 volts at 130 microamperes for the converter and +15 volts at 2.5 mA for the reference.

The converter can be used in either unipolar or bipolar operation. For unipolar, the output is 0 to +10 volts in response to a 12-bit binary input word. For bipolar use, the offset resistor (available at a pin) is connected to the reference output instead of to the converter output. In this configuration, an input of all 0s will provide an output of −10V, and an all-1 input will provide an output of +10 volts minus one least-significant bit, or approximately 9.9976 V.

The 872, which is not intended for high-speed applications, has a typical settling time of 35 microseconds, but Pittroff feels this is adequate for many uses where the low power consumption is needed.

Offset voltage is reset to zero internally, but can be further adjusted externally with a 100,000-ohm trimmer potentiometer giving an offset range of 200 millivolts. Likewise, quiescent output amplifier gain is preset, but can be reduced below 130 microamperes with an external resistor. However, this will affect slew rate and current capability (normally ±1 mA).

The 872-D1, with ±2.44 mV nonlinearity at 25°, is priced at $88 in single quantity, dropping to $66 for more than 200. The lower-accuracy 872-D2 (4.88 mV) is priced at $66 in single quantity.

Beckman Instruments, Helipot Division, 2250 Harbor Blvd., Fullerton, Calif. [381]

Power supplies intended for minicomputers, terminals

A line of 30-watt series-regulated dc power supplies is available off the shelf for OEM use in minicomputers, point-of-sale terminal systems, office equipment, and other IC-type

DYNAMIC HEADPHONES

Carrier Microphone Co., 439 S. La Brea Ave., Inglewood, Cal.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

MAGNETIC HEADPHONES

Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Connecticut Telephone & Electric Co., 70 Britannia St., Meriden, Conn.
Electrical Industries Mfg. Co., Red Bank, N. J.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Murdock Mfg. Co., Chelsea, Mass. (See page 127.)
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
RCA Mfg. Co., Camden, N. J.
Trimm Radio Mfg. Co., 1770 W. Berteau Ave., Chicago, Ill.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

Holders

CRYSTAL HOLDERS—see Crystals

Horns

SPEAKER PROJECTOR HORNS

Altec Lansing Corp., 6900 McKinley Ave., Los Angeles, Cal.
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Castlewood Mfg. Co., 12th & Burnett, Louisville, Ky.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Graybar Electric Co., Lexington Ave., at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hawley Products Co., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 167 N. Damen St., Chicago, Ill.
Operadio Mfg. Co., 13th Indiana Sts., St. Charles, Ill.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Insulation

See also Tubing, Finishes, Oil

BEAD INSULATION

American Lava Corp., Kruesi Bldg., Chattanooga, Tenn. (See page 47.)
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Saxonburg Potteries, Saxonburg, Pa.
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Steward Mfg. Co., D. M., E. 36th St., Chattanooga, Tenn.

CERAMIC INSULATION

Akron Porcelain Co., Cory Ave. & Belt Line, Akron, Ohio
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn. (See page 47.)
Ceramic Specialties Co., East Liverpool, Ohio
Colonial Insulator Co., 931 Grant St., Akron, Ohio
Cook Ceramic Mfg. Co., 500 Prospect St., Trenton, N. J.
General Ceramics Co., Radio City, New York, N. Y. (See page 41.)
General Porcelain Co., 951 Pennsylvania Ave., Trenton, N. J.
Hartford Faience Co., 271 Hamilton St., Hartford, Conn.
Illinois Electric Porcelain Co., Macomb, Ill.
Imperial Porcelain Works, Inc., Mulberry St. & New York Ave., Trenton, N. J.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J. (See page 105.)
Knox Porcelain Corp., 200 Mynderse Ave., Knoxville, Tenn.
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y. (See page 35.)
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
McDanel Refractory Porcelain Co., Beaver Falls, Pa.
Metsch Refractories Co., East Liverpool, Ohio
Mycalex Corp. of America, 7 E. 42d St., New York, N. Y. (See page 132.)
Porcelain Insulator Corp., 123 E. Main St., Lima, N. Y.
Porcelain Products, Inc., Parkersburg, W. Va.
Porcelier Mfg. Co., Greensburg, Pa.
Saxonburg Potteries, Saxonburg, Pa.
Square D Co., 6060 Rivard St., Detroit, Mich.
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Thomas & Sons Co., R., Lisbon, Ohio
Union Electrical Porcelain Works, Trenton, N. J.
Universal Clay Products Co., 1505 E. First St., Sandusky, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FABRIC INSULATION

Acme Wire Co., New Haven, Conn.
B & C Insulation Products, Inc., 22 W. 21st St., New York, N. Y.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Endurette Corp. of Am., Cliffwood, N. J.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Nepperhan Sales Co., 175 Fifth Ave., New York, N. Y. (Sole Distributors for Vap-O-Lite Products Co., Astoria, N. Y.)
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Vap-O-Lite Products Co.—see Nepperhan Sales Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FIBRE INSULATION

Brandywine Fibre Products Co., N. Walnut St., Wilmington, Del.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Lincoln Fibre & Specialty Co., Newport, Del.
National Vulcanized Fibre Co., Wilmington, Del. (See page 25.)
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Taylor Fibre Co., Norristown, Pa. (See page 174.)
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

GLASS INSULATION

Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Corning Glass Works, Corning, N. Y. (See page 120.)
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill. (See page 37.)
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio

PAPER INSULATION

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Brandywine Fibre Products Co., N. Walnut St., Wilmington, Del.
Case Bros., Highland Park, Conn.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Cottrell Paper Co., 19 Purchase St., Fall River, Mass.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hartford City Paper Co., Hartford City, Ind.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill. (See page 37.)
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Lincoln Fibre & Specialty Co., Newport, Del.
Mica Insulator Co., 200 Varick St., New York, N. Y.
National Vulcanized Fibre Co., Wilmington, Del.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Riegel Paper Corp., 342 Madison Ave., New York, N. Y.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Taylor Fibre Co., Norristown, Pa.
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

PHENOLIC INSULATION

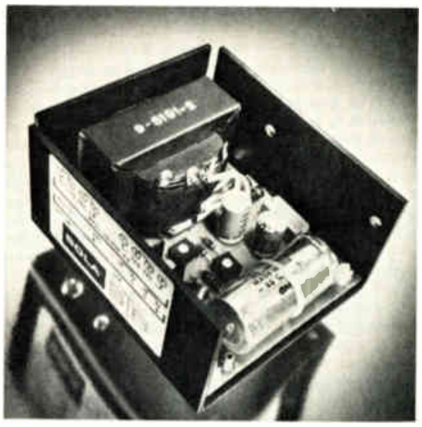
Celanese Celluloid Corp., 180 Madison Ave., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Dow Chemical Co., Midland, Mich.
Formica Insulation Co., 4662 Spring Grove Ave., Cincinnati, Ohio. (See page 9.)
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, Ohio
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
National Vulcanized Fibre Co., Wilmington, Del.
Orrsell Co., 64 E. Eighth St., New York, N. Y.
Panelyte Corp., 230 Park Ave., New York, N. Y.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Plax Corp., Hartford, Conn.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Ucinite Co., 459 Watertown Ave., Newtonville, Mass
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

Insulators

Alden Products Co., 117 Main St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.

New products

logic systems. The line consists of four models in the most widely used ratings: 5 volts at 3 amperes, 12 V at 1.8 A, 15 V at 1.6 A, and 24 V at 1.2 A. Input voltage for all models ranges from 108 to 132 V, or 216 to 264 V, with output regulation main-

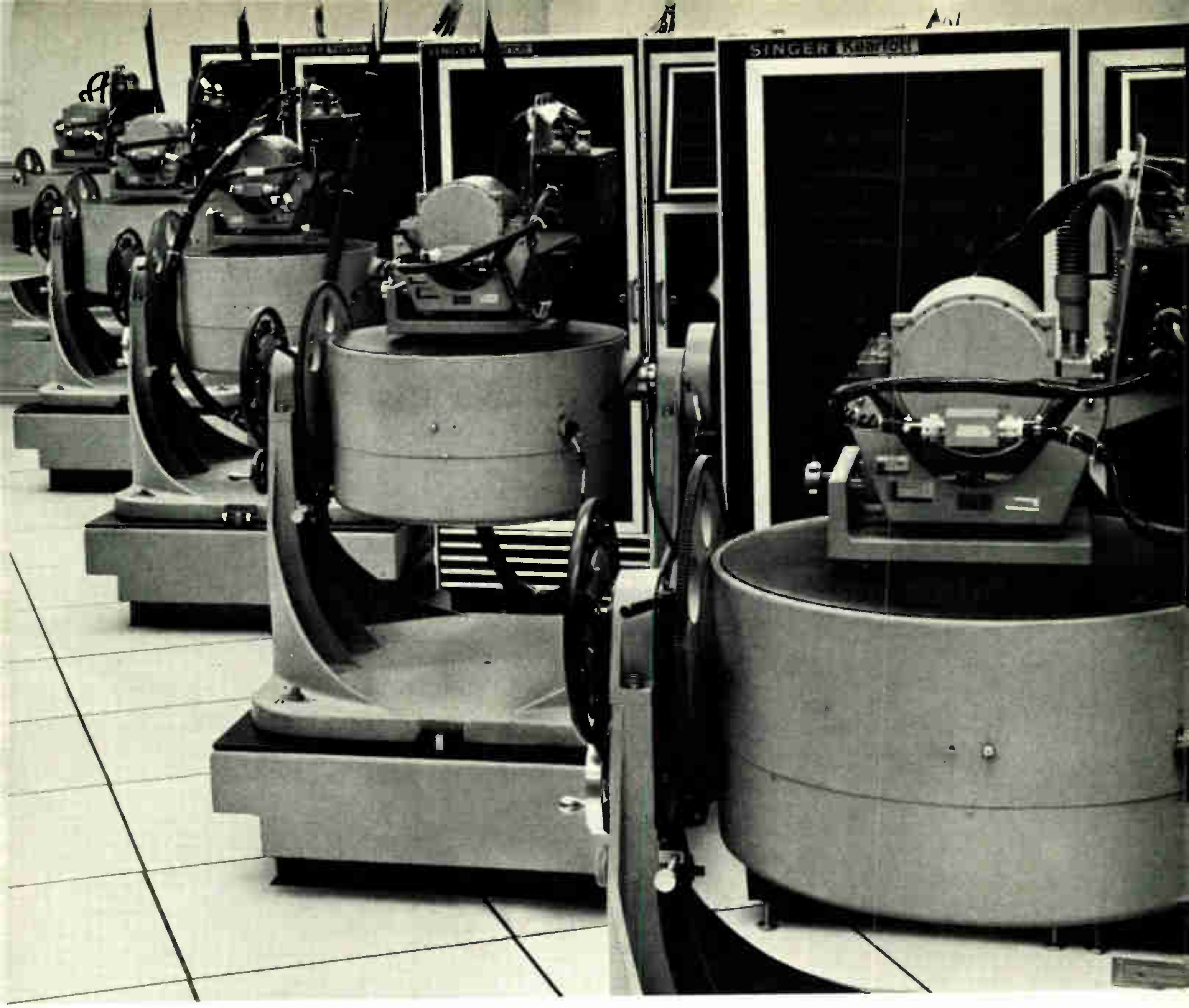


tained at ±1%. Input frequency range is 50–400 hertz, with load derated to 75% for 400-Hz operation. Automatic short-circuit protection is built in, and overvoltage protection is available as an option. Price is approximately $30.

Sola Electric Co., 1717 Busse Rd., Elk Grove Village, Ill. 60007 [401]

Data-acquisition system has 16 channels, uses 100 mW

A gated power supply, by turning on only when a conversion is requested, permits a 16-channel data acquisition system to operate with only 100 milliwatts of power. In the standby state, less than 120 microwatts is required. The system, called the DAS-16-LP, includes a 16-channel analog multiplexer, a sample-and-hold module, an 8- or 12-bit analog-to-digital converter, and the control logic for random and sequential channel-selection. The 16 single-ended analog input channels can accept either +5 or ±5-volt swings while presenting 10^9 ohms of input impedance. Data conversion time is 450 microseconds, so maximum system throughput rate is 2.2 kilohertz. Since the DAS-16-LP can be operated from a 12-volt battery, drawing only 8 milliamperes while



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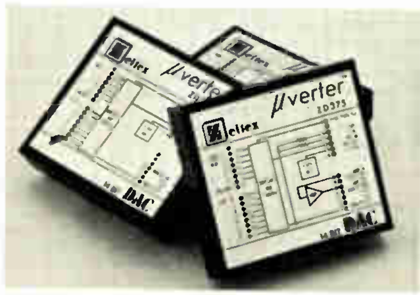
converting and a mere 10 μA in standby, it can be used in remote areas where line power is unavailable, as well as in the laboratory. Price is $750. Delivery time is stock to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [403]

14-bit d-a converters housed in small modules

Three 14-bit digital-to-analog converters provide linearity within ±½ the least significant bit and monotonic operation over a range of 0 to 50°C. One, designated the AD355, is a high-speed current-output unit; the other two have voltage outputs, with the ZD365 coded for unipolar and the ZD375 having bipolar-offset binary coding. Monolithic quad current switches assure good tracking of base-to-emitter voltage and beta for the most significant 8 bits, and bit weights are determined by a thick-film resistor network. In addition to providing high differential linearity, the combination of current switches and the thick-film network permits the converters to be packaged in modules that measure only 1.76 by 1.96 by 0.4 inches. In quantities of one to nine, price of the ZD355 is $299; of the ZD365, $310;



and of the ZD375, $320. Delivery time is six weeks.

