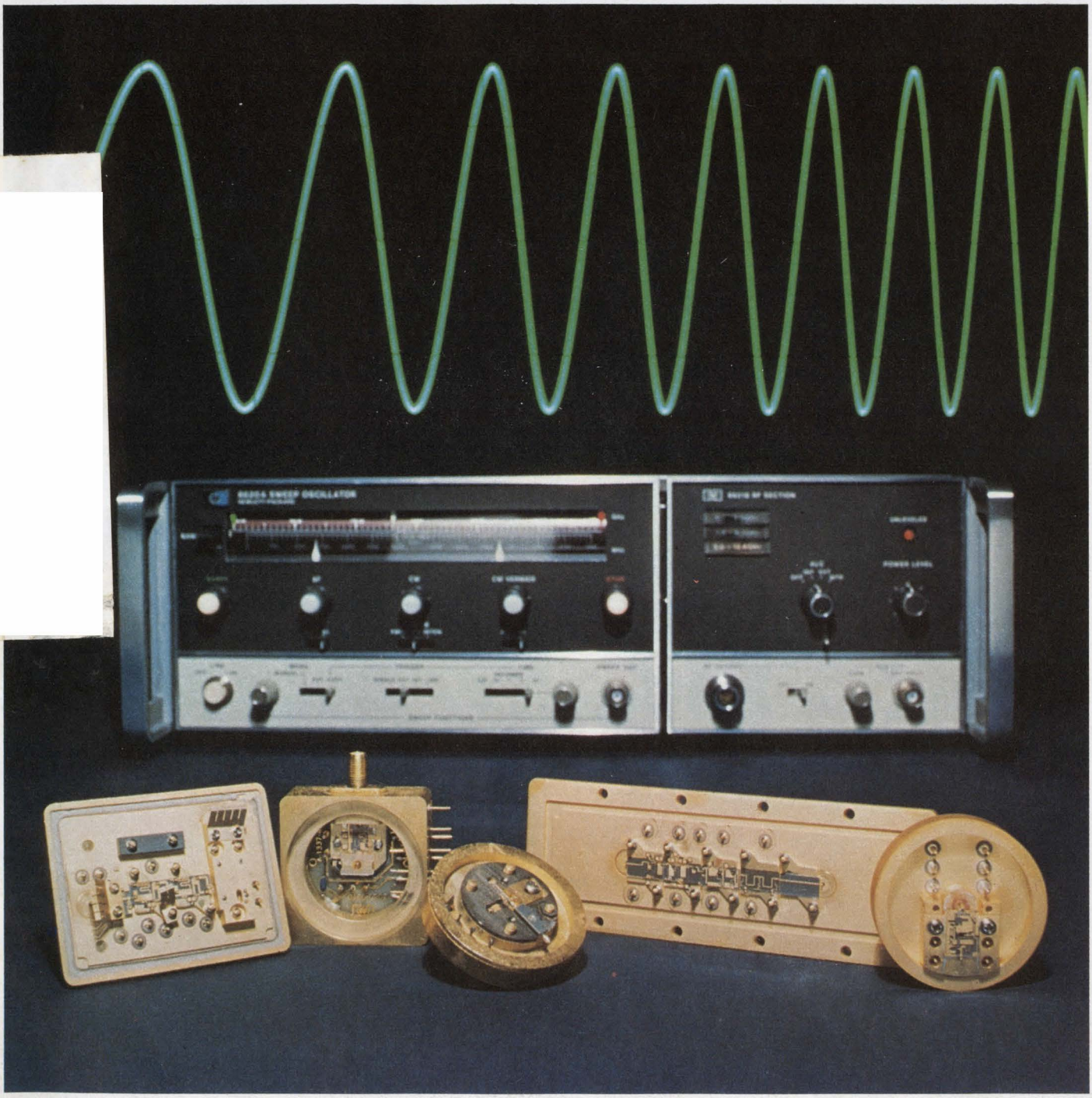
VOL. 23 NO.

Electronic Design 12

FOR ENGINEERS AND ENGINEERING MANAGERS

JUNE 7, 1975

Inside sweep generators: Better components have boosted the performance of sweepers. But frequencies still drift and power still varies over the band. Should you buy a narrow-band unit or one that covers a wide range in one swoop? Either way, you can expect problems. Stay level with sweepers, starting on p. 54.



Because you only have two hands.

AMPLIMITE high-density connectors

come with our exclusive, one-piece plastic strain relief/shield. You can't get one that's easier or less complicated to put on.

Hold the joined "clam-shell" in one hand. Turn the screw with the other. It's that simple to cut into your handling costs.

In addition, you have a highly versatile line of reliable and economical AMP high-density connectors.

With rack and panel interconnections as well as posted configurations. Straight as well as right-angle post contacts. And a variety of contact styles including some with insulation support features. Sizes are 9, 15, 25, 26, 37, 44, 50, 62, 78 and 104 positions.

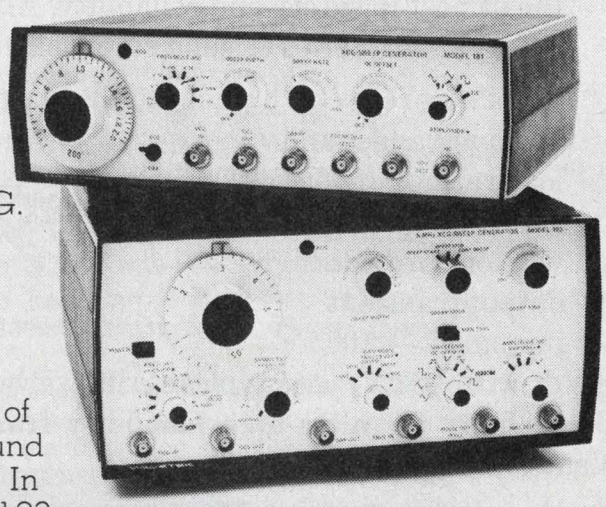
Of course AMPLIMITE connectors are intermateable with existing high-density types.

For immediate information, call (717) 564-0101. Or write AMP Incorporated, Harrisburg, Pa. 17105.

AMP
INCORPORATED

The most accurate word in function generators is XCG.

When we introduced the first of the 180 Series last month, we said we hadn't told you everything. What we didn't tell you about is XCG.



More 180s from Wavetek.

Now it can be told [or XCG revealed]

XCG stands for xtal-controlled-generator — which stands for a degree of accuracy never before found in any function generator. In both the Models 181 and 183, generator output is locked to a crystal at up to 25 discrete points on the frequency dial. This means they will produce waveform frequencies with synthesizer accuracy of 0.01% of dial setting. When you dial a frequency, you know it's precise, and you don't need a counter to prove it.

The Model 181 XCG/Sweep Generator $495

Besides being the most accurate function generator ever, the 181 is also a full sweeper — from 0.1 Hz to 2 MHz, with internal 1000 to 1 sweep. It provides sine, square, and triangle wave outputs (20V output p-p), as well as dc voltage, dc offset, and separate TTL output. And with full attenuation, you get ultra-clean signals down to −50dB. The only way you can come close to this performance is to buy the Model 180, which gives you everything but XCG for only $275.

The Model 183 5 MHz XCG/ Sweep Generator $695

As you can see, the Model 183 is a couple of hundred bucks more than the 181. Here's what that buys you: The 183 has a top frequency of 5 MHz, and provides continuous, triggered, and gated operation. For precise adjustment of continuous sweep, there's a control to individually set start and stop points. There's also a variable symmetry control and another for amplitude — down to −60 dB. All of this, plus XCG, add up to the most versatile and accurate function generator ever produced.

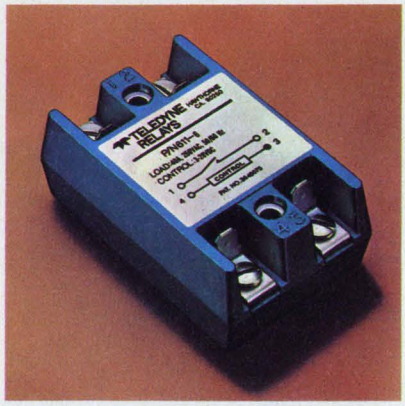
Our Conclusion

Now that you know something about the Wavetek 180s, you'll want to know more. So for complete specs or demonstration, just contact Wavetek, P.O. Box 651, San Diego, CA 92112. Or call (714) 279-2200.

WAVETEK®

INFORMATION RETRIEVAL NUMBER 2

An extra
our 611 S
AC solic



U.L. recognized

μsec guaranteed minimum
600-volt transient withstan
caused by over-voltage tran

All Teledyne 611s are optic
feature zero voltage turn-o
For added safety, we've enc
a rugged, high-impact packa
connections that include bot
and screw terminals. And in
heard, we're not the only on
package configuration.

All in all, if it's true reliabili
there's a Teledyne 611 ready
... in medical electronics, co
tool or process controls. For
assistance and fast delivery,

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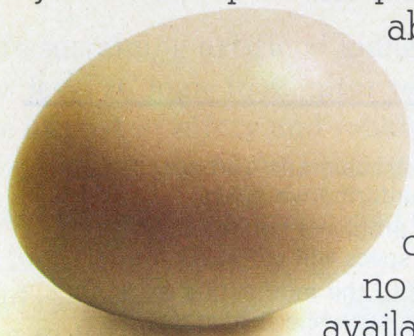
Telephone: 06121-30231/2 Telex: 04-18

How to bu

Which comes first—the hardware or the software? You n
to create new products with microcomputers. The tougher
you assure product profitability? That gets you into questio
ability, software support, design assist
in your supplier. When an electronics
cently asked readers
to rank their micro-
computer buying
criteria, it came as
no surprise to Intel that
availability, software sup-
port and supplier reputation topped the list.



Intel can supply you today with five general-purpose CPUs, supported by numerous peripheral, I/O and memory components, software packages and development manuals, and the industry's largest library of users' applications programs. Our five microcomputers span a 1000:1 performance range and include the lowest cost, highest performance and most popular designs available today. Their applications are equally broad from electron to high speed lers and proc want to make our customer begin designi pieces of the puzzle missin development cost, each CP more than a s matched syst advanced pro

INTEL MICROCOMPUTER SYSTEM FAMILIES

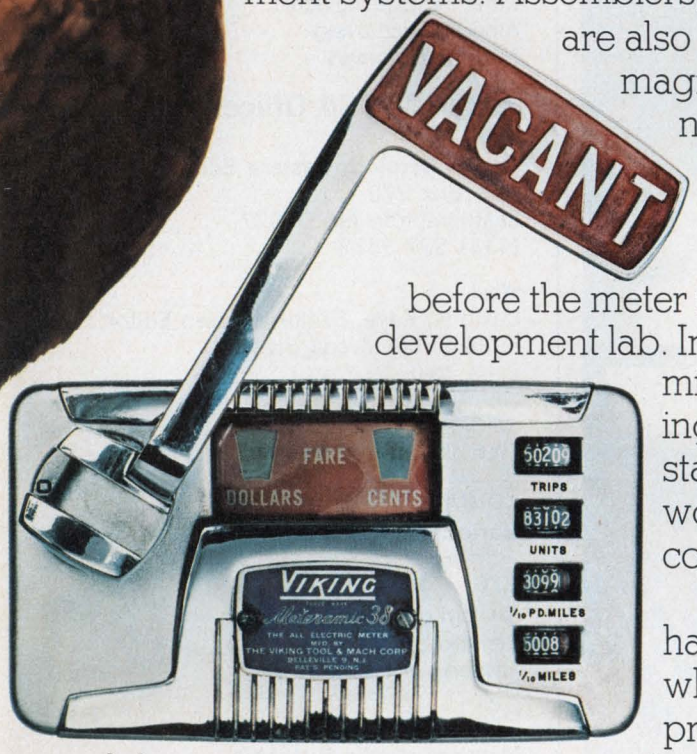
MICROCOMPUTER SYSTEM	MCS™4	MCS™40	MCS™8	MCS™80	Series 3000
CENTRAL PROCESSOR	4004	4040	8008	8080	3001, 3002, 3003
Technology	PMOS	PMOS	PMOS	NMOS	Schottky Bipolar
Parallel Bits	4	4	8	8	2 per 3002 CPE
Instruction Cycle	10.8μS	10.8μS	12.5μS	2μS	100nS
SUPPORT COMPONENTS					
RAMS (including CMOS)	4	4	5	5	8
PROMS	3	3	3	4	7
ROMS	4	4	3	3	6
*Peripheral Interfaces	6	6	6	6	8
Interrupt Unit			1	1	1
Clock Generator	1	1	1	1	TTL
*I/O Units	5	5	3	3	3
Total Component Choices	23	23	22	23	33
SYSTEMS SUPPORT					
Software Packages					
Microassembler					1
Assemblers	2	2	2	2	
Compiler			1	1	
Monitor	1	1	1	1	
Simulator	1	1	1	1	
Text Editor			1	1	
Manuals	6	6	5	6	1
User's Library	Yes	Yes	Yes	Yes	Yes
Intellec® Development System	Yes	Yes	Yes	Yes	In development

* Five additional I/O and peripheral devices will be available in 2nd half of 1975.

icrocomputer.

subsystems, peripheral interfaces, clock generators, priority interrupt and other control units, and the broadest selection of erasable and bipolar PROMs, compatible metal mask ROMs, CMOS and NMOS RAMs.

Moreover, Intel software packages include resident monitors, assemblers and text editors available on Intellec® microcomputer development systems. Assemblers, simulators and compilers are also available as cross products on magnetic tape or on leading time share networks. With these aids programs can be written and debugged in a fraction of the time required a few years ago.



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With Intel, there's no shell game about hardware or software delivery, no guessing whether the supplier can handle all your production commitments. Intel has been delivering microcomputers in volume since 1971. Our reputation speaks for itself. We've already delivered more general-purpose microcomputers than the rest of the industry combined.

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Across the Desk

Article on modems prompts a critique

The article "Build Compact Modems" (ED No. 1, Jan. 4, 1975, pp. 74 to 81) discussed a design approach to implement FSK modems. Since the Vadic Corp. is the largest supplier of such modems in the U.S., we feel impelled to comment on the technical merits of the design. Although the article did not state what modems or lines would be connected, it did leave the reader with the false impression that the design would be compatible with Bell 103 modems over the telephone company network.

The Bell 103 modem operates full duplex and requires 70-dB rejection of the local transmit carrier. The proposed design provides 45 dB of rejection. The measured error probability stated in the article approaches 0.5 dB of theoretical; however, this number is very theoretical, since it does not take into account distortions (frequency translation, impulse noise, jitter, etc.), other than white noise on the dial network. The hybrid (duplexer) used does not take into account reactive components in the telco network, and therefore offers generally less rejection than noted.

Ken Krechmer
OEM Marketing Manager
Vadic Corp.
505 E. Middlefield Rd.
Mountain View, CA 94043

The author replies

The objective of the article was to provide the basic fundamentals and guidelines for building FSK modems with LSI techniques. Consequently various connecting arrangements and optimum design specifications for specific systems were not detailed.

I agree with Mr. Krechmer's comment on Bell's 103 filtering level. This is identified in the article on p. 77 as follows: "Modems that are designed for a wide dynamic range of input signal levels (−15 to −55 dBm) require better than 70-dB rejection of the local transmit carrier."

I also agree with his statement that the duplexer does not take into account reactive components in the telephone network. This is pointed out on p. 76: "In practice, the line impedance can have reactive as well as resistive component variation."

Mr. Krechmer points out that the article did not take into account many of the distortions on the dial network. System tests have proven that performance for a worst-case 3002 line is degraded typically by 2 to 3 dB when the line specs are 10-Hz frequency translation and 15° p-p phase jitter at a 180-Hz rate.

Another disturbance that reduces data throughput is line dropouts. Such occurrences, up to 32 ms, are bridged by the MC-6860, so that channel establishment is maintained and data transmission can continue.

Modems using the MC6860 are compatible with Bell's 103, in that the handshaking protocol requirements are met, the Tx-Rx frequencies are common and data transmission can occur.

Modems designed to be equiva-

(continued on page 8)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N.J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

lent to a Bell 102, however, must contain more selective filters than those shown in the design example.

Garth Nash

Motorola Semiconductor
Products Inc.
5005 E. McDowell Rd.
Phoenix, AZ 85008

Throw-away calculator viewed as practical

Your Jan. 18, 1975 issue was a great boon to the scientist/engineer still trying to decide on buying a scientific calculator—or, indeed, to those of us considering a second calculator ("Special Report on Scientific Calculators," ED No. 2, pp. 24-30). I recently had to get my 1972 scientific calculator repaired. Compared with the original cost of the machine, the factory's minimum repair charge didn't appear large, but when compared with the current price of the machine or brand X's equivalent cost, the repair charge took "an arm and a leg."

It may be that with today's high labor costs, we're rapidly approaching the time that it will be uneconomical to repair calculators. They may become "throw-aways," just as transistor radios have become.

With this in mind, the engineer/scientist may well want to pass up his first-choice machine, with its many "convenience" features, for one with less convenience but a substantially lower price. By the time the unit needs repair out of warranty, it will truly be a throw-away.

Justin Whitney

6920 E. 17th St.
Tulsa, OK 74112

Author corrects an Idea for Design

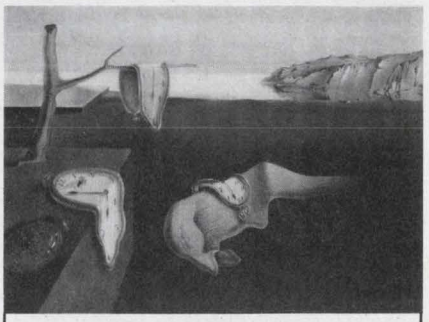
In my Idea for Design, "Optical Coupler Helps Transmit Data and Clock Signals on Single Wire Pair" (ED No. 26, Dec. 20, 1974, p. 104), the optical couplers in the text, to be consistent with the diagram, should be labeled OC3 and OC4 rather than G3 and G4. The polarity of the input diode on OC4 should be reversed, so it is opposite from the polarity of the input diode on OC3.

The circuit will not work as published without the above corrections.

Richard Gunderson
Senior Project Engineer

ADC Telecommunications
Div. of Magnetic Controls Co.
4900 W. 78th St.
Minneapolis, MN 55435

Misplaced Caption Dept.



"Damn those Mil temperature specs."

Sorry. That's Salvador Dali's "The Persistence of Memory," which hangs at the Museum of Modern Art in New York City.

Parentheses called simple to use

MOS Technology, Inc., pioneered the two-parentheses, hand-held scientific calculator and was a source of chips for almost all such units delivered in 1974. Thus I thought that you might be interested in an example of the calculating power of a two-parentheses machine, an RPN machine and a machine identified as AESH in the article written by John A. Ball. Memory register is not used but reserved for getting out of trouble in tough problems.

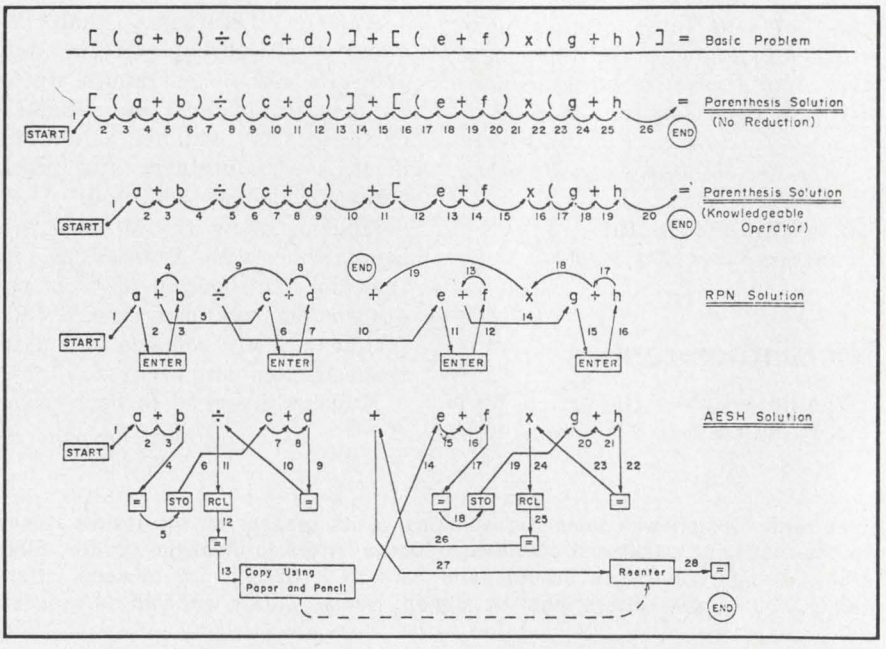
It is our contention that the two-parentheses machine is the simplest to use in complex problems and does not require the special training referred to by Mr. Ball. The problem solved four ways in the figure is

$$\frac{a+b}{c+d}+(e+f)(g+h).$$

One of the sequences for the two-parentheses machine is a brute-force approach, whereas the other is a knowledgeable approach that omits unnecessary parentheses. We believe that ease of use is more important in reducing errors than key stroke count. The AESH machine not only requires auxiliary memory to solve this problem but also calls for the use of paper and pencil.

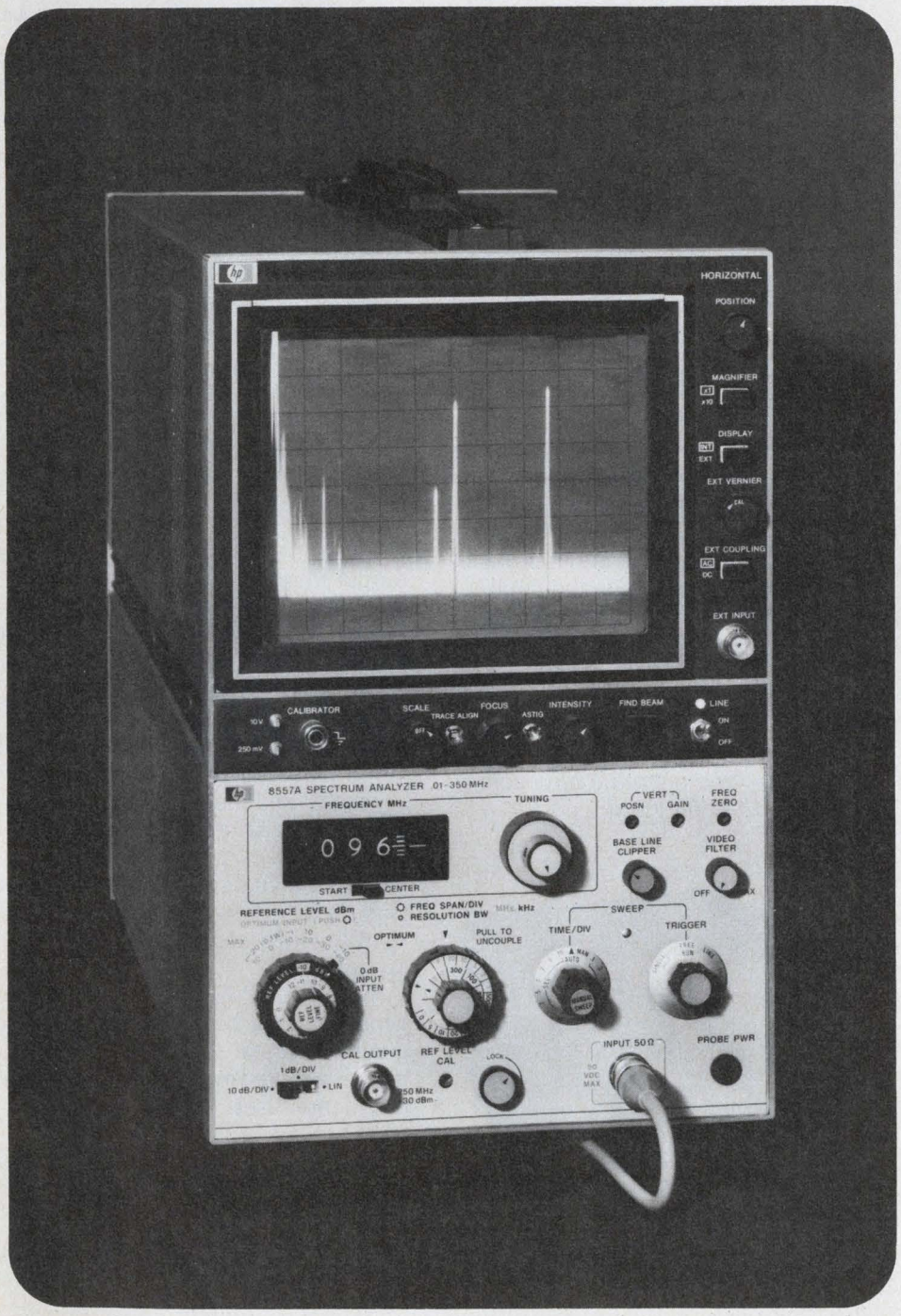
John Paivinen
President

MOS Technology, Inc.
Valley Forge Corporate Center



MEASUREMENT COMPUTATION NEWS
innovations from Hewlett-Packard

JUNE, 1975



in this issue

New VHF Spectrum Analyzer Offers Lab-Grade Performance at a Low Price

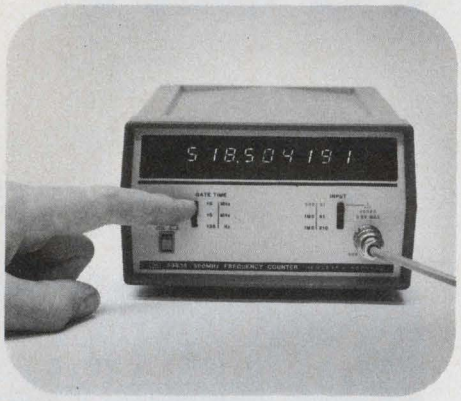
New 350 MHz Spectrum Analyzer plug-in is accurate, easy to use, and economical.

In the past, engineers usually time-shared one expensive spectrum analyzer, even though most of their measurements did not require high resolution. Now comes an analyzer priced for every bench, so the expensive analyzer can be reserved for more demanding measurements.

The new HP 8557A Spectrum Analyzer, a plug-in for HP 180-series scopes, features performance and accuracy that qualify it for lab use. Yet its ease of operation and economy make it attractive for such cost sensitive applications as production test, service, maintenance, and education. With 10 kHz to 350 MHz range, it's well suited for CATV, telecommunications, mobile radio, broadcast systems, navigational aids and telemetry measurements.

(continued on third page)

Direct counting up to 520 MHz with NEW low cost counter



Simple, virtually error-free operation complements the 5383A's high accuracy.

