FEBRUARY 6, 1975

Industrial hazards call for intrinsically safe designs/91

Microprocessor design with standard logic, part 2/102

Integrating calculator elements on a glass substrate/109

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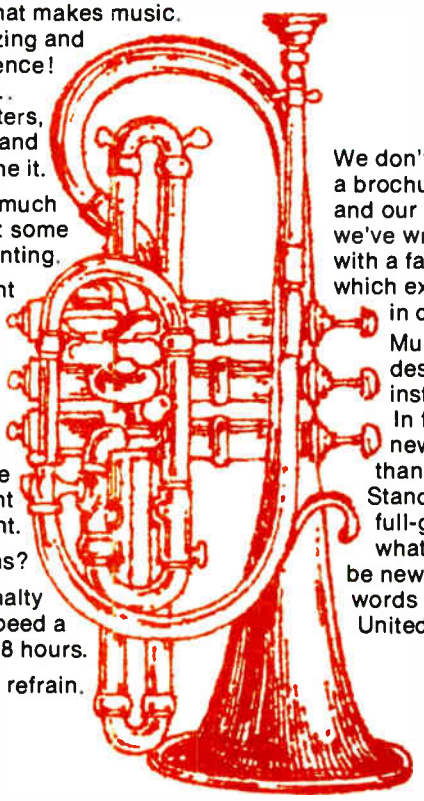

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Electronics
The International Magazine of Electronics Technology
Vol. 48, No. 3 • February 6, 1975

Highlights

The cover: I²L blazes new bipolar path, 83
A non-isolated gate structure boosts the density of the latest integrated-injection-logic chip, which also has five times the speed of a comparable 4-bit n-MOS microprocessor. The next I²L generation is expected to be even faster and should at last make the full benefits of bipolar LSI available to computer designers. Cover is by illustrator Tom Upshur.

Conference announces LSI advances, 72
Visitors to the International Solid State Circuits Conference in Philadelphia this month will learn about: denser-than-ever bipolar chips; faster-than-ever MOS memories; gallium-arsenide FET oscillators that set new power-frequency records; and charge-coupled devices that are revolutionizing analog signal processing.

How to build an intrinsically safe system, 91
The sparking that always occurs in electronic equipment is often powerful enough to trigger explosions in volatile atmospheres. This danger can be eliminated if the circuitry in the hazardous areas operates with low enough voltage, current, capacitance, and inductance values.

Using high-speed logic for microprocessors, 102
The parts count can be reduced when an application requires less than the utmost performance from a processor built from high-speed logic. This is the second half of a two-part article on the design of standard-logic processors that are faster than MOS chips and use fewer devices than random-logic systems.

And in the next issue . . .
An economical two-way pay-TV system . . . eight ways to improve radio receiver design . . . overcoming the deficiencies of zener diodes as voltage reference sources.

Electronics

Publisher's letter

The pace of electronics progress is nowhere more breathtaking than in solid state developments. Our cover story this issue, for example, details a technique for fabricating extremely compact integrated injection-logic gates that, since they require no space-consuming pn junctions for isolation, are comparable in size to a single transistor. What's more, power demands are low. The result: digital I²L structures with thousands of gates on a single bipolar chip. Read all about it on page 83.

The instrument-bedecked cockpit of today's Air Force plane may become a far less crowded place as the trend toward using digital methods in jobs that were once solely analog gains momentum. In place of the maze of "black boxes," a time-shared computer-based CRT display is being tried out at Wright-Patterson AFB. With it, a streamlined console could give the pilot even more data than he has available today—and do it with far more efficient use of space. You'll find our story about the program, called DAIS, on page 76.

Larry Armstrong, our Midwest bureau manager, wrote the story after interviewing the project officers at the Air Force Avionics Laboratory and going for a "trial run" of the prototype cockpit simulator that they have developed. In fact, the "trainee" in the photograph on page 76 is none other than our man Armstrong getting a hands-on demonstration of the DAIS hot bench.

Avionics, incidentally, is something of a hot field just now, as shown by the fact that we have two Probing the News articles on avionics in this issue: the DAIS story and one on the Air Force's ambitious plans for the next decade's worldwide air navigation system (see page 69).

That story, put together by our Washington bureau chief, Ray Connolly, details the steps that the Air Force is taking to replace the geographically limited Loran network with a global-reach Omega net. The prize for the winning contractor will be about $22 million for just the electronics on board some 1,000 transports. Development, spares, training, and maintenance are extra.

Having decided to switch to Omega—and its eight worldwide stations—the Air Force, in the words of one officer, has "dismissed the Newtonian navigators" with their high-cost inertial systems and is continuing, albeit in an upgraded form, with "the Maxwellian approach." But, as we point out in the story, Omega is not the last word in navigation. The Air Force is already working on the next generation—a satellite-based navigation system to go into operation about 1987. Maybe that will be called the Copernican approach.

The annual index of articles published in *Electronics* is now available, and a copy will be mailed to any reader who requests it. Just circle number 340 on the reader service card, which you will find inside the back cover.

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Readers comment

Unfooled indicator

To the Editor: The very useful lock indicator of the phase-locked loop devised by J. A. Connelly and G. E. Prescott [*Electronics,* Sept. 5, 1974, p. 112] has the undesirable capability of displaying the lock condition when no input signal is applied, or if the input is grounded. The outputs of the wave shaper (HA-2311) and the phase comparator (7400-7406) remain at ground, as they do in the true lock condition.

This can be overcome by exchanging the inputs of the 2311 wave shaper—connecting the input to the inverting lead and the ground to the noninverting lead—and replacing the 7400 and 7406 in the phase comparator with a second exclusive-OR. This exclusive-OR is already available on the chip of the 7486 90° phase shifter.

This modified circuit has the same properties of that published by Connelly and Prescott, but does not signal "lock" when no input signal is applied.

Gunther Kuerbitz
Aalen, Germany

Information source

To the Editor: Your readers may be interested in knowing the source of the market data for the bar graph you published on p. 87 of your Jan. 9 issue concerning the size of the markets for timesharing and remote computing services. The source of the information was a major market study undertaken by International Resource Development Inc. and published in November 1974. The figures were derived from a business analysis of the major suppliers of remote computing services.

Kenneth G. Bosomworth
International Resource
Development, Inc.
New Canaan, Conn.

Correction

The statement that Fujitsu Ltd. claims infringements of its patents by Digital Equipment Corp.'s Unibus (Jan. 9, p. 26) is erroneous. Fujitsu claims that other elements of DEC's PDP-11 infringe on two of its patents.

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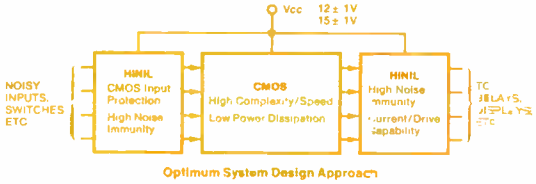

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News update

■ The recession has muddled many a marketing plan, including that of Bernard T. Marren, president of American Microsystems Inc. A year ago, Marren said he was going to change the Santa Clara, Calif., semiconductor maker's product mix from about 90% custom to a third each custom, standard, and memory [Jan. 10, 1974, p. 14]. Marren, then the newly named vice president and chief operating officer of AMI, said he expected to have the changes completed by 1976. Since then, the recession and inflation have hit hard; despite it all, though, AMI is now selling 51% custom circuits, 33% memory, and 16% standard. "Standard didn't grow as we would have liked," says Marren, partly because some of the companies AMI was counting on as customers have had to go out of business—while some of the more successful ones have integrated vertically. Not to be outdone, AMI itself is vertically integrating by making its own C-MOS circuits, light-emitting diodes, and liquid crystals.

■ Remember the gasoline crisis of early 1974? William Smith remembers it well. He's the president of Sunrise Elecro-Service Corp. of Farmingdale, N.Y., which developed a digital display terminal for taxicabs and was to have outfitted 250 New York City cabs [Feb. 7, 1974, p. 39]. A few were delivered, the price of fuel began to soar, and that was the end of that—those few were returned, and a $350,000 order came up all zeroes. But all is not lost. An improved version of the system is about to be delivered to a new customer—City Transfer Co., an affiliate of Allied Van Lines based in Anaheim, Calif. City Transfer plans to use basically the same terminal designed for the taxis, except that the it now operates at 4,800 baud rather than the original 3,125 baud.

■ The IPT Corp. of Sunnyvale, Calif., last year introduced a machine that made it possible to test

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News update

ICs dynamically for only a fraction of a cent more than room-temperature tests cost. The machine was developed mainly for computer makers concerned that guard-band tests wouldn't do the job well enough with MOS dynamic RAMs operating in high-density memory systems, where hot spots may occur during system operation [Jan. 10, 1974, p. 29]. IPT says it has sold its tester to some of the major manufacturers—and users—of ICs, including a major foreign-car manufacturer. And the company's vice president for sales, Arthur Rock, says he expects the IC tester market will get better because "there is more mil spec business now." However, he would offer no figures.

■At the height of last winter's energy crunch, the Lindberg division of Sola Basic Industries came out with a diffusion-furnace controller that allowed semiconductor makers to flip a switch and lower process temperatures to 900°C from 1,200° during idle weekends [Jan. 10, 1974, p. 29]. There was only one problem, as it turned out: as the energy crisis eased, so did sales of the Lindberg controller. But the device has found a new niche for itself, and product manager William D. McEntire estimates that half the furnaces sold today are equipped with it. "In some new processes," he says "especially those using 3-inch wafers, the controller is being used as a secondary set point device that allows ramping for the furnace." Typically, slices are loaded at 900°, the furnace ramps to 1,200°, and then drops to 900° for unloading.

■When the Surface Transportation Act of 1974 died as Congress adjourned without acting on it, perishing with it was a plan to spend $35 million on a computerized inventory system for the nation's railroad freight cars [Jan. 24, 1974, p. 36]. Don't look for a fast revival, because the recession has not only meant tighter budgets, but less rail shipping. **—Howard Wolff**

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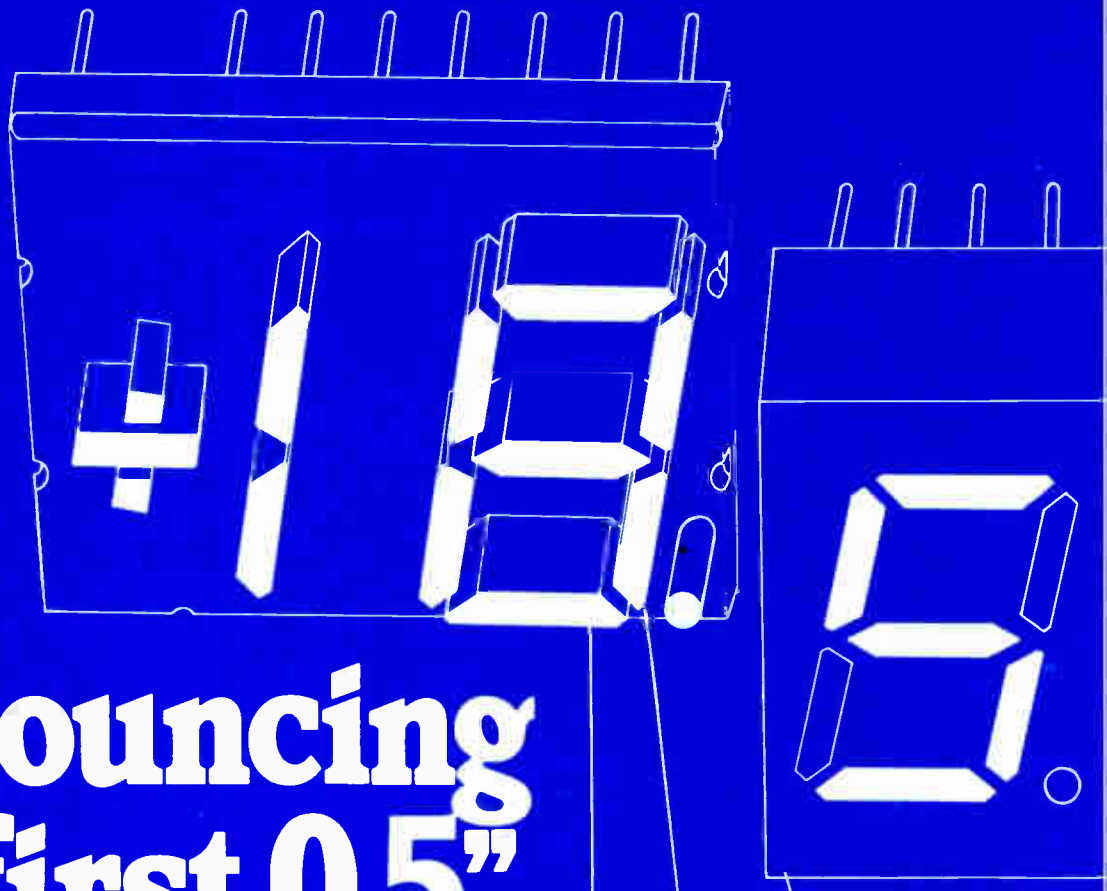

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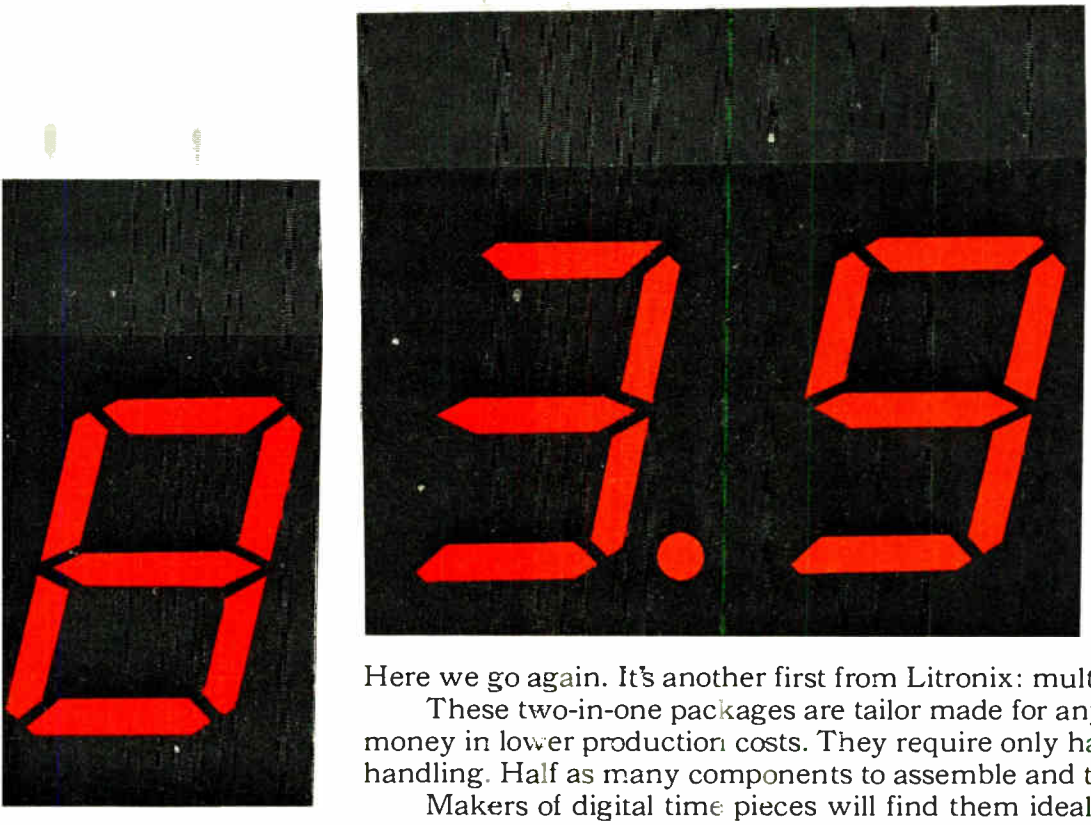

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People

Boucher insisted Microma get serious about watches

Forty-seven-year-old Richard Boucher almost turned down the chance to be president of Microma Inc., the digital watchmaking subsidiary of Intel Corp. Rumors had it that Intel was disappointed with Microma's performance and was looking around for buyers. "The first question I asked them was, were they bringing me on just to arrange for the selling of the company?" recalls Boucher, who at the time was assistant president at Electronic Arrays Inc. "They convinced me they weren't. They were serious about making Microma a dominant force in the digital-watch market. So I accepted."

But to persuade the world that Intel was indeed serious about Microma, Boucher—who says he's after 25% of the digital-watch business—insisted that a "high-power corporate staff" be brought in. Intel agreed, even though it meant giving up two of its own key executives.

Boucher had already enticed Irving Cooper, vice president of marketing at Litronix, to a comparable position at Microma. "His experience in the digital-watch market is about the same as mine—next to nil—but he was instrumental in getting that company [Litronix] established in the consumer electronic calculator market," Boucher says. "And that is the way it's going to be in the digital-watch business. It's no longer a technology game. It's a marketing game, with the consumer as the prize."

Boucher next asked for Intel's Keith Thompson, director of operations, responsible for assembly, manufacturing, and purchasing, and Desmond Fitzgerald, director of quality assurance. He wanted them as Microma's vice presidents of manufacturing and engineering, respectively.

Already supplying watches with liquid-crystal displays, Microma, which concentrates on the expensive $250-and-up end of the watch line, is now introducing light-emitting

New game. Marketing, not technology, is the digital-watch key, says Boucher.

diode displays and new smaller designs with lots of features. The next generation of LCD watches at Microma uses a 0.26-inch-thick, 3-volt module with continuous hours and minutes, as well as seconds, date, and backlighting on demand. That's 0.1 inch thinner than its predecessor.

The company's LED units will be 0.24-inch-thick, 3-volt modules, in two configurations: one with hours, minutes, seconds, day of the week, and the date, and the other, called the Chronograph, with all these plus a stop-watch feature.

Microwave ovens turn Blaha on

Bucking the dismal trend currently afflicting consumer electronics and appliances, sales of microwave ovens are expected to jump a healthy 25% this year, exceeding 900,000 units, according to a January estimate by Litton Industries' Microwave Cooking Products subsidiary. This makes for busy times at the Minneapolis organization, and probably no one there is busier than Verle Blaha, the informal and

Tasty. With microwave-oven sales climbing, Blaha's homework never looked better.

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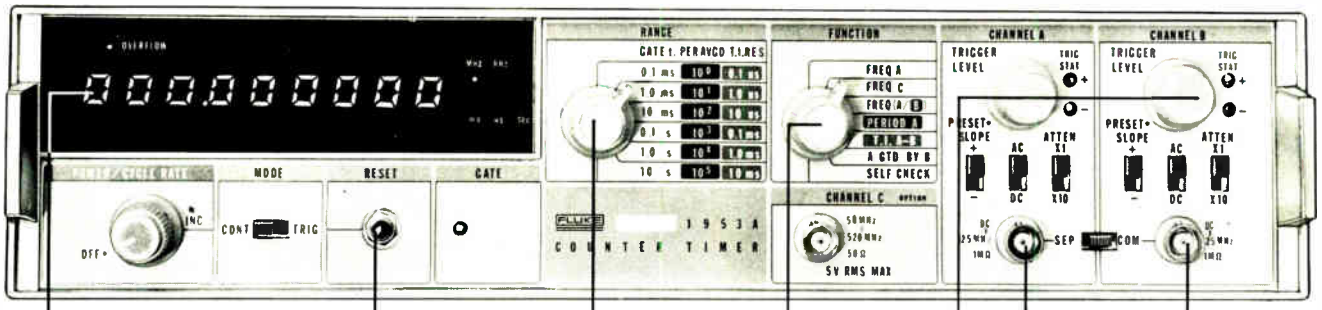

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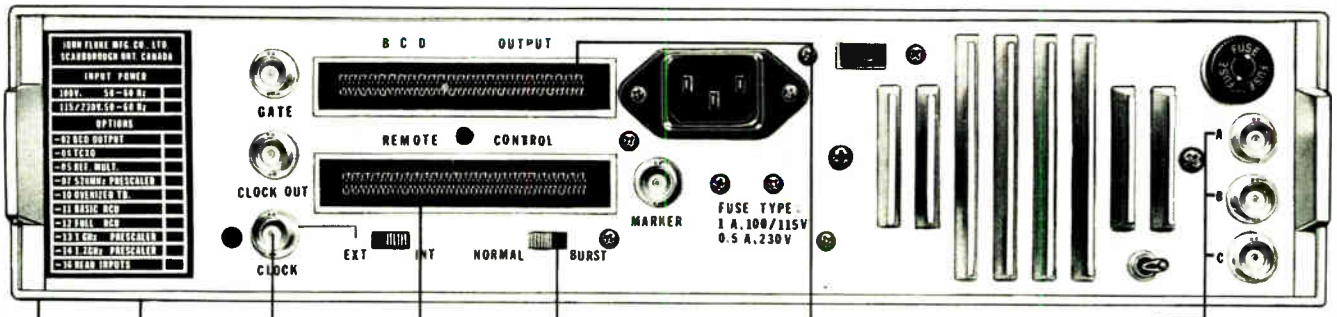
WIDE RANGING
Six choices of:
- Gate times
- Period averages
- Time interval resolution

VERSATILE
Measures:
- Frequencies
- Frequency ratios
- Period and period averages
- Time intervals
- Gateable totals
- Self check

FULL TRIGGERING CONTROL
Preset or variable trigger level controls with status indicators
Slope, coupling, and attenuation switches

TWO INPUT CHANNELS
Direct coupled amplifiers with 30 mV sensitivity

and gives you these options...



HIGHER ACCURACY
Higher stability timebase Options 04 and 10

PRESCALERS
520 MHz prescaler. Option 07
1000 MHz prescaler. Option 13
1250 MHz prescaler. Option 14

TIMEBASE MULTIPLIER
For operation from 1 or 5 MHz in addition to standard 10 MHz external reference clock. Option 05.

REMOTE PROGRAMMING
Basic remote programming. Option 11.
Full remote programming. Option 12.

BURST MEASUREMENTS
Select normal or burst measurements. Burst measurements made on Freq A or Freq C modes. Option 05.

DIGITAL OUTPUT
Parallel BCD output. Option 02

REAR INPUTS
Three rear panel mounted BNC jacks for A, B and C input channels, A and B are in parallel with front panel inputs. Option 16

it must be a Fluke
1953A Programmable Universal Counter/Timer

$849.00*

*U.S. price F.O.B. Buffalo, N.Y.
Remote programming and other options extra.

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For a demonstration circle 169 on reader service card.

For more information circle 15 on reader service card.

People

friendly vice president of engineering.

"We're looking at 45 different tasks," he says, "as we try to add new features to the ovens, as well as improve their reliability and manufacturability."

One feature added last fall, for example, was the ability to vary the magnetron-produced power level beamed into the cooking space. Previously, microwave ovens operated with full magnetron power only. Blaha's engineers accomplished this by varying the duty cycle of the magnetron. Not a very complicated arrangement, he concedes, but one that just had not been applied to microwave ovens before.

Warranty. Perhaps the most important on-going program within Blaha's group was the production of the failure-analysis studies that, coupled with design improvements, have increased the reliability of the magnetrons. Less than 0.5% fail during the two-year warranty period, says Blaha. When the first microwave oven was introduced in 1966, the figure was 15%.

The result of all this engineering effort is that at a time when many engineering staffs are being cut back, Blaha's is expanding. Ten people were added during the last half of 1974, bringing the total to 72.

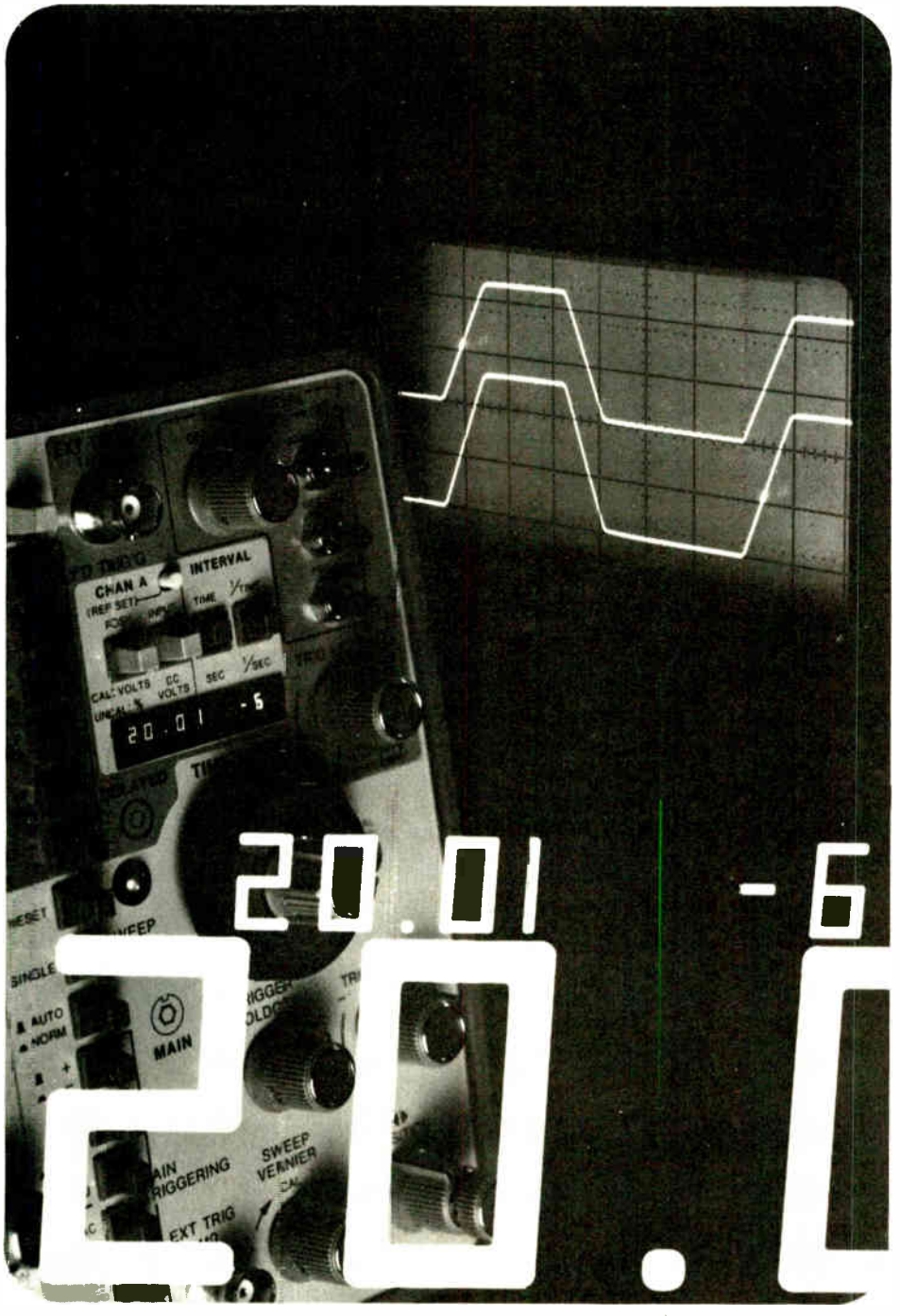
For the ebullient Blaha, there is obvious excitement in applying microwaves to cooking. And for Litton, it has meant a considerable market. Litton claims about 30% of 1975 consumer microwave oven sales that may reach $360 million.

Of his job, the 44-year-old Blaha avows, "I love it." Most of the more than 20 years of his engineering life—18 of it with Litton—has been spent on missile and other military projects "so classified I couldn't talk about them with my family, or so dull I didn't want to talk about them."

The situation is different now. "Most of the time there are five ovens in our kitchen at home, often new models we're still developing," he says. "One weekend we made 35 chocolate cakes to evaluate energy distribution."

MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

FEBRUARY, 1975



in this issue

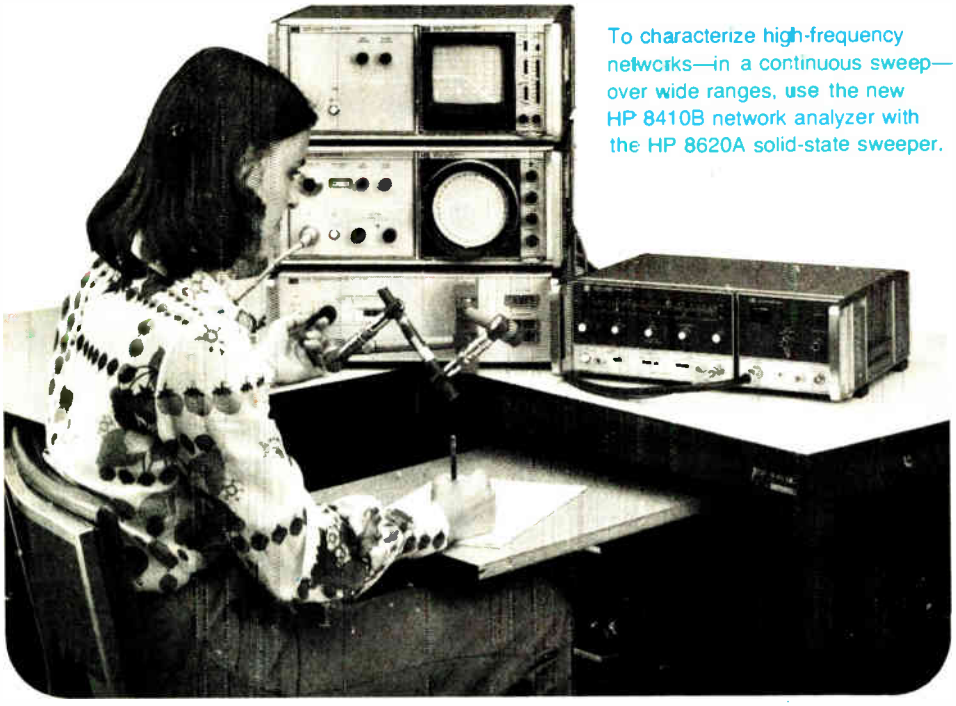
New smart oscilloscope with built-in microprocessor gives you answers

HP has combined a high-performance 275 MHz scope, a microprocessor, and LED display to put an end to graticule counting, mental calculations, and most conventional scope errors. The new 1722A gives you a quantum leap in measurement accuracy and convenience. It's a working lab partner that speeds measurements of time intervals, frequency, instantaneous or dc voltage levels, and relative amplitude expressed in percentage. And, instead of conventional reading errors, the 1722A gives you a 3½-digit LED reading of your measurements...in seconds, Hz, volts, or percent.

The microprocessor takes over several tasks you used to perform. It keeps track of dial settings, automatically

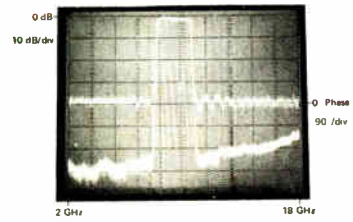
(continued on page 3)

Measure wideband microwave networks—in one sweep

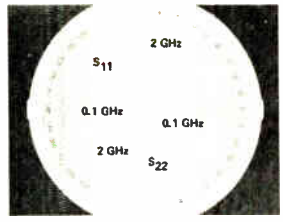


To characterize high-frequency networks—in a continuous sweep—over wide ranges, use the new HP 8410B network analyzer with the HP 8620A solid-state sweeper.

Two dramatic examples of continuous-sweep multi-octave measurements made with the new HP 8410B network analyzer:



Transmission characteristics (magnitude and phase) of 8-10 GHz bandpass filter, shown over 2 to 18 GHz range. Note that insertion Loss Trace (10 dB/div) is free from harmonic responses.



Polar plots of transistor s-parameters from 100 MHz to 2 GHz.

Frequency band switching is a thing of the past when multi-octave range networks are measured with the new HP 8410B network analyzer. The 8410B, successor to the popular HP 8410A* (which was limited to octave-wide sweeps), measures both the magnitude and phase of network parameters, vital data for microwave designers. Test configurations covering from 100 MHz to 40 GHz are offered.

Multi-octave measurements in one continuous sweep are possible when the 8410B is used with the HP 8620A sweep oscillator. For example, with the new HP 86290A sweeper plug-in, you can sweep test from 2 to 18 GHz. Or the HP 86320A RF plug-in and the 8410B cover from 100 MHz to 2 GHz, more than four octaves.

The 8410B network analyzer is a frequency-selective system that tracks the sweeper, resulting in a full 60 dB spurious-free dynamic range. Other multi-octave measurement schemes using broadband detection are typically limited to 20 or 30 dB range because of source harmonics.

*Existing 8410's can be retrofitted for automatic tuning.

For your copy of the Data Sheet, check L on the HP Reply Card.

Up to 24 Millicandelas from new high-efficiency RED, YELLOW, and GREEN LEDs

A new series of high-intensity, solid-state LED 'illuminators' are now available from HP. The new high-efficiency Red LEDs have an intensity of 24 mcd at a forward current of 10 mA.

Packaged in the T-1¾ outline, the lamps come in both wide and narrow beam types; the wide beam lamps using a diffused lens and the narrow beam lamps with a clear lens. These lamps have long general purpose leads to facilitate all types of mounting.

Four lamps of each color are being introduced, two light output categories for each beam angle. High intensity is obtained using a new HP technology employing a transparent gallium phosphide substrate and adding a reflector in the package. Higher Intensity is possible under "pulsing" conditions (or up to 20 mA dc) as these LEDs do *not* saturate. These lamps are rugged and are ideal for use in high ambient light conditions. The narrow beam, high output models are used as pushbutton switch illuminators and "Dead Front" panel annunciators. The wide beam models are used for low power panel indicators or backlighting.

For more information, check F on the HP Reply Card.

Red (5082-4650), Yellow (5082-4550) and Green (5082-4950) LED lamps.

NEW high-efficiency step recovery diodes

Special introductory price.

Our new high-efficiency step recovery diodes maximize cutoff frequency while maintaining a fast transition time. Thus, they provide excellent performance in low or high order multipliers and in comb generators.

The new 5082-0800 series diodes are passivated with a thermal oxide for maximum stability. You can buy them in chip form, in low-cost glass packaging, or in hermetically sealed metal-ceramic packages. Test data is supplied with each ceramic packaged device.

As an introductory offer, these devices are available in prototype quantity at the 100 piece price (offer good until April 30, 1975).

For more information, check E on the HP Reply Card.

(continued from page one)

New scope with microprocessor

computes time intervals and voltage levels, converts time measurements to frequency, and calculates percent. It even signals if you make an erroneous setting.

HP's dual delayed sweep gives you two adjustable intensified markers for displaying the start and stop points of a time interval. The microprocessor automatically computes and displays the time interval between the markers. This speeds digital timing measurements, reduces errors, and simplifies the adjustment of circuits to meet a timing spec.

The 1722A makes waveform measurements faster, more accurately, and more completely than conventional scopes costing up to twice as much.

For details on HP's microprocessor oscilloscope, check B on the HP Reply Card.

NEW HP-55 scientific pocket calculator offers 86 keyboard functions, programmability and built-in timer

HP introduces an extraordinary new programmable scientific pocket calculator. With all of the pre-programmed functions and operations of our popular HP-45, plus 38 new ones including statistical functions.

You can perform circular trigonometry in degrees, radians or grads and convert among any of them. Also, compute two-variable mean and standard deviation, linear regression, linear estimate, curve plotting and four simultaneous linear equations with four unknowns.

The HP-55 has 20 addressable storage registers—more than twice as many as any other scientific pocket calculator on the market.

And, the HP-55 is the only pocket calculator in the world with a built-in digital electronic timer with 100-hour capacity—a stopwatch that times and stores up to 10 events within the same experiment, accurate to 0.01%.

Whenever you wish to write a program to solve your particular calculations, just set the program switch, enter a program of up to 49 steps, then run it... as often as you wish. Meanwhile, you still have access to all 86 keyboard functions plus the 20 register memory.

And, with the HP four-register stack, enter the most complicated equations without having to keep track of the parentheses and brackets.

To learn more about the amazing new HP-55, check A on the HP Reply Card.

Faster graphs with new high-speed time-share plotter

Fast digital X-Y plotter accepts bit-serial ASCII at 10 or 30 characters per second.

Now you can plot up to seven vectors per second in any direction using the new 7203A high-speed graphic plotter.

Vectors of any length are plotted in any direction and the resulting graph appears as a smooth line, in contrast to the staircase often drawn by incremental plotters.

Check numerical control tapes, display statistical data, quickly analyze engineering designs or use this plotter for any application you have that requires fast graphics.

Four colors of ink are available in disposable pens. Pens are changed quickly and easily so that plots may be superimposed in color for comparison.

Each plot coordinate is expressed with a Binary number represented by the bit pattern of two successive ASCII characters. Thus, only 4 characters are required to define any move.

The 7203A operates in parallel with data communication terminals. Easy to use software subroutines are available for many time-share systems.

Plots are front panel scalable from 0 × 0 up to 10 × 15 in. (25 × 38 cm) using paper up to 11 × 17 in. (28 × 43 cm).

Check 1 on the HP Reply Card.

NEW HP display terminal offers an intelligent addition to your computer

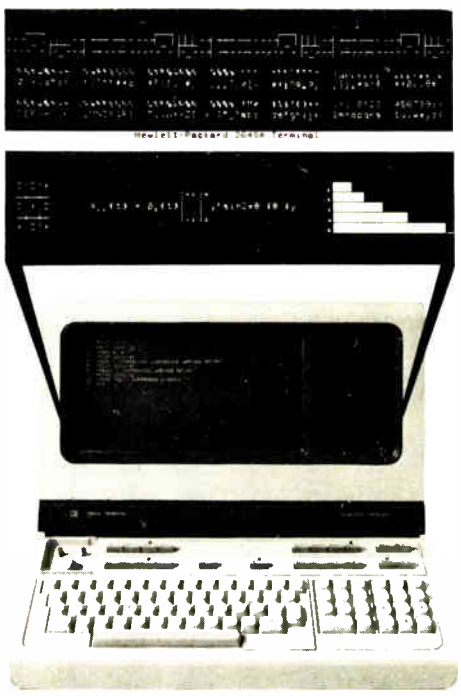
HP's new 2640A display terminal with built-in microprocessor is the intelligent, cost-effective answer to your data entry and information handling needs.

The 2640A operates either on-line or in stand-alone mode, with full editing capability. You can write 24 lines with 80 characters per line on the 5 by 10 in. (127 by 254 cm) rectangular display. High resolution ensures clear, precise character definition. You can also plug in three additional character sets, such as a line drawing set or a math set, and use them concurrently with the standard character set.

The 2640's dynamically allocated memory lets you store 8 to 50 lines or add optional memory modules and store over 400 lines depending upon line length. Memory protection is standard on all 2640A terminals.

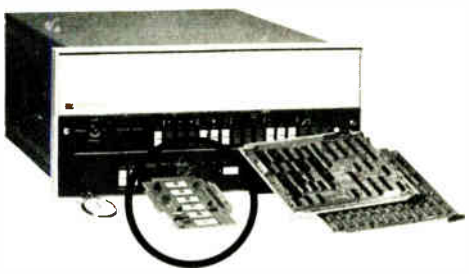
Should the modular 2640A need repair, just lift up the top and replace the necessary printed circuit cards. And, thanks to a universal interface, the 2640A works with a wide variety of computers.

For more information or a demo, check C on the HP Reply Card.



New Hewlett-Packard Model 2640A CRT Terminal is microprocessor controlled. Model 9866A Line Printer (left) is optional.

21MX computer with new **Dynamic Mapping System** plug-in gives you million word addressing space



Programmable DMS for 21MX computer expands address space.

A new Dynamic Mapping System (DMS) devised by HP for its 21MX series user-microprogrammable 4K RAM semiconductor memory minicomputer allows access to four independent memory spaces.

The 12976A DMS expands the memory address size to 20 bits, thereby providing a maximum main memory addressing space of 1,048,576 16-bit words. It does this without adding to the 650-nanosecond cycle time.

Accounting for the compactness and low prices of the new large-memory models, HP cites features common to the whole 21MX line. For example, all 38 of the new instructions are contained in a single 265 word module of microcode. Also included is read and or write protection on an individual 1K-page basis. All these instructions are on half of a single small circuit board. These new capabilities are plug-in installable.

The HP Dynamic Mapping System functions with main memory somewhat as "virtual memory" schemes function with disc memory.

The 38 new microcoded instructions in DMS firmware, including cross map moves and block transfers, give extensive control over memory allocation and protection. In addition to these 38 supplied by HP, the user can generate his own unique memory management and protection instructions using the standard microcode capability.

For more info on this new Dynamic Mapping System, check O on the HP Reply Card.

HP interface bus enhances signal generator

Joining the growing list of HP-IB compatible instruments is the HP 8660A/B synthesized signal generator. It's a fully programmable signal generator with .01 to 1300 MHz frequency coverage, 3×10^{-8}/day frequency stability (3×10^{-9}/day optional), +13 to −146 dBm output level, and AM, FM and pulse modulation capabilities.

When installed, the HP interface bus allows programming of:

- Frequency, in 1 Hz steps over the entire 1300 MHz range.
- Output level, in 1 dB steps over the entire 160 dB range.
- Modulation mode, either AM or FM.
- Modulation source, either internal 400 or 1000 Hz tone or external source.
- AM depth, in 1% steps from 0 to 99%.
- FM deviation, in 3 overlapping ranges, either 50 or 100 steps per range, from 0 to 1 MHz.

The HP-IB interface is available as option 005 on new instruments or as a field-installable kit 08660-60189 for instruments already equipped with the standard BCD interface.

To learn more, check M on the HP Reply Card.

Now, you can run a precision signal generator under calculator control.

Helpful techniques for using VHF signal generator

New application information available for 8640A/B.

Three new application notes show you how to extend the usefulness and accuracy of HP's 8640A/B VHF signal generator (450 kHz to 1100 MHz).

AN 170-1 explains how to improve the specified output level accuracy over narrower frequency limits—i.e., how to operate the generator for optimum accuracy. Also, special calibration can be used to minimize effects of frequency response, temperature, detector and meter linearity, and vernier error.

AN 171-1 describes a method for improving crystal filter measurements when using an HP vector voltmeter and the 8640A/B. This technique optimizes frequency tuning sensitivity by using a feedback signal from the phase meter to the generator external FM input.

AN 171-2 describes how to build a simple heterodyne circuit that extends the frequency down range to dc-450 kHz. The circuit mixes the rear-panel fixed 5 MHz crystal output with the tuned output signal and provides a stable frequency that can be read directly on the digital readout.

For your copies, check P on the HP Reply Card.

New capabilities, more options for HP-5300 measuring system

Now there is a high resolution 8-digit display mainframe (Model 5300B) with temperature-compensated crystal option in the HP-5300 series of electronic counters and digital multimeters.

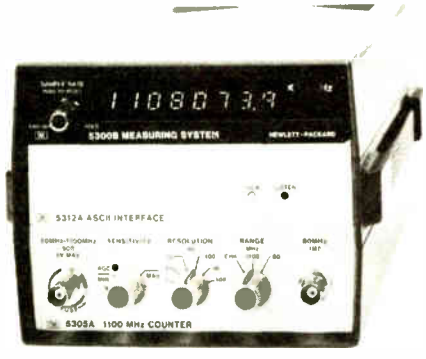
New snap-ons for the system include an 1100-MHz counter and a bus interface.

In the 5300 system, a complete instrument consists of two halves that snap together in about 15 seconds. The width of these units is a very compact 6¼ inch (160 mm). The upper half, or mainframe, contains the readout and associated circuitry. The instrument's measurement functions are determined by the lower half, or "snap-on", of which there are now 7 models for measuring frequency, time interval, ac and dc volts and ohms. The new 5312A ASCII "snap-between" module allows all of the 5300 functions to interface with data acquisition systems via the HP Interface Bus.

With the new 5305A 1100-MHz frequency counter snap-on, you get a sensitivity of 10 mV to 500 MHz and better than 25 mV to 1100 MHz, automatic gain control and manual attenuator to measure noisy or modulated signals, plus a front panel accessible input fuse to prevent costly front end damage.

With the new 5312A ASCII "snap-between" module you can mate other instruments and controllers to the 5300 series via the HP Interface Bus.

For more information, just check H on the HP Reply Card.



HP 5300 Measurement System adds 5300B 8-digit module, 5305A 1100-MHz counter, and 5312A ASCII interface to HP Interface Bus.

Now debug your control system design before you build it

New software for design engineers using 9830A calculator in BASIC language.

With HP's powerful 9830A programmable calculator and state-variables software, you now can know exactly how your control system will perform long before you've committed time, materials, and manpower to an expensive prototype.

The new state-variable software provides a complete transient response solution for control systems, whether for mechanical, electronic, hydraulic, optical, or hybrid systems. It's a carefully developed set of programs that will assure you a stable system in a minimum amount of time. There's no hassle with computer programming and interfacing. You just key in the values directly from your block diagram, and the 9830A does the rest automatically.

In 10 minutes or less, you get a high resolution plot of transient response and printed list of system parameters. If you want to adjust your design, you simply key in different values. Thus, you can explore alternatives—right at your desk—to find a better design or solution.

An extensive library of engineering and design programs are available from HP.

To learn more, check N on the HP Reply Card.

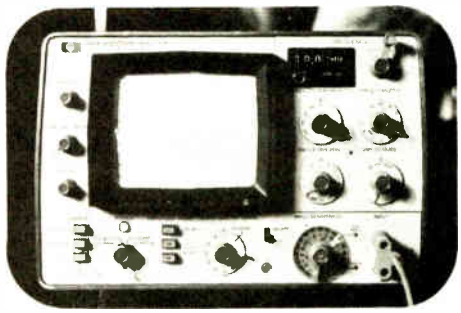
Low frequency spectrum analyzer offers unmatched resolution

Up until now, the biggest problem analyzing low frequency signals has been the display. Now, you can get a clear picture of mechanical vibrations, audio filters, or data communication channels with HP's 3580A spectrum analyzer, covering 5 Hz to 50 kHz. The trace appears on a CRT with 1 Hz bandwidth—that's the best resolution of any low-frequency spectrum analyzer on the market.

You can also store your trace in the CRT's digital storage. In fact, store two traces, and compare them on the CRT. You can study and interpret spectral information easily and quickly.

Dynamic range is 80 dB. HP offers unique adaptive sweep that speeds up your measurements and reduces analysis time. The 3580A weighs just 35 lbs (16 kg) and operates on batteries, as well as line power.

For more information, check D on the HP Reply Card.



There are many variables in a sound system; thus, instrumentation is needed to track down problems. HP's 3580A Spectrum Analyzer has the range and visual display necessary to analyze audio problems. With this unique instrument, distortion hum, equalization and reverberation can be quantified far better than even the best ear.

For versatility, ease of operation and wide applications, 50 MHz pulse generators

What every Logic laboratory needs: versatile, easy to operate 50 MHz generator.

The 8012B and 8013B pulse generators are ideally suited to the requirements of a general digital logic laboratory where ease of operation and wide range of applications are essential.

Their 10V outputs and fast transition times (3.5 ns on the 8013B and 5 ns on the 8012B) enable you to dynamically test TTL, ECL and even the latest CMOS logic. You can simulate noise patterns and, in double pulse mode, test device recovery times and make noise immunity measurements. You can also use them as amplifiers when generating worst case data patterns.

These instruments not only enable you to set up pulses more easily, but also much more quickly. One big time-saving feature is the unique front panel layout; the slider controls provide a simple, straightforward design that enables you to set up your pulses very quickly and with a minimum risk of incompatible pulse settings. They also greatly improve the readability of the pulse parameters. Another time-saver is the square wave mode which enables you to set up pulses very rapidly without having to worry about pulse width or delay.

In addition, the variable transition times of the 8012B enable you to generate any triangular or trapezoidal waveforms, and the two independent outputs of the 8013B enable you to test circuits designed with bipolar supplies.

For more information on these extremely flexible pulse generators, check K on the HP Reply Card.

A 20 column low-cost printer that really *is* quiet

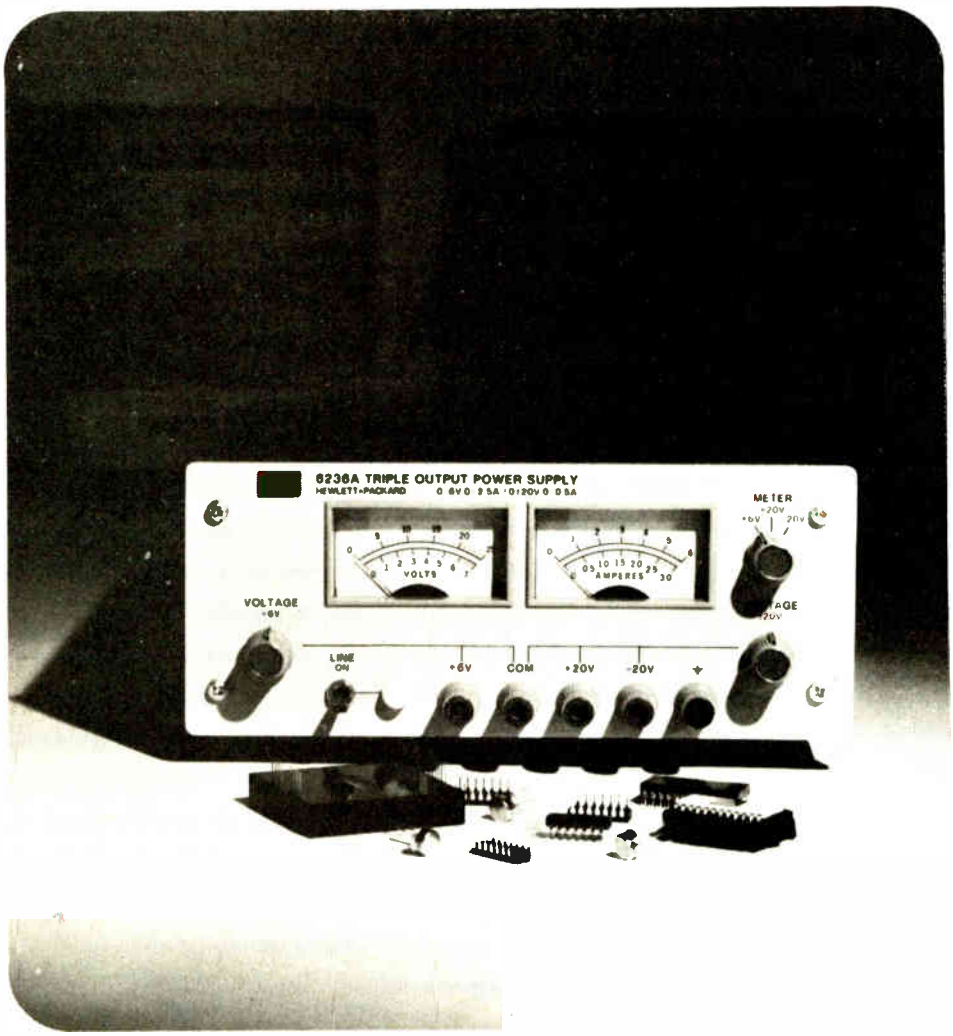
At last: a quiet printer that's really quiet. The new 5150A thermal printer prints faster than 3 lines per second, without any noisy impact mechanisms. It accepts data from BCD or ASCII sources and can list 20 columns of alphanumeric information, yet the price is extremely reasonable.

The 5150A uses heat-sensitive paper and a thermal print head, so you don't have to bother with ink spills or refills. Don't let simple design or light weight fool you—the 5150A is a high technology peripheral that can interface with minicomputers, any Interface Bus (HP-IB) instrument system or other digital data sources having acceptable codes and voltage levels. Available options include clock, BCD or ASCII interface and scanner—whereupon it can serve as an HP-IB controller.

For more information, check G on the HP Reply Card.

The 5150A printer is available in several different configurations to fit your system; here, it logs data from a 5345A Electronic Counter.

New triple-output bench supply for IC test and development



Separate voltage controls adjust the 0 to 6V and 0 to ±20V outputs, while the meter switch selects the desired V and I range for display on the panel meters.

Low cost, small size, and outstanding performance, make this new three-in-one lab supply a valuable aid to anyone designing or testing equipment using integrated circuits. Model 6236A delivers three outputs: 0 to 6V, up to 2.5A; and dual-tracking 0 to ±20V, 0 to 0.5A. The 0 to +20V and 0 to −20V outputs track one another within 1% to supply the symmetrical voltages needed by op amps and similar balanced-voltage-source applications. A single 0 to 40V @ 0.5A output can also be obtained by connecting across the −20 and +20V terminals.

All outputs are regulated to 0.01% +2mV, with ripple and noise of 0.35mV rms/1.5mV p-p. The dc outputs have smooth turn-on and turn-off characteristics so that no output voltage overshoot is produced when the ac line switch is operated. Both the 6V and ±20V outputs are protected from overloads by fixed current limiting circuits.

Model 6236A can be powered from a nominal 100V, 120V, 220V, or 240V, 47-63 Hz ac input. The supply weighs only 9½ lbs. (4.3 kg) and is 3½ in. high (8.9 cm), 8½ in. wide, (21.6 cm), and 12½ in. deep (31.8 cm). Single and dual-unit rack-mounting kits are available.

For more information on the three-in-one power supply, check I on the HP Reply Card.

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Meetings

Nepcon '75 West and International Microelectronics Exhibition, Industrial Scientific Conference Management Inc. (Chicago, Ill.), Anaheim Convention Center, Anaheim, Calif., Feb. 11–13.

CAD/CAM III, Computer-Aided Design and Computer-Aided Manufacturing, Society of Manufacturing Engineers, Hyatt Regency O'Hare Hotel, Chicago, Ill., Feb. 11–13.

International Solid State Circuits Conference, IEEE, Marriott Hotel, Philadelphia, Pa., Feb. 12–14.

Compcon Spring Computer Conference, IEEE, Jack Tar Hotel, San Francisco, Calif., Feb. 25–27.

Industrial Applications of Microprocessors, IEEE, Sheraton Hotel, Philadelphia, Pa., March 11–12.

Reliability Physics Symposium, IEEE, MGM Grand Hotel, Las Vegas, Nev., April 1–3.

Paris Components Show, (*Salon des Composants Electroniques*), Porte de Versailles, Paris, April 2–8.

Southeastcon '75, IEEE, Sheraton Center, Charlotte, N.C., April 6–9.

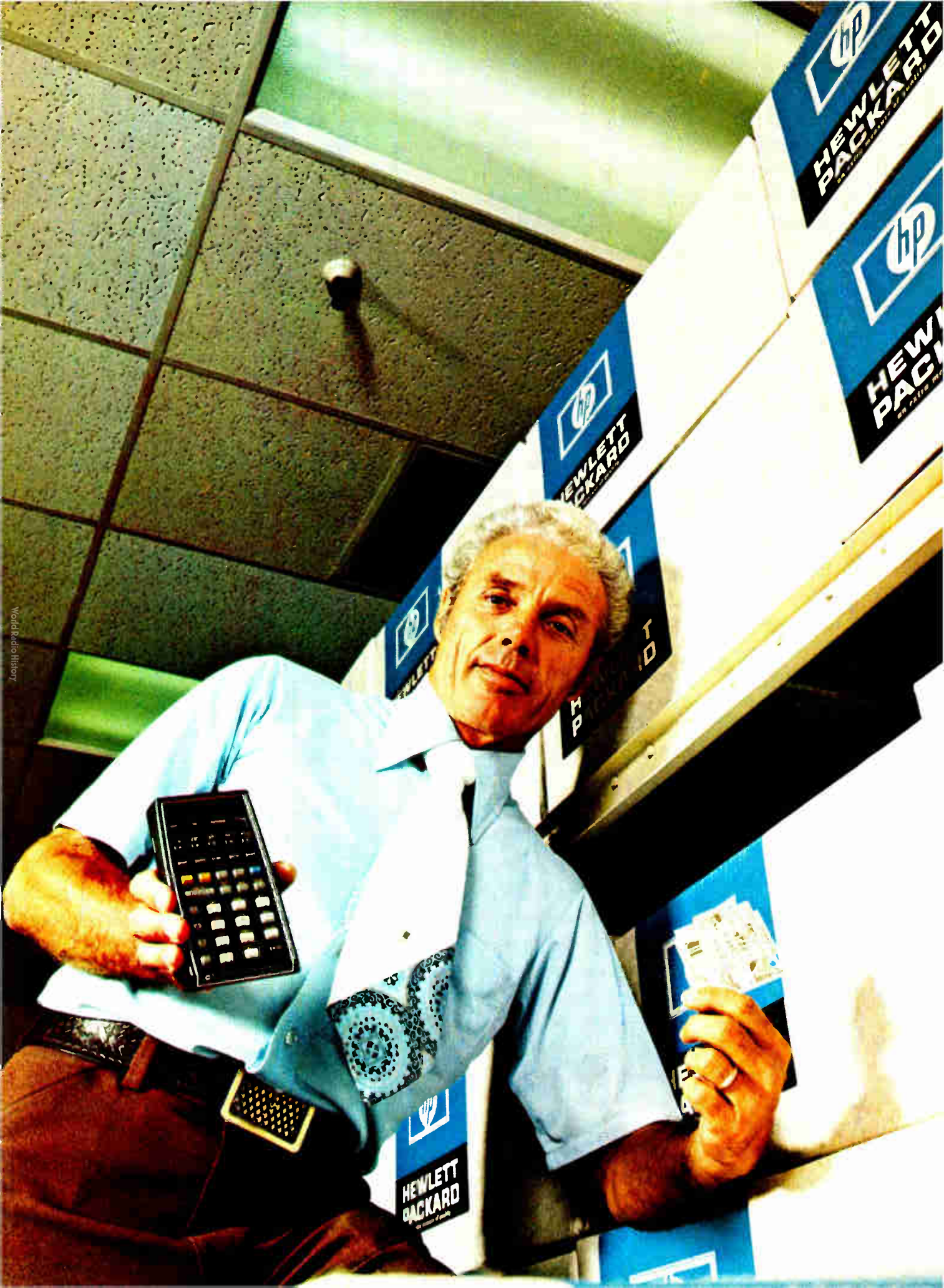
Intercon—IEEE International Convention, Coliseum and Americana Hotel, New York, N.Y., April 8–10.

Electronics Production and Test Equipment Exposition, U.S. Department of Commerce, Stockholm, Sweden, April 7–11; London, April 15–18.

Society for Information Display International Symposium, SID, Shoreham Americana Hotel, Washington, D.C., April 22–24.

International Optical Computing Symposium, IEEE, Mayflower Hotel, Washington, D.C., April 23–25.

National Relay Conference, NARM and Oklahoma State University, Stillwater, Okla., April 30–May 1.



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Tom Miller, Production Control Supervisor, Hewlett-Packard

"I supervised in-house production of printed circuitry for Hewlett-Packard. When the demand for our pocket-sized calculators taxed our own capacity for making printed circuit boards, I had to look outside the company.

"The scientific and business calculators Hewlett-Packard makes have infinitely more functions than the typical 'housewife' variety. And we have sold over one-half million of them. So we needed large volumes of quality boards for logic and battery charger applications.

"Photocircuits' reputation for quality was confirmed by my first visit.

"I've been in this business since 1955, so I knew of Photocircuits even before we made a facilities check. What I had heard proved to be true. Their overall efficiency was evident and everyone seemed to know what they were doing.

"We had no qualms about dealing with an East Coast house either. They were only a short 5 hours away by plane. And seconds away by WATS line. In fact, when we asked for price quotes, they got back to us within ten days. And that included mailing time.

"Their price was lower and they delivered what they promised.

"Long Island labor costs are comparable to the West Coast, but Photocircuits still managed to beat local prices. To me, that's another indication of overall efficiency.

"And even though we hit them at the same time as everyone else, Photocircuits guaranteed they would deliver a certain number of boards every week. They kept that promise.

"Quality-wise, they were the best boards I've seen in twenty years.

"We have some very stringent standards at Hewlett-Packard. Not only do we expect operational quality, but esthetics as well. If a customer tears the cover off one of our products, we want our components to look good.

"In both cases, performance and looks, Photocircuits was outstanding. Over half a million boards have been delivered. Less than 1% have been rejected for any reason whatsoever.

"What more is there to say?"

Photocircuits

Division of Kollmorgen Corporation, Glen Cove, New York 11542 (516) 448-1000

Printed circuitry for mass-produced electronics

FEBRUARY 6, 1975

Industrial hazards call for intrinsically safe designs/91

Microprocessor design with standard logic, part 2/102

Integrating calculator elements on a glass substrate/109

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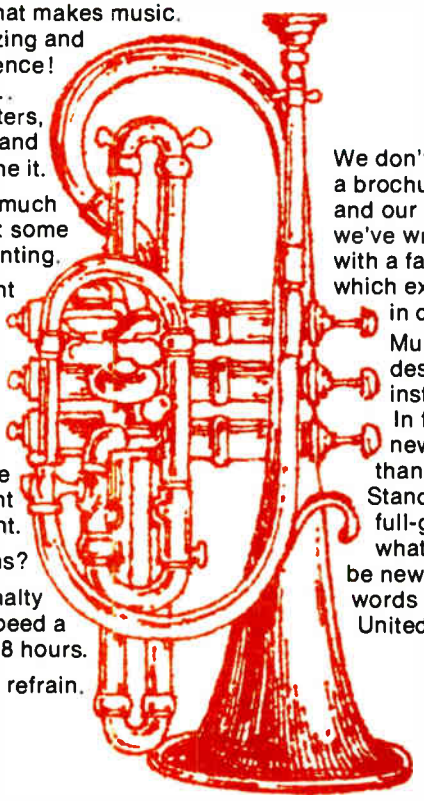

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Electronics
The International Magazine of Electronics Technology
Vol. 48, No. 3 • February 6, 1975

Highlights

The cover: I²L blazes new bipolar path, 83
A non-isolated gate structure boosts the density of the latest integrated-injection-logic chip, which also has five times the speed of a comparable 4-bit n-MOS microprocessor. The next I²L generation is expected to be even faster and should at last make the full benefits of bipolar LSI available to computer designers. Cover is by illustrator Tom Upshur.

Conference announces LSI advances, 72
Visitors to the International Solid State Circuits Conference in Philadelphia this month will learn about: denser-than-ever bipolar chips; faster-than-ever MOS memories; gallium-arsenide FET oscillators that set new power-frequency records; and charge-coupled devices that are revolutionizing analog signal processing.

How to build an intrinsically safe system, 91
The sparking that always occurs in electronic equipment is often powerful enough to trigger explosions in volatile atmospheres. This danger can be eliminated if the circuitry in the hazardous areas operates with low enough voltage, current, capacitance, and inductance values.

Using high-speed logic for microprocessors, 102
The parts count can be reduced when an application requires less than the utmost performance from a processor built from high-speed logic. This is the second half of a two-part article on the design of standard-logic processors that are faster than MOS chips and use fewer devices than random-logic systems.

And in the next issue . . .
An economical two-way pay-TV system . . . eight ways to improve radio receiver design . . . overcoming the deficiencies of zener diodes as voltage reference sources.

Electronics

Publisher's letter

The pace of electronics progress is nowhere more breathtaking than in solid state developments. Our cover story this issue, for example, details a technique for fabricating extremely compact integrated injection-logic gates that, since they require no space-consuming pn junctions for isolation, are comparable in size to a single transistor. What's more, power demands are low. The result: digital I²L structures with thousands of gates on a single bipolar chip. Read all about it on page 83.

The instrument-bedecked cockpit of today's Air Force plane may become a far less crowded place as the trend toward using digital methods in jobs that were once solely analog gains momentum. In place of the maze of "black boxes," a time-shared computer-based CRT display is being tried out at Wright-Patterson AFB. With it, a streamlined console could give the pilot even more data than he has available today—and do it with far more efficient use of space. You'll find our story about the program, called DAIS, on page 76.

Larry Armstrong, our Midwest bureau manager, wrote the story after interviewing the project officers at the Air Force Avionics Laboratory and going for a "trial run" of the prototype cockpit simulator that they have developed. In fact, the "trainee" in the photograph on page 76 is none other than our man Armstrong getting a hands-on demonstration of the DAIS hot bench.

Avionics, incidentally, is something of a hot field just now, as shown by the fact that we have two Probing the News articles on avionics in this issue: the DAIS story and one on the Air Force's ambitious plans for the next decade's worldwide air navigation system (see page 69).

That story, put together by our Washington bureau chief, Ray Connolly, details the steps that the Air Force is taking to replace the geographically limited Loran network with a global-reach Omega net. The prize for the winning contractor will be about $22 million for just the electronics on board some 1,000 transports. Development, spares, training, and maintenance are extra.

Having decided to switch to Omega—and its eight worldwide stations—the Air Force, in the words of one officer, has "dismissed the Newtonian navigators" with their high-cost inertial systems and is continuing, albeit in an upgraded form, with "the Maxwellian approach." But, as we point out in the story, Omega is not the last word in navigation. The Air Force is already working on the next generation—a satellite-based navigation system to go into operation about 1987. Maybe that will be called the Copernican approach.

The annual index of articles published in *Electronics* is now available, and a copy will be mailed to any reader who requests it. Just circle number 340 on the reader service card, which you will find inside the back cover.

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Readers comment

Unfooled indicator

To the Editor: The very useful lock indicator of the phase-locked loop devised by J. A. Connelly and G. E. Prescott [*Electronics,* Sept. 5, 1974, p. 112] has the undesirable capability of displaying the lock condition when no input signal is applied, or if the input is grounded. The outputs of the wave shaper (HA-2311) and the phase comparator (7400-7406) remain at ground, as they do in the true lock condition.