Zeltex Inc., 940 Detroit Ave., Concord, Calif. 94518 [404]

Hybrid clock oscillator spans 250 kHz to 20 MHz

An oscillator, model K-1100A, is suitable for commercial applications, including microprocessors, modems, and minicomputers. Using quartz-crystal-oscillator technology and thick-film hybrid processing, the K-1100A is a rugged oscillator with high reliability. Its wide range of frequencies goes from 250 kHz to 20 MHz and is stable to within

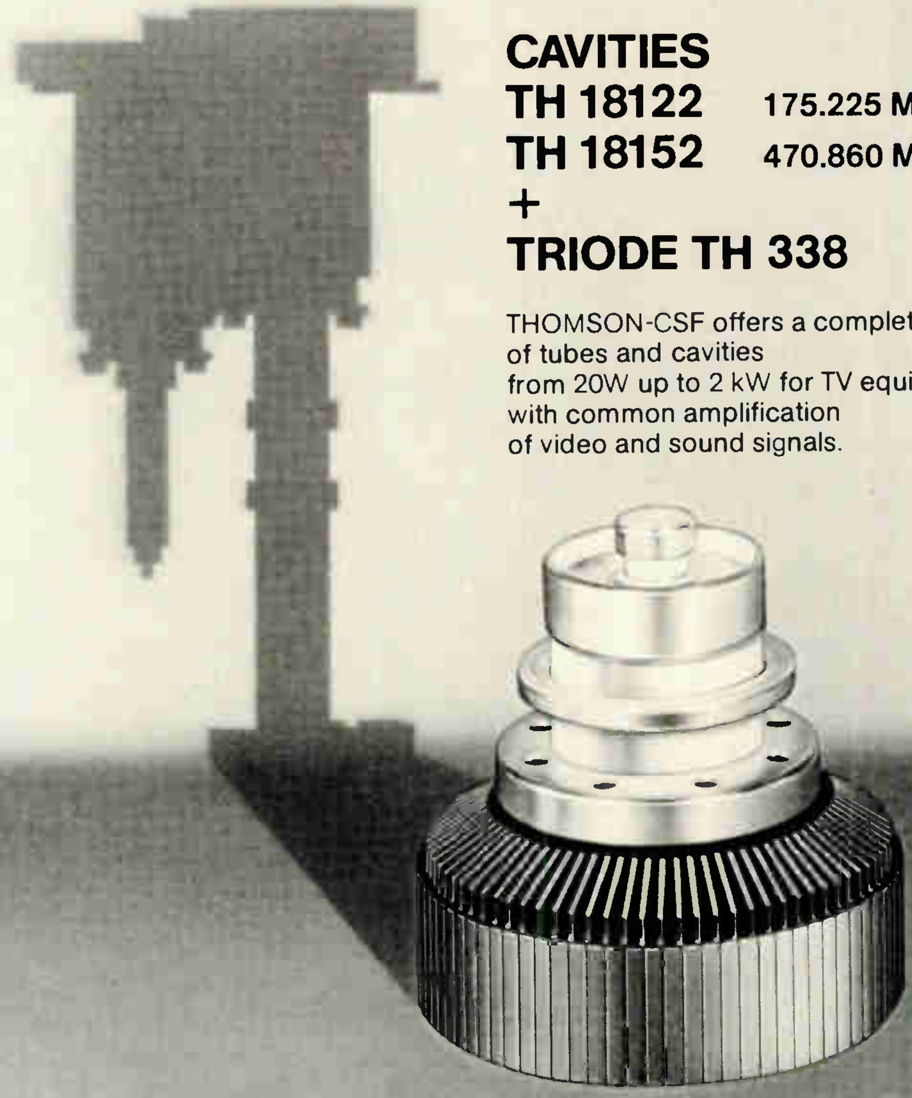
±0.01% over the 0–70°C range. The oscillator occupies only 0.083 cubic inch and is 0.200 in. high, permitting high-density packaging on standard logic boards with normal board spacing.

Motorola Inc., Component Products Division, 2553 N. Edgington St., Franklin Park, Ill. 60131 [387]

Industrial servo units snap into circuits

Customized servo electronics for applications such as process control and vehicle speed control are provided by modules that snap into a circuit and thus eliminate the need for inter-module cables and connectors. As control requirements expand, more modules can be added to the system. Three power modules are offered, plus one servoamplifier

The most efficient combination for 200-watt TV translators



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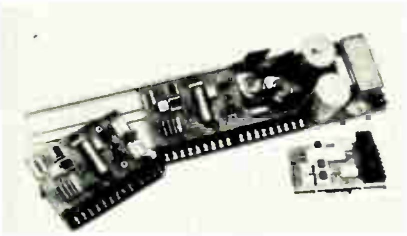
Sweden - THOMSON-CSF Elektronrör AB / Box 27080 / S 10251 STOCKHOLM 27 / Tel. (08) 22 58.15
United Kingdom - THOMSON-CSF Electronic Tubes Ltd / Bilton House, Uxbridge Road, Ealing / LONDON W 5 2TT / Tel (01) 579 55.11 / Telex : 25 659

1983

Circle 165 on reader service card



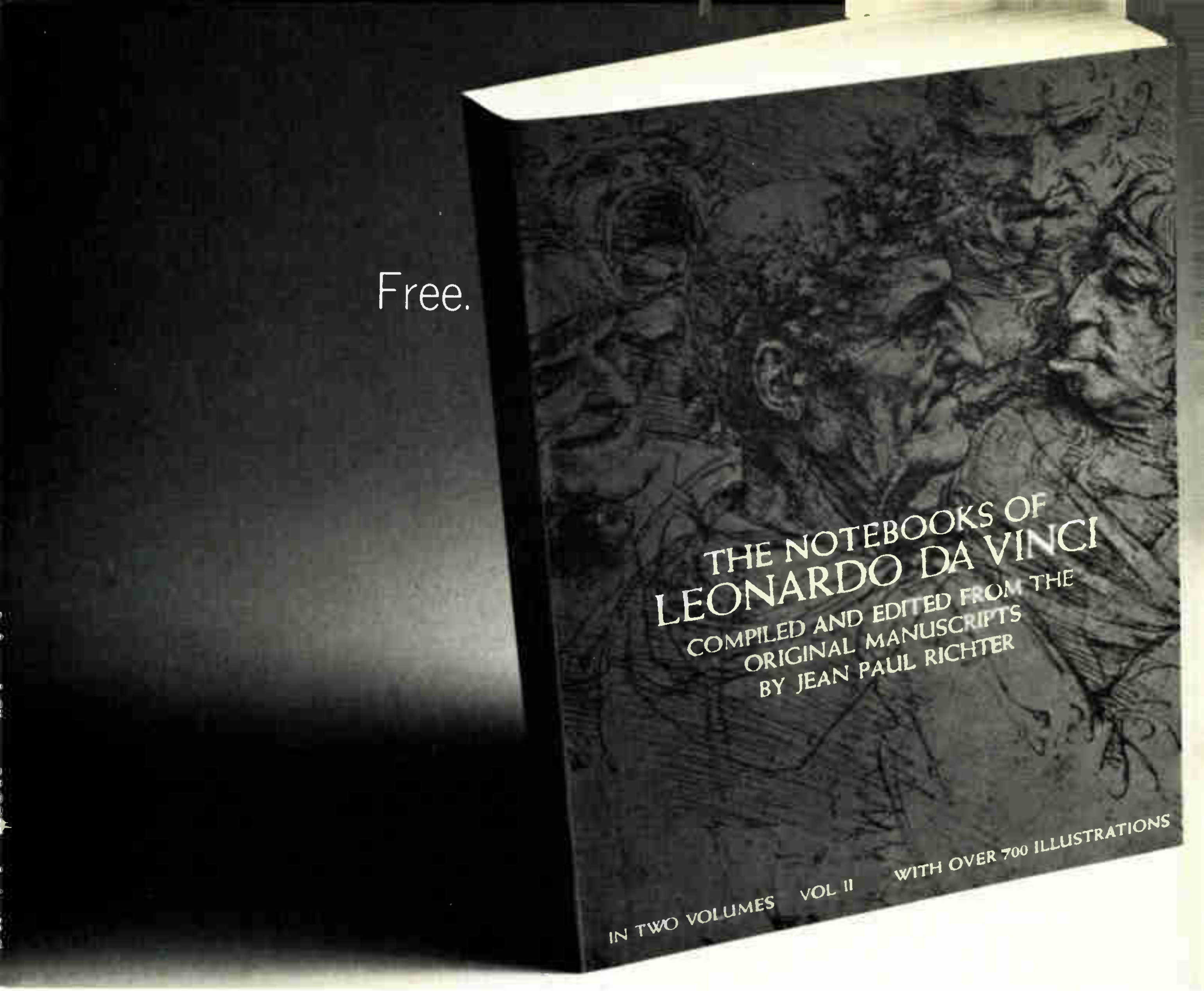
and various auxiliary-function modules. Appropriate electrical power conversion and voltage regulation are provided. The power supply in each servoamplifier has enough capacity to power several more servoamplifiers.

Moog Inc., Controls Division, East Aurora, N.Y. 14052 [385]

Buffer amplifier drives large reactive loads

The A-403 unity-gain buffer amplifier has an output voltage of ±120 V, output current of a minimum 100 mA, a minimum slew rate of 100 V/μs, and an input range of ±50 to ±120 V. The unit can drive a capacitive load, like a long coaxial cable, of up to 10,000 pF. In addition, an input impedance of greater than 10 kilohms permits the unit to be used with a wide variety of low-power operational amplifiers. The output is short-circuit-protected with foldback current-limiting. The A-403 has a guaranteed operating temperature range of -25°C to +85°C. It is packaged in a 1.6-by-3-by-1-in. plug-in module, and its heat sink permits operation without special cooling. Price is $50 in 1–9 quantities.

Intech Inc., 1220 Coleman Ave., Santa Clara, Calif. 95050 [388]



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Monroe, The Calculator Company
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Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Corning Glass Works, Corning, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J. (See page 105.)
Johnson Co., E. F., Waseca, Minn. (See page 96.)
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y. (See page 35.)
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.

MAST FOOTING and TOWER INSULATORS

Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.
Locke Insulator Corp., Baltimore, Md.

Inverters

American Television & Radio Corp., 300 E. Fourth St., St. Paul, Minn.
Electrical Products Co., 6535 Russell St., Detroit, Mich.
Electronic Laboratories, Indianapolis, Md. (See page 32.)

Jacks

see also Plugs

American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Audio Development Co., 2833 13th Ave S., Minneapolis, Minn. (See page 170.)
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carter Radio Co., 812 Orleans St., Chicago, Ill.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Cal.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Fahnestock Electric Co., 46-44 11th St., Long Island City, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R. 3029 E. Washington St., Indianapolis, Ind.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Standard Electric Mfg. Co., 925 Wrightwood Ave., Chicago, Ill.
Technical Appliance Corp., 516 W. 34th St., New York City.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Yaxley Mfg. Div. Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.

Knobs

see Dials
also Pointers

Alden Products Co., 117 Main St., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Radio Co., 30 State St., Cambridge, Mass.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mount Carmel, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio City Products Co., 88 Park Pl., New York, N. Y.
Radio Knob Co., 4916 W. Grand Ave., Chicago, Ill.
Richardson Co., 27th & Lake Sts., Melrose Park, Ill.
Rogen Brothers, 2001 S. Michigan Ave., Chicago, Ill.
Sillcocks-Miller Co., 10 Parker Ave., W., South Orange, N. J.
Syracuse Ornamental Co., Syracuse, N. Y.

Lacquer

see Finishes

Laminations

see Stampings

Lamps

DIAL LAMPS

Alden Products Co., 117 Main St., Brockton, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carlton Lamp Corp., 811 30th St., Union City, N. J.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.