Low cost counters generally use prescalers (input frequency dividers) to get up to 500 MHz. Unfortunately, prescalers impose a resolution or speed penalty—usually a decrease of 4 to 10 times. Now, however, by borrowing unique circuitry from our sophisticated higher priced counters, we're able to offer the HP 5383A, a new, laboratory quality, low cost model using the speedy, accurate, direct counting technique. This technique gives 1 Hz resolution up to 520 MHz using a 1 second gate time.

You're likely to find the 5383A close to ideal for production line testing, communication, navigation and telemetry equipment servicing and R&D since it offers a host of useful features such as:

- 10 Hz to 520 MHz, direct counting
- Nine digit readout
- Accuracy of ±1 count ± time-base error
- Time base aging rate <0.3 ppm/month
- Optional TCXO time base for high accuracy calibration needs
- 1 megohm, or fuse protected 50Ω input
- 25 mv to 50 mv sensitivity
- Gate times of 0.1, 1.0, 10 seconds
- Rugged aluminum case.

Start on your way to speedier, more certain frequency measurements by looking into the 5383A today.

For a data sheet, check J on the HP Reply Card.

New 4-Channel Recorder with Interchangeable Plug-ins offers greater versatility

Now you can record one to four input signals against time with the new HP 7404A oscillograph recorder. You can adapt this new recorder to your varied applications including the capability to amplify and measure dc signals with a broad range of sensitivities, or record transducer outputs with ac or dc excitation supplied.

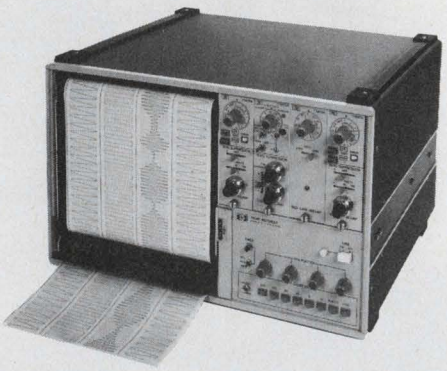
With the choice of plug-ins, you can measure parameters such as voltage, pressure, flow, force, displacement and temperature with respect to time.

The 7404A is a four-channel recorder but will also record on two 80 mm-wide channels.

Clear traces that dry immediately upon contact with the paper are produced by the pressurized ink system of these units. The pens are designed to last the life of the instrument, and will not be damaged by any input signal frequency.

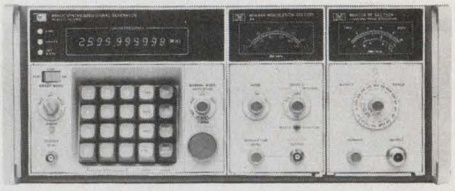
Twelve chart speeds are front-panel selectable as standard on the 7404A. Remote operation is also possible by contact closure or TTL.

To help you choose the recorder for your needs, find out more by checking L on the HP Reply Card.



New 4-channel recorder with easy paper loading, rugged stainless steel pens, modular construction.

New 1-2600 MHz signal generator features phase modulation, is HP Interface Bus compatible



L-Band communications and telemetry applications now have a new precision signal source.

The new HP 8660C synthesized signal generator spans the range 1 MHz to 2600 MHz in steps as small as 2 Hz. Also being introduced are two new modulation plug-ins which offer HP's first calibrated phase modulation capability.

This added frequency range and phase modulation capability provides precision signals needed to test satellite and space telemetry receivers or communications links. Or, it can serve as a local oscillator in certain frequency-agile transmission systems. The phase modulation also permits comprehensive analysis of phase-lock loop circuits.

The new plug-in modules include an RF Section (86603A) which generates output from 1 MHz to 2600 MHz at levels from +7 dBm to −136 dBm. Model 86634A is a phase modulation plug-in which provides calibrated, linear phase modulation at rates to 10 MHz. Another new modulation plug-in (86635A) provides phase modulation plus frequency modulation.

The 20-key mainframe keyboard provides digital entry of center frequencies, steps, or sweeps. The synthesizer's digital sweep mode is particularly useful in testing extremely stable or sharply tuned components, such as crystal filters.

With the HP-IB (Interface Bus), the generator may be connected as a programmed signal source for a variety of user-assembled mini systems for lab and production uses. (Option 005)

To receive more information, check Q on the HP Reply Card.

New Bench Supplies for MOS, CMOS and Linear IC Designs

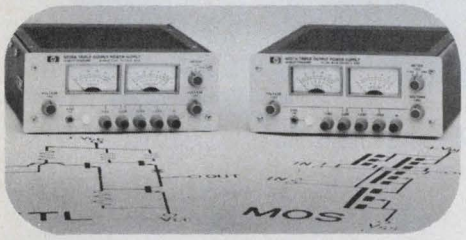
Now there are two low-cost bench supplies designed specifically for industrial and educational labs working with MOS, CMOS and Linear integrated circuits. The HP 6237A delivers three outputs: 0 to 18V, up to 1A; and dual-tracking 0 to ±20V, 0 to 0.5A.

The Model 6237A, and the 6236A shown below, are compact, easy to use and incorporate the key performance and safety features needed in the lab environment.

The complimentary Model 6236A has outputs: 0 to 6V, up to 2.5A; and 0 to ±20V, 0 to 0.5A, and is intended primarily for use with TTL/Linear IC designs.

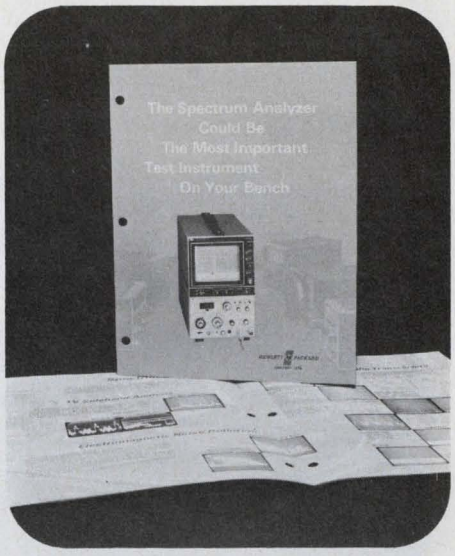
Each supply can be powered from a nominal 100V, 120V, 220V, or 240V, 47-63 Hz ac input. Both the single and dual-tracking outputs are protected from overloads by fixed current limiting circuits.

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



What every industrial and educational lab needs: convenient, low-cost dc power for TTL, MOS, CMOS and Linear IC test and development.

Why you should consider spectrum analysis



Our new spectrum analysis brochure shows the spectrum analyzer's versatility in making RF signal measurements such as field strength, power, noise, frequency, distortion and modulation. The brochure demonstrates these measurements as they may apply to your work: in powerful techniques for component evaulation, equipment testing and system performance verification.

In addition, the brochure is a guide to help you select the right analyzer for your application by defining critical spectrum analyzer specifications such as resolution bandwidth and amplitude measurement range.

For your copy of the brochure, check U on the HP Reply Card.

New automatic receiver system for versatile communication uses

The HP ARS-400 is a fully automatic precision receiver for signal detection and analysis in the 100 kHz to 18 GHz frequency range. It has many useful applications including satellite system monitoring, spectrum management, site surveillance, electronic intelligence, and EMI testing.

The system consists of reliable, field-proven commercial equipment under program control. The high-speed precision receiver features IF bandwidth from 10 Hz to 3 MHz, multiple detectors for AM, FM and SSB detection.

Specially designed calls have been included to allow the receiver to tune and measure at very fast rates.

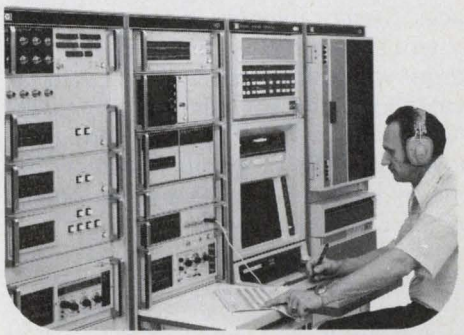
Application programs can be created by the user and stored on the disc unit for future use. Output data is written on the IBM-compatible, 9-track magnetic tape for later analysis on the ARS-400 or larger computer systems.

Critical signal parameters such as power, or modulation levels, signal bandwidth, carrier-to-noise ratio, etc. can be provided on-line.

The ARS-400 is capable of gathering significant amounts of usage information over several communications channels. This data can be analyzed on-line or stored on magnetic tape.

The ARS-400 is a totally integrated system, providing a fully characterized precision receiver, data processing capability, interactive graphics, and mass storage devices.

For details, circle P on the HP Reply Card.



New fully automatic precision receiver for spectrum management, electromagnetic interference, site surveillance, or system monitoring.

New VHF Spectrum Analyzer

(continued from page one)

Signal amplitudes from +20 dBm to −117 dBm may be measured and viewed over sweep widths ranging from 350 MHz down to 50 kHz. Eight resolution bandwidths from 1 kHz to 3 MHz permit a wide variety of measurements, such as viewing modulation or analyzing pulsed RF spectra.

Impressive, also, is the 8557A's ease of operation. Most measurements are a simple three step process:

1) Tune the inverted marker to the signal to be measured and read its frequency on the digital readout.
2) Zoom-in on the signal by decreasing the frequency span (bandwidth, sweep time, and video filtering are set automatically).
3) Raise the signal to the top of the CRT and read its amplitude (in dBm) from the reference level control.

Versions of the 8557A for measurements in 75 ohm systems are also available.

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

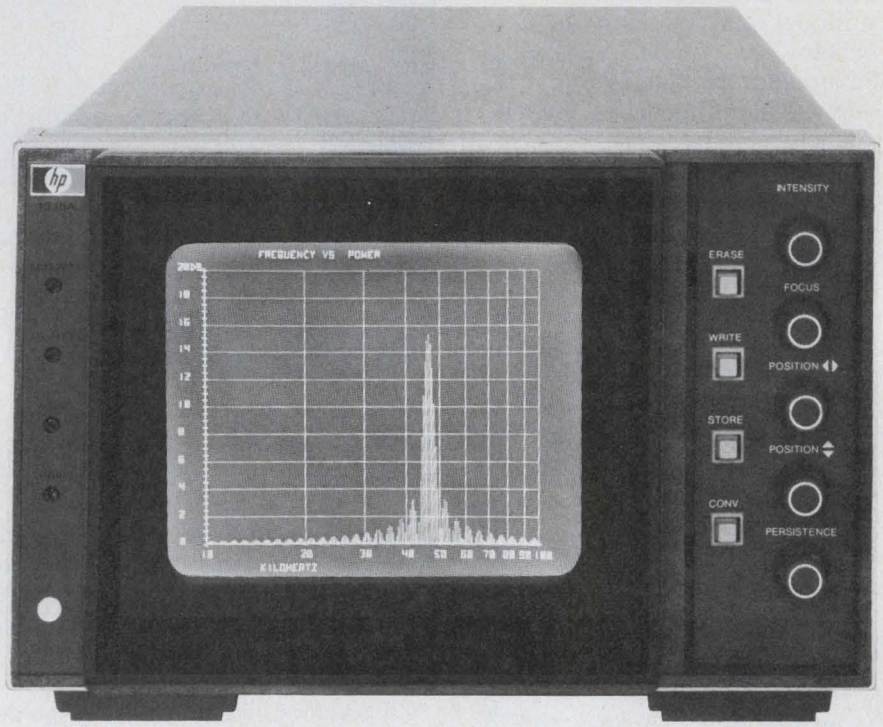
New RTE-III Operating System manages up to 512K bytes of memory, up to 64 partitions

Hewlett-Packard's new RTE-III is a disc-based real-time operating system that manages up to 512K bytes of memory, organized in partitions, using the Dynamic Mapping System in 21MX M20 or M30 Computers. Up to 64 multi-user partitions can be defined for simultaneous use such as executing and developing programs, and managing data in a variety of high-level languages that can include FORTRAN IV, Multi-User Real-Time BASIC, and ALGOL. RTE-III supervises execution of many different user's programs in a multi-programming mode; programs may be scheduled by time, events, other programs, or operator command. Software includes a file manager for easy access to random or sequential files. Disc storage can start at 5M bytes, and can be expanded to 118M bytes.

With RTE-III, users at multiple terminals may be developing interactive programs while other user's terminals are engaged in data management. Multi-stream batch processing can be used to provide job control over program development and other background operations. Optional distributed multi-processing software provides for real-time program scheduling and file management functions from remote satellite computers. RTE-III can support a variety of peripherals, including mag tapes, line printers, card readers, plotters, and analog and digital I/O interfaces. System integrity is safeguarded; system software provides for power-fail restart with intact programs and data; a watchdog timer calls the user when I/O devices fail to respond. There are now two levels of memory protection, one by hardware fences and the other by the Dynamic Mapping System.

For full details about this new operating system, check R on the HP Reply Card.

Two new OEM CRT displays feature high resolution with numerous options



Fine image detail and a well-focused spot at all intensity levels make the 1335A ideal for use in analytical and automatic test system applications.

Two new HP CRT displays offer exceptional picture quality and resolution, uniform focus with wide changes of intensity, and X-Y amplifiers with 70 ns rise times. These displays are ideal for use in systems for Spectrum, Fourier, Network and Chemical analysis, as well as in automatic test systems.

Model 1335A, shown above, is a variable persistence, storage, and non-storage CRT display with excellent performance. Persistence is continuously variable from about 0.2 seconds to full storage. The totally new CRT design offers a high resolution image with excellent contrast and uniformity for many applications.

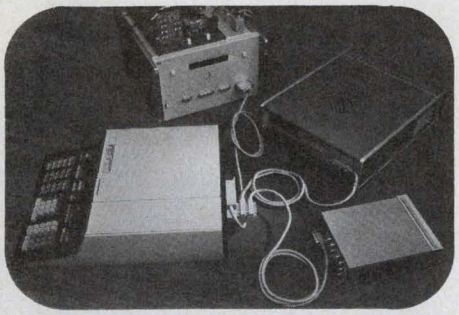
Model 1332A has a standard CRT with a spot of 0.305 mm (0.012 in.) diameter at high intensity levels which remains extremely well-focused over a wide range of intensity levels. The high resolution makes the display ideal for applications requiring sharp focusing on multiple gray shades or varying writing speeds with frequent video drive level changes.

Numerous options are available to tailor the displays to fit a specific application. These factory-installed options include:

(1) For the X-Y amplifiers: deflection factor, polarity, input impedance, and rise time;
(2) Z-axis amplifier: blanking range, polarity input impedance, gain, and digital input;
(3) for the CRT: graticule, phosphor (on the 1332A), and contrast filter; and
(4) for the mechanical frame: covers, controls, line voltage, and tolerance, and special ac cords.

For more information on these two new displays, check B on the HP Reply Card.

For improved lab productivity, HP Calculator family now interfaces with many instruments



Instrumentation control from a desk-top programmable calculator.

Now, assembling a custom calculator-controlled instrumentation system is fast and easy because of interfacing cables that allow you to connect multiple instruments.

Digital voltmeters, electronic counters, waveform analyzers and synthesizers, scintillation counters, clocks, capacitance meters and other instruments can be interfaced directly to a 9800 series calculator which can then operate as both a controller or a data logger.

HP interface cards accommodate instruments using 8-4-2-1 BCD output, 8-bit parallel codes in any input and output formats, and bit-serial data.

The new Hewlett-Packard Interface Bus (HP-IB) provides a byte serial interface system that offers plug-to-plug compatabililty between common instruments.

For more information on how to interface an HP 9800 series programmable calculator to your instrumentation, check S on the HP Reply Card.

The HP-46, a desk-top slide rule with LED display and printer output

Since its introduction nearly two years ago, thousands of scientists, engineers, and educators have purchased the HP-46. Applications range from the various engineering disciplines through biology and chemistry, to math, stat, medical research, navigation, even surveying.

The desk-top HP-46 has 48 preprogrammed scientific functions and operations. If you choose, it also prints a functional notation for each operation so you know what was done and when it was done. Thus, you can achieve the most effective use of the nine storage registers, three angular modes, and metric conversions.

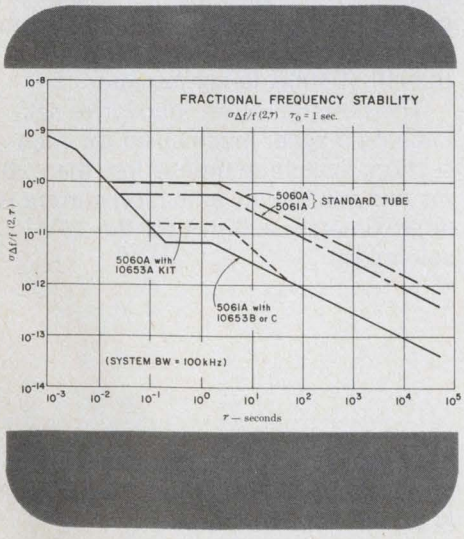
The HP-46 reduces intricate and extensive calculations to a series of quick key strokes. And, you can combine arithmetic operations. Serial calculations, chain calculations, and mixed chain calculations are uncomplicated without the need of reference tables.

Put the HP-46 on your desk simplifying calculations, eliminating tedious recalculations, and saving your valuable time.

For details, check A on the HP Reply Card.

Select either scientific or fixed point display to match your calculations with up to 10-digit accuracy.

Retrofit kits boost accuracy, stability and reproducibility of Cesium Beam frequency standards



Newly available retrofit kits give present owners of HP's 5060A and 5061A Cesium Beam Frequency Standards an order of magnitude improvement in short term stability. This improvement was formerly only available in newly-ordered 5061As as Option 004. The state-of-the-art performance improvements were attained through major design changes in the cesium beam tube: increased length of the microwave cavity results in higher accuracy, which was achieved without increasing tube size; increased cesium beam flux and a unique HP design of multiple beams results in better short-term stability and greater immunity to shock and vibration; more effective magnetic shielding reduces effects of external magnetic fields and improves settability.

See the graph to the left for performance characteristics. Other principal specifications of instruments upgraded by the kits are:

Accuracy	$\pm 7\times10^{-12}$
Reproducibility	$\pm 3\times10^{-12}$
Settability	$\pm 1\times10^{-13}$
Long Term Stability	$\pm 3\times10^{-12}$

To receive complete technical data, check T on the HP Reply Card.

New 4.5 GHz Counter offers highest performance in its frequency class.

The 5341A Counter offers "best case" performance gems like 30 MHz peak-to-peak FM tolerance, −20 dBm sensitivity, 100 μsec acquisition time and +30 dBm damage level on its microwave range.

For cost-effective UHF and microwave equipment production testing, as well as lab troubleshooting from 10 Hz to 4.5 GHz, the new HP 5341A Automatic Frequency Counter is close to ideal.

Compare its range, sensitivity, FM tolerance, speed, accuracy, resolution, overload tolerance, systems compatibility and built-in diagnostics—the new 5341A is unexcelled in the "up to 4 GHz" class of automatic counters today. Its unique "switchable filter" heterodyne technique allows a much faster signal acquisition than other methods. The 5341A can acquire and begin measurement of any frequency to 4.5 GHz within 600 μseconds (100 μsec in MANUAL mode). Operator convenience is a key feature of the 5341A, with a choice of automatic or manual operation and a unique self-troubleshooting technique.

The ten-digit LED display provides 1 Hz resolution all the way to 4.5 GHz. The 5341A may be purchased with frequency range limited to 1.5 GHz at a reduced price. If desired, you can later upgrade it to 4.5 GHz.

We welcome your comparison of the price-to-performance ratio with other microwave counters.

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

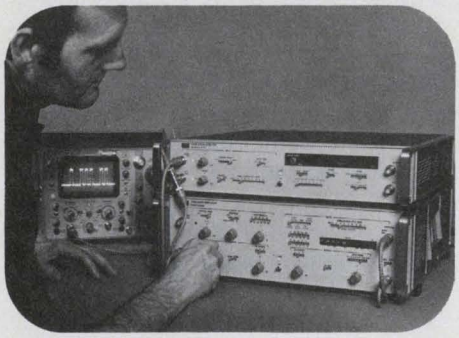
New capabilities added to bit-error-rate measurement system

Hewlett-Packard's 3760A Data Generator and 3761A Bit Error Rate (BER) Detector provides more flexibility and convenience for communication testing in such areas as fiber optics, digital radio, digital cable and millimeter wave transmission systems. The 3760A/3761A are also useful in applications such as digital multiplex and digital tape and disc recording.

HP's measurement system operates between 1 Kb/s and 150 Mb/s, providing a broader operating range than previously available. Both mean signal and dc triggering are available as a switch selectable option in the 3761A Error Detector. This allows the equipment to be used in either continuous or burst (e.g., time division multiple access transmission systems) signal modes. A second data output, delayed from the primary output by eight bits, is available on the 3760A Data Generator. This effectively provides two uncorrelated outputs for such test applications as four-phase, phase-shift-keyed transmission systems, and cross-talk interference tests. Fixed crystal clock speeds are available for the 3760A Data Generator. This provides the user added convenience where frequent testing at specific speeds is required.

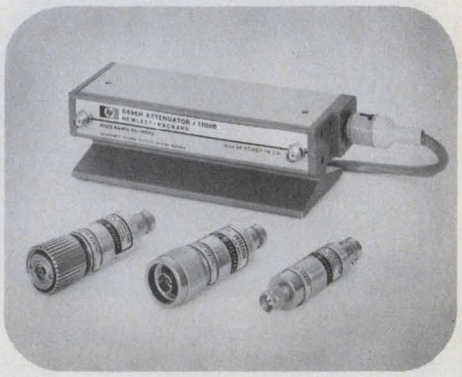
The 3760A Data Generator is also very useful as a stand-alone instrument. It provides flexible pattern (i.e., PRBS, 1010 sequence) and word generation signals with pulse generation quality.

For technical information on the 3760A, 3761A and the new options, check C on the HP Reply Card.



For design, development, commissioning and maintenance of pulse code modulation, PCM, systems, data generator and error detector provide a complete local or remote bit error rate measuring system.

New detectors and step attenuators for microwave measurements



Detectors

Low barrier hot carrier diode technology (LBHCD) has permitted a new family of microwave detectors covering the 10 MHz to 18 GHz range; HP 8470B (APC-7 or Type N), 8472B (SMA) and 423B (Type N, 12.4 GHz). These detectors have much flatter frequency response than previous point-contact types: ±0.2 dB over any octave to 8 GHz; ±0.3 dB, 10 MHz to 12.4 GHz; ±0.6 dB, 12.4 to 18 GHz.

Microwave detectors are general purpose components, widely used for CW or pulsed power detection, levelling of sweepers, and frequency response testing of other microwave components. Thus, improved flatness and SWR are highly desirable and directly yield more accurate measurements.

Programmable Attenuators

Models 8495 G/H and 8496 G/H programmable microwave attenuators offer 70 dB or 110 dB range in 10 dB steps from DC - 18 GHz. Models 8494G/H offer 11 dB range in 1 dB steps. Programmability makes the attenuators particularly well-suited for mini-system use under Interface Bus control, using the HP 59306A Relay Actuator.

The design uses an innovative self-latching magnet mechanism for each section. Switching time is less than 20 ms and momentary actuation current is approximately 100 mA for the 25V solenoids.

For detailed information on the detectors, check M; for the attenuators, check N on the HP Reply Card.

HEWLETT-PACKARD COMPONENT NEWS

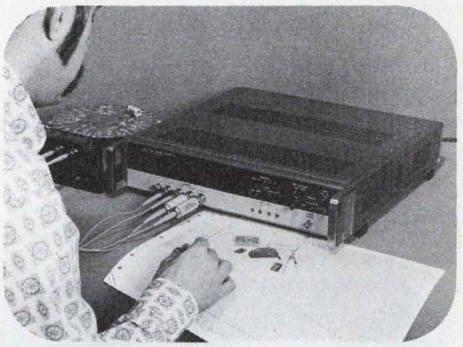
High speed measurements of low-value components with digital meter

If you're testing diodes and capacitors or trimming IC capacitors and resistors, you need fast precise inductance, capacitance, resistance and loss measurements. Plug the HP 4271A Digital LCR meter into your system and you get 10,000 measurements or more per hour.

Using a four-pair measurement technique that reduces stray capacitance and residual inductance, this 1 MHz digital meter measures capacitance from 0.001 pF to 19.000 nF with an accuracy of 0.1%, and inductance from 0.1 nH to 1900.0 μH. Capacitance loss components are measured as parallel conductance or as dissipation factor (as low as 0.0001). Inductance loss components are measured as series resistance (10Ω to 10 KΩ) or dissipation factor (as low as 0.0001). And you can vary dc bias from 0 V to 39.9 V in 0.1 V increments.

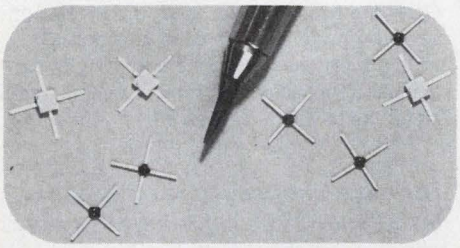
The LCR meter has a four-digit LED display with 90% overrange, and it interfaces easily with HP computers, calculators, and digital recorders.

For information on improving component testing, check D on the HP Reply Card.



Typical uses for the 4271A LCR meter include: testing discrete components and varicap diodes, checking semiconductors, and L or C examinations of delay lines.

Stripline Schottky Diode Quads for Double Balanced Mixers



For the first time, Schottky diode quads designed for use in microwave integrated circuits, microstrip or stripline, from 1 to 8 GHz, are available in hermetically sealed packages.

The 2.54 mm (0.10 in) square package, 5082-2261/62/63, contains a monolithic array of Schottky diodes interconnected in ring configuration. Uniform electrical characteristics among the four diodes result in a tightly matched quad.

Broadband quads, 5082-2291/92/93/94, for applications to 18 GHz, are available in a sub-miniature 1.27 mm (0.05 in) square ceramic package whose leads are brazed to the substrate for maximum package ruggedness.

For details, check F on the HP Reply Card.

Guaranteed ruggedness in new beam lead PIN diode

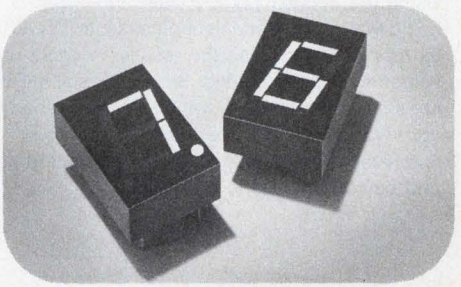
Each lead of these new beam lead PIN diodes will survive a two gram pull. This high lead strength is achieved by a new process enabling Hewlett-Packard to guarantee the ruggedness of this Model 5082-3900.

Breakdown voltage of the new diodes is a guaranteed minimum of 150 volts, and 200 volts is typical. Capacitance (C_0) is a low 0.02 picofarads, resulting in isolation equal to or better than other presently available PIN diodes.