This can be overcome by exchanging the inputs of the 2311 wave shaper—connecting the input to the inverting lead and the ground to the noninverting lead—and replacing the 7400 and 7406 in the phase comparator with a second exclusive-OR. This exclusive-OR is already available on the chip of the 7486 90° phase shifter.

This modified circuit has the same properties of that published by Connelly and Prescott, but does not signal "lock" when no input signal is applied.

Gunther Kuerbitz
Aalen, Germany

Information source

To the Editor: Your readers may be interested in knowing the source of the market data for the bar graph you published on p. 87 of your Jan. 9 issue concerning the size of the markets for timesharing and remote computing services. The source of the information was a major market study undertaken by International Resource Development Inc. and published in November 1974. The figures were derived from a business analysis of the major suppliers of remote computing services.

Kenneth G. Bosomworth
International Resource
Development, Inc.
New Canaan, Conn.

Correction

The statement that Fujitsu Ltd. claims infringements of its patents by Digital Equipment Corp.'s Unibus (Jan. 9, p. 26) is erroneous. Fujitsu claims that other elements of DEC's PDP-11 infringe on two of its patents.

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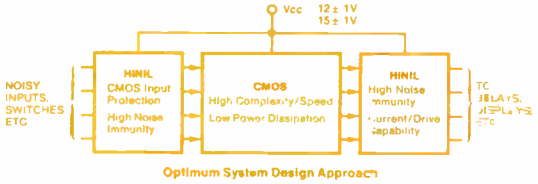

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News update

■ The recession has muddled many a marketing plan, including that of Bernard T. Marren, president of American Microsystems Inc. A year ago, Marren said he was going to change the Santa Clara, Calif., semiconductor maker's product mix from about 90% custom to a third each custom, standard, and memory [Jan. 10, 1974, p. 14]. Marren, then the newly named vice president and chief operating officer of AMI, said he expected to have the changes completed by 1976. Since then, the recession and inflation have hit hard; despite it all, though, AMI is now selling 51% custom circuits, 33% memory, and 16% standard. "Standard didn't grow as we would have liked," says Marren, partly because some of the companies AMI was counting on as customers have had to go out of business—while some of the more successful ones have integrated vertically. Not to be outdone, AMI itself is vertically integrating by making its own C-MOS circuits, light-emitting diodes, and liquid crystals.

■ Remember the gasoline crisis of early 1974? William Smith remembers it well. He's the president of Sunrise Elecro-Service Corp. of Farmingdale, N.Y., which developed a digital display terminal for taxicabs and was to have outfitted 250 New York City cabs [Feb. 7, 1974, p. 39]. A few were delivered, the price of fuel began to soar, and that was the end of that—those few were returned, and a $350,000 order came up all zeroes. But all is not lost. An improved version of the system is about to be delivered to a new customer—City Transfer Co., an affiliate of Allied Van Lines based in Anaheim, Calif. City Transfer plans to use basically the same terminal designed for the taxis, except that the it now operates at 4,800 baud rather than the original 3,125 baud.

■ The IPT Corp. of Sunnyvale, Calif., last year introduced a machine that made it possible to test

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News update

ICs dynamically for only a fraction of a cent more than room-temperature tests cost. The machine was developed mainly for computer makers concerned that guard-band tests wouldn't do the job well enough with MOS dynamic RAMs operating in high-density memory systems, where hot spots may occur during system operation [Jan. 10, 1974, p. 29]. IPT says it has sold its tester to some of the major manufacturers—and users—of ICs, including a major foreign-car manufacturer. And the company's vice president for sales, Arthur Rock, says he expects the IC tester market will get better because "there is more mil spec business now." However, he would offer no figures.

■At the height of last winter's energy crunch, the Lindberg division of Sola Basic Industries came out with a diffusion-furnace controller that allowed semiconductor makers to flip a switch and lower process temperatures to 900°C from 1,200° during idle weekends [Jan. 10, 1974, p. 29]. There was only one problem, as it turned out: as the energy crisis eased, so did sales of the Lindberg controller. But the device has found a new niche for itself, and product manager William D. McEntire estimates that half the furnaces sold today are equipped with it. "In some new processes," he says "especially those using 3-inch wafers, the controller is being used as a secondary set point device that allows ramping for the furnace." Typically, slices are loaded at 900°, the furnace ramps to 1,200°, and then drops to 900° for unloading.

■When the Surface Transportation Act of 1974 died as Congress adjourned without acting on it, perishing with it was a plan to spend $35 million on a computerized inventory system for the nation's railroad freight cars [Jan. 24, 1974, p. 36]. Don't look for a fast revival, because the recession has not only meant tighter budgets, but less rail shipping. **—Howard Wolff**

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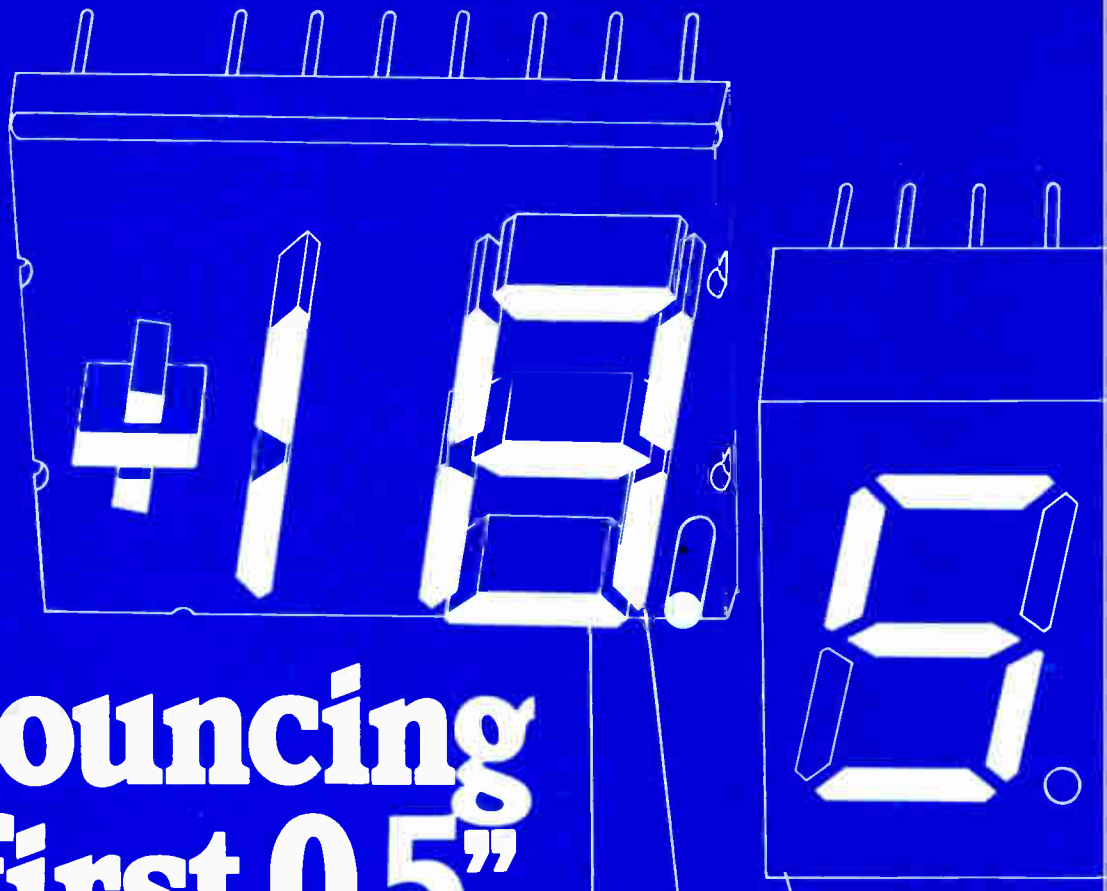

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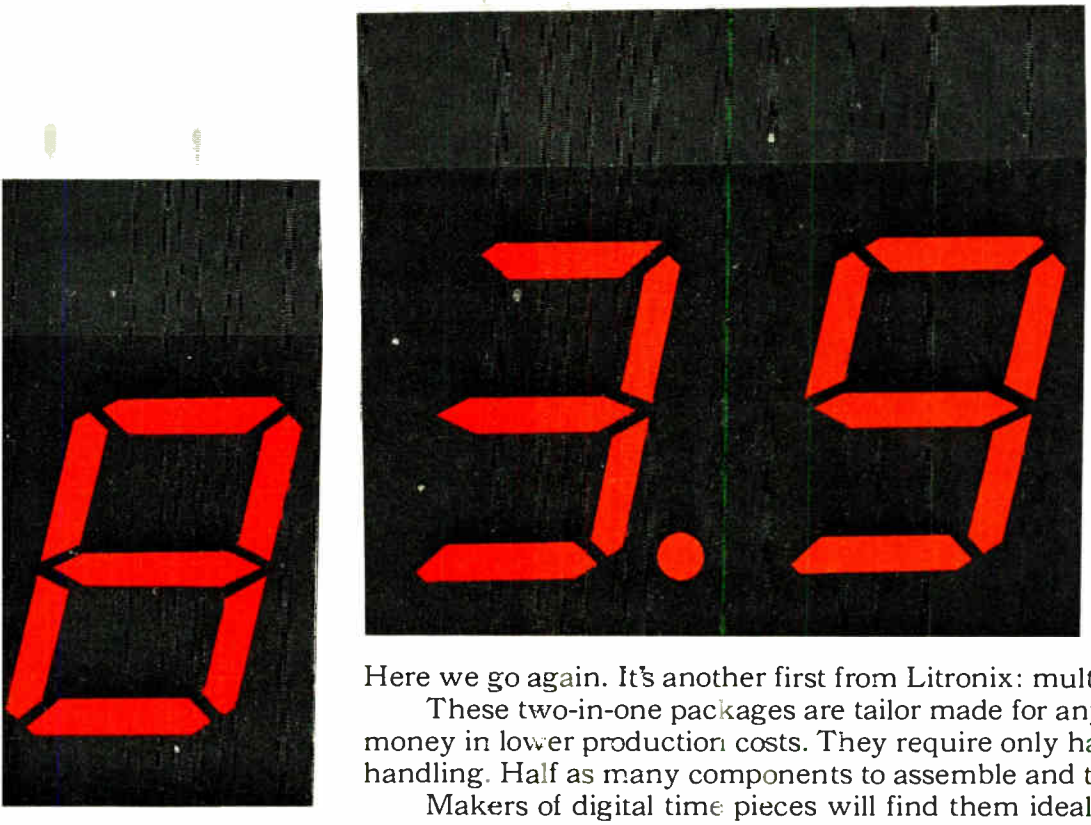

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People

Boucher insisted Microma get serious about watches

Forty-seven-year-old Richard Boucher almost turned down the chance to be president of Microma Inc., the digital watchmaking subsidiary of Intel Corp. Rumors had it that Intel was disappointed with Microma's performance and was looking around for buyers. "The first question I asked them was, were they bringing me on just to arrange for the selling of the company?" recalls Boucher, who at the time was assistant president at Electronic Arrays Inc. "They convinced me they weren't. They were serious about making Microma a dominant force in the digital-watch market. So I accepted."

But to persuade the world that Intel was indeed serious about Microma, Boucher—who says he's after 25% of the digital-watch business—insisted that a "high-power corporate staff" be brought in. Intel agreed, even though it meant giving up two of its own key executives.

Boucher had already enticed Irving Cooper, vice president of marketing at Litronix, to a comparable position at Microma. "His experience in the digital-watch market is about the same as mine—next to nil—but he was instrumental in getting that company [Litronix] established in the consumer electronic calculator market," Boucher says. "And that is the way it's going to be in the digital-watch business. It's no longer a technology game. It's a marketing game, with the consumer as the prize."

Boucher next asked for Intel's Keith Thompson, director of operations, responsible for assembly, manufacturing, and purchasing, and Desmond Fitzgerald, director of quality assurance. He wanted them as Microma's vice presidents of manufacturing and engineering, respectively.

Already supplying watches with liquid-crystal displays, Microma, which concentrates on the expensive $250-and-up end of the watch line, is now introducing light-emitting

New game. Marketing, not technology, is the digital-watch key, says Boucher.

diode displays and new smaller designs with lots of features. The next generation of LCD watches at Microma uses a 0.26-inch-thick, 3-volt module with continuous hours and minutes, as well as seconds, date, and backlighting on demand. That's 0.1 inch thinner than its predecessor.

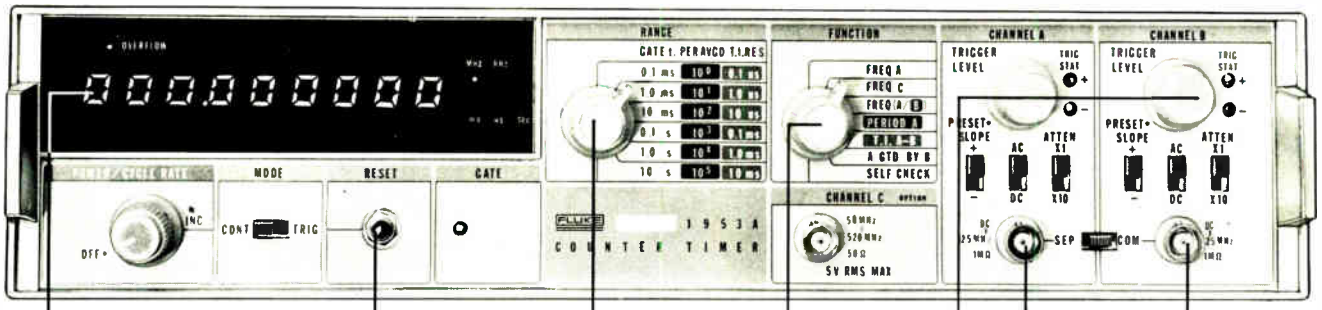
The company's LED units will be 0.24-inch-thick, 3-volt modules, in two configurations: one with hours, minutes, seconds, day of the week, and the date, and the other, called the Chronograph, with all these plus a stop-watch feature.

Microwave ovens turn Blaha on

Bucking the dismal trend currently afflicting consumer electronics and appliances, sales of microwave ovens are expected to jump a healthy 25% this year, exceeding 900,000 units, according to a January estimate by Litton Industries' Microwave Cooking Products subsidiary. This makes for busy times at the Minneapolis organization, and probably no one there is busier than Verle Blaha, the informal and

Tasty. With microwave-oven sales climbing, Blaha's homework never looked better.

If your counter looks this good...



EASY TO READ
9-digit LED display
Large 7-segment characters
Full leading zero suppression
Automatic annunciation and overflow

DISPLAY CHECK
Pressing reset button when counter is in self check mode lights all digit segments

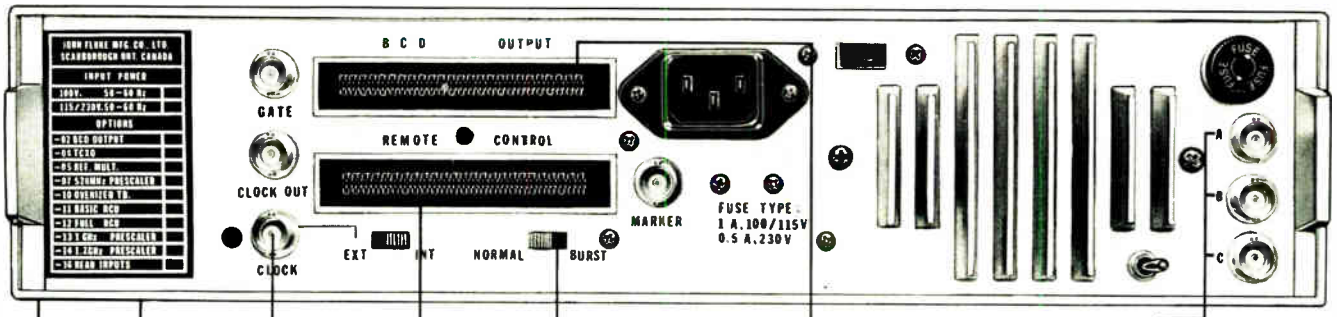
WIDE RANGING
Six choices of:
- Gate times
- Period averages
- Time interval resolution

VERSATILE
Measures:
- Frequencies
- Frequency ratios
- Period and period averages
- Time intervals
- Gateable totals
- Self check

FULL TRIGGERING CONTROL
Preset or variable trigger level controls with status indicators
Slope, coupling, and attenuation switches

TWO INPUT CHANNELS
Direct coupled amplifiers with 30 mV sensitivity

and gives you these options...



HIGHER ACCURACY
Higher stability timebase Options 04 and 10

PRESCALERS
520 MHz prescaler. Option 07
1000 MHz prescaler. Option 13
1250 MHz prescaler. Option 14

TIMEBASE MULTIPLIER
For operation from 1 or 5 MHz in addition to standard 10 MHz external reference clock. Option 05.

REMOTE PROGRAMMING
Basic remote programming. Option 11.
Full remote programming. Option 12.

BURST MEASUREMENTS
Select normal or burst measurements. Burst measurements made on Freq A or Freq C modes. Option 05.

DIGITAL OUTPUT
Parallel BCD output. Option 02

REAR INPUTS
Three rear panel mounted BNC jacks for A, B and C input channels, A and B are in parallel with front panel inputs. Option 16

it must be a Fluke
1953A Programmable Universal Counter/Timer

$849.00*

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Remote programming and other options extra.

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For a demonstration circle 169 on reader service card.

For more information circle 15 on reader service card.

People

friendly vice president of engineering.

"We're looking at 45 different tasks," he says, "as we try to add new features to the ovens, as well as improve their reliability and manufacturability."

One feature added last fall, for example, was the ability to vary the magnetron-produced power level beamed into the cooking space. Previously, microwave ovens operated with full magnetron power only. Blaha's engineers accomplished this by varying the duty cycle of the magnetron. Not a very complicated arrangement, he concedes, but one that just had not been applied to microwave ovens before.

Warranty. Perhaps the most important on-going program within Blaha's group was the production of the failure-analysis studies that, coupled with design improvements, have increased the reliability of the magnetrons. Less than 0.5% fail during the two-year warranty period, says Blaha. When the first microwave oven was introduced in 1966, the figure was 15%.

The result of all this engineering effort is that at a time when many engineering staffs are being cut back, Blaha's is expanding. Ten people were added during the last half of 1974, bringing the total to 72.

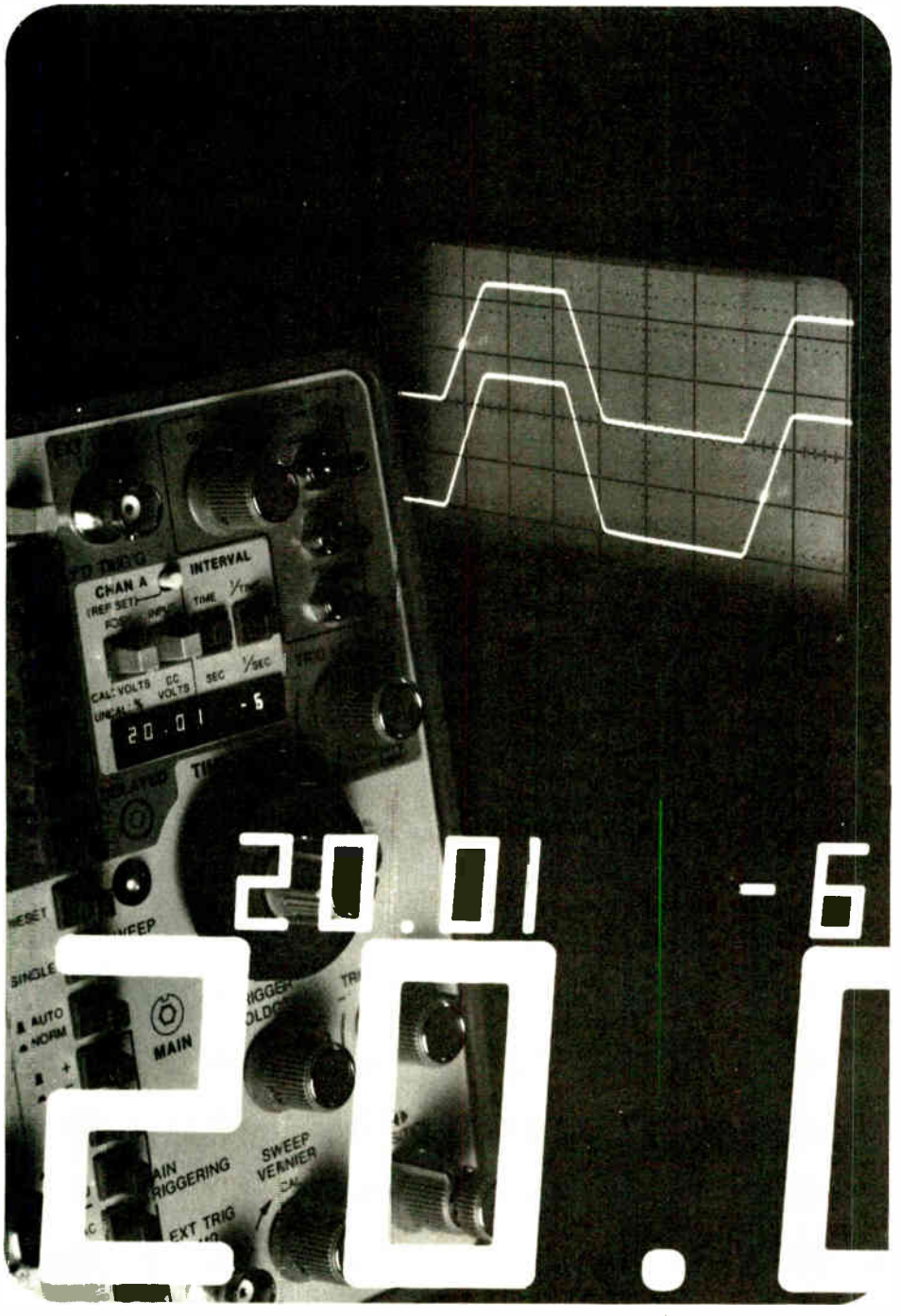
For the ebullient Blaha, there is obvious excitement in applying microwaves to cooking. And for Litton, it has meant a considerable market. Litton claims about 30% of 1975 consumer microwave oven sales that may reach $360 million.

Of his job, the 44-year-old Blaha avows, "I love it." Most of the more than 20 years of his engineering life—18 of it with Litton—has been spent on missile and other military projects "so classified I couldn't talk about them with my family, or so dull I didn't want to talk about them."

The situation is different now. "Most of the time there are five ovens in our kitchen at home, often new models we're still developing," he says. "One weekend we made 35 chocolate cakes to evaluate energy distribution."

MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

FEBRUARY, 1975



in this issue

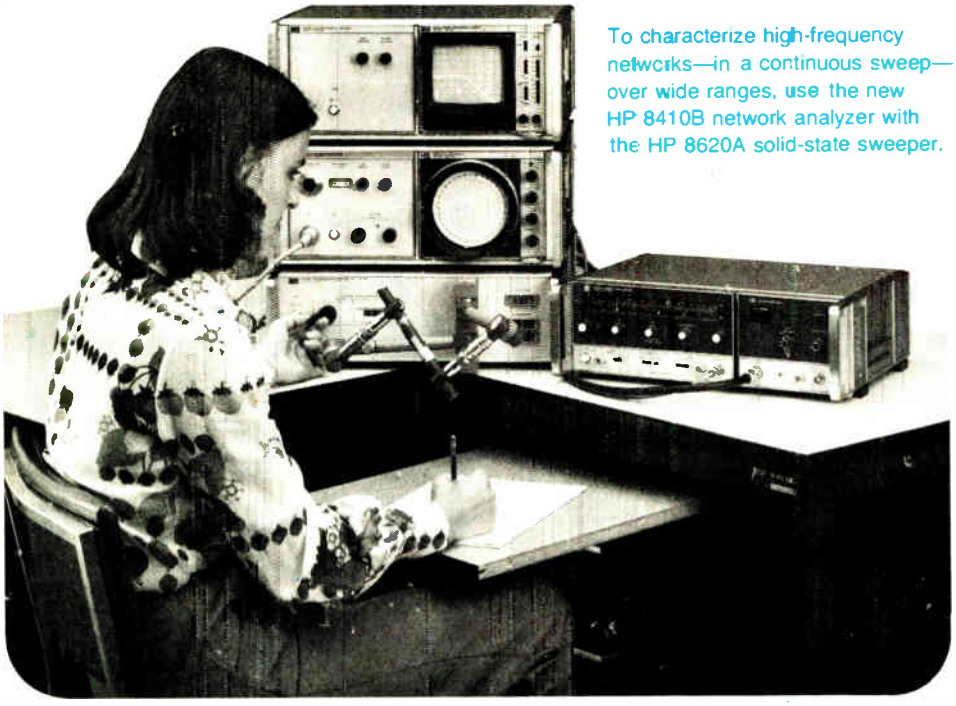
New smart oscilloscope with built-in microprocessor gives you answers

HP has combined a high-performance 275 MHz scope, a microprocessor, and LED display to put an end to graticule counting, mental calculations, and most conventional scope errors. The new 1722A gives you a quantum leap in measurement accuracy and convenience. It's a working lab partner that speeds measurements of time intervals, frequency, instantaneous or dc voltage levels, and relative amplitude expressed in percentage. And, instead of conventional reading errors, the 1722A gives you a 3½-digit LED reading of your measurements...in seconds, Hz, volts, or percent.

The microprocessor takes over several tasks you used to perform. It keeps track of dial settings, automatically

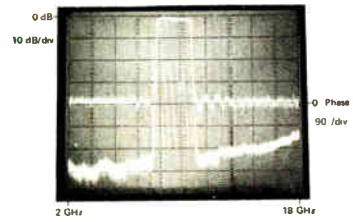
(continued on page 3)

Measure wideband microwave networks—in one sweep

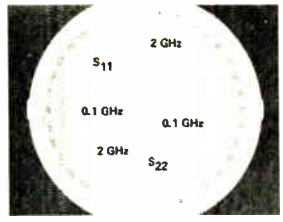


To characterize high-frequency networks—in a continuous sweep—over wide ranges, use the new HP 8410B network analyzer with the HP 8620A solid-state sweeper.

Two dramatic examples of continuous-sweep multi-octave measurements made with the new HP 8410B network analyzer:



Transmission characteristics (magnitude and phase) of 8-10 GHz bandpass filter, shown over 2 to 18 GHz range. Note that insertion Loss Trace (10 dB/div) is free from harmonic responses.



Polar plots of transistor s-parameters from 100 MHz to 2 GHz.

Frequency band switching is a thing of the past when multi-octave range networks are measured with the new HP 8410B network analyzer. The 8410B, successor to the popular HP 8410A* (which was limited to octave-wide sweeps), measures both the magnitude and phase of network parameters, vital data for microwave designers. Test configurations covering from 100 MHz to 40 GHz are offered.

Multi-octave measurements in one continuous sweep are possible when the 8410B is used with the HP 8620A sweep oscillator. For example, with the new HP 86290A sweeper plug-in, you can sweep test from 2 to 18 GHz. Or the HP 86320A RF plug-in and the 8410B cover from 100 MHz to 2 GHz, more than four octaves.

The 8410B network analyzer is a frequency-selective system that tracks the sweeper, resulting in a full 60 dB spurious-free dynamic range. Other multi-octave measurement schemes using broadband detection are typically limited to 20 or 30 dB range because of source harmonics.

*Existing 8410's can be retrofitted for automatic tuning.

For your copy of the Data Sheet, check L on the HP Reply Card.

Up to 24 Millicandelas from new high-efficiency RED, YELLOW, and GREEN LEDs

A new series of high-intensity, solid-state LED 'illuminators' are now available from HP. The new high-efficiency Red LEDs have an intensity of 24 mcd at a forward current of 10 mA.

Packaged in the T-1¾ outline, the lamps come in both wide and narrow beam types; the wide beam lamps using a diffused lens and the narrow beam lamps with a clear lens. These lamps have long general purpose leads to facilitate all types of mounting.

Four lamps of each color are being introduced, two light output categories for each beam angle. High intensity is obtained using a new HP technology employing a transparent gallium phosphide substrate and adding a reflector in the package. Higher Intensity is possible under "pulsing" conditions (or up to 20 mA dc) as these LEDs do *not* saturate. These lamps are rugged and are ideal for use in high ambient light conditions. The narrow beam, high output models are used as pushbutton switch illuminators and "Dead Front" panel annunciators. The wide beam models are used for low power panel indicators or backlighting.

For more information, check F on the HP Reply Card.

Red (5082-4650), Yellow (5082-4550) and Green (5082-4950) LED lamps.

NEW high-efficiency step recovery diodes

Special introductory price.

Our new high-efficiency step recovery diodes maximize cutoff frequency while maintaining a fast transition time. Thus, they provide excellent performance in low or high order multipliers and in comb generators.

The new 5082-0800 series diodes are passivated with a thermal oxide for maximum stability. You can buy them in chip form, in low-cost glass packaging, or in hermetically sealed metal-ceramic packages. Test data is supplied with each ceramic packaged device.

As an introductory offer, these devices are available in prototype quantity at the 100 piece price (offer good until April 30, 1975).

For more information, check E on the HP Reply Card.

(continued from page one)

New scope with microprocessor

computes time intervals and voltage levels, converts time measurements to frequency, and calculates percent. It even signals if you make an erroneous setting.

HP's dual delayed sweep gives you two adjustable intensified markers for displaying the start and stop points of a time interval. The microprocessor automatically computes and displays the time interval between the markers. This speeds digital timing measurements, reduces errors, and simplifies the adjustment of circuits to meet a timing spec.

The 1722A makes waveform measurements faster, more accurately, and more completely than conventional scopes costing up to twice as much.

For details on HP's microprocessor oscilloscope, check B on the HP Reply Card.

NEW HP-55 scientific pocket calculator offers 86 keyboard functions, programmability and built-in timer

HP introduces an extraordinary new programmable scientific pocket calculator. With all of the pre-programmed functions and operations of our popular HP-45, plus 38 new ones including statistical functions.

You can perform circular trigonometry in degrees, radians or grads and convert among any of them. Also, compute two-variable mean and standard deviation, linear regression, linear estimate, curve plotting and four simultaneous linear equations with four unknowns.

The HP-55 has 20 addressable storage registers—more than twice as many as any other scientific pocket calculator on the market.

And, the HP-55 is the only pocket calculator in the world with a built-in digital electronic timer with 100-hour capacity—a stopwatch that times and stores up to 10 events within the same experiment, accurate to 0.01%.

Whenever you wish to write a program to solve your particular calculations, just set the program switch, enter a program of up to 49 steps, then run it... as often as you wish. Meanwhile, you still have access to all 86 keyboard functions plus the 20 register memory.

And, with the HP four-register stack, enter the most complicated equations without having to keep track of the parentheses and brackets.

To learn more about the amazing new HP-55, check A on the HP Reply Card.

Faster graphs with new high-speed time-share plotter

Fast digital X-Y plotter accepts bit-serial ASCII at 10 or 30 characters per second.

Now you can plot up to seven vectors per second in any direction using the new 7203A high-speed graphic plotter.

Vectors of any length are plotted in any direction and the resulting graph appears as a smooth line, in contrast to the staircase often drawn by incremental plotters.

Check numerical control tapes, display statistical data, quickly analyze engineering designs or use this plotter for any application you have that requires fast graphics.

Four colors of ink are available in disposable pens. Pens are changed quickly and easily so that plots may be superimposed in color for comparison.

Each plot coordinate is expressed with a Binary number represented by the bit pattern of two successive ASCII characters. Thus, only 4 characters are required to define any move.

The 7203A operates in parallel with data communication terminals. Easy to use software subroutines are available for many time-share systems.

Plots are front panel scalable from 0 × 0 up to 10 × 15 in. (25 × 38 cm) using paper up to 11 × 17 in. (28 × 43 cm).

Check 1 on the HP Reply Card.

NEW HP display terminal offers an intelligent addition to your computer

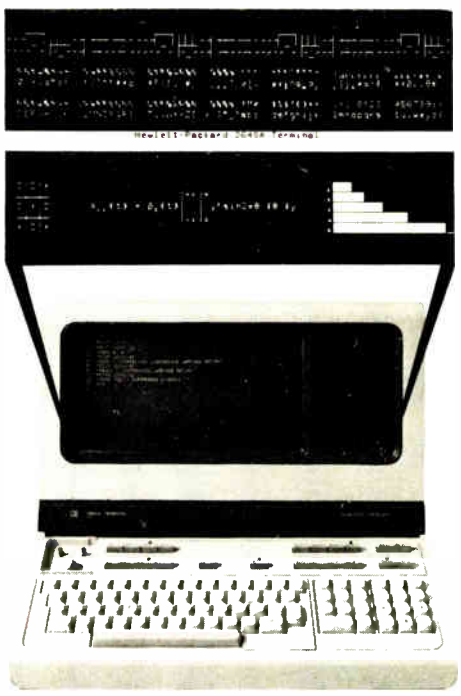
HP's new 2640A display terminal with built-in microprocessor is the intelligent, cost-effective answer to your data entry and information handling needs.

The 2640A operates either on-line or in stand-alone mode, with full editing capability. You can write 24 lines with 80 characters per line on the 5 by 10 in. (127 by 254 cm) rectangular display. High resolution ensures clear, precise character definition. You can also plug in three additional character sets, such as a line drawing set or a math set, and use them concurrently with the standard character set.

The 2640's dynamically allocated memory lets you store 8 to 50 lines or add optional memory modules and store over 400 lines depending upon line length. Memory protection is standard on all 2640A terminals.

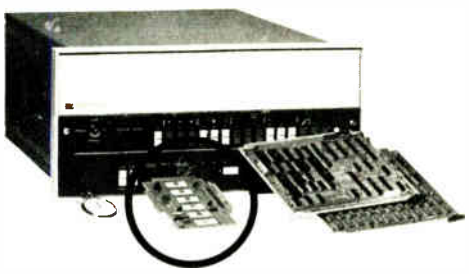
Should the modular 2640A need repair, just lift up the top and replace the necessary printed circuit cards. And, thanks to a universal interface, the 2640A works with a wide variety of computers.

For more information or a demo, check C on the HP Reply Card.



New Hewlett-Packard Model 2640A CRT Terminal is microprocessor controlled. Model 9866A Line Printer (left) is optional.

21MX computer with new **Dynamic Mapping System** plug-in gives you million word addressing space



Programmable DMS for 21MX computer expands address space.

A new Dynamic Mapping System (DMS) devised by HP for its 21MX series user-microprogrammable 4K RAM semiconductor memory minicomputer allows access to four independent memory spaces.

The 12976A DMS expands the memory address size to 20 bits, thereby providing a maximum main memory addressing space of 1,048,576 16-bit words. It does this without adding to the 650-nanosecond cycle time.

Accounting for the compactness and low prices of the new large-memory models, HP cites features common to the whole 21MX line. For example, all 38 of the new instructions are contained in a single 265 word module of microcode. Also included is read and or write protection on an individual 1K-page basis. All these instructions are on half of a single small circuit board. These new capabilities are plug-in installable.

The HP Dynamic Mapping System functions with main memory somewhat as "virtual memory" schemes function with disc memory.

The 38 new microcoded instructions in DMS firmware, including cross map moves and block transfers, give extensive control over memory allocation and protection. In addition to these 38 supplied by HP, the user can generate his own unique memory management and protection instructions using the standard microcode capability.

For more info on this new Dynamic Mapping System, check O on the HP Reply Card.

HP interface bus enhances signal generator

Joining the growing list of HP-IB compatible instruments is the HP 8660A/B synthesized signal generator. It's a fully programmable signal generator with .01 to 1300 MHz frequency coverage, 3×10^{-8}/day frequency stability (3×10^{-9}/day optional), +13 to −146 dBm output level, and AM, FM and pulse modulation capabilities.

When installed, the HP interface bus allows programming of:

- Frequency, in 1 Hz steps over the entire 1300 MHz range.
- Output level, in 1 dB steps over the entire 160 dB range.
- Modulation mode, either AM or FM.
- Modulation source, either internal 400 or 1000 Hz tone or external source.
- AM depth, in 1% steps from 0 to 99%.
- FM deviation, in 3 overlapping ranges, either 50 or 100 steps per range, from 0 to 1 MHz.

The HP-IB interface is available as option 005 on new instruments or as a field-installable kit 08660-60189 for instruments already equipped with the standard BCD interface.

To learn more, check M on the HP Reply Card.

Now, you can run a precision signal generator under calculator control.

Helpful techniques for using VHF signal generator

New application information available for 8640A/B.

Three new application notes show you how to extend the usefulness and accuracy of HP's 8640A/B VHF signal generator (450 kHz to 1100 MHz).

AN 170-1 explains how to improve the specified output level accuracy over narrower frequency limits—i.e., how to operate the generator for optimum accuracy. Also, special calibration can be used to minimize effects of frequency response, temperature, detector and meter linearity, and vernier error.

AN 171-1 describes a method for improving crystal filter measurements when using an HP vector voltmeter and the 8640A/B. This technique optimizes frequency tuning sensitivity by using a feedback signal from the phase meter to the generator external FM input.

AN 171-2 describes how to build a simple heterodyne circuit that extends the frequency down range to dc-450 kHz. The circuit mixes the rear-panel fixed 5 MHz crystal output with the tuned output signal and provides a stable frequency that can be read directly on the digital readout.

For your copies, check P on the HP Reply Card.

New capabilities, more options for HP-5300 measuring system

Now there is a high resolution 8-digit display mainframe (Model 5300B) with temperature-compensated crystal option in the HP-5300 series of electronic counters and digital multimeters.

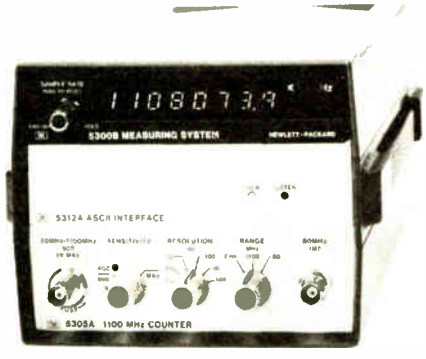
New snap-ons for the system include an 1100-MHz counter and a bus interface.

In the 5300 system, a complete instrument consists of two halves that snap together in about 15 seconds. The width of these units is a very compact 6¼ inch (160 mm). The upper half, or mainframe, contains the readout and associated circuitry. The instrument's measurement functions are determined by the lower half, or "snap-on", of which there are now 7 models for measuring frequency, time interval, ac and dc volts and ohms. The new 5312A ASCII "snap-between" module allows all of the 5300 functions to interface with data acquisition systems via the HP Interface Bus.

With the new 5305A 1100-MHz frequency counter snap-on, you get a sensitivity of 10 mV to 500 MHz and better than 25 mV to 1100 MHz, automatic gain control and manual attenuator to measure noisy or modulated signals, plus a front panel accessible input fuse to prevent costly front end damage.

With the new 5312A ASCII "snap-between" module you can mate other instruments and controllers to the 5300 series via the HP Interface Bus.

For more information, just check H on the HP Reply Card.



HP 5300 Measurement System adds 5300B 8-digit module, 5305A 1100-MHz counter, and 5312A ASCII interface to HP Interface Bus.

Now debug your control system design before you build it

New software for design engineers using 9830A calculator in BASIC language.

With HP's powerful 9830A programmable calculator and state-variables software, you now can know exactly how your control system will perform long before you've committed time, materials, and manpower to an expensive prototype.

The new state-variable software provides a complete transient response solution for control systems, whether for mechanical, electronic, hydraulic, optical, or hybrid systems. It's a carefully developed set of programs that will assure you a stable system in a minimum amount of time. There's no hassle with computer programming and interfacing. You just key in the values directly from your block diagram, and the 9830A does the rest automatically.

In 10 minutes or less, you get a high resolution plot of transient response and printed list of system parameters. If you want to adjust your design, you simply key in different values. Thus, you can explore alternatives—right at your desk—to find a better design or solution.

An extensive library of engineering and design programs are available from HP.

To learn more, check N on the HP Reply Card.

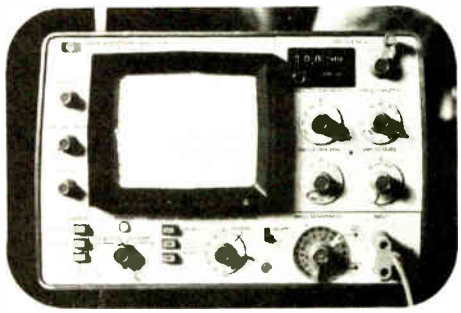
Low frequency spectrum analyzer offers unmatched resolution

Up until now, the biggest problem analyzing low frequency signals has been the display. Now, you can get a clear picture of mechanical vibrations, audio filters, or data communication channels with HP's 3580A spectrum analyzer, covering 5 Hz to 50 kHz. The trace appears on a CRT with 1 Hz bandwidth—that's the best resolution of any low-frequency spectrum analyzer on the market.

You can also store your trace in the CRT's digital storage. In fact, store two traces, and compare them on the CRT. You can study and interpret spectral information easily and quickly.

Dynamic range is 80 dB. HP offers unique adaptive sweep that speeds up your measurements and reduces analysis time. The 3580A weighs just 35 lbs (16 kg) and operates on batteries, as well as line power.

For more information, check D on the HP Reply Card.



There are many variables in a sound system; thus, instrumentation is needed to track down problems. HP's 3580A Spectrum Analyzer has the range and visual display necessary to analyze audio problems. With this unique instrument, distortion hum, equalization and reverberation can be quantified far better than even the best ear.

For versatility, ease of operation and wide applications, 50 MHz pulse generators

What every Logic laboratory needs: versatile, easy to operate 50 MHz generator.

The 8012B and 8013B pulse generators are ideally suited to the requirements of a general digital logic laboratory where ease of operation and wide range of applications are essential.

Their 10V outputs and fast transition times (3.5 ns on the 8013B and 5 ns on the 8012B) enable you to dynamically test TTL, ECL and even the latest CMOS logic. You can simulate noise patterns and, in double pulse mode, test device recovery times and make noise immunity measurements. You can also use them as amplifiers when generating worst case data patterns.

These instruments not only enable you to set up pulses more easily, but also much more quickly. One big time-saving feature is the unique front panel layout; the slider controls provide a simple, straightforward design that enables you to set up your pulses very quickly and with a minimum risk of incompatible pulse settings. They also greatly improve the readability of the pulse parameters. Another time-saver is the square wave mode which enables you to set up pulses very rapidly without having to worry about pulse width or delay.

In addition, the variable transition times of the 8012B enable you to generate any triangular or trapezoidal waveforms, and the two independent outputs of the 8013B enable you to test circuits designed with bipolar supplies.

For more information on these extremely flexible pulse generators, check K on the HP Reply Card.

A 20 column low-cost printer that really *is* quiet

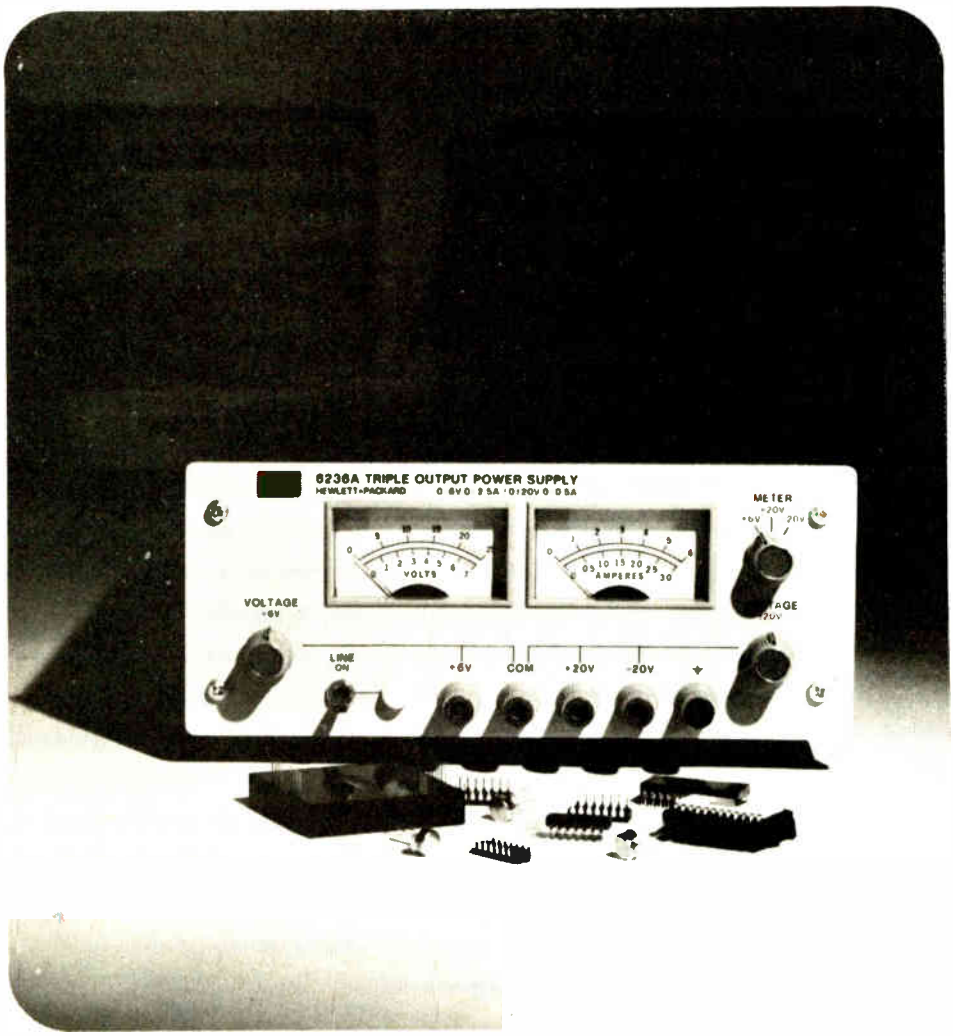
At last: a quiet printer that's really quiet. The new 5150A thermal printer prints faster than 3 lines per second, without any noisy impact mechanisms. It accepts data from BCD or ASCII sources and can list 20 columns of alphanumeric information, yet the price is extremely reasonable.

The 5150A uses heat-sensitive paper and a thermal print head, so you don't have to bother with ink spills or refills. Don't let simple design or light weight fool you—the 5150A is a high technology peripheral that can interface with minicomputers, any Interface Bus (HP-IB) instrument system or other digital data sources having acceptable codes and voltage levels. Available options include clock, BCD or ASCII interface and scanner—whereupon it can serve as an HP-IB controller.

For more information, check G on the HP Reply Card.

The 5150A printer is available in several different configurations to fit your system; here, it logs data from a 5345A Electronic Counter.

New triple-output bench supply for IC test and development



Separate voltage controls adjust the 0 to 6V and 0 to ±20V outputs, while the meter switch selects the desired V and I range for display on the panel meters.

Low cost, small size, and outstanding performance, make this new three-in-one lab supply a valuable aid to anyone designing or testing equipment using integrated circuits. Model 6236A delivers three outputs: 0 to 6V, up to 2.5A; and dual-tracking 0 to ±20V, 0 to 0.5A. The 0 to +20V and 0 to −20V outputs track one another within 1% to supply the symmetrical voltages needed by op amps and similar balanced-voltage-source applications. A single 0 to 40V @ 0.5A output can also be obtained by connecting across the −20 and +20V terminals.

All outputs are regulated to 0.01% +2mV, with ripple and noise of 0.35mV rms/1.5mV p-p. The dc outputs have smooth turn-on and turn-off characteristics so that no output voltage overshoot is produced when the ac line switch is operated. Both the 6V and ±20V outputs are protected from overloads by fixed current limiting circuits.

Model 6236A can be powered from a nominal 100V, 120V, 220V, or 240V, 47-63 Hz ac input. The supply weighs only 9½ lbs. (4.3 kg) and is 3½ in. high (8.9 cm), 8½ in. wide, (21.6 cm), and 12½ in. deep (31.8 cm). Single and dual-unit rack-mounting kits are available.

For more information on the three-in-one power supply, check I on the HP Reply Card.

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LET ERIE DESIGN and BUILD YOUR HIGH VOLTAGE POWER SUPPLIES and VOLTAGE MULTIPLIERS

When you talk about designing and packaging miniature, low current High Voltage Power Supplies and Voltage Multipliers, the name ERIE should come to mind first. Why? *No other manufacturer of these sophisticated devices has its own capacitor and rectifier technology in-house.* Only ERIE does it all. Our many years experience in producing State of the Art high voltage capacitors and high voltage silicon rectifiers — plus an unsurpassed technology in circuit designing, packaging and encapsulation, makes ERIE an ideal source for your high voltage component needs. From very low input voltages, ERIE can produce output voltages up to 50,000 volts. Application for these compact, high reliability devices includes night-vision image intensification systems, Apollo TV cameras, CRT displays, Avionics systems exposed to rugged environments, Industrial, commercial and military equipments . . . an almost infinite variety of applications. So bring ERIE in early. Let us design and build *your* High Voltage Power Supplies and Voltage Multipliers. We're equipped to handle large or small volume orders . . . in-house.

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Circle 27 on reader service card

Meetings

Nepcon '75 West and International Microelectronics Exhibition, Industrial Scientific Conference Management Inc. (Chicago, Ill.), Anaheim Convention Center, Anaheim, Calif., Feb. 11–13.

CAD/CAM III, Computer-Aided Design and Computer-Aided Manufacturing, Society of Manufacturing Engineers, Hyatt Regency O'Hare Hotel, Chicago, Ill., Feb. 11–13.

International Solid State Circuits Conference, IEEE, Marriott Hotel, Philadelphia, Pa., Feb. 12–14.

Compcon Spring Computer Conference, IEEE, Jack Tar Hotel, San Francisco, Calif., Feb. 25–27.

Industrial Applications of Microprocessors, IEEE, Sheraton Hotel, Philadelphia, Pa., March 11–12.

Reliability Physics Symposium, IEEE, MGM Grand Hotel, Las Vegas, Nev., April 1–3.

Paris Components Show, (*Salon des Composants Electroniques*), Porte de Versailles, Paris, April 2–8.

Southeastcon '75, IEEE, Sheraton Center, Charlotte, N.C., April 6–9.

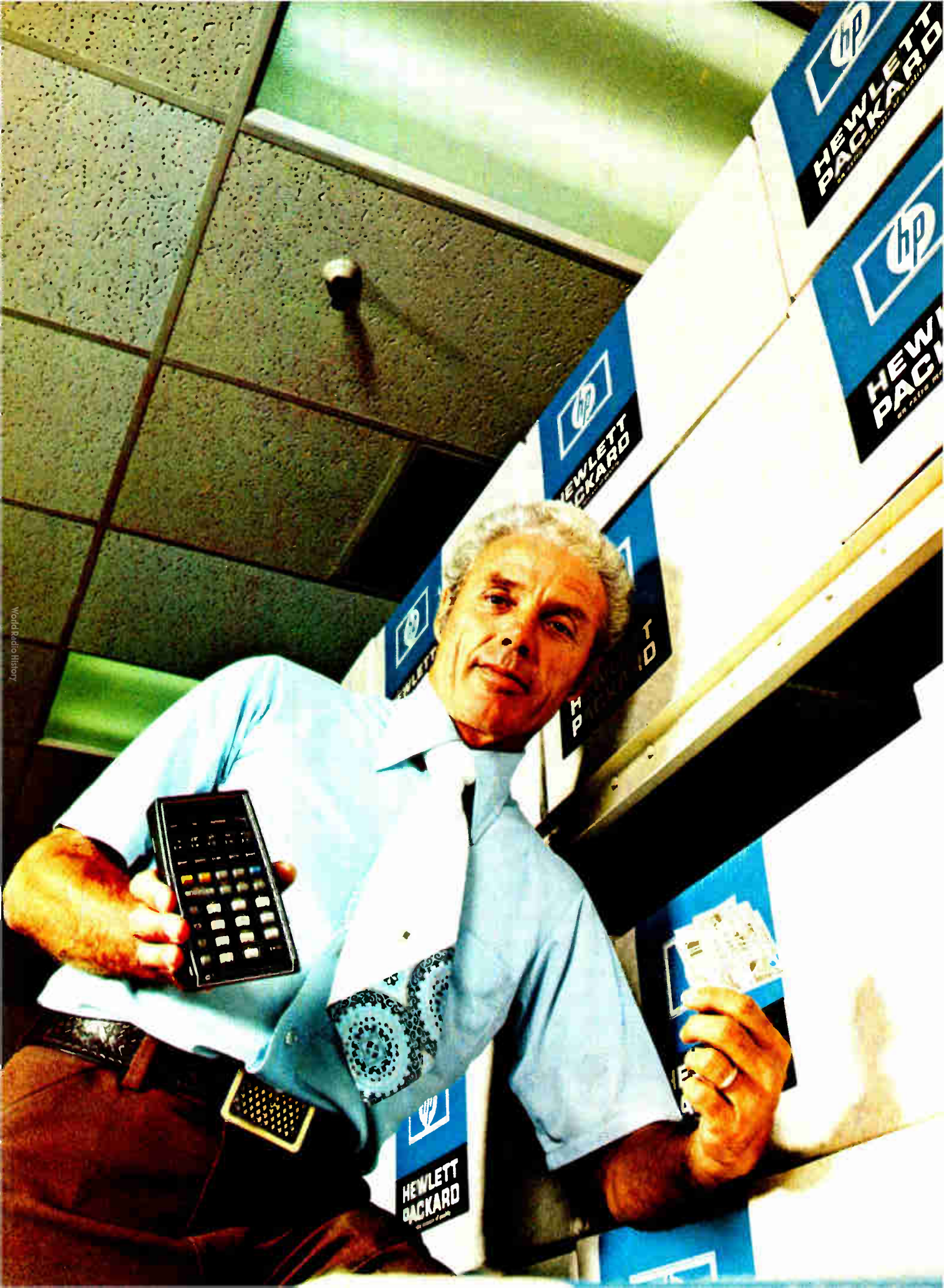
Intercon—IEEE International Convention, Coliseum and Americana Hotel, New York, N.Y., April 8–10.

Electronics Production and Test Equipment Exposition, U.S. Department of Commerce, Stockholm, Sweden, April 7–11; London, April 15–18.

Society for Information Display International Symposium, SID, Shoreham Americana Hotel, Washington, D.C., April 22–24.

International Optical Computing Symposium, IEEE, Mayflower Hotel, Washington, D.C., April 23–25.

National Relay Conference, NARM and Oklahoma State University, Stillwater, Okla., April 30–May 1.



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"My records prove it. Photocircuits shipped us over 1/2 million PCBs for calculators. Less than 1% were rejected."

Tom Miller, Production Control Supervisor, Hewlett-Packard

"I supervised in-house production of printed circuitry for Hewlett-Packard. When the demand for our pocket-sized calculators taxed our own capacity for making printed circuit boards, I had to look outside the company.

"The scientific and business calculators Hewlett-Packard makes have infinitely more functions than the typical 'housewife' variety. And we have sold over one-half million of them. So we needed large volumes of quality boards for logic and battery charger applications.

"Photocircuits' reputation for quality was confirmed by my first visit.

"I've been in this business since 1955, so I knew of Photocircuits even before we made a facilities check. What I had heard proved to be true. Their overall efficiency was evident and everyone seemed to know what they were doing.

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"Their price was lower and they delivered what they promised.

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"Quality-wise, they were the best boards I've seen in twenty years.

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"In both cases, performance and looks, Photocircuits was outstanding. Over half a million boards have been delivered. Less than 1% have been rejected for any reason whatsoever.

"What more is there to say?"

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Electronics newsletter

Showdown looms between U.S. and UK MLS finalists

A possibly bitter global showdown between the United States and the United Kingdom looms in June before the International Civil Aviation Organization **over the choice between the U.S. scanning beam and the UK's doppler-scanning system, developed by Plessey, as the "universal" microwave landing system.** The winner will have a head start on a multibillion-dollar market in new equipment. UK representatives, irate over what they call "political skullduggery" in a U.S. Federal Aviation Administration committee's recommendation of the "paper" scanning beam, rather than the "proven" doppler system, indicate **they may marshal Third-World countries to outvote the scanning-beam system if it remains the U.S. choice.**

UK officials charge that the FAA assessment committee changed evaluation and selection procedures to favor scanning beam when technical evaluation began to favor doppler scanning. They also say that they feel double-crossed because they trusted the FAA's selection procedures. A UK delegation has already protested to the FAA. **In the balance may be an agreement between the two countries for cooperative development of the discrete-address-beacon system.**

However, a suit filed in the U.S. by the Hazeltine Corp., which had also proposed a doppler system, may put a crimp in the FAA decision. **Hazeltine is trying to halt the FAA plan until completion of a two-month study by the General Accounting Office on the choice.** A delay would increase the odds for the UK entry, which would be able to build up its data base and the persuasiveness of its argument for the ICAO. **"The only winner out of this litigation will be the UK," says an FAA source, and the other U.S. loser, ITT Gilfillan, agrees.**

Fairchild offers Schottky TTL processor family

In a major move into high-performance LSI logic, Fairchild Semiconductor is supplying a 4-bit, bipolar LSI processor **built on five chips with low-power Schottky TTL technology.** Tom Longo, vice president and group general manager, says that because this family has a microcycle time under 100 nanoseconds, it is **aimed at minicomputer central-processor functions.** This contrasts with n-channel MOS processors, which are aimed primarily at the controller market. Equally important, Fairchild is making this LSI processor family pin-compatible with its Isoplanar complementary-MOS line.

The five chips of the processor element are: an arithmetic/logic register (9405); a last-in, first-out shift register laid out in 16 4-bit words (9406); a data-access register (9407); a random-access memory of 16 4-bit words (9410); and a data-path switch (9404). Included in the family are two 1,024-bit RAMs, 2-kilobit and 4-kilobit programable read-only memories, an 8-kilobit ROM, a cyclic redundancy-check generator (9401), and a serial/parallel first-in, first-out buffer memory (9403).

The 9401 generator/checker, the 1-kilobit RAM, and the 2-kilobit PROM are available now, Longo says, and the remaining devices will be available during the first half of this year. The pin-compatible C-MOS versions will be available in sample quantities in March or April.

Intersil to introduce first field PLA . . .

Foreshadowing a trend in logic design is Intersil Inc.'s TTL programable logic array, **the industry's first PLA that can be electrically programed in the field.** The device, called IM-5200, has 14 inputs, eight

outputs, and a total of 48 product terms. It is pin-compatible with National Semiconductor's 7576, a mask programable PLA with twice the capacity of the IM-5200. The Intersil device, which will be sampled next month, has the complexity of more than 480 four-input gates. Like all Intersil programable products, the 5200 is programed by an avalanche-induced-migration method that involves blowing out a diode in the transistor structure. Typical propagation delay is only 65 nanoseconds, and a single 5-volt supply provides power.

. . . as it offers one-chip circuit for LED watches

What is probably the first truly one-chip light-emitting-diode watch circuit has been developed by Intersil Inc. **Up to now, most LED watches required separate chips for both the segment and digit drivers**—even Mostek Corp.'s so-called one-chip circuit requires a separate bipolar segment-driver chip.

Not only does Intersil's new 7200 family have all its electronics—oscillator, divider, decoder, and segment and digit drivers—integrated onto one chip, **but it can drive a nine-digit alphanumeric display** as well as the standard seven-digit numeric display. The only external components, says Murray Siegal, director of special products and systems, are two silver-oxide batteries, a quartz crystal, a trimming oscillator, and two switches. To get the 125-square-mil chip, says Siegel, Intersil depended on its **standard low-voltage metal-gate C-MOS process.** The seven-digit model, ICM 7202, is now in volume production; the nine-digit version, ICM 7200, is being sampled and is due for volume production in July.

RFQs increase for linear ICs

In what could be the dawn of a brightening market for semiconductor products, linear-circuit marketing managers report a sudden dramatic **increase in the last few weeks in requests for quotations.** Categories, which pertain to both military and commercial data-acquisition systems, precision operational amplifiers (not commodity types), converters, sample-and-hold devices, and analog switches.

As one manager puts it, "Whereas, in November and December, you could spend all week on one RFQ, now we're staying up nights answering them. And, while RFQs aren't bookings, **at least it means someone out there is thinking of buying something."** On the other hand, there is no reported increase in quoting activity for digital components.

General Automation enters semiconductor equipment field

General Automation Inc. has applied its Adapt-a-Path numerical-control system, used up to now on massive machine tools, to the other end of the spectrum. **The company has developed a computer-controlled automatic wire-bonder control for integrated circuits.** The $12,000 system, which can be added to commercially available bonders, includes both a computer and a special X-Y table for the ICs.

The company developed the equipment for an automated production line making high-density multichip memory boards. GA claims the L101 controller **increases throughput by 270% to 2,500 wires per hour,** and a single operator can control as many as six machines. The equipment is adaptively programed simply by stepping through the bonds, rather than a read-only memory or paper-tape program.

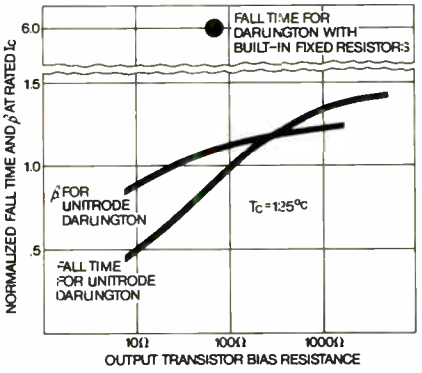
If you could cut your switching loss by 80%, how would you celebrate?

By eliminating a heat sink, maybe? Saving a bit of board space? Improving your circuit's operating characteristics?

Do it with our power darlingtons. Unlike other darlingtons, ours offer access to the output transistor base, and have no internal resistors. So they'll give you greater design flexibility, higher temperature stability, and faster switching time.

Because you can vary the bias on the output transistor, you can speed up your switching time or slow it down, give your circuit more gain, less gain, whatever you want.

Using our darlingtons, you can cut heat loss to one-third or one-fifth, and cut the size of your heat sink proportionately. Most heat dissipation occurs during fall time, so when you speed up your switching time, you automatically reduce dissipation. And thanks to external resistors, our darlingtons are much less sensitive to temperature than ordinary darlingtons.



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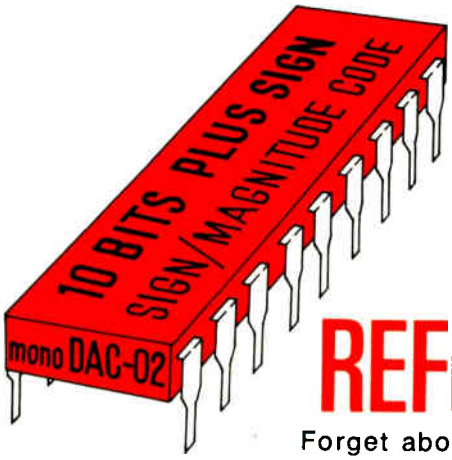

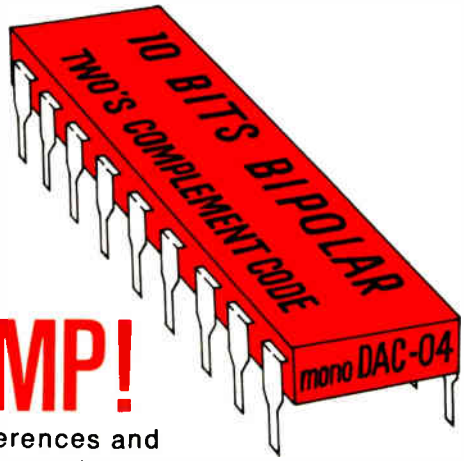

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RCA is close to commercial CCD cameras, arrays

Image sensor of 512 by 320 elements being readied for black-and-white TV cameras; sensors to be marketed also

RCA Corp. moved a step closer to the charge-coupled-device marketplace last week when it demonstrated a commercial camera that uses its 512-by-320-element silicon imaging sensor [*Electronics*, March 7, 1974, p. 67]. The arrays will be marketed separately in April, along with two black-and-white CCD television cameras. The two cameras, which differ primarily in their criteria for screen blemishes, are priced at $3,800 and $3,000.

Meanwhile, CCD-imaging technology is advancing on other fronts. General Electric Co.'s injection-type metal-oxide-semiconductor camera, introduced early last year, has been boosted to 244 by 188 elements and is being shipped to potential customers for evaluation as an optical sensor in tracking and guidance systems, remotely piloted vehicles, and point-of-sale terminals. The GE camera was preceded by Fairchild Camera & Instrument Corp.'s CCD imager with 100 by 100 elements, which was first demonstrated about 18 months ago [*Electronics*, Aug. 30, 1973, p.36]. And at Bell Labs, where work continues on CCDs for imaging and high-density facsimile, as well as other applications, a spokesman hints that substantial improvements in resolution have recently been made over the 256-by-228-element imager demonstrated a year ago.

The RCA arrays are priced initially at $2,300 and $1,500 each, depending on quality. They use the same frame-transfer system as the one the firm described very briefly in 1973. The system consists of three sections.