PILOT LIGHTS

Alden Products Co., 117 Main St., Brockton, Mass.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Bryant Electric Co., 1421 State St., Bridgeport, Conn.
Circle F Mfg. Co., 720 Monmouth St., Trenton, N. J.
Dial Light Co. of America, Inc., 92 West St., New York, N. Y. (See page 181.)
Drake Mfg. Co., 1713 W. Hubbard St., Chicago, Ill. (See page 155.)
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Hubbell, Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kirkland Co., H. R., Morristown, N. J.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Signal Indicator Co., 140 Cedar St., New York, N. Y. (See page 181.)
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Lines

COAXIAL LINES
see Cable

Locknuts

see Nuts

Loudspeakers

Altec Lansing Corp., 6900 McKinley Ave., Los Angeles, Cal.
American Communications Corp., 306 Broadway, New York, N. Y.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Atlas Sound Corp., 1442 39th St, Brooklyn, N. Y.
Best Mfg. Co., 1200 Grove St., Irvington, N. J.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Cinaudagraph Speakers, Inc., 3929 S. Michigan Ave., Chicago, Ill.
Crescent Industries, Inc., 4140 Belmont Ave., Chicago, Ill.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Fibre Form, Inc., 300 S. Washington St., Columbia City, Ind.
Fulton Radio Co., 100 Sixth Ave., New York, N. Y.
Gates Companies, Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hawley Products Co., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 33d Pl. & Cottage Grove Ave., Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Rola Co., 2530 Superior Ave., Cleveland, Ohio
Rowe Industries, 3120 Monroe St., Toledo, Ohio
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Tibbetts Laboratories, 179 Fifth St., Cambridge, Mass.
University Laboratories, 195 Chrystie St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vac-O-Grip Co., 2023 Detroit Ave., Toledo, Ohio
Western Electric Co.—see Graybar Electric Co.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Lugs

TERMINAL LUGS

Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Burndy Engineering Co., 459 E. 133d St., New York, N. Y.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Dante Electric Mfg. Co., Bantam, Conn.
Dossert & Co., 242 W. 41st., New York, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia, Pa.
Electrical Engineers Equipment Co., 25th Ave. & Division St., Melrose Park, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Grammes & Sons, Inc., L. F., 344 Union St., Allentown, Pa.

Communications

Receiver can test propagation path

Unit covers 10 kHz–30 MHz, receives telephony, SSB, and narrow-band fm

Originally designed for military search, surveillance, and monitoring applications, a 10-kilohertz to 30-megahertz radio receiver has now been introduced by Rohde & Schwarz in a commercial version. One expected application is the testing of propagation-path characteristics between proposed transmitter and receiver sites. Since the input level is converted to a dc voltage and is available at a jack at the rear of the receiver, a strip recorder could be connected and propagation characteristics recorded.

The fully transistorized unit, priced at $24,000, receives telephony, telegraphy, single-sideband, and narrow-band frequency-modulated transmissions. Frequencies are switch-selected in 1-MHz and 100-kHz steps, and a single knob tunes the receiver within the step intervals. A new method of frequency conversion allows the slopes on the frequency-response skirts of all 20 different bandwidths (from 150 hertz to 12 kHz) to be the same and to be independent of the received frequency. The receiver's dynamic range is greater than 80 decibels. Designated the model EK 56, the unit's resetting accuracy is within ±50 Hz for 100-kHz tuning and ±500 Hz for 1-MHz tuning. Stability is within 5 Hz/day.

The input first passes through a low-pass filter, which suppresses signals above 31MHz (and especially signals in the fm band between 80 and 110 MHz). An automatic-gain-control circuit, consisting of negative- and positive-temperature-coefficient thermistors, then passes the signal on to a push-pull rf amplifier which reduces second-order intermodulation distortion; the amplifier drives a double-balanced mixer, which reduces both second- and third-order distortion. The mixer converts the signal to a 40.525-MHz intermediate frequency. A crystal filter rejects the second image frequency (39.475 MHz), and a second i-f at 525 kHz is derived in a second mixer. The signal then goes to the main selectivity section, where the bandwidth is determined.

A new double-mixing technique in the selectivity section is what keeps the slopes of the frequency-response skirts constant. The 525-kHz i-f is first translated to between 52 and 64 kHz by one of a pair of "complementary" oscillators, and then a low-pass filter with a steep cutoff sets one edge of the final bandpass response. The signal is next converted back up to 525 kHz, and the second "complementary" oscillator, which is on the opposite side of the i-f, "flops" the signal over in the 52–64-kHz range. A second low-pass filter provides the other cutoff skirt of the bandpass response. The bandwidth is varied by adjusting the frequency difference between the two complementary oscillators, while the bandpass-cutoff skirts are determined only by the low-pass filters.

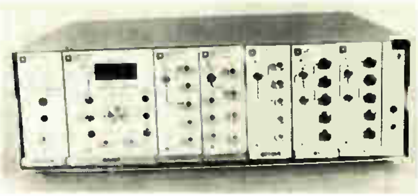
The signal then is passed through further i-f amplifiers and an agc circuit before being applied to the audio section for output on a built-in loudspeaker or phone jack. A front-panel microvoltmeter with a linear scale is connected in the agc loop to display input voltage.

The receiver uses no mechanically tuned components in the radio-frequency section—front-panel tuning is done only on the 2.75–3.75-MHz master oscillator of the receiver/monitor.

Rohde & Schwarz, 111 Lexington Ave., Passaic, N.J. 07055 [362]

Tester checks data sent at 70 megabits/second

A bit-error rate analyzer, designated the model 3200, is a modular test set capable of analyzing data-communications systems operating up to 70



megabits per second. The basic test set consists of three modules: a generator, an analyzer and an interface. Standard interfaces are ECL, TTL, T1, T2, and V.35, with special interfaces supplied upon request. The generator module produces a repeating 1,048,575-bit pseudo-random bit sequence at a rate determined by the interface module, and the bit pattern is applied to the interface module where the signal conversion takes place. The analyzer module accepts a repeating bit stream and a timing signal from the active interface and compares this received data with an error-free replica on a bit-by-bit basis. Bit errors and bit-error rates are shown on a 4-digit LED display. Price for the basic test set is $6,500. Delivery time is 90 days.

International Data Sciences Inc., 100 Nashua St., Providence, R.I. 02904 [372]

Low-frequency receiver has two-octave tuning range

A tunable low-frequency receiver for applications in sonar, acoustics, and radio-frequency monitoring covers 40 to 200 kilohertz with a sensitivity of 0.1 microvolt. Designated the model LF-24, the unit offers a choice of 1.2 or 4 kHz intermediate-frequency bandwidth, more than 40 hours of operation from an internal rechargeable battery, external operation from 12 volts dc or an optional 110 v ac adapter, dual input for an acoustic hydrophone and rf signal generator, and automatic gain control.

Bayshore Systems Corp., 5406A Port Royal Rd., Springfield, Va. 22151 [373]

Phone hybrid transformer converts 4-wire to 2-wire

Designed to meet telephone requirements for data and voice access, the model 51084 transformer contains a hybrid pair for converting a four-wire terminal into a two-wire voice path or the reverse. Isolation, balancing/matching networks, and retarding coils are internal. Frequency response over the range from 100 hertz to 4 kilohertz is within 0.2 dB, over levels from -30 dBm to +10 dBm. Longitudinal balance is 60 dB minimum, and return loss is 26 dB minimum. The trans-hybrid loss exceeds 50 dB. All specifications are met with 150 milliamperes dc of either polarity. The standard unit operates with impedance of 600 or 900 ohms, but any impedance or combination desired by a user can be supplied by minor variations. The unit is potted for rugged service and long life in any environment. Price of the 51084 is $69 each in quantities of 1,000. Delivery time is stock to four weeks.

Magnetico Inc., 6 Richter Court, East Northport, N.Y. 11731 [374]

Three modems tailored to different data systems

A series of three 2,400-bits-per-second data modems is fully on-line-compatible with the Bell System 201B dataset and is intended for operation over the direct-distance-dial network, series 3002 C2, or unconditioned transmission facilities. The model 2400B1-A, lowest-priced model in the series, operates over dedicated lines or the direct-dial network, using a manual data-access arrangement. It offers instant synchronization, instant carrier recovery, and rapid ready-to-send/clear-to-send response. The model also features analog-loopback and local-digital-loopback diagnostic capabilities. The model 2400B1-B is identical to the A version with the exception that it can provide automatic-answering capabilities. The model 2400B1-C has a diagnostic capability that enables the operator at a central site to select one of up to 41 remote modems for testing of the modem and the transmission link.

Penril Data Communications Inc., 5520 Randolph Rd., Rockville, Md. 20852 [376]

Amplifiers put out 50 watts, cover 500 kHz to 32 MHz

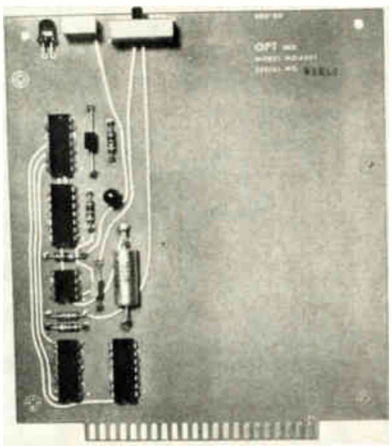
Four linear wideband rf power amplifiers are capable of 50 watts minimum output over a bandwidth from 500 kilohertz to 32 megahertz. The units, designated the series FK30-50, include calibrated wattmeters and

power supplies that can be used at either 110 volts/50-60 hertz or 220 v/50-60 Hz. The amplifiers will accept inputs of a-m, fm, single-sideband, and other complex modulations over their entire frequency ranges. The 42-dB gain of the FK30-50 units permit them to be driven to full power by any standard signal or sweep generator capable of supplying a +5-dBm signal level into a 50-ohm input. The models require no tuning and are capable of useful power outputs at up to 40 MHz with reduced gain. Saturated power is as high as 85 watts. The four models range in price from $1,375 to $2,085.

Rf Power Labs Inc., 11013 118th Place N.E., Kirkland, Wash. [375]

Printed-circuit card answers phone data calls

Compatible with the Bell System data-access arrangement (DAA) 1001A-CBS and with DTL/TTL circuitry on the user's end, an automatic answer card indicates and controls the transmission circuit during incoming phone calls. Electronic circuits are housed on the printed-circuit card, measuring 4½ by 5¼ by ½ inches and using a 22-pin card-edge connector. All controls are positioned on the outside edge of the card, designated the model 4301, for ease of adjustment in a rack-mounted environment. In operation, indication of an incoming call at the DAA activates the 4301 card which, in turn, performs the "off-hook" function. After a brief period, the 4301 transmits a signal to the customer's equipment in the form of a logic level indicating that the data path is complete and that information exchange may begin. If the mode switch is in "automatic," the telephone line will be dropped after a predetermined interval, indicating that information exchange may begin. When operating in the "manual" mode, a logic signal from equipment at the end of the transmission will place the telephone line "on hook."

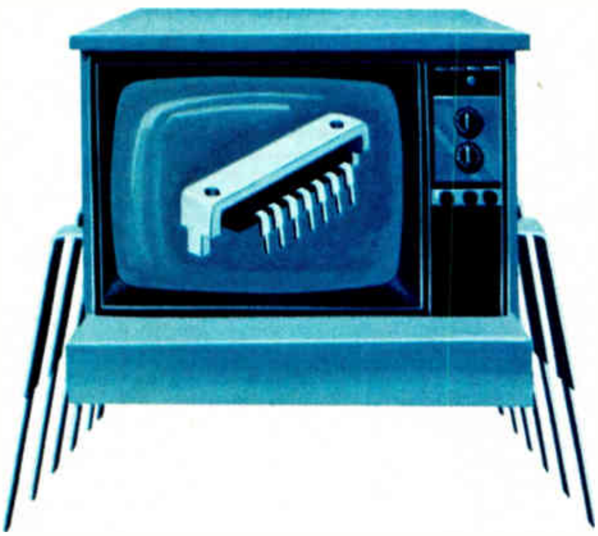


OPT Industries Inc., 300 Red School Lane, Phillipsburg, N.J. 08865 [377]

Who's tuned in on consumer electronics?

Rate ITT by its accomplishments. Take a look at our 3701 — it's a complete monolithic 2-watt FM sound system for TV, radio and other FM sound communications. It is packaged in a 14-pin power DIP. It eliminates shielded volume control cables and is impervious to output short circuits. It drastically reduces your total component requirement while providing limiting with less than 100 μV input. It's only one in a line of ITT devices that includes the popular 1330, 1352, 3064, 3065 (plus several proprietary circuits), as well as double-plug diodes, glass rectifiers, zeners and other consumer-oriented components. Tune in to ITT now!