These diodes are for use in strip-line or microstrip circuits using welding, thermocompression or ultrasonic bonding techniques. Applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies.

For detailed specifications, check G on the HP Reply Card.

New common cathode .43" display



.43" display offers a bright, continuously uniform seven segment display in a 0.3" dual-in-line configuration.

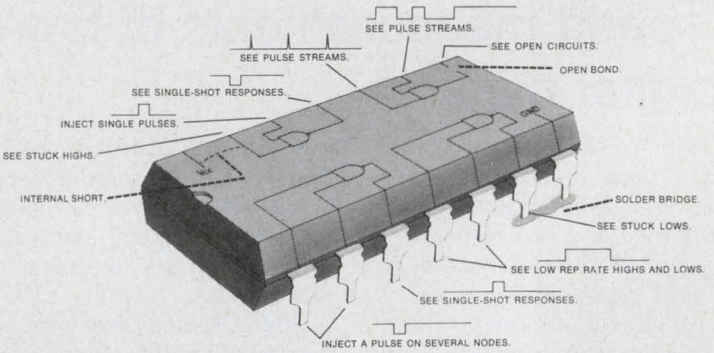
A new, common cathode 0.43-inch (11 mm) high LED display is low cost and easy to interface. The new direct-drive MOS clock circuits interface directly with this new HP 5082-7760 indicator. It is expected to be widely used in many consumer applications, including clock radios, business machines, TV channel indicators and low-cost electronic instruments.

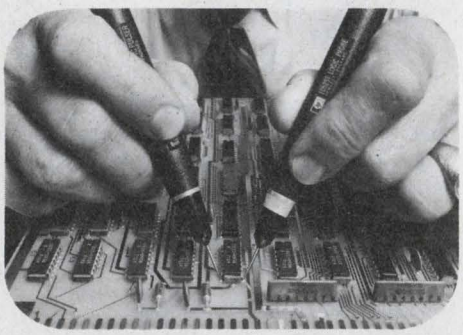
Designed for viewing distances of up to 20 feet, these single digit displays provide a high contrast ratio and a wide viewing angle.

For more details, check H on the HP Reply Card.

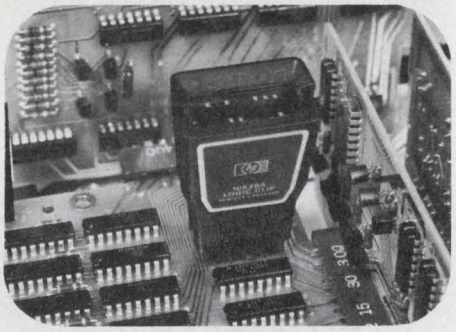
The IC Troubleshooters show it like it is... at new reduced prices

Originated by HP, the Logic Probe, Logic Pulser, and Logic Clip have seen widespread use where digital circuits are designed, built or serviced. Their popularity stems from their rapid, simple, virtually error-free operation, coupled with ruggedness. Now, these new low prices will further enhance their popularity.





Using the 10526T Logic Pulser and 10525T Logic Probe you can inject pulses into TTL/DTL gates directly and see the results—without unsoldering or trace cutting. Simply press the Pulser's button to inject a pulse and the Probe quickly verifies gate operation—high, low or bad level. It'll read single pulses down to 10 ns and pulse trains up to 50 MHz.



The 10528A is an easy-to-use tool for viewing all the pins of 14- or 16-pin IC's simultaneously. When used in conjunction with the 10526T Pulser, sequential logic circuits like shift registers come alive—each state change is immediately visible—and circuit analysis achieves new meaning.

The 5015T Mini-Kit puts it alls together—for less. Order the Probe, Pulser, and Clip in this convenient kit with carrying case provided. Get all of the stimulus-response capability of our popular troubleshooters in this fully integrated kit for the lowest price we've ever offered.

For more information on the latest techniques in digital troubleshooting, check E on the HP Reply Card.

HEWLETT hp PACKARD

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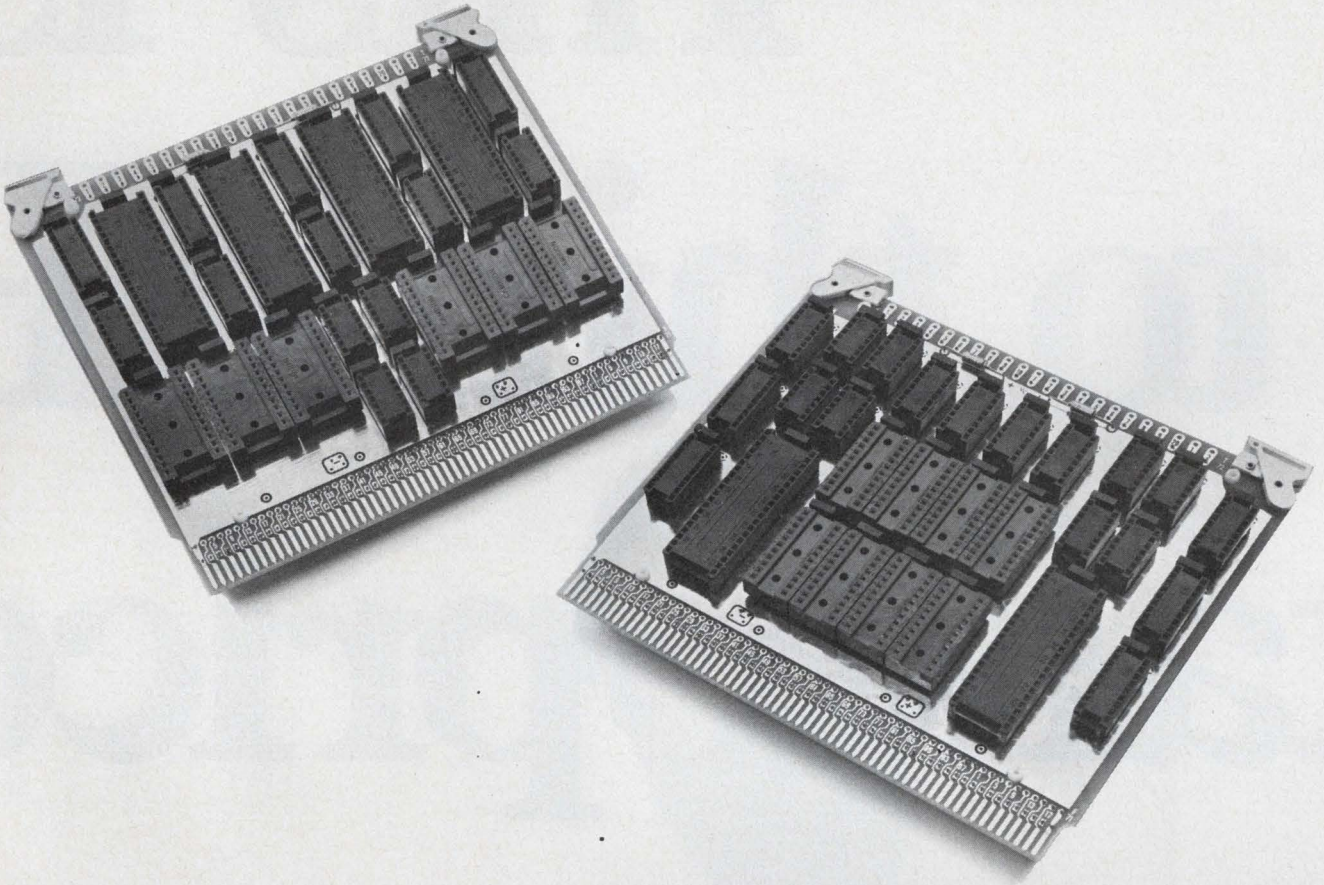
Canada-6877 Goreway Drive, Mississauga, Ontario, L4V 1L9, Ph. (416) 678-9430.
Japan-Yokogawa-Hewlett-Packard Ltd., Ohashi Bldg., 59-1 Yoyogi, 1-chome, Shibuya-ku, Tokyo 151, Ph. 03-370-2281/92.

New socket cards for microprocessors.

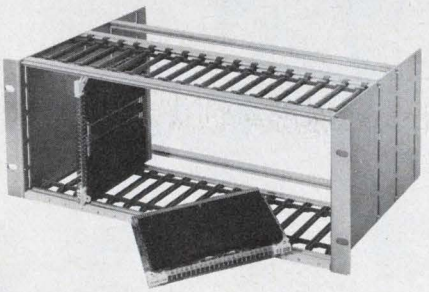


Instantly available, these two new cards are your answer to second-source problems. They enable you to change ICs and wiring for new pin patterns with great ease.

They are designed specifically for microprocessor applications, including controllers, random access memories, and erasable programmable memories. As such they are the newest in our line of 3D socket cards:

3D2017 Four 40-pin sockets, six 24-pin sockets, five 18-pin sockets, five 16-pin sockets, and four 14-pin sockets. $124.70.

3D2018 Two 40-pin sockets, eight 22-pin sockets, four 18-pin sockets, six 16-pin sockets, and eight 14-pin sockets. $140.70.



In addition, both cards provide a good ground plane for high-speed operation. They include a ceramic monolithic bypass capacitor at every socket, and provision for bypassing other voltages that may be required for chips. Power can be connected to various pins on LSI chips by means of solder tabs. And each card includes 22 built-in test points.

These cards are complemented by our line of Card-Pak card files, and our automated wiring service.

We're ready for you right now. And so is our nationwide distributor, G. S. Marshall. So call either of us today. Or, tear out this page and keep it handy until you are ready for us.

EECO
FOR PACKAGING

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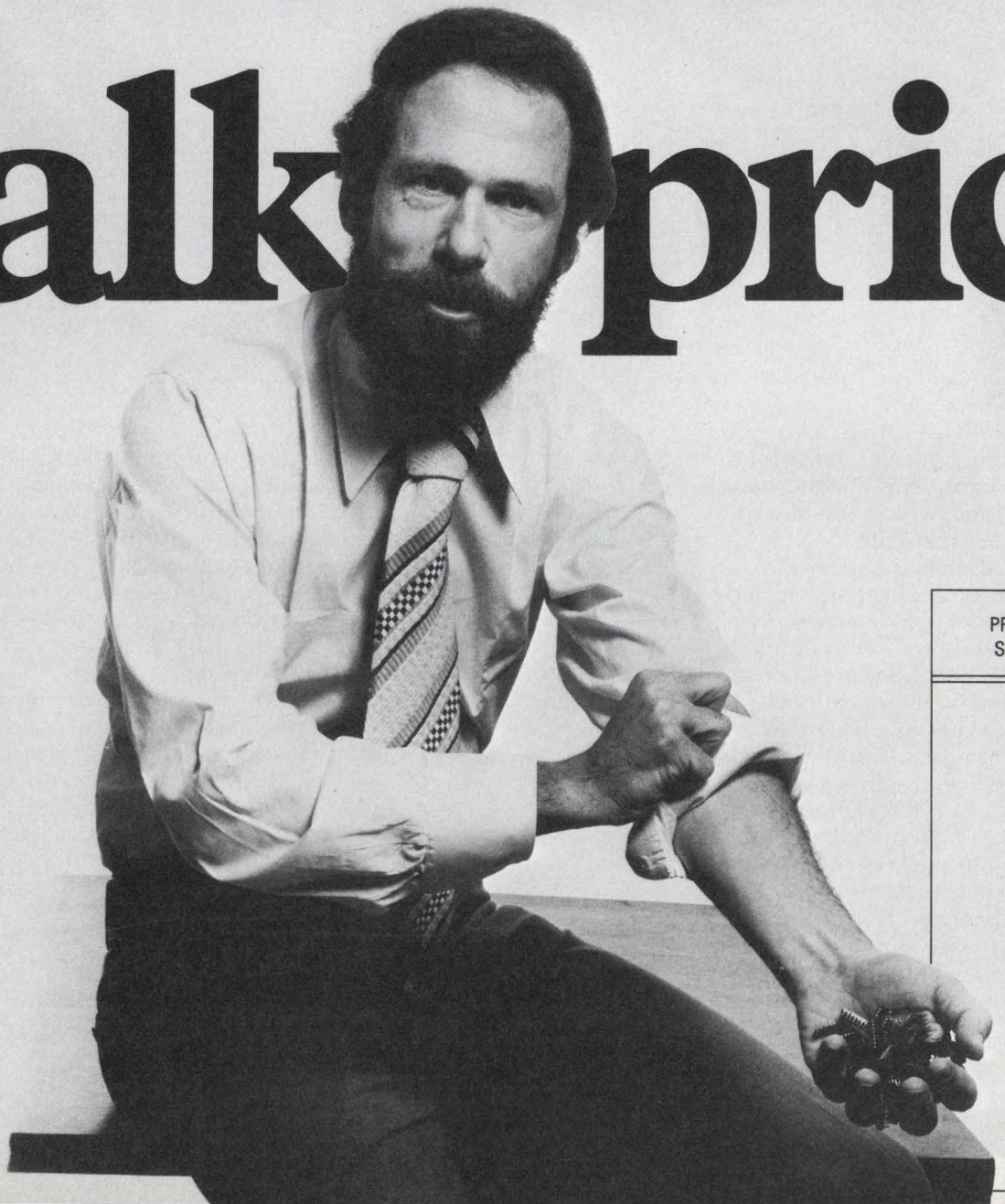
Phone 714/835-6000

INFORMATION RETRIEVAL NUMBER 7

"This is to think P talk price"



PROM SIZE	ORGANIZATION
1k	256 x 4
	256 x 4
	256 x 4
	256 x 4
2k	512 x 4
	512 x 4
	512 x 4
	512 x 4
4k	512 x 8
	512 x 8
	512 x 8
	512 x 8

the year ROMs and

You have every right to look to MMI for price and performance leadership; we're the biggest bipolar memory company in the world.

Since we were the first to design and produce 1K, 2K and 4K PROMs (and compatible ROMs) you'll recognize our part numbers; but the price and power figures are happy news. (And this is a year we can all use some good news.)

We've completely redesigned our PROM line. The Schottky process we're using has already been proven on our 8K, 9K, and 10K bipolar ROMs. On our new *Dash One PROMs* it not only cuts power requirements by 30% **without any loss of speed,** but it also yields good parts in quantities that allow **dramatic price reductions.** All major characteristics are improved. Fan-in is .25mA max. **Grow-back is virtually eliminated.** And we've added extra fuses to give you **superior programming yield. At least 95% of all units will program to completion** in 2 seconds or less. And we fully test every part for programmability before we ship it.

The results: MMI gives you better prices. Better performance. Better programmability. Better reliability.

Looks like a better year all around.

Please compare the numbers on the OLD and NEW chart. Then get the product and prove it for yourself. The industry is getting moving again. And we can help in lots of ways. Try us.

Call, telex or write our Marketing Department. Monolithic Memories, Inc., 1165 East Arques Avenue, Sunnyvale, California 94086. Phone: (408) 739-3535. Telex: 910 339 9229. In Europe, contact Monolithic Memories, Inc., Amsterdam, Holland, Phone: 100727. Telex: (844) 16365.

INFORMATION RETRIEVAL NUMBER 8

mmi

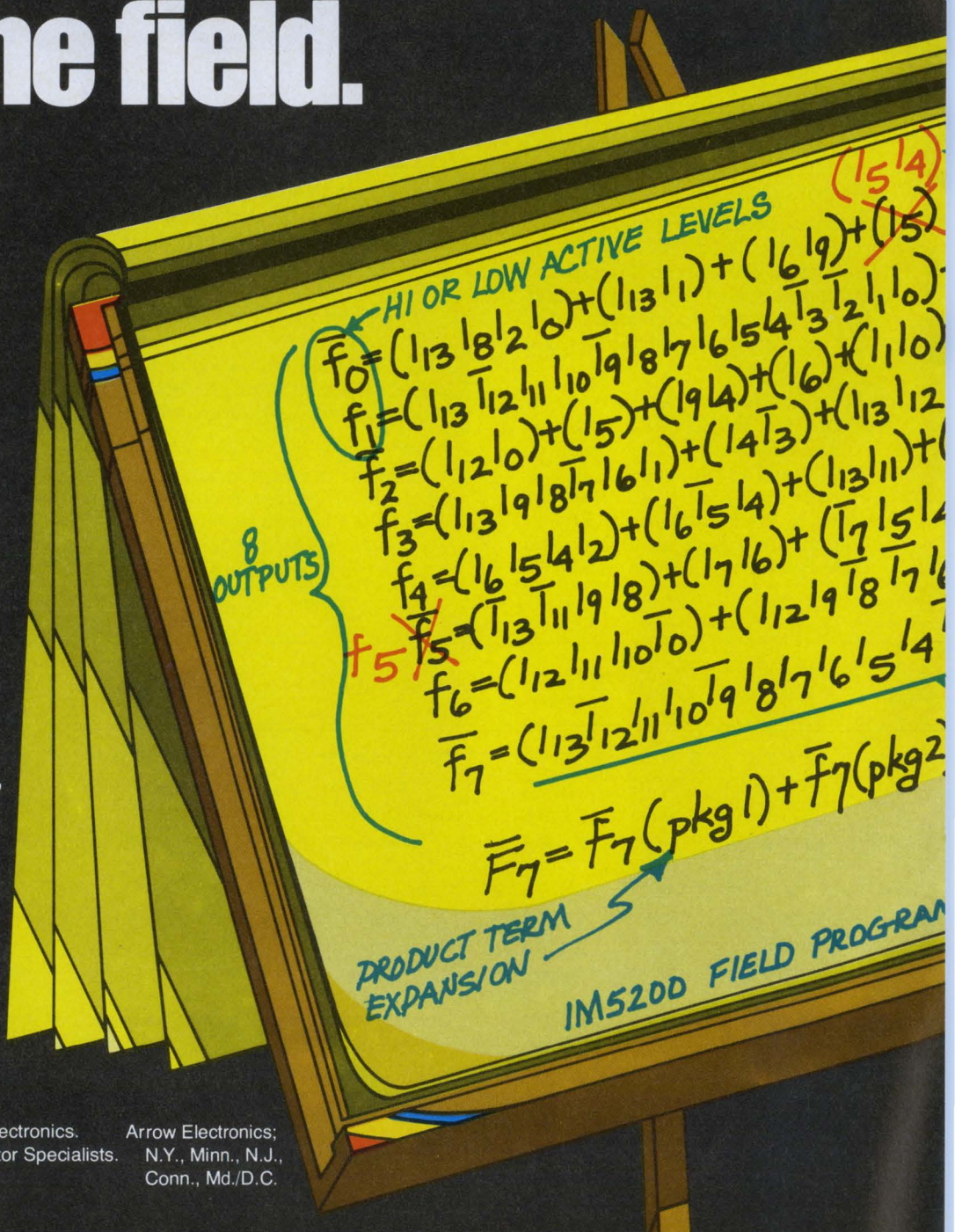
This is our year.

PROM PART NOS. OLD	PROM PART NOS. NEW	(100-999) PRICE OLD	(100-999) PRICE NEW	OUTPUT	MAX ICC OLD	MAX ICC NEW	OPERATING TEMPERATURE	ROM INTERCHANGEABLE PART NUMBER
6300	6300-1	$ 17.00	**$ 5.95**	Open Collector	120mA	105mA	0°c to 75°c	6200*
6301	6301-1	17.00	**5.95**	Tristate	120mA	105mA	0°c to 75°c	6201*
5300	5300-1	44.00	**11.95**	Open Collector	120mA	105mA	−55°c to 125°c	5200*
5301	5301-1	44.00	**11.95**	Tristate	120mA	105mA	−55°c to 125°c	5201*
6305	6305-1	45.00	**13.95**	Open Collector	130mA	105mA	0°c to 75°c	6205*
6306	6306-1	45.00	**13.95**	Tristate	130mA	105mA	0°c to 75°c	6206*
5305	5305-1	58.00	**24.95**	Open Collector	130mA	105mA	−55°c to 125°c	5205*
5306	5306-1	58.00	**24.95**	Tristate	130mA	105mA	−55°c to 125°c	5206*
6340	6340-1	70.00	**33.00**	Open Collector	140mA	140mA	0°c to 75°c	6240*
6341	6341-1	70.00	**33.00**	Tristate	140mA	140mA	0°c to 75°c	6241*
5340	5340-1	100.00	**54.00**	Open Collector	140mA	140mA	−55°c to 125°c	5240*
5341	5341-1	100.00	**54.00**	Tristate	140mA	140mA	−55°c to 125°c	5241*

**Pin-compatible ROM-mates are available for all MMI PROMs. Electrical specs are identical. MMI ROMs always cost substantially less than our PROMs, and now our PROMs are the least expensive in the industry.*

Intersil's new FPLA.

The first PLA that can be programed electrically in the field.



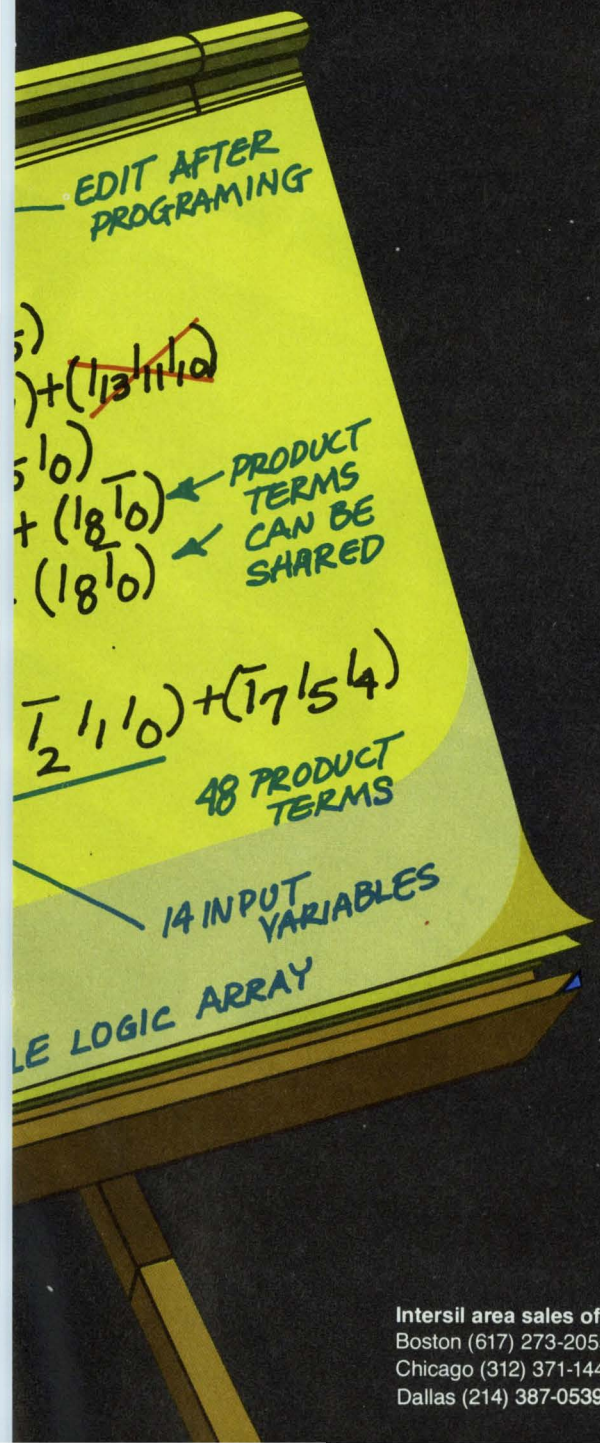
The PLA Unmasked!

Programed Logic Arrays make translation of Boolean logic into hardware much easier than ever before. They simplify design, reduce parts count, cut assembly time, use less power and are more reliable than discrete logic.

Until now programing a PLA required preparation of a mask, with delays and added cost. But no more.

The mask is eliminated in Intersil's IM5200. Electrically programable in seconds, it's the first **Field Programable** Logic Array (FPLA).

Intersil stocking distributors. Elmar/Liberty Electronics. Kierulff Electronics; Mass. Schweber Electronics. Semiconductor Specialists. Weatherford. Arrow Electronics; N.Y., Minn., N.J., Conn., Md./D.C.



FPLAs in production and available now.

The IM5200 is equivalent to a group of AND gates which may be ORed at any output. With 14 inputs, 8 outputs and 48 product terms, it provides the complexity of up to 500 4-input logic gates for applications such as random combinatorial logic, code conversion, microprograming, sequential control and others.

A TTL device, the IM5200 comes in a 24 pin DIP, with typical propagation delay of 65 nanoseconds. Price in 100-999 quantities is $25.00. Setup charge is $25.00 per program, with nominal per-unit programing cost.

And flexible? You bet.

For representing functions in true or complement form, the output level is programable to high or low active levels. Passive pullup outputs are useful for product term expansion by wire-ORing the outputs of different IM5200s.

Even after programing, there are provisions for editing. Entire product terms may be added or deactivated, new input variables added, or outputs changed from low level to high.

Proven AIM programing.

Programing is done with Intersil's Avalanche Induced Migration process, U.S. patent No. 3,742,592. AIM has created more than 3 billion memory bits in over 4 years' use with Intersil P/ROMs . . . without a single bit failure!

Reliability is outstanding because the entire process takes place beneath the surface of the silicon, hermetically sealing it from the environment. In addition, programing is much faster than with other methods.

Send for complete product data, including applications. From Intersil, 10900 North Tantau Ave., Cupertino, CA 95014.