Two of the sections are partitioned into vertical channels by means of diffused channel stops. Horizontal electrodes that pass across the entire device allow charge to be transferred vertically, with all channels transferring simultaneously.

A third region of the device is a single CCD line. Here, charge can be transferred horizontally to an output amplifier built on the chip.

In effect, says Ralph E. Simon, manager of electro-optics operations at RCA Electronic Components group's Industrial division, Lancaster, Pa., the imager is a large array of closely spaced MOS capacitors. "Charge, which is injected by light, is collected under the electrodes and then passed from electrode to electrode to an output diffusion where the charge is detected. The advantage of the CCD principle is that it permits information to be handled in a relatively small, simple structure."

According to Simon, this attribute is vital in the imager application, where a large number of resolution elements is required. It is also particularly essential in memory applications, he points out, where a high density of storage sites is needed.

Simon also says that the RCA silicon imaging device, with its 512 vertical picture elements and 320 horizontal elements, has the resolution required for broadcast television. RCA officials, however, don't believe the company's CCD cameras will be used in broadcast applications for at least another two to three years, and then probably only for special "spot" news coverage. There are other technical problems that have yet to be solved.

Blemish. A problem, for instance, is the loss of half a dozen or more elements in the picture produced by most CCD devices. This appears as a large white dot or blemish on the television screen.

Further, RCA is completing development of a custom C-MOS integrated circuit to generate complete vertical clocking waveforms. The device will be used in both CCD cameras, although RCA says it plans to offer the device as a separate product in the future.

Despite the long list of appli-

Tubeless. Rectangular charge-coupled device is the sensor for TV camera to be manufactured by RCA Electronic Components.

cations for solid-state imaging devices, and their low-cost potential, most suppliers believe vidicon tubes will be around for a long time. RCA says image sensors should be selling in the $30 region by the early 1980s. But as John Rado, Reticon president, points out: "You can buy a vidicon tube right now for $25 and get 500-by-500 resolution." □

Solid state

Three-inch rectifier handles 10 MW

A 3-inch-diameter rectifier—a third larger than any commercially available wafer—is being developed by Westinghouse Electric Corp.'s Semiconductor division. And there is the promise that a thyristor of comparable size will follow.

According to Derrick J. Page, manager of semiconductor development at Westinghouse's Research Laboratories in Pittsburgh, the new rectifier will allow electrical-control suppliers to get around the need to use more of the presently available 2-inch devices in parallel, thus reducing system costs and complexity and improving reliability. Westinghouse expects to introduce the rectifier as an off-the-shelf item next year. The 3-inch thyristor is just entering the testing stage.

The rectifier, says Page, can handle 10 megawatts of power. The most powerful commercially available solid-state device is a 5-MW solid-state rectifier.

"The first application of the 3-inch rectifier," says Page, "is likely to be in aluminum processing and fabrication, which demands high current." He also finds obvious applications in fusion reactors and electrochemical platers, because of their high energy requirements, and in welding, where power is stored and then dumped in high current increments.

Prototype. Although the device has been tested at 10 MW, Page believes it can handle 12 MW. "Continued development may raise its ratings even higher," he says. The prototype can handle 2,500 volts at an average current of 4,000 amperes. It has withstood a surge of 26,000 A under test, and members of Page's development team, including Prosenjit Rai-Choudhury and P. F. Pittman, believe it is capable of withstanding 40,000 A. The rectifier's developers say that, as a rule of thumb, the device carries 100 A per square centimeter, it measures nearly 40 cm^2 in area, and surge ratings generally run about 10 times the normal ampere rating.

The 2-inch rectifiers currently available can handle 2,000 V at 2,000 A, but Westinghouse researchers believe the performance of these devices is limited by the quality of the silicon and nonuniformities of resistivity.

Also, lower voltages are possible with thinner wafers, and Westinghouse initially is interested in low-voltage devices. Page says that 12 mils is about the thinnest silicon slice commercially available. This can be lapped on one side to 8 mils. However, the Westinghouse development team believes that the 40,000 A peak necessary for welding applications is possible with a 3-inch device of 10 mils thickness.

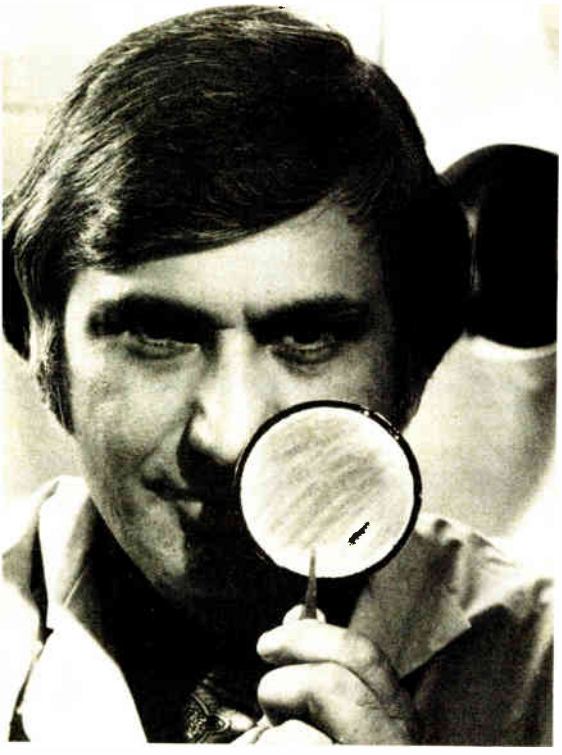
Properties. According to Page, the high-current capability built into the new rectifier was achieved partly through uniformity of both the silicon crystal structure and dope-element diffusion over the larger surface area, and partly from the extremely low thermal impedance of the device.

The rectifier, basically, is a slice of silicon and a molybdenum backing plate separated by an extremely thin layer of aluminum foil. But, according to Joseph E. Johnson, manager of design and engineering within the Semiconductor division's operations department, much of the device's "uniqueness" comes from the production process, plus its ability to dissipate heat.

One of the major problems that confronted the designers, for instance, was that in bonding, the molybdenum expands faster than silicon, producing cracks near the edge of the silicon. This problem was solved by alloying molybdenum to silicon in a hydrogen atmosphere and by using "certain wetting agents" during the production process.

"This is something we worked at very hard, and it succeeded where graphite compaction failed," says Johnson.

Johnson says he hopes to have a rectifier in the 500-600-V range this year, with an average current rating of 5,500 A. □



Powerful. Three-inch-diameter silicon disk held by Westinghouse's Prosenjit Rai-Choudhury goes into 10-megawatt rectifier.

Communications

IBM ponders court action on domsat

International Business Machines Corp. is reportedly weighing court action against the Federal Communications Commission ruling that

treats the company's proposed entry into the domestic satellite business as a special case. The FCC, in a 5-to-1 ruling in late January, warned that any IBM entry into satellite communications would come under "special policy conditions" to "minimize the adverse public-interest effects that might potentially arise." This special-treatment provision is seen as a solid legal ground on which IBM might challenge the commission, citing the principle of equality before the law.

The FCC action resulted from the joint petition of IBM and Comsat General Corp. to restructure CML Satellite Corp. [*Electronics*, July 11, 1974, p. 26]. IBM proposed to establish a subsidiary that would acquire 55% control in CML, and Comsat General was to increase its share to 45% on the withdrawal of MCI Communications Inc., and Lockheed Aircraft Corp. from the triumvirate in which each partner owns one third. The FCC modified this plan adding safeguards to prevent IBM from eventually dominating the domestic satellite field.

"If IBM goes to court," says the Washington counsel for one competitor, "it will give us a clear sign of how badly they want in on the domestic satellite business—and just how important it is to their future long-range plans." Lawyers for several IBM competitors believe the court option is being considered within IBM.

However, an IBM official declined comment on the possibility of a suit. He says the company will withhold comment until the full text of the FCC ruling becomes available, which FCC officials estimate will be mid-February.

Speculation that IBM will go to court has risen sharply with the news that it has won its appeal to overturn the 1973 antitrust judgment that ordered IBM to pay $259 million in damages to Telex Corp., the Tulsa, Okla., peripheral-equipment maker (see related story, p. 46). "They are 'hot' now—winners—and could easily decide to press their case," the counsel explains.

Apart from the extreme of court action, IBM has three other domsat options open to it as a result of the FCC ruling.

- IBM and Comsat General may find another partner and restructure CML, provided that no one company has "less than a 10% ownership interest or more than a 49% ownership, or otherwise be in a position . . . to exercise *de facto* control."
- Comsat General could arrange to lease satellite bandwidth to IBM, much as Comsat General has arranged to do with American Telephone & Telegraph Co. However, to do this, Comsat General would be obliged to choose between providing satellite channels on contract or public common-carrier services.
- IBM and Comsat General may each choose to enter independently of the other.

Reasonable. Whatever IBM does, says the FCC, the company must do more than set up a separate satellite subsidiary. IBM must also "permit reasonable and nondiscriminatory interconnection of customer-provided communications systems and/or terminal equipment."

At first glance, the FCC decision appears to have favored the arguments of IBM's opponents in the proceeding, including the Department of Justice and the Federal Trade Commission. Both opposed the application. But for those who, like the Computer Industry Association, visualize IBM's new goal as selling time on centrally located processors that can be dialed up directly through the customer's own rooftop antenna, the threat of an IBM-dominated communications monopoly remains [*Electronics*, Nov. 14, 1974, p. 67]. □

Commercial electronics

Recorder detects counterfeit bills

It may not play a tune, but a magnetic-recorder-based device for detecting counterfeit currency will flash a light when exposed to true paper money.

Recorder. Hand-held validator detects counterfeit U.S. currency by impressing magnetic signal on the printing inks.

The currency validator was developed by Arthur A. Burube, a consultant in automated traffic control systems who recently formed a company, Currency Validators Inc., in Lawrence, Mass., to produce a hand-held counterfeit-detection device. He's aiming it at both Government agencies and commercial organizations handling large amounts of currency.

In operation, the validator, which weighs less than 8 ounces, is rubbed over the portrait area of a bill. If the bill is valid, a light on the unit flickers. If counterfeit, there is no flicker.

Signals. Burube says the magnetic read/write head of the validator impresses a magnetic signal on the ferrous oxides used in the ink in all U.S. currency, much like the way data is encoded on magnetic tape containing the same material. Then, explains Burube, the validator head detects the residual magnetic effect on the bill, and by measuring the spacing between engraving lines, the unit can detect whether the engraving resolution is correct. This spacing, as well as the presence of the ferrous material, is sufficient to differentiate between real and fake money.

The first 100 units off the production line have already been deliv-

ered to Chase Manhattan International banking offices in Panama. Burube has also shown the validator to U.S. Secret Service officials and to the Federal Reserve Board. Edward Butler, head of counterfeit investigations at the Federal Reserve's Boston Office, would only say of the device: "We've seen it, and it worked."

Burube is now establishing a network of distributors for the validator initially in the East. The units will range in price from $89.95 to $129.95 each, depending on the quantity ordered.

Burube has applied for four patents on the magnetic head and the electronics in the validator, which runs on a single 9-volt battery. The next step will be to develop a model that emits a different sound for each currency denomination. □

Funds transfer to share one net?

Successful operation of a nationwide electronic funds-transfer system (EFTS) will require a shift from the individually controlled communications networks now being set up by separate groups to a shared data-communications utility. This is one of the conclusions of management consultant Booz, Allen & Hamilton Inc., in a report prepared for mutual savings banks.

To share a single utility, the commercial and savings banks must all use the same type of communications, which means that the only differences in the ways these institutions operate their EFT equipment will be in the services offered to consumers. In short, the consulting firm states, EFT is a tool, not a product.

Optimistic. To hardware manufacturers—suppliers of automated tellers, remote deposit terminals, and/or cash dispensers—the report offers the optimistic view that "EFT won't go away, but is a new and important resource to consumer financial services."

To the mutual savings banks, the smallest of the institutions in terms of total deposits and number of branches, Booz, Allen & Hamilton holds out the hopeful advice that electronic on-line terminals located in shopping centers or supermarkets could help make up their difference in size. This could give the mutuals a competitive lever to use against their larger commercial-bank competitors. At stake in the electronic funds-transfer system of the future are consumer savings accounts, which now represent the major growth business for banks.

Lead. Despite their smallness, the mutual savings banks took the lead in EFTS three years ago, when they formed the Mutual Institutions National Transfer System Inc. (Mints) to aid them in planning the new services. Now Mints, which has more than 300 members, has initiated another new service, called Cashmate. This system is based on a plastic debit card that is compatible with other bank cards in circulation.

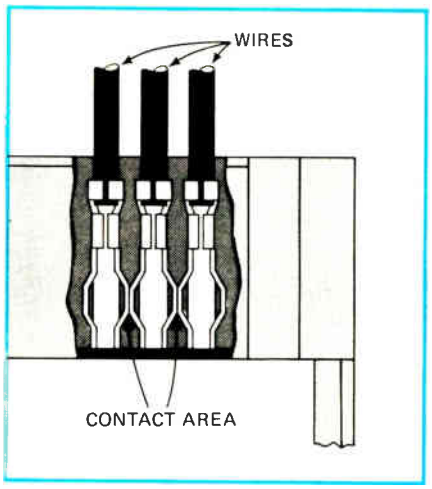
Consumers will be able to use the Cashmate card to withdraw or deposit money from savings accounts without using passbooks. It's designed specifically for use with remote on-line teller terminals being set up by more and more banks. Mints executive vice president C. Bickford Henchey says the Cashmate card system will be licensed to Mints members for about 2 cents per card. □

Packaging & Production

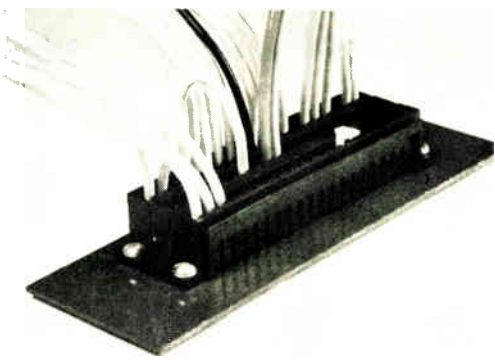
Junction plug-ins make own contacts

Call it a junction, distribution block, commoning block, or what have you, its function is to allow different circuits to branch off from a single main line.

Molex Inc. is calling it a connector, and the company's new design for this old function promises a flexibility that it hopes will win the device a bussing role for power and signal circuitry in office equipment,



Distributor. Common contacts are made from one terminal to the next as each is plugged into Molex connector. Connectors can also be stacked together, and linked with jumper cables as shown in the photo.

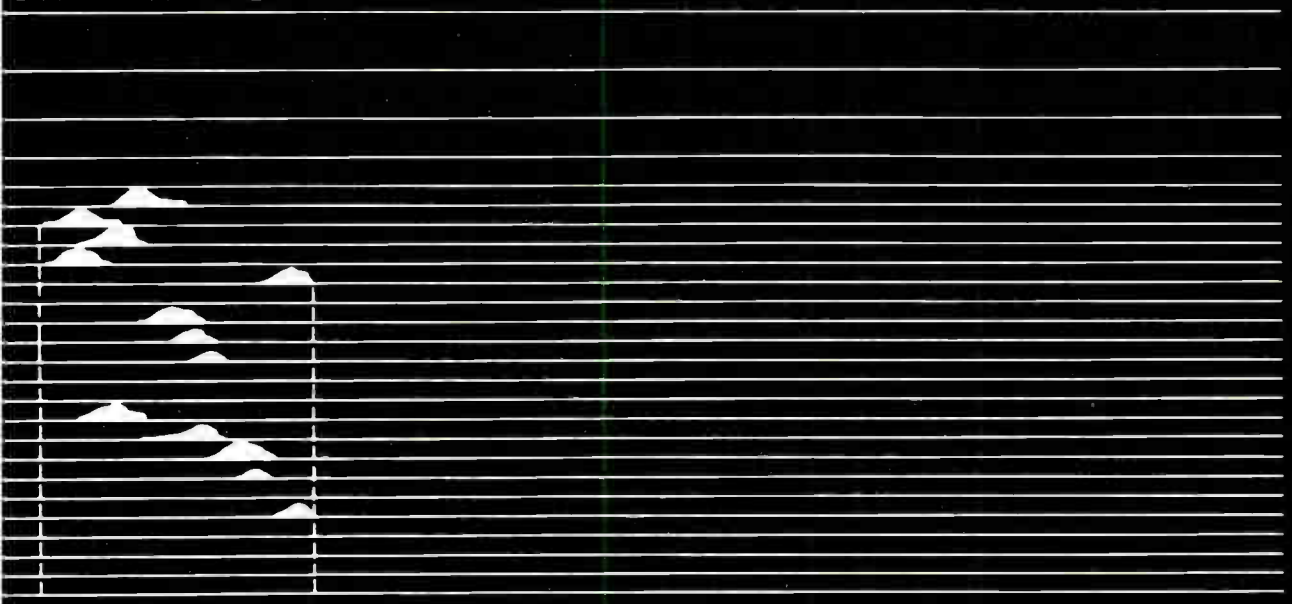


appliances, and consumer electronics gear.

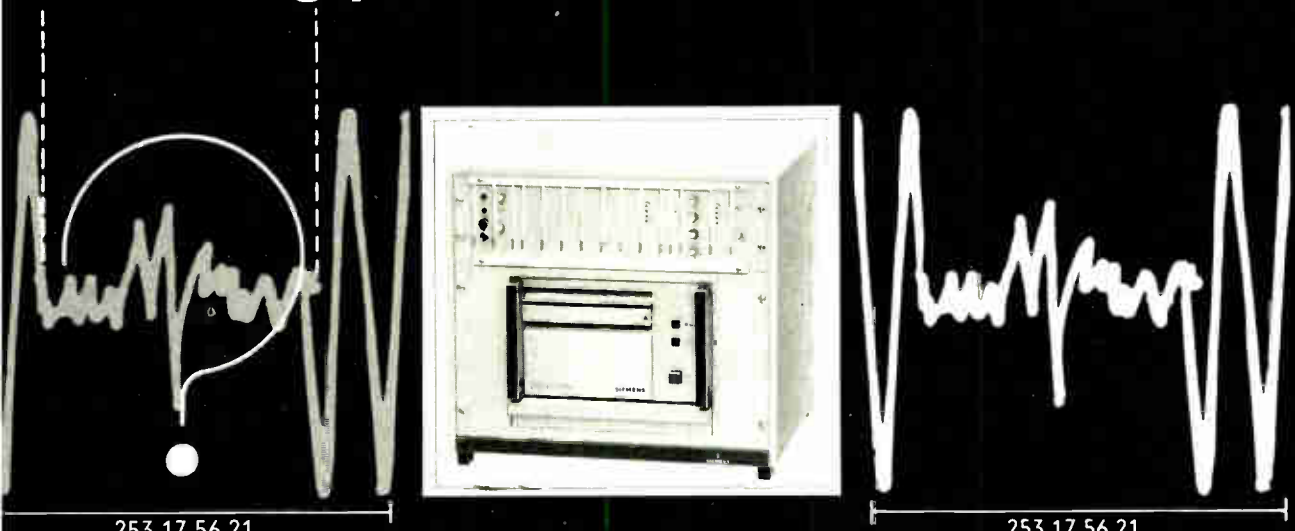
Instead of requiring separate male and female contacts fastened together in some way, the Lisle, Ill., connector manufacturer uses a single, U-shaped metal terminal with bowed flexible sides (see the drawing at the top of this page). The terminal, to which the wire is crimped, slips into a holding channel within a thermoplastic housing. The housing itself contains no conducting wires or busses for making contacts. Instead, contact from one terminal to the next is made as the bowed legs of adjacent terminals in their holding channels press up against each other.

"As the user puts the terminals into the housing, he shorts them out, one to the next," explains Robert V.

IEMENS



eizure of Nominal Value Deviations – onsidering previous events



hat caused the anomaly? Which riable quantities are effected? w long does the nominal value viation last? What eliminated it entually? – Questions, needing swers to make an exact fault anal- s possible. OSCILLOSTORE® helps u to answer such questions. Be- use OSCILLOSTORE can monitore continuous processes whidh can represented through electrical nals up to 10 kHz. OSCILLOSTORE ultaneously registers, depending task, up to 32 measurement lues for milliseconds or minutes.

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vith the OSCILLOSTORE by Siemens

Circle 43 on reader service card

Sebastian, manager of applications engineering.

In addition, the Molex housing sports a molded-in lip that allows rows of connectors to be stacked, as shown in the photograph in the middle of page 42. One row is linked to the next with a short jumper cable that plugs into the housing like any other terminal.

In contrast, the most popular terminal block system that Molex hopes to replace is more complex. It consists of a network of metal spades or tabs, wired to make them electrically common, and fastened to an insulating block with rivets. Using wires terminated with slip-on or quick-disconnect female contacts, the input is brought to the block, and two or more outputs distribute the power to other circuits. In some cases, an insulating sleeve is added to the female terminal for safety.

Housing. The first product in the new Molex family, to be launched this month, will be a 20-circuit housing with terminals that are suited for 250-volt, 20- to 25-ampere operation. A plastic detent rib molded within the housing provides a terminal insertion force of 2 pounds; withdrawal force is 10 pounds. Later, 5-, 10-, and 15-circuit blocks will be tooled, depending on how the demand in the marketplace develops, Sebastian says.

"Our next variation on the same theme will be a much smaller version, miniaturized for signal circuits," he adds. While the obvious advantages of the system are reduced cost and simplicity of use, the overriding selling point will be reduction of inventory, he notes.

Usually, terminal blocks are configured to the customers' needs, he says, with the separate contact junctions fastened to a single phenolic block. A different version may be stocked for each type of equipment. But because the Molex housings are of inexpensive plastic, Sebastian continues, a single standard assembly serves a range of applications. And, often, two or more sets of separate electrical junctions can be contained within the same thermoplastic housing. □

Communications

Chip lasers ready for optical systems

Tests of both long- and short-range fiber-optic data-communications systems are under way in New Jersey at RCA's David Sarnoff Laboratory, Princeton, and Bell Telephone Laboratories Inc., Murray Hill, following the development of solid-state injection lasers promising continuous operation of 100,000 hours at room temperature.

The long-life diode lasers with outputs of between one and 20 milliwatts were disclosed at the Optic Fiber Transmission Conference at Williamsburg, Va., in January.

RCA and Bell researchers and their counterparts in Japan, Germany and elsewhere have been seeking an efficient, low-cost light source for fiber-optic communications. Bell officials say they are now working on laser-pumped fiber-optic communications systems and expect to disclose a major system development in early 1976.

Researchers at Nippon Electric

DOD wants standardized fiber-optic systems by 1980

The military is aiming for standardized, fiber-optic point-to-point communications systems by 1980, and these systems will use what by then will be off-the-shelf components. To achieve this goal, DOD will fund dozens of fiber-optic applications this year. As much as $30 million could be made available [*Electronics*, Jan. 23, p. 49].

"There are areas where fiber optics can be used for communications right now, and we don't want to wait for further industrial development," says Parviz (Harvey) Soltan, chairman of a tri-service committee set up within the Department of Defense's Directorate of Defense Research & Engineering to review fiber-optic applications. He is also chief technician at the Naval Electronics Laboratory Center, San Diego, Calif.

Committees. To review proposed fiber-optic programs, the tri-service committee has set up five subcommittees, dealing with communications security, standardization of components, radiation environments, source and detector, and cable requirements. Fiber-optic systems offer important military advantages over hard-wired and radio-frequency equipment—notably immunity to radio-frequency and electromagnetic interference, and almost total immunity to wire-tapping by hostile forces.

Possible applications include everything from data buses in the B-1 bomber to cable for a proposed field-radar unit for the Marines, according to Don L. Albares of the Naval Electronics Laboratory. At the recent Optic Fiber Transmission Conference in Williamsburg, Va., Albares listed the following possibilities as being currently under review by the DOD:

- Aircraft wiring systems for the proposed Navy close-support fighter and the antisubmarine fighter, where the attraction is the light weight of fiber optics to replace heavy copper cables.
- Fiber-optic cables linking undersea sonar boxes to surface buoys and cables for towed sensor arrays.
- The Army's field-communications needs, such as a data-bus links between field communications and data-processing systems [*Electronics*, Jan. 9, p. 29].

DOD funding of various systems applications will aim at selecting the most efficient industrial designs by 1980, Soltan explains. Since corporate research and development funds would not be invested in the applications, Soltan expects companies to be willing to abandon an in-house approach in favor of another company's DOD-funded technology. □

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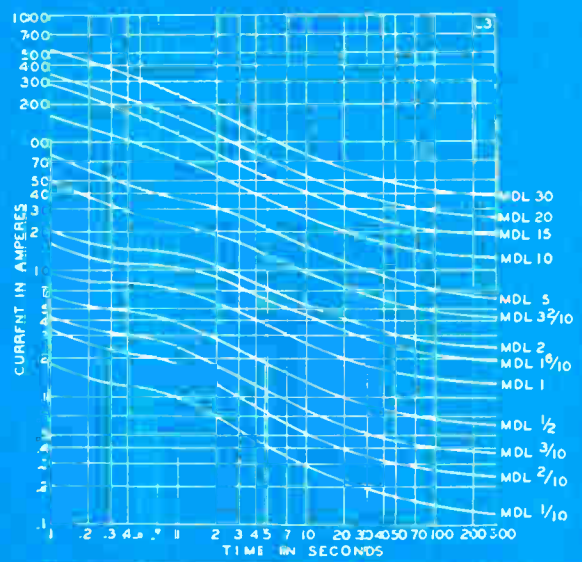
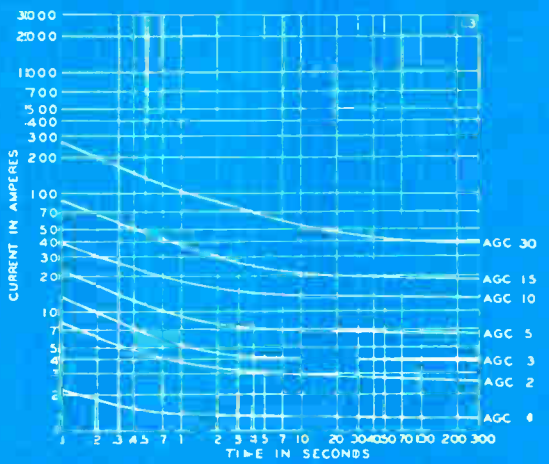
Time-current characteristics of FUSETRON® dual-element time-delay fuses



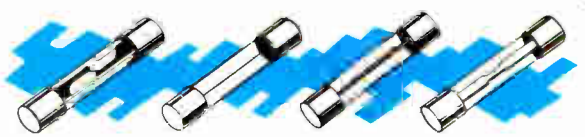
Time-current characteristics of BUSS® fast-acting fuses



FUSETRON® dual-element fuses

Time-delay characteristics avoid nuisance openings from starting currents or surges—yet, give full protection from short-circuits or dangerous overloads.

Voltage	Symbol	Amperes
250 or less	MDL	1/100, 1/32, 1/16, 1/10, 1/8, 15/100, 175/1000, 3/16, 2/10, 1/4, 3/10, 3/8, 4/10, 1/2, 6/10, 7/10, 3/4, 8/10 or 1
250 or less	MDX	1-1/4, 1-1/2, 1-6/10, 1-8/10 or 2
125 or less	MDL	1-2/10, 1-1/4, 1-1/2, 1-6/10, 2, 2-1/2, or 2-8/10
125 or less	MDX	3, 3-2/10, 4, 5, 6-1/4 or 7
32 or less	MDL	3, 3-2/10, 4, 5, 6-1/4, 8, 10, 15, 20, 25 or 30



BUSS® fast-acting fuses

Fast-acting characteristics provide the instantaneous high speed opening necessary to protect sensitive instruments or delicate apparatus.

Voltage	Symbol	Amperes
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250 or less	MGB	1/16 or 1/8
		MBW & MBB fuses now called AGC.
250 or less	AGC	2-1/2, 3
250 or less	MTH	4, 5 or 6
		For 250 volt fuses above 6 amperes—See ABC fuses.
125 or less	GLH	7, 8 or 10
32 or less	AGC	4, 5, 6, 7, 7-1/2, 8, 10, 15, 20, 25 or 30

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Co., Kawasaki, Japan, recently disclosed preliminary data from an experimental fiber-optic data system, but they lack the ability to fabricate laser chips with lifetimes of 100,000 hours. At the optics conference, they claimed lifetimes of only "several thousand hours."

Long-life laser chips are considered vital for successful fiber-optic communications systems because of their relatively high power output—at least five to 10 times the output of light-emitting diodes. The lower power output of LEDs would require

News briefs

McGraw-Hill is gloomy on GNP

The United States is faced with two consecutive years of downturn in the real gross national product for the first time since immediately after World War II. That's the conclusion of Douglas Greenwald, chief economist in McGraw-Hill Publications Co.'s economics department. Greenwald forecasts that, after adjustment for inflation, the 1975 GNP will be 2.3% lower than in 1974. And 1974's real GNP slipped 2.1% below the 1973 level, according to McGraw-Hill. "The last time we had two consecutive shrink years," says Greenwald, "was 1946–47." On the brighter side, though, he predicts a 1976 growth rate of more than 5%.

Ground-proximity-warning contract goes to Litton

Litton Industries Inc.'s Aero Products division in Woodland Hills, Calif., has won a $3 million contract to supply American Airlines' aircraft with ground-proximity warning systems. Delivery of the approximately 300 systems begins in June at a rate of about 40 units per week to meet the Federal Aviation Administration's deadline for installation of the systems by Dec. 1, 1975 [*Electronics*, Jan. 9, p. 49]. Pan Am and Braniff have installed systems made by Sundstrand Data Control Inc., another of eight suppliers of the units.

GE-designed microcomputer coming to market

General Electric Co. and Solid State Scientific Inc., Montgomeryville, Pa., have signed a technology-transfer agreement calling for Solid State Scientific to develop and market a GE-designed high-speed microcomputer. The central processing unit of GE's CRD-8 microcomputer will be converted from a TTL MSI circuit board into a single complementary-MOS-on-sapphire chip. Solid State Scientific will then manufacture and market the chips as well as complete microcomputer systems, including random-access memories and GE-designed read-only control memories.

Board of inquiry looking into BART crash

The San Francisco Bay Area Rapid Transit District's first fatal accident, which occurred last month, is being investigated by a special board of inquiry that includes representatives of other U.S. transit systems. The fatality occurred when a BART train crashed into a maintenance vehicle, killing the vehicle's driver. One question to be answered is why the accident was not prevented by the Westinghouse-built system that's designed to prevent more than one vehicle from occupying the same track space at once.

Telex to appeal reversal of IBM decision

Telex Corp. of Tulsa, Okla., plans to appeal to the U. S. Supreme Court the reversal by the Federal Court of Appeals in Denver of its antitrust award against IBM Corp. The appeals court swept away all findings of a trial court in Tulsa in September 1973 that ordered the computer colossus to pay $259.5 million to Telex. The appellate decision, however, upheld the lower court's judgment against Telex, and the peripherals manufacturer still must pay reduced compensatory damages of $17.5 million plus $1 million in punitive damages to IBM. Payments were based on the finding that Telex had misappropriated and pirated IBM trade secrets.

More layoffs at Motorola, Xerox, Teradyne

The Semiconductor Products division, Motorola Inc., last month laid off about 1,200 employees worldwide. The cutback in production and administrative personnel brings to about 6,800 the number of employees cut by the Phoenix, Ariz., semiconductor manufacturer since Nov. 1, when its worldwide employment stood at 30,000. Continued softness in consumer and automotive electronic products was the reason cited. Xerox Corp. is laying off 1,200 workers, mostly around Rochester, N.Y., where employment has dropped from 17,000 to 15,000. And Boston's Teradyne Inc. laid off 200 of its 1,200 workers because of reduced sales of test equipment.

Inselek enters Chapter XI

Inselek Corp., Princeton, N.J., has filed a Chapter XI petition in the Federal court in Trenton, N.J., apparently stymied by the slow growth of silicon-on-sapphire technology in which it specializes.

Honeywell and U.S. Steel unite on process control

Honeywell Inc. and U.S. Steel Corp. are in the final stages of negotiating an arrangement whereby computer-control systems that combine Honeywell controls and U.S. Steel's software will be marketed to the metals industry by Honeywell. The models cover such important systems as basic oxygen-furnace control, continuous casting, and galvanizing, line operations.

Data General plans to counter-sue Keronix

Data General Corp., the Southboro, Mass., minicomputer maker, plans a counter-suit against Keronix Inc., the Santa Monica, Calif., memory manufacturer that is suing Data General. Keronix charges Data General with arson, wiretapping, and theft. Data General president Edson deCastro has told stockholders the charges "are preposterous, the allegations are without substance, and the lawsuit is totally without merit. We deny all of the acts referred to in the complaint [which asks for $150 million in damages], and we will vigorously defend ourselves through every available legal process." Data General officials say they have "very substantial" claims against Keronix and will assert them in their suit.

Two new adjustable 4-terminal voltage regulators.

Fairchild's unique new *adjustable* 0.5 A voltage regulators are available either way you want them:

Positive (78MG Series).

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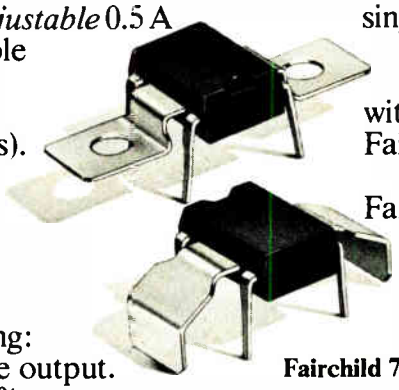
They both come in our unique power mini-DIP with integral heat sinks.



And talk about versatile. These adjustable devices are ideal for applications requiring:

1. Continuously adjustable output.
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Of course, adjustable or fixed, no one gives you a selection of voltage regulators like Fairchild with our broad line of 100mA-to-5A positive 7800 Series fixed devices.

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POSITIVE	2.5				78L02	NEW 78MG POS 500 mA
	5	78H05	7805	78M05	78L05	
	6		7806	78M06	78L06 (6.2V)	
	8		7808	78M08	78L08	
	12		7812	78M12	78L12	
	15		7815	78M15	78L15	
	18		7818			
	20			78M20		
	24		7824	78M24		
NEGATIVE	5			79M05		NEW 79MG NEG 500 mA
	6			79M06		
	8			79M08		
	12			79M12		
	15			79M15		
	18					
	20			79M20		
	24			79M24		

Note: μA723 is also available in positive or negative.

MADE IN FAIRCHILD

Electronics review

signal repeaters to boost signal-to-noise ratios.

GaAs crystals. Bell's Bernard C. DeLoach and Robert L. Hartman say the key to the long-life laser is "materials perfection," developed step by step since the first gallium-arsenide lasers were produced in 1970. "The first one burned up in minutes," Hartman recalls. Biggest part of the job was to grow the GaAs laser crystals without internal flaws or surface damage by means of a proprietary liquid-epitaxy process.

The addition of phosphorus during the fabrication reduced heat-producing stress, improving chip life to "several thousand hours," Hartman reports. Changing from hard-solder to soft-solder techniques to bond the chip to the header link also increased life. The Bell chips emit five to 10 mW of light at about 9,000 angstroms from a power input of about 0.2 W, Hartman says.

RCA's aluminum-gallium-arsenide lasers emit 20 mW from 0.5-W input at 8,000 Å. Its chips, 0.012 centimeter wide by 0.04 cm long by 0.007 cm high, have been rated by industry sources at 50,000 hours to 100,000 hours of continuous operation at room temperature. However, RCA researchers are reluctant to claim life of longer than 10,000 hours, which was announced at the conference. RCA attributed the increase in lifetime to two developments—recent improvements in techniques for etching chip faces, and a new high in material purity, attained in 1973. □

Management

Fairchild chairman: liquidity is vital

"Our first priority is to maintain our liquidity, despite declining sales." That is the assessment by board chairman-designate of Fairchild Camera & Instrument Corp., Roswell L. Gilpatric. Since 1967, he has been a director of Fairchild, Mountain View, Calif., which last year grossed $385 million, 80% in semiconductors. He is presiding partner of the New York law firm Cravath, Swaine & Moore. "We want to take advantage of our technological base and our manufacturing technology to broaden our product lines and take a look at more new end markets," he says. "We're going to work very hard to broaden our customer base, both here and abroad."

Gilpatric: Looking at new end markets.

Gilpatric is scheduled to succeed Walter Burke as chairman after the firm's annual meeting on May 2. He says, "there is no basis for the belief" among some Wall Street analysts that Fairchild is being restructured for acquisition—possibly by a major foreign electronics firm. "I think we'd rather do the acquiring.

"We're going to be very careful to avoid errors of the past," adds Gilpatric. "I think we stayed in defense products too long, for example. Our eggs have been in too many baskets; we were too spread out for a company our size." Fairchild will stick close to what it knows best—semiconductors—he says, "We'll broaden the things we're doing in the auto field, and we're moving ahead with our digital-watch and microprocessor programs."

Gilpatric actually began his association with Fairchild in 1932. "Sherman Fairchild was looking for a big, prestigious law firm, but he didn't want to spend a lot of money at the time," recalled Gilpatric as he sat in his 57th floor office overlooking New York's financial district. "I was quite new to the firm—just out of Yale Law School—when I met Sherman. He was the first client I brought to the firm."

Cravath, Swaine & Moore has served as Fairchild's outside counsel ever since, although Gilpatric has served several tours outside the firm. He was Deputy Secretary of Defense from 1961 to 1964. Previously he had been Assistant Secretary of the Air Force and thereafter, Under Secretary of the Air Force. □

Materials

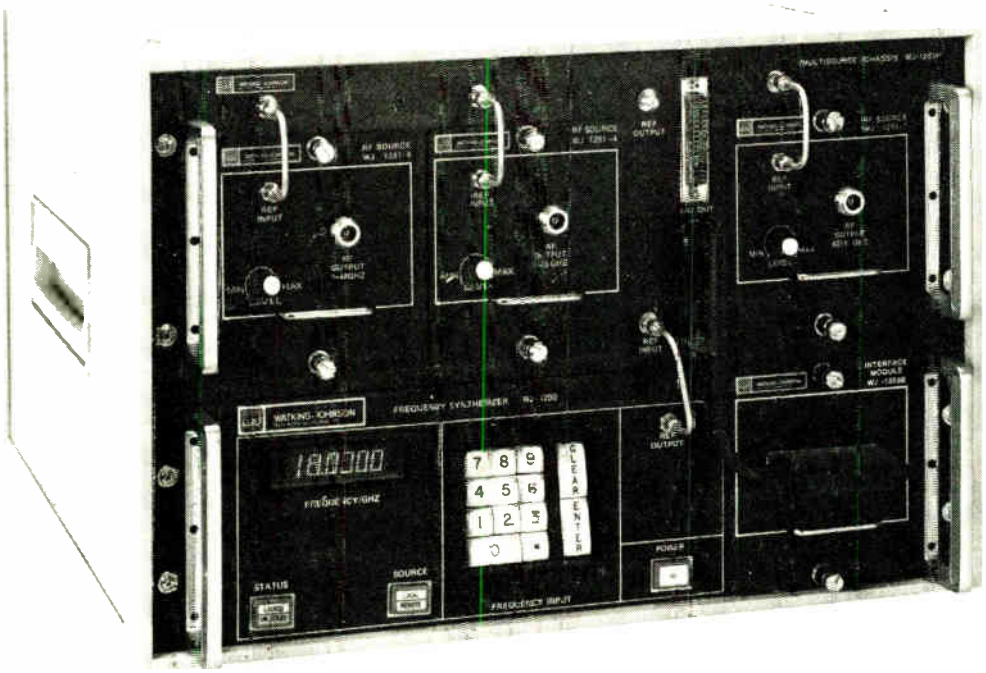
Chemicals key to LCD watches

Like weight-watchers, digital watchmakers like to slim things down. They know they've got to make models less bulky.

One company that's pushing hard to do this with advanced liquid-crystal formulations for its displays is American Microsystems Inc., where the goal this year is to bring drive requirements down so that a single 1.5-volt battery can drive the display, timing circuitry and an incandescent lamp for backlighting.

The Santa Clara, Calif., company, a leader in LCD watch manufacturing, wants to cut its watch module down to a 200-mil thickness, which is a little more than half the size of AMI's module introduced more than a year ago. That unit was 370 mils thick and required two batteries delivering 6 volts and 12 microamperes for its timing circuits and displays. A 200-mil-thick module would also be a considerable improvement over AMI's latest units, which are 275 mils thick [*Electronics*, Oct. 17, 1974, p. 32].

Boil and bubble. But AMI's success will not depend on sophisticated electronics alone. The critical element may well be the "witch's brew" of LCD formulations. Most of the work at AMI—and indeed by most LCD watch makers—has centered around three organic chem-



The WJ-1250 Modular Synthesizer System

1 to 18 GHz Coverage Provided in a 13 inch high configuration

The WJ-1250 Modular Synthesizer System pictured above provides a minimum of 5 mW across the full 1 to 18 GHz frequency range. The desired frequency may be commanded via the front panel keyboard or the rear panel BCD input connector, and the synthesized frequency is provided at the appropriate RF Source port.

By employing other available units, a minimum of 10 mW can be supplied across the full 0.5 to 18 GHz range in a 20 inch high configuration and still have room to accommodate a future 18–26 GHz RF Source. Lesser frequency coverage may of course be provided using fewer modular units, while programmable attenuation, modulation, single-port output, etc. can be accomplished through additional units.

With the output signal achieved directly from YIG-tuned oscillators, maximum power and spectral purity are maintained over the full range. Maximum full range switching time is 100 msec, and long-term stability is ±3 pp 10^9/day or that of an external reference.

For specifications on the WJ-1250 Modular Synthesizer System, its component modules, and other related products, contact the Watkins-Johnson Field Sales Office in your area or Systems Applications Engineering at the Palo Alto address and phone number below.

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SCIENCE/SCOPE

A new ultra-lightweight radio for tactical field operations, developed by Hughes, employs micro-miniaturized circuits including LSI (Large Scale Integration) to provide high reliability, plug-in modules for easy maintenance, and an AM mode for compatibility with current military systems. Called the HC-191 Manpack, it is a version of the AN/PRC-104 single-side-band transceiver Hughes is building for the U.S. Marine Corps. It has a frequency range of 2 to 30 MHz and 280,000 channels to make enemy jamming difficult. Another significant combat advantage is its completely silent automatic electronic tuning.

The complete Manpack radio weighs only 12½ pounds including a battery pack that gives 16 hours of service before recharging. With its built-in 8-foot whip antenna, the HC-191 has a range of up to 30 miles in the most difficult jungle or mountain terrain. For a copy of the HC-191 brochure, write: Marketing Department, Hughes Aircraft Company, Bldg. 600/C231, P.O. Box 3310, Fullerton, Calif. 92634.

Telephone users in the United Kingdom will benefit from the computer-controlled FACT-II wiring analyzer system recently delivered to Standard Telephones and Cables, Ltd., of International Telephone and Telegraph in Northern Ireland. The 68,000-lb. system can test 34 different products in any of over 5,000 electrical configurations. A special connector developed by Hughes makes it possible to simultaneously access 25,600 circuit terminations in less than 15 seconds.

FACT-II is an adaptation of the system Hughes originally developed to pinpoint and troubleshoot electrical problems in aircraft fire-control systems. Hughes has built 11 FACT systems for European users and scores more for North America, the Middle East, and Japan.

Laser rangefinders for the U.S. Army's M-1 battle tank are being developed by Hughes for prototypes by both Chrysler Corp. and General Motors Corp. Following a competitive evaluation in mid-1976, the Army is expected to select a single contractor. Hughes currently produces laser rangefinders for the Army's M60A2 tank and M551 Sheridan vehicle and is developing a full-solution laser fire control system for an improved version of the M60A1. A tank with a laser rangefinder can fire far more quickly and with a much higher first-round hit probability.

Hughes Ground Systems Group needs Senior Systems Programmer/Analysts and Communication Systems Development Engineers to join the technical staff due to growth of current research and development programs. Applicants must have a BS or MS in electrical engineering or computer science and U.S. citizenship. Qualified applicants should write or send resume to: M. F. Duggins, Hughes Aircraft Company, P.O. Box 3310, Fullerton, CA 92634. An equal opportunity M/F employer.

A solid-state watch module for ladies-size digital watches -- now in production at Hughes -- contains the equivalent of more than 1,500 transistors. It overcomes the size limitations of ladies' watches with a unique time-readout that flashes the hour for about a second, then gives the minutes. The new module supplements the men's watch modules now made for leading name-brand manufacturers by Hughes, one of the largest producers for the watch industry.

icals: Schiff compounds, esters and biphenyls. All are long complex chains of carbon, oxygen, hydrogen, with what are called alkyl radicals attached to the ends. But for lowest-voltage displays, AMI is looking at pure biphenyls.

According to Robert Young, senior scientist at the company's Display Systems division, all of the materials exhibit a phenomenon that makes them especially useful in LCDs—the twisted nematic field effect, which, in essence, is the ability to change the direction of polarization of linearly polarized light. Under normal non-energized conditions, an LCD cell appears clear when viewed between crossed polarizers. However, when an electric field is applied between electrode surfaces of the LCD, the molecules tend to align with the field, and the crossed polarizers make the energized portion appear dark.

"The problem has been," says Young, "that although all [of the chemicals] demonstrate the effect, they do it to varying degrees."

Biphenyls, for example, have the advantage of being the most stable compounds in the trio. Thus they are most resistant to environmental changes and impurities. Also, they have the best voltage turn-on and turn-off times (the speed with which the crystal orients with the field). At 1.5 volts, turn-on and turn-off times are 120 and 140 milliseconds respectively, adequate for digital watches. "But biphenyls are the hardest LCDs to make because of their very complexity," Young says.

By contrast, the Schiff compounds (with which AMI built its first LCDs) are probably the least complex of the three molecular structures, and as a result are easy to make and have high yields. Their main drawbacks are a sensitivity to epoxy and a relatively high driving voltage. To get the same turn-on and turn-off times as the biphenyls, a Schiff display requires 6 V.

Esters, the third compound, have not even been considered on their own by AMI, even though they have perhaps the lowest driving voltage of all, between 0.9 and 1.2 V. "Their big drawback is turn-on/turn-off times half the speed of either Schiff or biphenyl compounds—on the order of 600 to 700 milliseconds—clearly unsuitable for LCDs, especially when multiplexing is involved," he says.

However, for AMI's second-generation 3-V modules, Young and his co-workers have used a Schiff-ester hybrid LCD that has turn-on and turn-off times of 100 and 140 ms at 32 hertz. "We've looked at other Schiff-ester combinations looking for a viable 1.5-V LCD," he says.

"But to get any lower, our only option, difficult as it is, is a pure biphenyl LCD. But we've learned enough from the other two approaches, so that it is safe to say that within a year we'll have a 1.5-V LCD watch module in production." □

Optical gear finds water pollutants

Detecting dissolved pollutants in a municipal water system by means of conventional "wet-chemical" methods, which measure biochemical oxygen demand, can take several hours or even days. Now pollutants can be detected in seconds, according to Britain's H. Tinsley and Co., developer of a continuous monitor that uses ultraviolet light and differential sampling circuitry.

Besides saving time, the monitor also saves money. It is priced at about $2,400, compared with other equipment, which ranges between $9,600 and $12,000 and requires a skilled operator, states technical manager Gordon F. Hodges. What's more, the company says that, when properly calibrated, the new instrument has an accuracy within 1% to 2% of wet-chemical equipment.

No ventilation is needed in the unit, and power consumption is 20 watts. The first production models are coming off the line for use in municipal water systems and in process-control applications for making

such products as plastics and soap.

The instrument "isn't a new idea, but what is new is a practical instrument that does the job automatically," Hodges comments. The organic-pollution monitor is based on the principle that the degree of absorption of ultraviolet light by a fluid can be used to spot the presence of a pollutant in seconds, although the instrument cannot determine what the pollutant is.

The Tinsley instrument operates by electronically comparing the absorption of the ultraviolet light to that of visible light. A mercury-vapor quartz lamp is pulsed through the water at 1 megahertz so that ambient light cannot affect the results. The light is split by a dichroic mirror into ultraviolet and visible components, and circuitry containing a dual-log amplifier connected to a scaled subtractor compares the two beams. Fluids containing suspended solids or air bubbles won't affect the absorption readings, a Tinsley spokesman says, because both the visible and ultraviolet ranges are affected equally.

Construction. The monitor is supplied in two units—the optical section with its quartz lamp, and the electronic unit with the comparator circuitry, the controls, a 40-division absorption panel meter, and an outlet for an alarm or recorder hookup. The optical unit measures about 4 by 5.5 by 8 inches; the other, about 4 by 10 by 12 inches. In the optical unit, a tube 20 millimeters in diameter handles three gallons per minute of the fluid to be tested. On either side of the tube are transparent quartz windows through which the light from the lamp passes.

In operation, an oscillator drives the mercury lamp. The dichroic mirror on the receiving end divides the light into ultraviolet and visible components, which travel through parallel circuits, each consisting of a detector, preamplifier, electronic switch, and a low-pass filter. These circuits feed into the dual log amplifier, and then into a scaled subtractor. The result goes into a gain-and-zero-set unit for display on the panel meter. □

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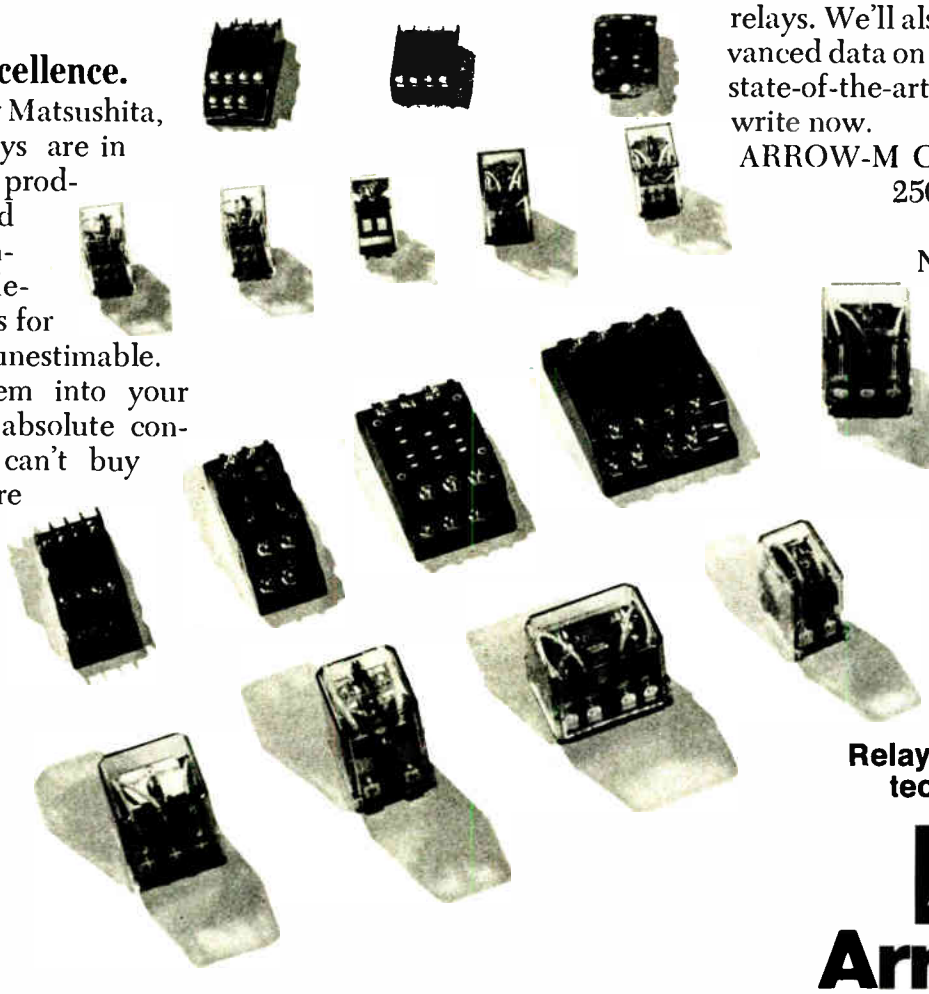

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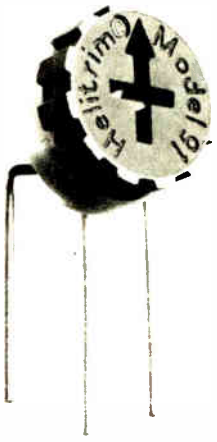

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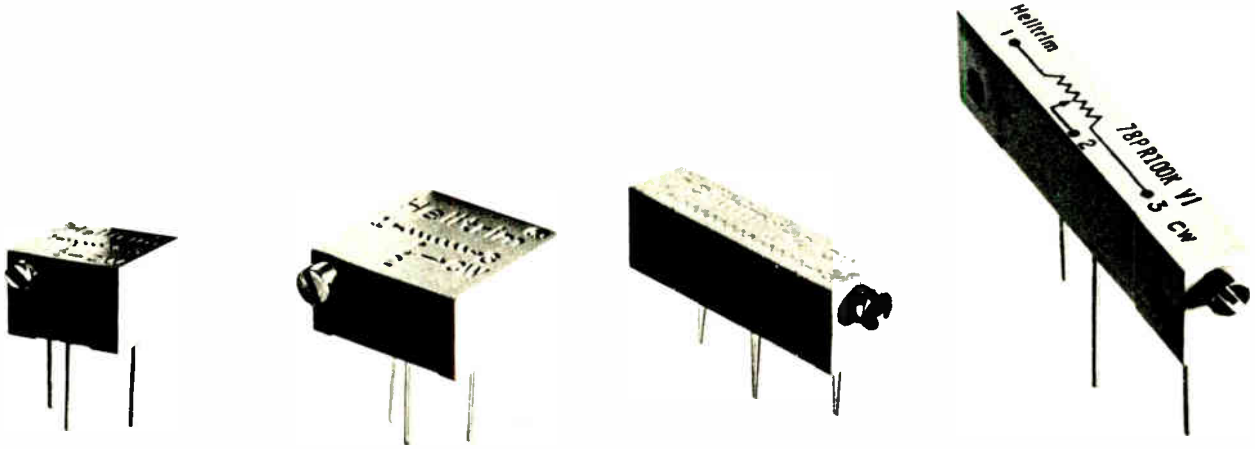

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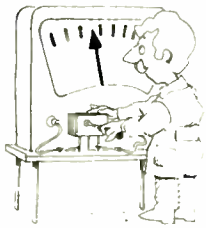

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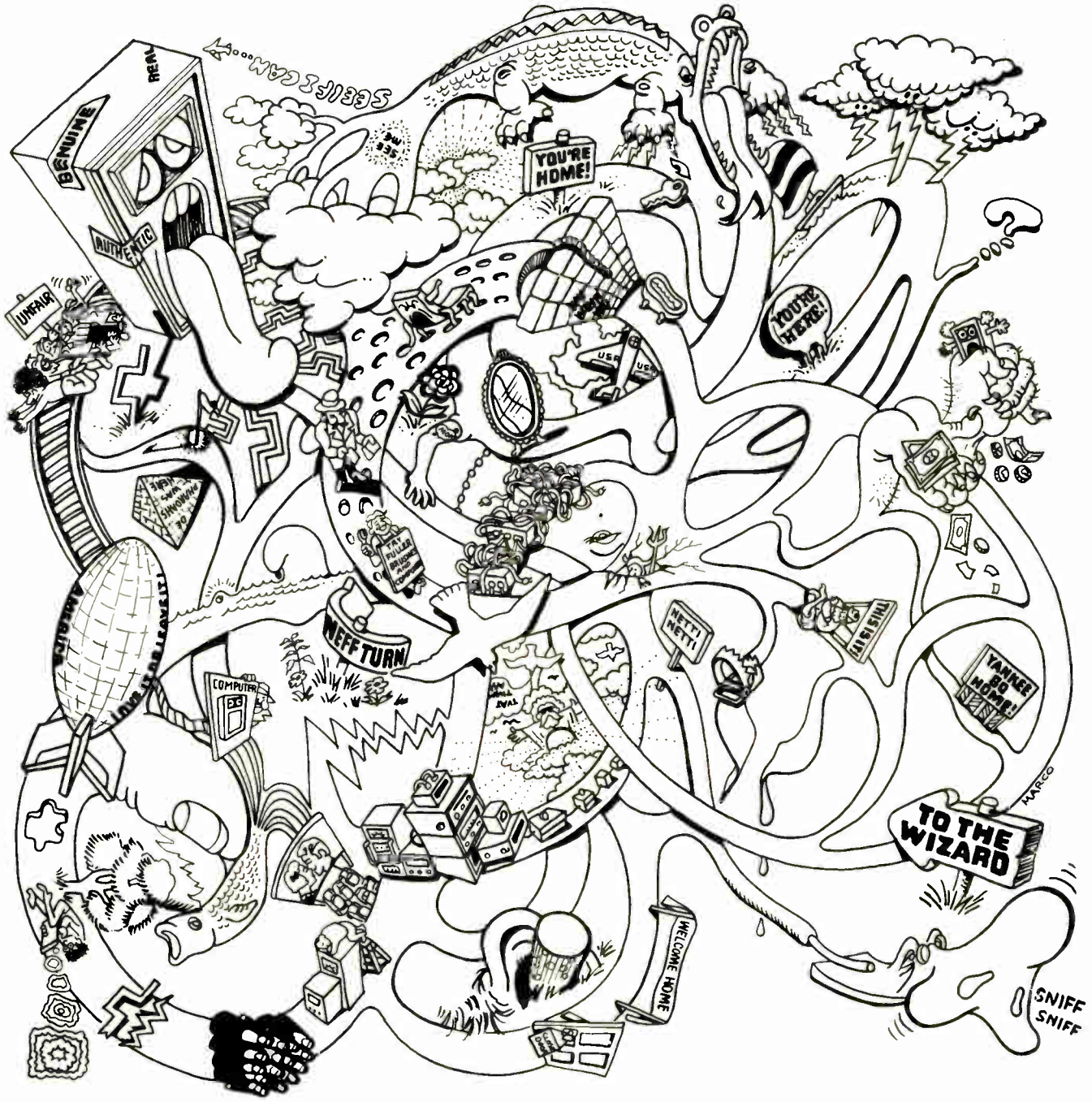

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The data acquisition problem is as simple as getting from point A to point B. Just take the analog signals from your sensors and convert them to digital signals for your computer to process.

The solution is not so simple. There are a lot of different ways to go. A lot of potential pitfalls to be avoided. A lot of trade-offs to be judged. Which way is best for your particular needs?

Amplifier-per-channel vs. low-level multiplexers.

If you're not seriously concerned with performance, if the lowest possible price is your only criterion, low-level multiplexers make sense for you. If you're willing to invest a little more money, however, an amplifier-per-channel system offers significant performance advantages. A few of the benefits are signal isolation, lower noise, faster throughput, greater accuracy, continuous analog output, less crosstalk, overload protection, and low pass filtering.

Amplifier-per-channel vs. instrumentation amplifiers.

If you have a real need to maintain constant manual control, and if price is no object, then instrumentation amplifiers are the way to go. On the other hand, if you're geared for computer-control and don't mind saving a great deal of money, an amplifier-per-channel system is the only reasonable choice.

The Neff 620 amplifier-per-channel data acquisition system vs. building your own.

If your engineers are analog-oriented and have a great deal of time on their hands, you might try to build your own system. Lots of luck. If such is not the case, the Neff 620 analog signal processor was designed and built especially for you.

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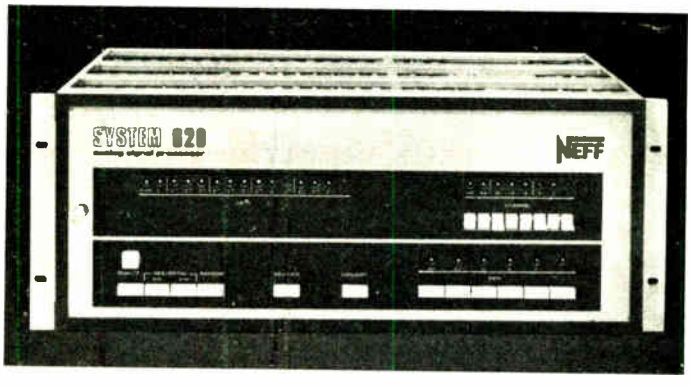

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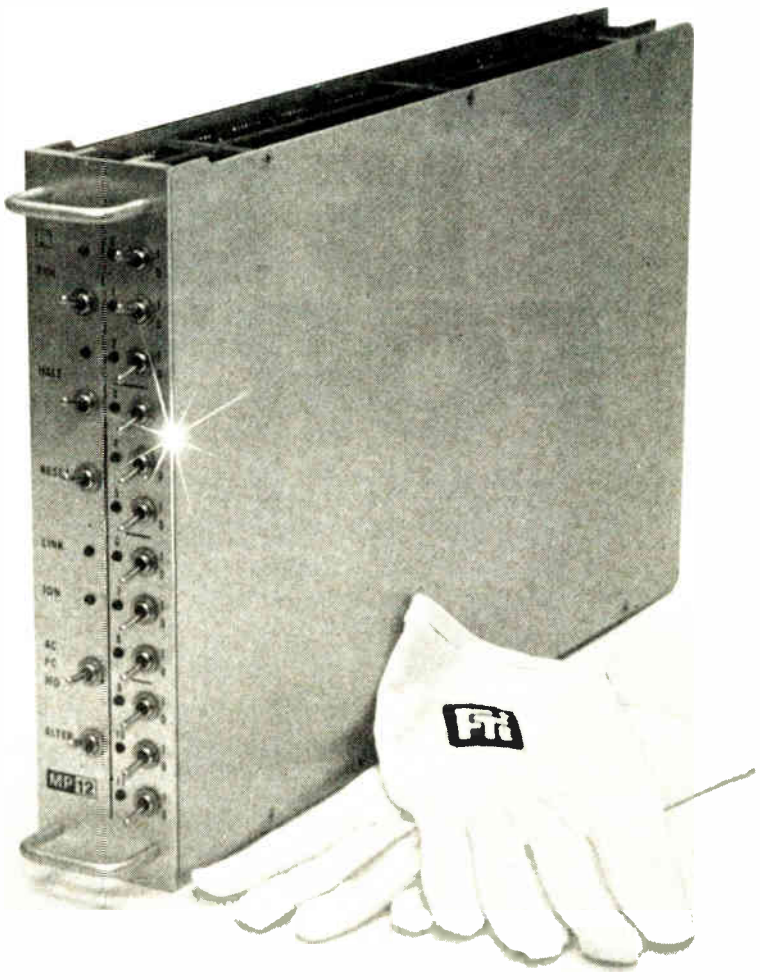
The clean machine



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Washington newsletter

EDP outlook dims as deadline nears on file security

In view of a September deadline for compliance with the Privacy Act of 1974, **the possibility looms that some Federal agency chiefs will simply shut down data banks containing personal information on citizens if such information is in duplicate elsewhere;** this, rather than pay for the new peripherals needed to make computer files secure from unauthorized access. It would mean a reduced Federal market for electronic data processing—not as lucrative as what was originally expected by the data-processing industry. What the bureaucracy is worried about is the forecast from the Office of Management and Budget that security measures would cost $1 billion over the next five years, $100 million of that for electronic security, additional memory and additional transmission costs.

If OMB pushes enforcement only nominally, which is deemed possible by sources in the General Services Administration and the Congress, few systems may be shut down. On the other hand—**as one source estimates—"dozens of EDP systems, maybe 100 or more" of the 7,800 operated by the Government, could be returned to inventory by agencies unwilling or unable to pay for strict security.**

Limbo possible in data-processing sales to banks

There could be a two-year dry season ahead for data-processing companies wishing to sell electronic funds-transfer systems (EFTS) to nationally chartered savings and loan associations and commercial banks. **Rep. Fernand J. St. Germain (D., R.I.) and Sen. William Proxmire (D., Wis.) have proposed a two-year moratorium on EFTS installations to await recommendations concerning data-processing standards** before Federal regulators are allowed to authorize new EFTS [*Electronics*, Nov. 28, 1974, p. 75]. A still-to-be-named national commission on EFTS is expected to come up with recommendations by the middle of next year. (For related story, see p. 42.)

Moratorium fever was sparked last Dec. 12 when the U.S. Comptroller of the Currency, James E. Smith, proposed allowing national banks to install on-line terminals in point-of-sale locations. A hearing on the Smith proposal is set for April 2. In the meantime, **EDP companies have been lobbying on Capitol Hill, arguing that the comptroller would not let big banks offer services unmatched by local banks, and that the moratorium is therefore unnecessary.**

Bidding is near on cockpit warning systems

Bids are due by the end of February to outfit the United Air Lines and Eastern Air Lines jet fleets with ground-proximity warning systems, according to industry sources. At stake is $5 million to $6 million in orders for the $3,500 system. Sundstrand Data Controls, Bendix Avionics, the Aero division of Litton Industries and the Edo Corp. are some of the companies trying to get a large part of the FAA-mandated market in cockpit warning systems. Litton has already won a $3 million contract to equip the American Airlines fleet (see p. 46).

Bendix has begun product presentations to European airlines, and also to the U.S. Air Force, eying the thousands of military transport planes as a lucrative market after commercial fleets are outfitted. There is a December 1975 deadline for the commercial outfitting.