ITT...Logically

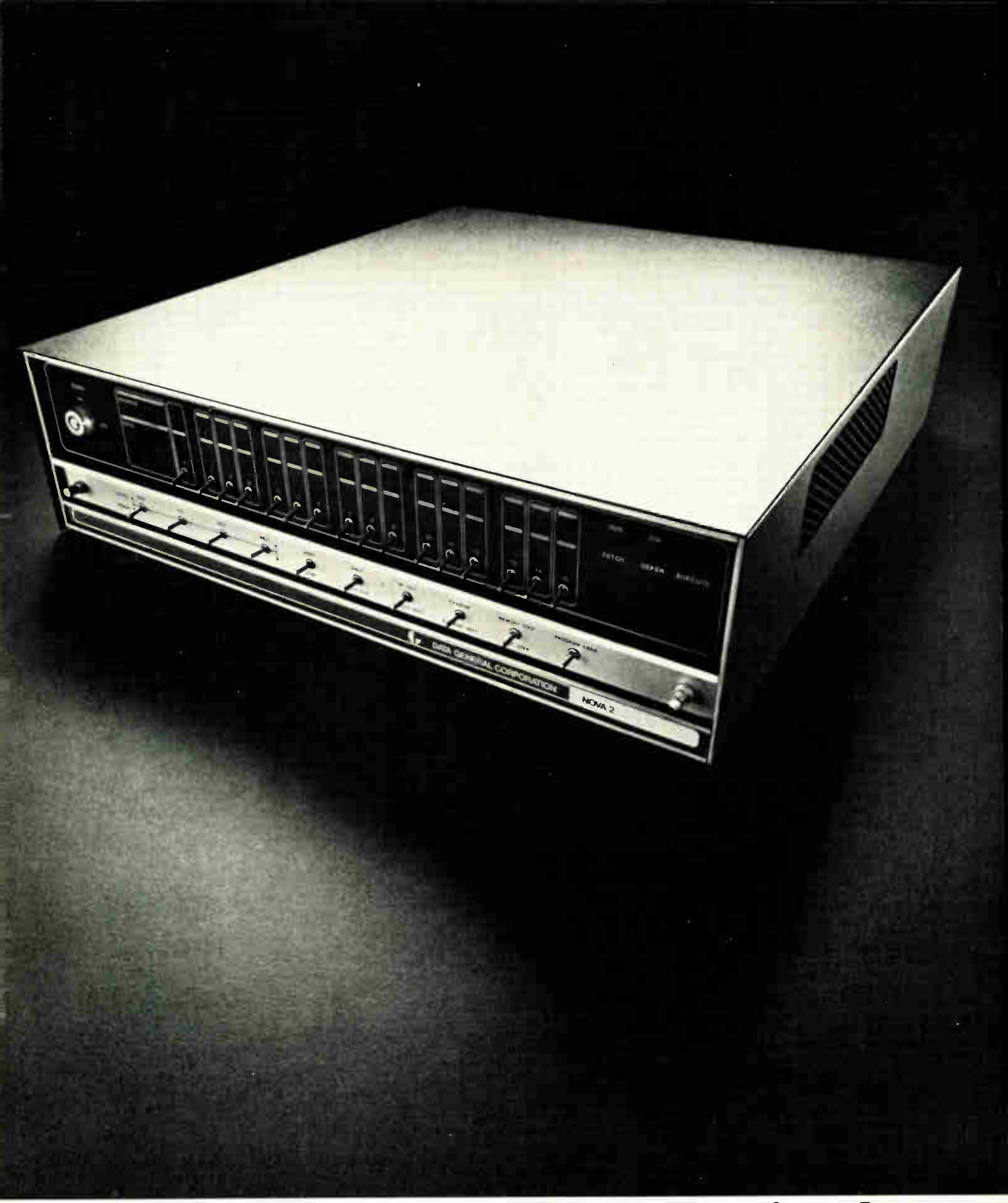


semiconductors

ITT Semiconductors is a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida 33407. Phone 305/842-2411. Factories in West Palm Beach, Florida • Lawrence, Massachusetts • Footscray, England • Colmar, France • Freiburg, Germany • Cascais, Portugal • Taipei, Taiwan • Sydney, Australia.

ITT

Circle 175 on reader service card



Now, nobody needs to wait for the computer everybody wants.

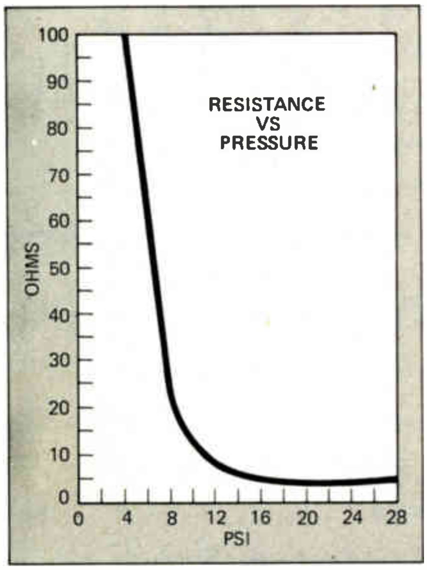
Materials

Elastomer has sensor quality

Resistance of conductive material varies with pressure over wide range

The resistance of a new conductive elastomer varies linearly with pressure over a range wide enough to make it suitable for a host of sensor applications, say its developers. The material, called Dynacon, was developed by a chemist and a chemical engineer who formed Dynacon Industries Inc. in Leonia, N.J., to make and market it. Dynacon is cast in sheets of treated metal particles suspended in a rubber or plastic that resemble the conducting elastomers being used for such things as electromagnetic shielding and electrical connectors.

However, unlike these conventional materials, which rely on the conduction of electrons by suspended metal particles in contact, Dynacon has an intermediary semiconducting zone—referred to as a charge-transfer complex by Dynacon president Harold Charles—which conducts electricity under pressure only along the direction in which the pressure is applied. The metal particles need not be in contact for conduction to take place, Charles emphasizes. Its resistance can be as high as 10 megohms and as low as 0.1 ohm.



Charles points out that the material can be produced in a variety of ways—to conduct very well, or only barely; to resist pressure or yield readily; or almost any combination of these features. It can be either cast or molded and die-cut from cast sheets into various forms. Current rating is 0.5 ampere per square inch, although intermittent currents of up to 5 A per square inch can be tolerated, says Charles. Voltage range is 6 to 13 V, with intermittent voltages considerably higher.

Right now, the Dynacon is a material in search of an application. And, accordingly, it is being made available in a sample kit containing 50 square inches of 25-mil-thick Dynacon in a silicone-rubber base.

Potential applications for what Charles calls Dynacon C include pressure, torque, and tension gages, potentiometers, small-motor controls, weight scales, and leveling devices. At least one company is considering it as a pressure sensor in the "hand" of a robot, Charles says.

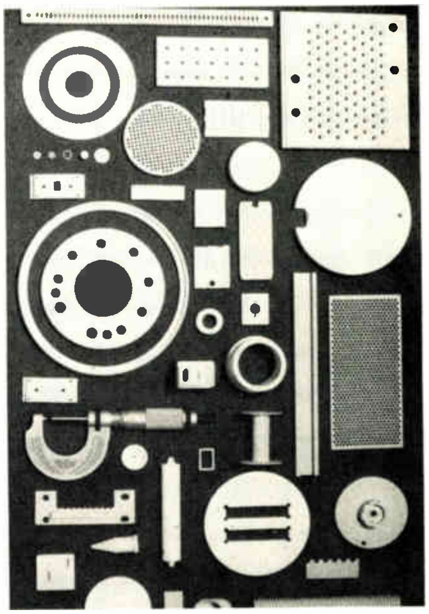
Another version of the material is Dynacon A, a highly conductive plastic for low-current switch elements, electromagnetic shields, strain-gage elements, and bin-level sensors. A third variation, Dynacon B, switches on when pressed.

Price of the sample kit is $10.

Dynacon Industries Inc., 117 Fort Lee Rd., Leonia, N.J. 07605 [340]

High-temperature parts available in ceramics

Precision high-temperature components and fixtures are available in ceramics such as aluminum oxide, aluminum silicate, boron nitride, and silicon nitride. If they are machined in both the green and fired states, complex geometries can be produced. Accuracy can be held to within +1%, but finer tolerances of +0.001 inch are also possible. Heat sinks, crucibles, and insulators are



among the wide variety of components available.

Duramic Products Inc., 426 Commercial Ave., Palisades Park, N.J. 07650 [477]

Polishing powder made for gallium phosphide wafers

A low-cost polishing compound, specifically designed for gallium phosphide (GaP) wafer production, is designated Gaaspol A. The material generates highly specular, damage-free surfaces with considerable stability and few pits or hillocks. Producing high-quality polishes in less than 30 minutes, Gaaspol A is packaged as a powder in individual vials. Each vial is mixed with deionized water to make 500 cubic centimeters of noncorrosive, nonhazardous solution. The polish is available from stock at $5 per vial or $30 per box of 12 vials.

Geos Corp., Stamford, Conn. 06902 [480]

Stamped heat sink made for TO-3 cases

The model 351 is an aluminum two-piece (base and retainer) stamped heat sink for the TO-3 cases used in pc-board applications. Said to require minimum board space and offer optimum heat transfer, the 351

Ideal Clamp Mfg. Co., 202 Bradford St., Brooklyn, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Ilsco Copper Tube & Products, Inc., 5629 Madison Rd., Cincinnati, Ohio
Industrial Screw & Supply Co., 711 W. Lake St., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kliegl Bros. Universal Electric Stage Lighting Co., 321 W. 50th St., New York, N. Y.
Krueger & Hudepohl, 232-8 Vine St., Cincinnati, Ohio
Morse Co., Frank W., 301 Congress St., Boston, Mass.
Multi Electrical Mfg. Co., 1840 W. 14th St., Chicago, Ill.
Patton-MacGuyer Co., Baker St. & Virginia Ave., Providence, R. I.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Rajah Co., Locust Ave., Bloomfield, N. J.
Risdon Mfg. Co., Naugatuck, Conn.
Shain, Chas. D., 145 Beach, 119th St., Bell Harbor, N. Y.
Shakeproof, Inc., 2565 N. Keeler Ave., Chicago, Ill.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Square D Co., 6060 Rivard St., Detroit, Mich.
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zierick Mfg. Co., 385 Gerard Ave., New York, N. Y.

Magnesium

see Metals

Magnets

PERMANENT MAGNETS

Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Indiana Steel Products Co., 135 S. La Salle St., Chicago, Ill.
Taylor-Wharton Iron & Steel Co., Highbridge, N. J.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind. (See page 171.)

Metals

ALUMINUM

Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa.

MAGNESIUM

American Magnesium Corp., 2210 Harvard Ave., Cleveland, Ohio
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit, Mich.
Dow Chemical Co., Midland, Mich.

NICKEL

Apollo Metal Works, 6601 S. Oak Park Ave., Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Ingersoll Steel & Disc Co., New Castle, Ind.
International Nickel Co., 67 Wall St., New York, N. Y.
Lukens Steel Co., Coatesville, Pa.
Riverside Metal Co., Riverside, N. J.
Superior Metal Corp., Clearing, Ill.

SPECIAL METALS

American Electro Metal Corp., 165 Broadway, New York, N. Y. (See page 114.)
American Platinum Works, New Jersey, R. R. Ave., at Oliver St., Newark, N. J.
Baker & Co., Murray & Austin Sts., Newark, N. J.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Callite Tungsten Corp., 544 39th St., Union City, N. J. (See page 46.)
Cohn, Sigmund, 44 Gold St., New York, N. Y.
Cross, H., 15 Beekman St., New York, N. Y. (See page 181.)
William B. Driver Co., Newark, N. J. (See page 143.)
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Handy & Harman, 82 Fulton St., New York, N. Y.
Independent Contact Mfg. Co., 540 39th St., Union City, N. J.
International Nickel Co., 67 Wall St., New York, N. Y.
J. M. Ney Co., Hartford, Conn.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.

STEEL, ELECTRICAL

Allegheny-Ludlum Steel Corp., Oliver Bldg., Pittsburgh, Pa.
American Rolling Mill Co., Curtis St., Middletown, Ohio
Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa.
Empire Sheet & Tin Plate Co., N. Bowman St., Mansfield, Ohio
Follansbee Steel Corp., Third & Liberty Sts., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
Republic Steel Corp., Alloy Steel Div., Massillon, Ohio
Union Drawn Steel Div., Republic Steel Corp., Harsh Ave., S. E., Massillon, Ohio
Wheeling Steel Corp., Wheeling Steel Corp. Bldg., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown, Ohio

THERMOSTATIC METALS

Baker & Co., Murray & Austin Sts., Newark, N. J.
Brainin Co., C. S., 20 Van Dam St., New York, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Chace Co., W. M., 1608 Beard Ave., Detroit, Mich.
Dole Valve Co., 1941 Carroll Ave., Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J. (See page 112.)