Intersil

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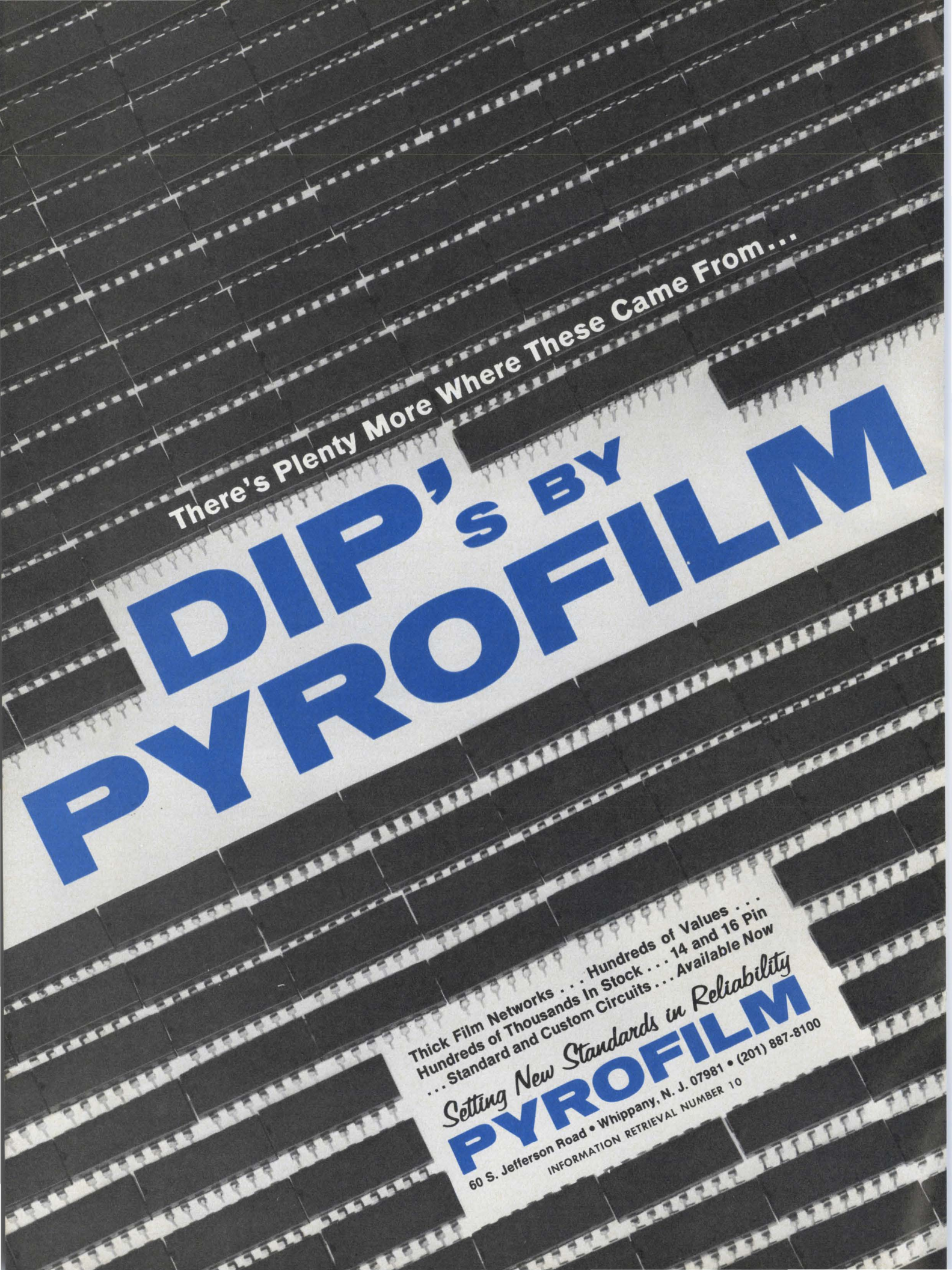
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INFORMATION RETRIEVAL NUMBER 10

News Scope

JUNE 7, 1975

Motorola processor to have 55-ns micro-instruction time

A new microprocessor that is to be at least twice as fast as any other available is under development at Motorola Semiconductor, Phoenix, AZ. Known as the MC 10800, the 4-bit slice processor is being made with emitter-coupled logic and is to have a micro-instruction cycle time of 55 ns.

It will be the first of a set of five related parts—designated M10800—that are being designed for high-performance applications, such as top-of-the-line minis, large mainframe computers, numerical and industrial control and digital communication systems.

According to William Blood, Motorola's manager of memory and logic systems, samples of the new micro will be available in the first quarter of 1976. Other parts in the set are to be offered six to eight weeks after that.

All circuits in the M10800 set, Blood notes, will be logic-level, power-supply and noise-immunity-compatible with the company's standard MECL 10k circuits, so that existing memory devices can be used.

The new microprocessor set is designed to overcome the limitations of currently available devices, according to Blood. Micros on the market today, he says, can be classified as either single-chip processors or 2-bit and 4-bit slice-oriented sets.

The single-chip processors, while ideal for many applications, have limited word lengths, fixed instruction sets and MOS speeds that often make them too slow to be useful.

The slice-oriented sets are better, in that they permit expansion of word length and microprogramming to instruction requirements. However, existing devices may have any or all of the following limitations: a minimal ALU function set, restrictive data routing and inadequate I/O ports.

Of course, these disadvantages can be overcome by the addition of MSI circuits, Blood notes, but that reduces the advantages of LSI.

The MC10800 will overcome these disadvantages by providing a powerful function set with over 200 instructions, Blood says. In addition, the versatile data-routing paths and I/O ports, will allow numerous options when a system is designed. The MC10800, Blood continues, will make it possible to accomplish in a single operation what would require several operations with other ALUs.

The MC10800 chip contains a latch mask block, the arithmetic logic unit, an accumulator, the shift network, input and output bus controls and associated interconnections. It is designed so it can be expanded laterally to any bit length in increments of 4 bits and expanded vertically to permit pipelining for increased data throughput rates.

The MC10800 will come in a new package—a 48-pin, quad in-line package. This will be the same size as the standard 24-pin DIP. The difference between the two is that the quad in-line package has twice the number of pins, with each alternate one offset from the preceding one. This results in a compact package that is pluggable, wire-wrappable and capable of being used with automated equipment.

Other devices from the five-chip set include the MC10801 control register function chip, which contains the logic for microprogram control; the MC10802 timing-function chip, which ties the system function blocks together; the MC10803 slice/memory interface chip, which contains memory data and address storage, and the MC10804, which is the slice look-ahead carry chip.

Prices for the new micro, Blood says, will be competitive with other available ECL devices.

Superconducting wire gives 'superior' results

A superconducting wire described as "superior in critical-current carrying density to any known superconductor" has been tested at the Naval Research Laboratory in Washington, D.C.

Critical current density is the maximum current per unit of cross section that a superconductive material can carry and still retain its superconductivity.

Superconductors, which operate at cryogenic temperatures, can carry heavy currents with little resistance loss. As a result, the wires and the system itself can be smaller than with conventional conductors. And, more importantly, the systems can operate with vastly improved efficiencies.

According to the developer of the improved critical-current density capability, D. G. Howe, a ceramics research engineer in the Navy laboratory's Material Sciences Div., the new capability could play an important role in the advancement of power generation, such as in large conventional generators, magneto-hydrodynamic (MHD) generators and controlled thermonuclear fusion reactors.

One of the main technical difficulties still preventing the successful development of efficient MHD generators, Howe says, is the absence of a superconductor capable of handling the necessary current density that the powerful MHD channel magnets require. The laboratory's new superconducting wire, he says, should meet this demand.

The improvement was made by an increase in the gallium content of an earlier Naval Laboratory alloy—vanadium-gallium. Laboratory scientists report that the best critical-current density observed so far at 4.2 K was 1 million amperes per cm^2 of a superconductor in a transverse magnetic field of 100 kilogauss.

Portable X-ray 'lifts' fingerprints from victim

Rapists and murderers may find themselves behind bars with increasing swiftness because of a portable X-ray machine that "lifts" faint, smudged fingerprints from a victim's body.

The machine, developed jointly by the Police Dept. of San Jose, CA, and Hewlett-Packard's division in McMinnville, OR, is the first portable unit designed to photograph faint prints. The uint weighs 60 lb. including the battery. Portability is important, because such prints usually fade within 24 hours.

In operation, a user first dusts with a lead powder the portion of the body to be X-rayed. Then he straps a special, small cassette to the body over the lead dust. The cassette, which holds the film plus copper and plastic filters, is applied with the film emulsion facing the skin.

The filters remove the soft, or low-energy, X-rays that emanate from the machine's source and that would inadvertently expose the film. Hard X-rays—those of high energy, to which the film is insensitive—pass through the filter and film, strike the lead dust and knock out electrons from the lead atoms. It is these electrons that actually expose the film, which is then developed to get a clear negative of positive photo.

Waveguide transmitting speed boosted threefold

While AT&T is testing its superfast microwave circular waveguide system, capable of transmission at 274 Mb/s, the Japanese are testing a system three times as fast—800 Mb/s.

The Japanese system, described at the recent IEEE International Microwave Symposium in Palo Alto, CA, operates at 43 to 87 GHz over a test link 22.7 km long. A repeater station is 15.3 km from the terminal.

The test link was described by Kazuhiro Miyauchi of the Yokosuka Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corp., Yokosuka-Shi, Japan.

The follow-on system, to be designated by the Japanese as W-40G, will extend 2500 km and have an end-to-end error rate of better than 10^{-7}. Error rate on the test link was 10^{-9}. Average repeater spacing will be 15 km. The system will consist of 28 800 Mb/s channels, making a total transmission capacity of over 22 Gb/s.

Miyauchi feels confident the future operational systems will be successful. He bases this on the good performance of the test link. As for cost, he notes: "The estimated cost is about half that of the most economical existing lage-capacity analog system."

Meanwhile AT&T's new high-speed coaxial cable between New York City and Newark is operating well, according to a Bell Laboratories spokesman. The cable, which was built with a transmission speed of 274 Mb/s for compatibility with the microwave link, was pressed into service ahead of schedule because of a series of fires in New York Telephone Co. buildings that put other links out of commission.

AT&T's conventional short-distance digital transmission system is the T1, consisting of plain copper wires in a cable. Each cable contains 900 pairs of wire, making 48 T1 links. Transmission speed is 1.55 Mb/s.

Transient suppressor protects RF lines

A subnanosecond metal-oxide transient suppressor that will protect rf transmission lines from fast-rise-time, high-energy electromagnetic pulses has been developed jointly by researchers at the Army Electronics Technology and Devices Laboratory, Ft. Monmouth, NJ, and the Yeshiva University Graduate School of Science in New York City.

The development was described at the Electronic Components Conference in Washington, DC. In a paper on "Metal-Oxide Subnanosec Transient Suppressors," the researchers noted that transient suppressors had been in use for some time in power and low-frequency circuits. These same devices, however, could not be used in rf transmission lines because of their lack of speed and their large off-state capacitance .

The new devices are made from niobium dioxide and housed in standard microwave diode packages. When inserted across a 50-Ω transmission line, the supressors can clamp 2-kV pulses to 200 V within 0.7 ns. Thus the bulk of the pulse energy cannot pass the metal-oxide switch.

Where clamping to even lower voltages is required, the researchers noted that a low-power diode could be inserted after the suppressor.

Alexanderson, pioneer of voice radio, is dead

Dr. Ernest F. W. Alexanderson, whose high-frequency alternator made voice radio possible and whose later developments paved the way for television, died in Schenectady on May 14. He was 97 years old.

Born in Sweden in 1878, Alexanderson studied engineering there and in Germany and then came to the U.S. in search of a more creative atmosphere. He found it in Schenectady in the highly innovative group of engineers led by General Electric's dynamic and somewhat eccentric mathematician, Charles P. Steinmetz.

"Inventors cannot be put in narrow compartments and told what to invent," Alexanderson once said. "It requires the atmosphere of liberty traditional with the old universities, which has been carried over in the GE research laboratory and was in the early days the dominant attitude of engineering. I believe it is very important for the company that such academic freedoms be maintained.—"

Alexanderson worked at GE throughout his long and fruitful career, from 1902 to 1948, except for a few years as chief engineer at the then Radio Corp. of America, which was formed by GE to handle trans-Atlantic communications.

His ability to find new, practical solutions to problems yielded 322 patents for Alexanderson. Among them—after the alternator—were the magnetic amplifier, the electronic amplifier, the multiple tuned antenna, the anti-static receiving antenna and the directional transmitting antenna. He also devised a radio altimeter.

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INFORMATION RETRIEVAL NUMBER 11


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digital

News

EEG unit worn by patient records data for 12 hours at 7000 bpi

An electroencephalograph unit that can be worn by a patient and work continuously for 12 hours has a cassette drive that runs at 1/6 ips and records data at 7000 bpi on four channels.

A standard C-120 cassette with chromium-oxide tape has been used by the designer, the Stanford Research Institute of Menlo Park, CA.

"We believe that this is the densest digital recording ever accomplished on a Philips cassette," says Charles S. Weaver, a senior research engineer at SRI.

Developed for the monitoring of EEG patterns from epileptic children, a single C-120 cassette can store 180 Mb. The system, built under contract to the National Institute of Neurological Diseases and Stroke, Bethesda, MD, consists of two major parts.

The first has a cap containing four preamplifiers, which are attached to scalp electrodes and four post amplifiers. The rest of the electronics is in a vest that the patient wears.

EEG digital monitoring of epileptic children will be done with this system from Stanford Research Institute. Scalp electrodes feed four channels of EEG data to a data-acquisition system in a lightweight vest worn by the child.

High-speed playback used

A separate system can be used to transcribe data from the cassette to a standard 1/2-in. IBM-compatible reel of computer tape. The playback subsystem contains a cassette playback transport, playback-head amplifiers, digital decoding and reformatting circuits, an IBM-compatible tape transport and d/a converters.

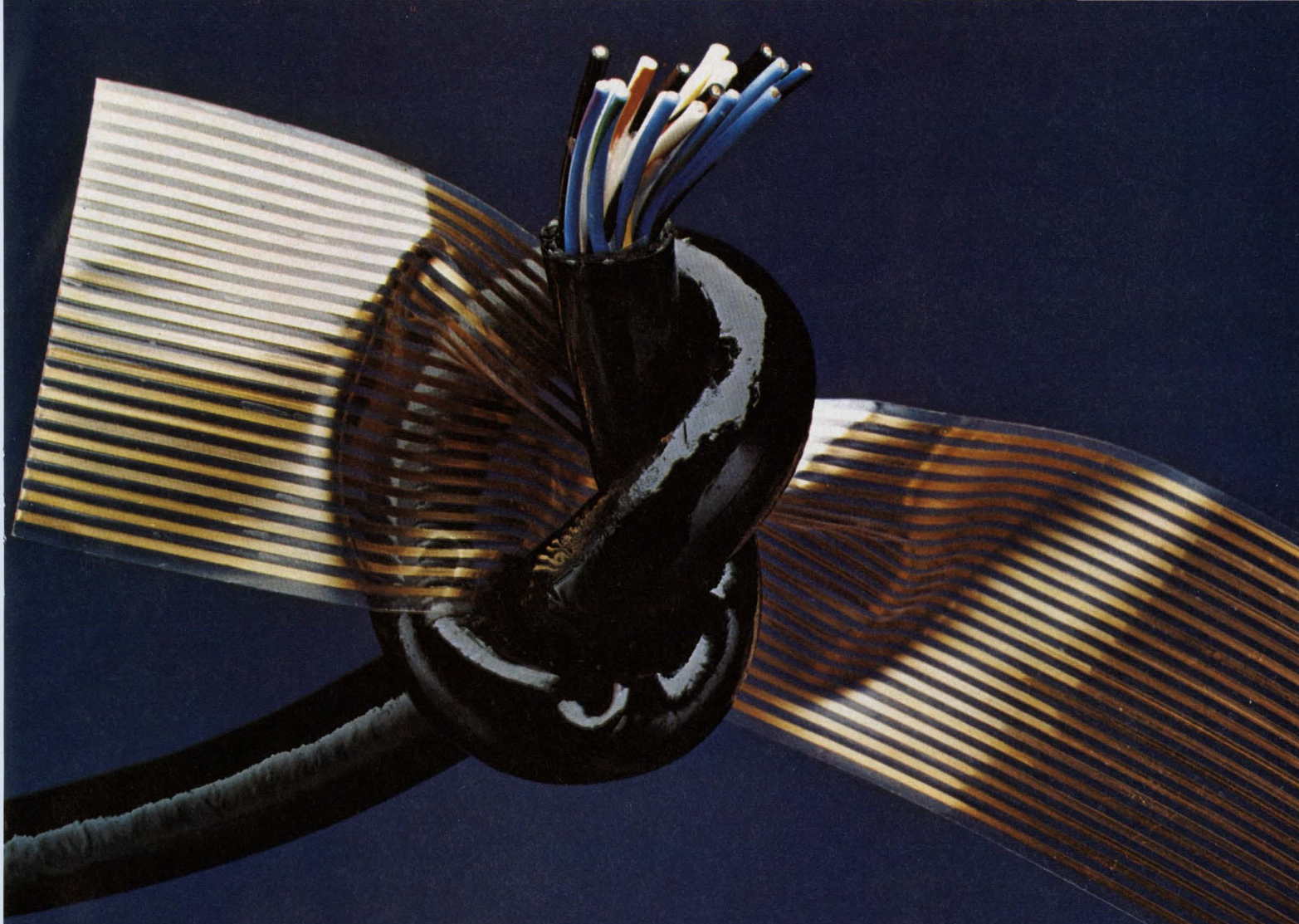
The cassette is played back at 45 times normal speed. John Yarborough, senior research engineer at SRI, points out: "By operating at many times normal recording speed when playing the tape back, we can transcribe 12 hours of recording in about 16 minutes."

What's in the vest?

Ideally the EEG waveforms from the post amplifiers should not contain any signal spectral components outside the 1-to-40-Hz frequency band. Therefore the signals from the cap go first through a set of 40-Hz low-pass filters. From there they go to a four-channel analog multiplexer and then to a sample-and-hold circuit.

From the sample-and-hold, the signal is digitized in an analog-to-digital converter and fed into a

David N. Kaye
Senior Western Editor



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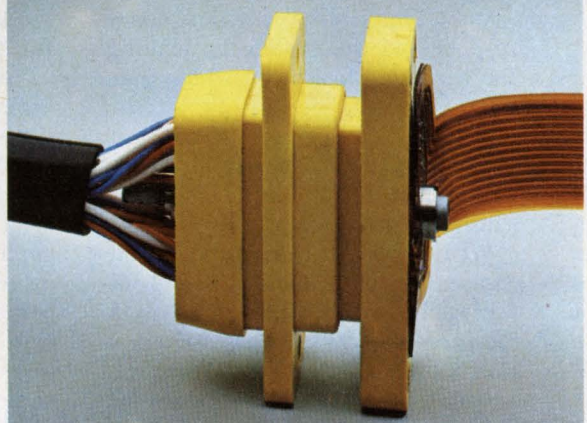

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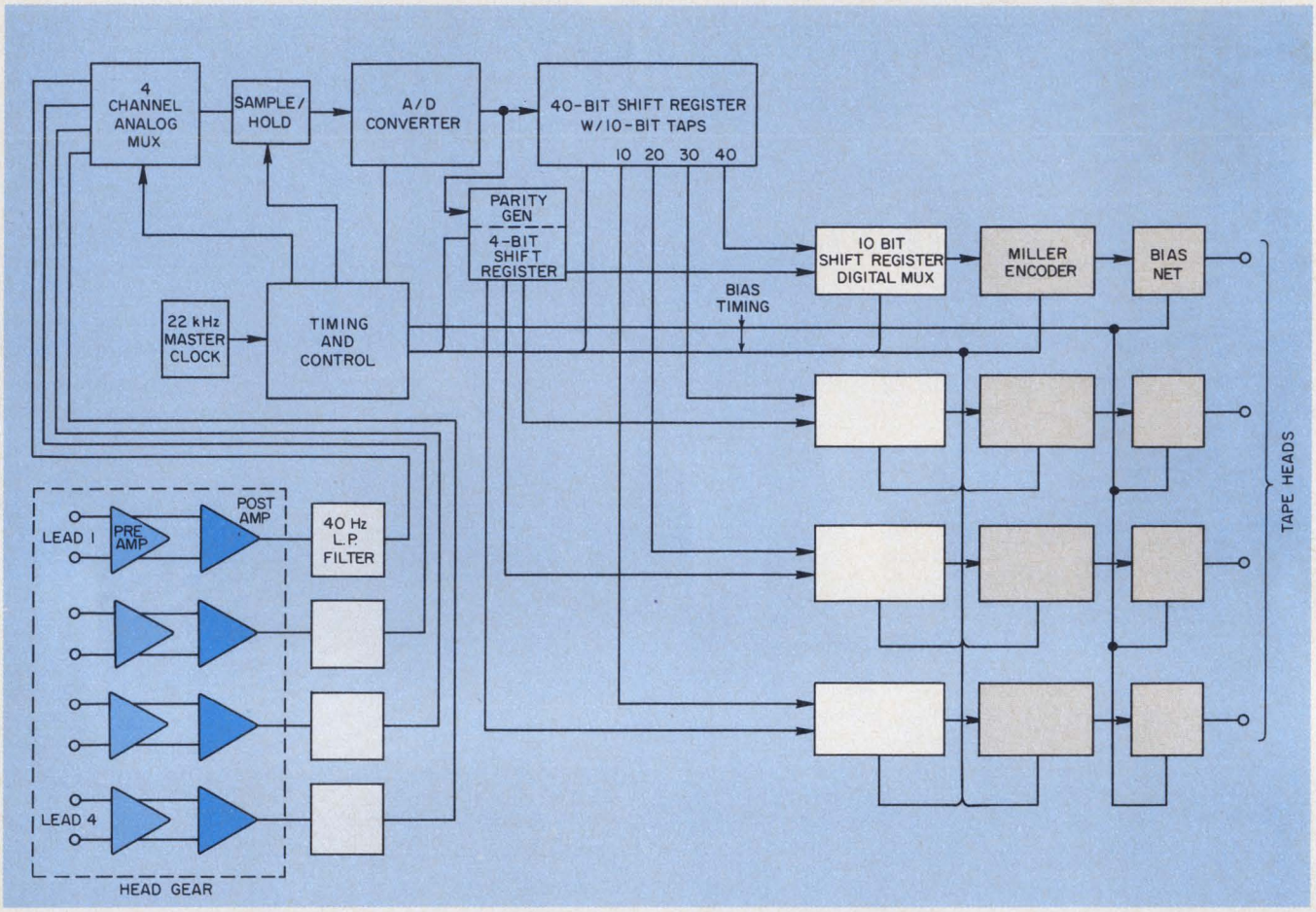

Four channels of analog EEG information are digitized and Miller-encoded. The coded signals are recorded on a Philips type of cassette at a density of 7000 bpi. The cassette is played back at 45 times normal speed making it possible to transcribe 12 hours of recording in 16 minutes.

40-bit shift register. This shift register has taps at the 10th, 20th, 30th and 40th bits. Four sets of 10 bits each correspond to the four signals from the differential preamps in the cap.

The signals go from the four taps on the shift register into four 10-bit shift registers. At this point a parity bit is inserted into each bit stream, and the resulting signal is Miller-encoded.

Miller coding explained

Miller coding is a self-clocking scheme that allows for very dense data recording. There is a flux transition in the middle of a bit cell if the bit is a ONE. But when the bit is a ZERO, there is no transition. However, if two or more ZEROs occur in a row, there is a flux transition at the end of the bit cell for the second ZERO and for every ZERO until the next logic ONE. The Miller encoded signal then goes through a bias network and to the recording heads.

Floyd Brown, a research engineer at SRI, notes that, for maximum density, bias recording is used instead of saturation recording.

Brown and Yarborough report that the main design problems remaining center on the recording head design. The four-track head must be very accurately aligned.

"Now we have six minutes of head misalignment," Yarborough says. "This limits the frequency response of the system by making the head gap look a lot wider than it is."

SRI is looking for a supplier that can provide four-track heads with much better alignment for a Philips cassette recorder.

Weaver says that further increases in data density could be achieved through the use of data compression. "With data compression," he notes, "we feel that we can at least double the capacity of the tape."

SRI is also working on a lighter version of the recorder—3-1/2 pounds instead of 5. And while the first version was powered by a lithium battery pack with a life of about 75 hours, a later model will use lightweight conventional batteries with a life of 20 hours. That is all that is needed for most tests, Weaver says.

Other uses foreseen

SRI looks to other applications for the recording scheme.

"Although the system has been optimized as an EEG recorder," Weaver notes, "the digital recording techniques employed allow the system to be easily modified to meet the requirements for other applications. For example, the drive speed could be altered to permit higher or lower a/d conversion rates than the 100 samples per second used here. It would also be possible to decrease the number of channels digitized and increase the a/d conversion rate." ■■

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INFORMATION RETRIEVAL NUMBER 14

Engine sensor-telemetry system hailed as the new racer's edge

Johnny Rutherford, who entered his new Gatorade-McLaren racer in the Indianapolis 500 last week, didn't ride completely alone. His car was equipped with an elaborate telemetry system that told the boys back in the pit just about everything that was going on in the car's engine as well as information on its driving characteristics. Such information had never before been available during a race.

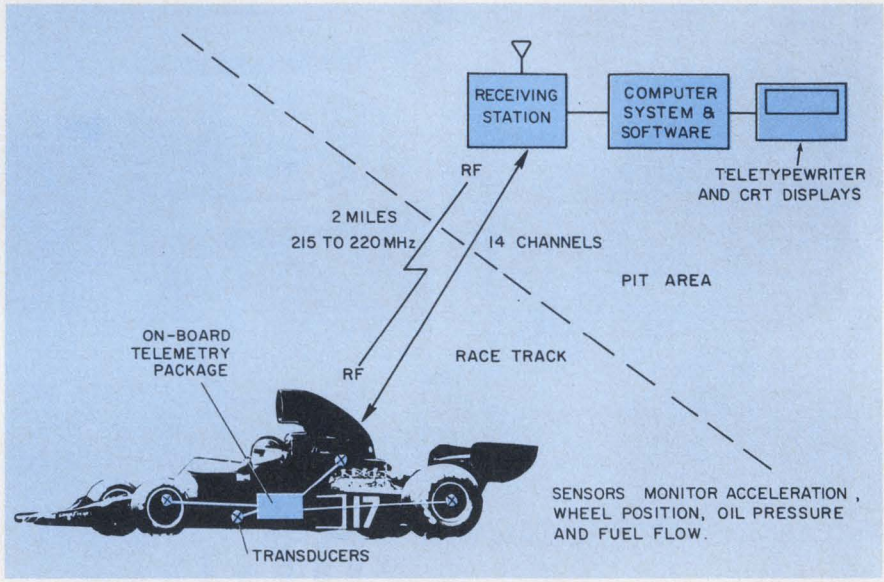
Sensors in the system monitored temperatures, pressures, rpm and fuel flow. The data were relayed to the pit crew by a 14-channel, FM multiplexed telemetry system.

The sensor devices were built by AST/Servo Systems, Inc., Newark, NJ, a subsidiary of Vernitron Corp. The telemetry system was supplied by EMR Telemetry of Sarasota, FL, a subsidiary of Schlumberger. EMR developed the electronics package along with Data General, Southboro, MA, and Bruce McLaren Motor Racing Ltd., known as Team McLaren, in Colnbrook, England.

When all this equipment is in operation, telemetry signals received in the pit are fed into a Data General Nova 2 computer with a 32-k memory, which makes comparisons between various readings and presents significant conclusions to the pit crew. The computer output is displayed either on a CRT or printout from a teletypewriter.

"This prototype system," says McLaren's director of engineering, Tyler Alexander, "will offer the most sophisticated instrumentation package of its kind ever associated with a high-performance vehicle.

John F. Mason
Associate Editor



Real-time measurements of the performance of the engine and the car itself are displayed in the crew's pit in one second.