Washington commentary

The reliability challenge

Caught in the crunch between the soaring costs of weapons and personnel and a Congress increasingly critical of military spending, the Pentagon is leaning hard on contractors to improve system reliability and maintainability as a cost-cutting device. DOD's approach to its R&M problems was detailed at the end of January in Washington by Jacques S. Gansler, deputy assistant secretary for materiel acquisition. The key points from his remarks to the 1975 R&M symposium follow. **—Ray Connolly**

The average cost of a soldier has doubled in the last five years, while the total military force has been reduced by 1.2 million, or about one third. In addition, equipment costs for new weapon systems have shown a fourfold increase over the past decade, excluding the effects of inflation.

The vicious cycle

To keep up the force levels, the DOD must continue to use old systems. Many of these old systems are wearing out and therefore they generally have lower reliability, thus they cost more to operate and maintain. This, then, calls for more use of the increasingly very expensive manpower—a vicious cycle!

The defense account which has been increasing the most rapidly over the past few years is the cost of equipment operation and maintenance. This is the area in which you here can have the greatest impact—if you are able to reverse the trend of rising costs.

Unless these trends are reversed, in only a few years all of our defense dollars will be spent to cover manpower, and operating and maintenance costs, with none left for procurement of new systems or modernization of existing equipment.

What DOD is doing

Now, what can be done?

First, in the area of reducing equipment costs, a critical step is "design to cost." To get the quantities of equipment we need requires designing equipment to an affordable cost; secondly, more test and evaluation; thirdly, more competitive prototypes.

Other steps currently under way which will also reduce our equipment costs include:

- More advanced-technology demonstrations before incorporating new technology into a weapon system. When the state of the art is pushed in new systems, our costs go up dramatically. However, we have found that when the technology was first fully demonstrated and then applied as a product improvement, our costs were almost half.
- Through feasibility demonstration of new components and new technology, we will develop more options for our weapon systems. But we will do less full-scale development.
- We are planning far more standardization, especially of subsystems. The defense standards board has been set up to do this; and through its panels, we are moving with selected success.

In addition, we have recently established a joint industry/Government group looking at better application of military specifications and standards to see where we can provide guidance to allow more flexibility in their use. Also we have just set up a second industry/Government group looking at broader use of commercial equipment.

An area of particular concern to me is the need to be realistic in specifying our reliability, availability, and maintainability requirements. You need to help us to do this. On the other hand, the DOD also looks to you to realistically demonstrate that these requirements have been met in the field, not the laboratory environment. We ask you to take a great leap forward in field demonstration methodology so as to permit prediction and evaluation of true field reliability.

The changed environment

In the "cold war" era, maximum performance was king, and we were willing to pay whatever it cost. In times of conflict, as in Korea and Vietnam, minimum delivery time was required, and again we accepted the higher costs for maximum performance at the earliest possible date. But in today's environment—of inflation, shortages, and an all-volunteer service—cost has succeeded to the throne.

You in the R&M area have responsibility for correcting the single biggest cost area. For years, you have been talking about the need to do some of these things. But now you have to start coming up with specific suggestions to make them work.

Some of you have been responding to this challenge. Others of you have gone on the defensive and are trying to protect your own institutions, rather than aggressively moving in a direction that will help all of us. If we are not successful in reducing equipment costs and support costs, we will no longer have a credible defense deterrent. The choice is yours; but to achieve anything it has to be done now!

The new EPC 2200 XYZ recorder for spectrum analysis.

Low Cost. Lightweight. Precise.

The new EPC Model 2200 is the first truly fine quality, lightweight, low cost XYZ recorder ever made.

When matched with a spectrum analyzer, the Model 2200 prints spectral data on continuous, dry-paper hard copy over a 19.2" display. A hard copy history-plot of spectral data not only permits data comparison, but reveals spectrum lines buried as much as 6 db below the noise level. And the 19.2" display presents in excess of 3,000 data points with each sweep. Information that is subtle and transient on a scope becomes clear and permanent on an XYZ recorder.

The Model 2200 interfaces with either digital or analog equipment. It sweeps at speeds between 1/10 second and 8 seconds.

The EPC Model 2200 is currently built in four modified formats. Further customization is possible to meet specific customer requirements.

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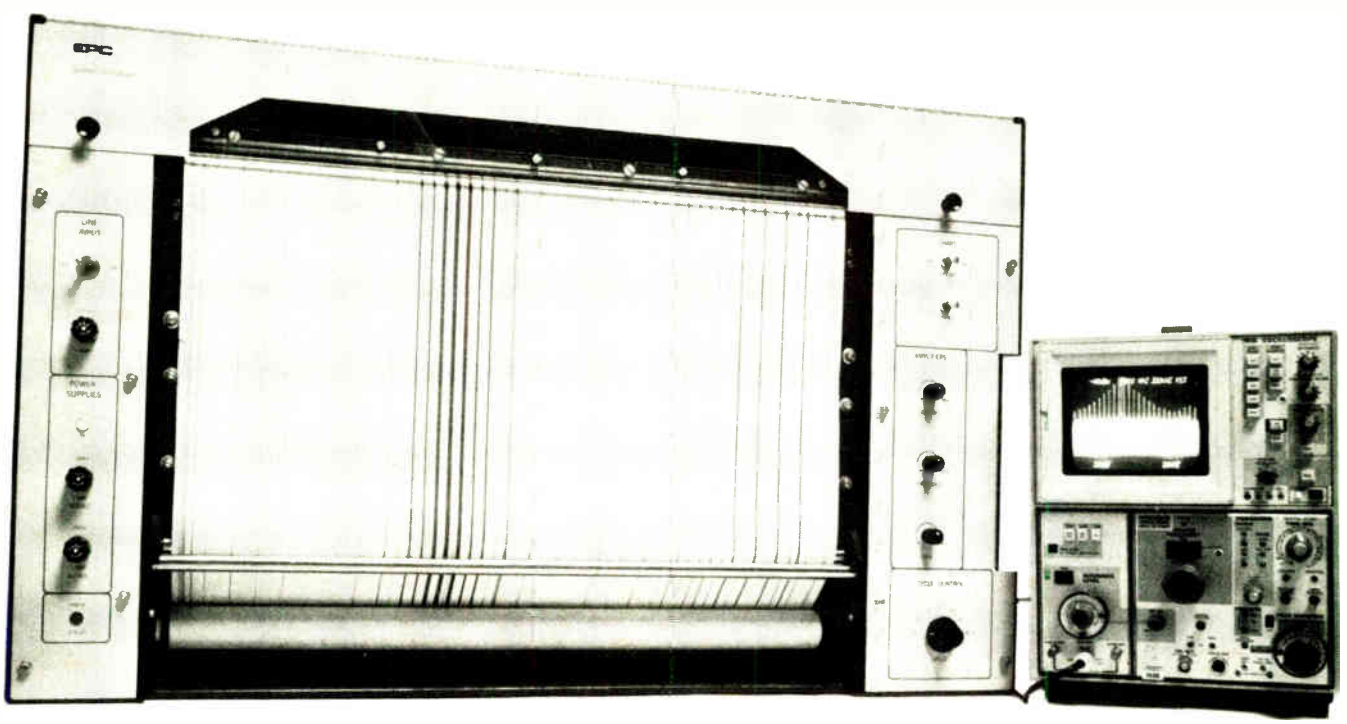


Circle 61 on reader service card 61

Two linear detectors in portable X-ray machine measure metal stress

One sure way to get a precise reading of surface stresses in metal structures is to measure the crystal deformations by X-ray diffraction. Trouble is, this method traditionally requires a precision goniometer working under laboratory conditions to pick up diffraction peaks. That rules out on-the-spot inspections of such structures as pressure vessels, ships' hulls, and beams.

The precision goniometer is dispensed with, however, in a new set of stress-checking gear that Compagnie Générale de Radiologie (CGR) has readied for the market. Instead of the usual point-detector/goniometer combination, the CGR gear employs a pair of linear detectors that cover the whole diffraction field.

The measuring head—X-ray source, detectors, and a mounting frame, complete with magnets to hold it on steel plates—weighs only 18 kilograms. "You can bring our machine right out to the structure," says Georges Dodement, who heads the nonmedical activities of CGR. The company, part of the Thomson-Brandt group, has set a rough price of $55,000 for the equipment and plans to start deliveries this spring.

Time-saver. Along with its *in situ* advantage, the instrument cuts dramatically the time it takes to make stress readings, Dodement points out. Ordinarily, about eight hours must be spent to do the job manually—painstakingly setting up the goniometer at different angles to spot diffraction peaks with a point detector and then calculating the stress. With the CGR gear, a reading takes only about 15 minutes.

CGR has paired its light-weight measuring head with a minicomputer programed to handle the calculations and print out the stress in hectobars, with accuracy to 3 units. The computer is packaged with the electronics in a portable cabinet that weighs 200 kilograms.

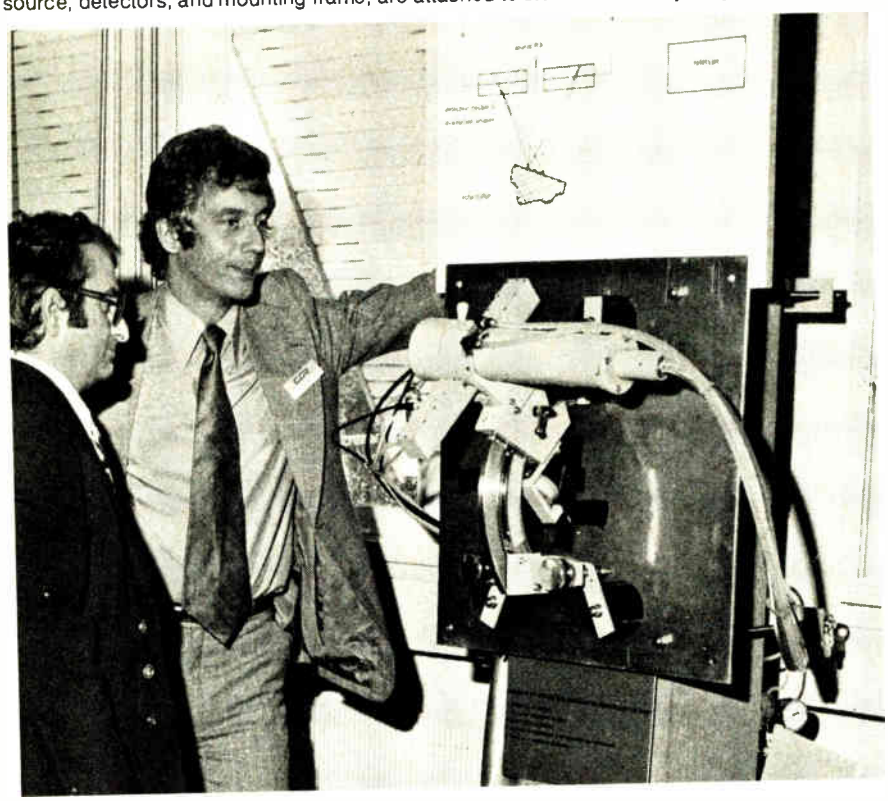
Crucial to the stress-measuring set, Dodement points out, are its linear detectors. The basic idea was first conceived by a researcher working at a U.S. Atomic Energy Commission facility, and now CGR has commercialized the invention, under license from the agency. The detector operates at high voltage and utilizes a carbon-covered quartz fiber inside a gas-filled chamber, fronted by a metalized Mylar window 5 centimeters long.

When an X-ray photon diffracted back from the surface being checked passes through the window and ionizes the gas, an avalanche of electrons is set up at the point where the photon is absorbed. They collect at the corresponding spot on the quartz fiber, which functions as the anode of the detector, and propagate along it toward both ends.

Measurement. The exact spot where the electrons hit the fiber is measured electronically, but not by trying to measure the difference in time it takes them to reach the ends. Instead, the circuitry compares the difference in the time between the pulses at each end of the fiber. Processing that information results in a pair of uniform pulses whose spacing reflects the position along the fiber where the electrons first hit.

Because the linear detectors cover a wide field with their 5-centimeter windows, they pick up the diffraction peaks directly. As a result, operation of the equipment is straightforward. First, the Young's modulus, the Poisson coefficient, and the Bragg angle for the material

Portable. The head for precision measurement of metal-surface stresses, including X-ray source, detectors, and mounting frame, are attached to steel structure by magnets.



under test are fed into the computer, along with the Bragg angle, for a calibration of the material. Then no-stress peaks are measured by taking readings on gold or iron powder sprinkled on the test area. Next, readings are taken on the structure—first with the X rays hitting it head-on and then at an angle of 45°. The computer then figures out the stress in the structure. □

West Germany

Skin touch actuates IC light switch

A West German component maker is relying on the homeowner's fascination with novelties to induce him to buy a new light switch based on an integrated circuit and operated at a touch. Intermetall GmbH, an ITT subsidiary, will produce the IC, but it won't sell the switch itself.

First samples of the UAA 1001 IC, a bipolar device that comes in a dual in-line minidip plastic package, will soon be delivered to switch manufacturers. Intermetall will also market the external semiconductor components—a triac, a diac, and several diodes per switch—which are made by other ITT affiliates. The switch can operate on the 110 volts ac used in the U.S., as well as the 220 v ac used in Europe.

Expensive. Intermetall says that the finished switch, including a dimmer, will cost 10% to 20% more than conventional dimmer-type switches. However, observers estimate that the new switch will sell for five times as much as conventional household switches without dimmers. A key market target is expensive new homes whose owners won't mind paying a few extra dollars for the novelty, convenience, and reliability.

However, the switch can be installed in existing homes without the need for rewiring, as would be required for the touch-type elevator switch, which the product resembles. And unlike an elevator switch, the IC switch operates by the conduction of the slight amount of electricity in the body of the person touching it.

When a person touches the switch plate, his body resistance is in series with two input resistors, which typically have a value of 4.7 megohms. The current that flows through the body to ground is so negligible it is harmless. A 500-kilohm potentiometer in the external circuitry can control light brightness by means of a small shaft protruding through the switch plate. If the dimmer is not desired, the switch manufacturer short-circuits the potentiometer. The switch also has a remote-control input that allows it to be operated in parallel with similar switches or electromechanical ones.

Circuitry. The UAA 1001 has three circuits—a highly sensitive input circuit with a Schmitt trigger, an on/off-status memory, and an output stage, which controls the ignition circuit of the external triac. Controlled by the Schmitt trigger, the status memory feeds a signal to the output stage, which consists basically of two thyristors.

These thyristors are connected so that they are blocked when the switch is on, allowing the external triac to be ignited. When the switch is off, each of the thyristors is conducting during one half cycle, which prevents triac ignition. A capacitor/resistor network supplies the voltage for the IC's logic, and a coil/capacitor circuit at the switch output suppresses static. □

Around the world

Gold-diffusion isolation increases IC density
A process of gold-diffusion isolation being developed by Nippon Electric Co. may lead to bipolar ICs that perform better than present ones, yet save dramatically on chip real estate. The key is not to waste space on isolation regions. The other advantages are simplified processing and somewhat higher operating speed, which reduces switching time. What's more, increasing the density level, which can lower costs below those of present bipolar circuits, may make bipolar more attractive than MOS technology in situations where the main attraction of MOS now is higher density. An experimental hex inverter gate measures 0.8 by 0.96 millimeter, an area that NEC engineers say is about half the amount required by conventional techniques.

Modular TV camera can be upgraded
A high-reliability television camera for industrial applications has been built in modular form by Marconi-Elliott Avionic Systems Ltd. so that it can be tailored to the job and expanded. Extended tests predict a mean time between failures of 8,000 hours for everything but the camera tube. For the European market, the camera scans 625 lines at 50 fields per second or for the U.S. market, 525 lines at 60 fields per second. Price in its simplest form without the camera tube is $1,500, but various options can boost the price to more than $2,400. The system consists of two units—the camera itself and the camera-control unit. Modularity is attained by means of printed-circuit boards, each of which contains a complete functional circuit.

Analog indicator uses ICs and LEDs
An integrated circuit that drives a line of light-emitting diodes has been designed by Siemens AG to serve an analog indicator similar to a column of liquid in a thermometer. The West German firm will begin next month to sample the bipolar IC, the UAA180, which selectively switches the row of LEDs on and off. A chain of 12 different amplifiers—one for each LED—converts the analog information to be indicated into voltages that control the LEDs. These voltages switch the LEDs on and off successively so that a light band moves back and forth across the scale. Reference voltages mark both ends.

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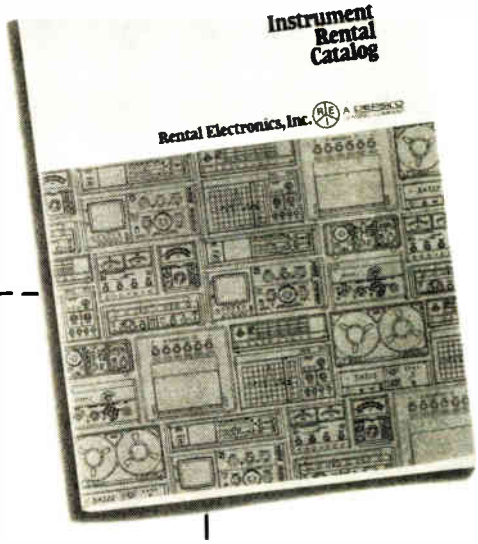

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International newsletter

Europeans fear Cramer moves may portend U.S. grab

If Cramer electronics, the second biggest broad-line components distributor in the U.S., is entering the UK market, can Hamilton and other large U.S. companies be far behind? That's the reaction by some observers to **Cramer's announcement that it will begin doing business in the UK on March 1, and it intends to open up shop in France and West Germany in 1976.**

Some observers worry that entrance of companies the size of Cramer—$152 million in sales in 1974—could mean a U.S. takeover of most of the UK and European markets. **One executive comments that it would become easy for U.S. companies to "dump" products in Europe that aren't selling well in the U.S.,** although getting franchises and market penetration will take a while. Cramer's two-and-a-half-year-old Italian operation now has sales of more than $5 million annually. The UK's largest distributor, ITT Electronics Services, sells about $17 million a year.

French firm sees spurt in sales of radiation detectors

Le Matériel Téléphonique, a French ITT affiliate best known for its telephone exchanges, flight simulators, and navigation hardware, predicts a spurt this year in sales of its lesser known radiation-detection gear. The company has signed **a contract with the nine-nation nuclear-energy community, Euratom, to market a nondestructive tester that checks plutonium levels** in radioactive wastes and spent-fuel rods from nuclear-power plants. LMT officials foresee a potential market of 20 or so of the $35,000 testers in Europe within the next three years. LMT also expects to score this year with a wide-angle multidetector for neutrons. **Intended for in-reactor diffraction experiments, the 130° version of the apparatus covers a sector that would otherwise require 650 individual detectors.**

Germany attracts new investments, despite downturn

West Germany, despite the slowdown of its economy, continues to be one of the preferred countries for investments by foreign electrical-electronics firms. **During the first six months of last year, foreign investments were increased 14.9% or $185 million. Most came from American, Dutch, Swiss, and French companies.** This upward trend, says an official at the Electrical Industries Association in Frankfurt, continued during the second half of 1974 and is likely to hold up this year. The reason for it is the good long-term prospects of West Germany's electrical-electronics markets.

At the same time, foreign investments by German firms also went up by 7.2%, or more than $100 million, during the first half of last year. The preferred countries for German investors were Great Britian, Switzerland, Spain, and Brazil.

Executives fear UK vote against Common Market tie

Some electronics executives in the United Kingdom fear that voters will turn down Britain's continued membership in the Common Market in the upcoming referendum engineered by the Labour government. If the UK withdraws, electronics companies may face higher tariffs, **which will put them in a noncompetitive position in selling their**

goods on the Continent. One distribution executive worries that higher tariffs may force him to tackle the tough, expensive U.S. market. Even if the UK could negotiate a special trading position after it leaves the market, years might pass before settlement of the issue. **Some executives are talking about organizing pro-Market advertising compaigns through their trade associations.**

Japanese to sell own faster 8080 microprocessor

A pin-compatible version of the Intel 8080 8-bit n-channel microprocessor has been boosted to a new performance level by the joint effort of two Japanese companies subsidized by the Ministry of International Trade and Industry. **Mitsubishi Electric Corp. and Oki Electric Industry Co. will both sell the chip and use it in their own equipment in a grab at a piece of Japan's microprocessor market.** That market is said to total more than $3 million a month, including central-processing units, peripheral chips, and memories.

Improvements include interface current high enough to directly drive transistor-transistor logic and operation at the clock frequency of 2.5 megahertz, 25% faster than the 8080. Samples will be available in March and production quantities in July. Other devices available, and to become available by summer, include a static n-channel random-access memory of 1,024 bits by one word, a dynamic n-channel 4,096-bit RAM, an n-channel read-only memory with a capacity of 8 kilobits, an 8-bit input/output port, and a 4-bit bidirectional bus driver.

Customer types gasoline order, computer bills him

A computer-controlled self-service gasoline station is undergoing long-term tests in Braunschweig, West Germany. At the station, operated by Deutsche BP AG, a subsidiary of British Petroleum, the conventional gasoline pumps are replaced by special dispensers with keyboards. **The customer taps the keyboard to select regular, high-test, or a mixture of gasolines, as well as the number of liters, the money value he wants, or a "full tank."**

The operation is controlled by a small MOS-based computer located in the attendant's office. The computer is made by the Scheidt und Bachmann GmbH, a manufacturer of special-purpose electromechanical and electronic equipment. **If the six-month tests go well, BP says, it will install more such stations to streamline operations at big stations.**

Addenda

Kyoto Ceramic Co., a leading Japanese manufacturer of ceramic packages and substrates, will deliver a ceramic-production plant to V/O Technopromimport, the Soviet Union's industrial import agency. The $17 million package includes $4.4 million for technology. The integrated plant, to be delivered in June 1976, handles the mixing of raw materials and turns out completed products, including hybrid circuits and substrates for variable resistors. . . . **The 11 West Germans caught providing information on the operation of IBM Corp. computers to the intelligence agency of "an Eastern power," will be tried for violation of embargo regulations.** Nine of the 11, one of whom is an IBM maintenance technician, are still being detained. No trial date has been announced.

been determined yet," although he believes "we can get down to the microprocessor level."

What the computer must do sounds relatively simple. The specification calls for aircraft position in latitude and longitude, ground speed, track, and range. But as Beran, a career navigator, explains: "The problem is this: the propagation corrections are probably the biggest difficulty of converting the signals received into useful information. The corrections involve the speed at which the airplane is traveling over the ground; the time of day; the date; whether it is traveling over ground, or water, or ice; and the relative position of the airplane to the transmitter. All that information has to be either stored, or you are going to have to work out a very, very clever program."

Moreover, the processor will have to "be able to dead-reckon during periods when there is signal outage, or when the signal-to-noise condition degrades to the point where the system is not usable. We want this set to be able to do the same thing the human navigator does."

In July 1976, the third and final phase of production is scheduled to begin after a single winning contractor has been named. That timetable is designed to permit the Air Force to start installing its first operational system in April 1977—eight months before the beginning of the phaseout of the Loran A network that Omega is designed to replace. But it will be the second preproduction phase in which the Air Force will learn if it can meet the design-to-cost target it is aiming for.

One cost key will be the development of a specification by Aeronautical Radio Inc. for the Omega hardware, Beran notes. The control-and-display unit will be the first to get one. "We have a hard spec now," he says, "and the kind of standardization that permits is going to drive the cost of the equipment down" by calling for commercially available parts wherever possible.

The Aeronautical Systems division at Wright-Patterson Air Force Base arrived at its price target rather simply, aided by the fact that Omega's vlf technology has been around for more than a decade now. "Commercially available Omega receivers without processors range in price from $3,000 to $8,000," observes the division's Brig. Gen. R.A. Foster, deputy for reconnaissance/strike/electronic warfare and Col. Beran's boss. "Processor costs of existing avionics equipments are estimated to be in the $5,000 to $15,000 range. The airborne Omega target price is consistent with these component prices."

Omega boss. Lt. Col. John F. Beran, career Air Force navigator, runs Omega project office. His project could mean $22 million sale in on-board electronics for winning contractor.

First-generation airborne, automatic Omega units now cost between $30,000 and $50,000 apiece, but Foster notes that present Air Force plans call for "a more austere" system than existing automatic sets. That constraint plus "the combination of progress along the learning curve, new technology, and competition can bring about significant reductions in price," he argues, and make the $15,000-per-plane figure achievable.

Warranties. A somewhat trickier goal in holding down Air Force Omega life-cycle costs will be its attempt to develop a contractor warranty system to maintain the equipment—another innovation with its roots in Arinc, the company owned by the nation's commercial airlines and operator of their communications net. "The reliability improvement warranty, or RIW concept, has evolved as a means to resolve the continuing problem of acquiring equipment and finding that field reliability is considerably below that called for in the procurement specification," explained Gen. Foster. The Omega contract will call for an initial RIW period of five years with two renewal options.

Under the plan, a manufacturer will get a fixed price to repair all equipment failures in that time frame. By improving equipment reliability in the manufacturing phase and thus cutting down on field repairs in the warranty period, a manufacturer can maximize profits. That's the incentive that the Air Force hopes it can sell industry to the point where it will become a standard procurement practice on awards where the state of the technological art is not being pushed. The advantage to the Air Force, of course, is the economy it expects to realize in reduced training outlays for technicians and smaller inventories of spare parts at its depots throughout the world. □

Digital IC news from RCA...

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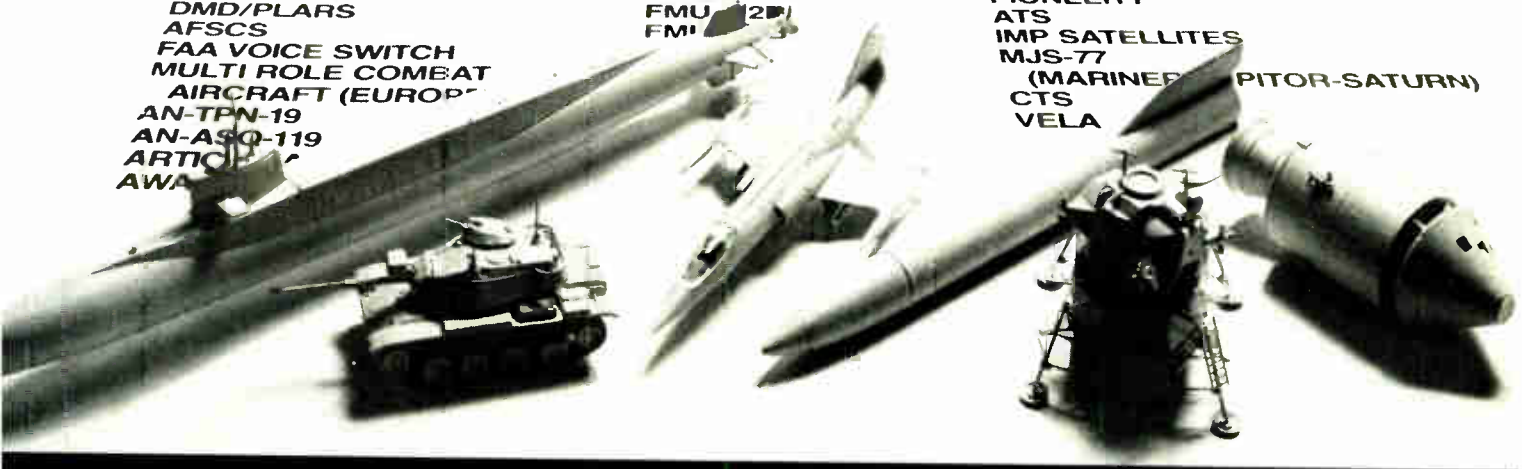


RCA. The first house in CMOS.

Circle 71 on reader service card

Solid state

ISSCC has news for LSI users

Preview of Feb. 12 meeting in Philadelphia uncovers developments in instrumentation, communications, data processing, computerized control

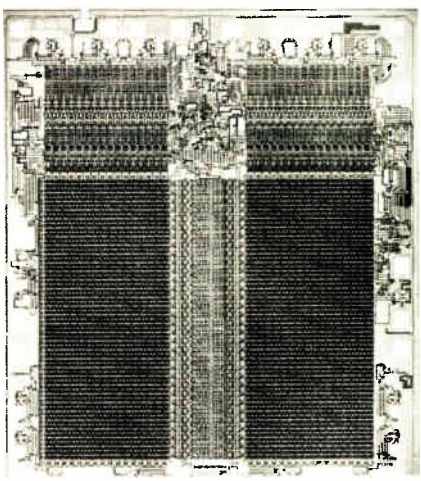
by Laurence Altman, Solid State Editor

The bell is about to sound for the next round of LSI technology as designers take the wraps off new circuits aimed at the next generation of instrumentation, communications, data-processing, and computerized control equipment. That will be the message from Philadelphia and the International Solid State Circuits Conference, where the annual revelations of just what is forming on the leading edge of IC technology will be made Feb. 12 through 14.

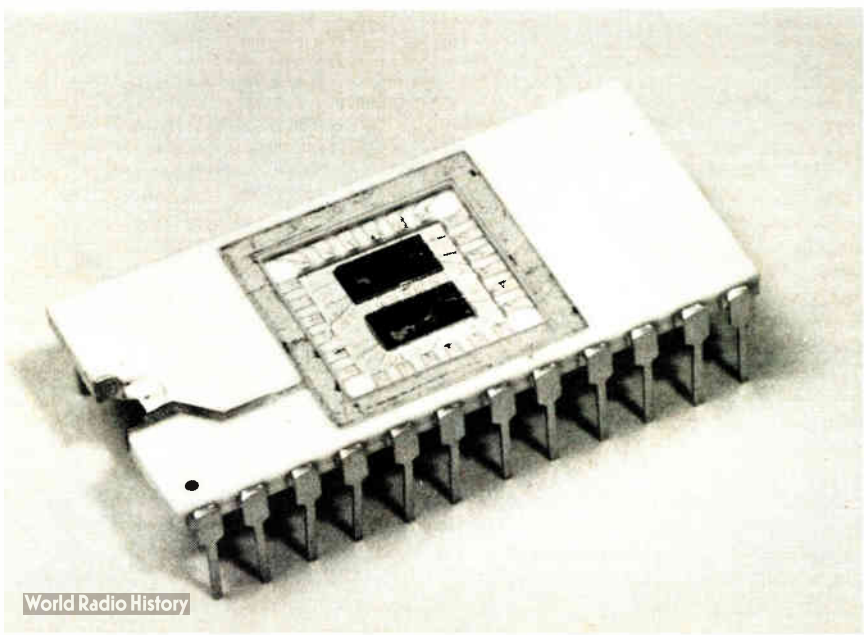
Here's what's going to be discussed:

- In digital circuits, bipolar LSI techniques have matured. Now, micropower circuit elements designed with single-transistor logic gates or single-transistor memory cells can be put onto chips containing either tens of thousands of gates of logic or thousands of bits of random-access memory. Meanwhile, improved n-channel and complementary designs are speeding up MOS memory access times to less than 100 nanoseconds, while retaining the MOS hallmarks: low power and high density. These fast MOS RAMs will compete briskly with bipolar units for buffer and cache-memory systems.
- In industrial analog devices, IC digital-to-analog converters are being built with linear techniques that pair dedicated LSI chips in single converter packages. The result is 12- and 14-bit d/a converters. Moreover, the harder-to-design single-chip 12-bit analog-to-digital converter is close to reality, now that MOS and bipolar linear elements are being combined in a compact design. Here, linear versions of injection logic structures could provide the needed digital functions on the converter chip. Finally, in analog communications, improved switching is available from a mixed junction-field-effect-transistor and bipolar chip design that results in eight channels of analog multiplexing with a switching time better than 1 microsecond.
- In microwave, power-frequency records are being set by gallium-arsenide FET oscillators operating at 5 to 10 milliwatts in X band. Also, high-power GaAs FETs, using interdigitized designs, are achieving 1-watt outputs and 6-decibel gains at 6 gigahertz.
- Finally, in analog-signal processing, complex filtering and bandwidth-delay problems are being solved with single-chip charge-coupled devices. These circuits by themselves are revolutionizing signal processing in new military and commercial communications systems. For example, a 500-point Fourier-transform CCD chip that has been built for secure military systems can handle a transformation that ordinarily would take almost a bank of discrete analog components or an expensive digital computer. Using another CCD method, researchers have developed a 10-channel multiplexed analog delay line for bandwidth compression.

Digital stars. A closer look at the developments reveals that the new



Superstar. That's Intel 4-k RAM, right, introduced two years ago. Analog Devices' DAC, below, will be unveiled this year.



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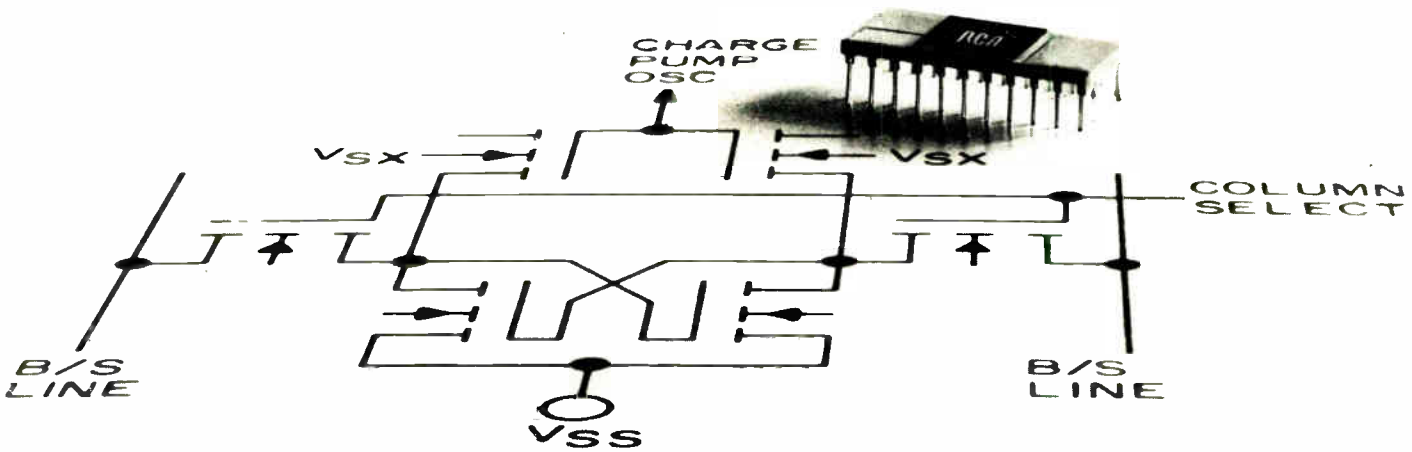
RCA



RCA. The first house in CMOS moves into memories

digital LSI circuits are varied and wide-ranging. The highlight in memory design is Intel Corp.'s 4,096-bit random-access memory, which breaks the 100-nanosecond speed barrier [*Electronics*, Jan. 23, p. 25]. The RAM has an access time of less than 80 ns. Moreover, by virtue of its compatibility with emitter-coupled logic at both the inputs and outputs, this n-channel device is not only suited for buffer memories driven by ECL controllers but also is potentially useful as fast ECL-controlled main memory. Clearly, if these high laboratory speeds can be transferred to production devices, this design could weaken the appeal of 1,024-bit fast n-MOS RAMs.

A bipolar memory design that bears watching is the 1,024-bit programable read-only memory from Siemens AG researchers, who have built the device with ECL structures that use conventional nichrome fusible links for field programing. This PROM, which has the popular 256-word by 4-bit programable processor organization, can be accessed in 15 ns—fast enough to work with today's bipolar processor designs.

Two trends are evident in the new logic designs: subnanosecond standard logic, and low-power, single-transistor-gate LSI structures. In the high-speed area, researchers at Nippon Electric Co. in Japan are reporting an ECL-type logic family that, with a speed-power product of 8 picojoules, achieves a 400-pJ propagation delay per gate and a 2-GHz toggle frequency. These results, which were obtained on 50-ohm transmission-line systems, earmark the family for data-telecommunications applications, where high-speed controls are required to handle the wide-bandwidth capacity of the new networks.

Another high-speed device is Hewlett-Packard's 1.8-GHz logic circuit. It uses a junction-isolated ECL process, as opposed to the passive or dielectric type of isolation that's become popular with subnanosecond designs but which is more difficult to build, and it achieves cut-off frequencies of 6 GHz that boost the performance of today's emitter-coupled circuits well into the subnanosecond range.

In the single-transistor-gate designs, two developments stand out: International Business Machines Corp.'s new Schottky-transistor logic design developed in West Germany, and Motorola's new complementary-constant-current logic, or C^3L, which also uses low-threshold Schottky diodes in single transistor cells.

In the Motorola approach, [*Electronics*, Dec. 12, 1974, p. 36], pnp current-source/load devices make up the entire gate structure, providing a dense and fast LSI design. Its density is 60 to 120 gates per square millimeter; its speed-power product is 2 pJ, and its gate propagation delays are well into the 2-ns ECL range. □

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Avionics

DAIS takes center stage

Air Force program seeks to time-share instruments and displays in cockpit; first R&D version is already prepared to 'fly'

by Larry Armstrong, Midwest bureau manager

Military avionics gear has traditionally evolved in the form of "black boxes." Newer digital systems have been built one at a time and shoehorned into already crowded cockpits. As military aircraft and their missions have become more and more complex, cockpits have become more crowded and "busy."

To reduce avionics costs and increase pilot efficiency, the Air Force Avionics Laboratory at Wright-Patterson Air Force Base has come up with a flexible cockpit simulator that leans heavily toward displays and controls that are time-shared to reduce cockpit and panel space they require. They will be incorporated into what the Air Force calls a hot bench—actually, a test bed for avionics systems—now scheduled for September 1977 demonstration, that will link all the elements of the far-reaching DAIS (for Digital Avionics Information System).

On the ground. This simulated cockpit is being used for R&D on the forthcoming avionics test bed for DAIS, a program for time-shared displays and controls.

Requests for proposals on all major hot-bench procurements—mission software, multiplex system, processors, and a technical-support team—are out now, with the single exception of the controls and displays package. RFPs for that hardware are expected later this month. The hot bench was designed and will be managed in-house, although procurement specs were written by Boeing and Texas Instruments.

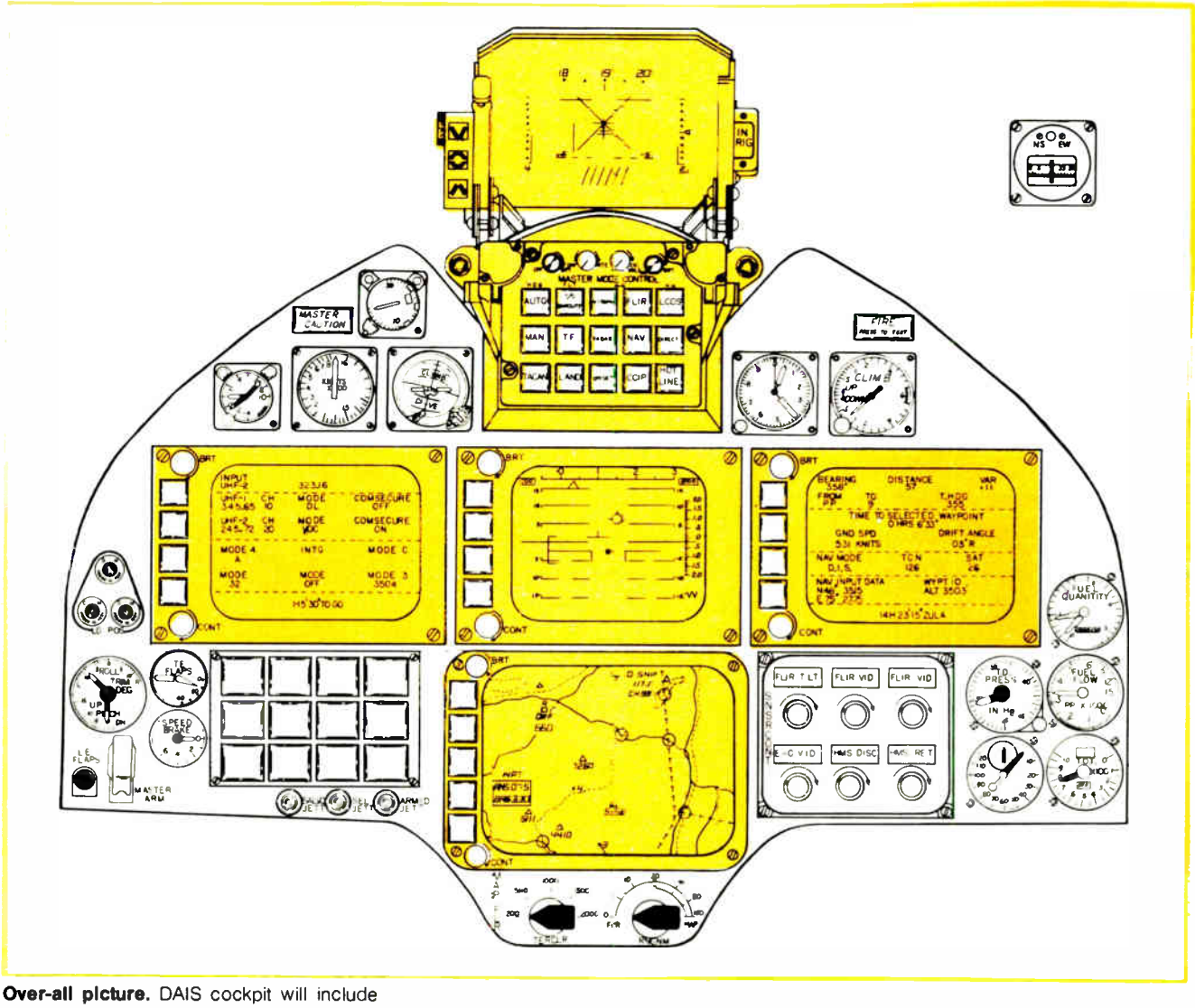
To figure out what hot-bench controls and displays are needed and to help debug the software for the facility that will support the hot bench, the avionics lab is using a flexible, general-purpose cockpit simulator that resembles the cockpit that will be used eventually as the DAIS hot bench. Although the hot-bench cockpit will be a one-seater that's laid out for primary DAIS aircraft—the A-7, A-10, and F-16—the prototype in the lab now sports pilot and copilot seats.

The existing R&D cockpit also serves as a tool to get pilots involved before the DAIS hot bench is built, points out Nicholas A. Kopchick, DAIS controls and displays project engineer at Wright-Patterson, near Dayton, Ohio. To that end, A-7D pilots will begin "flying" the general-purpose simulator before the end of the month.

Hardware in the DAIS hot-bench cockpit will be small and packaged as part of an avionics system; the existing cockpit simulator was patched together with commercially available components, though it looks pretty much like the eventual DAIS cockpit.

When it's all put together in the hot bench, though, it will look like and fly like a DAIS-equipped A-7 or F-16. Principal displays will include a head-up display; a 9-inch vertical-situation display on a color cathode-ray tube containing horizon line and pitch and roll indexes, as well as altitude, air speed, and heading presented digitally; and a 9-in. horizontal situation display in color superimposing navigation information on a map. Flanking the horizontal situation monitor will be two 5-in. monochrome CRTs. All status functions, such as weapons management, communications and navigation data, and engine instrumentation are divided between these two multipurpose displays, and can be called up when the mission demands them. In addition, the DAIS hot bench will be fitted with dedicated analog displays for backup purposes.

Some traditional controls in the DAIS cockpit will be dedicated, such as stick and throttle, volume controls for communications, and buttons for weapons activation. But most control functions will be organized into four levels, Kopchick says. The first level will be dedicated controls for the major areas the pilot has to manage in the cockpit: communications, navigation, sensors, aircraft, and weapons. Second and third levels will incorporate 196 active DAIS functions into the software



Over-all picture. DAIS cockpit will include head-up display, 9-inch color CRT for vertical situation display, 9-in. CRT for horizontal situation display, and a pair of 5-in. monochrome CRT displays.

for presentation on multifunction keyboards, and the fourth level will be digital entry on a dedicated touchpad.

Most control functions, such as communications, will be split between two primary multifunction keyboards: a 16-button legend-projection keyboard, with 12 possible legends per button, and one of the 5-in. multifunction CRTs, which will have 12 bezel-mounted switches. The third multifunction keyboard, a green plasma panel with 12 bezel-mounted switches, is redundant, and will be on the pilot's right.

To get into the communications mode, for example, the pilot would press the communications button on the dedicated function-select panel. The system will respond by changing the backlight for that button from white to green, but present the communications-status format on one of the multipurpose displays. The aircraft's various radio sets will be controlled through a keyboard.

Using the keyboard, the pilot will select his radio, such as uhf; the legends on the keyboard will immediately change to tell him what he can do with the radio, such as select frequencies or channels. He will then enter, say, frequency digits on the dedicated digit-entry pad, and check them visually on the communications-status display. Frequency will be selected, and the display updated, with an "enter" key.

The facility that will support the fully integrated DAIS hot bench is also going on stream now—it's built around a Digital Equipment Corp. DECsystem 10 with 256,000 words of 26-bit memory, a dual-processor system, six tape drives, and eight 10-million word disks interfaced to DEC PDP-11/20s and 11/45s to simulate major subsystems.

The DAIS concept itself, instead of merely replacing analog black boxes with digital ones, proposes a distributed array of minicomputers for processing, multiplexed signal distribution, shared controls and displays, and modular software.

DAIS will first be demonstrated in the laboratory in 1977 with the hot bench. While the concept is applicable to any airframe, the base line design chosen for the DAIS hot-bench demonstration was based on two mission profiles: close air support at night and in adverse weather, as flown by A-7s and A-10s, and night air superiority by the F-16. □

Electronics abroad

Europe heads for pollution standards

Common Market decision on drinking water and installation of systems to monitor air may bring order out of chaos for equipment makers

by James Smith, McGraw-Hill World News

For the makers of pollution-detection and control equipment, Europe is a nightmare. Not only do national and, in some countries, provincial regulatory agencies present a crazy-quilt pattern of rules but pollution meanders back and forth over national boundaries. However, a recent Common Market move bodes well for equipment makers.

Last November, Common Market governments agreed on minimum standards for surface water destined for drinking. It was a small act, on the face of it, but it should simplify matters because it transcends national boundaries. Now the European Economic Community is beginning to attack air pollution, and the first proposal calls for channeling of national measurement data to a central authority.

The move came as the U.S. started a model pollution-detection study in St. Louis designed to come up with a standard system [*Electronics*, Dec. 26, 1974, p. 62].

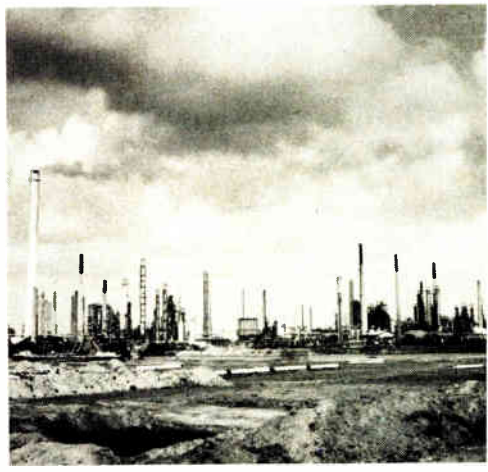
If nothing else will get governments to agree to comprehensive Common Market standards for air and water, the pollution across national frontiers may eventually force them to face facts. Some reasons:

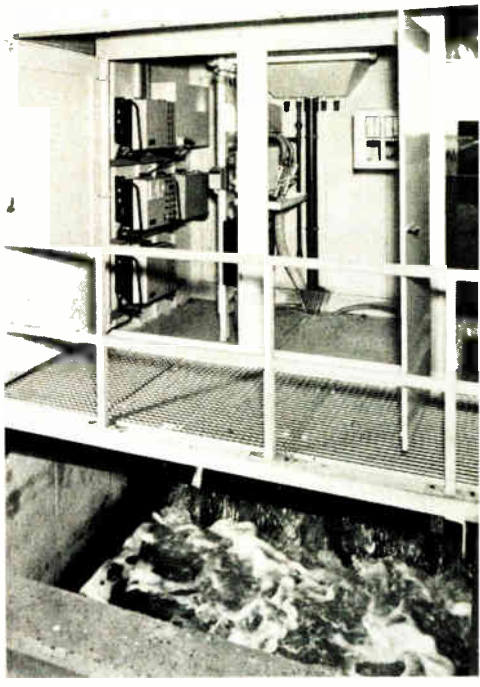
- Norway has some of the highest carbon-dioxide readings in Europe, even though the country is one of the most rural.
- Pollution of the Rhine River, from which Holland draws much of its drinking water, has been a sore point among all countries through which the river passes.
- Cross-border air and water flows have caused conflict between the Dutch and Belgians.

Still, it will be a while before industry feels less frustrated by the varying and changing national rules. A.B. Bok says, "So far, industry itself has had to move beyond legislation and the government." Bok, marketing manager for pollution-measuring equipment at Philips Gloeilampenfabrieken in Eindhoven, the Netherlands, says 30 to 40 computerized automatic remote monitoring systems for air pollution are in operation or are being set up in West European countries. Experimental work is moving ahead on remotely controlled continuous water-monitoring equipment, and at least two governments are studying the possibility of setting up national systems to monitor surface water.

Bok estimates the value of ambient systems—as opposed to those that measure at the source—now operating or being installed is $30 million to $40 million. Free-standing air-monitoring units, often with in-station analog or digital recorders, will account for another $25 million to $30 million a year until 1980, when it may become largely a replacement market. However, source-monitoring systems, most of them private, could increase the potential to perhaps $50 million a year.

National systems. So far, the Dutch national air-monitoring system is more extensive than any other. The network includes 275 sulphur-dioxide monitoring units interlinked in regional nets and tied to a central computer in Bilthoven, headquarters of the Dutch meteorological service. This year, several stations will be expanded to handle other air pollutants, and later, it will monitor dust and hydrocarbons.





Air and water. Top photo shows Rynmond area of Holland, whose air is monitored by a Philips system. Same company's equipment monitors water at a sewage plant in Dordrecht, Holland, shown in bottom photo.

Not to be outdone, the Belgian government plans in October to start its own national air system, engineered by the Belgian firm CEI and using mainly equipment designed in the U.S.The system includes 68 carbon-dioxide monitors located mainly in urban areas. In addition, the Belgians will monitor other pollutants and dust. Telephone lines will link five local process computers from Varian Data Machines in the various cities to each other and to a central data bank and control system in Brussels. Bids for the central data bank have not been requested yet, but without it, the system costs about $8 million.

In Germany, where control of air pollution is the responsibility of the seven state governments, there are two air-monitoring systems—one, a Siemens-engineered system in Baden-Württemberg, and the other, in Bavaria, contracted by Dornier Systems GmbH, integrated by Rohde & Schwarz, instrumented by various suppliers of Camac (computer-aided measurement and controls) equipment, and controlled by Digital Equipment Corp. PDP-11s.

Emerging. Still in the infant stage is an emerging market for monitors of surface water, effluent, and drinking water, which Bok thinks will be "far larger than the air business." Technology to cope with this problem has not yet been proved in operation. Philips last year introduced a line of monitoring units capable of measuring the so-called conventional parameters of surface water, and it now claims 40 to 50 units are being tested experimentally in Europe and the U.S.

There are no complete systems yet for automatic surface-water monitoring, although Philips and the Dutch government are jointly developing equipment and a plan for a national linkup. And Belgian authorities have drawn up specifications for a 100-station surface-water system. It will probably be tied to an existing Siemens network that monitors water levels in the country's canal and river system. Experimental stations from Siemens and Philips are being tested by some government agencies, which plan also to order equipment from other producers. □

Companies

Signetics making comeback

Corning subsidiary, severely wounded by reliance on TTL, has changed product mix to include quantities of MOS

by Bernard Cole, San Francisco bureau manager

As Mark Twain once said about stories of his death, the stories that Signetics Corp. is in dire financial straits are "greatly exaggerated," according to company officials.

The semiconductor-manufacturing subsidiary of Corning Glass Works has worried Wall Street analysts for some time. In general they view Signetics as a weak link in the semiconductor industry because of its high dependence on transistor-transistor logic, which has undergone precipitous price erosion, especially in the last six months.

Even so, according to John Halter, Signetics marketing vice president, the Sunnyvale, Calif.-based company, if not exactly well, is recuperating. As for rumors that Signetics was to be sold, he says, Corning has received no purchase offers and is seeking none.

Signetics' fourth-quarter loss in 1974 totaled $5,148,000. With sales of $120,836,000, the company closed the year with a loss of $3,876,000. And its work force was cut drastically, from 11,000 to 6,000.

How does Signetics plan to come back? "First, of course, is our need to reduce our dependence on TTL," Halter says. "This is something we have recognized for several years and have been hard at work on."

The result has been that from 90% TTL two years ago, Signetics now has only about 50% in that area with the rest in linears and MOS. And some of the TTL is in the newer bipolar memory market rather than in flip-flops. The bipolar memory products include a 1,024-bit emitter-coupled random-access memory, a 4,096-bit read-only memory, and a 4-kilobit PROM.

The company is banking heavily on MOS products by mid-1975, first with a 4-k, 22-pin RAM it is second-sourcing to the Intel-Texas Instruments configuration [*Electronics*, Jan. 9, p. 25], then a 1-k n-channel static RAM, and an 8-k ROM. Several complementary-MOS products are also planned, he says. But making an impact with those products won't be easy. Signetics isn't regarded as a strong MOS competitor, nor is it recognized as a leader in microprocessors, where another of its 1975 product pushes will come.

The company is now sampling its 2650 PIP (programable integrated processor), an n-channel silicon-gate ion-implanted 8-bit MOS device on one chip. Priced at about $200 each in quantities of 100 and up, it is aimed at both the low-cost and high-speed ends of the market [*Electronics*, Sept. 5, 1974, p. 133].

Signetics is also at work on a bipolar microprocessor, probably something like the one recently introduced by its sister Corning subsidiary, Scientific MicroSystems.

Now that it has more clearly identified its targets, Signetics has quietly revamped its entire marketing structure. Where product marketing functions for C-MOS, ECL, and TTL were once split among three divisions, they have now been melded into a new Logic division with Charles Wheatly, formerly head of the company's TTL division, as general manager. David Laws, former marketing manager at Litronix, is marketing manager. A separate marketing and processing organization has been set up under Larry Liktler, former manager of PROMs and ROMs, to handle military products. And a division has been created under Jerry Crowley, former sales vice president, to put Signetics into new businesses. □

The view from outside

The view of Signetics by competitors and industry analysts is mixed. Semiconductor industry analyst James R. Berdell of the San Francisco securities firm of Shuman, Agnew & Co. says, "If they turn around it will be more a function of the economy." Signetics' problem, he agrees, is product mix: too much TTL. "To grow as fast as, say, an Intel," says Berdell, "they will have to change their product mix and put more emphasis on MOS."

While Signetics is attempting to do that, the company's emphasis on distributor sales could be vital. "It's obvious why they made that move," says an executive at Fairchild Semiconductor. "It was an effort to gain market share. And if the market had continued to grow for another couple of quarters, it might have worked. As it was, the bottom dropped out, and Signetics barely managed to hold on."

But David Parks, president of Gnostic Concepts Inc., a Menlo Park, Calif., consulting firm, thinks this distributor emphasis actually might work in Signetics' favor over the next three quarters. His reasoning: a lot of companies that bought OEM last year, including the large computer makers, are going to buy from distributors in 1975 because they will be willing to settle for smaller purchases rather than buy six months' supplies for inventory.

SHORTFINDER FF202

Faultfinders now make a self-programming system to test loaded PC boards. Called the Shortfinder FF202, it is micro-processor-controlled to test between nodal points, automatically isolate circuit defects during the test cycle and supply printed data for circuit repair. By reducing testing, troubleshooting and repair time, the FF202 increases product yield and lowers manufacturing costs.

The versatile Shortfinder can also be used to test the integrity of the PC boards before components are inserted, testing for shorts, continuity, opens and leakage between circuit paths. With suitable adaptors it may also be used to test cables, wiring harnesses and backplanes.

Any standard fixture for a 600 point plugboard receiver may be used on the Shortfinder. With optional receivers the Shortfinder can provide 2000 connections to the board under test. Additional memory is also an option and will provide dual test program capability, permitting the loading of one board while another is being tested.

Ideal for manufacturers with many different types of circuits, the self-programming FF202 virtually eliminates programming time. A typical 600 point board can be automatically programmed in about 6 minutes and tested in 6 seconds. Only 400 ms is required for each test failure printout. The mag tape cassette may be used for permanent storage of the test program.

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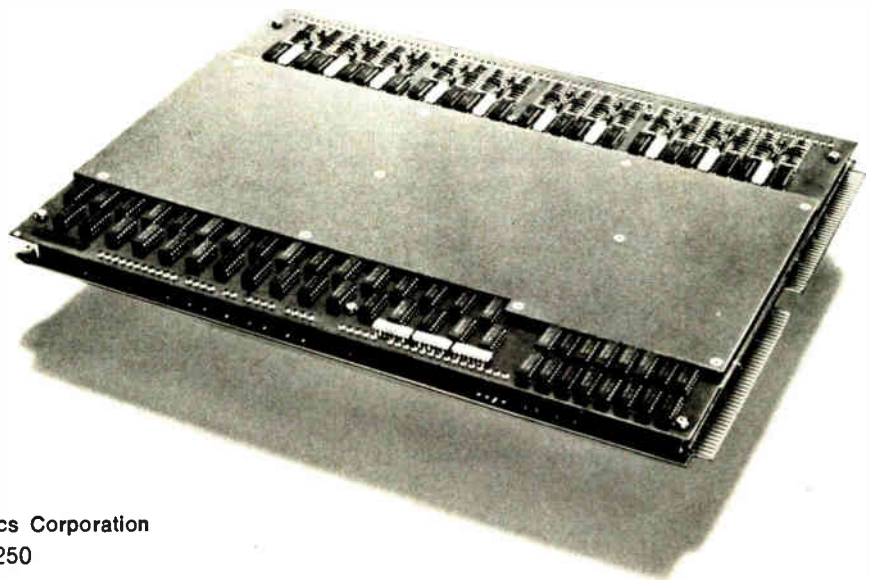

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I²L takes bipolar integration a significant step forward

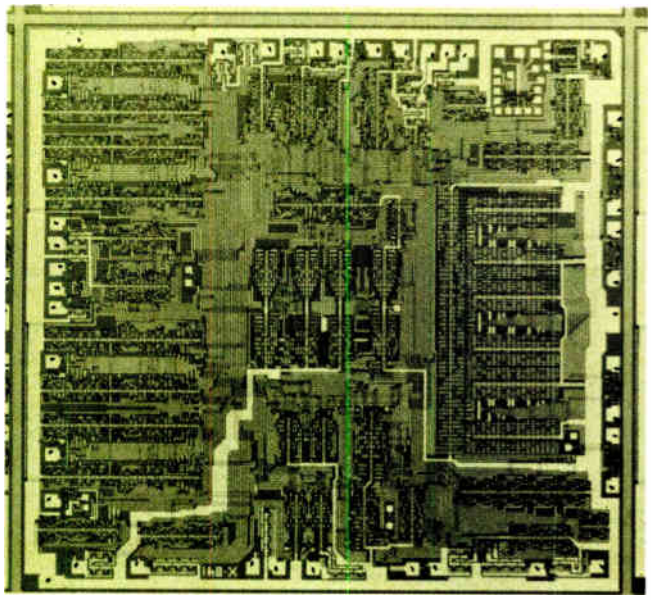
Extraordinary compactness is achieved in new microprocessor while speed is increased up to five-fold over n-channel devices; 4-bit controllers to 16-bit minicomputers can be simulated

by Richard L. Horton, Jesse Englade, and Gerald McGee, *Texas Instruments, Dallas, Texas*

☐ For specialty applications such as watch circuits and linear control elements, integrated injection-logic circuits are already in production. But only with the development of purely digital techniques can system designers realize the full impact of this new bipolar structure. To this end, an extremely compact I²L gate has been devised that does not require isolation between elements within the gate—in contrast to I²L linear types that rely on conventional, space-consuming pn junctions to separate their devices. In the new, non-isolated I²L form, gates shrink to the size of a single transistor, so that, together with their low power capabilities, digital I²L structures may contain thousands of gates on a single high-performing bipolar chip.

With these non-isolated gate structures, a 4-bit bipolar microprocessor chip (Fig. 1) has been built that operates up to five times faster than today's n-channel devices. At the same time, this I²L processor element, which is directly compatible with existing bipolar interface circuits, provides greater instruction capability than n-channel designs. And because the 4-bit device is expandable to larger systems with simple interconnections, this circuit element can handle a wide range of computer functions—from simple 4-bit controller jobs to full 16-bit minicomputer process control functions.

True, the processor speeds achievable with these first-generation I²L gates—propagation delays of 20 to 50 nanoseconds—are not as fast as with today's TTL technologies. But techniques to boost I²L speeds toward the TTL level while still maintaining a compact low-power LSI format are known to be on the way. These integrated-injection logic chips will, for the first time, provide process control and computer system designers with the full benefit of highly efficient bipolar LSI circuits.



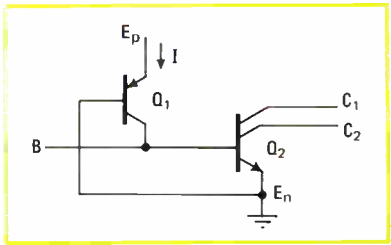
1. The first. Entering the picture is the industries first standard-product microprocessor built with the integrated injection logic bipolar technique. This 4-bit-slice device, SBP0400, bridges performance gap between today's n-channel and Schottky devices.

Part 1: Fundamental structure.

All the size and low-power advantages of integrated injection logic come directly from shrinking the old direct-coupled transistor logic (DCTL) into a single complementary transistor equivalent. In this scheme (Fig. 2) the resistor in the DCTL gate is replaced by an active current source; the emitter-grounded output transistor pair is replaced by a single multicollector transistor, and a simple pnp transistor is added to serve as the current injector source.

Thus the six transistors of a three-input DCTL gate are reduced to a single I²L transistor pair. The vertical npn transistor Q_1, with the multiple collectors C_1 and C_2, operates as an inverter, and the lateral pnp transistor Q_2 serves as both the current source and active load. No large ohmic resistors are required for either the source or load function. What is perhaps most ingenious, the base of the multi-collector npn transistor is made common with the collector of the lateral pnp current source, while the base of the current source is made common with the emitter of the multi-collector npn. Because of the elements in common (see panel p. 85), the entire I²L gate, when it is configurated on silicon, only takes up the room of a single multi-emitter transistor.

Again, the basic I²L



2. Structure. Digital form of I²L has vertical npn transistor Q_1 with multiple collectors C_1 and C_2 operating as inverter; and lateral pnp transistor Q_2 as current-source and load.

structure can take two forms: isolated or non-isolated. The isolated form, which so far has received more public attention [*Electronics*, Oct. 3, 1974, p. 111-118], makes use of a conventional reverse-biased pn junction for component isolation. Since this form of isolation completely separates adjacent devices, it is the isolated I²L structures that are used in circuits containing mixed-component functions.

Fabricated with a 6-mask bipolar process, isolated I²L allows all other standard bipolar and MOS design techniques (Schottky TTL, ECL gates and memories, and n-channel MOS devices, including linear functions) to be combined directly with the I²L gates. This means that along with I²L digital sections, a single low cost monolithic chip can hold such linear and special buffer functions as LED drivers, memory decoders, current regulators, op amps, comparators, oscillators, and very-fast digital TTL or ECL logic.

Indeed, the I²L watch, entertainment and other commercial LSI circuits already in production are made with this technique. This isolated form of I²L can also be combined with Schottky and ECL memory structure to provide fast low-cost bipolar memory designs. Here the I²L-type gates would form the internal array of the memory, while the TTL or ECL transistors would form the peripheral interface elements. RAMs with I²L-type arrays (74S209) have already been built, pointing to a new low-cost bipolar approach to medium-performance (100 ns) memories.

The boss LSI technology

Even as isolated forms of I²L have endless possibilities for combining linear and digital functions into heretofore-unattainable degrees of circuit integration, it is non-isolated I²L that results in the most dense and efficient form of bipolar logic yet devised for the fabrication of very complex digital ICs. Utilizing the single transistor switch with the common ground planes shown in Fig. 2, this logic form capitalizes on the high carrier mobility inherent in bulk silicon structures. It need not be isolated, nor does it require ground metalization, because in this single-transistor gate the output of one gate serves as the input of the next.

Nevertheless, these I²L gates are capable of operating at nanosecond speeds and microwatt power dissipation (Table 1), with a component density 10 times that of conventional bipolar circuits, and twice that of p-MOS. Furthermore, non-isolated I²L circuits can be built with a 4-mask, two-diffusion bipolar process, at high yields—an essential requirement of any LSI process where thousands of gates per circuit must be fabricated on a wafer of complex circuits.