Mica

Asheville Mica Co., 5 River Rd., Biltmore, N. C.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
English Mica Co., 220 E. 42d St., New York, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Huse-Liberty Mica Co., 171 Camden St., Boston, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Macallen Co., 25 Macallen St., Boston, Mass.
Mica Co. of Canada (N. Y.), Inc., Massena, N. Y.
Mica Insulator Co., 200 Varick St., New York, N. Y. (See page 100.)
Mica Mfg. Co., Sperry Bldg., Brooklyn, N. Y.
Mica Products Mfg. Co., 139 Spring St., New York, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
New England Mica Co., Waltham, Mass.
New Hampshire Mica & Mining Co., Washington St., Keene, N. H.
Richardson Co., 27th & Lake Sts., Melrose Park, Ill.
Schoonmaker Insulation Co., A. O., 635 Greenwich St., New York, N. Y.
Southern Mica Co., Johnson City, Tenn.
Spruce Pine Mica Co., Spruce Pine, N. C.
Tar Heel Mica Co., Plumtree, N. C.
U. S. Mica Mfg. Co., 1521 Circle Ave., Forest Park, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Microphones

American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal.
Amperite Co., 561 Broadway, New York, N. Y.
Astatic Corp., 830 Market St., Youngstown, Ohio. (See page 146.)
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio. (See page 22.)
Carrier Microphone Co., 439 S. La Brea Ave., Inglewood, Cal.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electro Voice Mfg. Co., 1239 South Bend Ave., South Bend, Ind. (See p. 154.)
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago, Ill.
Gates Companies, Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Olson Mfg. Co., 362 Wooster Ave., Akron, Ohio
Operadio Mfg. Co., St. Charles, Ill.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Rowe Industries, Inc., 3120 Monroe St., Toledo, Ohio
Shure Bros., 225 W. Huron St., Chicago, Ill. (See page 40.)
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Tibbetts Laboratories, 179 Fifth St., Cambridge, Mass.
Turner Co., 909 17th St., N.E., Cedar Rapids, Iowa
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Western Electric Co.—see Graybar Electric Co.

Motor-Generators

see Generators

Motors

FRACTIONAL HORSEPOWER MOTORS

Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Allis Co., Louis, 427 E. Stewart St., Milwaukee, Wis.
Armor Electric Mfg. Co., 1020 Holland St., Erie, Pa.
Baldor Electric Co., 4370 Duncan Ave., St. Louis, Mo.
Barber-Colman Co., River & Loomis Sts., Rockford, Ill.
Black & Decker Electric Co., Kent, Ohio
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
B & R Mfg. Co., Toledo Factories Bldg., Toledo, Ohio
Brown-Brockmeyer Co., 1000 S. Smithville Rd., Dayton, Ohio
Burke Electric Co., 12th & Berry Sts., Erie, Pa.
Canatsey Electric Mfg. Co., 620 Wyandotte St., Kansas City, Mo.
Century Electric Co., 1806 Pine St., St. Louis, Mo.
Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.
Delco Appliance Division, General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
Delco Products Div., General Motors Corp., 329 E. First St., Dayton, Ohio
Diehl Mfg. Co., Trumbull & First Sts., Elizabethport, N. J.
Dumore Co., 14th & Racine Sts., Racine, Wis.

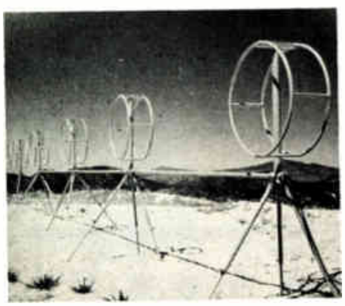
HERMES LOOP ANTENNA

THREE SAMPLE SITES
ON THE NORTH AMERICAN
CONTINENT —

DIFFERENT LATITUDES
DIFFERENT CLIMATE

FROBISHER BAY, CANADA

MARSHFIELD, MASS.



NEAR SAN DIEGO, CALIF.

Good Listeners maintain a low profile

Even in the solitude of the forest depths, from rooftops, arctic tundra, swamps to sweltering tropics, 'neath snow, sand or ice,
the Hermes Loop antenna keeps an ear to the sky.
The amazing aperiodic antenna does away with vast log periodic and rhombic arrays - those towering antenna farms.
Excellent directional characteristics in rosette configuration, the Hermes loop antenna provides an omnidirectional broadband receiving array in space merely 1/100th that of the traditional antenna farm.
More than 53 government agencies around the world have pressed the loop antenna into service.
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Only Hermes Electronics makes it.

2-32MHz BROADBAND

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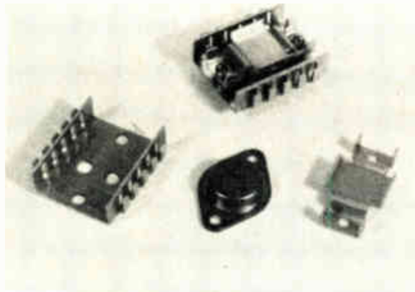
Hermes Electronics Limited
Suite 315
2020 F Street NW
Washington, DC 20006 USA
202-296 2978
TWX 710 822 1106

utilizes a lanced fin configuration in the base piece for maximum surface exposure. Also, the incorporation of a stamped spring-type retainer in the mounting of the device ensures a positive surface alignment between the device and base, taking little or



no space above the device while offering extra heat dissipation. Available from stock with no finish, price of the base is 15 cents; of the retainer, 10 cents.

Aham, 968 W. Foothill Blvd., Box 909, Azusa, Calif. 91702 [479]

Acid gold strike solution produces 24-karat plating

An acid gold strike solution, called E-100, which produces a dense 24-karat gold electroplate, is specifically designed to promote adhesion of subsequent precious-metal electroplates, particularly over base metals that tend toward passivity. These include steel, nickel, and Kovar. The E-100 strike solution is also recommended as a preplate for the company's E-70 bright gold-plating solution, which is suitable for the processing of printed circuits, connectors, contacts, diodes, switches and relays.

Engelhard Industries, 430 Mountain Ave., Murray Hill, N.J. 07974 [405]

Conformal coating protects, stabilizes resistor networks

Hybrisil is the name of a set of conformal coatings that have been specifically designed to protect and stabilize thick- and thin-film resistor networks. The materials, which are one-part systems, silicone-based and easily applied, are said to provide a low-cost yet reliable process for resistor encapsulation. In addition, the need for high-temperature firings with cermet encapsulations is avoided. Several Hybrisil compositions are offered. Hybrisil-100 cures to a flexible translastic material in normal room humidity. Hybrisil-200 is a silicone-mica-filled system that cures at an elevated temperature. Hybrisil-300 also cures at an elevated temperature to produce a coating that will withstand very high voltage. Hybrisil preparations are available in pint, quart, gallon and 5-gallon sizes. The quart size is priced at $20.

Transene Co. Inc., Rte. 1, Rowley, Mass. 01969 [406]

Thick-film pastes available in a kit

Evaluation kits of a thick-film paste system for electro-optics consist of four conductor materials and two dielectric materials, including high- and low-temperature-firing nickel conductors, copper and silver conductors, an opaque dielectric, and a clear dielectric. These pastes, and others in the system, are designed for a variety of electro-optics applications, including the production of LED, liquid-crystal, and plasma displays, channel multipliers, fiber optics and ultraviolet-transmitting faceplates. The paste systems are said to raise throughput and yields, and also to improve both performance and reliability.

Cermalloy, 14 Fayette St., Conshohocken, Pa. 19428 [407]

True rms voltage, current and power measurements all at 0.1% accuracy

YEW INSTRUMENTS FOR PERFECTION

A three-in-one instrument, Type 2503 provides digital readout of power (300mW to 18kW), true rms voltage (3V to 600V) and current (100mA to 30A). Our patented time division technique assures accurate, precise representation of all types of waveforms without regard to distortion content. This versatile unit is thus ideally suited to power measurement of thyristor-controlled circuits, fluorescent lamps, motors, transformers, magnetic circuits and a wide range of other devices.

Quick response, negligible instrument loss, high overload stability, photocoupler isolation of input and output circuitry, and outstanding noise rejection more than meet the needs of even the most stringent applications. The standard Type 2503 is equipped with a BCD output and remote control facility, with analog output available as an option.

Let us tell you how Type 2503 can be put to work for you as either a single instrument or in a systems application.

- **Main Specifications**

Measurement Ranges: Voltage; 3/10/30/100/300/600V
Current; 0.1/0.3/1/3/6/10/30A
Power; 300mW to 18kW

Frequency Ranges: ···· Voltage; DC and 25Hz to 2kHz
Current; 25Hz to 2kHz
Power; 40Hz to 1.2kHz

Accuracy: ················ Voltage; ±(0.1% of rdg + 0.05% FS) from 50Hz to 400Hz, ±(0.2% of rdg + 0.07% FS) for DC, 25Hz to 50Hz and 400Hz to 2kHz
Current; ±(0.1% of rdg + 0.05% FS) from 50Hz to 400Hz, ±(0.2% of rdg + 0.07% FS) from 25Hz to 50Hz and 400Hz to 2kHz
Power; ±(0.1% of rdg + 0.05% FS) from 50Hz to 400Hz, ±(0.2% of rdg + 0.07% FS) from 40Hz to 50Hz and 400Hz to 1.2kHz

Resolution: ·············· 1mV/digit, 10μA/digit, 0.1mW/digit

- ***Suitable for precision measurement of even distorted waves***
- ***Protected to withstand 2,200V AC***

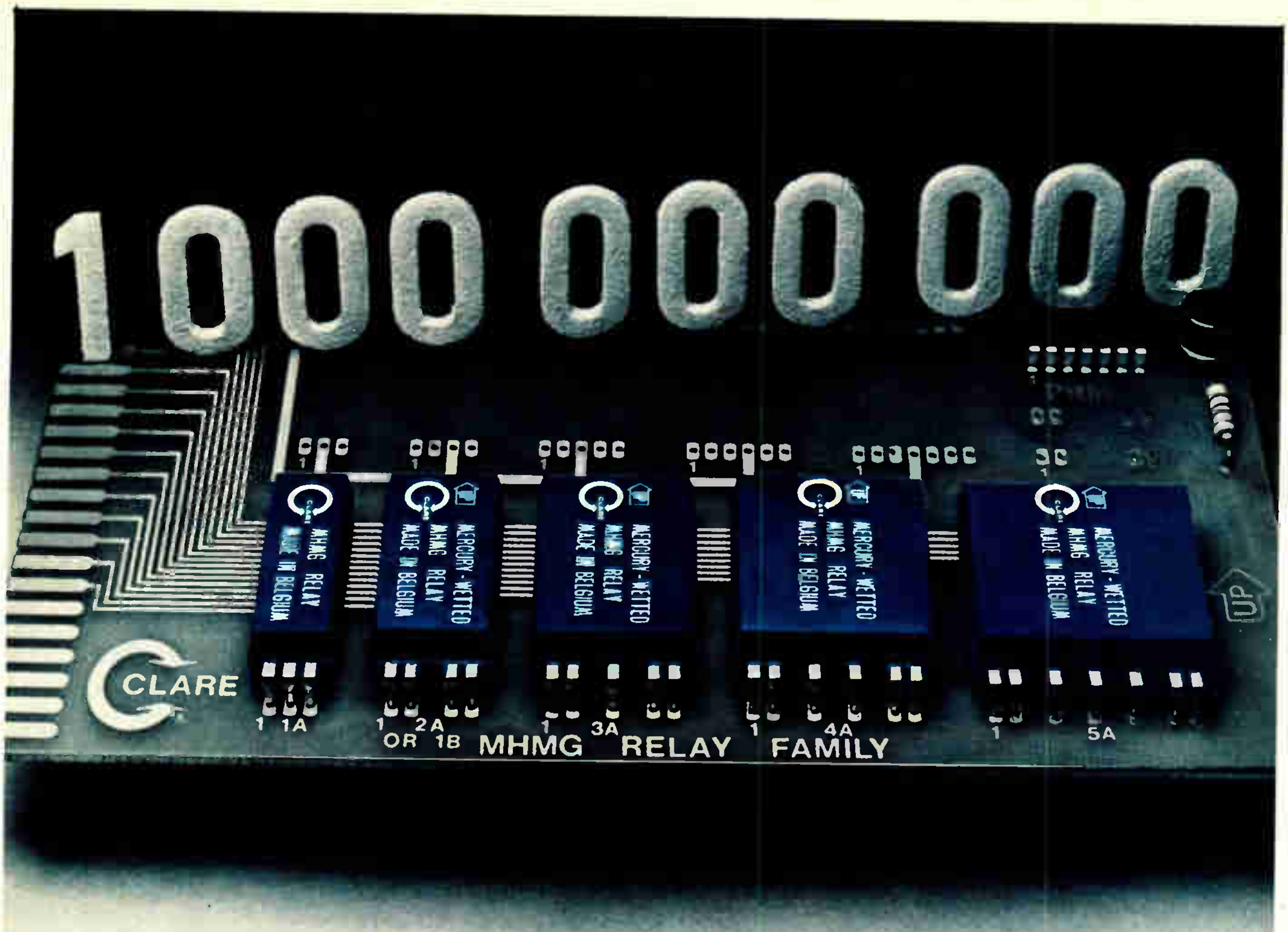
YEW

- *For Electronic Measuring, Recording Instruments:*

YOKOGAWA ELECTRIC WORKS, LTD.