"The system will bring economies to the team, improve over-all performance and give us a safer car. And, for the first time, we'll know exactly what the car is doing at any given point. Additionally it will relieve the driver of any anxieties, allowing him to concentrate better on the profession of driving.

"The car will have 14 of its functions monitored. The computer will track the ride height of each of the four wheels, the forward and sideward acceleration, the oil and water temperature, oil and water pressure, manifold pressure, air inlet temperature, turbocharger air flow and fuel flow."

Alexander notes that some of the measurements can be used when a car is being prepared for a race, and others play an important role during a race.

"Readings such as wheel riding height and forward and lateral acceleration will help us get a car ready for a race," Alexander says.

In the pit, a Nova 2 computer examines data telemetered in from the racing car and either displays anything relevant on a CRT or prints it.

"During practice runs we use the driver's evaluations of the car's handling to make adjustments in the suspension, and to adjust the car's air flow for the best amount of downward force. The acceleration and ride height data, which

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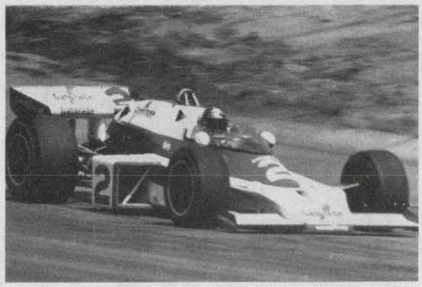
INFORMATION RETRIEVAL NUMBER 15

were never available before, will give us scientific measurements."

During a race the computer keeps track of the fuel that the car uses. "Previously," Alexander says, "there was no way to accurately measure the amount of fuel in the car. During a race we can only estimate how much fuel is left, based on the approximate mileage the car gets at race speeds."

Now, the small, propeller-like flowmeter, inserted in the fuel line, monitors the amount of fuel that goes to the engine. Sensors count the flowmeter's revolutions and radio the information to the computer, which converts the revolutions into fuel consumption.

"This will avoid calling a car in for unnecessary refueling and prevent a car from running out of fuel because its consumption was higher than our estimates," Alexander notes.



Johnny Rutherford's racer is loaded with sensors and telemetry to give the pit crew real-time engine readings never before available.

The computer can also count the number of laps the car has made around the track, by counting the times the transmitter in the car goes by.

"The transmitter signal is strongest then," Alexander says, "and the computer can tell when that happens, because it monitors the signal 100 times every second. The computer also can time the laps by counting the interval between the signal peaks."

The telemetry transmitter is one of two radio transmitters in the Gatorade-McLaren car. The other is used for two-way radio communication between the pit crew and the driver.

The telemetry transmitter operates in the vhf band from 215 to 220 MHz. The minimum power output of 2 W is considered adequate when used with an omnidirectional antenna system over a line-of-sight distance of 1.5 miles.

EMR selected a rugged omnidirectional antenna both for use on the vehicle and at the monitor station. The coaxial antenna may be mounted on the rear bumper or at any convenient spot on the vehicle, and it will provide a low radiation angle without using the roof or trunk lid as a ground plane. The radiated signal is vertically polarized. ■■

E beam tested as nuclear-power trigger

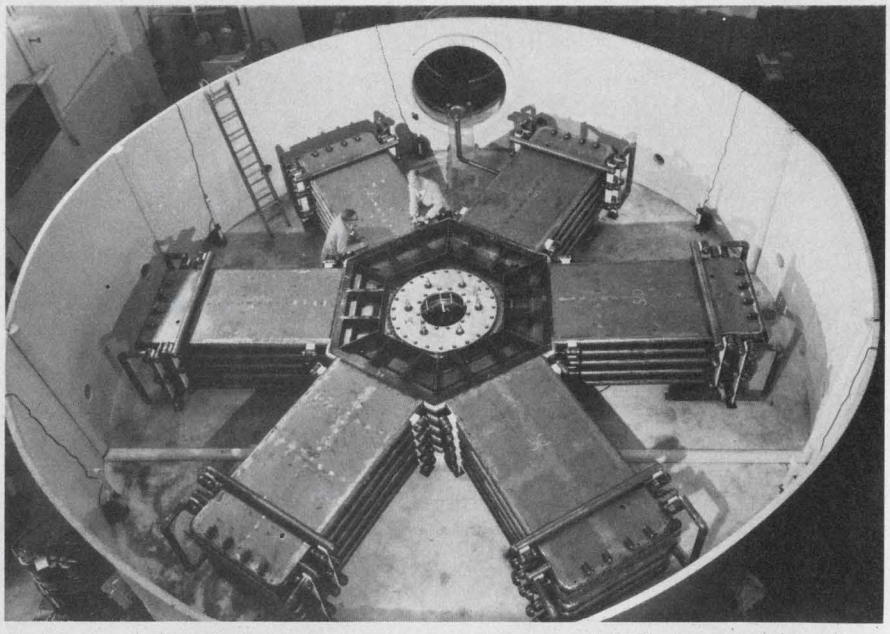
Can an electron beam powerful enough to produce fusion be focused small enough to irradiate a typical pellet of nuclear fuel?

Sandia Laboratories in Albuquerque, NM, believes that it can be and has built an accelerator to prove it. If the tests are successful, an accelerator 15 times the size of the new machine, called Proto 1, will be built. Ultimately, such an accelerator would be used for a nuclear fusion power plant to generate electricity.

Sandia and other laboratories are interested in electron-beam accelerators because theoretically they are capable of converting up to 75% of their input energy into beam energy, compared with 1% or less that the more conventional short-pulse lasers produce.

The problem with the E beam is in focusing. The laser can be focused relatively easily by optical means, with lenses. But the electrons have a space charge, which means they tend to repel each other.

Sandia scientists hope to focus the E beams by injecting plasma (ionized gas) to neutralize the electron space charge, so that magnetic forces squeeze the electrons into a small-diameter beam.



Proto 1 electron-beam accelerator makes use of 12 transmission lines (two in each of this six-segment array) to generate pulsed electromagnetic energy. This energy discharges onto two cathodes that ring the hole in the center of the array. The cathodes create electron beams, which irradiate a fuel pellet placed along the cathode's axis.

In focusing experiments to date, researchers have been able to focus a 7-in.-diam beam down to about a 10th of an inch—about the diameter of BB pellets. ■■

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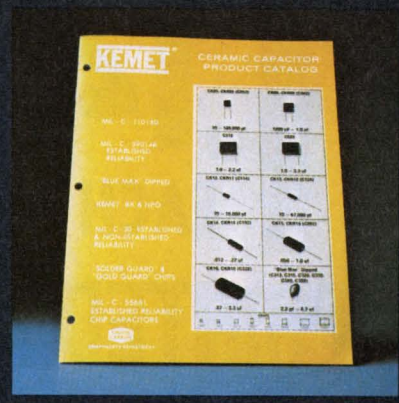

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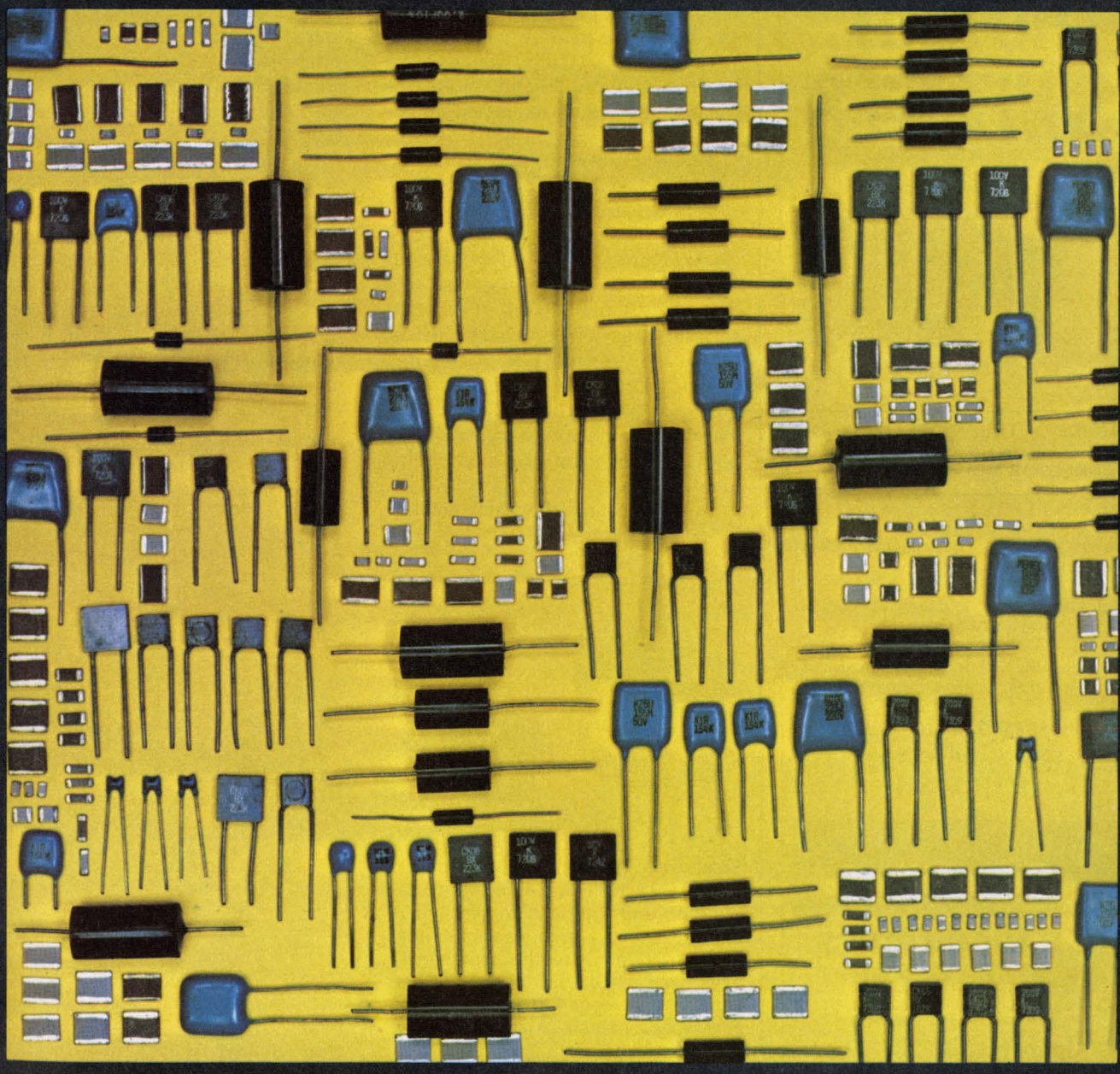

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Welded wire chassis keeps CRT terminal light and cool

A number of manufacturers of television units, oscilloscopes and other CRT terminals are now housing their CRTs in open wire frames instead of the conventional metal enclosures.

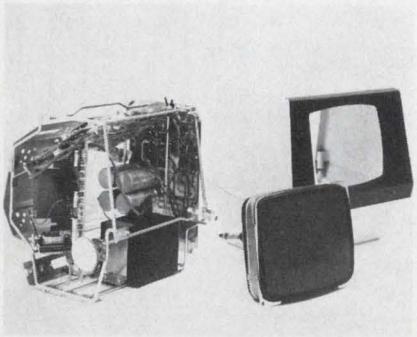
A chassis made simply of welded wire automatically eliminates heat problems, explains its manufacturer, E. H. Titchener Co., Binghamton, NY. No fans are needed. And the frame weight is cut by approximately a third—the wire chassis usually weighs two to three pounds. Testing and maintenance are made easier and quicker, too.

Manufacturers already using the wire chassis include Hazeltine Corp., Greenlawn, NY, for terminals used in business offices; Raytheon, Norwood, MA, for clerk-to-computer airline reservations systems; Bunker-Ramo, Trumbull, CT, for desk-top terminals used in brokerage firms, and Computer Optics, Bethel, CT, and Redactron Corp., Plainview, NY, for warehouse inventory control displays and word-processing equipment.

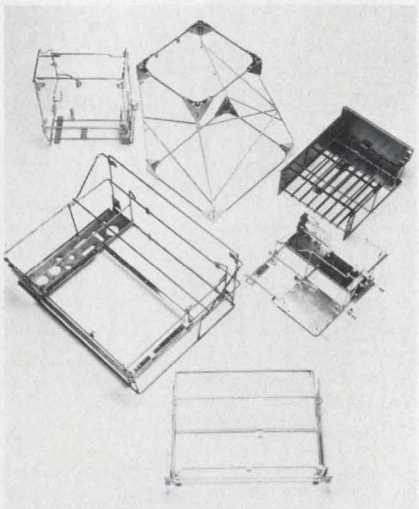
In most cases, the parts-holding chassis is manufactured of wire, 1/8-in. to 3/16-in. in diameter, either AISI 1008 or 1010 low-carbon steel. The wire is coated with zinc and bleached chromate, electrolytically applied, to afford corrosion protection and a chrome-like surface.

In addition to the frame, cold-rolled strip steel and stampings are welded onto the chassis to provide mounting studs and screw holes for holding the electronic gear—printed-circuit board cards, transformers, condensers, knobs and dials, lights and the picture tube.

Hole-to-hole dimensions, critical in an assembly of closely packed electronics, can be kept to a tolerance of ±0.010 in., the company says. Circuit boards are mounted with permanent fasteners or plastic snap locks to permit the boards to be popped out conveniently and replaced. The picture tube is normally bolted to four stampings with weld studs, and the power transformer is affixed to a heavier stamping on the bottom of the frame, for a lower center of gravity. ■■



Steel wire chassis for this Bunker-Ramo CRT terminal eliminates heat build-up and the need for fans. It is lighter, cheaper and easier to test and maintain. Once the components have been placed on the chassis, the cabinet is dropped over it and the assembly finished. Manufacturer of the open wire frames is the E. H. Titchener Co., Binghamton, NY.



Wire chassis shapes can be built in any design a CRT user requires.

NEWS

MW system to help space shuttle land

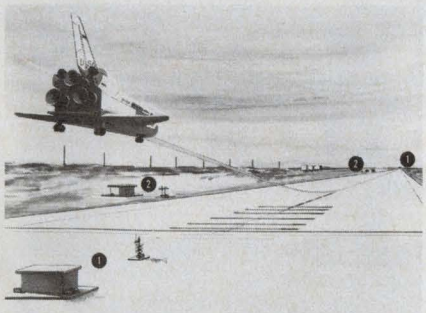
When the first space-shuttle landing tests are made—now scheduled for September, 1976, at Edwards Air Force Base, CA—they will use a microwave landing system.

Designed by Cutler-Hammer's AIL Div., Deer Park, NY, the system is based on off-the-shelf hardware originally developed for the Federal Aviation Administration. The signal-in-space characteristics, for example, are identical to those of the Navy's C-SCAN system.

The system consists of a scanning beam localizer and glide path and a precision DME (distance measuring equipment) system, all sharing the same channel at K_u band. Dual redundancy will be provided on the ground and triple in the air. Each ground station will have a monitoring system to detect malfunctions in signal format, rf drift or fade, or any misalignment. It will also test-interrogate the DME function.

Any detected discrepancy will cause a switchover to standby equipment without interruption of service. Both ends of the shuttle landing runways will be equipped.

The antenna scanning mechanisms are of the torsion-bar resonant type, oscillating at 2-1/2 Hz. Transmissions take place on both to and fro scans, resulting in five beam scans per second. The glide-path antenna has a 1.3-degree beamwidth and is slightly under 4 ft long. The localizer antenna has a 2-degree beam and is about 2 ft wide. ■■



Helping the space shuttle land will be AIL's microwave scanning-beam landing system. The azimuth/DME sites are at 1 and the elevation sites at 2.

The SR-50. The SR-51.

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Answers are calculated to 13 significant digits, rounded off and displayed to 10. And for maximum accuracy, all 13 are held inside for subsequent calculations.

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For a closer look at real math power, delve into the list. You'll see for yourself the SR-50 is a lot of calculator for the dollar. And the SR-51 does everything the 50 does and a lot more: Mean, variance and standard deviation. Linear regression. Percent and percent difference. Has a random number generator. And, offers 20 preprogrammed conversions and inverses.

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FUNCTION	SR-51	SR-50
Log, ln x	yes	yes
Trig (sin, cos, tan, INV)	yes	yes
Hyperbolic (sinh, cosh, tanh, INV)	yes	yes
Degree-radian conversion	yes	yes
Deg/rad mode selection switch	yes	yes
Decimal degrees to deg.min.sec.	yes	no
Polar-rectangular conversion	yes	no
y^x	yes	yes
e^x	yes	yes
10^x	yes	no
x^2	yes	yes
$\sqrt{x}$	yes	yes
$\sqrt[x]{y}$	yes	yes
1/x	yes	yes
x!	yes	yes
Exchange x with y	yes	yes
Exchange x with memory	yes	no
% and Δ %	yes	no
Mean, variance and standard deviation	yes	no
Linear regression	yes	no
Trend line analysis	yes	no
Slope and intercept	yes	no
Store and sum to memory	yes	yes
Recall from memory	yes	yes
Product to memory	yes	no
Random number generator	yes	no
Automatic permutation	yes	no
Preprogrammed conversions	20	1
Digits accuracy	13	13
Algebraic notation (sum of products)	yes	yes
Memories	3	1
Fixed decimal option	yes	no
Keys	40	40
Second function key	yes	no
Constant mode operation	yes	no

To assure you reliable performance, every calculator is subjected to severe environmental and reliability testing prior to release to production. In production, every one is thoroughly tested, then "burned-in", then thoroughly tested again. If there's any problem, we want to find it before it gets to you.

Inside, steel machine screws anchor all important structural elements – plastic welds and glue fastenings aren't good enough. A double-tough Mylar* barrier keeps dust and moisture from getting under the keyboard. The case is high-strength, injection-molded plastic designed to take a beating. It's a quality calculator. And you know it as soon as you get your hands on one. The heft and solid feel tells you it's a fine-quality instrument even before you press a key.

The SR-50 and SR-51 are human engineered, too, for maximum comfort and efficiency. For a hand or a desktop. Keys have positive-action, tactile feedback. And the bright, wide-angle displays are easy to read at your desk or on the go. Slim. Compact. Light. In your briefcase or on your belt, you'll hardly notice just 8.3 ounces.

Technological leadership and quality craftsmanship are why Texas Instruments can offer so much value at such low prices: $109.95 for the SR-50. $179.95 for the SR-51.

20 Preprogrammed Conversions

FROM	TO
mils	microns
inches	centimeters
feet	meters
yards	meters
miles	kilometers
miles	nautical miles
acres	square feet
fluid ounces	cubic centimeters
fluid ounces	liters
gallons	liters
ounces	grams
pounds	kilograms
short ton	metric ton
BTU	calories, gram
degrees	gradients
degrees	radians
°Fahrenheit	°Celsius
deg.min.sec.	decimal degrees
polar	rectangular
voltage ratio	decibels

See them at your nearest TI calculator retailer. Or, send for our new fact-filled color brochure. It details the outstanding capability of both the SR-50 and SR-51 with full feature descriptions, sample problems, entry-method considerations and more. Circle the reader service number. Or write, Texas Instruments, M/S358, P.O. Box 22013, Dallas, Texas 75222

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INFORMATION RETRIEVAL NUMBER 20

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Double-Balanced Mixer Kit $79.95

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- ***. . . and to cut, skin, slice, sever, snip, saw, screw, scribe, shape, scrape, strip, pick, pry, punch, trim with the Swiss Army knife included in kit.***

There's an analogy between the popular Swiss Army knife and Mini-Circuits Laboratory's new double-balanced mixer kit (DBK-4). Both have been designed to serve their owner when the need arises . . . and both products should be on hand when the need arises.

Double-balanced mixer kit (DBK-4)

BE A PLANNER AND SAVE $41.75.

Order now and receive six double-balanced mixers (2) SRA-1, (2) SRA-1W, (1) SRA-3, (1) SRA-6) and one Swiss Army knife for only $79.95. (A $121.70 mixer value if purchased separately.)

MODEL	Frequency Range (MHz)	Conversion Loss (dB) Total Range	Isolation (dB) Lower band edge to one decade higher LO-RF	Lower band edge to one decade higher LO-IF	Mid range LO-RF	Mid range LO-IF	Upper band edge to one octave lower LO-RF	Upper band edge to one octave lower LO-IF
SRA-1	LO-0.5-500 RF-0.5-500 IF-DC-500	6.5 typ. 8.5 max.	50 typ. 35 min.	45 typ. 30 min.	45 typ. 30 min.	40 typ. 25 min.	35 typ. 25 min.	30 typ. 20 min.
	Price $9.95—Quant. (1-49)							
SRA-1W	LO-1-750 RF-1-750 IF-DC-750	6.5 typ. 8.5 max.	50 typ. 45 min.	45 typ. 30 min.	45 typ. 30 min.	40 typ. 25 min.	35 typ. 25 min.	30 typ. 20 min.
	Price $24.95-Quant. (1-5)							
SRA-3	LO-0.025-200 RF-0.025-200 IF-DC-200	6.5 typ. 8.5 max.	60 typ. 50 min.	45 typ. 35 min.	45 typ. 35 min.	40 typ. 30 min.	35 typ. 25 min.	30 typ. 20 min.
	Price $21.95—Quant. (1-5)							
SRA-6	LO-0.003-100 RF-0.003-100 IF-DC-100	6.5 typ. 8.5 max.	60 typ. 50 min.	60 typ. 45 min.	45 typ. 30 min.	40 typ. 25 min.	35 typ. 25 min.	30 typ. 20 min
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INFORMATION RETRIEVAL NUMBER 21

Washington Report

Pentagon surviving budget-cutting fray

The Pentagon is going to make out well next fiscal year, despite cuts by the Senate and House Armed Services Committee. The House Committee chopped $3.7-billion out of a total request of $29.8-billion, and the Senate group voted for a cut of $4.8-billion. But already in the Pentagon's coffers are $1.3-billion that had been requested for military aid to South Vietnam and $902-million the Navy had asked for to cover anticipated inflationary shipbuilding costs.

All of the Pentagon's really high-priority projects seem to be relatively intact. The B-1 program won't move as fast as the Air Force wanted, but it is still very much alive. The same goes for the Navy's Trident program.

The Senate committee did vote to reduce the number of shipbuilding starts next year, but it left intact the funds requested for other programs, including the six AWACS (Airborne Warning Control System) aircraft the Pentagon wants. The House committee had cut that program in half. Final details will be worked out in conference.

Efforts are expected in both houses of Congress to make further trims, but considering the reverses in Southeast Asia and the fragile detente with the Soviet, the experts don't think the final figure will be lower than $25-billion, the amount the Senate committee arrived at.

COMSAT seeking to sever Government apron strings

Contending that it is a mature, viable commercial enterprise, the Communications Satellite Corp. (Comsat) is asking Congress to amend the act that created it in 1962 so it can operate much like any other common carrier, not tied to the Government.

A bill introduced by Sen. Warren G. Magnuson, Democrat of Washington, and Sen. James B. Pearson, Republican of Kansas, would authorize the creation of a new corporation for profit that would not be an agency of the Federal Government. As a communications common carrier, Comsat still would be subject to regulation by the Federal Communications Commission, as it is now, but the FCC wouldn't have the approval authority it holds today on efforts to obtain additional capital.

FAA to choose aeronautical satellite contractor

The Federal Aviation Administration expects to request bids by mid-year for the space segment of its Aeronautical Satellite Program and to select a prime contractor towards the end of the year, says James E. Dow, acting administrator. In recent testimony before the House Appropriation

Subcommittee on Transportation, he requested a total of slightly over $1.9-billion for his agency—which is $179-million more than was authorized last year.

For facilities and equipment, the FAA is requesting $250-million, of which $43.9-million would be for navigation aids, instrument landing systems and visual aids. Included are funds for replacing 10 obsolete long-range radars and 18 obsolete ASR-8 radars, now used for airport surveillance, and the acquisition of 17 solid-state Direct Access Radar Channels to complete the outfitting of all en-route centers.

Under research, engineering and development, the agency is asking for $80.4-million. Included, Dow says, are programs for discrete-address radar beacons and the Intermittent Positive Control ground-based collision avoidance system; experimental communications/surveillance satellites; advanced air-ground communications systems and other systems to improve air traffic control.

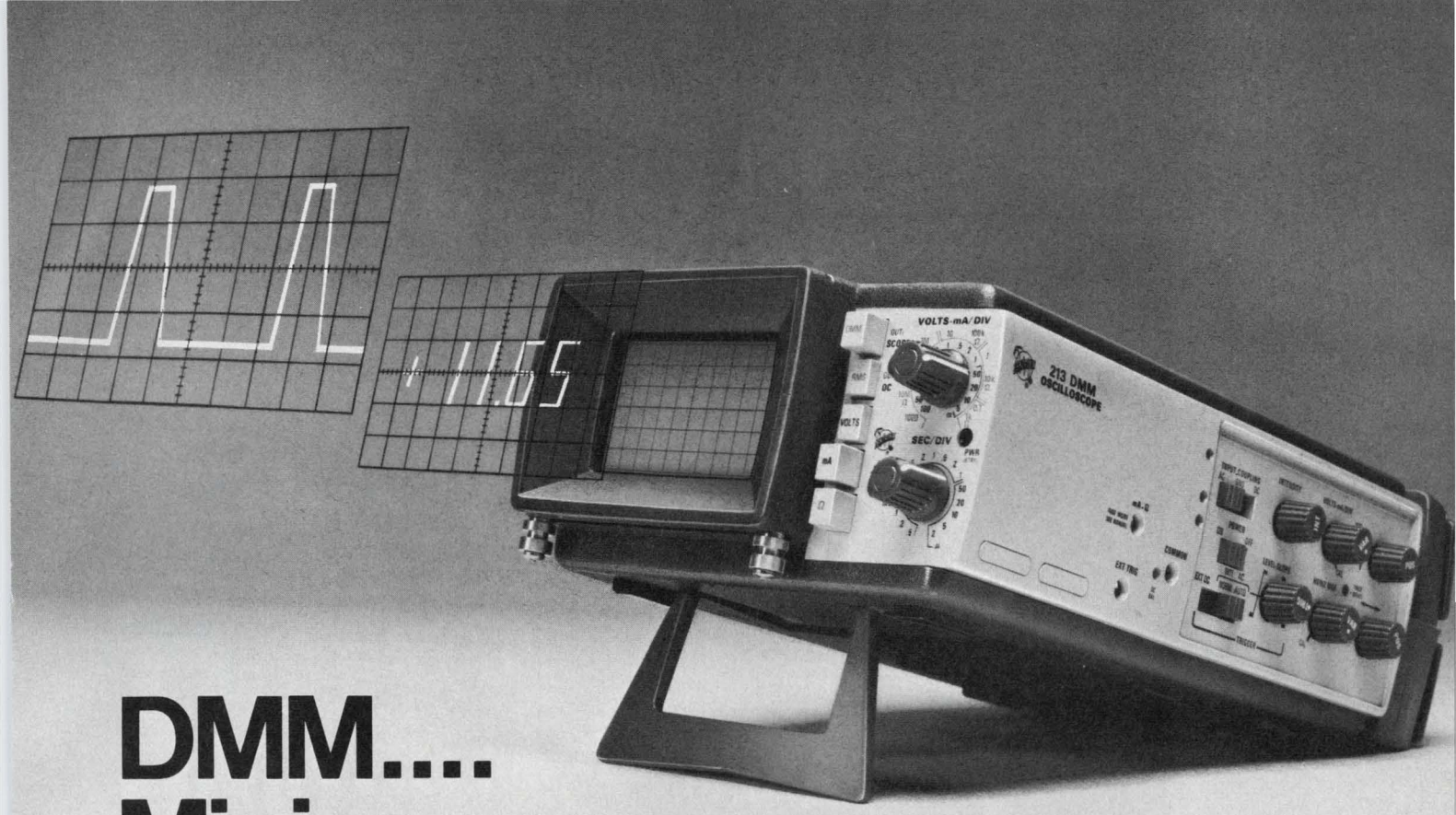
New source of RFI: aquarium thermostats

The Federal Communications Commission is drawing a bead on another source of rf interference that is plaguing electronics engineers—aquarium thermostats. Agency experts say undesirable radiation is emitted at the thermostats, or from power lines supplying other buildings from the same transformer. So far, commercially available power-line filters have not been effective in eliminating the interference.