The advantages of the I²L process are shown in Fig. 3, which compares the process complexity and gate-size relationships of the various digital technologies in use today. In process complexity, I²L is simpler than all other techniques except low-performing p-MOS, which requires the same number of mask steps but needs one less diffusion step. And, compared to I²L, the newly-evolved depletion-load MOS technology, being relied on so heavily in today's n-channel memories and microprocessors, requires an additional mask step. It also requires two ion implementation steps as opposed to none for I²L although depletion-load MOS does use one less diffusion. In any case, compared to TTL's 7 masks and 4 diffusions, and C-MOS's 6 masks and 3 diffusions, the I²L process is simplicity itself.

Even so, this process results in the smallest component size of any technology in operation—as Fig. 3 shows, the product is less than one tenth the area of either a conventional TTL or C-MOS gate. Even the newest LSI forms of TTL occupy four times as much space.

Speed-power comparisons (Fig. 4) show still another advantage of I²L gates; they have the lowest speed power product of any technology in use today, approaching a theoretical limit of 0.001 picojoule. Even non-optimized I²L test bars have operated with 100 ns propagation delays while dissipating 100nW of power per gate—surpassing today's best C-MOS circuits.

TABLE 1: COMPARISON OF I²L AND TTL PROPERTIES

Parameter	I²L	TTL
Packing density (7-μm mask details)	120 – 200 gates/mm²	20 gates/mm²
Speed-power product	4 – 0.2 pJ/gate	100 pJ/gate
Gate delay	25 – 250 ns	10 ns
Power dissipation	6 nW – 70 μW	10 mW
Supply voltage	1 – 15 V	3 – 73 V
Logic voltage swing	0.6 V	5 V
Current range (per gate)	1 nA – 1 mA	2 mA
Interconnect	Single-level	Double-level

Constant speed-power

Yet, unlike C-MOS, whose power dissipation rises dramatically at higher speeds, I²L gates can be pushed to speeds of 10 to 20 ns while maintaining a virtually constant speed-power product. Indeed, an I²L gate optimized around a high-speed 50-ns format is the one used in the current 4-bit microprocessor circuit design.

Finally, Fig. 5 shows where I²L processor circuits fit into the spectrum of computer applications. I²L microprocessors can potentially handle all the jobs now being performed by today's MOS systems—from non-real time processing, to calculator jobs requiring millisecond add times, to the 50-ns real-time processing of some mainframe controller systems. Second and third generation I²L designs are expected to significantly extend this capability into higher performance applications (Fig. 6).

Taking the simplest case, one in which a single npn grounded-emitter transistor forms the basic I²L gate,

How it's built

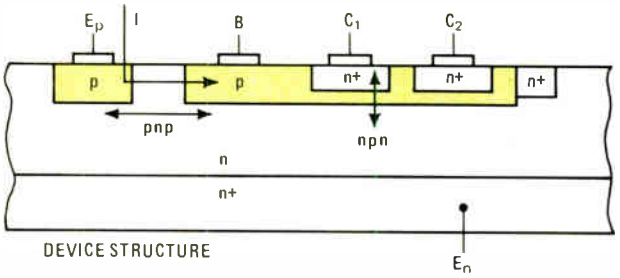
Designers at Texas Instruments are evaluating a number of I²L fabrication techniques. The one used to build their first microprocessor was chosen for its compatibility with existing TTL production facilities.

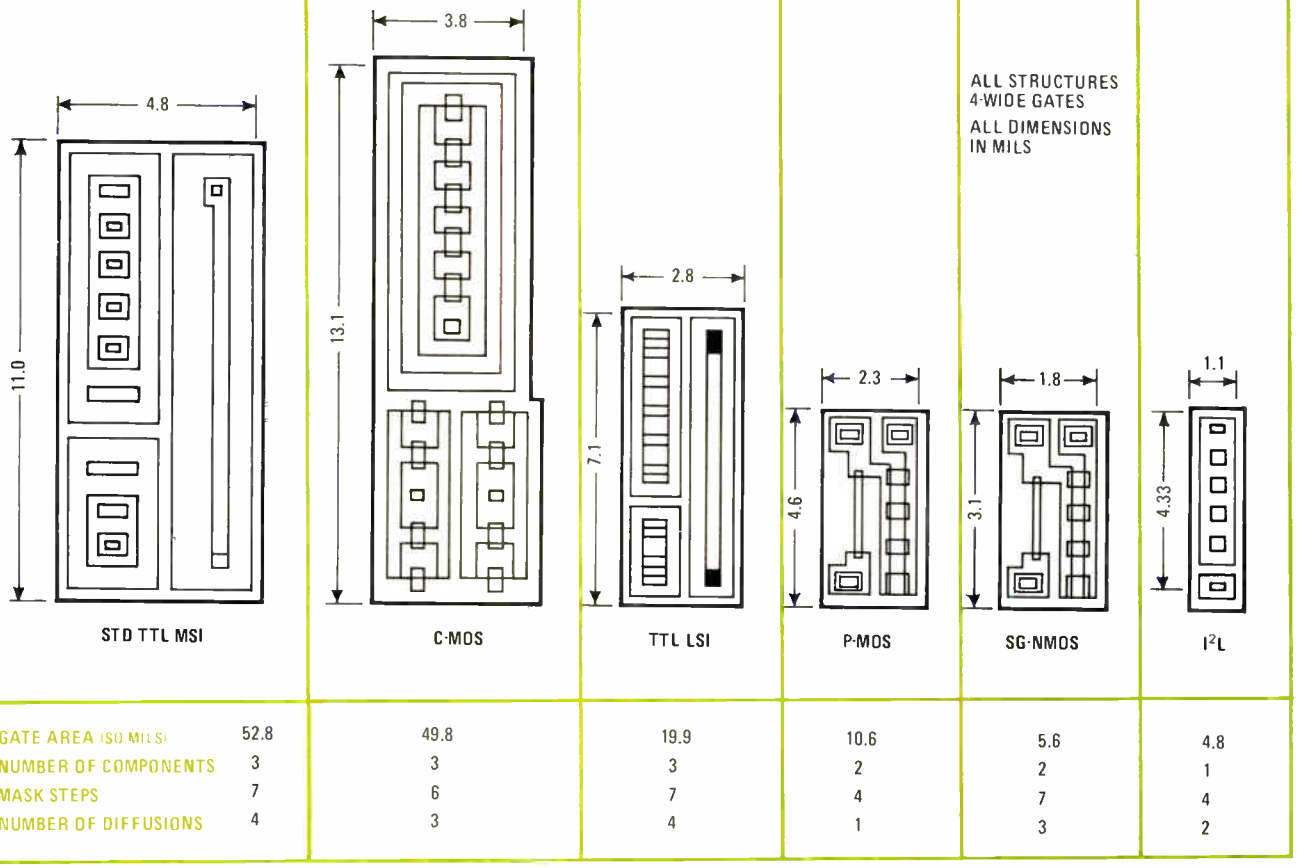
An I²L circuit's high packing density is due mainly to the simplicity of designing with a single transistor gate. In the accompanying illustration, for example—working from the bottom up in the cross-section of an I²L gate—the n+ substrate serves not only as the structural base for fabrication, but also as a common ground plane to interconnect all the grounded-emitter transistor gates. This eliminates the need for any surface metallization for ground interconnections. Likewise, the thick n-type epitaxial layer, grown on top of the n+ substrate, serves not only as the grounded-emitter region of the vertical npn switch, but also as the grounded-base region of the lateral pnp injector.

Continuing upward in the cross-section, the first of the two diffusions serves as the p-base region of the vertical npn, and also as the p-collector region of the lateral pnp injector. The second diffusion completes the I²L gate by providing the multiple-collector n+ regions of the vertical npn.

Metallization is then deposited and etched to provide interconnection between various I²L transistor gates. Note that the lateral pnp is integrated into the vertical npn structure and therefore does not exist as a discrete component. Furthermore, a single lateral pnp can be utilized as a current injector for multiple npn gages as long as symmetry in the layout is maintained to avoid current-hogging. Density is enhanced by the simplicity of a single-transistor gate requiring no component isolation.

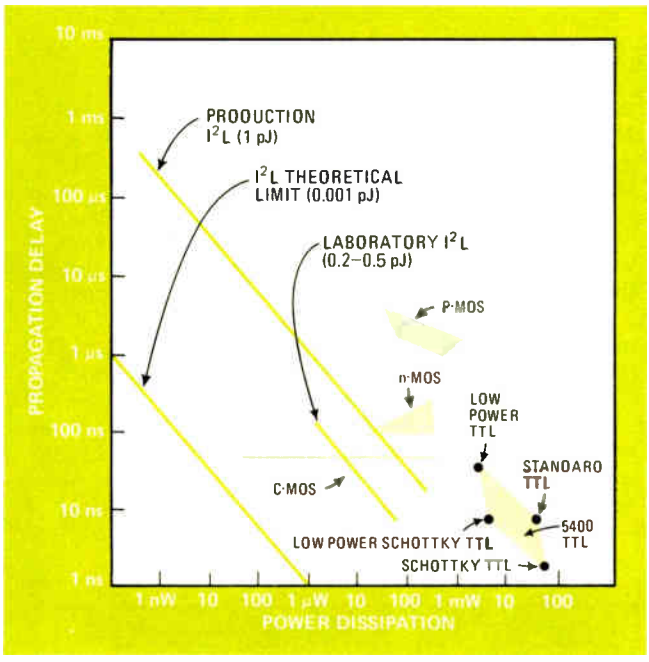
The similarity existing between I²L and TTL circuits is worth noting. This, essentially, is in the similarity between the basic multi-collector I²L transistor and the common multi-emitter TTL transistor. The I²L multi-collector regions correspond to TTL's multi-emitters, the I²L and TTL bases occupy similar regions, while the I²L emitter and TTL collector reside in the deepest n regions. An I²L multicollector transistor is, in essence, a TTL multi-emitter transistor operated upside down. Transistor logic in I²L structures is implemented by controlling inverse beta, while in TTL structures the forward beta is controlled.



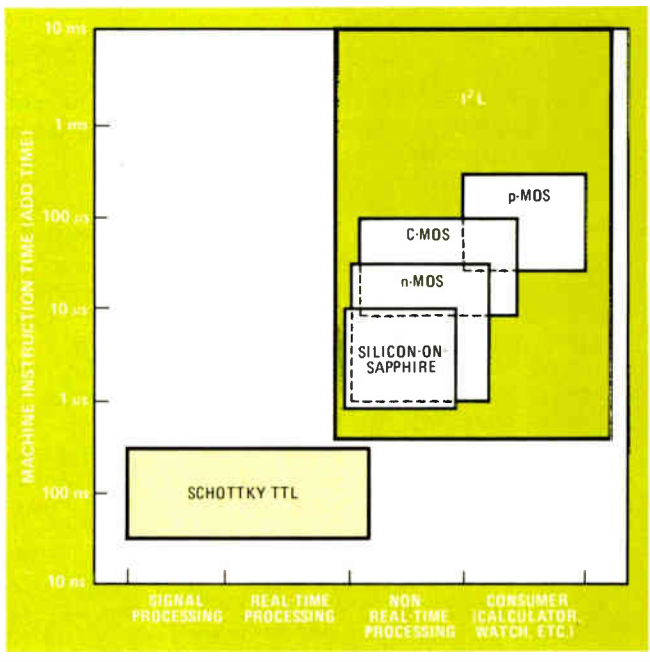


	STD TTL MSI	C-MOS	TTL LSI	P-MOS	SG-NMOS	I²L
GATE AREA (SQ MILS)	52.8	49.8	19.9	10.6	5.6	4.8
NUMBER OF COMPONENTS	3	3	3	2	2	1
MASK STEPS	7	6	7	4	7	4
NUMBER OF DIFFUSIONS	4	3	4	1	3	2

3. Shaping up. An I²L gate fabricated with non-isolated elements saves space and is simple to build, compared to other techniques. It's simpler than all but p-MOS gates and its 5 square mil area makes it the smallest. All structures shown are 4-wide gates.



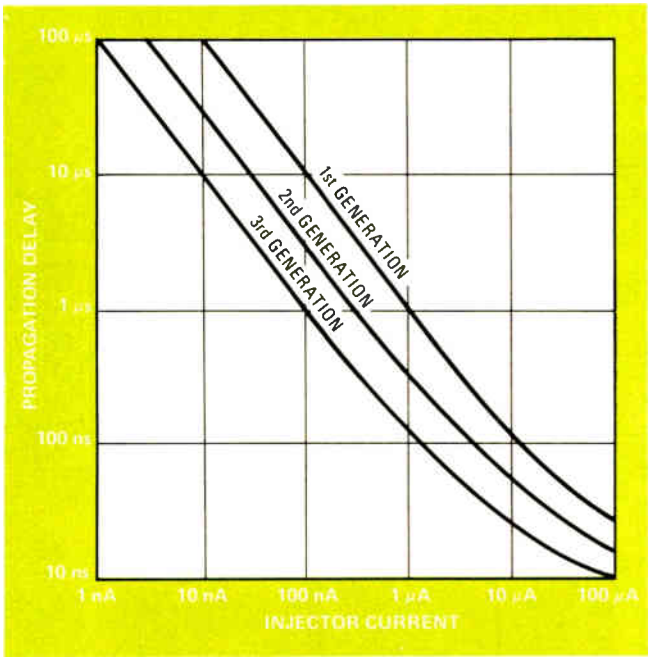
4. Speed/power. The beauty of an I²L gate is its ability to operate at very low power levels while running at respectably fast gate speeds. The same is not true, generally, of today's C-MOS circuits, whose low power properties are sacrificed at high frequencies.



5. Tomorrow. An I²L microprocessor potentially can take over all jobs now being done by MOS units. This includes non-real-time and consumer-type applications. What's more, I²L does overlap into real-time—processing jobs now being handled by TTL products.

positive NAND logic is implemented through the use of a multiple-collector npn switch functioning as an inverter. Here the logical isolation required to perform NAND logic is accomplished by ultilizing the multiple-collector outputs to function as isolated ANDing inputs to the stages that follow. Positive NOR logic can also be readily implemented by wire-ORing the I²L gate outputs (Fig. 7). Now, when the I²L npn transistor is normally biased on (low output) by a lateral pnp current-injector transistor, which is connected between the base of the npn and an external current source, switching action is accomplished by the steering of this injector current.

This is done by adjusting the base-to-emitter gate input voltage V_{BE}. A low input voltage of less than one V_{BE} (750 mV) pulls injector current out of the input through the on (low) output of the driving gate. Robbed of its base drive in this manner, an I²L transistor gate will turn off with its open-collector output rising to a high logic level.



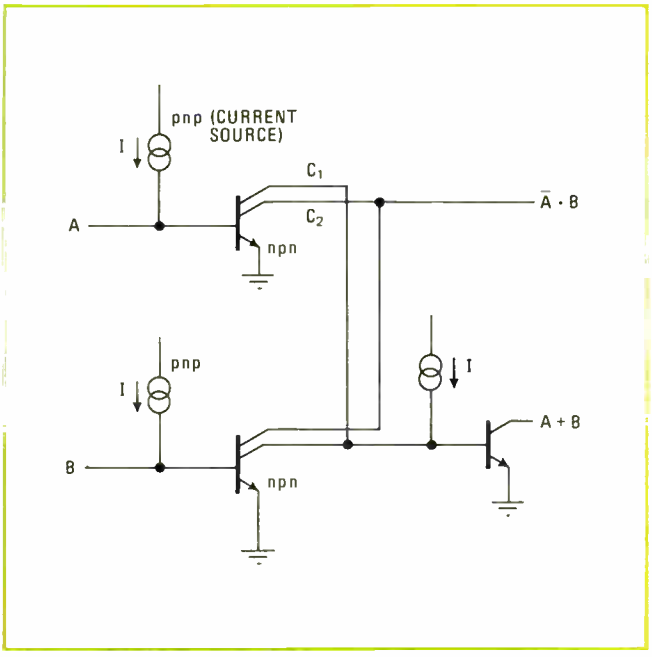
6. Only starting. Impressive as today's production I²L devices are, faster ones are coming. This year's second generation devices and next year's third generation will show steady improvements. Ten-microsecond to 20-nanosecond devices are forseeable.

Steering the current

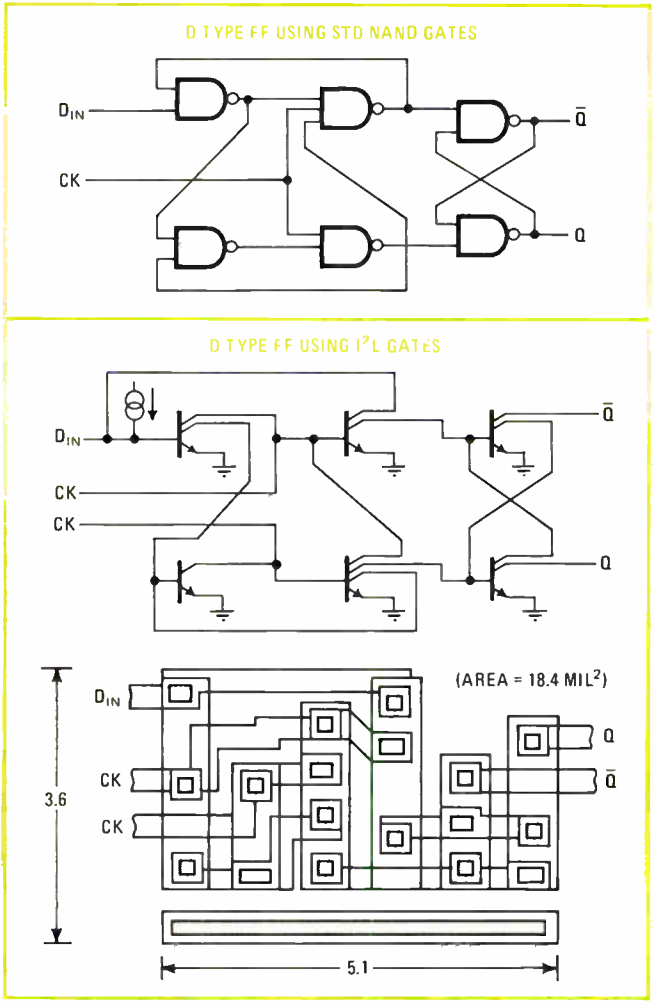
This voltage level, as with any open-collector logic, is determined by the load circuit, or pull-up, utilized. In a typical I²L circuit design this is simply the clamp level at the input of the next stage—one V^{BE} (750 mV) above ground.

A high input logic level is achieved, essentially by default, when a low-impedance path of less than one V_{BE} potential is absent from the input. Deprived of a ground path of less than one V_{BE} potential, the injector current will forward bias the I²L transistor gate into the on state and produce an output low-logic level equal to one V_{sat} above ground, or typically 50 mV. It is therefore possible to achieve, by simple steering of the injector current on the npn switch, typical I²L internal logic swings of 700 mV—this from a V_{sat} of +50 mV to a V_{BE} of +750 mV.

Figure 8 shows how I²L transistor gates are interconnected to perform a basic logic function. The NAND gate logic is that of a common TTL D-type flip-flop. The schematic directly below it shows the same D-type flip-flop in I²L NAND/NOR logic at a component count of one transistor per gate. Directly below the I²L schematic is a



7. Sound logic. NAND functions use the multiple-collector npn switch as an inverter, where logical isolation is obtained by making the collector outputs function as isolated ANDing inputs of the next stages. NOR logic results from WIRE-ORing gate outputs.



8. Easy fit. Basic to the high packing density of I²L digital circuits is its one-transistor-gate structure. Here a standard D-type flip-flop built with I²L gates takes up less than 20 square mills; it is so small it could fit under a single bonding pad.

scaled topographical drawing of the I²L D-flop. The p-injector used to power the flop is indicated along the drawing's horizontal axis. Note that an entire I²L static flip flop, which would require six 4 by 4 mil bonding pads interfaced to the outside world, would virtually fit under one of those bonding pads. It is this compact geometry that accounts for the high component density of the I²L LSI processor designs currently in production.

All told, practical I²L gates can handle a range of 6 magnitudes or more of injector current—from picoamps to microamps—at speeds ranging from hundreds of microseconds to tens of nanoseconds. They can be powered up for maximum speed, then powered down by a magnitude of 100 to 10,000 without losing functions or data (if they're memories). They do not display increased power dissipation with frequency nor produce the switching noise transients common in standard push-pull logic built with C-MOS or TTL. They require neither gold doping nor Schottky clamping, as does conventional logic in which transistors are easily saturated.

I²L logic is fully static, requiring no multiphase clocks, and temperature stability is superior, with circuits capable of military temperature range operation from -55°C to 125°C.

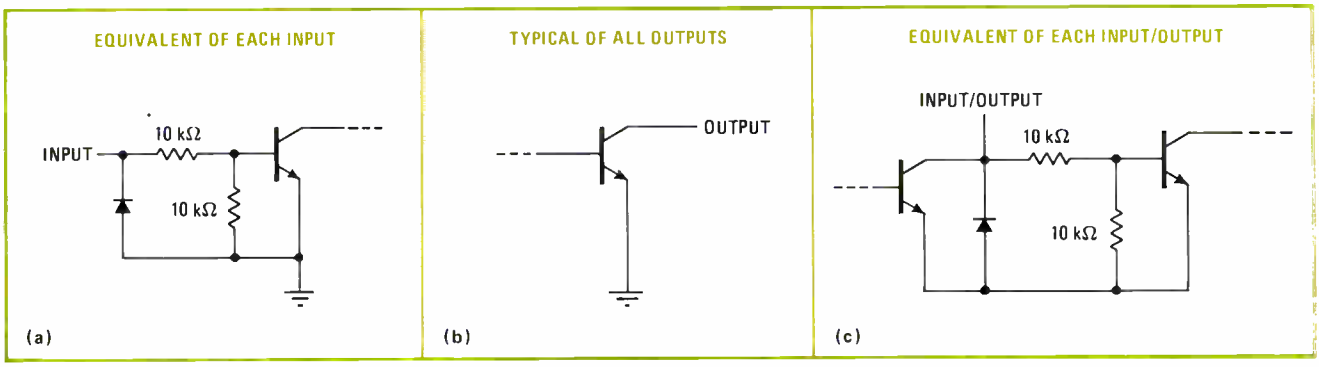
Designing I²L digital circuits

With the basic gate layouts of Figs. 7 and 8, a designer can use a variety of input/output circuits (Fig. 9). In the I²L microprocessor chip described in this article, input/output characteristics were selected with one objective in mind: full TTL compatibility. The input circuit, shown in Fig. 9(a), is actually an RTL configuration modified for TTL compatibility. An input threshold of nominally +1.5 volts is achieved with two 10-kilohm resistors functioning as a voltage divider, which boosts the one V_{BE} threshold of the input transistor to 1.5 V.

The input electrical characteristics, plotted in Fig. 10(a) as input current vs. input voltage, show the 10 kilohm load line and the threshold knee at +1.5 V. These high-impedance, high-threshold characteristics were chosen to reduce input loading and to increase the input noise margin over a standard TTL input, yet they retain full compatability with all 5-V logic families. The I²L inputs also utilize an input-clamping diode to limit negative excursions, or ringing, on the receiving end of a transmission line.

The output schematic and its characteristics, as shown in Figs. 9(b) and 10(b), are virtually identical to TTL or DTL open collector outputs. When turned on, an I²L open collector output will rapidly fall towards ground potential, producing a low logic level.

Standard design practice for I²L is again patterned after TTL in that I²L outputs are generally over-designed by 100%. While a typical I²L output will sink 40 mA without pulling out of saturation, the outputs of I²L logic circuits are guaranteed to sink 20 mA (10 Schottky TTL loads) at 400 mV maximum under worst-case condi-



9. Compatible. These input and output sketches show how easy I²L gates can be made compatible with TTL gates. The input in (a) is actually a modified RTL structure, while outputs (b) and (c) are virtually identical with TTL or DTL open-collector outputs.

tions. The high-logic output level, output rise times, and input-noise immunity are determined by a discrete pull-up resistor.

Common I/O configurations, as in Fig. 9(c), can also be utilized for improved functional performance and higher packing densities. This schematic is recognizable as an integration of the separate I/O schematics and electrical characteristics already described.

Powering an I²L circuit

I²L gates, which are current-injected-logic when placed across a curve tracer, resemble a silicon switching diode, a fact that enables a designer to use any voltage or current source capable of supplying the desired current at a voltage of 850 mV or greater. No tricky impedance matching or feedback is required. Perfectly acceptable would be a dry-cell battery, a 5-V TTL supply, a programable current supply for power-up and power-down operation—practically whatever power source is convenient.

If a 5-V TTL power supply were to be used, for example, a series dropping resistor would be connected between the 5-V supply and the injector pins of a typical I²L microprocessor device for selecting the desired operating current. The resistor value in this case would be:

$$R = E/I, \text{ or } R_{drop} = V_{supply} - 0.85\ V)/150\ mA$$
$$R = (5.0\ V - 0.85\ V)/0.15\ A = 28\ ohms$$

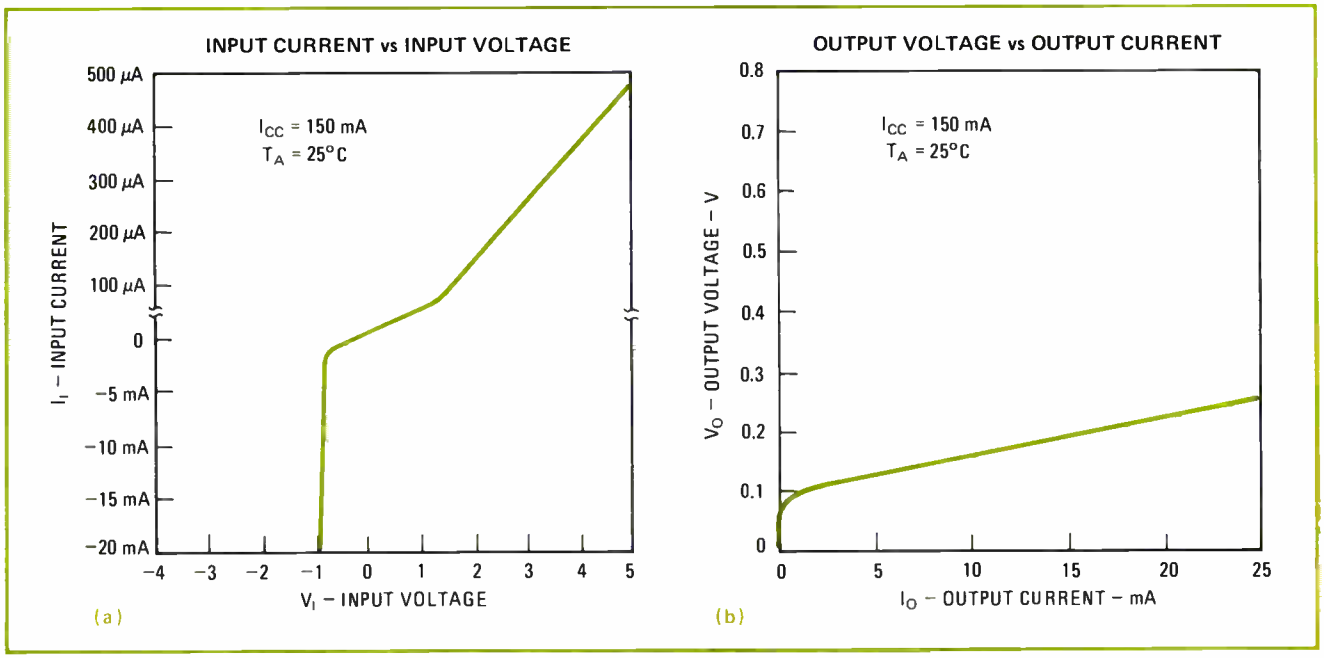
Part II: The I²L microprocessor

The first LSI digital circuit built with non-isolated I²L logic is a microprocessor chip slice designated SBP 0400, which stands for "semiconductor bipolar processor," 400 series. It is a 40-pin, 4-bit microprogramable binary processor element containing more than 1,450 gates—easily the most complex standard product bipolar logic chip built to date.

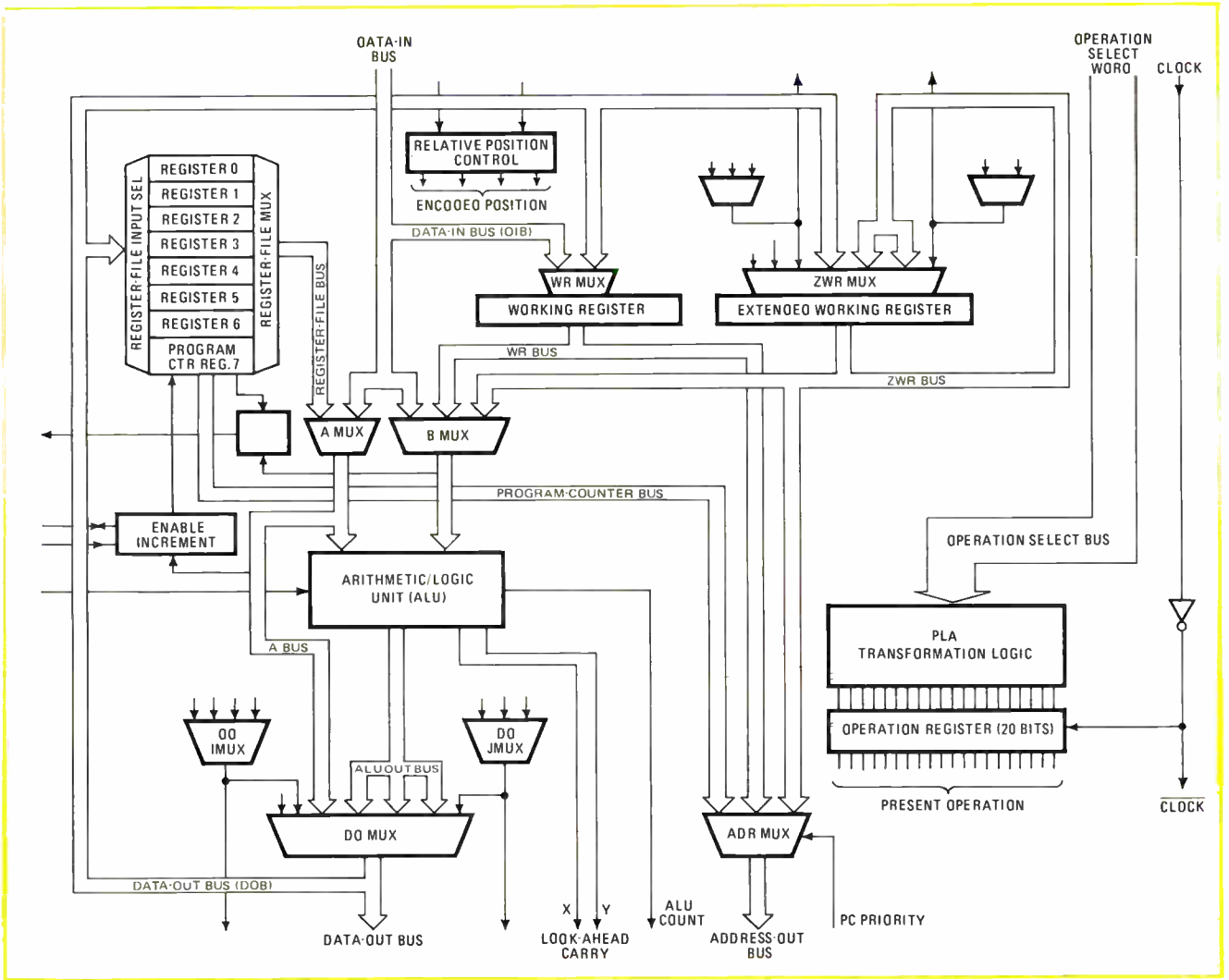
Containing all the functions required for 4-bit parallel processing (except for sequencing controls), the features of the SBP0400, as shown in the block diagram of Fig. 11, could only be duplicated by using 30 to 40 small and medium-scale TTL integrated circuits.

The chip contains:

- A 16-function symmetrical arithmetic logic unit (ALU) that has full-carry look-ahead logic.



10. Plotting it. Input and output current-voltage characteristics makes designing with I²L a pleasure. The input shows a 10 kilohm load line.



11. Organized. Among the principal blocks of the SPB0400 chip are the 16-function arithmetic logic unit (ALU), and the factory programable logic array (PLA), which provides 512 standard one-clock operations.

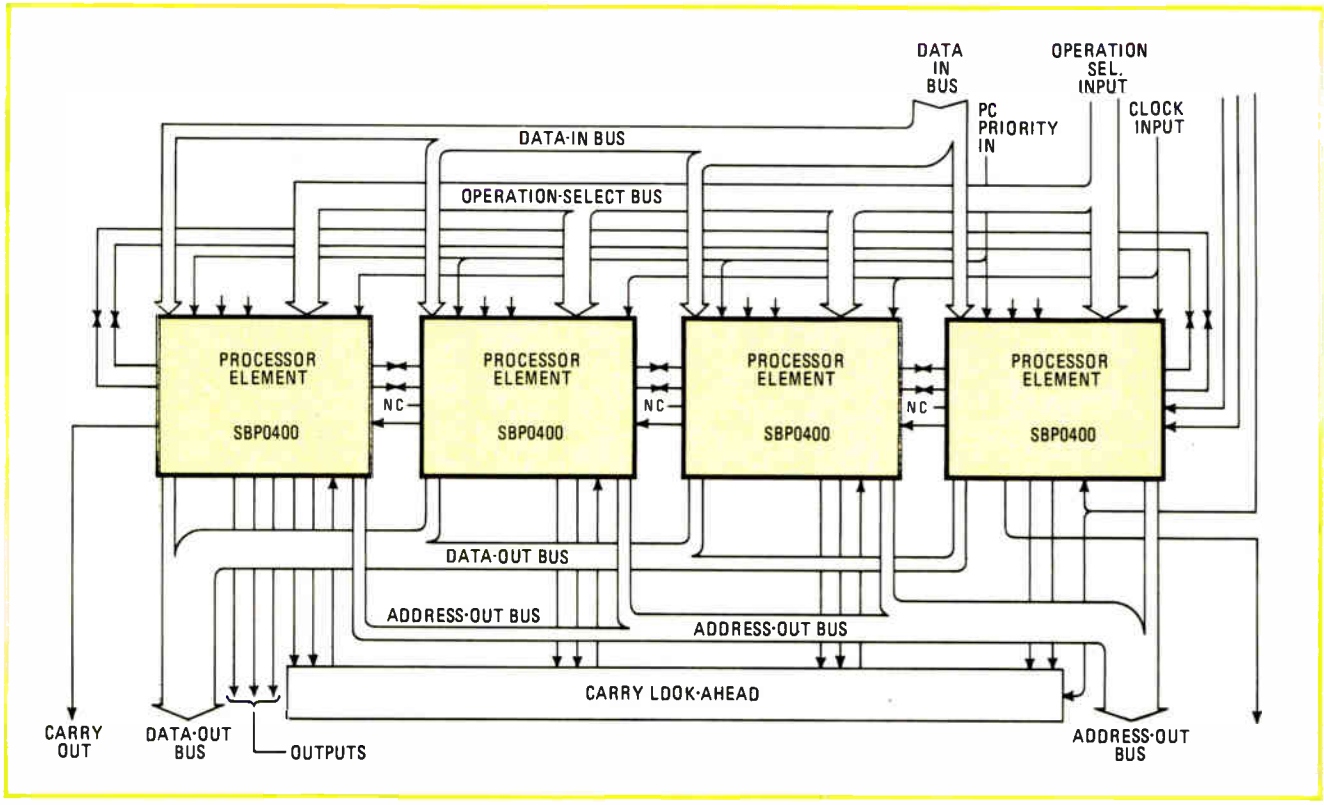
- An 8-word general register file that includes a program counter and incrementor.
- Two 4-bit working registers that can handle both single- and double-length operations.
- Scaled-shifting multiplexers enabling the chip to handle a wide variety of interface conditions.
- Finally—and perhaps the most innovative feature—a factory programable logic array (PLA) instead of the usual fixed-size control ROM. The 512 standard operations programed into this on-chip logic array provides a greater degree of instruction capability than is achievable by any other standard bipolar or MOS LSI processor.

This basic 4-bit I²L processor slice is directly expandable in 4 bit multiples—Fig. 12 shows the configuration for a 16-bit system. Like the single 4-bit chip, larger multichip systems provide full-carry look-ahead logic and parallel access to all control, data, and address I/O functions. It is this parallel access, together with the high bipolar speeds (typical propagation time of 110 to 530 ns at power dissipation of 128 mW), that's responsible for the device's short cycle time capability.

Thanks to the program flexibility offered by the PLA and standard micro-programing techniques, this single 4-bit slice offers a designer a repertoire of 512 one-clock operations, from which a wide range of instruction can be implemented. This compares with a fixed instruction capability of less than 80 for today's second generation n-channel microprocessors, and less than 125 basic operations today's TTL bit-slice systems. This large one-clock operation capability means that a wide range of existing designs can be emulated without loss of software compatibility or increased software investment.

Indeed, virtually any set of instructions is available. In a single one-microsecond clock cycle, for example, any one of 459 non-redundant operations can be selected, including such complicated tasks as transferring data from the processor's register to the external memory, or from memory to register, or from register to register; modifications of the operand or combinations of modifications by means of the 8 arithmetic or 8 boolean functions residing in the ALU; single or double precision arithmetic shifts, with protection of single- or double-signed binary words; single or double precision logical shifts, and so on.

Again, the key to the processor's high flexibility is the



12. Expanded. Four SBP 0400 chips form the heart of a 16-bit parallel machine that has full-carry look-ahead operation. This system can efficiently emulate many low-end minicomputer applications.

programable logic array. As a factory-programable block of combinational logic that forms the operation transformation control center, the PLA decodes the 9-bit operation-select word input lines and generates a 20-bit internal control word. This control word is stored in the operations register and contains the appropriate logical operation—functional-block, bus-enable, and/or bus-select, for execution of the decoded instruction.

Using the processor

The operations register is composed of 20 D-type edge-triggered flip-flops. Upon each positive transition at the clock terminal, the operation register loads the preset PLA output. Loaded, the operations register continuously enables the various functional blocks for execution of the ongoing operation, while the PLA can be receiving the instructions for the next operation.

The 4-bit, parallel, symetrical binary arithmetic logic unit (ALU) meanwhile provides the arithmetic/boolean, operand combination/modification mechanism. The ALU, as directed by the operations register, performs one of eight arithmetic operations, or one of eight boolean operations, on either or both of two operands. The two operands are bused, one to the A input port of the ALU (Fig. 11) via the A bus, and one to the B input port of the ALU via the B bus. The A input port has access to the register-file bus and data-in bus. The B input port has access to the data-in, working-register and extend-working-register buses.

The SBP0400 has accommodations for ALU ripple carry-in and ALU ripple carry-out. To facilitate look-ahead generation across larger word sizes (over 8-bit lengths) each SBP0400 has output accommodations for both ALU carry-generate (Y) and ALU carry-propagate (X) which are compatible for use with a standard TTL look-ahead generator.

Register file

This 8-word, 4-bit set of D-type general registers is controlled by the operations register. The registers can be used as temporary storage for source data needed in existing processor routines.

An additional register file (location seven) has the added capability of performing as a program counter. Accessed in the same manner as the other files, RF7 is not only presettable but it can also be controlled externally for incrementation by one or two on the next clock transition. This capability is available at the program-counter-carry-in input and the increment-by-one-or-two input.

In addition to the integral operation (pipelining) register, implementation of overlapping instruction fetch and execute commands is further simplified as the content of the program counter is directly available at the address-out bus (AOB). Regardless of the conditions established by the present instruction, a PC priority input overrides and routes the PC data on the AOB input terminal.

For cascading purposes, the most significant output bit at intermediate and least significant package positions is available at the PCCOUT terminal. Depending on the significance of the SBP0400's relative position, these functions are under the control of the POSO and PSOI inputs. □

Intrinsic safety foils explosive situations

Commercially available safety barriers are simplifying the design of circuits that must operate in dangerous environments, and they offer a practical alternative to purging or spark-proof housings

by Robert J. Redding, *Design Automation (London) Ltd., Maidenhead, England*
and Alan Krigman, *ICON/Information Concepts, Inc., Philadelphia, Pa.*

☐ All that's needed to trigger an explosion at a refinery or some other location having a flammable environment is a tiny spark from an electronic measurement or control system. Yet if control electronics contain energy-storage elements, and if contacts are made or broken, sparking is virtually impossible to prevent. Sparks will occur when contacts are closed in a capacitive circuit or opened in an inductive circuit.

To get around the problem, the electronics engineer has three choices: explosion-proofing, purging, or intrinsic safety. An explosion-proof circuit is enclosed in an Underwriter's Laboratory, Factory Mutual, or other approved housing that is capable of withstanding an internal explosion without transmitting the flame to the external environment. If the circuit is purged, the components are enclosed in a conventional housing, and the housing is continually flushed with air or an inert gas. The object is to dilute the hazardous atmosphere near the circuits so it cannot explode.

But explosion-proofing and purging are usually costly to implement and inconvenient to operate and maintain. The flanges on an explosion-proof housing must not be scratched, for example, because an explosion may propagate along the scratch to the outside world. Another problem can exist when the enclosure is opened for maintenance. If it is not resealed properly, sparks can escape through the flanges. These dangers are more serious in large installations where maintenance needs are great, or under extremely harsh conditions, such as marine or offshore environments. The third option, intrinsic safety, is therefore attracting increasing interest among electronics engineers.

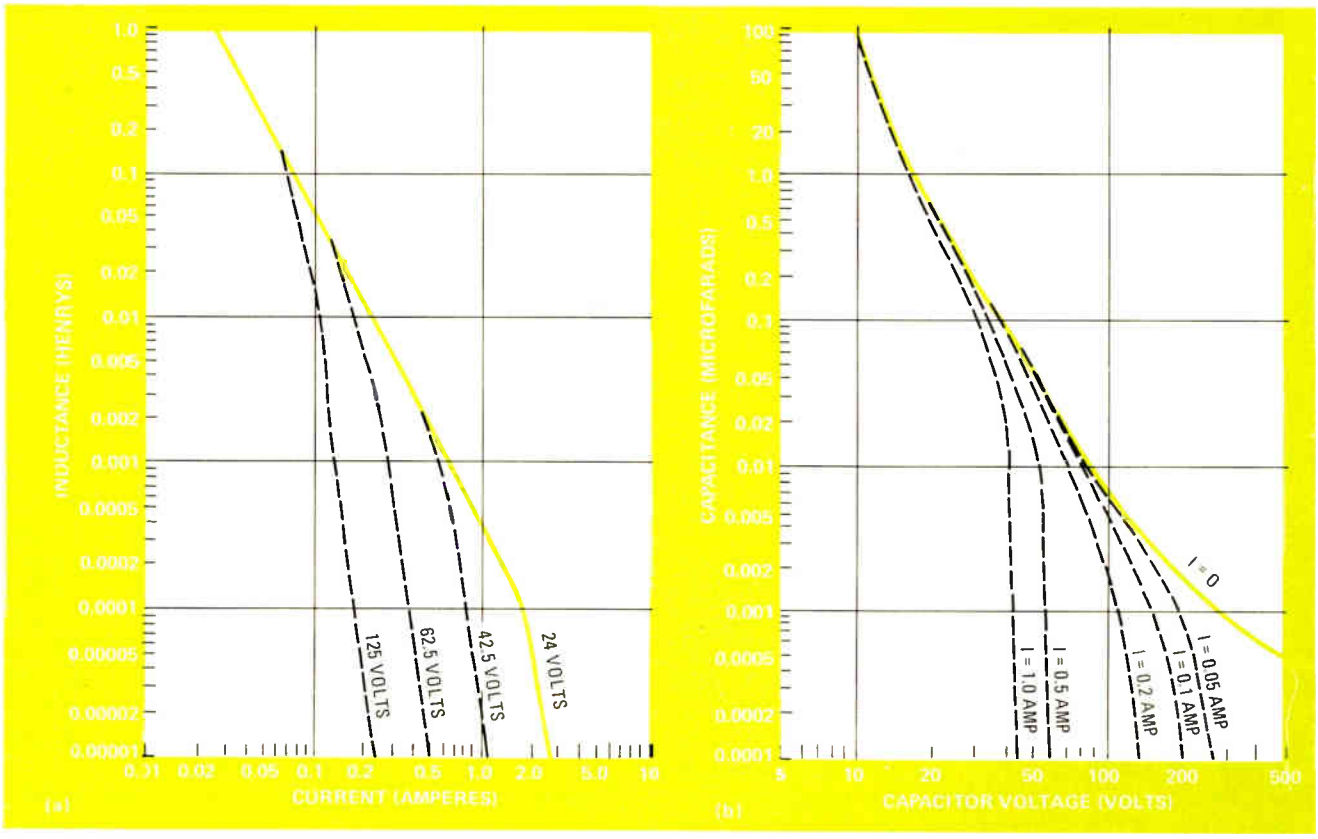
Simply enough, intrinsically safe equipment is incapable of releasing sufficient electrical or thermal energy, even under abnormal conditions, to cause ignition of a hazardous atmosphere. The concept is not new, but it has taken recent advances in solid-state electronics to make the approach especially practical and economical.

In practice, intrinsic safety is achieved by limiting the voltage and current available in the hazardous area, and by protecting or snubbing any capacitance or inductance so that stored energy can be dissipated without creating dangerous sparks. These conditions must be met, regardless of any faults that may occur.

To design an intrinsically safe circuit, the engineer must first determine the allowable circuit conditions for the most easily ignited mixture of air and the particular volatile gases and/or vapors involved. This information is found on the ignition curves for various gases published in the National Fire Protection Association Standard 493-1969, or the Instrument Society of America Recommended Practice RP 12.2. Similar data for European standards is found in R.J. Redding's "Intrinsic Safety," published by McGraw-Hill in 1971.

While the curves differ slightly from standard to stan-

Designed for intrinsic safety. Leeds & Northrup developed its Centry line of process control instruments to be used in loops protected by energy-limiting barriers. Such instruments particularly interest the safety-conscious chemical and petroleum industries.



1. Hydrogen and air. Curves show actual ignition limits for the most easily ignited mixture of hydrogen and air. In practice, a safety factor of four must be applied for normal conditions. Curve (a) indicates the series inductance that will not result in ignition for a particular current and voltage, while curve (b) depicts the shunt capacitance that will not result in ignition.

dard, a factor of safety is applied to each standard, so in the end, the values are pretty much the same.

The curves in Fig. 1 show the minimum ignition current and voltage for hydrogen in inductive and capacitive circuits. If the voltage available in the hazardous area is limited and the circuit resistance is known, the maximum current can be calculated. Then, from the appropriate ignition curves, the allowable inductance and capacitance for that voltage and current level can be determined. An intrinsically safe circuit can be designed for any specific gaseous environment, but for optimum safety, it is best to design for hydrogen. Hydrogen is the most easily ignited gas; if a circuit is safe in hydrogen, it will be safe in any volatile atmosphere.

Once safe current and voltage levels have been determined, the engineer must ensure that they will not exceed these levels. A simple way to do this is to select an approved intrinsic safety barrier. The barrier consists of a commercially available network of zener diodes and resistors, including a fuse, that limits the voltage and current delivered to the hazardous area. The barrier will not allow the hazardous-area circuit to be energized beyond a predetermined degree, even if the full main voltage is applied directly to the input (safe-side) terminals of the barrier. (See Fig. 2)

Barriers simplify design

As a result, the circuit on the safe side becomes irrelevant to the question of safety, and it can be changed at will without affecting official approval. In addition, barriers simplify initial approval, because the inspector can forget about the circuit on the hazardous side and only worry about the safe side.

The components in the barrier are not replaceable. Since field replacement of parts might compromise the intrinsic safety of the system, the unit is encapsulated. If a component fails, the entire barrier must be replaced.

A barrier is inserted between each device, transmitter, or transducer in the hazardous area and its associated control-room instrument or controller. All signals must pass through the barrier before entering the hazardous area. Physically, the barrier is usually located at some point in the structure separating the unsafe area (plant) from the safe area (control room).

Safety, a system consideration

After the barrier is selected, the engineer must check the reactance of the hazardous-area circuit, including the cables, to make sure it is sufficiently below the limits set by the voltage and current from the barrier. For purposes of inspection and insurance, components that are certified as intrinsically safe should normally be used. Using certified components doesn't automatically make the system intrinsically safe, however; the total hazardous-area system must still be evaluated.

Wiring can present a problem in this evaluation, since cable inductance may exceed allowable limits. Unless resistance is also high, the distributed nature of the inductance makes snubbing impossible. The problem can generally be overcome by minimizing cable

lengths and selecting aluminum rather than copper conductors.

In cases where circuit inductance and capacitance must exceed the levels allowed for apparent maximum voltage and current, it is sometimes possible to insert resistance into the circuit. Physically, this has the effect of increasing the charge- or discharge-time constant, thereby lowering the energy dissipation rate. A more satisfactory alternative in many applications is to use diodes rather than resistors to decrease the power-release rate in a spark. The advantage here is that normal circuit operation is relatively unimpeded, while a large resistance is inserted to minimize spark-discharge effects. All energy storage and snubbing circuitry must be potted as one integral module having terminal reactance below the established limits. Once the unit is encapsulated to prevent exposure of unsafe points to the hazardous atmosphere, the internal module elements become irrelevant. The potting material will prevent individuals from tampering with the circuit and it will also protect the circuit from physical and environmental damage.

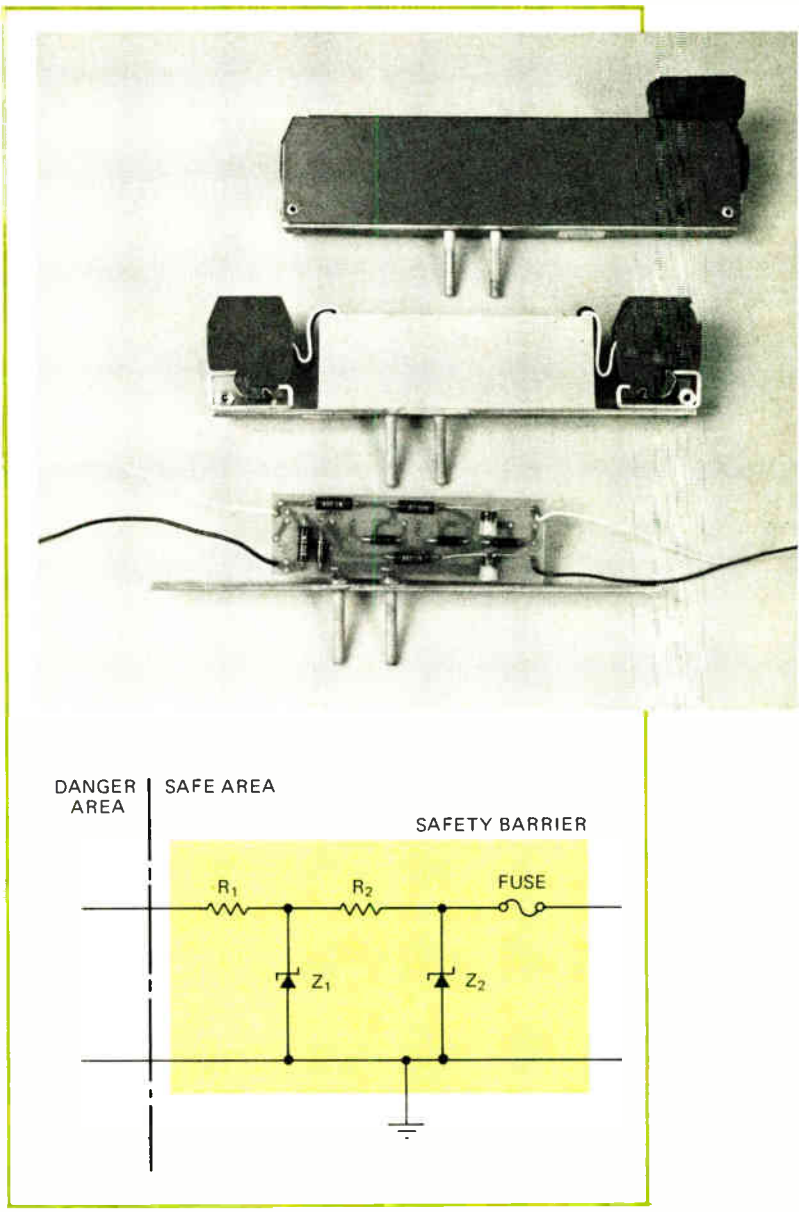
Problems other than design

While the design may, on paper, be intrinsically safe, improper installation can change that. For example, a wireman may take a whole reel of cable, unwind what he needs, but never cut the cable. So a circuit designed to have 100 feet of cable between a transducer and the control room may actually have 1,000 feet, with 900 feet wrapped around a spool somewhere. The unwrapped cable introduces a large inductance into the circuit.

Careless maintenance can also thwart safety efforts. A maintenance man might replace a transmitter with one that performs the same job but isn't quite the same electrically. Fortunately, it is possible to check the reactance connected to the terminal of the hazardous-area side. This can even be done through the barrier. In fact, it's a good idea to do so in order that the test apparatus itself does not cause an explosion. An impedance meter would normally be used for the test, but this can produce an erroneous reading because instrumentation circuitry often contains a moving-coil galvanometer or other variable inductor.

It is better to use an energy storage measuring device, such as that described by R.J. Redding in "Intrinsic Safety." Basically this unit is a battery-powered, high-impedance voltmeter containing some switching circuits and a measuring capacitor. When attached to the input terminals of the barrier, the battery energizes the hazardous-area circuit while the measuring capacitor is disconnected. Throwing a switch removes the battery from the circuit and allows the circuit to discharge into the measuring capacitor. The readout, though not quantitative, will give some indication of the energy stored and dissipated.

Next, the tester is connected to a capacitor that is equivalent to the maximum capacitance allowable in the hazardous-area circuit, and the procedure is repeated. If the reading is higher than that produced by the hazardous-area test, the hazardous area is still within spec. The same test is also performed with an inductor that is equal to the allowable inductance.

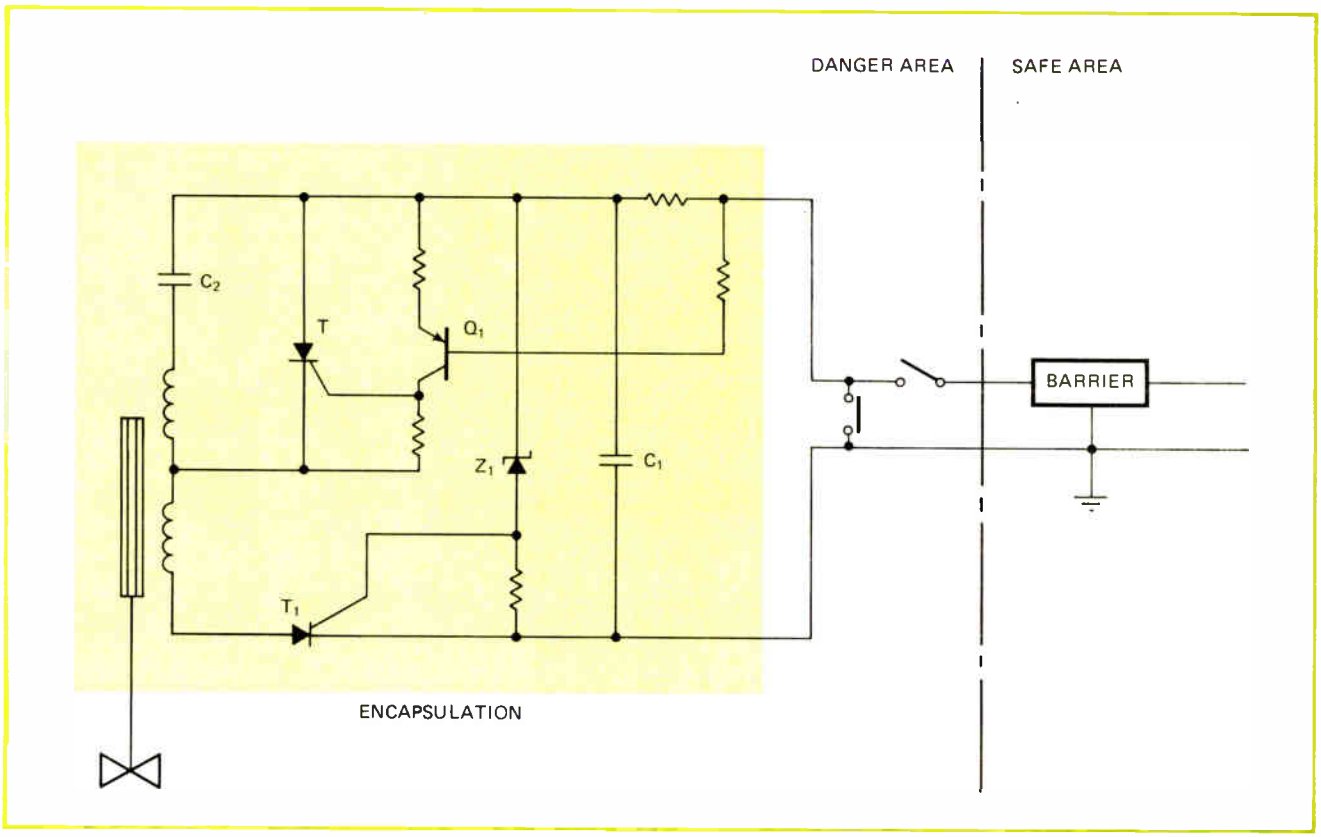


2. Barrier. External fuse mounted on upstream (safe) side of assembled safety device (top of photo) is set to blow at a lower current than the encapsulated fuse as a cost-saving precaution. Circuit board at the bottom is a double-barrier configuration, while the schematic illustrates the basic barrier configuration.

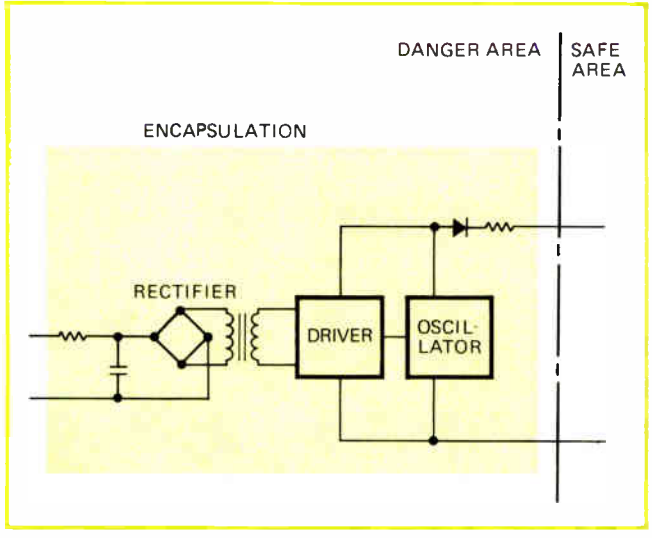
In some instances, a traditional design can be modified to lower its operating-power requirements, making it intrinsically safe.

For example, solenoid devices normally operate at several watts. But the energy needed to start the armature moving is considerably greater than that needed to hold it in position. So if a solenoid device has a low enough holding current, it can be operated from an intrinsically safe source provided there is a means to trigger the switching action with a low-energy pulse. One possible technique is to use a permanent magnet as the latch to hold the armature in position.

Figure 3 shows a practical means of operating a magnetically latched solenoid valve from a barrier. In it,



3. Low-level solenoid operator. Intrinsic safety may demand change in component design. This encapsulated circuit will operate a magnetically latched solenoid valve from a low-level signal.



4. High-voltage operation. Encapsulated inverter circuit produces high voltages at intrinsically safe power levels to operate devices such as ionization detectors.

capacitor C_1 charges to the voltage limit of the barrier. Zener diode Z_1 then causes thyristor R_1 to discharge the capacitor through the coil. The resulting surge moves the valve to the on position, where it is latched by a permanent magnet. The discharge of C_1 also charges capacitor C_2 in series with the coil. When the solenoid valve control lines are short-circuited, transistor Q_1 is turned on. Thyristor T_2 then causes capacitor C_2 to discharge through the coil, opposing the latching magnet and causing the valve to switch back to the off position under spring action.

This configuration is especially useful when the valve must remain on if power fails. The power supplied to the unit only determines the frequency of operation, and this particular valve design has been operated from solar cells.

High voltages or currents

In other cases, it is unavoidable that certain measuring devices used in hazardous environments have high voltages or currents. For example, smoke, fire, and radiation-detectors working on the ionization principle require high-voltage supplies. If connecting wires are more than a few hundred yards long, cable capacitance would hold sufficient energy to produce an explosive spark.

One solution is to transmit energy through the cable at low voltages, and obtain high voltage at the sensor by means of an inverter. The unit shown in Fig. 4 operates in this manner. The inverter is designed to fit into the base of a smoke-detector so that the high-voltage leads are only a few inches long. When the sensor is exposed to smoke, its resistance decreases and the current from the barrier rises. At the same time, the current drawn at the safe side of the barrier increases and will activate an alarm that is electrically isolated from the hazardous area. A similar principle comes into play where high current is required at low voltage, as in a hot-wire gas detector. The main difference in implementation is the ratio of the transformer windings. □

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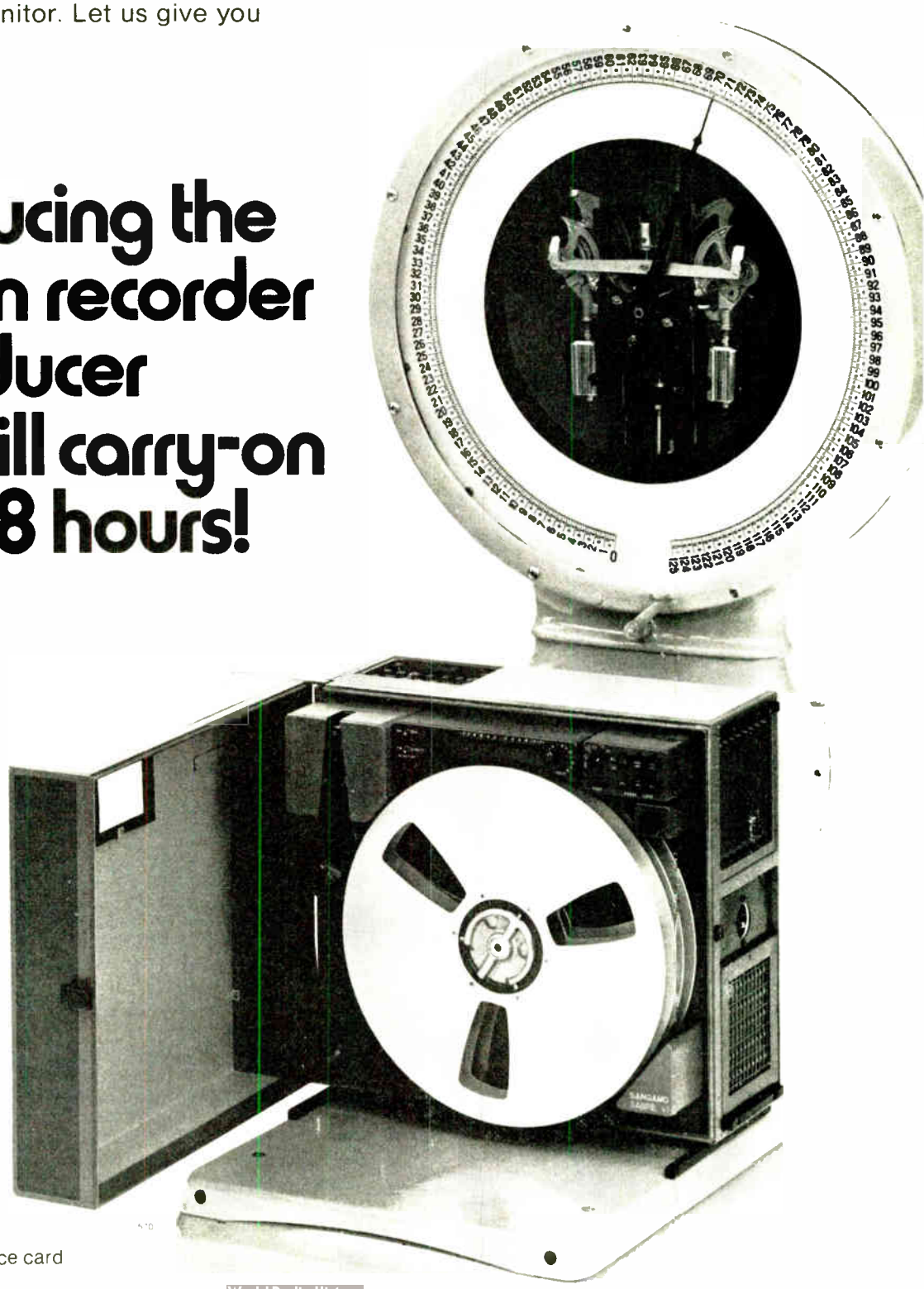


Circle 95 on reader service card

Compensating the 555 timer for capacitance variations

by Kenneth Lickel
Philips Medical Systems Inc., Shelton, Conn.

With the 555 timer, any error in the value of the external timing capacitor causes a corresponding error in the duration of the output pulse. If several fixed timing resistors are used to permit selection of various output pulse widths, it may be desirable to compensate for the capacitor variation instead of changing each timing resistor. The circuit below allows correction for capacitor tolerance variations up to ±12.5% by adjustment of a single variable resistor.