Yaesu-Mitsui Bldg., 5-7 Yaesu, Chuo-ku, Tokyo 104, Japan Phone: 274-6511 Telex: J28544 YEWTOK

Overseas Offices: • YEWTEC CORPORATION, 1995, Palmer Ave., Larchmont, New York, 10538, U.S.A. Phone: 914-834-3550, Telex: 710-566-1104 • YEW EUROPÄISCHES VERBINDUNGSBÜRO, 2000 Hamburg 26, Hammer Landstrasse, 76 I.O.G., Germany. Phone: Hamburg 2191310, Telex: 41211435 YEW D (for domestic call, omit "41")
Representatives in Europe: • Belgium: COMPTOIR COMMERCIAL INTERNATIONAL S.A., (03) 32.78.64 • France: TEKELEC AIRTRONIC, 626-0235 • Finland: FINN METRIC OY, 460 844 • West Germany: NBN ELEKTRONIK, (08151) 13036 • Italy: VIANELLO S.P.A., 5483811 • Norway: AS MAXETA, 53090 • The Netherlands: TECHMATION NV, 020-456955 • Spain: ATAIO INGENIEROS, 215-35-43 • Sweden: TELEINSTRUMENT A.B., 87-03-45 • Switzerland: OMNI RAY AG, 01-340355 • United Kingdom: MARTRON ASSOCIATES LTD., Marlow (06284) 5071.



BILLIONS OF SWITCHING OPERATIONS AT A PRICE YOU CAN AFFORD

CLARE MHMG

A new family of epoxy molded mercury-wetted relays.

MHMG relays offer billion (10^9) operation-bounce free mercury-wetted switching performance, load handling capability from signal-level to 50 VA, multipole flexibility from one to five contacts, epoxy molded packaging for PCB mounting, and at a cost approaching dry reed relays.

Like all Clare mercury-wetted relays, the heart of the MHMG is a Clare manufactured hermetically sealed glass capsule. Contact switching is mercury-to-mercury. So there's no contact wear, no contact bounce, constant ON and OFF impedances - every operation. Maximum switching ratings for MHMG relays are 350 Vdc, 1 Amp.

The MHMG family are high quality components for telecommunications, business machines, industrial data logging and control, and other electronic instrument applications.

For more information contact :
C.P. Clare & Co.3101 West Pratt Blvd., Chicago, Illinois 60645.
Telephone (312) 262-7700 - Telex 25-3775

C. P. CLARE & COMPANY a subsidiary of
GENERAL INSTRUMENT CORPORATION

MarkCom

Circle 185 on reader service card

New literature

Resistors. A two-page data sheet from Elliot Industries, 23987 Craftsman Rd., Calabasas, Calif. 91302, describes the series G line of noninductive precision wire-wound resistors. The devices feature small size and stable high-temperature operation. Circle 421 on reader service card.

Product news. Milertronics News, a publication of Milertronics, 525-A Airport Rd., Greenville, S.C., is printed every other month and highlights the company's products, as well as providing applications notes and other information. [422]

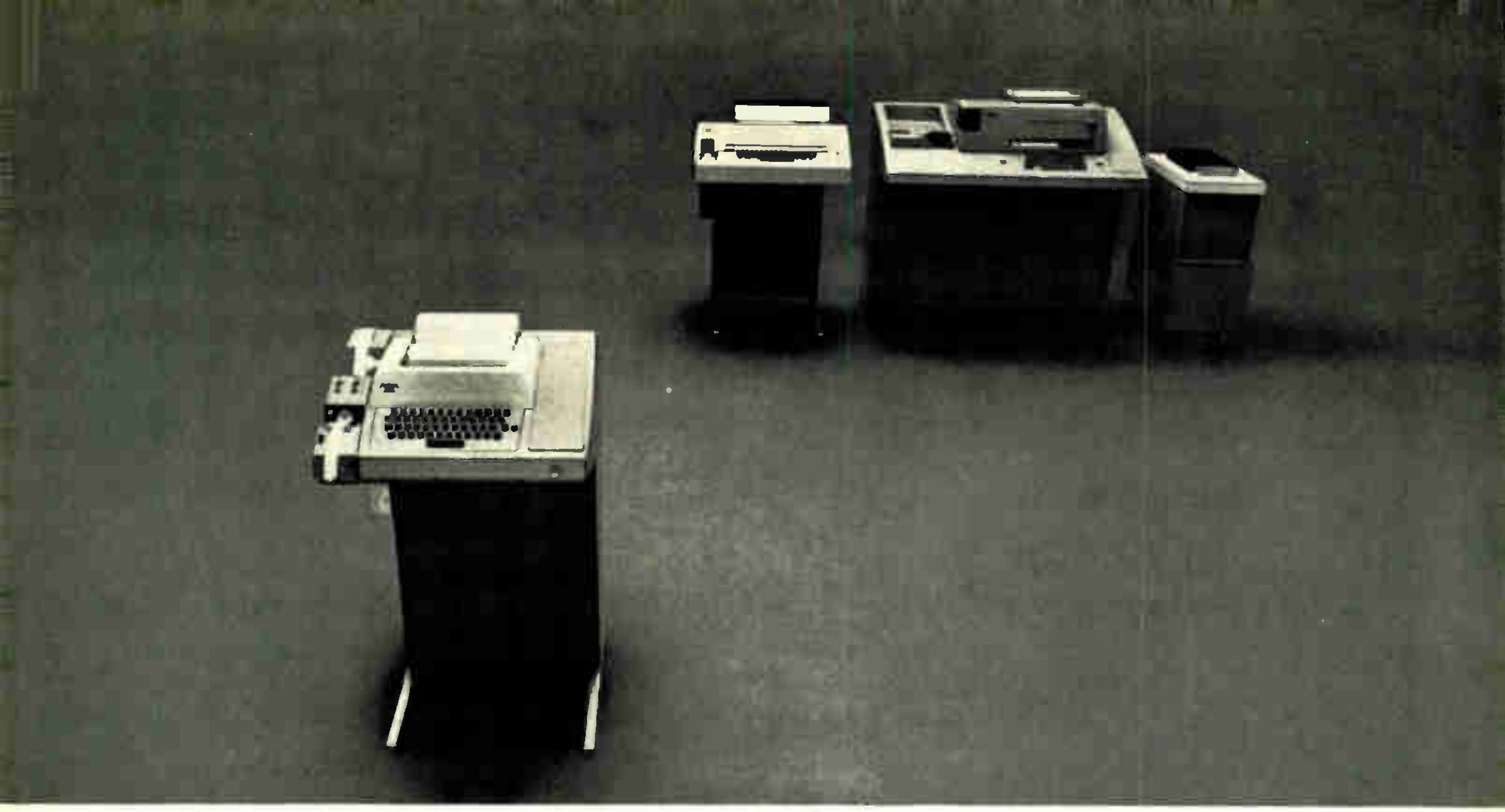
Keyboards. A pair of brochures on keyboards is available from Bowmar Instrument Corp., 8000 Bluffton Rd., Fort Wayne, Ind. The four-

page and six-page publications respectively provide applications and product information. [423]

Interconnections. Amphenol Industrial division, Bunker Ramo Corp., 1830 S. 54th Ave., Chicago, Ill. Integrated-circuit interconnections are described in a 16-page catalog, which provides specifications and line drawings. [424]

Annunciators. A 16-page brochure from TEC Inc., 9800 N. Oracle Rd., Tucson, Ariz. 85704, describes the Data Monitor series 7700 annunciators, which provide high-density alarm displays by integrating solid-state logic into the company's Data Panel display systems. [425]

Fuse resistors. The effective use of fuse resistors is discussed in a bro-



As good as the model 33 is, we're aware that for some people it's not enough.

Our model 33 is the standard of the data communications business for three very good reasons. Economy, reliability and versatility.

Yet we realize some applications require a little more. That's why the model 33 isn't an orphan.

Some of our customers want everything the model 33 offers, but they want it in a wide-platen configuration to accept standard computer fan-folded forms. For them, we make the model 38.

Some customers may have applications requiring an extremely rugged terminal. A machine that can operate day and night for months on end with little maintenance. For them, we make our heavy-duty model 35.

Still others need a unit that can give them greater speed. For them we build our 4210 magnetic tape terminal. The 4210 is compatible with all our other terminals and can move data on-line at speeds up to 2400 wpm.

Our data terminals are offered in various configurations: models 33, 35 and 38 can be ordered as ASR, KSR and RO units.

It takes more than manufacturing facilities to build the terminals Teletype® Corporation offers. It also takes commitment. From people who think service is as important as sales. In terminals for computers and point-to-point communications.

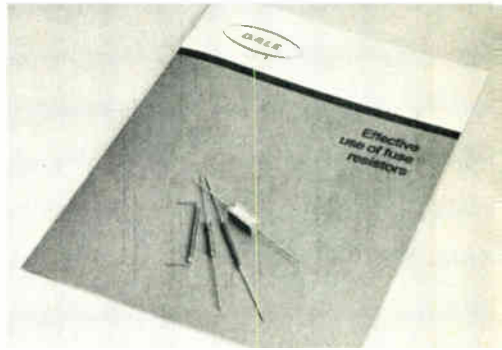
TELETYPE

The computercations people.

For more information about any Teletype product, write or call: TERMINAL CENTRAL, Teletype Corporation, Dept. 53R, 5555 Touhy Avenue, Skokie, Illinois 60076. Phone 312/982-2500.
Teletype is a trademark registered in the United States Patent Office.

Circle 187 on reader service card

New literature



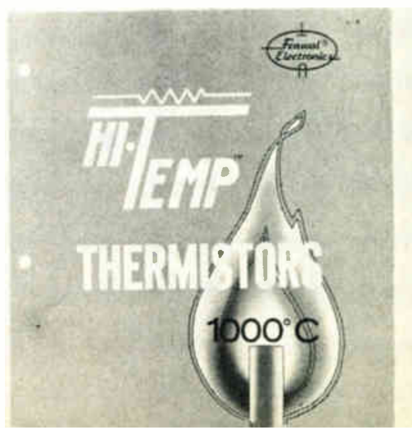
chure issued by Dale Electronics Inc., Box 609, Columbus, Neb. 68601. [426]

Dc-to-dc conversion. A brochure filled with specifications and performance data on miniature dc-dc conversion power-supply ICs and modules is being offered by LRC Inc., 11 Hazelwood Rd., Hudson, N.H. 03051 [427]

Page reader. A set of four data sheets is available from Data Recognition Ltd., Loverock Rd., Battlefarm Estate, Reading, Berks., England, covering the company's Dataterm 3 optical-mark page reader, DT311 full document buffer unit, system 8300 off-line document-reading system, and the system 8301 communications optical-mark-reader computer terminal. [428]

Base-metal contacts. Engelhard Industries, 430 Mountain Ave, Murray Hill, N.J. 07974. A product brochure is being offered to describe precious- and base-metal contacts, clad materials, thick films, plating solutions, brazing metals, and refining services. [429]

Thermistors. Bulletin L-8 describes the Hi Temp series 10,000-ohm thermistor unit manufactured by Fenwal Electronics, 63 Fountain St.,



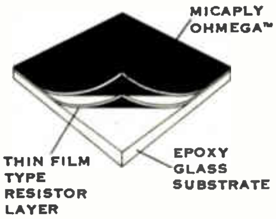
Micaply® Substrates and Circuits

For Thick/Thin Film Applications

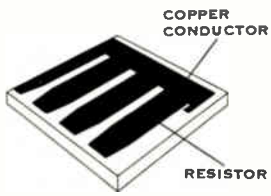
Thick/thin film resistor-conductor circuits utilizing Micaply Ohmega™ Resistor-Conductor Laminates

Circuits of Micaply Ohmega™ offer designers a proven epoxy glass substrate with both the resistor and conductor layers completely covering the substrate on one or both sides. **Selective etching produces conductors complete with integral thin film type resistors as shown at the right.** The circuits shown above are examples of its use to replace more expensive thick/thin film resistor circuits and discrete resistor circuits.