The FCC's position on such possible radiation devices as electric shavers, mixers, vacuum cleaners and thermostats has been that of merely requiring such equipment to be operated without interference with other electronic equipment. But, because of growing concern, the commission says now that it expects manufacturers to take measures to eliminate or substantially reduce interfering radiation before the equipment leaves the factory. If voluntary efforts by industry aren't satisfactory, the FCC says it will initiate rule-making procedures.

Capital Capsules:

The loss of 140,000 jobs in U.S. industry and $2-billion in export sales may result if the Commerce Dept.'s export promotion program is cut, the Electronic Industries Association has warned. The Office of Management and Budget has ordered cuts. . . . **The outlook for foreign military sales is bright again this year,** but not quite as good as it was last year. In 1974, **sales on a government-to-government basis** were $8-billion, plus another $1-billion transacted on a commercial basis. Defense officials believe the Government sales will run between $7-billion to $8-billion this year. If some pending aircraft sales come through before June 30, sales for 1975 could outstrip the 1974 total. . . . **A radar that will not only tell the number of vehicles in a convoy but also their types** is on the shopping list of the Army Mobility Equipment Center. Wanted is a sensor system for the Remotely Monitored Battlefield Sensor System. The capability sought includes detection of number, type, location, speed and heading of mixed targets.. . . . **An electrically powered wheelchair that responds to 32 voice commands** is the latest development of the NASA Jet Propulsion Laboratory. Developed under a Veterans Administration program, the wheelchair is for quadriplegics and others severely handicapped. Not only do voice commands control chair movements; they also operate a manipulator arm on the chair that can be extended from one to four feet to pick up objects with two pincer fingers.



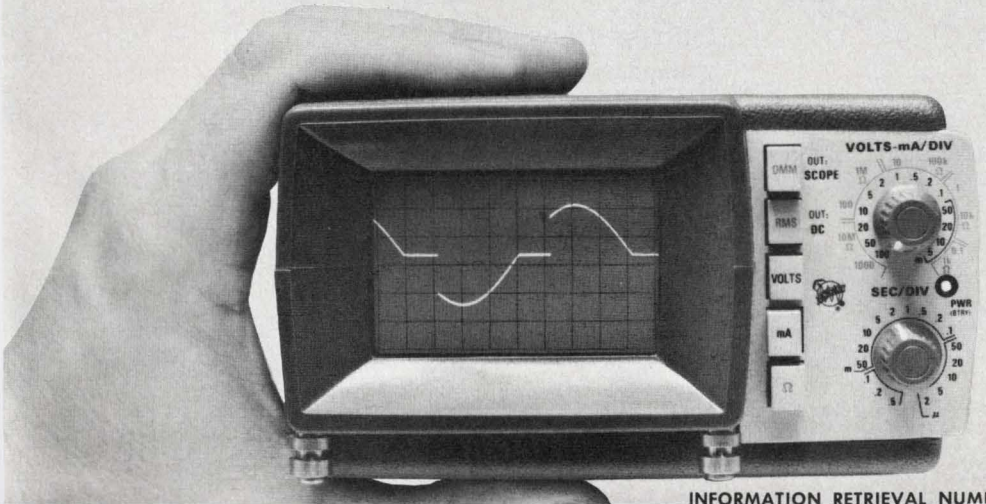
DMM.... Miniscope.... both in one handheld unit

You no longer have to settle for only a DMM or suffer the inconvenience of carrying two separate instruments. The new TEKTRONIX 213 DMM/Oscilloscope provides the instrumentation needed to reduce service costs by performing more of your servicing on site, on the first call. And it weighs only 3.7 lbs. This precise, full function, 3½ digit DMM and 1 MHz oscilloscope in one compact (3.0 × 5.2 × 8.9 in.) package fits easily in your briefcase or tool kit. During operation the 213 can be hand held, rested on the equipment under test, or even carried on a convenient neck strap.

Included in the extensive measurement capabilities of the 213 are precise dc voltage from 0.1 V to 1000 V full scale, dc current from 0.1 mA to 1000 mA, true rms voltage and current over the same ranges, and resistance from 1 KΩ to 10 MΩ full scale. In the oscilloscope mode, the 213 displays both voltage (5 mV/div to 100 V/div) and current (5 μA/div to 1000 mA/div) waveforms.

With its easy portability and internal battery power (3.5 hours operation), the 213 DMM/Oscilloscope is equally at home at the top of a ladder, on a catwalk in a processing plant, in a moving vehicle, in an office environment, or at a remote field location. And rugged construction insures that the 213 will withstand rough handling.

At only $1200, the 213 adds outstanding versatility to the Tektronix 200 Miniscope Series. Other instruments in this line include both single and dual-channel 500 kHz oscilloscopes, a dual-channel 500 kHz storage oscilloscope and a 5 MHz oscilloscope for higher frequency applications. All of these Miniscopes share the 213's advantages of small size, light weight, internal battery power, rugged construction, double insulation, and integral voltage probes and power cord.



For detailed information on this complete DMM and Oscilloscope in one small, handheld package, contact your local Tektronix Field Engineer, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe, write: Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

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INFORMATION RETRIEVAL NUMBER 22

FOR DEMONSTRATION, 151

RIGHT ON TARGET AGAIN

SGS ATES

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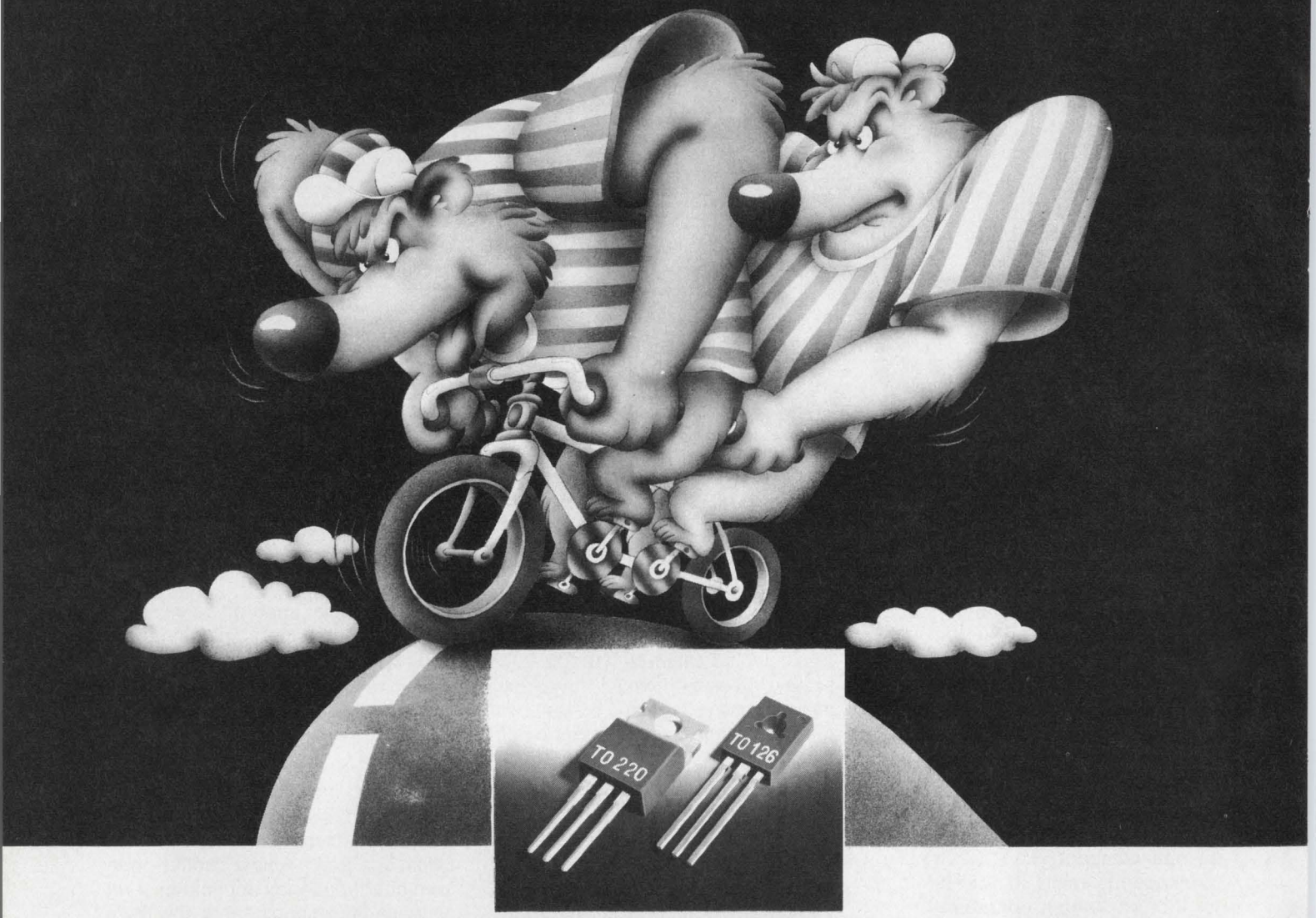

Complementary power pairs in plastic

Epibase-darlingtons

4 Amperes - TO 126 pack

NPN	PNP
2N 6037	2N 6034
2N 6038	2N 6035
2N 6039	2N 6036
SJE 800	SJE 700
SJE 801	SJE 701
SJE 802	SJE 702
SJE 803	SJE 703

8 Amperes - TO 220 pack

NPN	PNP
BDX 53/A/B/C	BDX 54/A/B/C

Epibase-transistors

2 Amperes - TO 126 pack

NPN	PNP
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SJE 720/21/22	SJE 710/11/12

4 Amperes - TO 126 pack

NPN	PNP
2N 5190/91/92	2N 5193/94/95
SJE 220/1/2/3/4/5	SJE 230/1/2/3/4/5

4 Amperes - TO 220 pack

NPN	PNP
2N 6121/22/23	2N 6124/25/26
SIP 31/A/B	SIP 32/A/B

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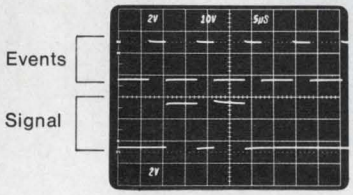
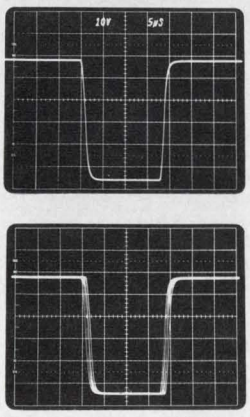
INFORMATION RETRIEVAL NUMBER 23

DELAY BY EVENTS, STABLE DISPLAYS, AND EASY-TO-USE CONTROLS: HOW DO YOU GET ALL THIS IN AN INEXPENSIVE LABORATORY OSCILLOSCOPE WITH DELAYING CAPABILITY?

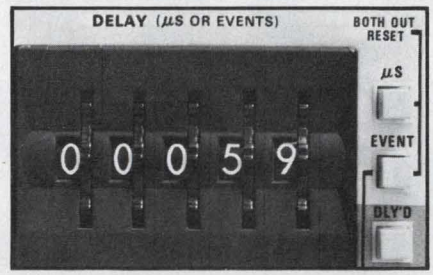
The TEKTRONIX 5B31 Digitally Delaying Time Base has a delay-by-events mode in addition to delay by time (up to 99,999 μs in 1-μs increments). In the delay-by-events mode, you can synchronize the delay to a specific event and then trigger the sweep up to 99,999 events later.



The 5B31 has a digital delay system—a crystal-controlled clock, a digital counter, and a circuit that eliminates 1-count ambiguity—that introduces no more than 20 ns of jitter at any sweep speed. So the 5B31 will have little effect on the stability of your display, even at very high sweep speeds.

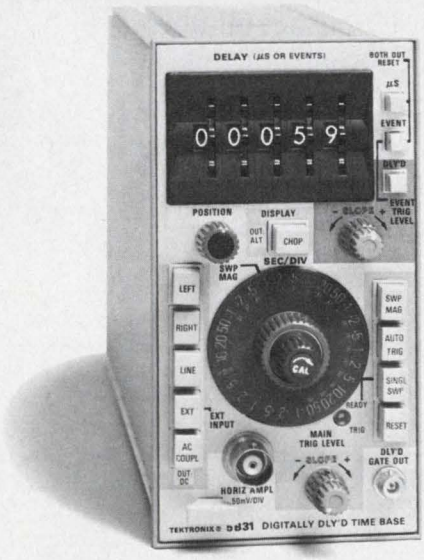


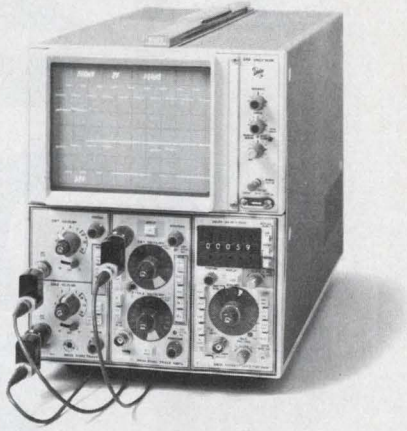
The 5B31 has easy-to-use controls: thumbwheels and pushbuttons instead of dials. You can set and read out the delay from the 5-digit thumbwheel to the nearest μs or event, select the delay mode by pushing the μs or events button, and trigger at the beginning of the delay by pushing the DLY'D button.



Then you can study any portion of the waveform in detail by adjusting the thumbwheels and increasing the sweep speed.

You can choose a 5400-Series laboratory oscilloscope with this digital delaying capability for less than $2000. This oscilloscope system gives you the basic performance and capability you need now and the potential to expand for your future measurement needs.





How can we offer you this flexibility? The 5400-Series, a comprehensive group of plug-ins and store and non-store mainframes, can be combined to make up just the right oscilloscope measurement system for you.

We'd like to help you select the right system for your needs. Let us send you all the technical details on the 5400-Series Oscilloscopes and the 5B31 Digitally Delaying Time Base. Write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands. For a demonstration, contact your nearest Tektronix Field Office. U.S. Sales Prices F.O.B. Beaverton, Oregon.

DIGITAL DELAY/ANOTHER 5000-SERIES SYSTEM.

TEKTRONIX®
committed to technical excellence

OUR NEW DIGITALLY DELAYING TIME BASE

INFORMATION RETRIEVAL NUMBER 24 FOR DEMONSTRATION, 152

Meet the 1500W zener.

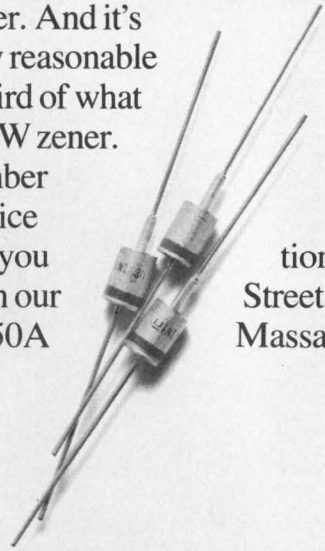
The zener with the specs of a surge suppressor.

If you're using power zeners as surge suppressors, you need to know whether the zener will protect your circuit. And the usual specs aren't much help.

Here's the zener you've been waiting for. It's designed and spec'd as a suppressor, with 1500W peak pulse power capability – higher than any conventional zener. And it's available at a very reasonable price – about a third of what you'd pay for a 50W zener.

Circle our number on the reader service card – we'll send you the whole story on our 1N5629A-1N5650A series of power zeners. And you'll never have to guess about surge suppression again.

Unitrode Corporation, 580 Pleasant Street, Watertown, Massachusetts 02172.

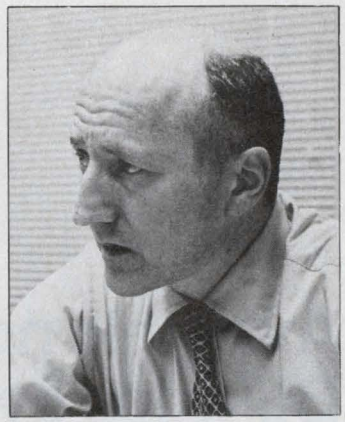


UNITRODE

INFORMATION RETRIEVAL NUMBER 25

Editorial

Genius to bum



Jack's company is taking a bath this year. Last year, continuing its annual growth rate of about 17% a year, Jack's company hit a record sales volume of some $35,000,000. So everybody knew that Jack was a genius, a man so capable and so shrewd that he never made a mistake. Or, a least, he didn't make serious mistakes.

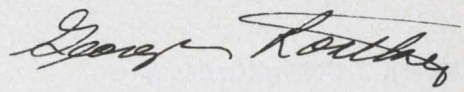
When you visited his company you could sense the high morale, the spirit of enthusiasm. You could smell the odor of success. And when his employees spoke of Jack, they did so with a certain reverence. But this year Jack's a bum.

Sales have plunged to an annual rate of some $13,000,000. And earnings have plummeted even more precipitously. Further, some of Jack's bold and brilliant ventures of past years have turned out to be duds. So, in keeping with the popular business practice of burning up all the bad news in a bad year, Jack is writing off some huge losses.

If you visited Jack's company now, you'd find that morale stinks; people have forgotten his past glories and they talk (well, they really whisper) about his blunders. You get the feeling he's pretty stupid. Those people are wrong again.

There are lots of star performers in our industry, loads of brilliant engineers and managers. But nobody bats 1000. The only folks who don't make mistakes are dead. If we want to evaluate live people properly, we'd better recognize that they're going to make mistakes—some of them serious. As observers, the most serious mistake that *we* can make is to assume that the past is a perfect indicator of the future.

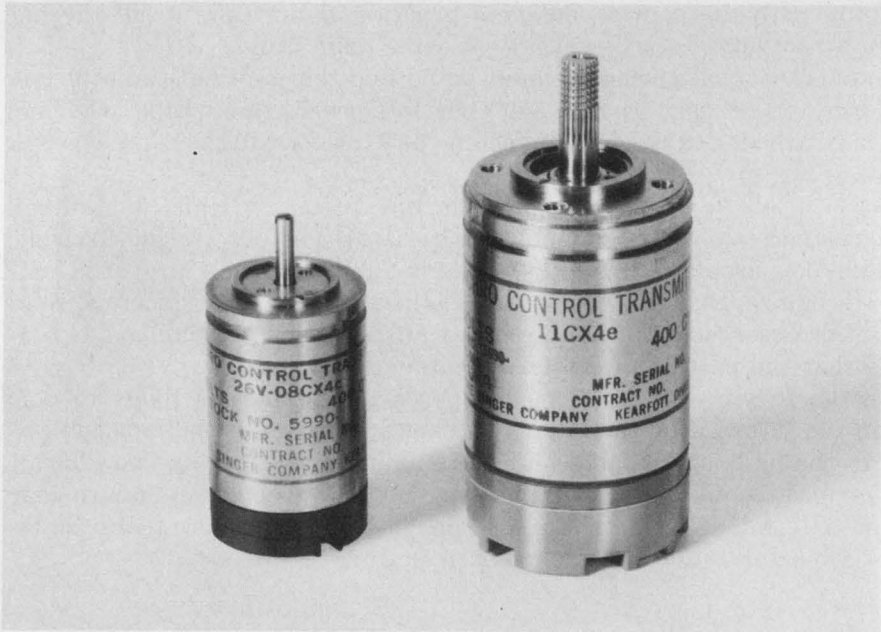
Sure, the fellow who pulls one blooper after another is likely to goof again in the future. And the fellow who has scored many brilliant achievements in the past is more likely to score again. But there are no guarantees. For most companies in our industry 1975 has been an unhappy year. But not a terminal year. There will be plenty of terrific years in the future—even for those who took a bath in 1975.



GEORGE ROSTKY
Editor-in-Chief

We made them first. To last.

Available now from Singer: Size 8 and 11 Bu/weps synchros designed to meet the latest requirements of MIL-S-20708C specifications.



Kearfott, the first to design Bu/weps size 5, 8 and 11 synchros, has over the years constantly made them better. These units are used in fire control systems, radar, navigation, missile functions and other applications requiring a high level of precision, endurance and reliability.

These Kearfott synchros operate over the entire temperature range of—55°C to + 125°C. They are DOD qualified and listed in the QPL.

(They can also meet reasonable cost requirements in computers, electronics and other types of business equipment.)

You can get these synchros in the following Bu/weps types:

Size 8	Size 11
26V 08CX4c	26V 11CX4c
26V 08CDX4c	11CX4e
26V 08CT4c	26V 11TX4c
	26V 11CDX4c
	11CDX4b
	26V 11CT4d
	11CT4E

We'll be happy to send you drawings and technical details on request. Also for Kearfott Size 5 Bu/weps CX, CDX and CT units, and Size 11 and 15 resolvers. Units with the same characteristics but different Bu/weps shaft variations are also available. Write for information to the Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, N.J. 07424.

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Average access 35 ms
Data Rate: 312 K bytes/sec.

9747 DSU with Cartridge Disk Drive interface
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21 OEM offices, in 11 countries, specializing in service to the mini OEM.

Call (612) 830-5624 or return coupon.

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Please send information on your Cartridge Disk Drives.

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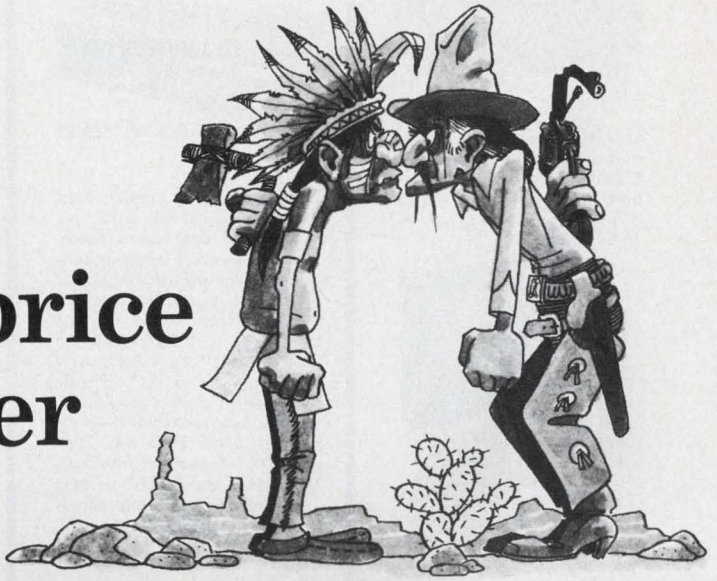

This isn't a shootout about new product so if you're expecting the latest bullets on the latest gizmo, move on now.

If, however, you want to see us take a stand on pricing your next silicon power transistor you'll have to continue to the bitter end.

Simply stated our policy is this: *we'll be competitive on 99.9% of the power transistors in our broad line.*

Sounds simple but it isn't.

We think a fair price for a good product is the only way to last. So do you.

Used to be you knew us as the me-too in discretes. Others innovate, Motorola follows.

That held true 'till we decided the only way to capture first place in silicon power was to become the technological leader. So we started a technology war that scored like:

Motorola	Competition
Aluminum TO-3, TO-66	Copied it
EpiBase* technology	Copied it
EpiBase Darlingtons	Copied it
Annular† Darlingtons	Copied it
Thermopad II* Plastic	Uncopied
Power Regulators	Copied it
HV Darlingtons	Copied it
Switchmode* Power	Copied it

We won hands down. And more to come.

Former leaders are cutting prices now.

There's a price war going on. And everybody expects us to be in it.

We are.

But we won't degrade total service because prices are lower. That's shoot-from-the-hip bs.**

If you want fair and square product at competitive cost you'll be forced to recognize Motorola still offers more than anyone who waves their latest red-inked price sheet at you.

Straight arrow stuff. Clean neat devices . . . Easy to find specs . . . Low failure rates . . . Many salesmen . . . Few service hassles . . . Volume . . . Applications help . . . Good literature . . . Ready to assemble parts . . . Standards.

Things real leaders have to have to last. Things most of you want for long term peace of mind.

Things wheeler-dealers *never* have – now or after their bubbles burst.

In the meantime we'll meet them, and you, on any battleground in the USA at high noon or otherwise.

And when the chips are down we know you'll be on our side.

Or else.