The output pulse width, t, is given by the time required for the timing capacitor to rise to the value of the control voltage, V_{CON}. That relationship can be shown by the equation:

$$V_{CON} = V_{CC}(1 - e^{-t/RC})$$

or

$$t = -RC\ ln(1 - V_{CON}/V_{CC})$$

This equation shows that the pulse duration depends on the ratio of V_{CON} to supply voltage V_{CC} for given values of timing resistor R and timing capacitor C.

In the technique used to compensate for error in the timing-capacitor value, the ratio V_{CON}/V_{CC} is varied with an external resistance that shunts the 10-kilohm resistance inside the timer. As the circuit diagram shows, this external resistance consists of a 200-kilohm variable resistor R_A in series with a 17.8-kilohm fixed resistor R_B. The ratio V_{CON}/V_{CC} determined by the voltage-dividing network is:

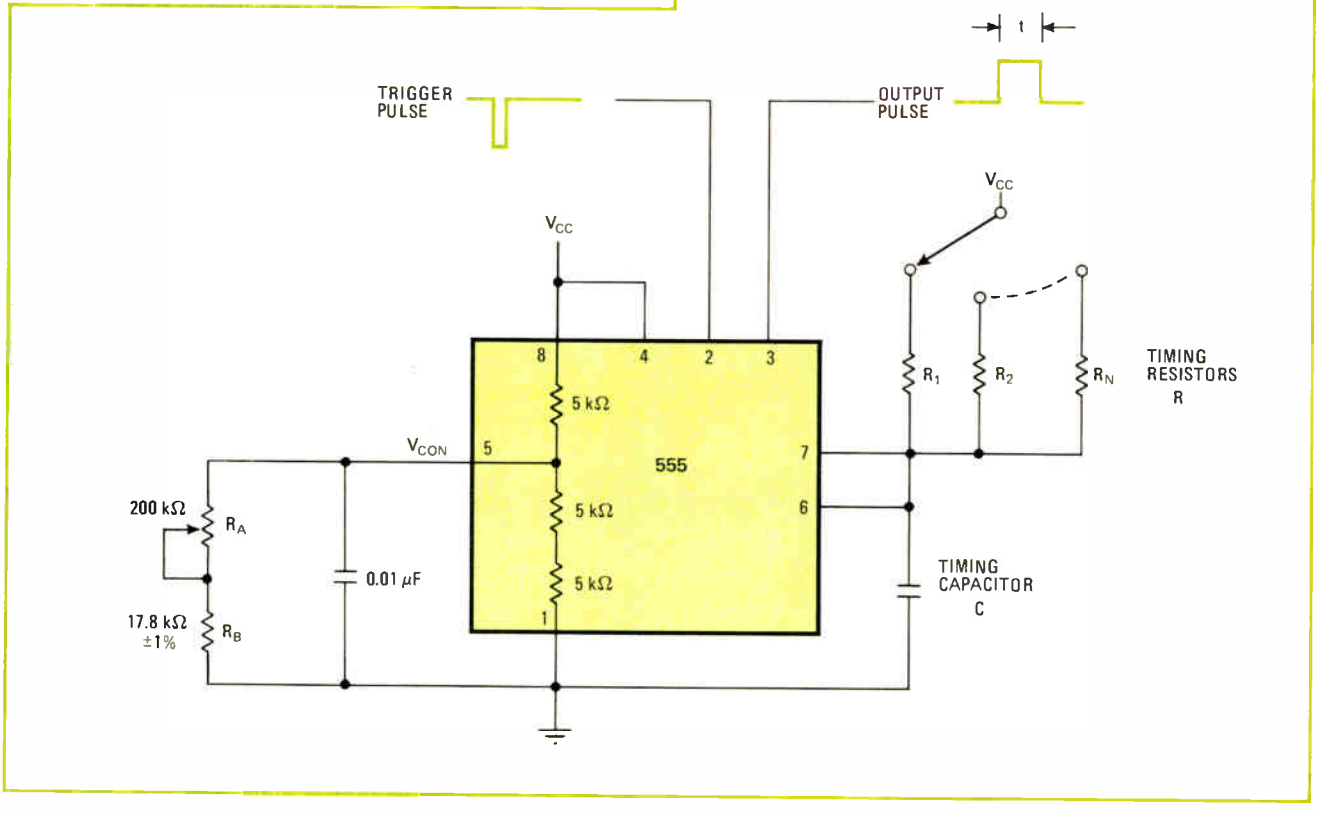
$$V_{CON}/V_{CC} = R_p/(R_p + 5\ k\Omega)$$

where

$$R_p = (10\ k\Omega)(R_A + R_B)/(10\ k\Omega + R_A + R_B)$$

If R_A is set at its minimum value (zero):

Timer. External variable resistance alters control voltage of 555 timer to compensate for variations in timing capacitor.



$R_p = 6.4\ k\Omega$

and

$V_{CON}/V_{CC} = 0.56$

Therefore, the pulse duration is

$t_{min} = 0.83\ RC$

Similarly, if R_A is set at its maximum value (200 kilohms), the pulse duration is:

$t_{max} = 1.07\ RC$

Thus the variation of R_A can vary the output-pulse width by ± 12.5% about a nominal value of (0.83 + 1.07)RC/2. For the circuit shown, therefore, the nominal width of the output pulse is:

$t_{nom} = 0.95\ RC$

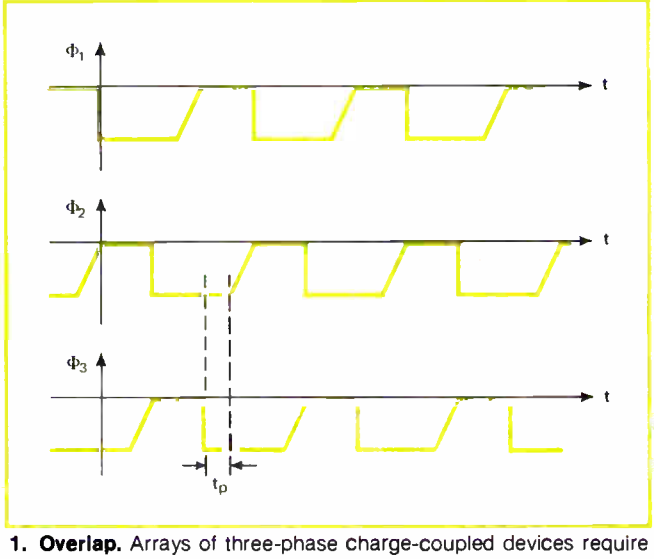
If values for the timing resistors and capacitor are calculated from this formula, then capacitor variations of ±12.5% can be compensated by adjustment of R_A. If wider tolerances are desired, R_B must be reduced; new values must then be calculated for R_p, V_{CON}/V_{CC}, t_{min}, t_{max}, and t_{nom}. □

Generating overlapped clock phases for CCD array

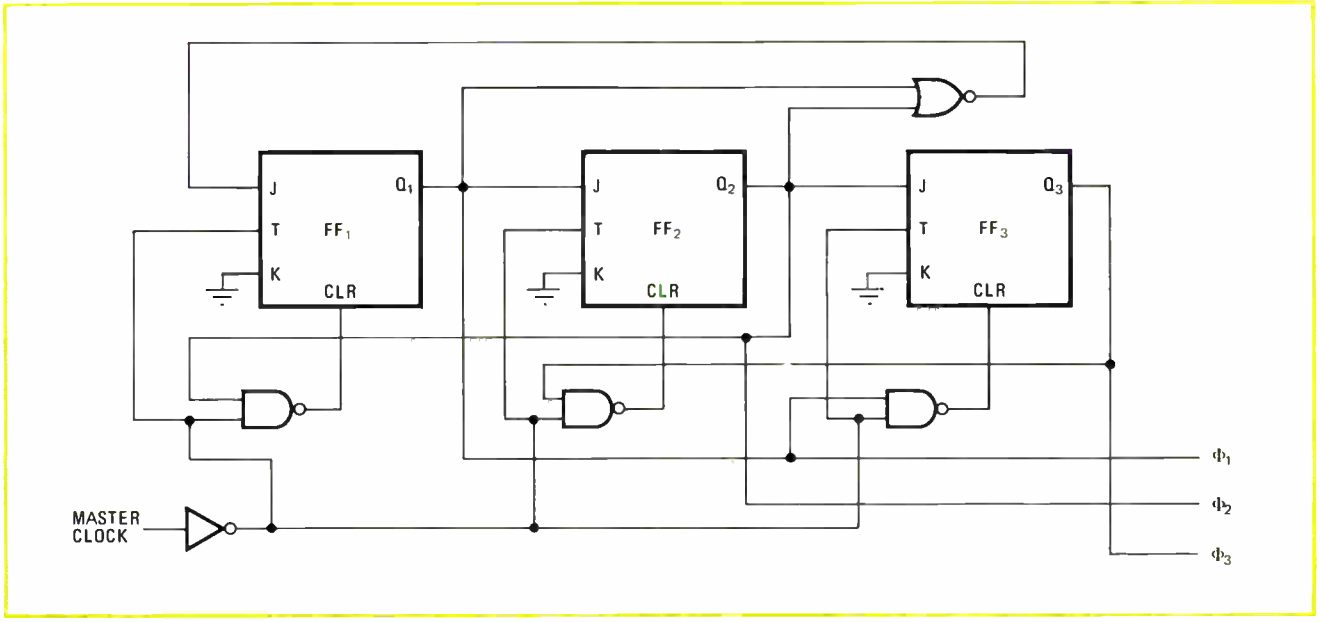
by Hans-Jörg Pfleiderer and K. Knauer,
Siemens AG, Munich, Germany

Arrays of three-phase charge-coupled devices require overlapped clock pulses (Fig. 1) for satisfactory operation. To generate these overlapped pulses, Fairchild Semiconductor, which produces the arrays commercially, suggests a rather complicated logic circuit in a report that it circulates.

But a less complicated circuit (Fig. 2) can also generate the train of overlapped pulses, as shown in the timing chart (Fig. 3). When the master clock pulse goes high, J-K flip-flop FF_1 turns on only if the outputs Q_1 and Q_2 are both low. With FF_1 on, Q_1 rises, opening the gate so that the rise of the next master clock pulse turns on FF_2, without affecting FF_1. However, with Q_2 up,



1. Overlap. Arrays of three-phase charge-coupled devices require overlapping pulse trains for proper operation. The logic to produce these trains does not have to be complicated—it need not involve more than three flip-flops and a few gates.



2. Pulse-train generator. When the master clock's pulse rises, one flip-flop turns on, gated by the state of the flip-flop before it. When the pulse falls, the preceding flip-flop turns off, this time gated by the state of the following flip-flop.

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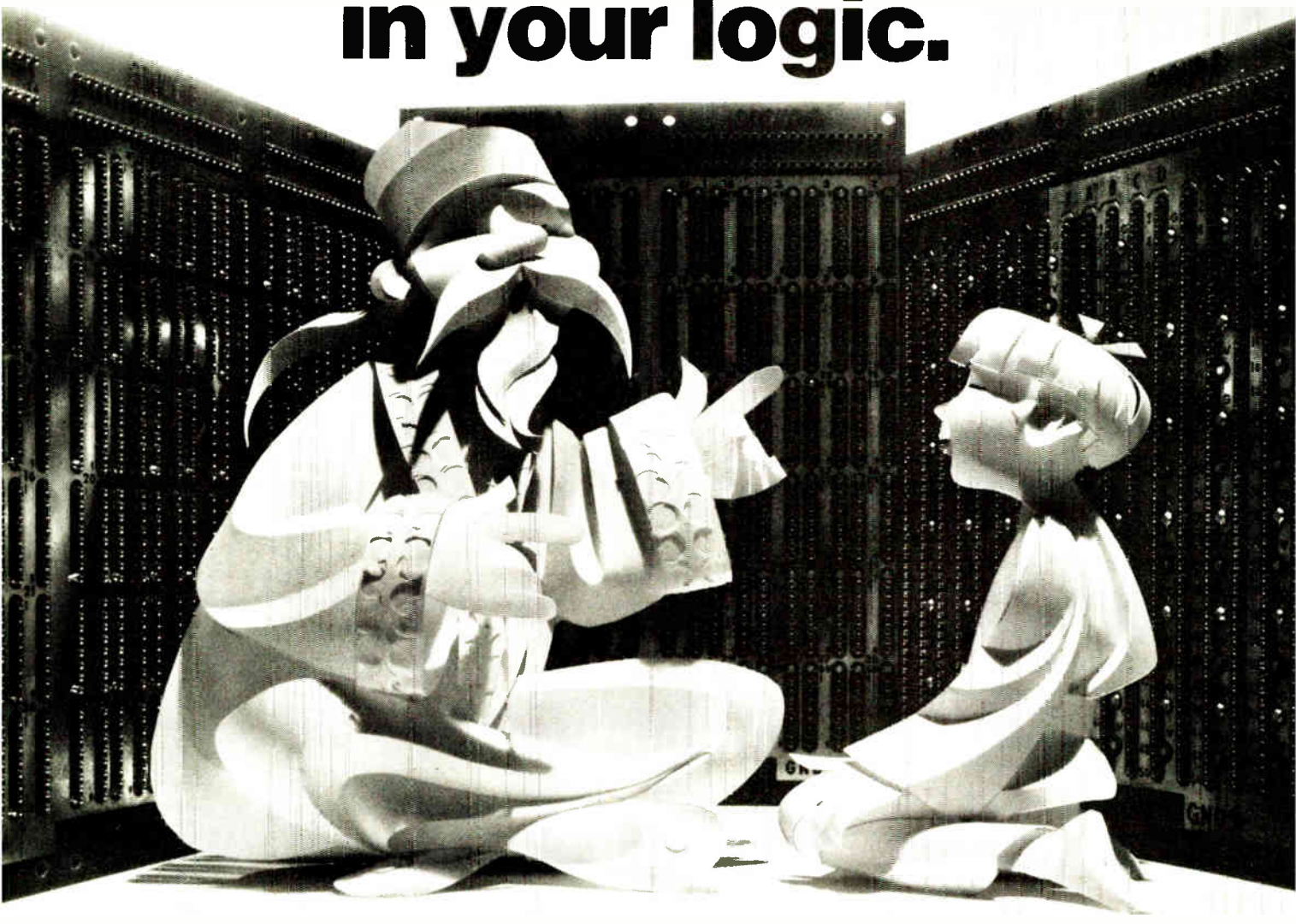

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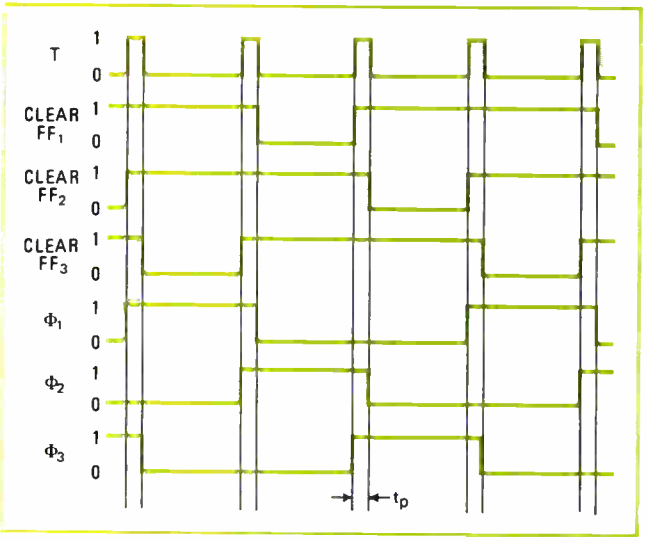
the fall of the master clock's pulse clears FF_1 via the CLR input of FF_1.

This approach—setting the output of each flip-flop high with the J input, provided the preceding flip-flop is already on, and setting it low with the clear input when the following flip-flop is on—is used for each of the three flip-flops. The width of the overlap is approximately equal to the width of the master clock's pulse, and the frequency of each waveform is one third that of the master clock's pulse. The circuit is self-correcting and also self-starting.

The same idea can also be used in driving the phase voltages for a two-phase CCD. □



3. Pulse timing. As the three flip-flops turn on and off (second, third, and fourth traces from top), their outputs overlap by the width of the clock pulse, minus circuit delays. The frequency of each waveform is one third that of the master clock's pulse.

Overvoltage indicator can be added to C-MOS IC tester

by Rajni B. Shah
Rohde & Schwarz, Fairfield, N.J.

A warning light that signals the presence of an overvoltage can be added to the features described in "In-circuit IC tester checks TTL and C-MOS" [*Electronics*, May 30, 1974, p. 120]. A light-emitting diode glows if the IC under test has any pin voltage greater than 18 V. The warning circuit, like the rest of the test circuit, draws its power from the IC being checked. As described here, it can operate at overvoltages as high as 30 V.

The indicator circuitry, shown below, is connected to the tester described previously. Warning LED D_1 is shunted by Q_1, which is normally held in conduction by the potential applied to its base through R_2. Q_2 is normally inhibited by the base connection through R_3. If the voltage at any IC pin exceeds 18 V, however, zener diode D_2 breaks down, and Q_2 starts to conduct. Conduction in Q_2 pulls the base of Q_1 up to turn off Q_1. The voltage drop across Q_1 then is sufficient to light up LED D_1, indicating the overvoltage. □

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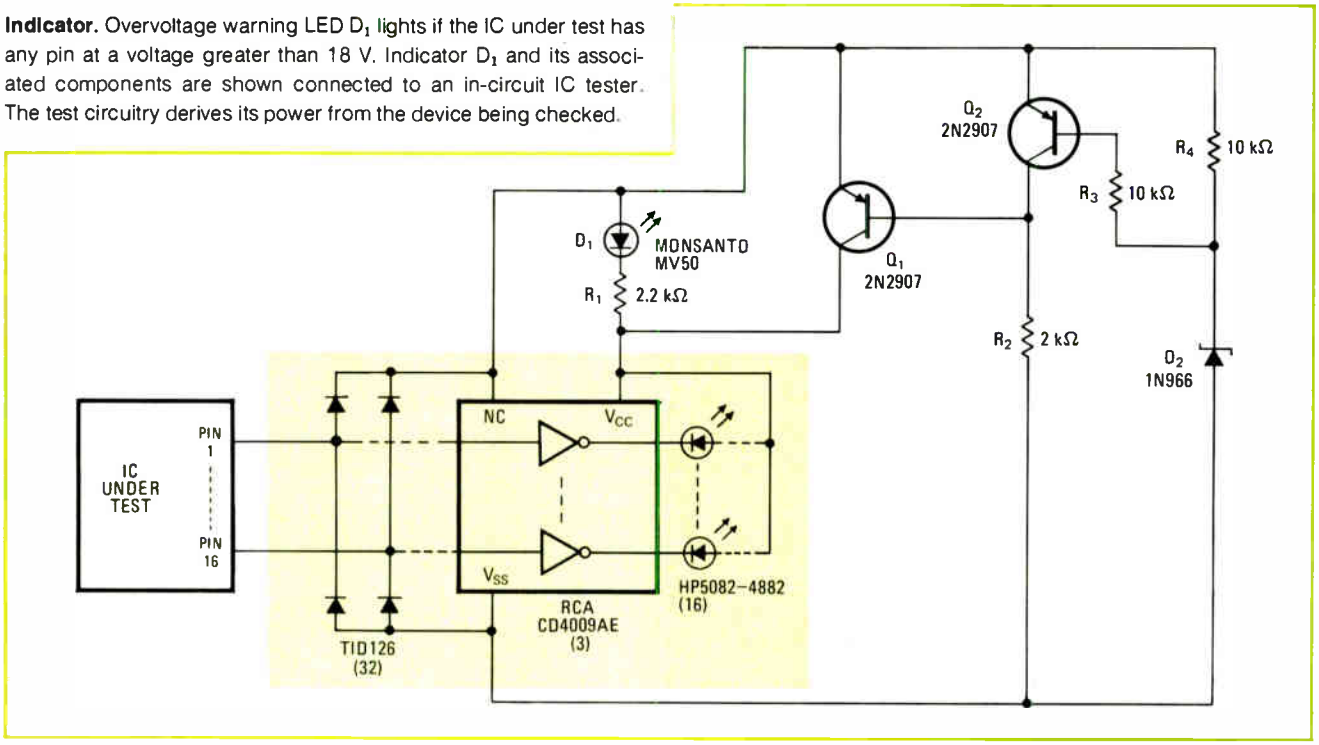
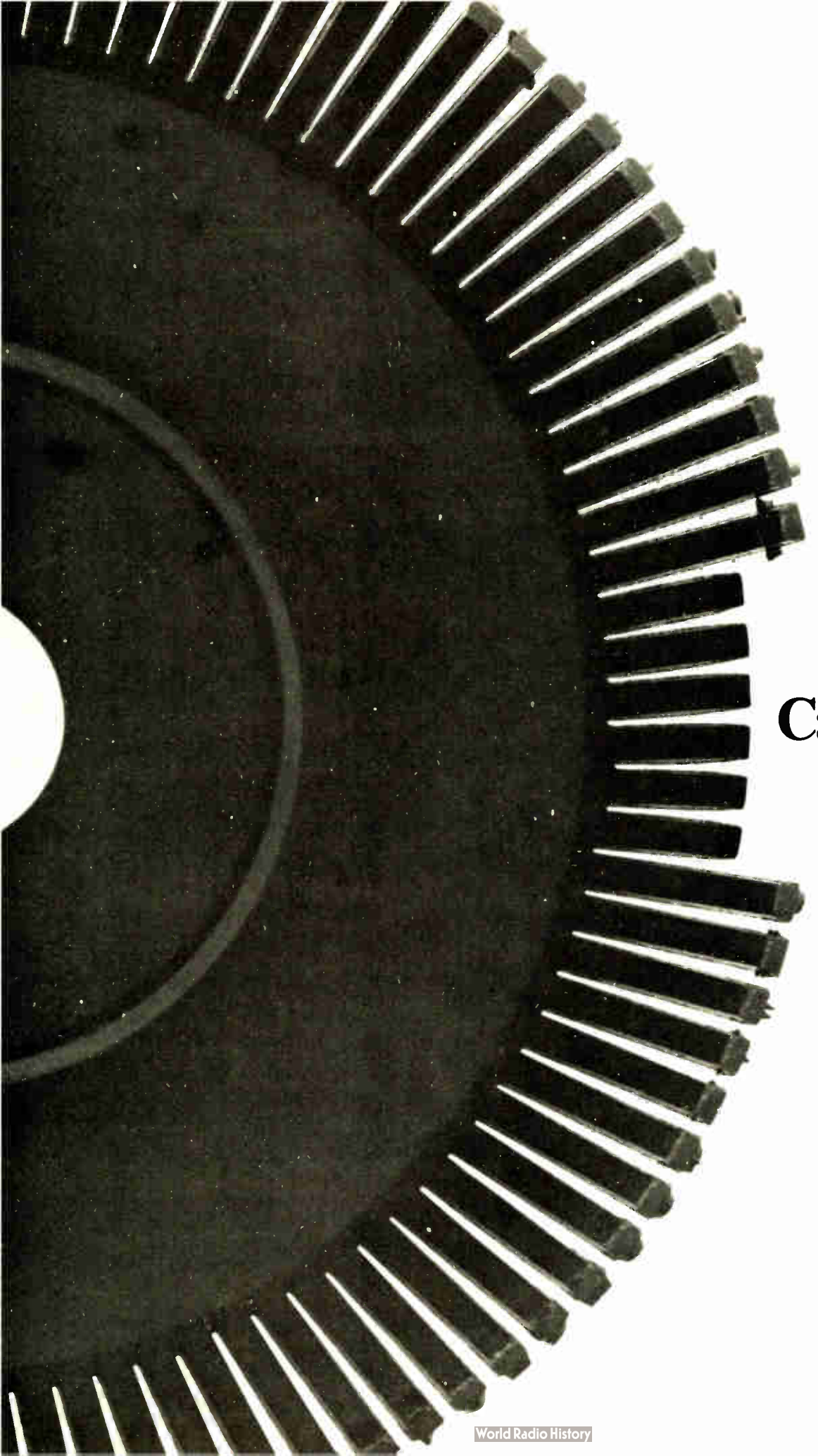


Indicator. Overvoltage warning LED D_1 lights if the IC under test has any pin at a voltage greater than 18 V. Indicator D_1 and its associated components are shown connected to an in-circuit IC tester. The test circuitry derives its power from the device being checked.



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Designing microprocessors with standard-logic devices, Part 2

In comparison with TTL random-logic systems, many fewer devices are needed to build high-speed standard-logic processors; but even fewer are necessary when the particular application requires less than optimum performance

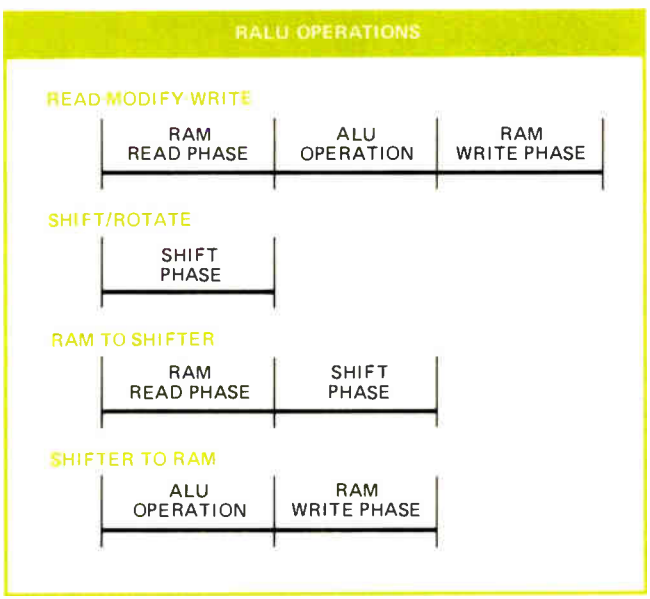
by Robert Jaeger, *Signetics Corp., Sunnyvale, Calif.* *

☐ Processors built with standard high-speed logic take a middle course between MOS microprocessors and random-logic TTL designs—they're faster and more flexible than MOS chips and use many fewer ICs than the random-logic systems. For different applications, they can be optimized in several different ways, as Part 2 of this two-part article describes. (Part 1, which appeared in the last issue, discussed their basic elements: a register/arithmetic/logic unit or RALU, a control memory, and input/output circuitry.)

Generally, the number of devices needed to build a standard-logic processor can be reduced whenever the acceptable level of performance is less than the highest attainable. When speed is not crucial, for instance, the microinstruction format can be modified to reduce the number of read-only memories or programable ROMs required by the control memory. Different types of memory branching can also be used sometimes to reduce memory size and/or program length. The flexibility of the approach will be illustrated by two standard-logic processor designs.

* Now with MSI Data Corp., Santa Ana, Calif.

1. Monophase or polyphase. RALU operations typically require one or more steps to complete after a single microinstruction is received. More complex microinstructions can be executed faster with polyphase operation, but this often dictates additional decoding logic and more control inputs than with monophase.



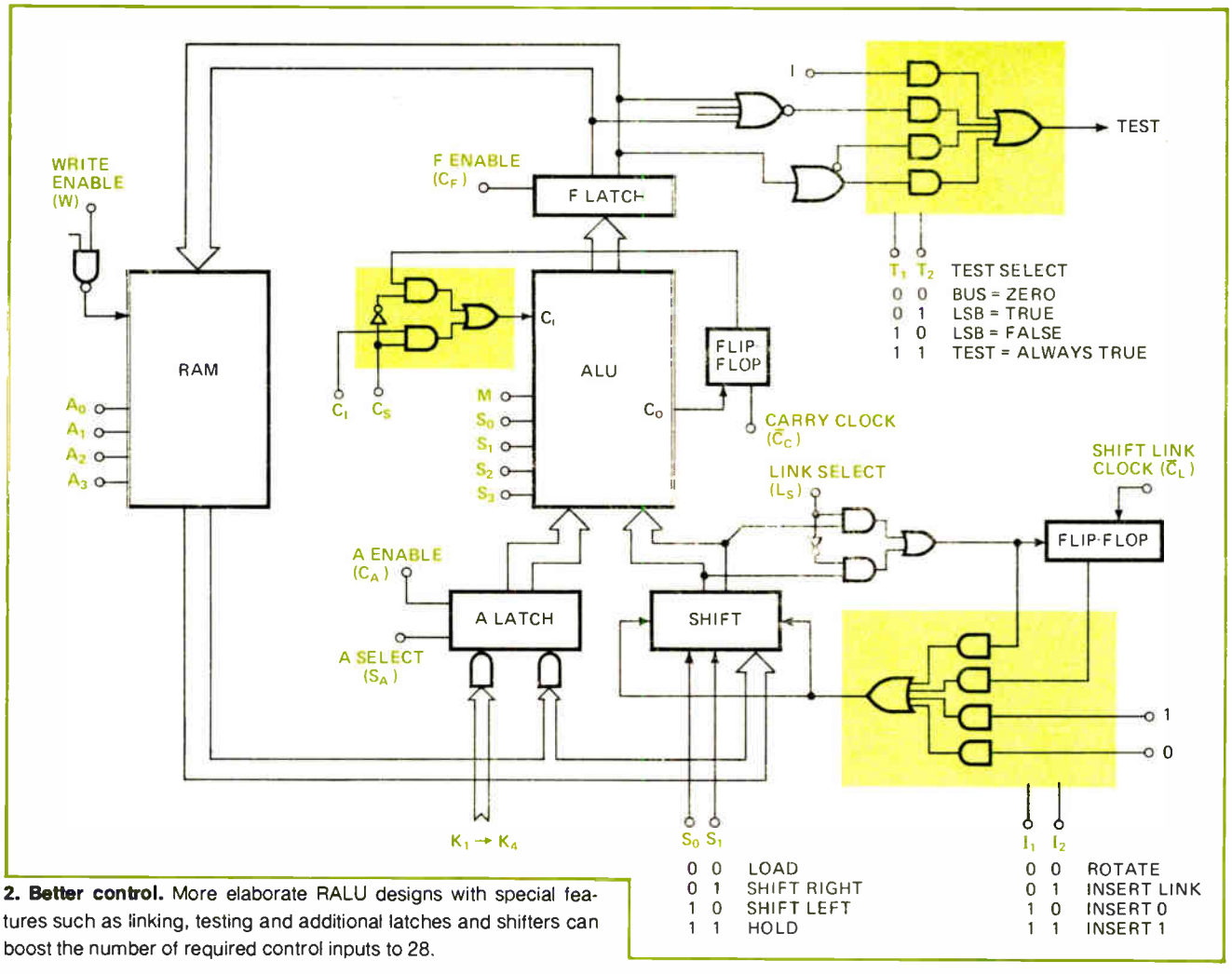
The role of the microinstruction

A single microinstruction from the control memory may cause the RALU to perform one operation (called monophase) or more than one (polyphase), and the designer should choose carefully which best suits his system. Figure 1 shows four different kinds of RALU operations, which require one, two, or three phases.

The advantage of polyphase RALU operations is that complex microinstructions, such as "read-modify-write," are executed by the RALU in the shortest possible time. Once the microinstruction has been accessed, the RALU needs no further reference to the control memory. Execution time is limited only by the propagation delays of the RALU logic elements.

TABLE 1: POLYPHASE VERSUS MONOPHASE CONTROL INPUTS

	Number of RALU control inputs used
Polyphase microinstructions	
Increment RAM word	17
Branch if K is equal to contents of shifter	17
Rotate shifter and branch if LSB = 0	18
Rotate shifter and load result into RAM	21
Monophase microinstructions	
Transfer RAM word to A latch	7
Transfer RAM word to shifter	7
ALU operation (A, B to F latch)	10
Shifter operation	6
Test and branch	7
Load 4-bit K input to A latch	6



2. Better control. More elaborate RALU designs with special features such as linking, testing and additional latches and shifters can boost the number of required control inputs to 28.

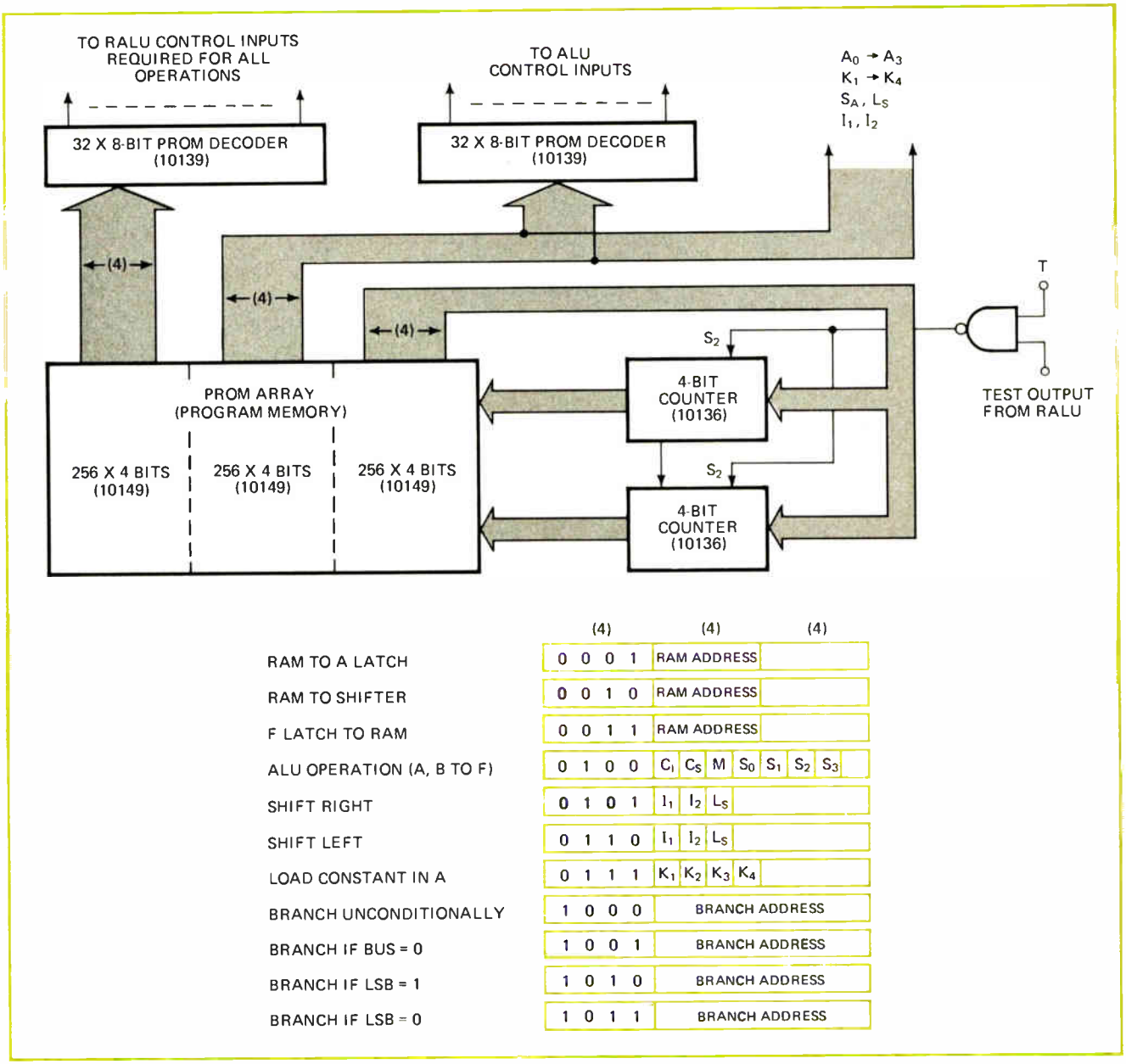
Another advantage is that a sequence of RALU operations can be specified by a single microinstruction. This provides a kind of instruction encoding, which reduces the number of instructions needed in the control memory to perform a given system function.

There are several disadvantages, however, which argue against the use of polyphase operations, unless the system needs the speed. First, if a fixed-phase sequence is used for each microinstruction, the simpler ones will take as long to execute as the more complex ones. If a variable-phase technique is employed, additional decoding logic is required to select the phases to be used in executing each microinstruction. Second, a wide microinstruction is required from the control memory to provide control signals to all the RALU control inputs. This precludes the possibility of encoding the microinstruction to reduce its width, and also increases the required size of the control memory.

Table 1 shows some possible monophase and polyphase microinstructions, together with the number of RALU control inputs that must be specified in order to execute them. The RALU in Fig. 2 has 28 control inputs and a highly flexible 38-bit microinstruction format. However, most microinstructions, particularly if they specify a monophase RALU operation, would not require all 38 bits for every operation, and restricting microinstruction capabilities can yield significant savings in the size of the control memory, and therefore its total cost.

Table 2 shows five types of operations that can be performed on the RALU and the number of bits in the microinstruction required for each. Some of the control signals must have a defined logic state for every microinstruction, since it is important to ensure that the performance of a microinstruction on part of the RALU does not affect other logic states in the RALU. That is, a shift operation should not disturb the contents, either of the A latch or the ALU's output latch, and a memory operation should not disturb the contents of the link flip-flops. For this reason, some of the control signals must have a defined logic state for every microinstruction. The logic state of the remainder of the signals, however, is significant only when performing an operation on that part of the RALU affected by a specific microinstruction.

Consequently, of the 38 control signals shown in Table 2, only eight must have defined logic states for all microinstructions. Of the remaining 30 control signals, no more than 10 are needed for any specific type of operation. By restricting the number of RALU operations that can be performed in response to a single microinstruction from the control memory, the micro-



	(4)	(4)	(4)
RAM TO A LATCH	0 0 0 1	RAM ADDRESS	
RAM TO SHIFTER	0 0 1 0	RAM ADDRESS	
F LATCH TO RAM	0 0 1 1	RAM ADDRESS	
ALU OPERATION (A, B TO F)	0 1 0 0	C_I C_S M S_0 S_1 S_2 S_3	
SHIFT RIGHT	0 1 0 1	I_1 I_2 L_S	
SHIFT LEFT	0 1 1 0	I_1 I_2 L_S	
LOAD CONSTANT IN A	0 1 1 1	K_1 K_2 K_3 K_4	
BRANCH UNCONDITIONALLY	1 0 0 0	BRANCH ADDRESS	
BRANCH IF BUS = 0	1 0 0 1	BRANCH ADDRESS	
BRANCH IF LSB = 1	1 0 1 0	BRANCH ADDRESS	
BRANCH IF LSB = 0	1 0 1 1	BRANCH ADDRESS	

3. Encoding. Microinstructions can be arranged in such a way as to minimize size of program memory. This control memory, which was built with ECL 10K components, uses microinstructions with 12-bit word lengths, examples of which are shown at right.

instructions need never be wider than 18 bits—and the number of ROMs or PROMs needed to store those microinstructions can be reduced.

Further reductions in the width of the microinstructions can be achieved by encoding the bits they contain. Basically, the control memory provides the RALU with control signals that specify an operation, and with a sequence of microinstructions that tell the RALU to perform a more complex, system-level function.

Encoded microinstructions

These two functions can be separated, with one part of the control memory providing the microinstruction-decoding function, and the other part providing the sequencing function. The bit positions in the "sequence" or "program" memory, then, do not have to bear any direct relationship to a specific RALU control input, since this function is left to the instruction decoder. The microinstructions to be used in the processor can be designed to minimize the size of the program memory and provide the most efficient utilization of the memory bits.

Figure 3 shows a control memory that has a 12-bit microinstruction. The 10139 is a 32-by-8-bit ECL PROM, used for decoding the microinstructions, and the 10149, organized 256 by 4 bits, is used as the program memory. A list of possible microinstructions that might be used with this design is also shown.

It's possible to encode a microinstruction in only 8 bits, but it is then extremely difficult to define instructions that reference memory (branching) or those that contain data or constants. Such instruction sets are possible, though, and one is being used in one of the newer MOS microprocessors. Writing useful programs with these instructions, however, is a tedious and time-con-

suming task. One solution is to use "double-byte" instructions, but that requires additional instruction-decoding logic and therefore adds to the device count. (A double-byte instruction consists of two successive 8-bit words, each of which is half of a 16-bit instruction. The additional logic required is an 8-bit buffer register on the output of the memory for temporary storage of the first byte of the instruction, and a single flip-flop to hold the execution phase of the processor during more than one control-memory cycle. When 8 bits will be enough, a single-byte instruction is used.)

Memory branching

A key feature of a processor is the ability to modify its current sequence of instructions by branching to a different sequence of instructions in another part of the memory. The branching range and kinds of branches that can be performed will influence the ease of programing, size of the memory, and response time of the processor to external inputs.

Branch instructions can be either conditional or unconditional, and either direct (when the instruction contains the address of the next instruction) or indirect (when the instruction contains the address of a location in memory whose contents specify the address of the next instruction). Another kind of branch is an indexed branch. In this case, the address in the branch instruction is modified by adding to or subtracting from it the contents of one of the registers in the RALU. Branch instructions may contain any or all of these features.

Another kind of branch instruction is used for temporarily branching to another part of the memory. The current address is stored temporarily in a register or set of registers. Return to the current-instruction sequence is accomplished by another kind of instruction, which transfers the contents of the temporary register back to the memory-address register. This pair of instructions is useful for reducing the size of a program, since a common subroutine can be used by different parts of the program without having to be repeated.

A subroutine might also contain a branch-and-store instruction within it, which would require a second temporary storage register for saving the second return address. This set of temporary registers constitutes a return-address stack, which may be implemented either by using registers in the RALU or by storing the address in an external memory.

The usefulness of a return-address stack depends heavily on the particular processor application. A stack reduces memory size the most when the program repeatedly uses the same subroutines. But it also increases the program's execution time, since the branching instructions have to be added to the program to reduce the memory requirements.

Central-processing units

The central-processing unit in a computer system is a special application. The function of the CPU is to provide an interface to the main memory, which, by implication, is larger and slower than the processor's control memory. The processor receives instructions from the main memory and transfers data to and from it. The

Steps in designing a processor

The design of a processor consists of two parts: the hardware or logic design, and the programing or software design. But before either can be started, the system's operating requirements must be established.

The best way to do this is with a flowchart, which must be accurate and include every operation that will be required of the system. This flowchart describes the system's sequential operations (in this case in terms of system-level operations rather than individual microinstructions) and the decision points (which in this case represent branch instructions). The chart should also include some provision for system initialization and take into account system failure modes.

The next step is to establish the critical timing paths in the flowchart—that is, to define those functions, or groups of functions, that must be completed within some maximum allowable period of time. This is important not only for the selection of a logic family but also to establish whether monophase or specialized polyphase insructions will be required. The flowchart will also show those places, particularly in I/O operations, where a specialized instruction could be used to reduce the control memory's requirements.

At this point an instruction set can be defined that will allow the processor to meet the system's performance requirements and make efficient use of the bits in the control memory. Once the instruction set is defined, the hardware and software can be designed simultaneously.

The hardware design consists of implementing, not the required system functions as in the case of random-logic designs, but the logic necessary for the processor to execute those instructions in the defined instruction set in the time allotted. The required system-level functions are designed in the software or control-memory program. Software design consists of using the defined instruction set to implement the operations specified by the system flowchart.

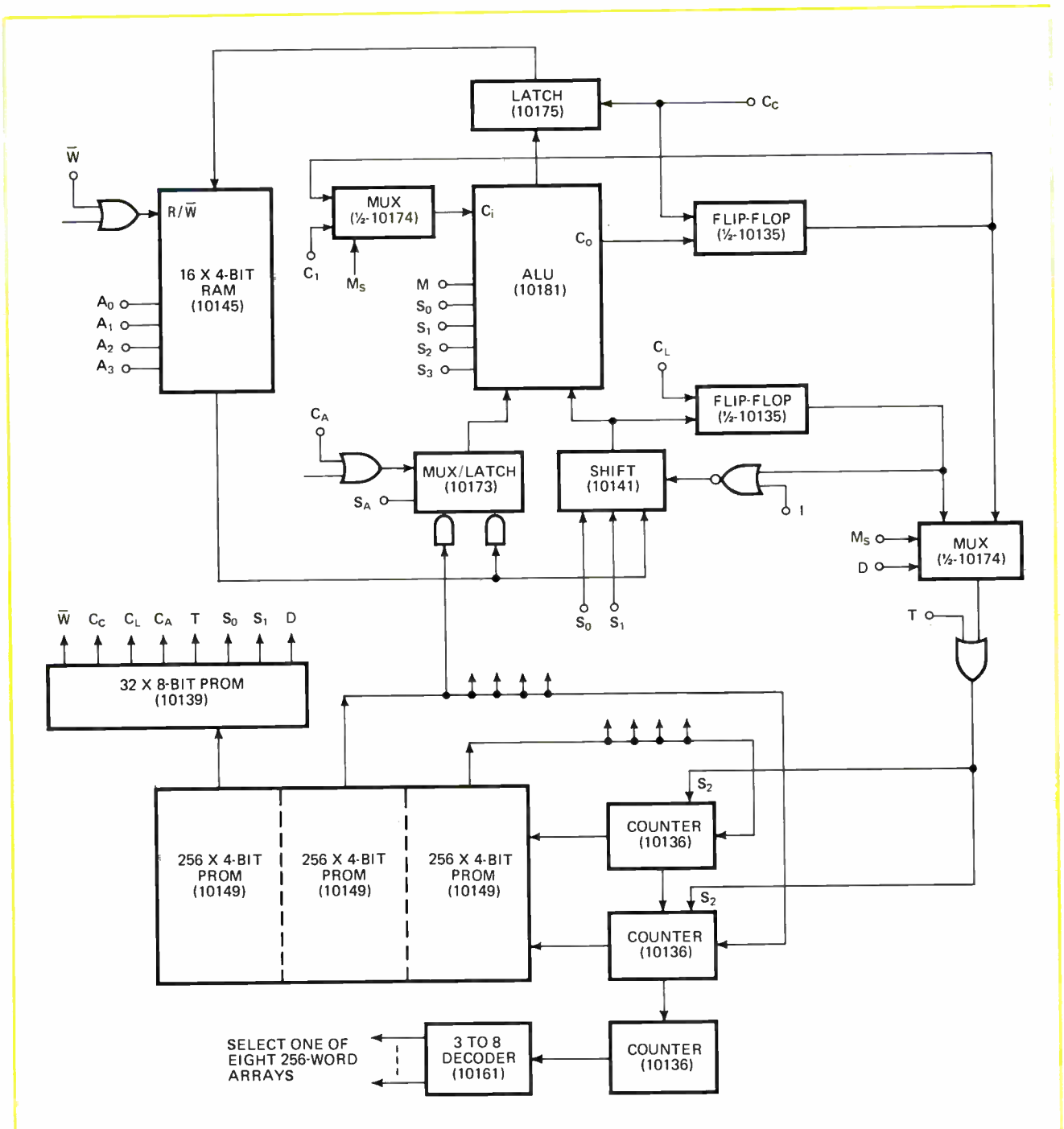
TABLE 2: MICROINSTRUCTION BITS REQUIRED FOR CONTROL

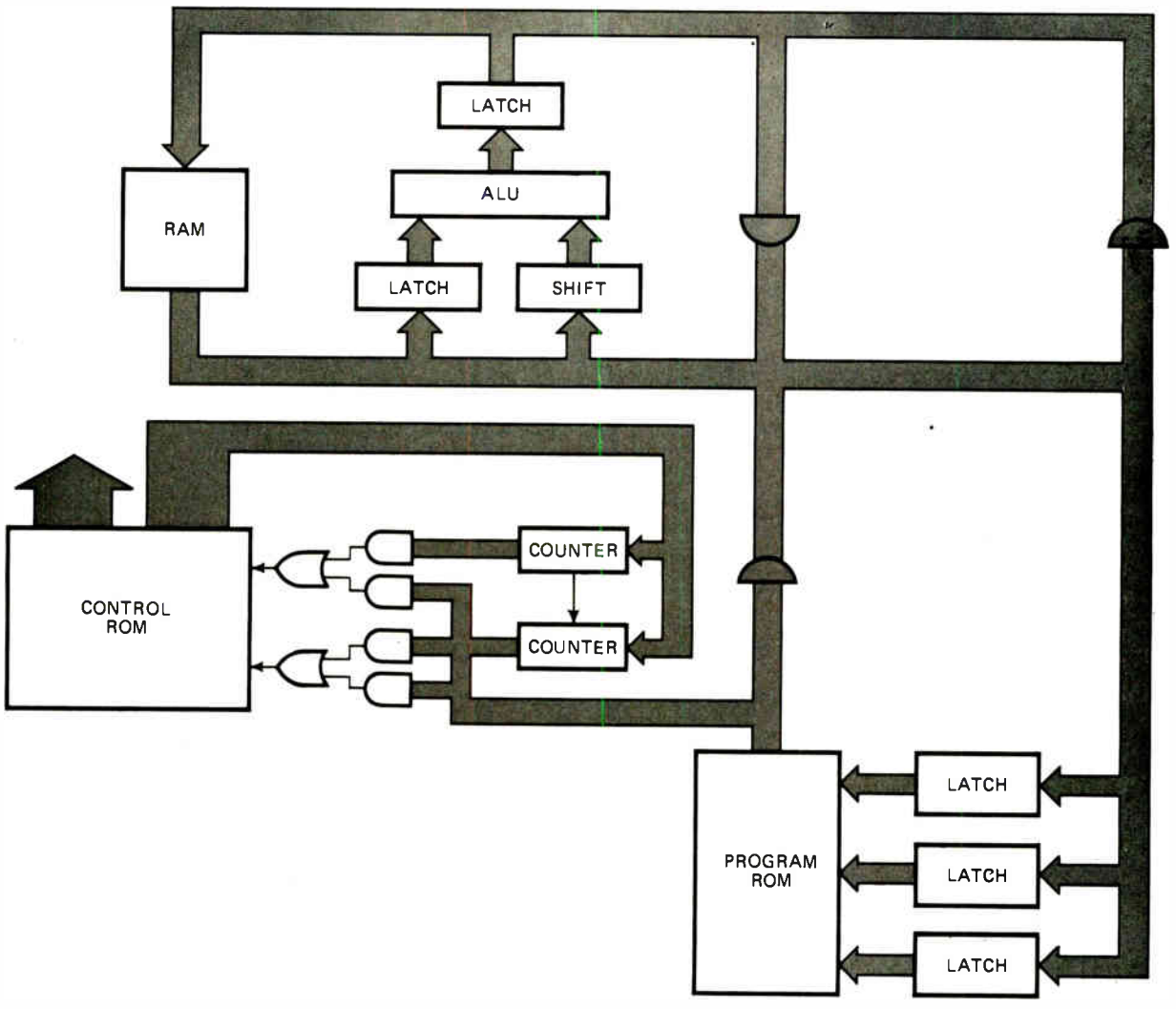
RALU control inputs		Number of bits used per microinstruction					
		All	RAM	ALU	Test and branch	Shift	$K_1 \rightarrow K_4$ to A latch
RAM	W	1					
	A_0, A_1, A_2, A_3		4				
A latch	C_A	1					
	S_A		1				1
Shift	S_0, S_1	2					
	I_1, I_2					2	
	L_S					1	
	C_L	1					
ALU	$C_i, C_S, M, S_0, S_1, S_2, S_3$			7			
	C_0	1					
	C_F	1					
	T_1, T_2				2		
	Branch address				8		
	K_1, K_2, K_3, K_4						4
	Test enable	1					
	Total	8	5	7	10	3	5

number of instructions can be quite large—usually more than 100—and they specify operations to be performed on data in the registers, as well as data transfers between the memory and peripheral devices. In this situation, the main memory can be treated as another external interface.

The processor sets up the main-memory address either by incrementing a number used as the program counter or by specifying the address of a main-memory location for a data transfer. The main-memory address may be formed by adding or subtracting the contents of a register from memory data (indexed addressing), by using memory data as address pointers (indirect addressing), or by using memory data directly as the next memory address (immediate addressing). It is the function of the processor to interpret the instructions from the main memory and to perform the sequence of operations on the RALU and interfaces specified by it. As the first step in the processing of a main-memory instruction, the processor may sense the state of an input line

4. Little leaguer. This 4-bit emitter-coupled-logic processor requires only 13 devices over and above a read-only-memory/programable ROM array. Multiple-byte instruction capability can be added with more logic.





5. Big leaguer. More complex design forms a central processing unit in which the control memory performs a sequence of microinstructions in response to an instruction from the program ROM. This feature can be used to emulate another computer or an MOS microprocessor.

to determine if another operation should be performed first. This is the "interrupt" feature that is found in most computers.

Examples

Figure 4 shows a small 4-bit ECL processor that uses only 13 devices plus an array of 256-by-4-bit ROMs or PROMs. Either the Motorola 10150 or the Signetics 10149 can be used for the ROM/PROM array. The 12-bit memory-address counter adds only five devices to the RALU. In either design, additional features may be added—more test functions, return-address registers, or multiple-byte-instruction capability—by using additional logic. For large ROM/PROM arrays, it may be advantageous to use one of the 4,096-bit TTL ROMs or PROMs, such as the Signetics 8205 or 82S115. ECL interface devices like the 10124 and 10125 will convert the TTL-logic levels to the ECL levels and vice versa.

An 8-bit design with all the features required of a CPU is shown in Fig. 5. Here, an 8-bit instruction on the input points to a memory location in the ROM/PROM array. This location contains a branch instruction, which presets the 8-bit address counter to the starting address of a subroutine, which processes the instruction. The 16-bit memory address register can be loaded from the outputs of the RAM, ALU, control memory or main memory. An arbitrary set of instructions may be provided in the control-memory program.

This results in a flexible design that could be used either to process specialized instructions or to emulate another computer (or MOS microprocessor). Not only are the individual bits in the instruction divorced from the RALU control inputs, but the RALU RAM locations themselves, selected by the control-memory program, are transparent to the main-memory instructions. Another interesting feature of this design is that a 4-bit RALU could be used, yet, to the main memory, the processor could appear to be an 8-, 16-, or 32-bit device. The design can also accommodate multiple-byte instructions of any desired length. □

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Each user is free to write programs in FORTRAN, BASIC, Macro Assembler and Micro Assembler languages. So they can fit the language to the problem instead of the other way around. In fact, problems can be divided into subtasks and each written in the language best suited to the task. For added convenience, programs written in one language can call subroutines written in other languages. And to wrap everything up, all Prime programming languages used the same file system so that any program, written in any language can access any data base without any modification or reprogramming.

A Multifunction System.

A virtual memory Prime 300 is like having up to 15 separate computers in one box. So there's a lot of computing muscle available to tackle just about any mix of applications. Users can develop real-time application software, execute batch command files, use the system as a sophisticated calculator via immediate-mode BASIC, handle data base management, even develop microprograms for the Prime 300's writeable control store or other microprogrammable devices.

Three Systems to Get You Started.

Prime has put together three starter systems, each with a different price/performance balance. If you buy them as packaged, you get a system complete with all necessary system software, one year maintenance policy and an attractive packaged system discount.

You can select a small system for up to four users built around a 300 with 64K byte main memory and 6M byte moving head disk for $44,000. Or a system for up to eight users we call "The Personal Archive System," that features four diskette units for loading and unloading individual user files, a 12M byte work disk and 300 processor with 128K byte memory, for only $68,000. For 15 users you can get a system with 256K byte main memory, 60M byte moving head disk, and 16-line asynchronous multiline controller for $110,000.

Virtually Unlimited Expansion.

Any of these starter systems can be easily and economically expanded. You can add main memory up to 512K bytes. Attach a total of eight 60 million byte disks, four 12 million byte disks and eight diskettes. Add multiple printers and tape drives. Mix terminal types and speeds. And support it all with exactly the same operating systems and language processors you started with.

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Calculator's parts are integrated on a single glass substrate

Thin-film methods are used to deposit electrodes on the substrate for a liquid-crystal display; thin-film wiring interconnects components, forms keyboard contacts; the chip is soldered on

by Atsushi Asada, *Business Machine division, Sharp Corp., Nara, Japan*

☐ Over the past few years, costs of manufacturing electronic calculators have been drastically reduced by technological improvements in design. Low-cost manufacture has brought calculator prices within range of large numbers of consumers, creating a mass market. And calculator makers are still finding ways to lower manufacturing costs even further.

Perhaps the greatest reductions in manufacturing costs have resulted from integration of the calculator functions on a single chip. This has led to a simple, low-cost assembly procedure: piecing together four major components—keyboard, integrated-circuit logic, power-supply unit, and display or printer.

However, little value is added by a manufacturer that simply assembles these parts. The maximum value is added by making and integrating all the necessary components in the same factory. The ultimate in cost-cutting could be achieved by building the calculator from raw materials as a single part in a single assembly process.

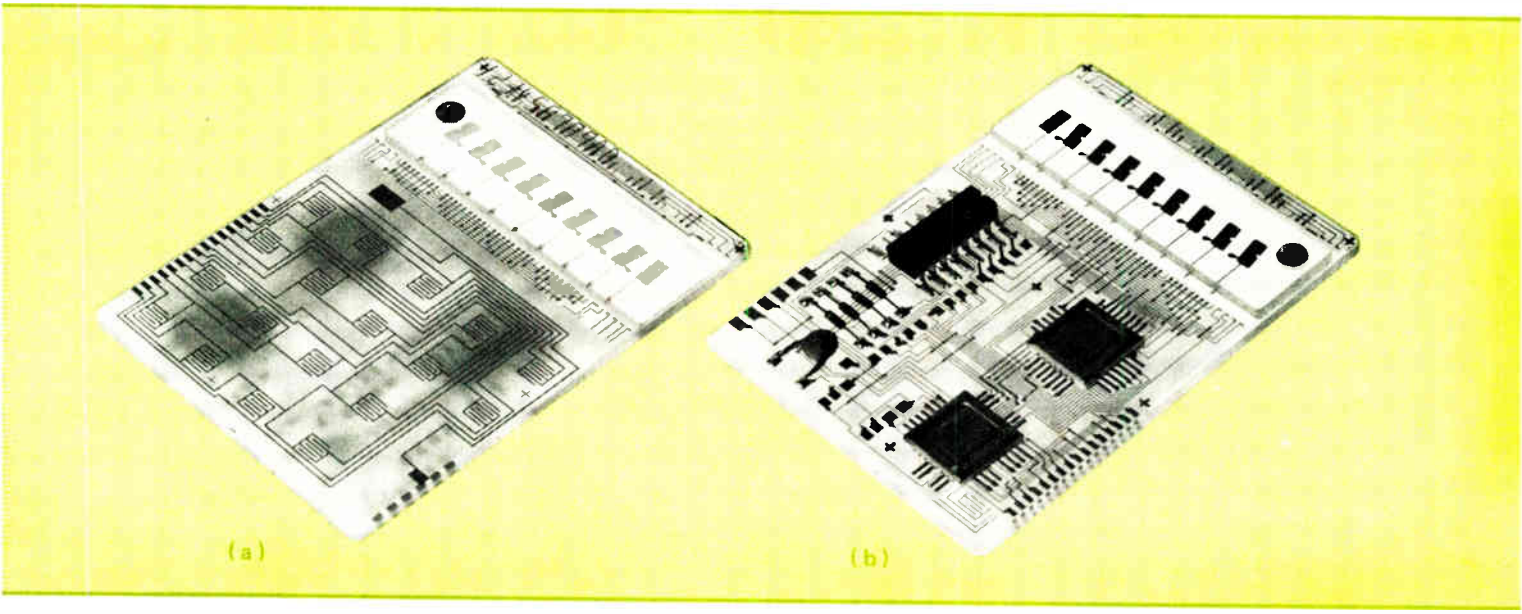
The calculator on a substrate (COS) developed by Sharp Corp. is a giant step toward complete system integration. A soda-glass substrate (Fig. 1) that replaces the conventional printed-circuit board not only holds the calculator chip, but also contains the keyboard contacts and serves as the front half of the glass package for the liquid-crystal display.

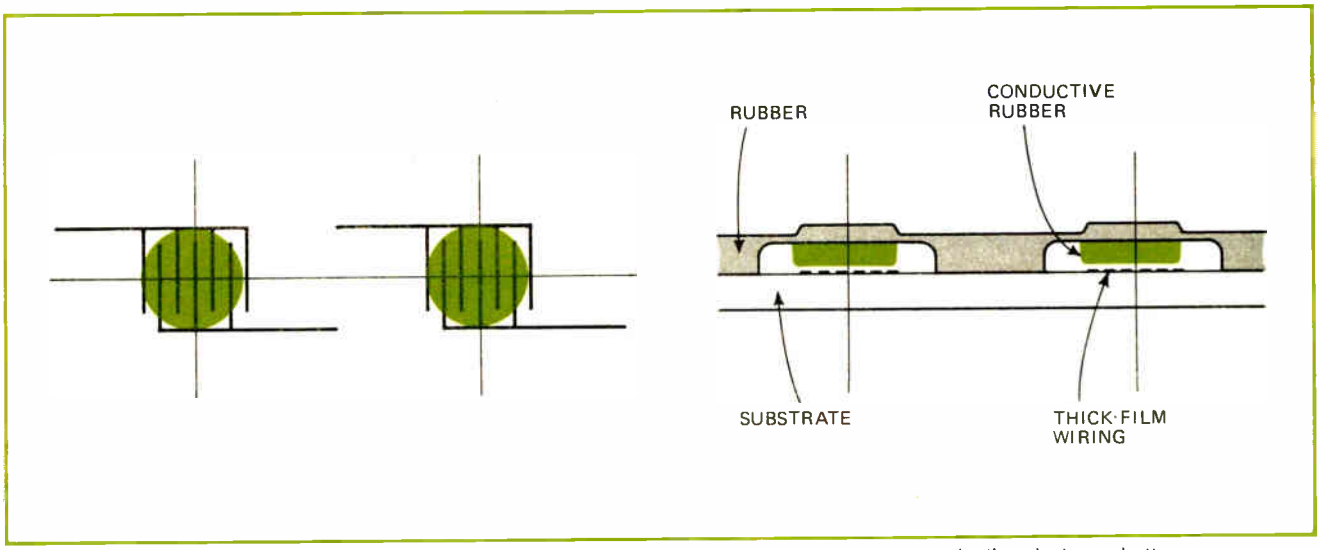
Logic circuits and a few discrete components are mounted on the substrate, and a power-supply subassembly is wired to it. The COS system eliminates as many intermediary components as possible. It also minimizes the amount of labor necessary for assembly, making the process engineering- and equipment-intensive.

To accomplish this, a thin-film process was developed for coating the electrodes of the liquid-crystal display onto the glass substrate, a method was devised for depositing the thick-film wiring that serves as keyswitch contacts and interconnection circuitry, and an effective method was found for bonding the LSI calculator chip to the glass substrate.

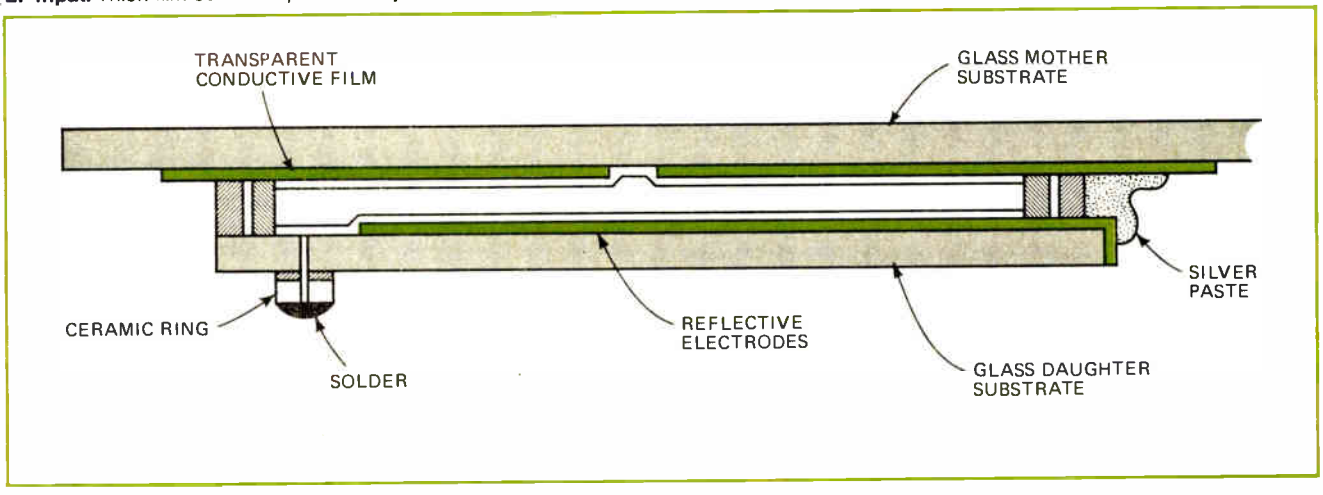
A liquid-crystal display that operates in the dynamic-scattering mode was chosen for its low power dissipation. This display had to be designed, not only for ef-

1. Calculator on a substrate. A soda-glass substrate carries keyswitch contacts and the front half of a liquid-crystal-display package on one side (a). The other side contains the rear half of the display and the interconnecting calculator circuitry (b).





2. Input. Thick-film comb-shaped circuitry forms the contacts for keyswitches. The actuators are conductive elastomer buttons.