Complete design assistance and circuit production are available. Contact us for an evaluation of your requirement and comprehensive technical literature. Find out how Micaply Ohmega™ can reduce your circuitry cost.



Before Etching

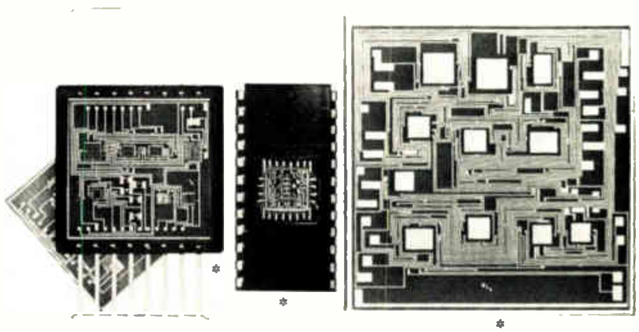


After Etching

- Much lower cost than conventional materials and processing.
- 25 or 100 ohms-per-square sheet resistivity.
- Line widths consistent with thin film microelectronic techniques.
- Subtractive etching process — no screening, firing, or vacuum equipment required.
- 10" x 36" sheets for processing economy.
- Can be easily drilled and cut.
- Can be multilayered for higher density.
- Resistors can be laser trimmed.

**Circuits courtesy Micro Telemetry Systems*

Hybrid microcircuits utilizing Micro-Thin Copper Clad Laminates (a low cost ceramic substrate alternative)



Micaply® Micro-Thin Copper Clad Laminates make possible lower cost hybrid microcircuits. Epoxy glass microcircuits like the ones shown above eliminate the cost and costly processing of ceramic in many applications. Micro-Thin is an epoxy glass laminate completely clad on one or both sides with 100 microinches of copper. Using conventional etching techniques conductors with line widths as fine as two mils can be produced.

Complete design assistance and prototype service is available. Contact us for an evaluation of your requirement and for comprehensive technical literature. Find out how Micaply® Micro-Thin can reduce your microcircuit costs.

- Much lower cost than metal coated ceramic substrates.
- 100 microinch copper clad epoxy glass.
- Can be easily drilled and cut.
- 10" x 12" sheets for processing economy.
- Etched line widths as fine as two mils.
- Can be multilayered for higher density.
- Active and passive chips are easily bonded.
- No screening, firing, or vacuum equipment required.

Request complete literature on Micaply Ohmega™ and Micro-thin Copper Clad Laminate materials and production services.

The Mica Corporation

10900 Washington Boulevard, Culver City, California 90230, (213) 839-5282, TWX: 910-340-6365, Telex: 674999

Micaply International, Ltd. Silloth, Cumberland, England, Silloth 571, Telex: 64120, Cable: Micaply Silloth

Electric Motor Corp., Racine, Wis.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electro Dynamic Works of Electric Boat Co., Ave. A & North St., Bayonne, N. J.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
Franklin Transformer Mfg. Co., 607 22d Ave., N. E., Minneapolis, Minn.
General Electric Co., Schenectady, N. Y.
Hansen Mfg. Co., Princeton, Ind.
Haydon Mfg. Co., Forrestville, Conn.
Heinze Electric Corp., Lowell, Mass.
Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Howell Electric Motors Co., Howell, Mich.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kendrick & Davis Co., Lebanon, N. H.
Kimble Electric Co., 2023 W. Hastings St., Chicago, Ill.
Kingston-Conley Electric Co., 68 Brook Ave., North Plainfield, N. J.
Leich Electric Co., Genoa, Ill.
Leland Electric Co., Dayton, Ohio
Marathon Electric Mfg. Corp., 32 Island St., Wausau, Wis.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Merkel-Korff Gear Co., 213 N. Morgan St., Chicago, Ill.
Motorstat Electric Corp., 5005 Euclid Ave., Cleveland, Ohio
Northwestern Electric Co., 408 S. Hoyne Ave., Chicago, Ill.
Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio
Peerless Electric Co., 740 W. Market St., Warren, Ohio
Redmond Co., A. G., Owosso, Mich.
Reliance Electric & Engineering Co., 1084 Ivanhoe Rd., Cleveland, Ohio
Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Russell Electric Co., 340 W. Huron St., Chicago, Ill.
Signal Electric Mfg. Co., 1915 Broadway, Menominee, Mich.
Smith Mfg. Co., F. A., Union at Augusta, Rochester, N. Y.
Speedway Mfg. Co., 1834 S. 52d Ave., (Cicero) Chicago, Ill.
Star Electric Motor Co., Bloomfield Ave. & Grove St., Bloomfield, N. J.
Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Cal.
Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Sundt Engineering Co., 4759 Ravenswood Ave., Chicago, Ill.
Sun[illegible] E[illegible]rical Div., General Motors Corp., 523 Dana Ave., Warren, Ohio
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Cal.
Valley Electric Corp., 4221 Forest Park Blvd., St. Louis, Mo.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati, Ohio
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Warren Telechron Co., Homer Ave., Ashland, Mass.
Wesche Electric Co., B. A., 1628 Vine St., Cincinnati, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PHONOGRAPH MOTORS

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Diehl Mfg. Co., Trumbull & First Sts., Elizabethport, N. J.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
General Electric Co., Schenectady, N. Y.
General Industries Co., 3537 Taylor St., Elyria, Ohio
RCA Mfg. Co., Camden, N. J.
Rotor Corp. of America, 10 Norwood St., Dayton, Ohio

Mountings

VIBRATION INSULATING MOUNTINGS

Armstrong Cork Co., 995 Concord St., Lancaster, Pa.
Firestone Tire & Rubber Co., 12 S. Main St., Akron, Ohio
Goodrich Co., B. F., 500 S. Main St., Akron, Ohio
Johns-Manville, 22 E. 40th St., New York, N. Y.
Korfund Co., 48-15 32d Pl., Long Island City, N. Y.
Lord Mfg. Co., 1635 W. 12th St., Erie, Pa. (See page 133.)
Vibration Eliminator Co., 25-08 37th Ave., Long Island City, N. Y.

Needles

CUTTING NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Capps Co., Frank L., 244 W. 49th St., New York, N. Y.
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 504 N. Water St., Milwaukee, Wis.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Federal Recorder Co., Elkhart, Ind.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 2947 N. 30th St., Milwaukee, Wis.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Paraloy Co., 600 S. Michigan Ave, Chicago, Ill.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Pfanstiehl Chemical Co., 104 Lake View Ave., Waukegan, Ill.
Phonograph Needle Mfg. Co., 42 Dudley St., Providence, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rangertone, Inc., 73 Winthrop St., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.

PLAYING NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 504 N. Water St., Milwaukee, Wis.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 2947 N. 30th St., Milwaukee, Wis.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Lowell Needle Co., Putnam, Conn.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
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Clendenin Bros., 108 South St., Baltimore, Md.
Cleveland Cap Screw Co., 2917 E. 79th St., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
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Detroit Plating Industries, 1043 Mt. Elliott, Detroit, Mich.
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THE CREATIVE CHALLENGE:

exploring the universe of design possibilities of engineered metallic mesh, mazes and matrices.

NO. 2

EMI & INTERACTION SHIELDING in Computers, Process Controls, & Instruments

The understandable tendency to associate EMI (Electro-Magnetic Interference) exclusively with communications equipment—radio receivers, telephones, radar, etc., is a hangover from the days when the term "RFI" (Radio-Frequency Interference) was used; and, indeed, the earliest applications of shielding were all concerned with attempts to exclude unwanted noise from RF Circuits.

That narrow viewpoint was appropriate in 1944, when we developed the electronics industry's very first RFI gasket, but now, thirty years later, we find ourselves shielding such "high-level" devices as digital logic circuits in computers, process controls, and instruments of all kinds. *In fact, it is difficult to find a single class of electronic devices that does not require effective shielding, in some environments.*

True, the sub-microvolt front end of a communications receiver cannot function in *any* environment (except a "shielded room") without effective EMI attenuation. But anyone who has developed or applied high-density digital circuitry knows that *high-level circuitry, too, can be plagued by EMI, despite the fact that its minimum signal/noise tolerance is at least 100 times (40 dB) higher than that of communications equipment.*

It's all a matter of *environment.* The EMI source from which a communications receiver must be shielded may be a sparking commutator 8 feet away; but the backplane wiring of a digital minicomputer may be only 8 *inches* away from the switching regulator in its own power supply! What is more, broadband digital circuits are sensitive to noise over a much wider spectrum than tuned receiver circuits. And digital circuits are very often used in *close proximity to other high-speed (fast-pulse) digital devices*—printers, teletypewriters, etc. In industrial environments, it is not uncommon to find broadband noise fields that are 50-60 dB stronger than those inside a communications center. *Clearly, the 100:1 sensitivity advantage of digital circuitry can be wiped out by a 1000:1 increase in environmental noise level.*

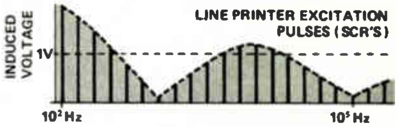
What has all this to do with knitted wire mesh? Simply this: *knitted wire mesh is the most versatile engineered material ever developed for providing the EMI "barrier," or "seal" in a shielding assembly.* It is available in an almost unlimited range of metallic materials, and can be combined with elastomers, to form resilient, highly compressible, close-tolerance, easily installed EMI seals. Mesh can be made air-permeable, for dust filtration. It can be made transparent to light—yet *opaque* to EMI. It can be supplied in a wide range of standard and custom shapes, sizes, and forms. A few of these are shown in Figure 1—but don't let your imagination bog down there. Accept the creative challenge, work with us, and the sky's the limit.

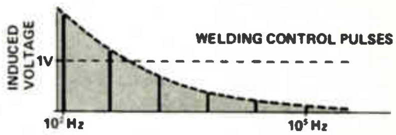
In Figure 2, we have shown three Fourier Spectra of EMI generated by environmental and interactive EMI sources in digital process controls. Note the broad range over which the interference may exceed 1 Volt. In such an environment, *it often takes **weeks** to "debug" a system that worked perfectly in the lab!*

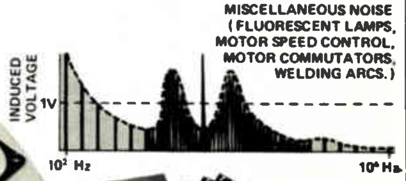
And any system may, even after costly debugging, encounter a *new source* of EMI, and go sour all over again . . .

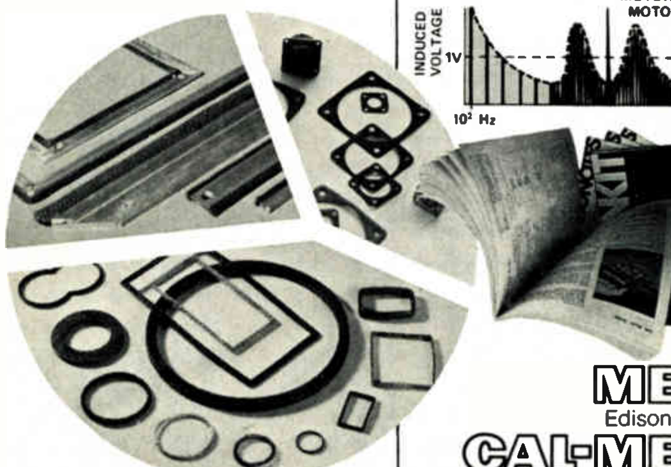
Note: By now, if you are a conscientious designer, you have begun to develop "EMI Anxiety"—the neurotic fear that somewhere out there, evil men are waiting, with megawatt/gigaband/white-noise sources, all focused on your device. These feelings, we are happy to tell you, are far from fantasy. Fortunately, help is available. METEX maintains a free EMI counselling and therapy clinic, at which knitted-wire-mesh techniques are applied—analytically and effectively.

As a first step, write—*today*—for our quarterly engineering publication, **"The Creative Challenge"**—free to engineers and designers whose responsibility includes outwitting today's troubled electromagnetic environment. You'll begin to feel better immediately... and, when our free Design Kit arrives, you will find new courage to apply the samples, photos, and data it contains.