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Send for it.
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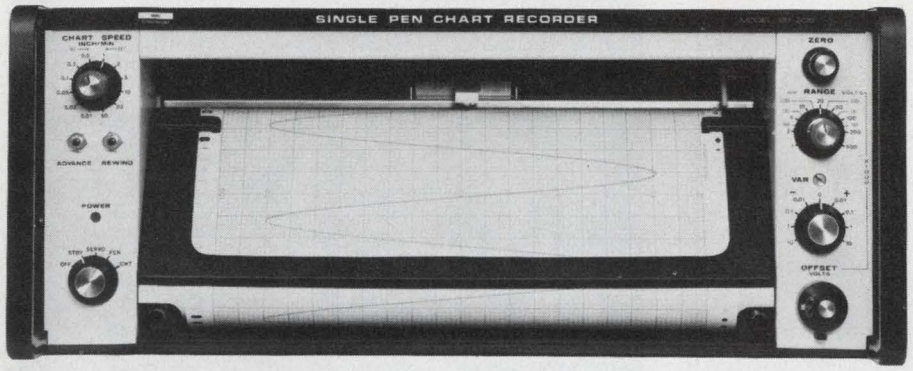
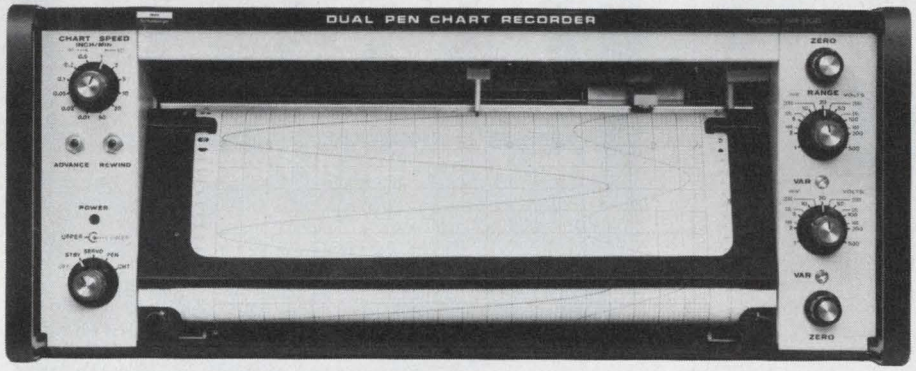
*Trademark Motorola Inc. **business suicide †Patented process Motorola Inc.

Heath sets a new performance level for laboratory recorders



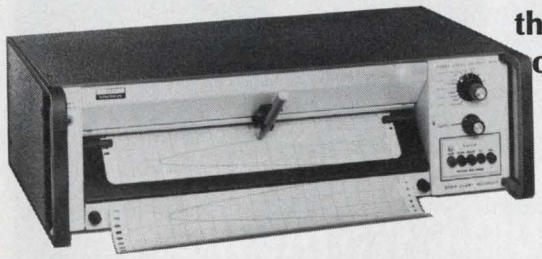
Our new single-pen SR-205 has many standard features that are available only as extra-cost options with other manufacturers. Like front panel zero controls for pen placement anywhere with zero input ...full scale input ranges of 1, 2, 5, 10, 20, 50, 100, 200 & 500 mV *or* volts...calibrated positive & negative offset for input signal suppression...pushbutton chart advance and rewind...12 chart speeds from 50 in/min to 0.01 in/min in a 1-2-5 sequence...remote control capability for all functions. Balance time is only 250 msec for accurate response to fast-changing signals. Maximum error is ±0.2% of full scale. A great recorder value—only $995*.



The new SR-206 brings dual-pen recording to the Heath/Schlumberger recorder line. Both channels offer the same capability as the SR-205 above, except for calibrated offset...both inputs provide 18 calibrated ranges from 1 mV to 500 V full scale...pens are separated by one large division on the chart for easy comparison ...remote control includes separate pen lift and events marker for each channel... disposable, nylon-tipped pens for sharp, distinct traces at any chart speed. The SR-206 is the most complete recording system in its price class. Only $1395*.

Heath/Schlumberger has engineered precision and performance into two new strip chart recorders that are probably all the lab recorder you will *ever* need. Each recorder is a complete system — there are no extras to buy. The price even includes events markers, electric pen lift, necessary hardware for rack mount and easy conversion to metric operation. Chart drive is quartz crystal controlled for stable chart operation regardless of line frequency. Front panel pushbuttons provide two-speed chart advance and rewind. Remote control by TTL-level signals for pen lift, chart drive, events marker and servo mute is possible through a connector on the rear panel (mating connector supplied). An enclosed conductive plastic slideware is used for long life without periodic cleaning. Pen motor current limiting circuitry allows the pen to be driven continuously off scale with no audible noise and no possibility of damage to the recorder.

The precision and versatility of the SR-205 & SR-206 will make them the most-used instruments in your lab.



Research-quality performance on a low budget... the SR-255B only $365*

The SR-255B is our best recorder value. It offers a full 10-inch chart width...pushbutton selection of 10 mV, 100 mV, 1 V and 10 V full scale spans with variable control for expansion to 100 V full scale...10 digitally-derived chart speeds from 10 to 0.01 in/min with accuracy to 0.5% or better...floating input with better than 10 megohms input impedance to minimize source loading... complete remote control capability for all functions. Only $365*, calibrated and ready for use.

Send for your free Heath/Schlumberger Catalog

The latest Heath/Schlumberger Assembled Instruments Catalog has complete specs and descriptions for all of the above recorders — along with many other high performance, low cost instruments for industrial, research and educational applications. Send for your free copy today.

Please send my free copy of the latest Heath/Schlumberger Assembled Instruments Catalog.

HEATH/SCHLUMBERGER INSTRUMENTS
Dept. 511-070
Benton Harbor, Michigan 49022

HEATH
Schlumberger

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EK-462

INFORMATION RETRIEVAL NUMBER 124

Complete and Adjustment-Free Sample/Hold

Model MN343 S/H in a dip features:

- HIGH SPEED... 7.5 μsec acquisition time. ...60 nsec aperture time.
- LOW DROOP RATE ... 100 μV/msec.
- GUARANTEED ACCURACY... $\pm$.02% at 25C. ...$\pm$.05% (0 to 70C and $-$55 to +125C).
- SMALL SIZE... 14 pin hermetic dip.

Micro Networks continues to lead the field in the engineering and production of complete, adjustment free conversion products.

Model MN343—with internal holding capacitor—is the first complete and adjustment free S/H in a dip. It is laser trimmed for offset and gain, eliminating the need for external components and trim pots. Because of its high speed and low droop characteristics it is a perfect match to the 12 bit high speed A/D converters such as Micro Networks' MN5200. For the operating range $-$55 to +125C, the MIL-range unit MN343H will lose only 1 mV—or less than $\pm$½ LSB out of 12 bits in 50 μsec.

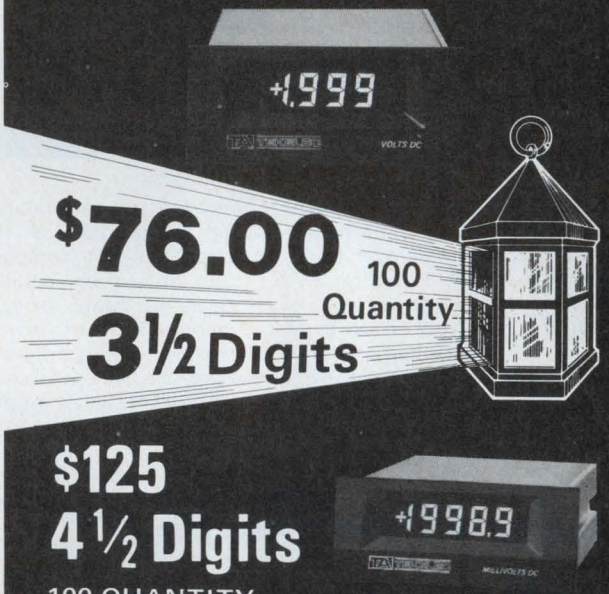
For additional information, prices and specifications, write or call.

Micro Networks Corporation
324 Clark Street • Worcester, Mass. 01606/Tel:617-852-5400

INFORMATION RETRIEVAL NUMBER 125

TEKELEC HAS THE SPIRIT OF '76

The $76 Digital Panel Meter



$76.00 100 Quantity
3½ Digits

$125
4½ Digits
100 QUANTITY

3 YEAR WARRANTY ON LIQUID CRYSTAL DISPLAY

- 14 Voltage and current ranges
- Sensitivity to 1 μV/digit
- Shielded transformer power supply
- 220 V RMS Common mode voltage
- Overrange indication
- Bi-polar operation with automatic polarity indication
- All metal case for better noise immunity
- Available for DC power
- Power consumption 1½W nominal
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TEKELEC, INC. TA

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ANOTHER DIMENSION

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Simpson® 260 VOMS

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- **Extra shock and drop-resistant construction, high impact, custom-molded panel and case**
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- **33 ranges with extra voltage, current, resistance and low-power ohms functions**
- **Plus — all the features of the time-honored, ever popular 260-6**

260-6XL, Complete with batteries, test leads and manual **$90.00**

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Reset pushbutton releases when overload exists. Will not reset until overload condition is eliminated.

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RANGES:

DC Volts	0-0.25; 0-1; 0-2.5; 0-10; *0-25; 0-100;* 0-250; 0-500; 0-1000
AC Volts	0-2.5; 0-10; *0-25; 0-100;* 0-250; 0-500; 0-1000;
DC Microamperes	0-50 (250 MV Drop)
DC Milliamperes	*0-0.5; 0-5; 0-50;* 0-500
DC Amperes	*0-5* (250 MV Drop)
AC Amperes	6 ranges from 0-5 to 0-250 with optional Model 150 Amp-Clamp adapter.
DB Scale (1 MW 600 Ω Reference)	—20 to +10; —9 to +21: *—1 to +29; +11 to +41;* +19 to +49
Resistance (Standard Power)	*Rx1* (6 Ω center scale), *Rx100* (600Ω center scae), *Rx1K* (6000 Ω center scale), *Rx10K* (60,000 Ω center scale)
Resistance (Low Power)	*Rx1* (20 Ω center scale) *Rx10* (200 Ω center scale) Max. open circuit voltage only 100mV! Max. measuring power only 0.125 mW!
Size	5¼ x 7 x 3⅛" (133 x 178 x 79 mm)
Weight	2.5 lbs. (1.14 kg)

ACCESSORIES

Model 150 Amp-Clamp, Catalog No. 00532 complete with a No. 00533 test lead	$29.50
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Grip-Tip Extension Probe, Catalog No. 00118	$ 4.75
Rigid Case, Catalog No. 00805	$20.50
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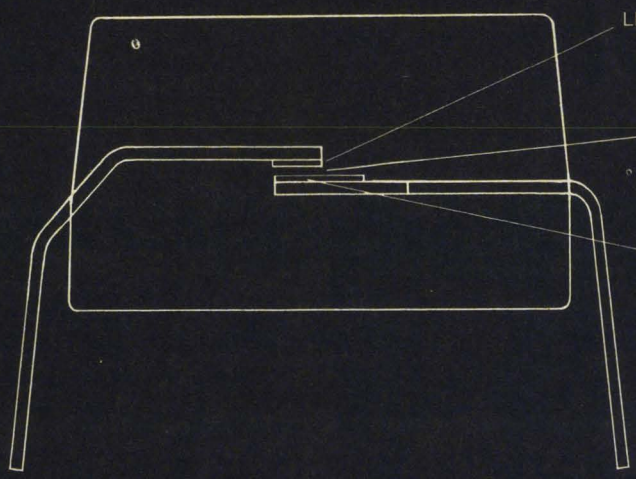
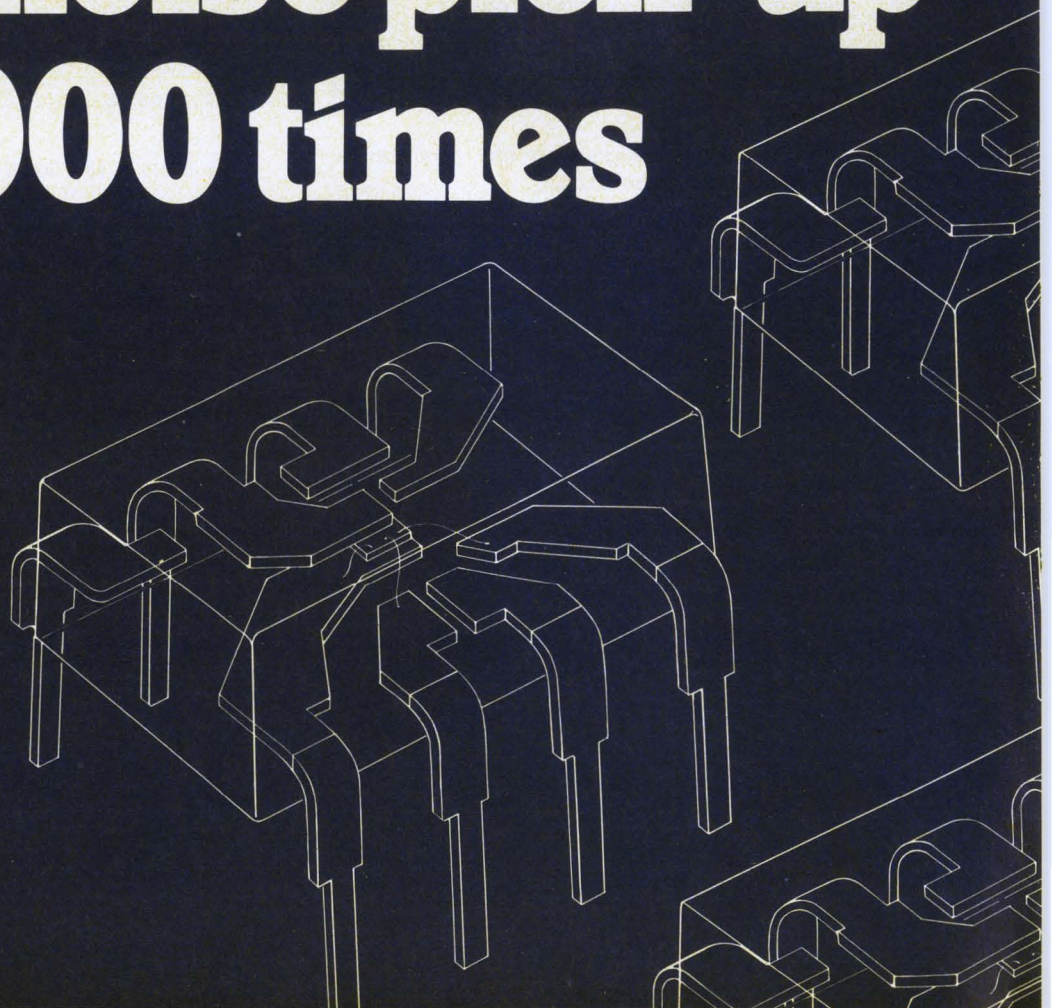


Ultra fast opto-isolator cuts noise pick-up 100,000 times



The specs are startling. Our IL-100 Isolite can transmit data at rates up to 5 megabits per second. And with common mode rejection of 50 db. That's better than any opto-isolator ever made, regardless of speed.

This performance is good enough to eliminate noise pick-up problems in nearly all hard-wired data transmission applications.

Such a state-of-the-art breakthrough means you can tie together computer and peripherals without resorting to brute force techniques for eliminating noise pick-up—such as laying in conduit and shielding systems, all of which are highly expensive.

And it means you save countless hours when a system is installed, modified or moved.

The IL-100 is a true solid-state device. It is DTL/TTL compatible, so it can be designed into your next solid-state system without the extra components required by pulse transformers.

It has an unusually versatile Schottky-clamped 3-state output that gives you built-in multiplexing capability without extra parts.

And its built-in Schmitt trigger virtually eliminates chance of oscillation, making your designs less critical and more reliable.

With propagation delay of only 75 nanoseconds, there is no opto-isolator made that offers comparable performance.

Don't use yesterday's technology to protect today's solid-state circuits. For details on the IL-100 ultra high-speed opto-isolator, contact Litronix, Inc., 19000 Homestead Road, Cupertino, Calif. 95014. Phone (408) 257-7910.

No wonder we're No.1 in LEDs

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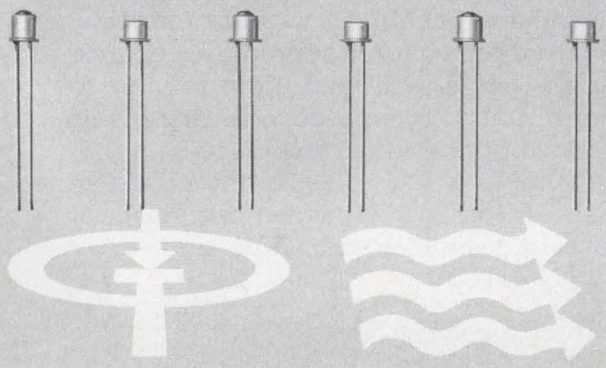
INVISIBLE LIGHT from General Electric

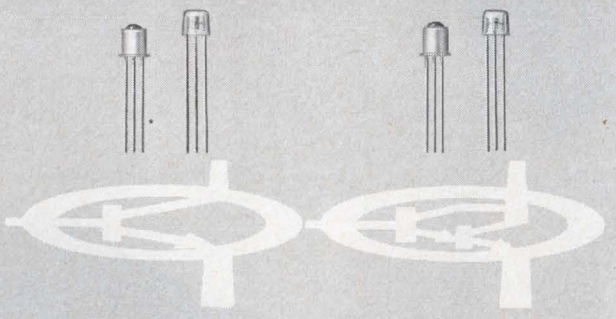
6 NEW INFRARED LEDS



- High non-coherent power out @ 9400Å from GaAs liquid epitaxial pellet
- LED55C series offers guaranteed 5.4mW output @ 100mA
- Available in hermetic TO-46 type packages...choice of lens or flat cap
- Exact replacements for SSL55 & 56 series
- Suggested resale prices start @ $1.56 in 1K lot quantities

....AND DON'T FORGET OUR DETECTOR LINE

- 11 models feature either ultra sensitive Darlington or transistor inputs
- Complements General Electric LED55 & 56 series infrared emitters
- Choice of top viewing hermetic TO-18 type or side viewing plastic packages



Competitively priced and available thru authorized General Electric Electronic Components Distributors

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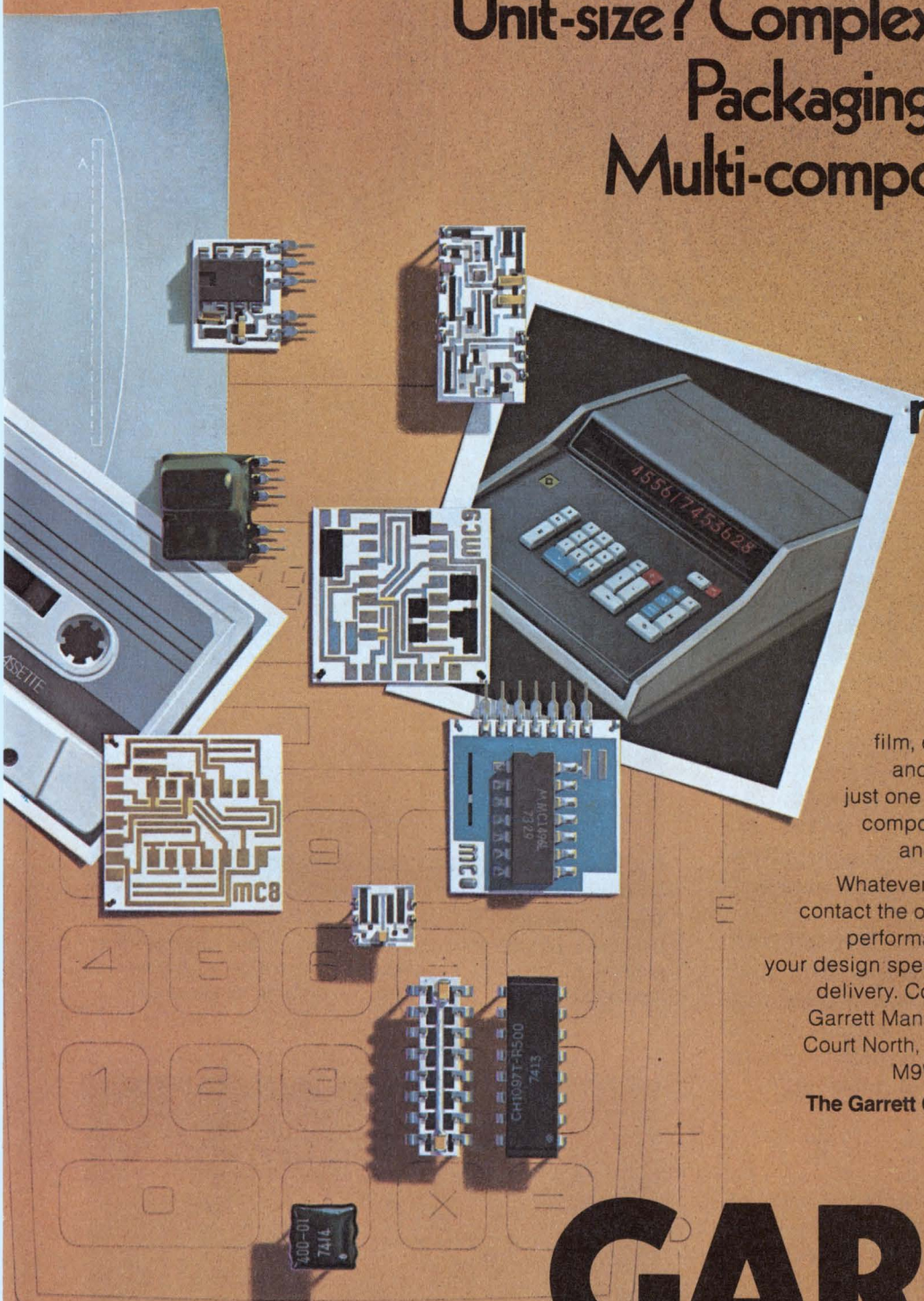
GENERAL ELECTRIC

What's your design problem... Unit-size? Complexity? Reliability? Packaging? Field service? Multi-component handling?



Garrett hybrid microcircuits are the solution.

Garrett custom engineering can meet your requirements with hybrid microelectronic technology, performance-proved in consumer, industrial, and military products.

Our high-volume production capability, which encompasses thick film, thin film, component attach of discretes or chips, and automated testing, allows you to order just one micro device instead of many separate components. Reduces your material-handling and labor costs. And increases efficiency.

Whatever your hybrid microcircuit requirements, contact the one reliable source that offers maximum performance at minimum cost. Garrett. Send us your design specs for fast response on price quote and delivery. Contact: Manager, Microelectronic Sales, Garrett Manufacturing Ltd., 40 Voyager Court North, Rexdale, Ontario, Canada. M9W 4Y3. Tel. (416) 677-9790.

The Garrett Corporation One of The Signal Companies

GARRETT MICROCIRCUITS

They solve the problem

INFORMATION RETRIEVAL NUMBER 30

FOCUS on Sweep generators

If collision with error heightens truth, prepare for dizzying altitudes in your search for the right sweep generator.

It is true that the sweeper has improved enormously since its early days. Outputs are flatter. Residual fm and drift have been cut. Distortion and noise are down. But sweepers still aren't perfect, and if the instrument itself has come a long way, the manner of its specification hasn't.

Look at flatness. It's one of the most important sweeper specs—and one of the most ambiguous. If you're testing wideband devices, you'd like the sweeper's output amplitude or power to stay level as the frequency skims along. If the output doesn't stay flat, you can't distinguish the device's response from that of the sweeper. Your results are meaningless, unless you somehow compensate.

So you're relieved when you see a tiny ±0.2-dB variation listed for a unit's flatness. But your smiles turn to gloom pretty fast when your test amplifier's response comes out looking like a roller-coaster course. What went wrong? Perhaps that ±0.2-dB sweeper isn't so flat after all.

Flat is beautiful

What you weren't told is that flatness isn't an absolute, intrinsic quality—far from it. Flatness depends on so many variables, it's doubtful that it can ever be fully stated.

Touch the variable attenuator or vernier: There goes the flatness. One setting of this control may hurt the spec, another can iron out the wrinkles. Boost your sweep speed to, say, beyond 10 sweeps per second to get a flicker-free scope display. What happens? If the leveling loop's bandwidth isn't wide enough—and chances are it isn't—forget about leveled power.

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Assoicate Editor

Various plug-ins for the TF2361 sweep generator—backbone of the Marconi line—convert the unit from a general purpose to a specialized instrument. Shown is the video plug-in: 25 kHz to 30 MHz in one sweep.

Multiplexed, multiband sweeper systems, from Weinschel, give continuous coverage from 0.01 to 18 GHz. A single p-i-n device performs leveling and multiplexing.

Shove a high-directivity coupler between the sweeper and load to get a good source match and, you guessed it, the coupler digs into the flatness. Connect the load at the end of long cables, and the same thing happens. Change detectors and—ditto.

Even when a power meter or wideband detector tells you the output is reasonably level, don't count on it. Every sweeper output contains distortion products that can invade the leveling loop and affect flatness. Consequently if the vendor measures flatness with wideband detectors, the distortion comes through; if he uses a narrowband or frequency-selective device, the unwanted signals are dumped.

The upshot of all this is: Distortion limits flatness, and the two specs must be compatible. If the data sheet highlights a flatness of ±0.25 dB—but spurious signals are only 20-dB down—

Single, dual or multiband plug-ins can fill the hole in Wiltron's 610C solid-state mainframe, a 100-kHz to 22-GHz box. Optional harmonic markers are provided in the video output, rather than the rf output.

watch out. Those two numbers don't mix. To approach the 0.25-dB figure, look for spurious levels at least 30 dB below the fundamental.

Peer deeply into leveling specs to get answers to other questions: Does the figure cover the entire range or just a narrow sliver? Is the leveling internal? External? Both? Perhaps it's neither.

Don't forget that even automatic leveling loops have limitations. How well the loop regulates depends on gain, bandwidth, detector characteristics, coupler response and other factors. Negative peak detectors can give results that differ widely from those of positive detectors. For this reason, some units provide a manual polarity switch to select the proper phase. Other sweepers do this automatically.

To keep output power constant, loop gain must be high. To respond to rapid variations, so must the loop bandwidth. But if the gain is too high, you're likely to get some rather neat—but unwanted—oscillations. If too low, you get something else: no leveling.

Some sweepers need a manual gain readjustment to maintain optimum leveling each time you change your power level. Others do this automatically. With still other sweepers, you don't have to worry about it—you can't get the power level you thought you would.

Power to the people?

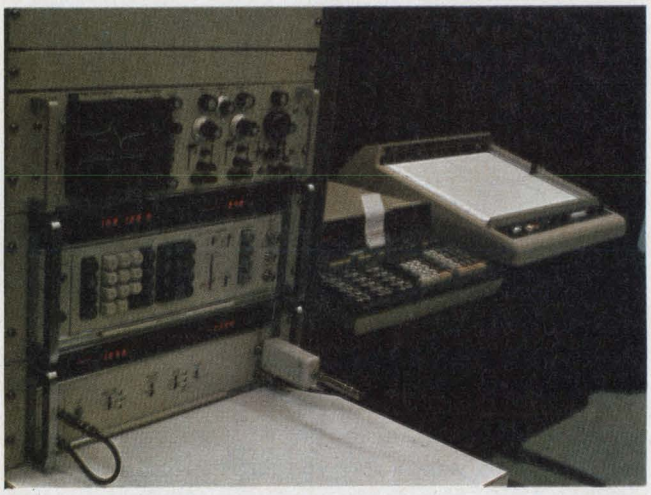
Everybody wants to know how much power he's going to get in a sweeper, especially leveled power. And manufacturers will gladly tell. Unfortunately the phrase "maximum leveled power" means different things to different people. To some, it means that the minimum power you'll get within a band will exceed the stated value when at the highest leveled power setting (if you went 'Wha?' you're not alone).