3. LCD. Liquid-crystal material is vacuum-injected between the substrate and a second glass plate (a daughter substrate) to make the dynamic-scattering display. A ceramic disk is then soldered onto the hole, and the hole is sealed.

ficient calculator operation, but also to permit integration of the display packaging into the glass substrate.

Depositing thin film

The first manufacturing process is coating a transparent conductive film of indium oxide on the substrate to form electrodes for the display. An evaporation-in-oxygen method ensures uniform quality and minimizes danger from chlorine gas.

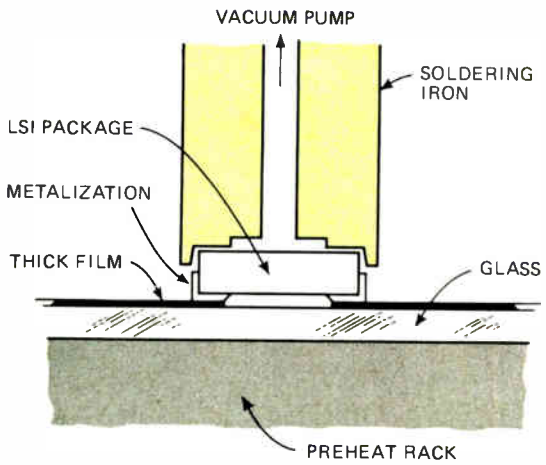
Spraying methods proved to be unsatisfactory for coating the substrate. Spraying solutions in fine foggy forms presents difficulties in achieving uniformity in the coating. A successful spraying method would require a control system that would be costly to design and maintain. In addition, the temperature on the glass substrate would have to be regulated to prevent white blotches, unevenness, and pinholes in the glass that would increase the electrical resistance of the deposited electrodes, as well as add to the opacity of the glass.

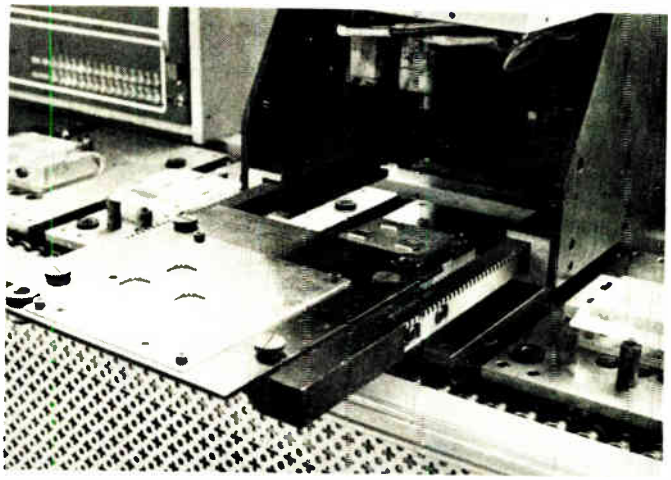
Another important fact to consider is that expensive pollution-prevention equipment would be required to eliminate chlorine gas that would be a by-product of a spraying system. This gas can cause pinholes in the substrate glass and erode parts of the furnace.

On the other hand, a vacuum-evaporation method can ensure uniform products by relatively simple control of the vacuum pressure and evaporation rate. Vacuum equipment can be automated by using leak valves and power-supply controls. If the glass substrate is initially clean and kept free from impurities, the hard-vacuum environment virtually eliminates the likelihood of pinholes from foreign particles on the substrate.

When the substrate is heated in the vacuum chamber, such impurities as moisture are almost completely excluded. When pressure within the chamber reaches 5×10^{-5} millimeters of mercury, a small amount of oxygen is sent through the leak valves. At between 3×10^{-4} and 5×10^{-5} mm of mercury, indium oxide powder is introduced into the chamber. This is evaporated onto the substrate at the rate of 300 to 500 angstroms per minute.

The electrodes, which are 500 to 1,000 Å thick, have a surface resistance of 100 to 400 ohms per square and transparency greater than 80%. The lower limit of surface resistance is determined by the requirements to keep opacity to a minimum, and the upper limit is a





4. IC mount. A fixture is used to align the integrated circuits on the substrate and to apply heat for soldering.

function of an increment in resistance that takes place during the thick-film process that follows.

Surface resistance of the transparent electrodes after thick-film firing can increase by as much as four to seven times the value before firing. To prevent this increase, a silicon-dioxide film is coated over the transparent electrodes. This method, however, restricts the allowable temperature rise of the assembly to 200°C.

To overcome this temperature limitation, the width of the lead to each character segment was increased, and the driver's output impedance is kept down to 50 kilohms per segment.

Depositing thick film

After evaporation, the segments of each display digit are patterned by a photoresist method. Because the etching time of indium oxide is strongly influenced by temperature, an automatic temperature-control unit is required. The temperature is kept low, an average of 50° C, to minimize formation of chlorine gas. After the character segments and their leads are formed, an interface with the rest of the calculator circuits is made by ohmic connection through gold thick-film deposition.

Thick-film wiring interconnects components on the substrate and forms the contacts for the keyboard (Fig. 2). A gold-palladium paste is used instead of a simpler gold paste because gold alone tends to combine with the tin in solder to form intermetallic compounds, which reduce adhesion to the substrate. Although gold-bearing paste is used because of its reliability, silver-type pastes are being tested as a possible replacement.

Wiring widths are between 200 and 300 micrometers, and the distance between wires was set at 200 to 350 μm to provide tolerances wide enough for maximum assembly-line productivity. A vitreous glass paste with low softening point is used between the gold-palladium paste and the substrate to improve adhesion.

Fabricating the display

The liquid-crystal display operates in the dynamic-scattering mode. In this mode, when an electric field is applied to the nematic liquid crystal, incident light is scattered, rather than transmitted. A reflective electrode is required behind the display digits, and this electrode in the COS system is an evaporated aluminum film.

The liquid-crystal material is introduced between electrodes by vacuum injection. After injection, a thick-film ceramic disk is soldered on to the injection hole, and the hole is sealed.

The substrate containing the transparent electrodes is pasted to a daughter substrate containing the reflective electrodes with a film spacer between them to form a cell (Fig. 3). The cell thickness must be kept within a tight tolerance to obtain the required electro-optical display characteristics.

Cell thickness is controlled by selecting a film spacer of uniform thickness that does not react to liquid-crystal materials. Adhesive materials must also be chosen carefully so that sealing will be hermetic. A mixture of silicon dopant and resin adhesive was chosen after it was proved in environmental and reliability tests. This mixture, which can be screen-printed, adheres well to a glass substrate. A silver paste around the edge of cells connects the reflective electrodes to the glass substrate.

Interconnecting the IC

To interconnect the calculator chip to the substrate, a fast, low-temperature solder is required because the chip can withstand temperatures only as high 190°C. But since there is a 10°C temperature drop between the silicon chip and the package leads, the solder temperature is 200°C.

Common tin-lead solder has a melting point of 183°C, but requires a soldering iron heated to 230°C to 240°C. To meet the temperature requirements, the solder chosen is composed of 43% tin, 43% lead, and 14% bismuth. Before soldering, the substrate is preheated to 140°C in an oven to prevent thermal shock from damaging the substrate. The soldering temperature of 200°C is then applied to the package for 20 seconds.

Because positioning is critical, a fixture (Fig. 4) is used to align the IC package for soldering. Lead pitch on the device is only 1.27 millimeter, and lead width is 0.6 millimeter. □

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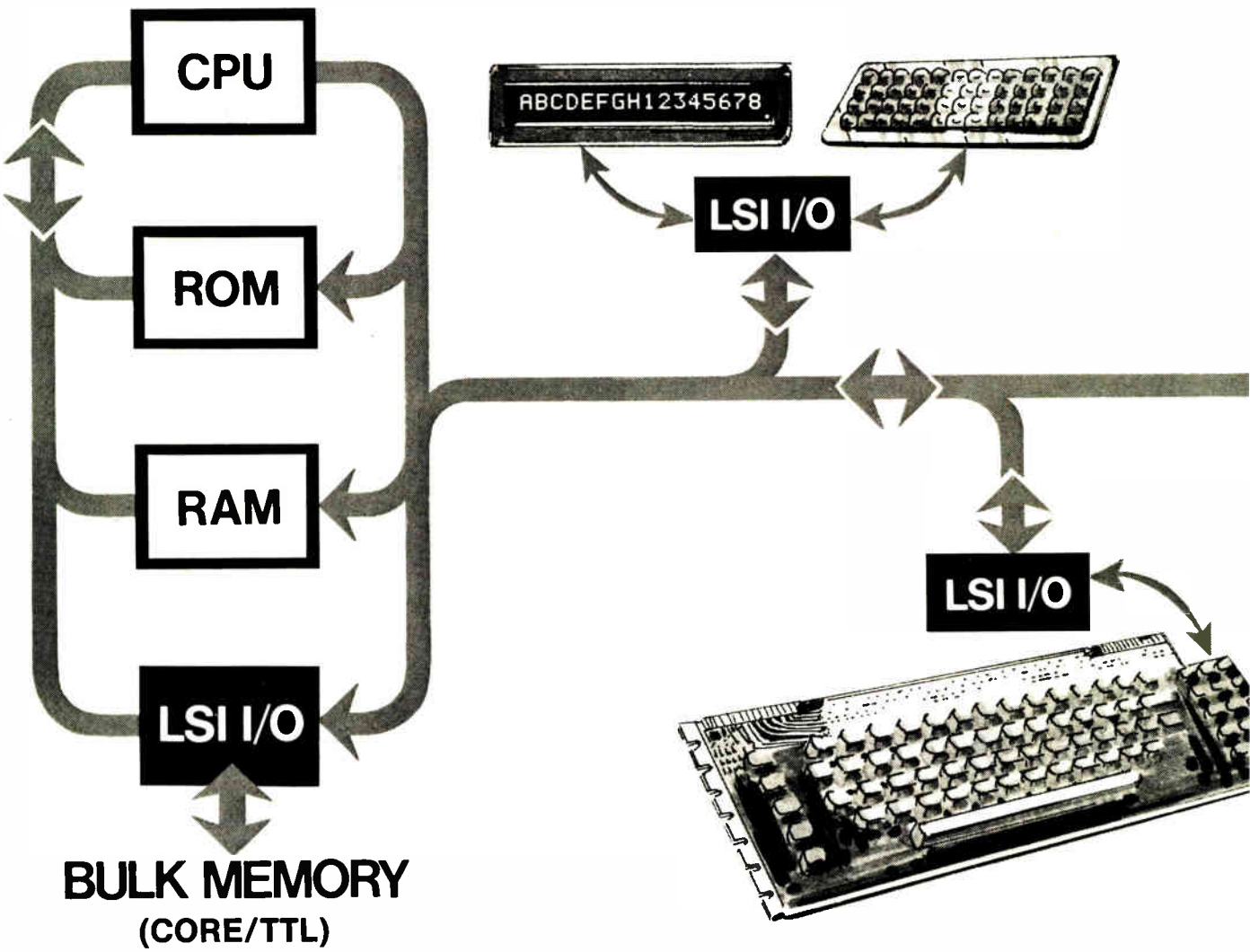

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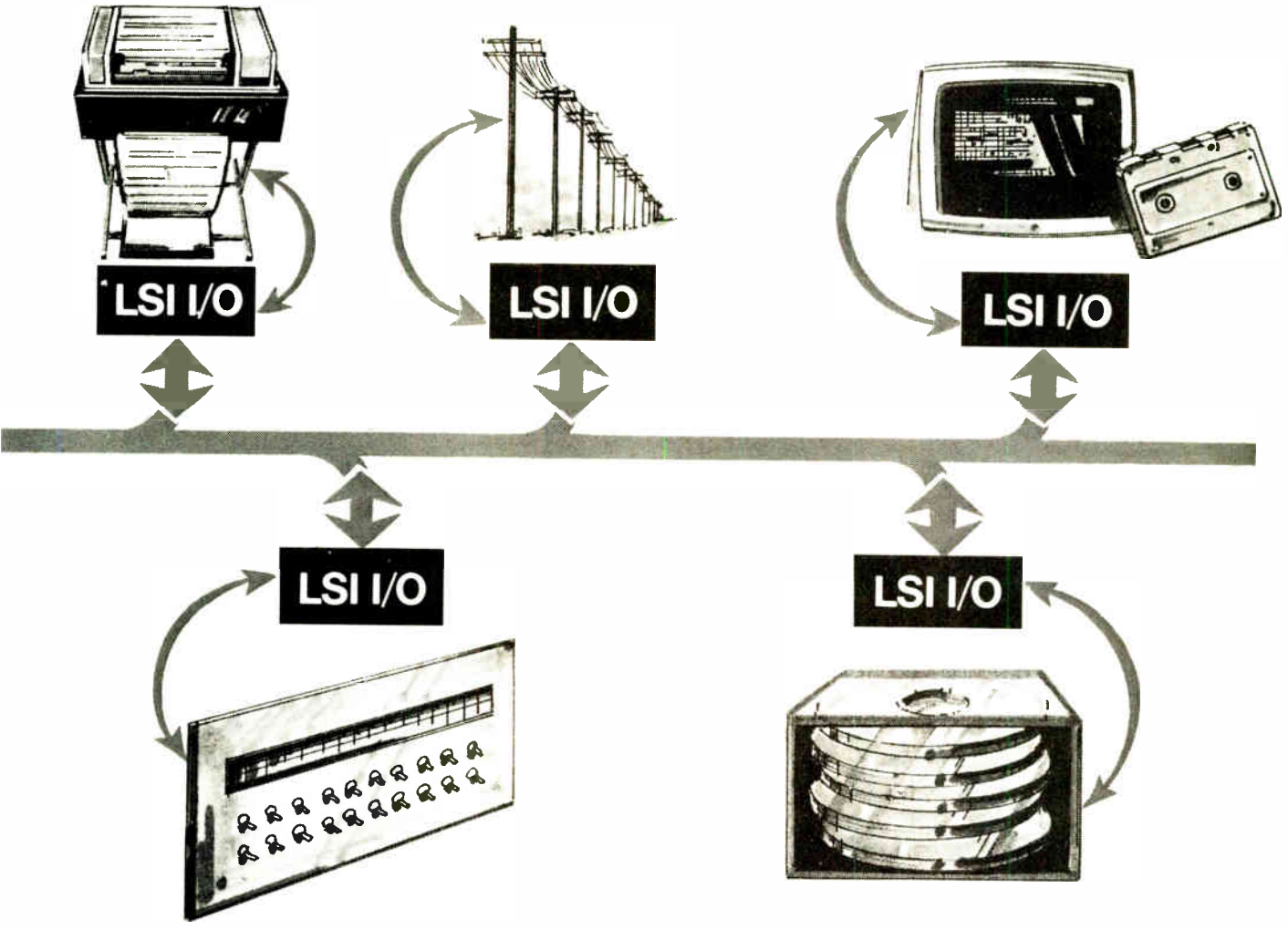


Circle 113 on reader service card 113

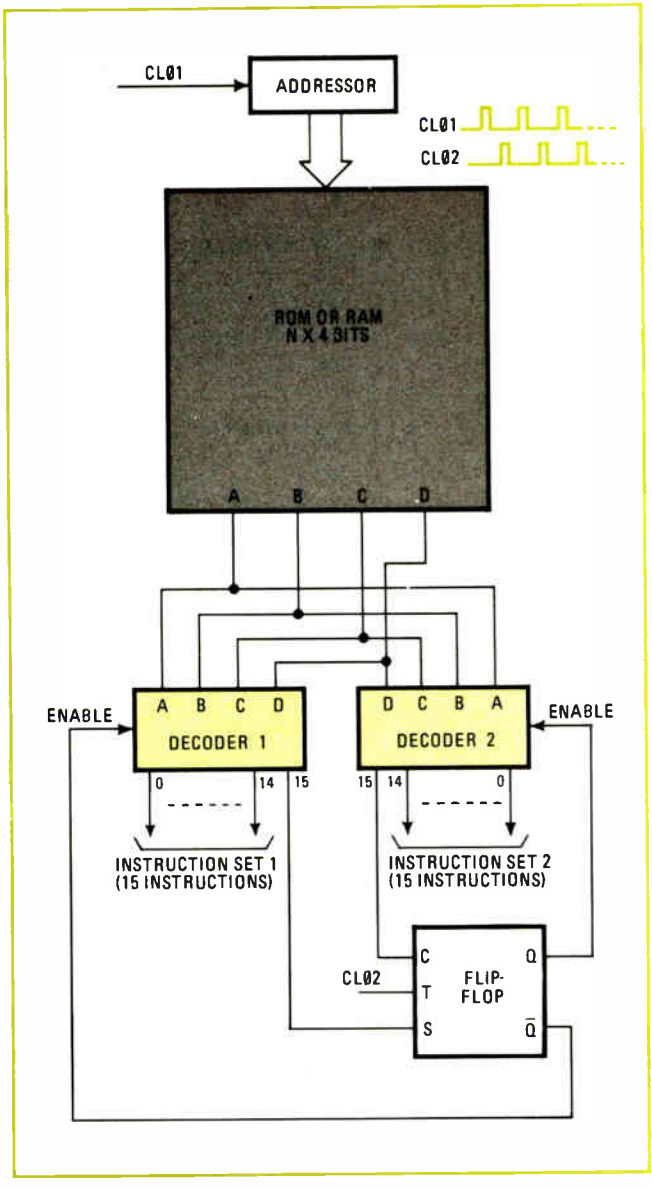
Increasing an instruction set without increasing word length

by C. W. Moser Jr.
Western Electric Co., Winston-Salem, N.C.

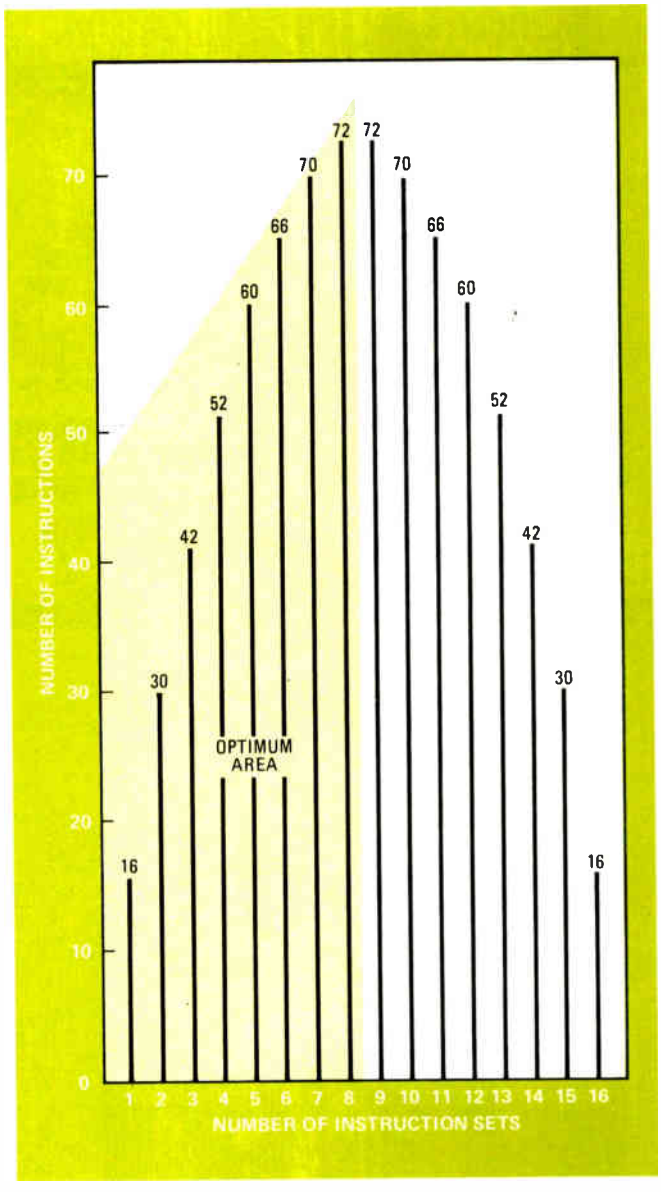
The number of instructions in a system-instruction set can be increased without increasing the word length. Normally, a 4-bit instruction word can be decoded as one of 16 possible instructions (i.e., $2^4 = 16$). If more than 16 instructions are required for a particular application, the instruction word can be lengthened, or the technique described below can be used.

Figure 1 shows an N-by-4-bit memory in which each

1. Decoder circuit. Instruction words in memory can have either of two meanings, depending upon state of flip-flop. With this two-set technique, each 4-bit word provides 30 possible instructions.



2. More sets. Maximum number of instructions obtainable from a 4-bit word is plotted as a function of the number of instruction sets (or decoders). Optimum area has fewest components per instruction.



4-bit instruction word can be decoded as one of 30 possible instructions; these instructions are divided into two sets of 15 instructions each. A 4-bit instruction word in the memory can have either of two meanings, depending on the state of the flip-flop. If the flip-flop is clear, decoder 2 is disabled and decoder 1 is enabled; therefore the instructions in set 1 can be performed.

If it is necessary to perform an instruction that is in set 2, the flip-flop must be set to provide an enabling pulse to decoder 2. For this purpose, line No. 15 from decoder 1 is connected to the set lead of the flip-flop; thus a 1111 instruction from decoder 1 sets the flip-flop, disables decoder 1, and enables decoder 2 so that the instructions in set 2 can be performed. Similarly, line No. 15 from decoder 2 is connected to the clear lead of the flip-flop; thus, a 1111 instruction from decoder 2 clears the flip-flop, disables decoder 2, and enables decoder 1 so that instructions in set 1 can be performed.

If the number of instruction sets is increased, the total number of possible instructions increases up to a point, and then actually decreases as more sets are added. Figure 2 shows the number of possible instructions obtainable from a 4-bit word as a function of the number of instruction sets (or number of decoders). The total number of instructions decreases for more than nine instruction sets, because every set must include commands for enabling every other set. The shaded region of the graph is optimum in that fewer components are required per instruction than in the unshaded region.

This technique is most valuable in operations where one group of instructions (for example, instruction set 1) is performed many times and the second group is performed after the first group. Of course, this technique can be applied to systems that use words other than 4 bits long.

In some applications, a decrease in the total number of bits and an increase in the total number of words can be realized in comparison with similar applications that make use of longer words. This technique slightly lengthens the microprogram and the execution time because time must be allocated when accessing a different set of instructions. □

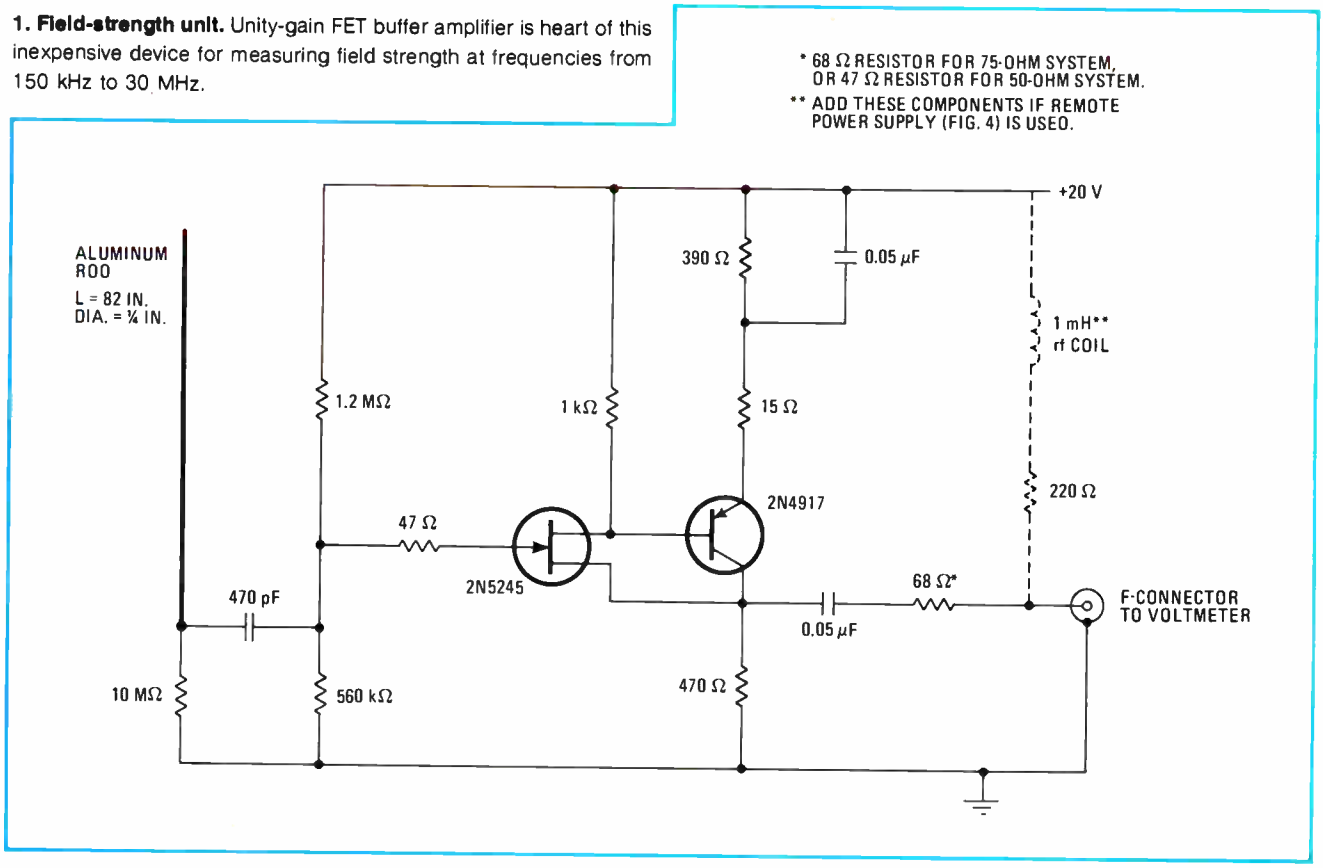
Low-cost field-strength unit uses simple buffer

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

Field strength at frequencies from 150 kilohertz to 30 megahertz is measured by feeding the output of a standard flat-frequency-response antenna into a tuned voltmeter. Commercially available broadband antenna-and-amplifier units suitable for this task cost about $500; however, a setup identical in function and performance can be built for about $5.

In the field-strength measurement, a vertical antenna

1. Field-strength unit. Unity-gain FET buffer amplifier is heart of this inexpensive device for measuring field strength at frequencies from 150 kHz to 30 MHz.



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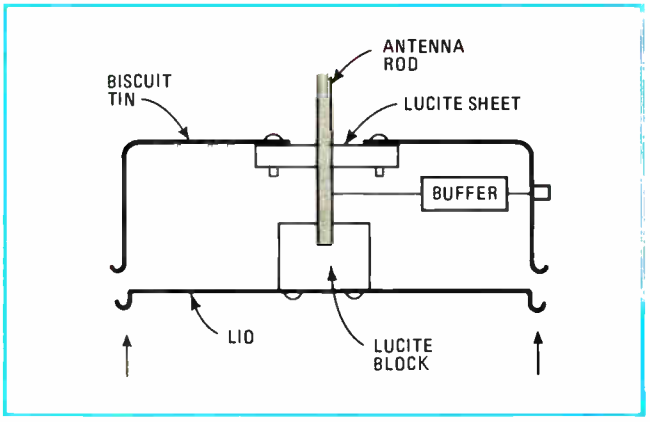
that is effectively two meters long provides an output, measured in microvolts, numerically equal to twice the ambient field strength (measured in microvolts per meter). This voltage cannot be applied directly to the tuned voltmeter because of the very high source impedance of the antenna at low frequencies. Instead, an impedance converter is used between the antenna and the tuned voltmeter (50-ohm or 75-ohm rfi receiver or spectrum analyzer). The 6-decibel loss resulting from the converter-to-voltmeter impedance match cancels the 6-dB gain produced by using an antenna two meters long; therefore, the voltage applied to the tuned voltmeter is numerically equal to the field strength, permitting direct measurement without any corrections for frequency or for antenna gain.

The heart of the device is a unity-gain buffer amplifier (shown in Fig. 1). The buffer uses a field-effect transistor and a pnp transistor connected to provide 100% negative feedback; the resulting stage has high input resistance, low input capacitance (about 4 pF), low output impedance, near-unity gain, and a frequency response that is flat to 85 MHz.

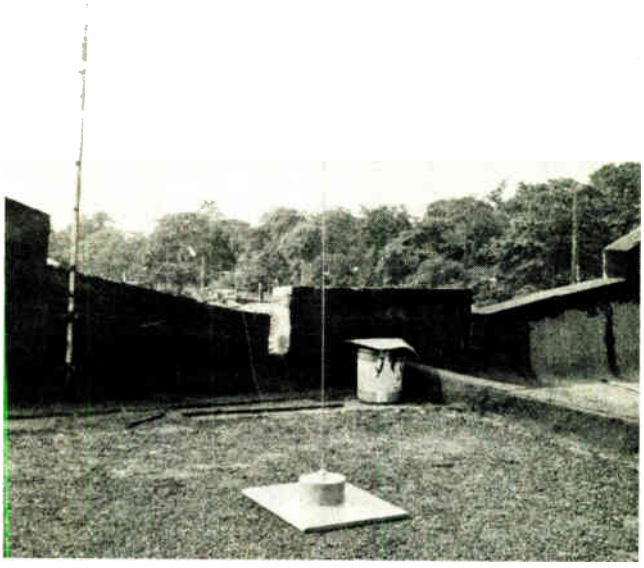
A biscuit tin about 9 inches in diameter supports the rod antenna and provides a no-cost, watertight enclosure for the buffer amplifier. At frequencies greater than 150 kHz, the loading on the antenna is determined primarily by the input capacitance—not the input resistance—of the buffer; therefore the construction technique must minimize capacitance in both the buffer amplifier and the antenna support. A suggested mechanical arrangement is shown in Fig. 2. For permanent outdoor installations, rubberized sealant should be used around the antenna-entrance hole, the Lucite sheet, and the lid. A photograph of a complete assembly is shown in Fig. 3.

The buffer amplifier can be battery-operated for intermittent use, but a remote power supply like the one in Fig. 4 is best for long-term or outdoor use. □

Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

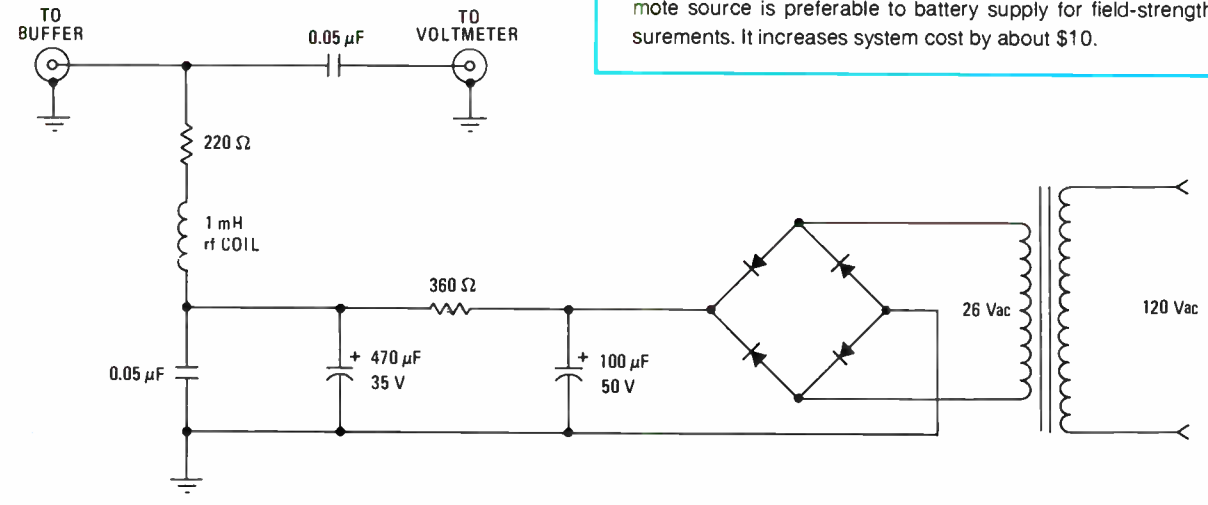


2. Assembly. Biscuit tin supports rod antenna and provides no-cost, weathertight enclosure for buffer amplifier. (In photograph below, the biscuit tin lid is screwed to a wooden board so the device won't tip over in high winds.)



3. Working unit. Photograph of field-strength measurement device in operation. Simple device described here equals performance of commercial units, at vastly less cost.

4. Power supply. For long-term operation or outdoor use, this remote source is preferable to battery supply for field-strength measurements. It increases system cost by about $10.



←Circle 116 on reader service card

Engineer's newsletter

Bell modems versus the rest

Use data-communications modems? You'll want to check out the recent survey from Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075, which **evaluates users' experiences with modems made by Bell System and by independent manufacturers.** The results show that although users are equally satisfied with the performance and reliability of both groups of equipment, **they rate Bell's maintenance service higher and prefer the better diagnostic facilities of the non-Bell modems.**

The survey also indicates that most modems operate at relatively low speeds. Of all the modems reported on, about two thirds operate at speeds of 2,400 bits per second or less and **only 10.8% operate at 9,600 bits or more per second.**

Paired-LED display monitors activity on phone or data lines

As you may already know, a pair of light-emitting diodes connected in parallel with reverse polarity makes a handy zero-beat-frequency indicator [*Electronics*, March 15, 1973, p. 119]. The applications for this type of display can be easily extended to monitoring the activity on a telephone line, notes Calvin R. Graf of San Antonio, Texas—simply use low-current LEDs for the display and a current-limiting 10-kilohm ½-watt resistor in series with the LEDs.

Such an indicator is particularly helpful when two or more phones are connected to the same line or when data terminals are being used. **The LEDs will display line activity, no matter where the extensions are located or how many there are.** Because the circuit makes use of changes that occur in line voltage level and polarity during normal operation, it does not affect line operation adversely.

Let's label the diodes LED_1 and LED_2. If the local and extension phones are not in use, LED_1 is bright, and LED_2 is dark. **When a call is dialed on the local phone, LED_1 flashes the dial pulses, while LED_2 remains dark.** If both phones are in use or if only the extension phone is in use, LED_1 is dark, and LED_2 is dim. A call on the line (phone ringing) causes both LEDs to flash 20 times per second.

Wire and cable guide tells all

If you have to specify wire and cable for a computer, telecommunication, process control, aerospace or electronic system, it will be worth your while to get hold of Brand-Rex's 70-page "Wire and cable engineering guide." The guide presents **detailed information on all electrical, mechanical and environmental properties of practically all types of wire and cable,** conductor materials, coatings, insulations and types of processing (coded, textile overbraided, shielded, jacketed, and so forth). **Copies cost $10 each** from: Brand-Rex Co., Publication WC-74, Willimantic, Conn. 06226.

New EEs still in oversupply

Bad news in a shrinking job market— **once again, more electrical engineers were graduated in the 1974 class than any other type of engineer.** At 11,347, the EEs outnumbered the runners-up, civil engineers, by more than 3,000, reports the Engineering Manpower Commission of Engineers' Joint Council. EEs also accounted for 3,702 master's degrees and 700 Ph.D.s.

—Laurence Altman

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At the risk of sounding brash, we'd like to tell you exactly where we stand in the minicomputer marketplace:

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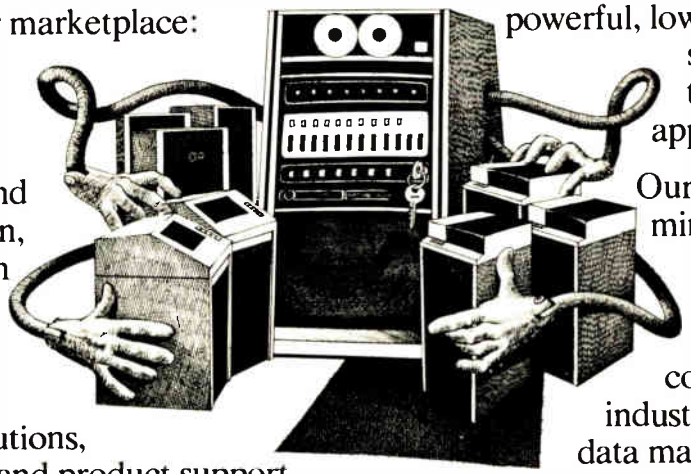

In these three areas, we offer a better package of total solutions, performance, price and product support than any computer company in the world.

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Involvement has always been our long suit.

We've never favored the sell 'em and leave 'em end of the business. Which is why we're *not* number one in volume hardware sales. We think it's better to be the best specialist than the biggest generalist.

The most mini for the money.

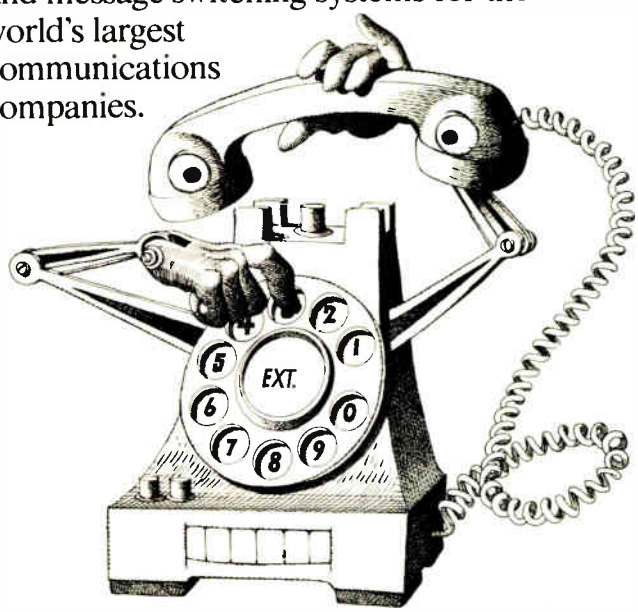
A good example is our family of SPC-16 computers. Quite simply, they are the world's most powerful minicomputers. They do more work in less time with less memory than any other mini you could buy. As a result, we offer the least expensive solutions instead of the least expensive minicomputers.

Our SPC-16 family has helped a lot of OEMs and end-users build a lot of powerful, low-cost systems for a lot of tough, tight-budget applications.

Our family of mighty minis is also one of the primary reasons we offer so much capability in communications, industrial automation and data management systems.

The best total communications systems.

General Automation is the major supplier of minicomputers for PABX control systems, front end processors, Telex message systems and message switching systems for the world's largest communications companies.



Our extensive experience has also made us the number one solver of tough problems for any company that needs a custom communications system.

If we can't solve your communications problem, nobody can.

The best total data management systems.
We can put you in better touch with your business by replacing a lot of time-consuming, non-productive status meetings, paperwork and guesswork with simple, automated systems that tell everyone who needs to know, everything they need to know, whenever they need to know it. No matter where they are or what they do or how they do it.

We can deliver a compatible, expandable, high-performance family of systems that can form a network offering batch data processing, real-time data entry and retrieval, decentralized control and custom applications software.

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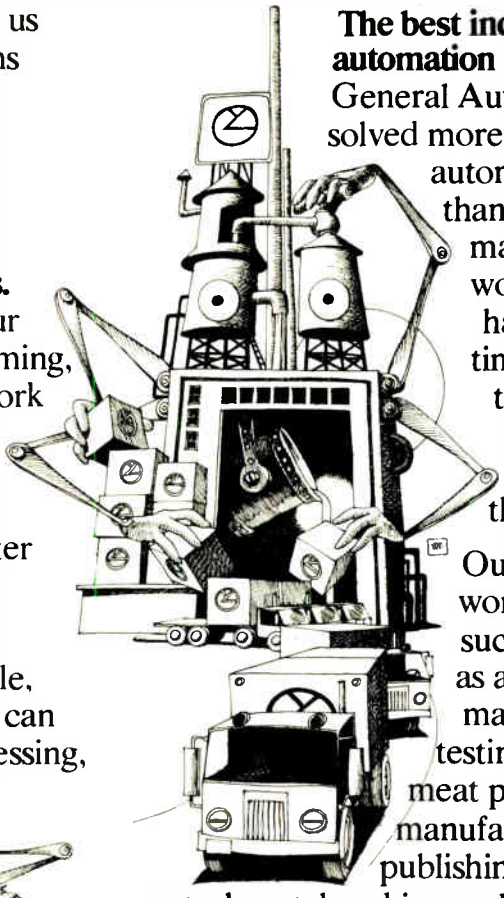
In addition, we sell a low-cost, highly interactive turn-key system through distributors for companies that need economy more than system growth. And we manufacture the number one IBM 1130 replacement system.

Nobody can offer a better total solution in data management.



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General Automation has solved more industrial automation problems than any minicomputer manufacturer in the world. As a result, we have invested more time and understand this field better than any minicomputer manufacturer in the world.

Our systems are working in such applications as automotive manufacturing and testing, process control, meat packing, electronics manufacturing, newspaper publishing, warehouse control, metalworking and dozens of others.

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Challenge us.
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In Europe, write General Automation, S.A., 24 rue du Sergent Bauchat, 75012 Paris, France. Telephone (1) 346/7973.
In Canada, write G. A. Computer Ltd., 880 Lady Ellen Place, Ottawa K1Z5L9, Ontario. Telephone (613) 725-3626.

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GENERAL AUTOMATION

Scope is combined with multimeter

Instruments, integrated into a hand-held package, share display, voltage probe, power supply; miniscope offers bandwidth of 1 megahertz

by Andy Santoni, Instrumentation Editor

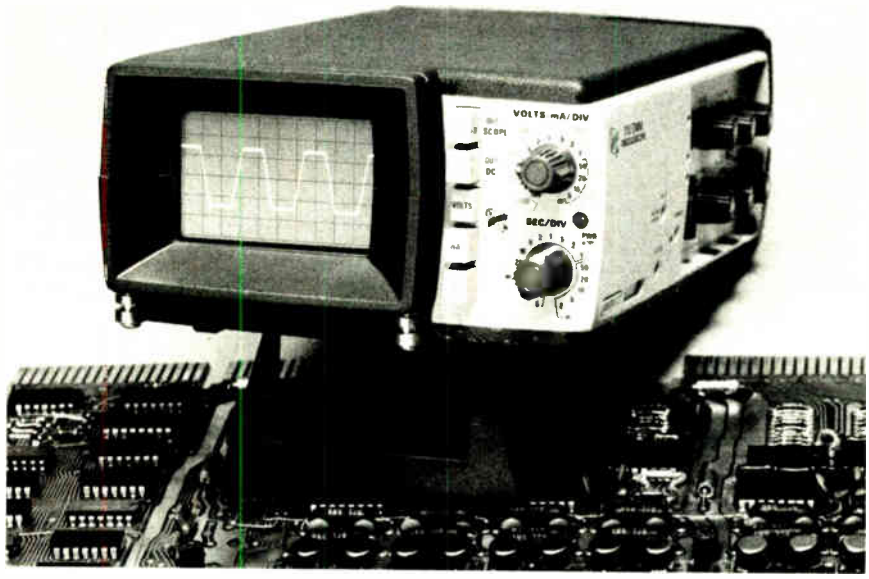
One step toward simplifying field-service instrument requirements has been to mount a digital multimeter piggyback on an oscilloscope, as Tektronix did with the DM40 and DM43 options for its 400-series portable scopes [*Electronics*, June 13, 1974, p. 133]. The combinations are powerful test tools, but they're heavy (about 30 pounds), expensive ($2,000), and require ac power.

Tektronix has now gone a step further by integrating the scope and multimeter functions in one compact and lightweight package. The hand-held instrument, model 213, combines a true-rms multimeter and an improved version of the company's model 211 miniscope. The new miniscope has a 1-megahertz bandwidth, compared with 500-kilohertz for the original 211.

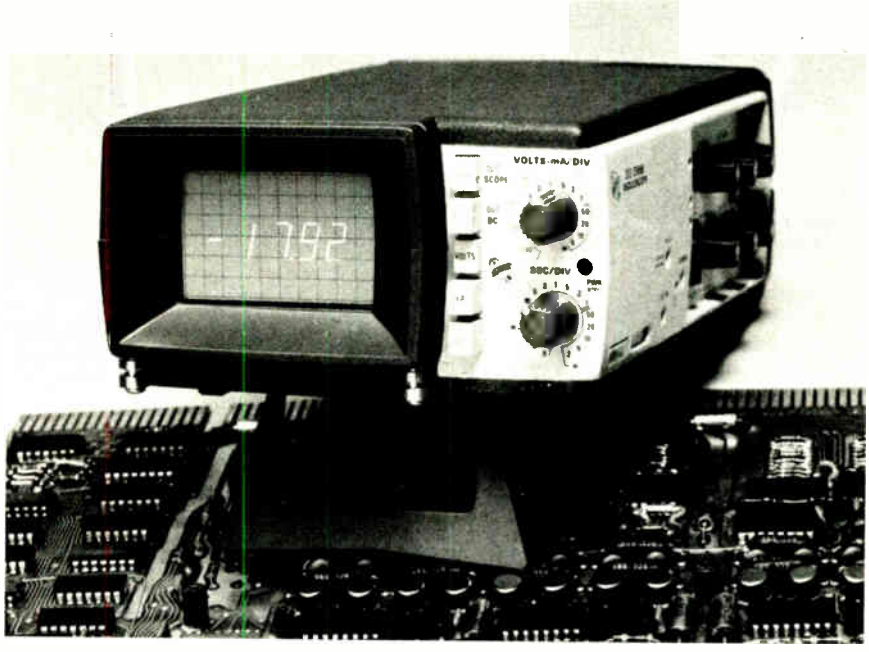
The combined instrument is expected to have many applications in field-maintenance of electronic equipment, including computer peripherals, communications equipment, industrial control systems, and medical electronics.

In the oscilloscope mode, the model 213 offers 14 calibrated vertical voltage-deflection factors from 20 millivolts to 100 volts per division at rated bandwidth, extending to 5 mV/division at a 400-kHz bandwidth. As a side benefit of the instrument's current-measuring capability, the scope section can also display current waveforms, with vertical current-deflection factors from 5 microamperes per division to 100 mA/division in 14 steps. Current bandwidth is dc to 400 kHz on most ranges, dc to 200 kHz on the 5- and 10-μA/division scales.

Horizontal-deflection factors are



Shared display. Tektronix model 213 can operate in oscilloscope mode (above) or as a digital multimeter. The two functions also share other parts of hand-held instrument.



New products

from 2 microseconds to 500 milliseconds per division in 17 steps, and a variable sweep magnifier provides a maximum increase of five times in sweep rate.

The model 213's true-rms capability in the DMM mode makes the instrument especially useful when measurements of nonsinusoidal ac signals are required. Full-scale dc- and ac-voltage ranges extend from 0.1 to 1,000 volts, dc and ac current ranges from 0.1 milliampere to 1 A, and resistance ranges from 1 kilohm to 10 megohms. The 3½-digit (2,000 count)-plus-sign display occupies a 1.5-by-4-centimeter area on the cathode-ray tube.

Selection of either DMM or oscilloscope mode is made by means of a front-panel push-push switch. In either case, readout is displayed on the CRT which has six-by-10 divisions of 0.5 centimeter per division. The DMM and oscilloscope share a built-in voltage probe, current-input jacks, and input attenuators.

The two functions also share the instrument's power supply. The model 213 can be operated for three and a half hours on internal nickel-cadmium batteries, or from an ac line of a 90 to 136 V, 48 to 62 Hz. A no-charge option changes the ac voltage input to 180–250 V, and permits operation from 180–250-V dc supplies. A built-in battery charger operates whenever the unit is connected to line voltage.

A double-insulated case permits floating the model 213. Insulation voltage is 500 V rms or 700 V dc plus peak ac when operating from the internal battery. All of these features are packed into a case measuring less than 3 by 5¼ by 9 inches and weighing less than four pounds, including accessories.

The model 213 is priced at $1,200, and delivery's from stock. By comparison, the model 211 is $695; the 5-MHz, single-channel model 221 and the 500-kHz dual-channel model 212 are $825; and the 500-kHz, dual-channel storage miniscope, the model 214, is priced at $1,075.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [338]

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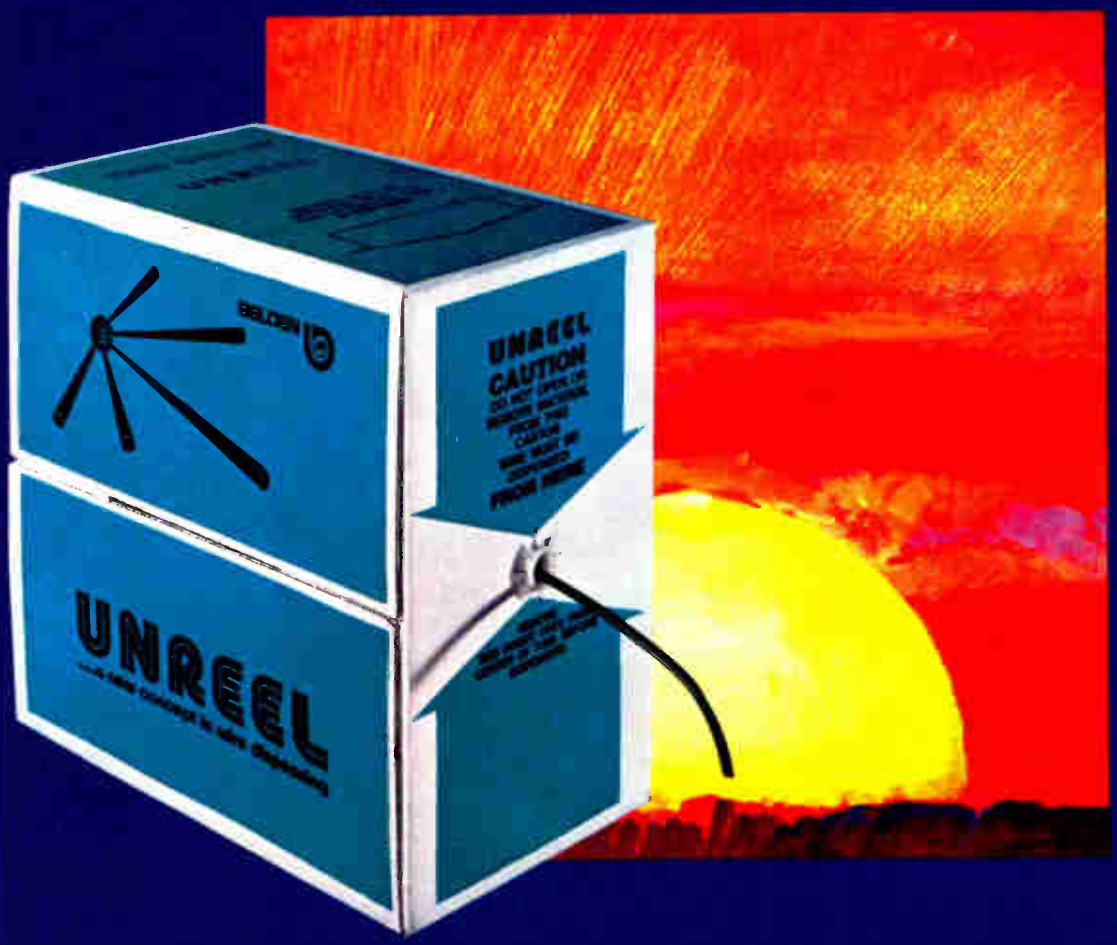

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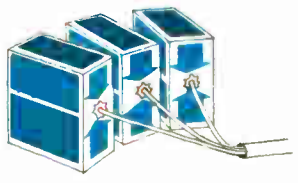

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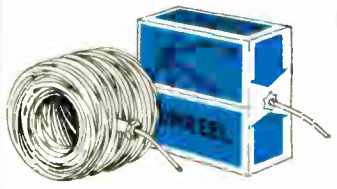
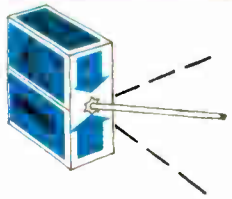


Saves time. No reels, spools or pipe racks to drag back and forth.



Feeds out from any angle without damaging wire.

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Circle 126 on reader service card

Plastic relays are hermetically sealed

Low-priced commercial devices for telephone, data-transmission systems offer long life as well as protection against severe environments

by Lucinda Mattera, Components Editor

Traditionally, hermetically sealed devices come in fairly expensive metal cans. However, a Japanese relay manufacturer, Matsushita Electric Works Ltd., has developed a process for hermetically sealing a plastic package. Initially, the company will be offering three new series of sealed plastic relays, to be sold here by Arrow-M Corp. of Mountainside, N.J., a wholly owned subsidiary of Matsushita.

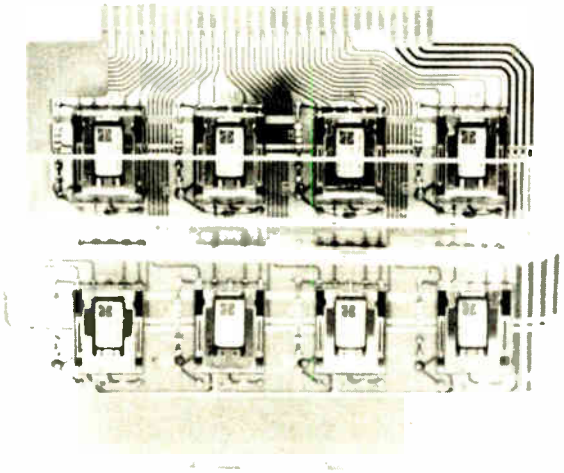
Because of their plastic housings, these commercial-grade relays are about half the price of their hermetically sealed metal counterparts, and they meet the leakage requirements of MIL-STD-883 at 85°C. The principal applications are expected to be in the communications industry for telephone and data-transmission systems.

Until now, it has been impossible to achieve a hermetic seal for a plastic housing. But Matsushita has found an organic-free plastic and an epoxy resin that are compatible, allowing the package to be sealed in a conventional manner. Each relay is first completely assembled, and all plastic parts are degassed. Then the relay is baked to exhaust whatever gas it contains. It is next backfilled with dry nitrogen (from which all moisture has been removed) and then sealed with an epoxy resin.

The three new series are sealed versions of earlier products. The series NFE relays are flatpack printed-circuit-board units, the series KE relays are high-reliability types, and the series HCE devices are miniature power units.

The principal feature of all the relays is long life—a minimum of 10^8 mechanical operations, which is at least double that of comparable units. Also, the contacts for the new relays are simultaneously molded into one block, so that there are no screws or rivets to loosen.

The series NFE devices, which can be either double-pole or four-pole double-throw relays, contain a highly efficient magnetic circuit, as well as a built-in shock absorber. Operating power is as low as 260 milliwatts for the dpdt model and 400 mW for the 4pdt unit, while contact bounce is approximately 1.5 milliseconds. For either model, coil voltages range from 6 to 60 V dc, and maximum current rating is 2 amperes. The 4pdt package measures 0.425 by 0.953 by 1.165 inches. In quantities of 1,000 and coil voltages up to 24 V, the dpdt model is priced at $3.68 each, and the 4pdt model at $4.49.



Taking an oil bath. Hermetic seal protects plastic-packaged relays from dust, moisture, and even oil, as shown here.

Because of their dual magnetic gap, the series KE cradle relays provide a large contact pressure of 11 grams nominally, making them highly reliable switching devices. Both a dpdt model and a 4pdt model are available. Current rating is 2 A maximum, and coil voltages from 3 to 110 V dc are offered. For coil voltages up to 24 V and in 1,000-unit quantities, the dpdt version costs $4.02, and the 4pdt version costs $4.42.

To increase contact life, the series HCE relays have arc barriers between each set of contacts and debris wells into which arc particles can fall. Three models are available—spdt, dpdt, and 4pdt—in dc coil voltages of 6 to 110 V, and ac coil voltages of 6 to 240 V. Current rating is 5, 3, or 1 A, depending on the model. Package size is 0.827 by 1.079 by 1.319 in. For quantities of 1,000 and coil ratings up to 24 V dc, price is $3.37 for the spdt unit, $4.06 for the dpdt unit, and $4.42 for the 4pdt unit.

All the relays are available from Arrow-M's stock.

The company also recently announced [*Electronics*, Dec. 12, 1974, p. 133] a line of sealed plastic miniature reed relays. These series R spdt units can switch up to 20 W at 500 hertz.

Arrow-M Corp., 250 Sheffield St., Mountainside, N.J. 07092 [339]

Instruments

Panel meter has 0.5-inch LEDs

First of new series offers automatic zeroing and binary-coded-decimal output

A large display is essential in process instrumentation and other applications where readings must be taken at distances of 10 to 20 feet. And the 13-millimeter-high (½-inch) light-emitting-diode display of

Newport Laboratories Inc.'s latest 3½-digit digital panel meter looks even larger than it is.

The first of a new DPM series, the model 203 meter is expected to find large-volume usage in clocks, as a TV channel indicator, in point-of-sale equipment, and in both portable and rack-mounted equipment. Priced at $81 each in quantities of 100, the automatic-zeroing unit offers 100 decibels of common-mode rejection, standard selection of 200-millivolt or 2-volt range, plus optional 20-V or 200-V scales, and standard provision for ratio measurements. The LED displays are electrically quiet. President Barrett B. Weeks, says that gas-discharge displays, though perhaps more satisfactory esthetically, generate electromagnetic interference.

Because of their MSI TTL design, the meters have binary-coded-decimal outputs—which usually come only as an option, comments Weeks. He adds that the TTL is still equal to or lower in cost than MOS circuitry. The BCD is especially useful in voltmeters of the 3½ digit range and higher, where users often want data-logging and similar features in the equipment.

The meters make true average readings rather than absolute value measurements that include noise, as do some other digital meters on the market. "This gives better normal-mode noise rejection, which is especially significant if the signal has a large noise component," observes Weeks, who adds that it's an advantage in many process-control applications, and in the 200-millivolt full-scale range, where each least significant digit represents 100 microvolts.

Total error is ±0.05% of reading ±1.5 counts. Reading rate is four per second. The meter is protected against overvoltages to 100 V in the basic 0.2- and 2-V scales. Input impedance in these ranges is 1 megohm. Polarity setting is automatic.

The model 203 meter operates from 115/230 V ac. It fits in the standard cutout used by many in the industry, 99.7 by 42.7 mm. The unit is 120 mm deep, with the bezel 104 by 48 mm. The case is made of Lexan.

Newport Laboratories Inc., 630 E. Young St., Santa Ana, Calif. 92705 [351]

6,000-count panel meter uses single-slope conversion

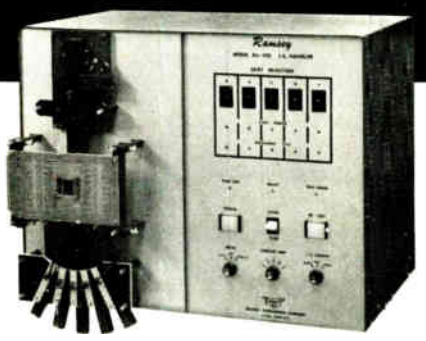
Unlike most 3½-digit panel meters, which count to 2,000, Data Technology's model 3362 counts to 5,999. Using a single-slope converter to cut power consumption and operating temperature, the 3362 provides 4-digit resolution for the measurement of temperature (up to 60° or 600° in the desired scale), angle (beyond 360°), and such commonly encountered supply voltages as 5 V and 28 V. Traditional 3½-digit meters provide only 3-digit resolution in these ranges. The 3362 has three voltage ranges—600 millivolts, 6 V, and 60 V—resolution is 100 microvolts in its most sensitive range. Input resistance is 1,000 megohms in the two lowest ranges and 10 megohms in the 60-V range. Input-bias current is typically 1.5 nanoamperes. Maximum 90-day drift is 0.08% of reading at 23°C. Beckman 7-segment planar glow tubes are used for display. Read on command, hold on command, and display and polarity inhibits are standard features. Options include parallel binary-coded decimal outputs and a ratio/external reference input. Price of the 3362 is $189 each in small quantities. The BCD option adds $35, and the ratio option is an additional $15. Delivery is from stock to 30 days.

Data Technology Corp., 2700 South Fairview, Santa Ana, Calif. 92704 [353]

Noise dosimeter computes daily noise exposure

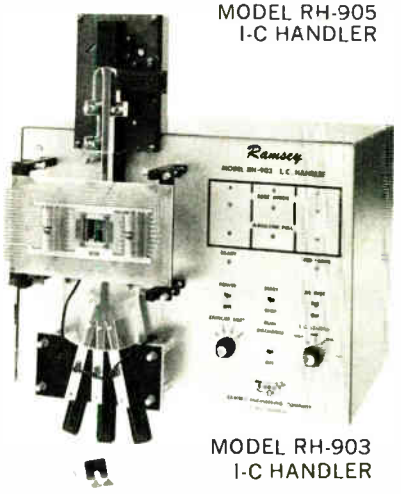
Designed to determine if a person's total daily noise exposure is within the limits of the Occupational Safety and Health Act and the Walsh-Healey Act, the model SPL-105 is a pocket-size noise dosimeter with a detachable microphone that can be placed next to any part of the body. The battery-operated 4-digit instrument is equipped with an enclosed meter in a sealed case so that

If you test, handle, sort, or straighten leads on DIPs, there's a RAMSEY unit to fit your exact requirement... and your pocketbook.



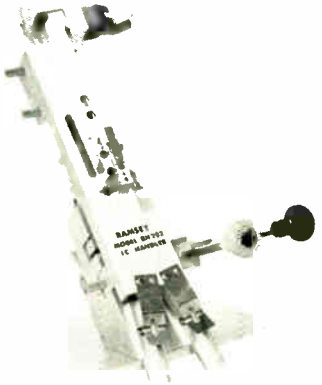
MODEL RH-905
I-C HANDLER

For example, Ramsey's Model RH-905 I-C Handler, the top of the line. We've been saying no other I-C handler can do so much, so well, so fast, and we're prepared to prove it. It features 5 category sorts . . . it's software programmable, via convenient thumbwheel switches . . . convenient thumbscrew adjustments permit handling of a full range of package sizes and configurations . . . a unique photo detector system provides instant readout of the status of all input, output and test functions . . . it incorporates a built-in interface board . . . and its modular design permits easy interchange between mechanical and electronic sections to accommodate different package size configurations.



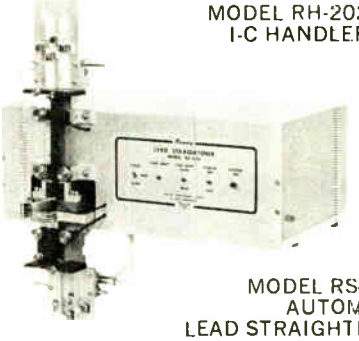
MODEL RH-903
I-C HANDLER

The Model RH-903 I-C Handler retains many of the features of the RH-905 . . . but at a considerable saving in cost if you don't require the full capability of the higher priced unit. It features 3 category sorts, built-in interface board and the same photo detector system for instant status readout.



MODEL RH-202
I-C HANDLER

Then there's the manually operated Model RH-202, a lot of I-C handler for the money. It provides an easy, inexpensive way for you to automate your I-C testing. The Model RH-202 is completely self-contained . . . requires no air or power. It accommodates a variety of package configurations, 6- through 18-pin, or 24- through 40-pin. Precious metal contacts are individually replaceable. It incorporates a performance board for bypassing and decoupling for device compensation.



MODEL RS-5618
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If people sitting at benches, using long-nose pliers to straighten DIP leads manually, sounds like a horse-and-buggy operation, take a look at Ramsey's RS-5618 Automatic Lead Straightener. It matches the continuous throughput of 17 to 20 persons straightening DIP packages manually. Operating continuously at speeds up to 5,000 devices/hour, it handles 6- through 18-pin DIP packages, straightening leads uniformly to any degree required for automatic or manual insertion into PC board hole locations.

For additional information, write or call Ramsey Engineering Co., Electromechanical Products.

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certified records can be maintained on the basis of its readings. It is A-weighted and has a range from 90 to 115 decibels. An accessory, the model MR-105 direct reading dB (A) meter, plugs into the side of the SPL-105 converting the unit into a direct-reading real-time dB meter. The dosimeter is available from stock.

Columbia Research Laboratories, MacDade Blvd. and Bullens Lane, Woodlyn, Pa. 19094 [354]

Digital gaussmeter spans dc to 400 Hz

The model 811 digital gaussmeter is a Hall-effect instrument with a frequency range of dc to 400 hertz. The 3½-digit (2,000-count) meter measures magnetic flux density over five

ranges from 20 gauss full scale to 200,000 gauss full scale. There are 110 Hall-effect probes in a variety of configurations available to work with the meter. Maximum error is less than 0.2% of reading. Drift is less than 0.1% of full scale over any time period.

F. W. Bell Inc., 4949 Freeway Drive East, Columbus, Ohio 43229 [355]

Low-cost tester tells when to recharge batteries

A low-cost battery tester and continuity checker that tests rechargeable batteries under typical load

This NEW instrument

replaces most of what you now use to inspect R, L, and C components

It's the GR 1685 Digital Impedance Meter, which is in reality a complete incoming-inspection station for passive components. On each range it automatically measures series capacitance and inductance at either 120 Hz or 1 kHz and ***measures resistance at dc.*** A built-in digital limit comparator (optional) enables rapid GO/NO-GO sorting. The basic accuracy is 0.1% for dc and 1-kHz measurements and 0.5% for 120-Hz measurements. Measurement ranges are .01 pF to 20,000 μF for capacitance, .01 μH to 2000 H for inductance, and 0.1 ohms to 20 Megohms for resistance.