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New literature

Framingham, Mass. 01701. The unit has a referenced temperature of 750°C and a tolerance on resistance of ±30%. [430]

Overvoltage. A four-page bulletin from Heinemann Electric Co., Trenton, N.J. 08602, provides technical information on over- and under-voltage-protection devices. [431]

Switching power supplies. An eight-page article from RO Associates Inc., 3705 Haven Ave., Menlo Park, Calif. 94025, is entitled "Principles and Facts About Switching Power Supplies." Applications and general information are provided. [432]

Direction-finding. The first in a series of applications notes from American Electronic Laboratories Inc., Box 552, Lansdale, Pa. 19446, is entitled "Broadband Direction-Finding Application of Video Detectors from 500 MHz to 20 GHz." Antenna selection and signal processing are discussed, as well as general systems information. [433]

Transistor guide. A 24-page guide to bipolar transistors and FETs is available from Intersil, 10800 N. Tantau Ave., Cupertino, Calif. 95014. The cross-reference lists 1,162 part numbers in alphanumeric order, showing Jedec registration, and house numbers of the major suppliers. In addition, a brief description and indication of applications are given. [434]

Data logger. Monitor Labs Inc., 4202 Sorrento Valley Blvd., San Diego, Calif. 92121. A 16-page brochure describes the system 9400 data logger, which can also be configured for computerized data-acquisition networks. [435]

Irradiated PVC. Brand-Rex Co., Willimantic, Conn. 06226. A revised 12-page specification sheet is available on irradiated polyvinyl chloride, suitable for internal wiring of meters, panels, and electronic equipment, where minimum size and weight are desired. [436]

Soldering. Pure Alloys Inc., 69

New Books

Electronics in the Life Sciences, Stephen Young, Halsted Press, John Wiley & Sons, 198 pp., $11.50.

As its title indicates, this is a book for engineers interested in the biological or medical aspects of engineering. A major problem often encountered in developing electronic systems in such new fields is the level of sophistication to be used. This arises because there is a lack of intuition concerning which parameters are important, which require close control, and what the state of the measurement art is. The tendency is to apply electronic overkill to a particular problem, which, in addition to adding time and expense to a particular project, often doesn't do the job.

Stephen Young's little monograph can give the engineer an insight into how biologists think about electronics and what types of measurements and measurement problems they encounter. The level of electronics is relatively simple. The author spends almost half the book describing such basic laboratory instruments as the oscilloscope, the power supply, and the multimeter. The last half of the book is spent describing data-logging, controlling stimuli and measuring response with available transducers, automated experiments, and digital electronics.

It is the final chapters of the book that are of significant value. Here Young suggests modifications and ways of increasing the sophistication of experiments, and he explains the means of making and interpreting biological measurements.

The value of this work is as much in what isn't said as what is. The book isn't very detailed, yet it describes relatively sophisticated experimental setups. The text is well written, and it is of more value to a person getting started in the field than to one working in it. In brief, it provides an introduction to electronics in biology which allows an engineer to get to work before becoming benumbed by the sophisticated treatises one reads to become an expert in one area of the field.

—Joel DuBow
Components Editor

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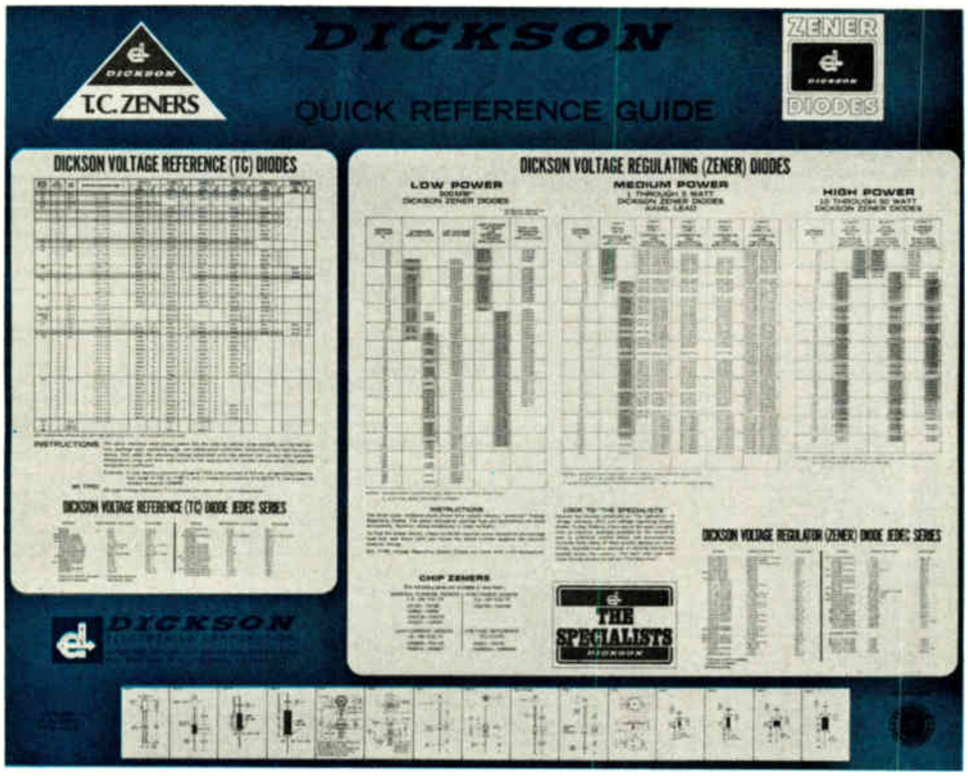

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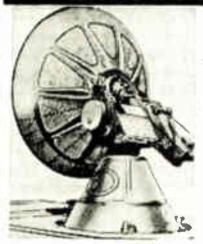

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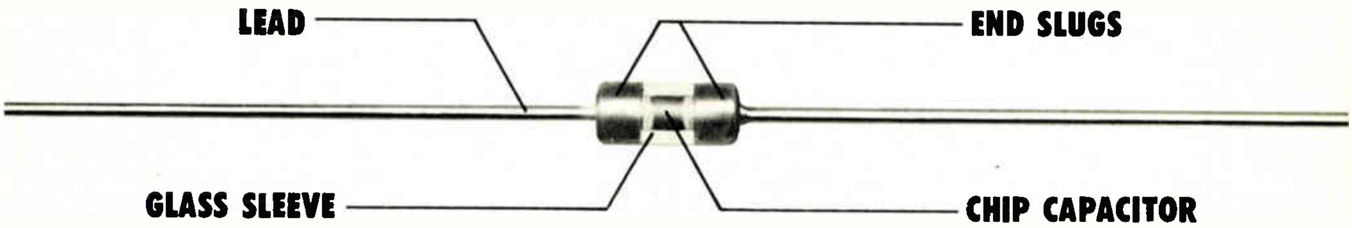

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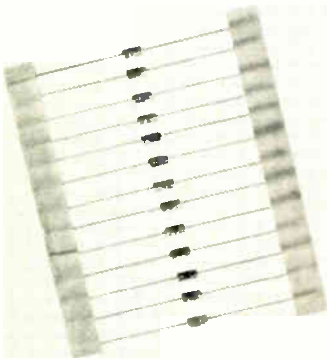

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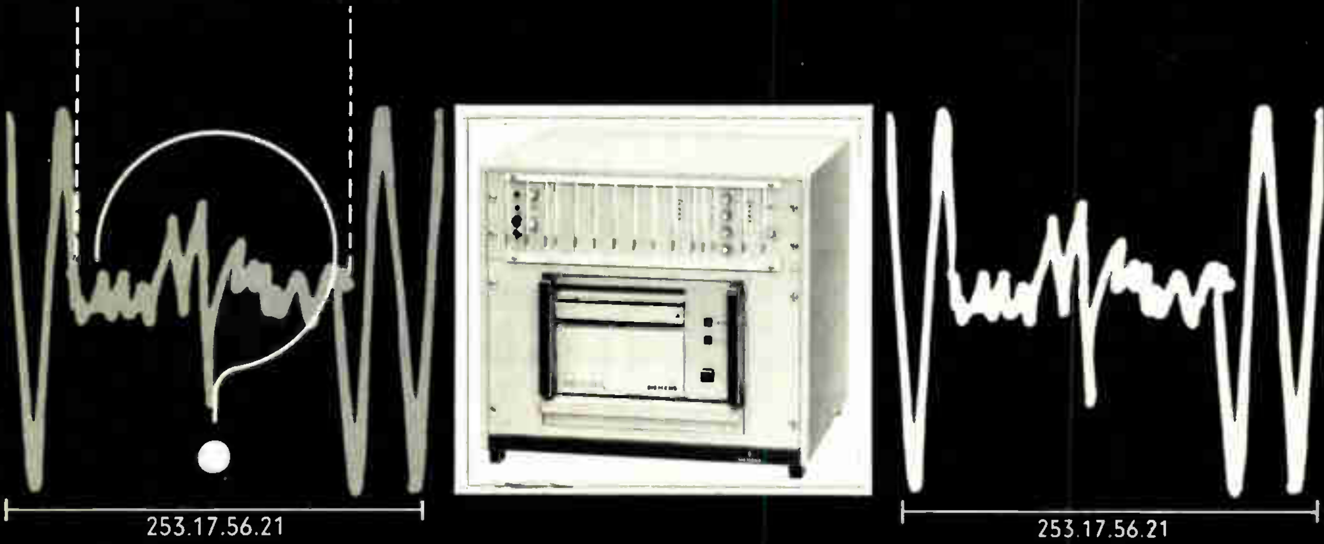

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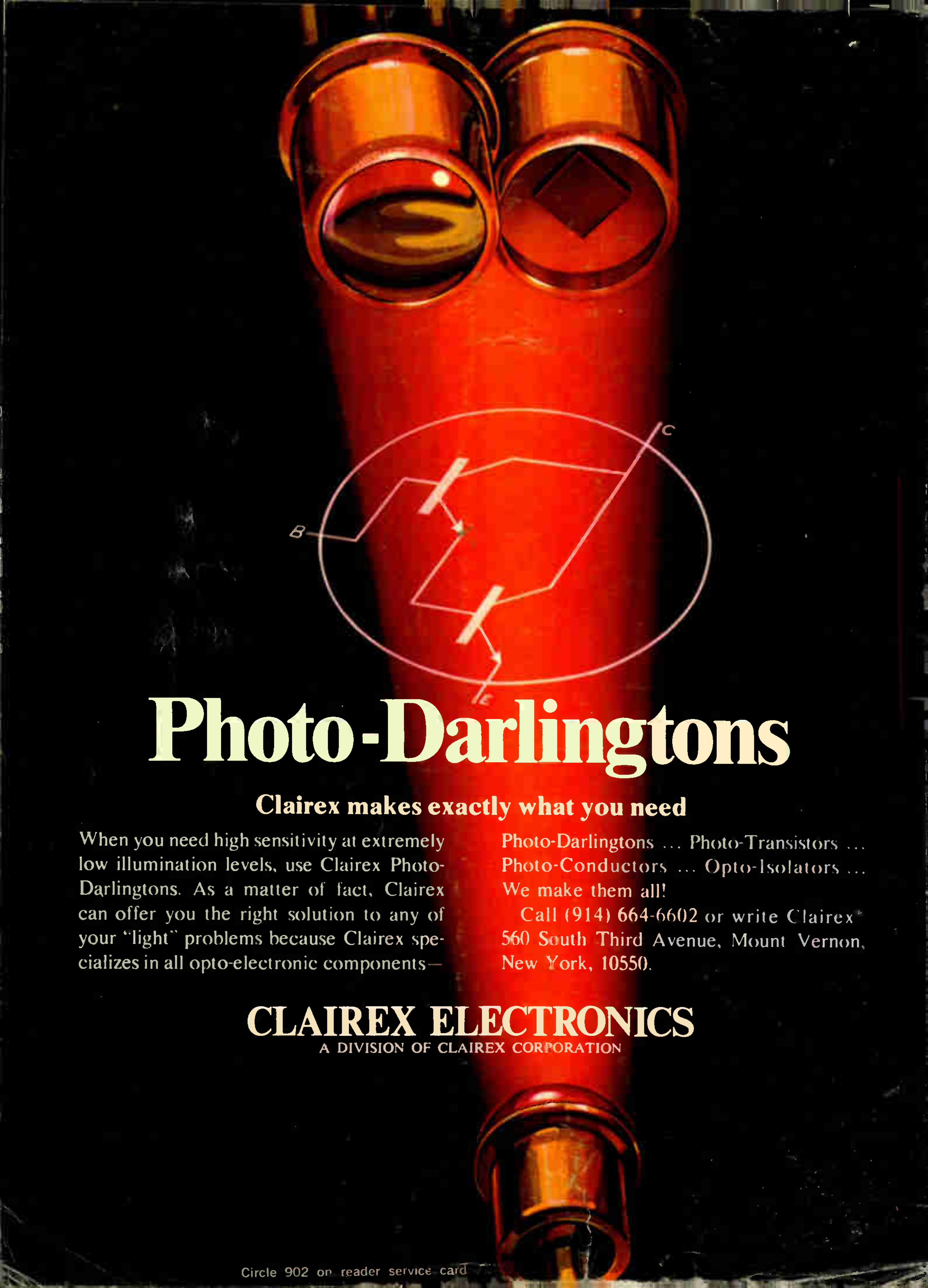

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