Other benefits include:

- **For ac measurements, D and Q limits automatically indicated (adjust dial to determine values).**
- **Measurement speed up to four measurements per second.**
- **Lighted arrows indicate direction to turn range and D/Q limit dials.**
- **Parallel data output available for external equipment such as additional limit comparators, handlers, data printers, and card punches.**
- **Test fixture (optional) has PASS/FAIL lights.**

The 1685 is equally convenient to use whether you screen many of the same type of components or measure the values of several different components. For complete information circle the number that appears below or call or write any GR Sales Office. You'll be surprised at the price, too.

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New products

conditions is marked to indicate levels at which batteries should be recharged. Priced at only $18.75, the WT-537A has a standard scale for carbon-zinc and alkaline units, as well as a separate scale for mercury and nickel-cadmium batteries. Packaged in a high-impact orange case, the WT-537A measures 5.125 inches by 3.625 in. by 2 in., and weighs 10.5 ounces.

RCA Electronic Components, 415 South Fifth St., Harrison, N. J. 07029 [356]

Power-line recorder responds to transients up to 1 MHz

A portable four-pen power-line recorder responds to sags and surges over the full range from dc to 1 megahertz from 0 to 1,000 volts. The model 5209D uses separate pens to record sag duration, sag amplitude, surge duration, and surge amplitude. The duration range is from 10 microseconds full scale to 10 milliseconds full scale. The instrument uses phase-locking techniques to continuously compare an internally generated waveform with the line waveform; thus it cannot miss any transient within its range. Price of the recorder, which is built for laboratory or field use, is $3,495; delivery is from stock.

Micro Instrument Co., Power Instrument Division, 580 Opper St., Escondido, Calif. 92025 [359]

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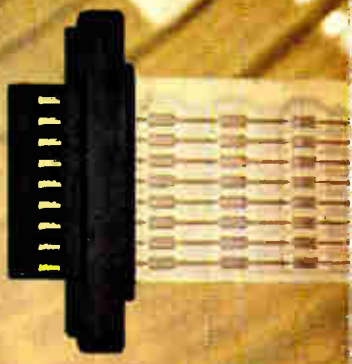

AMP
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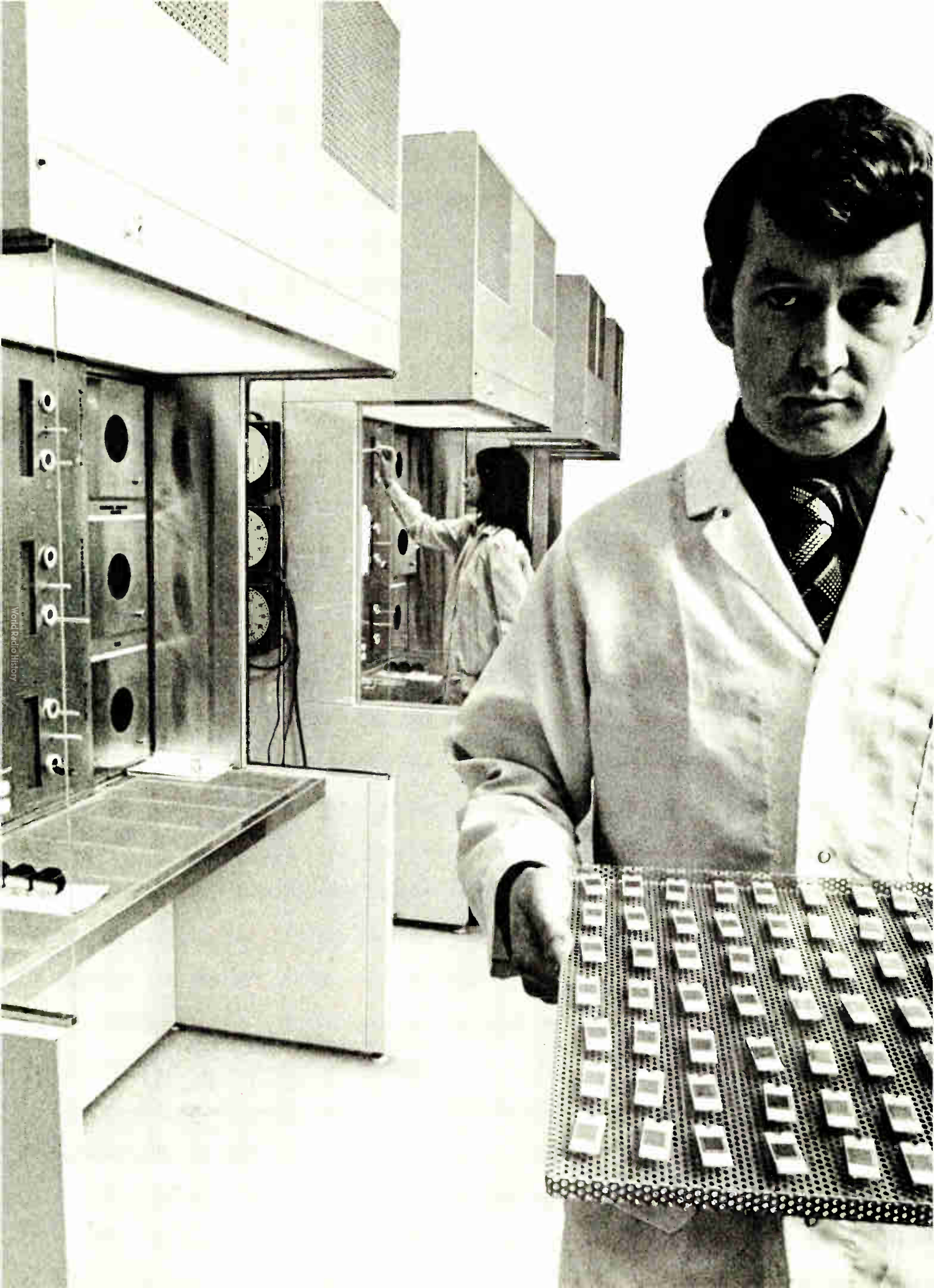
Circle 133 on reader service card



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No other 12-bit DAC–IC or module – gives you greater accuracy. Or a lower cost.

Introducing the AD562 – the revolutionary IC from Analog Devices Semiconductor that outperforms every other 12-bit DAC on the market.

Simply stated, the AD562 is a 12-bit IC digital to analog converter in a hermetically sealed, 24-pin DIL package.

It gives you guaranteed monotonicity over the full operating temperature range, with a maximum total error as low as ¼ LSB (0.006%) at 25°C, and a 3ppm/°C maximum gain temperature coefficient.

The logic inputs are positive-true, and are specifically designed to be both TTL and CMOS compatible. In addition, both binary and BCD versions are available.

How the AD562 came about. The state-of-the-art AD562 could only come from a company like Analog Devices.

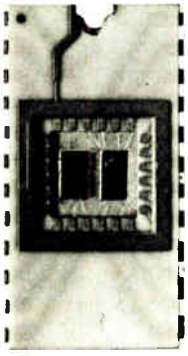
After all, we're the world's leading manufacturer of A/D and D/A converters for test and measurement instrumentation. And with converter products like the AD562, we're extending that leadership in integrated circuit form.

CMI – the new technology that made it possible. To give the AD562 its unmatched accuracy, we developed a process called CMI-Compound Monolithic Integration.

CMI is the partitioning of a complex function into a minimum number of monolithic chips, each specifically designed to work with the others, and assembled in a single package.

For greater performance, the AD562 features two chips. A monolithic, 12-bit precision, bipolar transistor current switch and control amplifier chip. And a compatible silicon-chromium thin-film resistor network containing the DAC bit-weighting and range resistors.

First, they're internally connected. Then, while the AD562 is powered, all the resistors are trimmed by a computer-controlled automatic laser trimmer.



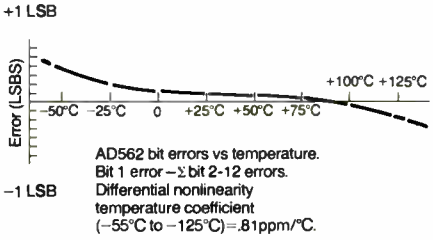
The result is outstanding resolution and scale factor calibration. And state-of-the-art performance at a very low price.

The AD562 does even more for you. You'll find that the AD562 gives you a lot of operating advantages.

Like providing five pin-programmable output ranges, both bipolar and unipolar.

Acting as a two-quadrant multiplier when you apply a variable external reference voltage.

And offering a newly developed current switching cell structure which provides superior immunity to supply voltage variation, and reduces nonlinearities due to thermal transients as the bits are switched.



AD562 bit errors vs temperature. Bit 1 error – Σ bit 2-12 errors. Differential nonlinearity temperature coefficient (–55°C to –125°C) = .81ppm/°C.

Three temperature ranges to choose from. You can specify the AD562 guaranteed for operation over three temperature ranges. The model K: 0 to +70°C. The model A: –25 to +85°C. And the model S: –55 to +125°C.

And best of all, prices start as low as $39 in hundreds.

If you'd like more information on the AD562, call Analog Devices Semiconductor, Norwood, MA. 02062.
East Coast: (617) 329-4700
Midwest: (312) 297-8710
West Coast: (213) 595-1783

ANALOG DEVICES

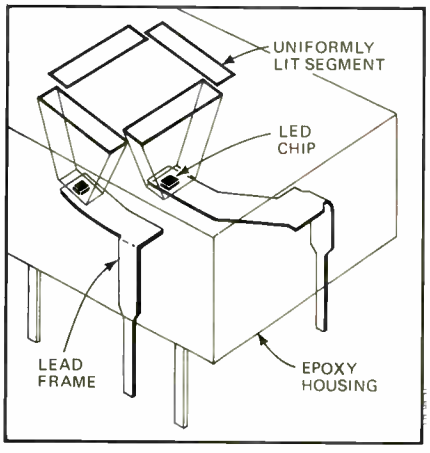
Circle 135 on reader service card

Components

LEDs offer high efficiency

0.43-inch-high readouts in red, yellow, and green challenge gas-tube displays

Despite the increasing popularity of red light-emitting-diode displays, LEDs emitting other colors, particularly green and yellow, have not made a significant dent in the market [*Electronics*, May 30, 1974, p. 66]. Gas-discharge tubes still dominate in many high-ambient applications, such as avionics systems, clocks, appliances, point-of-sale terminals, and instrumentation.



Now, in a challenge to gas-discharge tubes, Hewlett-Packard Co. is introducing 0.43-inch seven-segment LED displays in high-efficiency red, yellow, and green that can be operated at four times the brightness of present LED displays. The red and yellow displays, designated the 5082-7650 and 5082-7660, respectively, are made from gallium arsenide phosphide on a transparent gallium-phosphide substrate [*Electronics*, May 2, 1974, p. 34]. The green 5082-7670 display is made from gallium phosphide on a transparent GaP substrate.

"These new displays can operate in two modes," says Donald Bennett, optoelectronics product marketing manager in the HPA division. "One is the high-current, high-intensity mode. The other is the low-current, MOS-compatible mode." In the first, operating with a 20-milliampere current load, the displays are four times brighter than the older LED displays. In the second, at 5 mA, they have the same intensity as the older displays operating at 20 mA.

The high efficiency of the new red and yellow displays derives from GaP's transparency to light emitted by a GaAsP junction—as opposed to its opaqueness to the shorter wavelengths emitted by GaP junctions. When the GaAsP on GaP combination is backed by a reflecting lens, a much greater fraction of light can be collected at the output cavities, and the resulting colors appear brighter and clearer than do GaP-only systems. "In addition to competing with gas-discharge technology on its own ground," says Bennett, "these new color LEDs with their 5-V-supply requirement open up a whole new range of portable applications—particularly in instrumentation."

In order to maximize on/off contrast, the bodies of the displays have been painted to match the appearance of an unilluminated segment. And to provide an easier-to-read device, the emission wavelength of the red displays has been shifted from the standard GaAsP true red—655 nanometers—to the orange end of the red spectrum at 635 μm.

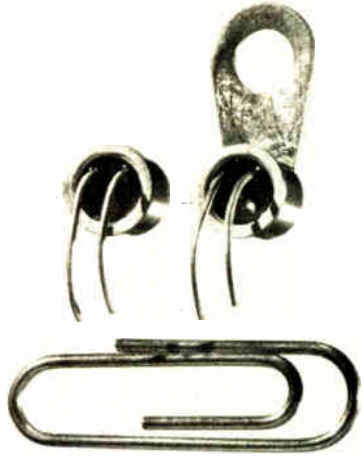
All of the displays, says Bennett, are meant to used in conjunction with contrast-enhancing filters. All three color units are available now at $3.95 per digit for 100-pieces.

Optoelectronics Product Marketing Manager, HPA Division, Hewlett-Packard, 640 Page Mill Rd., Palo Alto, Calif. 94304 [341]

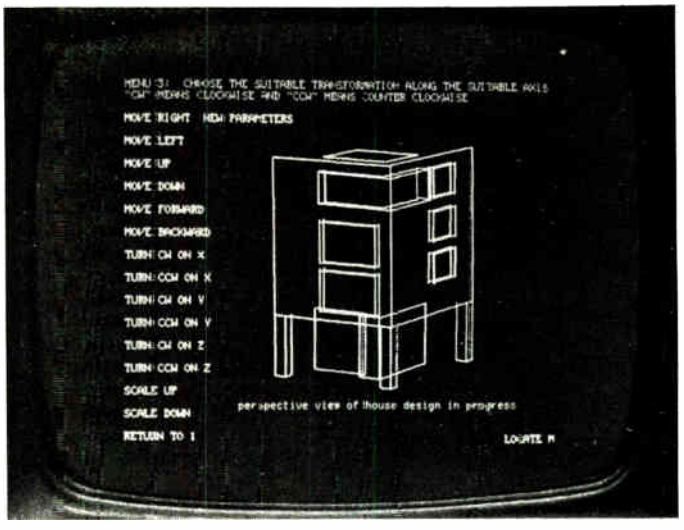
Low-cost temperature switch is voltage-programable

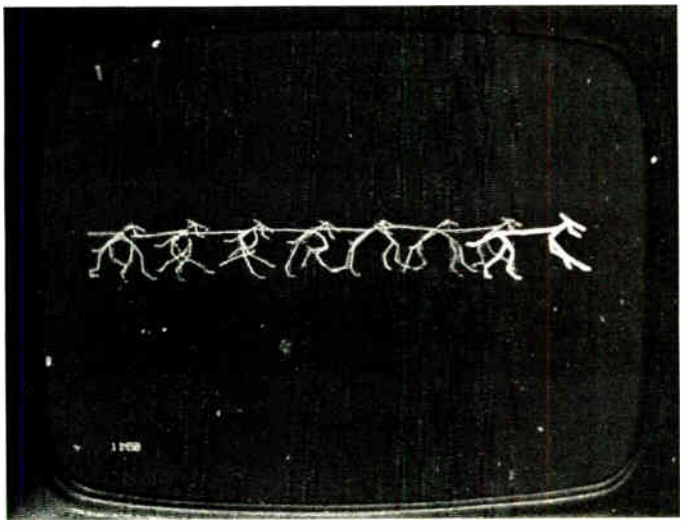
A stable temperature-actuated solid-state switch can be programed to operate at any temperature between a maximum of 50°C and a minimum of approximately -30°C, simply by changing the voltage across it. Actually, the device has no intrinsic low-temperature limit, but lowering the switching temperature means raising the programing voltage, so that the need to work with high voltages imposes a practical limit of about -30°C.

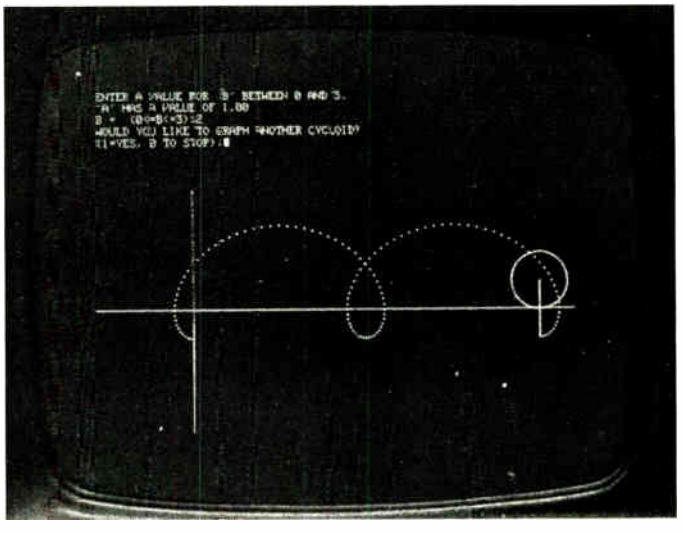
Built around a single-crystal metal-oxide material, the two-terminal Moxie switch is a true regenerative device. At its programed transition temperature, it switches from an off state, in which it has a resistance of at least 30 kilohms, to an on state in which it has a saturation voltage drop of 5 to 10 volts. Once turned on, the Moxie switch stays on unless its current is interrupted, or a reverse current pulse is applied. In purely dc operation, therefore, the device is actually a latching switch. Since it is a completely symmetrical bipolar device, the switch does not latch up when ac is applied. It shuts off whenever the current through it tries to reverse direction. If powered by a stable supply voltage, it can be precisely programed by a single external resistor. Temperature stability is better than 0.1°C, and short-term drift is less than 0.05°C.



The Moxie switch is not a high-power device. The current through it should not exceed approximately 50 milliamperes. Packaged in a TO-18 case, it sells for 40¢ apiece in small quantities. Delivery of the







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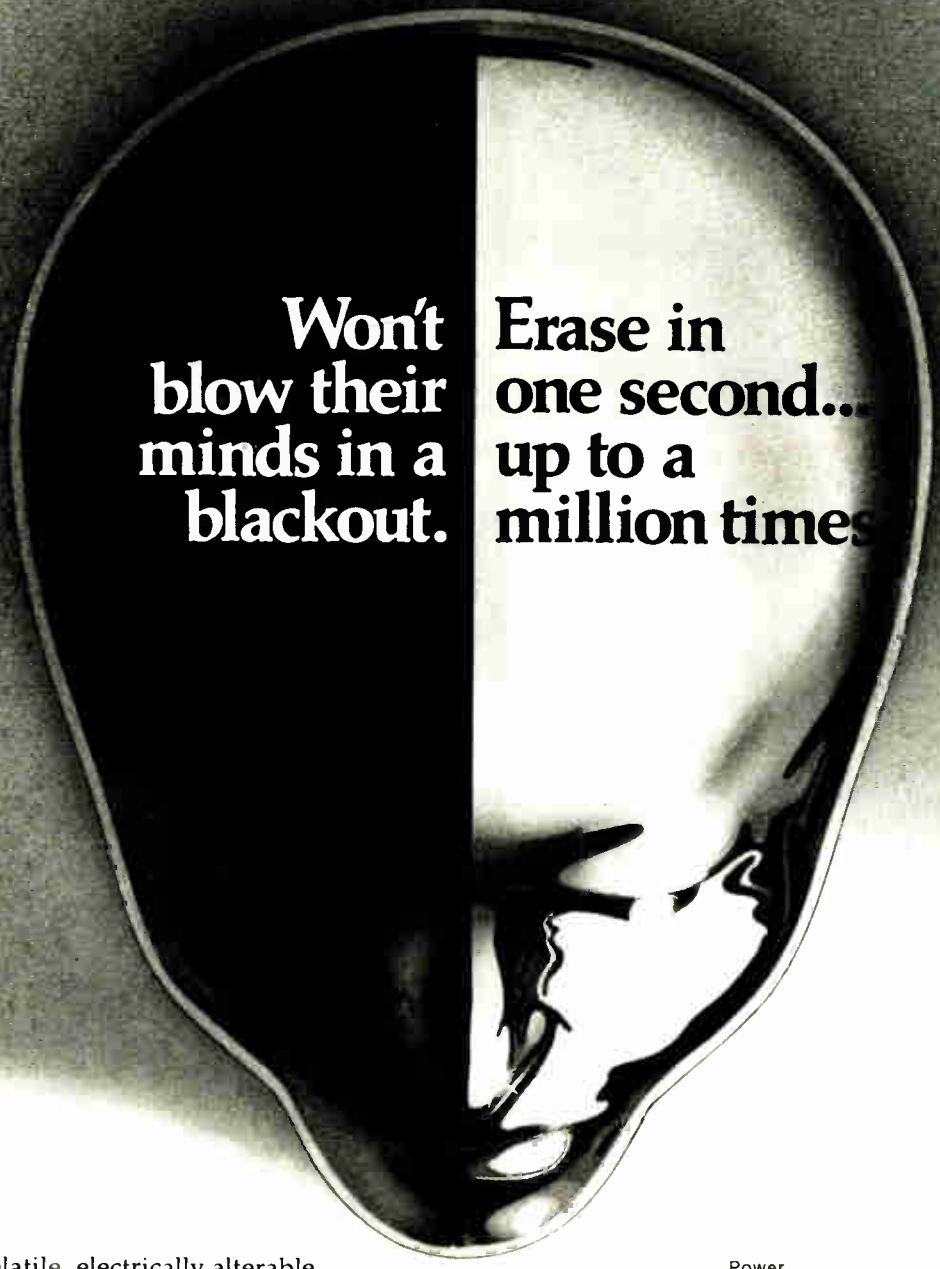

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5. They're particularly useful for communications, computer peripherals, and very low power applications.
6. Standard products and custom capability.

Part Number	Description	Power Supplies (Volts)	Package	Notes
NC7001	64 x 1	±15	18 DIP	ROM Organization
NC7002	1024 x 1 512 x 2	±15	40 DIP	ROM Organization
NC7010	1024 x 1 512 x 2	±15	28 DIP	ROM Organization
NC7030	8 x 16	±15	18 DIP	Shift Register Stack
NIT-80C	1K x 8	±15	PC Board	8K Memory Module
NIT-80T	1K x 8	±15, +5	PC Board	8K Memory Module

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NITRON, 10420 Bubb Road, Cupertino, CA 95014

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Circle 138 on reader service card

New products

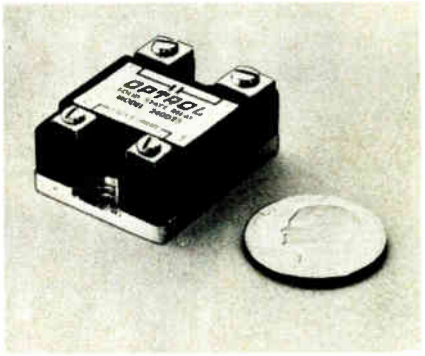
metal-oxide switch is from stock.
Multi-State Devices Ltd., 1330 Trans-Canada Highway, Dorval, Quebec H9P 1H8, Canada [342]

Epoxy-coated metal-film resistors are highly stable

Designed to surpass the specifications of MIL-R-10509 characteristics C, E, and F, type VM epoxy-coated metal-film resistors are available in six power ratings from 0.1 watt to 2 w. Any resistance value from 30 ohms to 300 kilohms, for the 0.1-w units, up to 100 ohms to 10 megohms, for the 2-w resistors can be made. Tolerances of plus or minus 0.25%, 0.5%, and 1.0% are standard, with specials available to a limit of 0.12%. The power ratings of all VM resistors are based on continuous operation at an ambient temperature of 125°C. Operating temperature range is −55°C to 165°C with linear derating at 2%/°C above 125°C. Manufactured by the evaporation of a metal alloy onto a ceramic substrate with gold end bands, and finished with coatings of a proprietary silicon epoxy and paint, the VM series is highly moisture resistant, and typically exhibits less than 0.1 microvolt per volt of noise. Deliveries are currently running two to three weeks.
Vermont Precision Resistor Co., P.O. Box 1170, Stowe, Vt. 05672 [344]

Solid-state relays switch 45 amperes at 480 volts

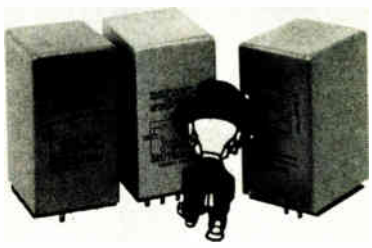
By incorporating what the company calls a "Heet Spreader" into its latest line of solid-state relays, Optrol has been able to achieve current ratings as high as 45 amperes. The Heet Spreader is a high-efficiency thermal-transfer device which cools the relay's power SCRs by spreading their heat onto the device's die-cast aluminum base. Offered in 3, 5, 10, 25, and 45-ampere ratings, with voltage ratings of 120, 240, and 480 v, the relays use twin power SCRs



with built-in snubbers. (A snubber is a low-pass filter that protects the relay against damage and false triggering caused by transients.) The dual-SCR circuitry eliminates lock-on problems, and provides improved starting characteristics for inductive loads such as electric motors, solenoids, coils, and transformers. Resistive loads, such as traffic lights, are handled equally well. The relays all feature zero-voltage turn-on to prevent radio-interference problems, and they all include optical coupling for input/output isolation.
Optrol Inc., 5842 Research Drive, Huntington Beach, Calif. 92649 [343]

Time-delay relays are accurate to within 1%

A line of time-delay relays which are accurate to within 1% for any voltage-temperature combination from −70°C to +125°C and from 20 to 30 volts dc, has a repeatability of within 0.1% at any fixed voltage and temperature. Rated at 10 amperes, the relays are double-pole double-throw units with reset times of just 10 milliseconds. Standard fixed time



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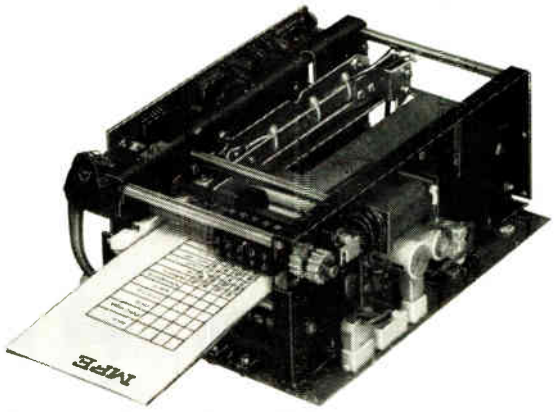

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The Gould 6000 Data Acquisition System: 128 fully floating and integrating inputs, scans to 200 points/sec.

The portable and rugged Gould 6000 analog to digital data logger-reader is the best way to monitor and precisely record low frequency data. It accepts both analog and digital input signals, converts the data to digital form, displays the data for real-time monitoring and stores up to 500,000 readings on a 3M ¼" computer grade mag-tape. It offers high noise rejection, high input impedance, programmable gain and much more.

Write Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Kouterveldstraat Z/N, B-1920 Diegem, Belgium.

GOULD

Circle 187 on reader service card

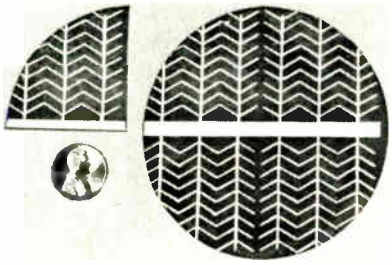
delays range from 500 ms to 180 seconds. Versions in which the time may be altered by changing an external resistor are also offered. The relays, which meet or exceed the requirements of MIL-R-6106 and MIL-R-83726, are said to be the first high-reliability units to attain their accuracy and repeatability. The relays consist of a Deutsch "E" series relay and a C-MOS digital timing circuit mounted in a package that measures approximately 1 by 1.25 by 1.75 inches.

In addition to the relays, Deutsch is producing a companion voltage sensor with time delay. Rated at 2 amperes, this unit picks up at a preset voltage and drops out when the voltage drops below a preset minimum for 150 ms. This unit is accurate to within 0.25 volt over the temperature range from −70 to +85°C.

Deutsch Relays Inc., 65 Daly Rd., East Northport, N.Y. 11731 [345]

Three-inch solar cell develops 1 ampere at 0.5 V

A silicon solar cell three inches in diameter can supply up to 1 ampere at 0.5 volt. Because it uses no lenses to increase efficiency, the device is extremely thin—0.001 inch thick.



Priced at $19.95, the cell (stock number 42,270) is claimed to deliver five times more power per unit cost than any previous cell. The unit can be ordered by mail; its price includes delivery charges. Smaller, cheaper, lower-power photocells are also available.

Edmund Scientific Co., 380 Edscorp Bldg., Barrington, N.J. 08007 [346]

Semiconductors

Schottky RAM draws 275 mW

256-bit memory has typical access time of 35 nanoseconds

A new Schottky TTL 256-bit random-access memory is as fast or faster than other devices of this type, but requires 50% to 60% less power, claims its developer, Advanced Micro Devices. The RAM, designed for use in high-speed core memories in digital systems, comes in two versions, the tri-state AM27LS00 and the AM27LS01, with open-collector outputs.

The address time over the commercial operating range, 0°C to 75°C, is 45 nanoseconds. The typical access time at room temperature is 35 ns, and a 55-ns access time is guaranteed over the military operating range, −55°C to +125°C.

But the AM27LS00/01s' main claim to fame, says Sven E. Simonsen, technical director, is low-power design, which yields a high ratio of speed to power. Its typical dissipation rating is 275 milliwatts, compared with 500 to 700 mW for other standard 256-bit bipolar RAMs. The typical power-supply current of 55 milliamperes, he says, is less than 60% of the typical current of competing devices. The devices have a 10% power-supply tolerance.

"The AM27LS00/01 are true low-power designs—not just reworked high-power designs," says Simonsen. "The process used is quite similar to that used in the ECL 10,000 devices. But added to it are Schottky diodes. The basic RAM matrix is ECL with current sources, which give us access speeds that vary little with temperature or input-voltage variations."

The 16-pin memories are organized 256 words by 1 bit with an 8-bit binary address field and separate data-input and output lines. In addition to either a three-state or open-collector output, the devices have three active low-chip-select inputs. All inputs are buffered to represent an input of only 0.5 of a transistor-transistor-logic load. The power-supply voltage may be 4.5 V to 5.5 V.

The commercial parts in hermetic dual in-line packages are $20.40 each in quantities of one to nine, $17 for 10 to 99, and $14.60 each in lots of 100 or more. Flatpacks are $28.60, $22.80, and $20, respectively. Military parts in hermetic DIPs are $37.75, $31.40, and $26.20 respectively, and the flatpacks are priced at $54, $45, and $37.50 respectively.

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086 [411]

C-MOS content-addressable memory holds 8 8-bit words

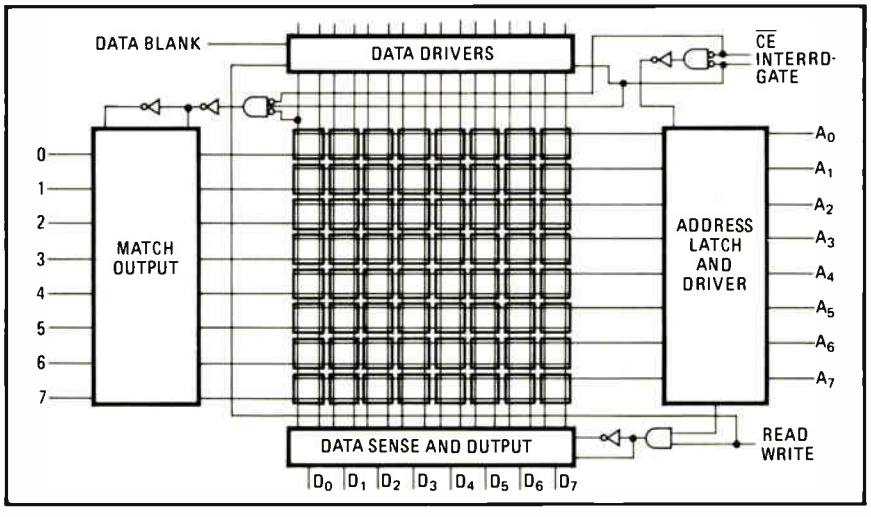
Believed to be the first content-addressable memory (CAM) on the market, the SCL5533 (shown below) is a 64-bit device organized as eight 8-bit words. A CAM is a new type of computer component that is capable of telling whether an input word is stored in the memory. Since it performs an exact match search, the CAM should be useful in pattern-recognition systems, air-traffic control, signal sorting, and system-control applications. The CAM has several modes of operation. In its interrogate mode, it responds with a yes or no when an input word is presented. In its learn mode, the CAM will write a word into memory if there is no match. Finally, the device has conventional read/write capability, and it can be used as a 64-bit random-access memory.

Typical interrogate time for an 8-bit word is 110 nanoseconds, and read access time is 150 ns. A chip-enable function allows many chips to be combined into a memory bank of any desired capacity. The device's inputs are compatible with C-MOS and its outputs are compatible with tri-state MOS or TTL. The quiescent power requirement of the static memory is 25 microwatts. Housed in a 48-pin ceramic dual in-line package, the SCL5533 costs $21 in lots of 1,000. Delivery is from stock.

Solid State Scientific Inc., Montgomeryville, Pa. [413]

Six-function chip works with printing calculators

A calculator chip that performs the four basic arithmetic functions and also has percentage and memory operations, contains all of the logic needed to interface with a Seiko 102/104 printer or its equivalent. A line of output buffering allows the model 1022 MOS/LSI circuit to be calculating or accepting keyboard entries while a print operation is underway. The 12-digit cal-



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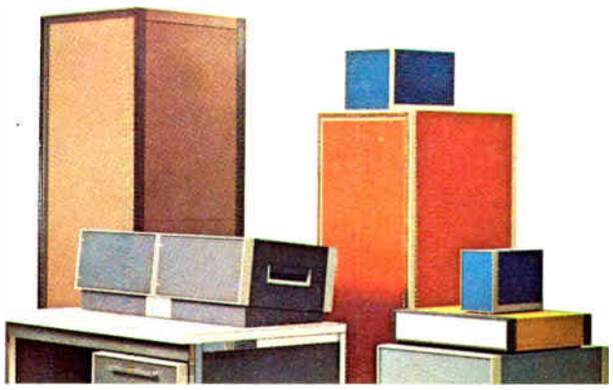
Circle 145 on reader service card



culator is housed in a 40-pin DIP and sells for $45 in hundreds.
SMC Microsystems Corp., 35 Marcus Blvd., Hauppauge, N. Y. 11787 [412]

C-MOS analog multiplexers consume only 15 milliwatts

New products

pins, TI had to get rid of three pins to put the new device into its 18-pin package. One pin was eliminated by multiplexing the data input and output ports together—making the device usable only in bus-oriented systems. A second pin was dropped by generating the chip's 5-volt supply on-board from the +12-V supply, thus making a separate 5-V input unnecessary. The third pin that was eliminated was the chip-select pin, a function that TI estimates is unused in 90% of the device's applications. Active power dissipation of the RAM is 350 milliwatts. Pricing, in quantities of 100 to 999, is $26.73 each for plastic packaging, and $30.69 for ceramic.

In a move similar to that of TI, National Semiconductor has announced the development of a 4-k n-channel silicon-gate RAM, to be housed in an 18-pin DIP. Called the MM5270, the device is expected to be available in production quantities by the middle of this year, the company says.

Texas Instruments Inc., Inquiry Answering Service, P. O. Box 5012, Dallas, Texas 75222 [414]
National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. [415]

1,024-bit, n-channel RAM has 60-ns access time

Representing RCA's initial entry into the n-channel market, the model MW7001ID is a static random-access memory, organized 1,024 by 1 bit that has a maximum access time of 60 nanoseconds. The LSI device, which is pin-compatible with the AMS 7001I, made by Advanced Memory Systems, has a 180-ns maximum cycle time, TTL-compatible inputs, and a maximum power dissipation of 650 milliwatts. In its standby mode, the memory consumes a maximum of 512 microwatts. Housed in a hermetic, ceramic, 22-lead, dual in-line package, the MW7001ID is priced at $10.50 each in quantities of 1,000.

RCA Solid State Division, Box 3200, Somerville, N. J. 08876 [416]

An autoranging DMM for only $299?

Yes. And it's a KEITHLEY—no less. The new Model 168 is a full-function DMM. It measures ac/dc volts, ac/dc amps and ohms too. Autoranging, optional battery operation, two-terminal input, push-button operation and lighted function indicators are only a few of its added features. Send for full details now.

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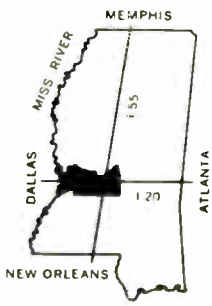

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Harry McLemore or George Kurts

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Circle 191 on reader service card

You don't have to buy a new car to get an electronic ignition.

Let's face it. After 37 years, even a Phantom III can use a lift. That's why I put a Delta Mark Ten B Capacitive Discharge Ignition on my Phantom . . . to give her a spark I'd pit against any '75 model car. I went to Delta because they aren't Johnny-come-latelys. Delta's been making electronic ignition systems for over a decade.

Whatever kind of car you drive, you can give it the same great Delta performance I gave mine.

- Mark Ten B Capacitive Discharge Ignition Systems are manufactured by Delta Products, Inc., a company with a conscience, and with a proven record of reliability both in product and in customer relations.
- The Mark Ten B really does save money by eliminating the need for 2 out of 3 tune-ups. Figure it out for yourself. The first tune-up or two saved pays for the unit, the rest is money in your pocket. No bunk!
- Because the Mark Ten B keeps your car in better tune, you actually can save on expensive gasoline.
- With a Mark Ten B, spark plugs stay clean and last longer . . . fouling is virtually eliminated.

I want to know more about Mark Ten B CDI's. Send me complete no-nonsense information on how they can improve the performance of my car.

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Mark Ten B, assembled	$64.95 ppd	Standard Mark Ten, assembled	$49.95 ppd
Mark Ten B, kit	$49.95 ppd	Deltakit®	$34.95 ppd

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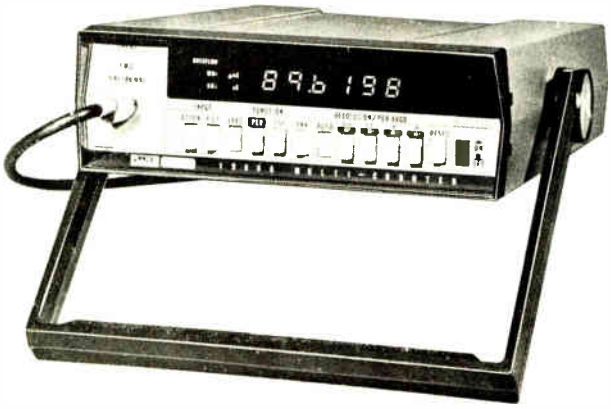

This may look like a multimeter... but it's really an autoranging multi-function counter

We've had a lot of comments that our new 1900A multi-function counter looks like our 8000A multimeter. We agree. In fact we planned it that way. Both are attractively styled and designed for user convenience. But inside they're vastly different instruments.

The 1900A is an advanced LSI/MOS multi-function counter with . . . autoranging in both frequency and period mode . . . 5 Hz to 80 MHz range with 25 mV sensitivity . . . event counting to 10^6 . . . automatic overflow . . . six digit LED display with automatic annunciation . . . all for the unbelievably low price of $349.*

Plus you can order a rechargeable battery option, or a data output option that lets you use the 1900A in systems applications.

And just in case you're wondering – here is what the 26 range, 5 function 8000A multimeter looks like.

Phone your local Fluke distributor to-day for a demonstration, or contact us direct.

*U.S. price F.O.B. Buffalo, N.Y.

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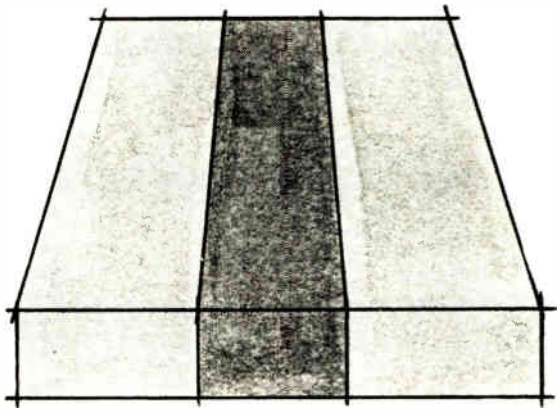


Circle 161 on reader service card

YOU'RE WHISTLING IN THE DARK...

if you think that heart disease and stroke hit only the other fellow's family.

GIVE... so more will live
HEART FUND

Contributed by the Publisher

Circle 148 on reader service card

Data handling

Cartridge drive built for field

Unit has many features of large tape drives; stores 1,600 bits per inch

Though many tape drives using the ¼-inch 3M cartridge are designed as a step up from insufficiently rugged cassette drives, a new drive from Data Electronics Inc. is designed down from a ½-inch reel-to-reel drive. President Hal H. Georgens says the model CMTD-3000 drive is intended for a harsher field environment than the typical clean computer room.

Like a traditional tape drive, the new unit requires only a few moving parts—basically a motor and capstan. The motor has a shock-resistant gimbal mount, and motor speed is controlled by an accurate tachometer pickup and servo system, rather than back-voltage from the motor. Other large-tape-drive features are a cast-aluminum mounting, rather than sheet metal, plug-in subassemblies for electronic and electromechanical modules, and optional tape-cleaner and hard-surface tape heads. The heads, a $70 to $80 option, provide more than 3,000 hours of tape life, three times that of conventional cartridge-drive tape heads, says Georgens.

The cartridge can be easily inserted and removed with only one hand.

The commercial version of the drive uses plastic ICs and other electronic components, the ruggedized version uses ceramic. Mechanical parts are identical.

Both drives are ANSI/ECMA-compatible with phase-encoded storage of 1,600 bits per inch and 23-megabit storage capability that can be transferred at 192 kilobits a second. One- or four-track serial or four-track parallel recording can be selected. Interfaces are TTL-compatible, and the tapes can be read while writing. Up to eight drives can be connected, with a 3-bit address selecting one. Four drives can be mounted in a 7-inch-high, 19-in.-wide panel, for 92 megabits of storage. The individual deck is 4.4 by 5.9 by 6.9 in.

Running speeds are 30 in./s writing with bidirectional reading, and 90 in./s (optional 120 in./s) bidirectional search and rewind. Instantaneous speed variation is under ±3%, with long-term variation under ±2%.

Power required is +5 volts, regulated at 1.5 amperes, and ±28 V, unregulated at 1.4 A (3-A surge), the company says.

The basic commercial drive is priced at $600 to $800 in quantities of 100, depending on options.

Data Electronics Inc., 370 N. Halstead St., Pasadena, Calif. 91107 [361]

Printers and plotters have 200-dot-per-inch resolution

The Versatec D900 series of electrostatic printers and plotters brings dual-array density and 200-dot-per-inch resolution to machines that accept economical 8.5-inch-wide paper. The series' dual-array writing head prints an overlapping dot pattern in a 16-by-16 matrix. Models include the LP-D960 printer, the D900 plotter, and the D900A printer/plotter. All use raster scan, a stationary writing head carrying a dual array of 1,600 styli evenly spaced at 200 to the inch, and the manufacturer's proprietary matrix electrostatic writing technique. The printer and printer/plotter can print 600 lines per minute asynchronous, with 100 columns per line and 12.5 characters per inch across the 8.5-in. paper. The plotter and printer/plotter can plot 1.25 in. per second in paper-drive increments of 0.005 inch. Plotting width is 8 in. Small-quantity prices are: $6,700 for the LP-D960 printer, $7,800 for the D900 plotter, and $8,900 for the D900A printer/plotter. Delivery time is 30 days.

Versatec, 10100 Bubb Rd., Cupertino, Calif. 95014 [363]

Compact data terminal prints 34-character lines

A compact, stand-alone printer—the 5010 data terminal—prints 34-character lines at a rate of 110 characters per second, or 90 to 240 lines per minute, depending upon line length. Built around the same printing mechanism as Victor's top calculator line, the 5010 is expected to find applications in receive-only terminals, as a print-out device for circuit-board testers, in microcomputer systems, and in general data-logging and communications equipment. No parts move when the terminal is idle; its motor runs only when it is printing. Thus wear is reduced, and reliability is enhanced. Double-line buffering permits a new line to be received while the previous one is being printed. The terminal, which prints in two colors on standard 3.75-inch adding-machine paper, has an elongated-character mode in which it prints lines up to 17 characters wide at double width. The machine measures 12 by 18 by 6.5 inches, and weighs 16 pounds. Its small-quantity price is $1,195.

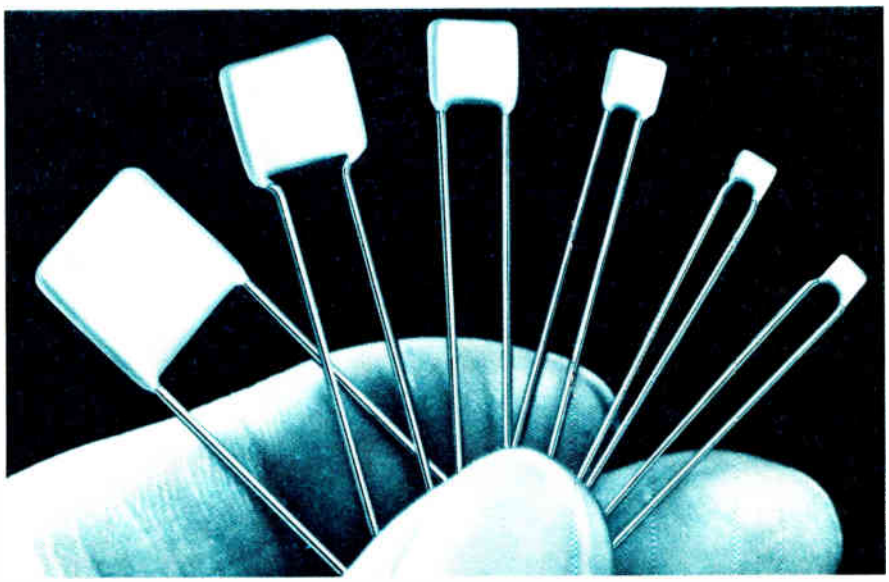
Victor Comptometer Corp., 3900 North Rockwell St., Chicago, Ill. 60618 [365]

Impact printer bangs out 330 characters per second

Able to print at rates as high as 330 characters per second, or 125 lines per minute, the 102AL is a 132-column, serial, impact printer that makes extensive use of large-scale

QUALITY IN VOLUME

When you achieve it, you can offer true competitive value. That's just what we're doing at USCC/Centralab for 1975. MONO-KAP™ radial, and MONO-GLASS axial monolithic ceramic capacitors are now available to volume users *from stock* to eight weeks. Our investment and "learning curves" last year guarantee competitive responsiveness — USCC will welcome your specials and non-stock orders. Here's an offer you haven't heard lately — your money is going to buy more at USCC. Cash in on the best values in monolithic ceramic capacitors.



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MONO-KAP™ radial-leaded epoxy coated capacitors are reliable performers; they're rugged enough to work in MIL environments. 4.7 pF to 10 Mfd., 50 to 200 WVDC in 4 dielectrics, including Z5U, in a variety of case sizes featuring meniscus control to 0.032 inches. Large quantity orders from stock.

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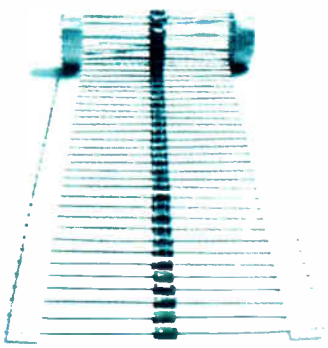
MONO-GLASS axials are glass encapsulated, designed for automatic PCB insertion; furnished reel-packed for high volume applications. They're available in 50 and 100 WVDC from 1 pF to 1.0 Mfd.; four dielectrics: COG, X7R, Z5U and Y5V.



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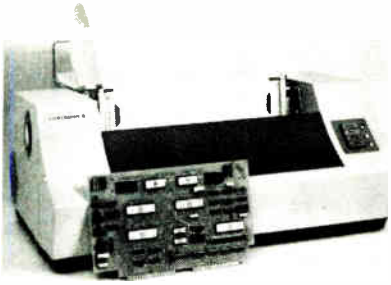
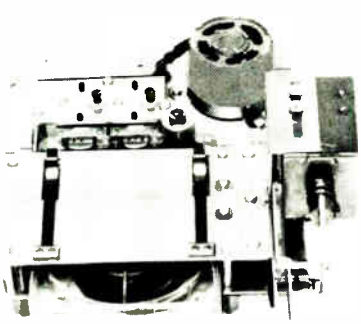


integration to minimize parts count and thus maximize reliability. The unit can produce an original and up to four copies. Its last printed line is always visible for immediate reading. In its standard mode, the printer produces a line of elongated boldface characters on command. Because it uses a dot-matrix technique for generating characters in a 9-by-7 pattern, the printer can easily handle a variety of foreign and specialized character sets. The small-quantity price of the 102AL is $4,675; delivery time is 60 days.

Centronics Data Computer Corp., Hudson, H. H. 03051 [364]

Endless-loop tape transport uses NAB A-size cartridge

The model A3 endless-loop tape transport is electrically controlled for remote operation and utilizes standard NAB A-size tape cartridges. Designed for machine-control, memory-refresh, telephone equipment, and other applications in which repetitive information is required or rewind is undesirable, the transport is modular in construction, to allow the addition of many different options for different purposes. The transport's high-traction, self-aligning pinch roller contains instrument ball bearings, thus eliminating tape-edge wear caused by the tape pulling up and down. Price of the A3 transport, in quantities of 1,000, is approximately $65 each depending upon which options are selected; delivery time for sample quantities is three weeks.



Amilon Corp., 49-12 30 Ave., Woodside, N. Y. 11377 [366]

Computer system, including display, sells for $5,400

Built into a single console, the 2220/2200S combines a CRT display, a tape cassette drive, a keyboard, 4,096 bytes of memory, and a central processing unit that contains a hardwired Basic interpreter. The price of the unit, which is a compact version of Wang's System 2200 computer, is $5,400. A leasing plan is also available. Included in the minimum-price configuration are several frequently used manipulation statements and mathematical functions such as SIN, LOG, HEX, and CONVERT. Finally, the computer has the capability of operating one additional peripheral, such as a printer. Optional at extra cost are additional memory (up to 16 kilobytes), a matrix read-only memory which gives the user 14 pre-programed matrix operations, and the capability to handle up to three additional peripherals. Delivery time for the 2220/2200S is four weeks after receipt of order.

Wang Laboratories Inc., 836 North St., Tewksbury, Mass. 01876 [368]

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Circle 152 on reader service card

Packaging & production

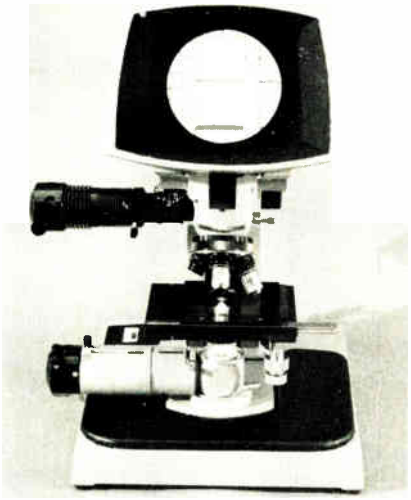
Big screen aids wafer inspection

Viewing head eliminates distortion, graininess, ghost images, reflections

Despite long strides toward automation in the semiconductor industry, certain key areas—such as inspection stations—remain in the hands of human operators. It is here that a wafer fabrication line, for example, can undergo drops in productivity due to the fatigue that workers suffer after long hours bent over binocular microscopes.

While it has not yet come up with a way of automating this particular job, Cobilt, a division of Computervision, has introduced a large-screen viewing head for microscopes that, according to Peter Wolken, vice president of marketing, will go a long way towards reducing eyestrain and muscle fatigue.

Called the model 730 Vistascan, the viewing head eliminates several of the problems that have kept this sort of system from use in jobs where particularly high resolution and accuracy are required—problems such as image distortion, graininess, ghost images and distracting surface reflections.



Using a specially designed optical system, the Vistascan is an aerial-image, biocular viewing head that presents a high-resolution, quality image at arm's length. And what is particularly important, he says, is that the image is flat and in focus over its entire field.

Other features of the Vistascan include an image diameter of 12 inches for convenient arms-length viewing; an image resolution that exceeds the visual acuity of any observer, as well as an essentially grainless display; a viewing surface that is free of ghost images and surface reflection; and a wide viewing angle of 25°.

In addition, says Wolken, the Vistascan performs well with low power illumination. Developed originally as an optional accessory for use with its CA-700 series inspection stations, Cobilt's model 730 viewing head can be used on a wide variety of microscope mountings, says Wolken. The viewing-head system will sell for about $2,000 each. In addition, Cobilt will market a model 750 Vistascan microscope system, which includes scope and viewing head, for $4,000 each.

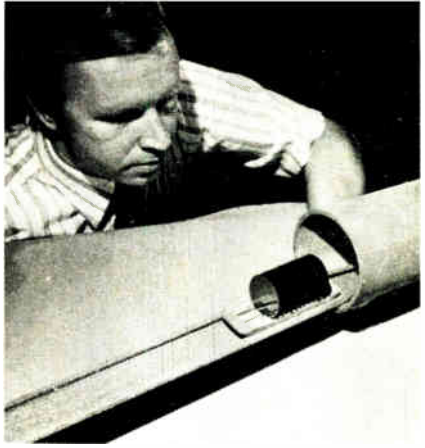
Computervision Corp., Cobilt Division, 1135 East Arques Ave., Sunnyvale, Calif. 94086 [391]

Silicon carbide replaces quartz in diffusion furnaces

For many IC fabrication jobs, diffusion-furnace components made of quartz will suffice. For some diffusion cycles, however, silicon wafers must be processed for three to four days at 1,200°C. Under these conditions, quartz systems have a life measured in only days or weeks.

But now Norton Co.'s Industrial Ceramics division has developed a diffusion-furnace system made of silicon-carbide components, and the company promises longer life, higher productivity, and better cost performance.

Called the Crystar system, it is said to improve the processing of



silicon wafers for semiconductor devices by making automated production and high-temperature operation possible on a broader scale than before.

Three silicon-carbide parts make up the system: a process tube, a paddle, and a wafer boat (see photo above). The process tube provides the controlled-atmosphere chamber in which wafers are processed. It needs no liner for support nor heat sink, thereby providing large wafer capability in existing furnaces. The paddle, a wheeled carrier for wafer boats, facilitates automatic insertion and withdrawal and eliminates quartz dust and sticking. The wafer boat provides support and assures separation of the wafers during processing. The process tube and wafer boats are treated with high-purity silicon, creating a nonporous, gas-tight body. These components may also be used separately in conjunction with quartz or other components.

The Crystar components can operate at 1,200°C to 1,300°C for months. In addition, Norton says, they have greater strength and better thermal-shock resistance than quartz. Prices for the tubes are $1,000 to $1,500; for the paddles, $600 to $700; and for the wafer boats, $100 to $500.

Norton Co., 1 New Bond St., Worcester, Mass. 01606 [392]

Backplane continuity tester is self-taught

The model N123 interconnection test system is a microprocessor-controlled continuity tester for manufacturers of small- and medium-size interconnection networks, including

CMOS RAMs: 2-for-1 sale!

Our 512-bit CMOS RAM sells for about the same price as those other 256-bit RAMs. Two bits for the price of one!

In 100-999 quantities, our silicon-gate S2222A will run you $15.36 a piece or just 3 cents a bit. 1000-4999 quantities really knock the price down—to $10.75 each.

The price isn't the only thing that's low. Standby power is less than 20 nanowatts a bit, and operating power 15 microwatts a bit. With that little power, just think what you can do with our RAMs in terminals, buffers, battery operated systems, portable calculators, time clocks, and military systems.

This is how our dense new CMOS RAM stacks up:

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- Static memory: no refresh
- Temperature range: 0° to 70° C
- Single read/write control line
- Simple memory expansion: chip enable
- 16-pin dual in-line package

The S2222, a higher performance version, is also available with standby power of less than 4 nanowatts a bit, 200 ns access time and 470 ns cycle time.

These days, you need to save every bit you can. Frank Rittiman will show you how. Call or write him at AMI, 3800 Homestead Road, Santa Clara, CA 95051. Phone (408) 255-3651. Or contact your distributor.

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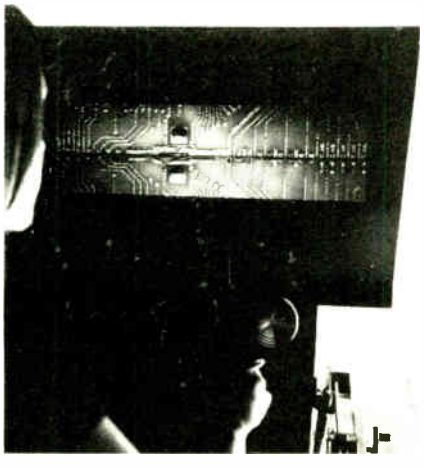
AMERICAN MICROSYSTEMS, INC.

backplanes, cable assemblies, and wiring harnesses. The system teaches itself the interconnection scheme by examining a known good network, and will find all wiring errors in a single pass. Both the interconnection pattern and the errors that are found can be printed out on a strip printer. The N123 includes a strip printer along with a simple keyboard, a CRT display, and a magnetic-tape cartridge unit. Its basic price is under $15,000; delivery time is 20 weeks.

Teradyne Inc., 183 Essex St., Boston, Mass. 02111 [393]

Visual comparator handles boards up to 16 × 16 inches

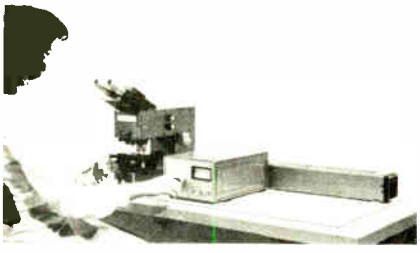
An optical circuit-board comparator allows an operator to compare production boards with a known good master board. The comparison is made on a magnified split-screen image in which corresponding narrow sections of both boards appear to flow out of the center line as moving mirror images. The full-color images are 3.6 times actual size, and can be increased to 7.2 times by an auxiliary magnifying lens. Image movement is under the operator's control so that he can start, stop, reverse, slow down, or speed up the machine. The manufacturer claims that the comparator can discern differences in line width or line position as small as two thousandths of an inch.



Metron Optics, P. O. Box 690, Solana Beach, Calif. 92075 [394]

Laser trimmer removes defects from MOS masks

A laser machine for the removal of defects from MOS photolithographic chrome masks completely vaporizes chrome spots as small as 1 micrometer and as large as 25 μm. The model LMT laser mask-trimmer is claimed to be particularly useful for



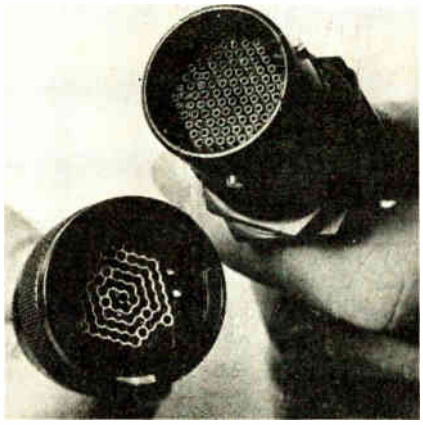
reworking hard-surface high-quality chrome masks such as are used for C-MOS circuits. It is said to produce edges as sharp as those produced by the photolithographic process itself. The trimmer also works well with emulsion masks. Price of the LMT is $29,500 with a Bausch & Lomb or equivalent microscope, and $39,500 with Leitz optics. Delivery time is 30 to 60 days.

Florod Corp., 5306 West 144 St., Lawndale, Calif. 90260 [395]

Connector packs 91 contacts into a size-15 shell

A line of circular connectors—the MD 73 family—uses a center-to-center contact spacing of 0.065 inch, thus making it possible to mount up to 91 contacts in a size-15 shell. Most other high-density circular

New products



connectors use a spacing of 0.080 inch and can typically hold only 61 contacts in the same-size shell. Potential applications for the new connector include instrumentation, telecommunications, and other systems in which efforts have been made to miniaturize the equipment. The MD 73 series is believed to be the first line of circular connectors to use the Twist/Pin concept, already proven in other types of connectors, in which seven helically wound wires form the contact pin. Each contact in the MD 73 series can handle 5 amperes and has a sea-level voltage rating of 1,000 volts rms. Prices range from $35 to $100 per mated pair, depending upon shell size and quantity. Samples can be delivered within eight weeks.

Malco, a Microdot Company, 220 Pasadena Ave., South Pasadena, Calif. 91030 [397]

Vacuum tool picks up, aligns dice and wafers

Operating from a standard shop-vacuum line, the Roto-Pic allows a user to pick up semiconductor wafers horizontally from trays and vertically from boats, as well as to pick up individual dice and align them without setting them down. The unit has a positive hold and release bar, which allows the operator to lift a finger without dropping the object. Rubber caps and various-sized tips are available, also a kit including vacuum pump and hoses.

Unitool Corp., 3740 Skypark Dr., Torrance, Calif. 90505 [399]

New literature

Power supplies. Forty-five new products, including regulated, unregulated, encapsulated subminiature, and constant-current power supplies, are described in a 24-page catalog available from Standard Power Inc., 1400 So. Village Way, Santa Ana, Calif. 92705. Circle 421 on reader service card.

Designing microwave circuits. Calculator application summary No. 5952-8924, entitled "Microwave Circuit Design with the HP 9820A & 9821A," tells how a new software package can be used to plot constant-gain and constant-noise-figure circles, to design impedance-matching ladders, to convert S, Z, Y, and H parameters to any or all of the three other types, and to perform many other microwave-oriented calculations and transformations. The summary is available from the Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [422]

Prefinished metals. A 20-page catalog covering the Nickeloid family of plated and laminated prefinished metals is offered by the American Nickeloid Co., Peru, Ill. 61354. The catalog includes design data and product-selection tables, as well as fabrication and assembly techniques. It covers chromium, nickel, brass, and copper platings, in addition to vinyl laminates and bonded color finishes. [423]

High-dielectric capacitors. Brochure No. 49-04, published by Murata Corp. of America, Rockmart Industrial Park, Rockmart, Ga. 30153, lists the company's line of high-dielectric ceramic disk capacitors. It includes technical specifications, dimensional data, temperature characteristics, and testing criteria. [424]

Solid-state switch drivers. A line of TTL-compatible solid-state switch drivers for shunt/series and series/shunt p-i-n diode switches is described in a six-page bulletin from LRC Inc., 1001 Digital Dr., Hudson, N. H. 03051 [425]

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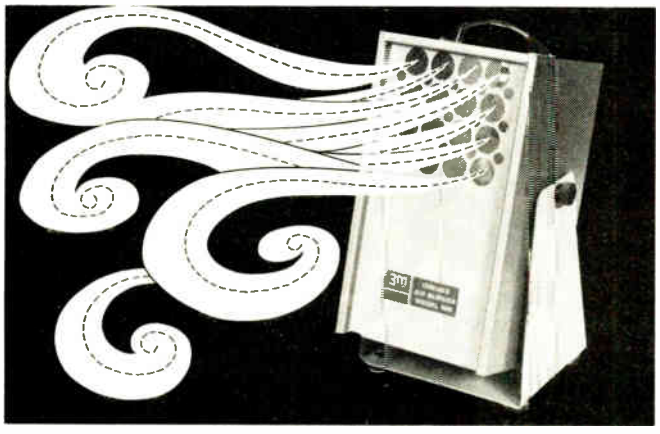

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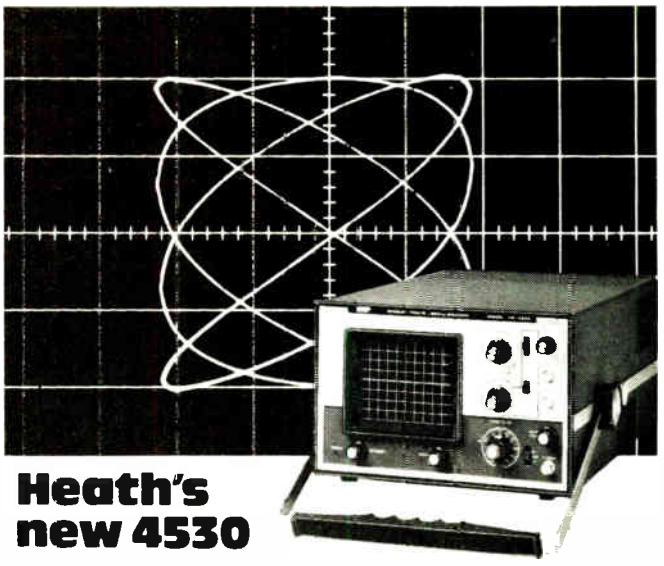

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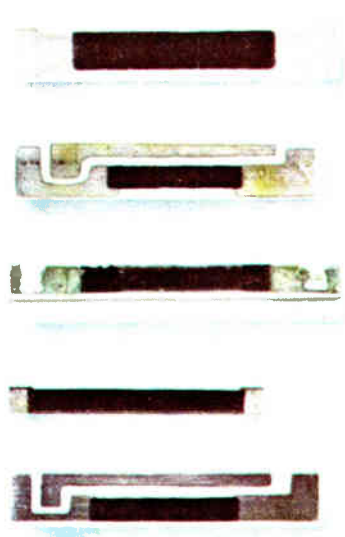

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