To others, the MLP is the nominal value around which a plus or minus figure spells out the level variations. And then there are those who say that the maximum leveled power is the minimum power in a band when the unit is leveled. Who's right? Take your choice.

Most buyers look for high power. Indeed, sweepers over the years have pushed for even higher power, until today 10 mW out of 18-GHz, solid-state units is typical, and you can get even more at lower frequencies. But the cost for each extra decibel of power above 10 mW is staggering. And though you need high power to drive some loads, often the extra power is wasted. Generally the more a sweeper designer pushes his source for power, the more harmonics and noise he gets. No matter how much power you've got—or extra detector sensitivity for that matter—harmonics or noise are what limit many measurements.

What's needed in most cases is dynamic range, not high power. This means you've got to check a sweeper's output for its bottom end, too—something that's often forgotten. Dynamic range can be limited by the external detector, of course. Remember, though, that you've got still another way to stretch the range: Opt for a more sensitive receiver or a network or spectrum analyzer that's matched to the source. (Some spectrum analyzers offer a tracking-generator output that can be used as a swept source to give a wide dynamic range display.)

Signal purity must be watched closely. With enough harmonics, reflection measurements can be off by 20 or 30%. You can easily filter harmonics in an octave-band or narrow-bw sweeper. Many vendors do. But with broadband sweepers, you'll need tracking YIG filters to keep har-



Team a synthesized sweeper, such as Hewlett-Packard's 3330B, to a programmable calculator and a network analyzer, and you can automatically plot amplitude and phase curves or print out circuit characteristics.

Systron-Donner's low-cost sweeper is the 540A multiband unit. The $1195 mainframe accepts all plug-ins from the company's two other sweeper series.

monics to the lowest achievable today—rarely better than 30 dB. When you add filters to the output, don't forget to account for the insertion loss.

Peek around corners to look for harmonics. That's what you literally must do in some cases. Why? Because the harmonic spec doesn't include the band edges—where, as you may guess, the harmonics are the worst.

A new sweeper may not sweep clean

Even when you think you've got the spurious spec trapped, it can slip away from you. Just twirl the attenuator knob, and up goes the distortion. You may have started with the rated nonharmonic spurious level of −45 dB, but reduce the output power by 10 dB, and your unwanted level climbs to only −35 dB.

Don't search for a phase-noise number when you evaluate a sweeper's purity. Almost nobody specifies it. However, if you intend to use the sweeper in its cw mode, you just might be interested in phase noise. If you are, ask for a figure.

Keep in mind that the wider the bandwidth, the wider the door is open to noise, instability and drift. Sure to lead the pack is another shaky spec: residual fm.

Every sweeper has unavoidable frequency modulation. The question is how much, relative to the bandwidth of the test device. With poor fm, the best you can hope for are ragged response curves. At worst, fm can wipe out all definition in narrowband devices. If you try to sweep slowly, you can't with too much fm. So you've got to know how much residual fm to expect. Finding out isn't easy.

You might see a statement that says "residual fm: 500 Hz." That sounds pretty good. But is it? Is the figure in rms, peak or peak-to-peak? You don't know. What bandwidth was used to measure the modulation? 10 kHz? 100 kHz? Don't try to compare two units unless you know. But do compare a sweeper's minimum sweep-width spec with its residual fm. If the fm isn't at least 10 times less (preferably 100), forget the minimum width.

Don't forget that when you buy greater frequency capability for future use, you also buy more residual fm. You can't very well test 10-kHz filters when that 500-MHz sweeper has 10 kHz of unwanted frequency swing. Better stick to a 20-MHz box, with about 200 Hz of residual. Or you can look for sweepers with switchable bandwidths. In some, you set a narrowband position manually. In others, automatic circuitry sets optimum bandwidths to keep residual fm down.

Frequency instability can smear your trace all over the screen. And residual fm isn't the only culprit. Change the temperature by just one degree, and frequency can easily get knocked down or up by 500 kHz in a 300-MHz instrument—100 times more than the residual fm. Let the line voltage vary by 10% and—bingo—another ±30 kHz. Reach over and twiddle the rf or power level. Guess what? Lop off or tack on another 30 kHz.

None of this means that sweepers can't do the job. They can. But you must know the limitations—even if it takes a little arm-twisting to get the facts.

Don't turn your back once you pin down the effects of tempco, line voltage and residual fm. If you do, the trace may not be there when you return. "What happened now?" Drift.

Enter drift, exit response

All sweepers drift. The data sheet may not say so. But with time, the center frequency will wander away from its setting. If the short-term drift isn't good, you'll have to glue your fingers

Part of Texscan's VS series, the Model 80 covers 1 to 1200 MHz in two overlapping bands and offers five different sweep-rate modes.

In Singer's 6600 Series of microwave units, all frequency indicators are located on the lone 13-in. scale. Thus plug-in panels are uncluttered.

to the frequency control. Long-term drift, on the other hand, may not be a problem unless, say, you're testing stacks of filters. By the time you plug in the last filter, you may not see a response. Is the filter bad? Or did the frequency drift?

Unless the vendor tells you what he means by short and long-term, you can't really pin down drift. Short, to some, is one to five minutes, while long means one to eight hours. Others call 10 to 15 minutes "long." Whatever the definition, a drift spec without time is meaningless.

Remember, the wider the bandwidth, the more likely the drift. Remember, too, that drift is crucial in testing narrow-bandwidth circuits and components. Instability in a sweeper can discourage you to the point where you'd like to give the unit a good smack. Don't do it. Some sweepers are sensitive to shock.

Try giving it a light tap or two instead before you buy the instrument. If it sweeps up a few megahertz, you'll have learned something about how vibrations can affect the output. Can an internal fan, or fans on surrounding equipment, have an effect? While you're at it, check other environmental specs—like humidity—to see what these can do.

Even before you worry about annoying departures from the center frequency, ask yourself: What is my center frequency?

When you bought that sweeper with 1% accuracy, you felt pretty good. And when you added a second unit with a 4-digit counter to set and read center frequency, you felt even better. Unfortunately neither may be quite as accurate as you expected.

In the first unit, you forgot to ask an important question: Percentage of what? Bandwidth? Indicated value? Full scale? Another parameter? And though 1% sounds great, with a 1% 1000-MHz box, you can't trust the dial to identify a device's tuned frequency by better than 10 MHz. In this case, you'll need more accurate dial calibration (if you can get it) or markers. In cw mode, you can always use an external counter.

The vendor also forgot something with that first sweeper. He didn't say that you couldn't dial better than a few hundred kilohertz. So you may well ask: How can I get 5-kHz accuracy if I can't adjust any finer? The answer is you can't.

With the second unit—the digital dialer—the manufacturer didn't specify dial accuracy at all. He hoped the supposed unambiguous readout would cloud the issue.

The moral is: Insist on both frequency accuracy—preferably in units of hertz—and resolution. But don't stop there. Get the accuracy for all modes of operation, both cw and sweep. Get the accuracy as a function of sweep speed—especially in YIG-tuned sources. At the faster speeds, accuracy can plummet by a factor of five. Does the spec sheet say so?

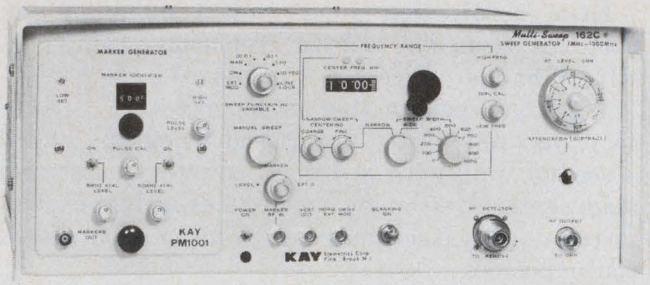
If your unit has a cw mode, do this: Zero in on a frequency, starting from the high end of a band. Then shoot over to the low end and approach the frequency from that direction. The difference between the readings (you didn't expect them to coincide, did you?) is the unit's hysteresis.

You won't find hysteresis on many sweeper brochures. Another spec you might not see—one that can be important in the cw mode—is residual a-m, distributed sidebands caused by noise. Or if a-m is mentioned, other items needed to make the spec meaningful are nowhere in sight. Needed here are at least the measurement bandwidth and, preferably, how the residual a-m was measured.

Sweeping specs under the rug

Of all sweeper characteristics, linearity may cause the greatest confusion. Some vendors say it's important. Others deny it. And then there are those for whom linearity poses no problem at all—they simply ignore it.

Disagreement even extends to the definition of



The 162C is Kay Elemetrics' wideband, 1-to-1000 MHz generator. A summation sweep mode is offered as an option to test CATV amplifier trunk lines.

linearity. A sweeper is perfectly linear if its incremental change of frequency with respect to time ($\Delta f/\Delta t$) is perfectly constant. But other manufacturers' definitions link linearity to internal sweep voltages or other parameters. None of the variations may be strictly incorrect. But are you getting the information you really need —how the spec affects your measurements?

What you should know is this: Where and at what frequencies is linearity measured? If it's expressed as a percentage, find out: Percentage of what? If expressed as a ratio, remember that 1.2:1 is a linearity (or nonlinearity) of 20%.

Is linearity really important? Not if you've got accurate markers to tell you where you are, says one school of thought. Not if your dial or frequency-accuracy spec tells you what you need to know, says another. And not unless you're going to control frequency with an external voltage, a third group contends.

Who is right? Everybody and nobody.

If you're using a scope to see a device's response, it would be nice if you could calibrate frequency along the X axis. And you can if the linearity is good enough. Markers can do the job, of course, but they're not without problems, and they cost extra in some cases. However, if you want to identify frequencies more accurately, then you'll probably need markers.

Another reason why linearity can be important: You turn your sweep speed up to get the best, flicker-free picture, then you use the picture to tune a filter. Satisfied, you slow the sweep to plot a curve. Hey, what's that extra bow in the curve? Is it the filter? Maybe. But chances are the sweeper's linearity changed when you slowed the sweep. In fact, it probably improved. But you tuned the filter at the fast sweep, remember, where you thought the linearity was good. Better retest the filter.

Chances are, the linearity spec will be tied to the maximum frequency, rather than the sweep width. Consequently, as you squeeze the width down, the nonlinearity—as a percentage of the width—gets worse. Now suppose you've got a 500-MHz box with a linearity of 1%, or 5 MHz. You confidently dial a narrow width of 10 MHz, with 100 MHz on the left edge of the screen and 110 MHz on the right. Where's 105 MHz? In the center, where you'd like it to be? Possibly. In fact, 105 MHz can be anywhere on the screen—yet the sweeper still meets its published specs.

The lesson here is: Find out how linearity varies, not just with sweep speed but with width and other parameters. And while you're at it, dig into sweep width, rate, range and markers, too. Surprises await you.

Mark these words

When linearity is really bad, you'll probably need markers to tell you where you are. Various types are available, including pips, birdies, combs and, more recently, intensity-modulated dots and even horizontal markers. But step gingerly. Markers aren't a panacea; they can bring their own set of troubles. For instance, markers can be rich in harmonics. Will you be sacrificing signal purity for extra markers?

Then again, how accurate are markers, anyway? If the marks are derived from the internal sweep-drive voltage, then they will be only as accurate as the proportionality between the frequency and voltage. This may not be better than about one-half to 1%.

Of course, you can opt for crystal-controlled pulses or birdies—frequency bursts—to improve accuracy by up to two orders of magnitude. But you may need one crystal oscillator per marker frequency or range of frequencies. This can add up to big bucks. And accuracy isn't always guaranteed. A marker isn't infinitesimally narrow—it has width. If the marker is much wider than the sweep width—a condition easily attained—the CRT will show nothing but marker. Where's your accuracy then? Another question: What's the marker amplitude and how flat is it with frequency? Get the answer.

You might have to lean on markers for another reason: There's no other way to tell how wide your response curve is. You've got a width control, all right. But it isn't calibrated, or it reads in percent of band. The data sheet didn't tell you this, of course. It listed minimum and maximum sweep widths, so you assumed you'd be able to set anywhere in between. You can't without markers. In keeping with its penchant for mystery, the specs sheet didn't reveal one thing you inadvertently could do with the sweep-width knob—change the center frequency.

Similarly, we've already seen that the sweep-speed control can affect other parameters. Some instruments, though, have one preset rate, synchronized to the line frequency. You can save money with a fixed-rate unit. But you'd better

be sure that the response of present or future circuit or devices is compatible with the rate. Otherwise you won't be able to live with it. Life can be a bit uncomfortable with yet another incompatible duo: the mismatched load and source.

Opposites don't attract

If a sweeper's output impedance doesn't equal that of the load and connecting cables, you'll have reflections. And reflections lead to measurement errors. You may start with a nominal 50-Ω system. But as the frequency varies, so does the impedance of both the load and the sweeper—and so does the load voltage, for even more errors.

So you can't ignore mismatch. External leveling can help smooth changes at the load. So can a front-panel slope adjustment offered in some units. And so can the vendor, by telling you at least what impedance the output voltage comes from—zero, 50 Ω, or what—and across what load you get the rated voltage. If you can get the vendor in an informative mood, slip this one to him: Exactly what happens to the output frequency as the VSWR varies?

If the vendor's really being candid, he might even tell you how much stray radiation spews from his box and how he measured it. Or how somebody else's garbage riding on the power line affects the sweeper (perhaps it just shoots through and pours from the sweeper output jack). He might even tell you how accurate his output meter is and exactly what the meter monitors.

Such moments of candor may not last long. Even so, listen attentively. Perhaps you'll learn something that will help you in one decision you're sure to make. That's whether to buy a plug-in or all-in-one unit.

Until recently, you had to choose either a narrowband sweeper (usually one octave) or you bought a mainframe controller with plug-ins for each band of interest. Or you selected a sweeper with bandswitching—four or five manually switched bands without plug-ins. Today the movement toward broadband sweeps continues, and you can get multi-octave plug-ins or units that automatically switch between internal oscillators to cover, say, 1 to 1000 MHz or 100 MHz to 18 GHz in one sweep.

The arguments for plug-in expandability vs less expensive all-in-ones are well known. With the arrival of the broadbander, however, new pros and cons must be weighed.

First, many broadband designs use heterodyning or multiplication to generate frequencies in the region below about 2 GHz. While newer designs offset many of the limitations of the heterodyne approach—like higher spurs, broadband

Low frequencies down to 0.035 Hz are the forte of the 965A from Vibration Instruments. The unit delivers squares and triangles, as well as sinusoids.

noise, less stability and frequency accuracy—you've still got to watch these areas carefully. Second, in sequentially switched sweepers, with multiple oscillators, you've got an entirely new problem area: the switching points.

Block that gap

If the top frequency of a lower-range oscillator doesn't coincide exactly with the bottom frequency of the next higher one, you'll get either a gap or an overlap in frequency. In a broad sweep maybe you won't care if a few points are missing. In a narrow sweep such discontinuities are intolerable.

Moreover if you phase-lock the sweeper to another box and go through a frequency break point, you'll probably lose lock for at least 2 to 10 ms. You can skirt such problems if you look for a sweeper that automatically avoids bandswitching in narrow sweep modes.

You'll probably look for other things you'd like the sweeper to avoid—like transients at the switching points, extra long switchover time intervals with an accompanying loss of output power, leveling-loop glitches and the like. One feature you might like, though, is a blanking pulse at the switch points. With blanking, you can modulate the Z axis so you don't see the switching points on the CRO screen. One more point: Don't expect phase continuity at the switching points. You won't get it.

To avoid transients, sequential sweepers with multiple sources keep the oscillators on all the time. This means you'll have to wait perhaps a half hour for warmup if you unplug the unit. It also means that the instrument consumes more power, which creates heat. This isn't necessarily bad if the manufacturer is successful in getting rid of the heat. If he isn't, reliability will suffer.

Some vendors use fans to get rid of heat. Those that don't are quick to point to potential problems with fans: reliability, noise, vibration, EMI and extra power consumption. But as in every design tradeoff, it's results that count, not "potential" problems.

Tugs-of-war between vendors occur in many other design areas. One such conflict plants YIG-

tuned oscillators at one end and varactor-tuned units at the other. You, of course, serve as the rope.

No clear winner

Sure, YIGs with the right design can beat varactors in purity, stability, linearity and other areas. But there's no guarantee. And, of course, varactors have their own potential assets: higher power, faster tuning, reduced power consumption and less weight compared with YIGs. Again, check for results, not just components.

Don't let such controversies steer you away from other important areas—like the specs that describe a sweeper's modulation characteristics or programmability, for example.

Concentrate on such items as modulation bandwidths in both a-m and fm modes. Check modulation sensitivity: Is the MHz/V spec constant or does it vary with the band and even with frequency? If it isn't constant, you'll be constantly twiddling the modulation source.

Is the programming analog or digital? What inputs are needed to program the sweeper? What levels? What impedance will the input see? Pin these down exactly.

Instrument options run a close second to stock-market options for risks to the buyer. Watch for this ploy: The performance data listed includes specs of options, but the listed price covers the stripped instrument. Another: Bold print proclaims a super five-year warranty. What happens when you get out your magnifying glass? The most expensive component—the YIG oscillator—isn't covered. P.S.: The five year warranty may not be free; sometimes you've got to buy it.

Though advice freely given may be freely ignored, heed this warning: Take nothing for granted with sweepers. You can easily pay $20,000 for a good microwave instrument. For that kind of money, you may not expect the unit to quit oscillating at the upper 20% of its range. But it can happen. You won't be looking for frequency discontinuities when sweeping backward. But gaps can appear. And you may not believe your eyes the first time you see the frequency backtrack, instead of changing smoothly and monotonically. But it's a possibility.

Perhaps none of these things will happen. But sweepers aren't easy to design, especially above 8 GHz. Units may meet the letter of the spec sheet but not the intent, so caution is the watchword. The first question to ask is: Do I really need a sweep generator?

Sweeper or synthesizer?

If your application calls for very narrow sweep widths—1% of center frequency, or less—or if you need extreme stability and resolution, then perhaps a frequency synthesizer will do a better job. Indeed, a significant trend today is toward synthesized sweepers for use in narrowband automatic test equipment. For instance, with Hewlett-Packard's 3330A/B automatic synthesizer hooked up to a programmable calculator, network analyzer and X-Y plotter, you can sweep out a crystal response with resolutions of 0.01 dB for amplitude and 0.01 degrees for phase.

Hewlett-Packard, of course, is the industry leader in sweeper shipments. Latest in HP's line is the 86290A, a 2-to-8-GHz plug-in for the company's 8620A mainframe, and the 86222A plug-in, a 10-MHz-to-2.4 GHz unit. The 5-1/4-in.-high 86290A weighs just 33 lb, yet gives frequency accuracy of ±20 MHz at 18 GHz. Drifts are less than 50 ppm in 10 min, and linearity is about 0.05% of output frequency.

The HP 86222A delivers 20 mW with ±0.25-dB flatness over the full sweep and features intensity-modulation markers rather than the traditional birdie types. Both plug-ins are matched to HP's network analyzers, such as the 8410B, so that you can make, for instance, multi-octave vector measurements.

For even higher power, HP's 8690B family includes both solid-state and BWO plug-ins, with outputs exceeding 100 mW, depending on the band.

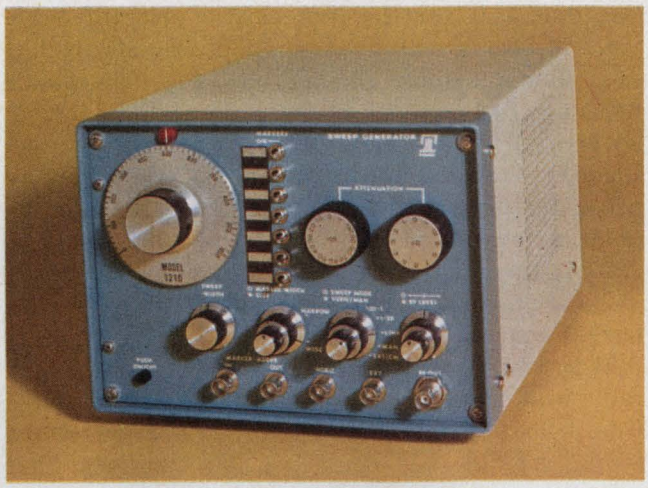
Also marketing units that extend from the audio to the microwave regions is Kay Electrometrics. Its line comes in three package sizes: 19-in. rack, compact bench units with built-in markers and oscilloscope plug-ins. The company's 162C sweeps from 1 to 1000 MHz in one band. With a flick of a knob, the 162C becomes a narrowband sweeper.

Those in the TV industry might be interested in Marconi's TF 2361, a plug-in unit that goes up to the vhf bands. The video plug-in covers 25 kHz to 30 MHz in one sweep and, with a blanking and sync mixer plus a differential-probe unit, you can build up a complete video measuring system.

Frequencies hit the stratosphere

Need a millimeter wave sweeper? Micro-Now Instrument Co. is a specialist in this area. And you'll probably need an expert, since specs for these units aren't as well defined as the lower frequency generators. Micro-Now's sweepers cover 33 to 110 GHz and provide power to 100 mW using BWOs.

Not to be confused with Micro-Now is the Micro-Tel Corp., manufacturers of an unusual sweeper, the SG-800. What makes this 0.1 to 18-GHz unit unique are specs like −60-dB harmonics, 99-dB calibrated output attenuator and a



Internal switching in the Telonic 1210 couples two sweep sources and delivers a continuous band of frequencies from 200 kHz to 1000 MHz.

At just $495, the Wavetek 1050 is one of the most economical vhf generators around. Despite the low price, the unit provides ±0.25-dB flatness.

pulse-modulation on/off ratio of 65 dB. Unusual, too, is the unit's removable and remotely controlled rf assembly, which can be placed up to 500 feet away. For all of this, however, be prepared to pay a high price. Many of the features and specs are optional.

For more conventional instruments, the 9500 series from Narda Microwave covers 1 to 18.5 GHz without plug-ins. One of the first broadbanders, this series offers four digital frequency selectors that can be programmed with resolution of 100 kHz over the entire range. And pushbuttons give the user six different sweep combinations. Latest developments at Narda include a high-speed YIG multiplier for flicker-free displays and a boost in power level to 10 mW.

Three instruments form the present line at Philips Test and Measuring Instruments. The PM 5164 ranges from 0.1 Hz to 100 kHz, costs just $1135 and delivers four simultaneous outputs: a sine, square and triangle of fixed amplitude plus any one of the three with adjustable amplitude. Both sweep speed and width are variable. The PM 5324 covers the hf range, and the PM 5334 the TV, i-f and rf frequencies. Both cost under $1000.

If it's power you need over the range from 25 to 1000 MHz, Rohde & Schwarz can give it to you. The company's SMLU sweeps this entire range or any part and delivers up to 2 W. And harmonics are down more than 30 dB (typically 40 to 50 dB). Another swept power generator is Ailtech's 50-watter, the Model 473, which goes from 225 to 400 MHz.

Pioneers still active

Competing strongly in the microwave market is Singer Instrumentation, a pioneer in sweepers through its Alfred line. Singer's 6600/9514/9515 series forms the backbone of the company's multirange, continuous-sweep system. Though the series features a wide line of plug-ins, including new models that deliver 40 mW in the 1-to-2 and 2-to-4-GHz bands, Singer is moving away from octave units toward broadband, completely integrated units. In keeping with another strong trend, the company emphasizes programmability of all major functions.

Another "old timer" and significant force in the sweeper business is Systron-Donner. Three basic families cover the spectrum from 100 kHz to 18 GHz with a selection of plug-ins and options. Model 50520, for instance, accepts up to eight plug-ins and, depending on the controller, can sweep sequentially among the eight. Another model, the 5000A, takes just a single plug-in.

Markers can be a headache to use, but Systron has come up with an intensity modulated marker system to relieve the pain. Move the intensified dot anywhere on the screen, and a counter automatically tracks and displays the dot's position, even in the swept mode.

Moving down in frequency, you'll find a number of outfits competing in the uhf/vhf range and below. Telonic Altair's 1210/1240 uses internal switching to go from 1 to 1000 MHz in one shot. The company's dedicated sweepers (uhf and vhf TV) can be set with digital inputs that control a phase-locked synthesizer. Features of most Telonic units include 1-dB attenuation steps, buffer amplifiers to minimize frequency pulling, and up to seven birdie markers in PC-card form.

Almost nobody has a more complete line than Texscan, with six broad series spanning the spectrum from 500 Hz to 6500 MHz. From dedicated TV units to high-power (20 W) to sophisticated laboratory instruments, Texscan's sure to have an appropriate model. Use of ICs and im-

Digital tuning and frequency readout characterize the 9535 from Narda. This solid-state broadbander sweeps continuously from 1 to 18.5 GHz.

proved mixers and amplifiers have allowed the company to offer units such as the VS-90B—a 5-to-2350-MHz box with no plug-ins—and the WB series, a 10-pounder with programmability, −40-dB distortion, countdown or horizontal markers, and other goodies.

For really low frequencies, check into the VIC 965A, from Vibration Instruments. With it, you can go as low as 0.035 Hz and sweep to 35 Hz—a 1000:1 range. In fact, you can set the upper and lower limits anywhere over a 1000:1 range up to 35 kHz. And you can dial in exact rates, either linear (3% accuracy) or logarithmic (5%), from 0.001 Hz/s to 10,000 Hz/s in the former and 0.1 to 99.9 Oct/min. in the latter. But you can't get all rates on all frequency ranges.

Eminent in the vhf/uhf market from 1 to 1500 MHz is Wavetek Indiana. Brand new is the company's fixed-rate Model 1050—a 1-to-400-MHz box that sells for the remarkable price of $495, yet still boasts −30-dB harmonics, ±0.25-dB flatness and a display linearity of 2%. Wavetek's most popular sweeper is the programmable 2001, covering 1 to 1400 MHz in three bands and offering start-stop, cw and Δf modes, as well as many other features. Other popular units include the 2000, a low-priced version of the 2001, and the 1801A, targeted for the CATV industry.

Back in the higher frequency bands, you're sure to run into Weinschel Engineering's plug-in, 0.01-to-18-GHz Model 430A or its multiplexed, multiband sweeper, the 4310A/k. The Weinschel line boasts a number of automatic functions —like a YIG lag compensation network that maintains accuracy at even the highest sweep speed and circuits that keep residual fm low and the output leveled regardless of sweep rate.

Other unique Weinschel features include automatic polarity selection in the external-leveling mode and a single level control with automatic loop-gain adjustment.

Over 20 plug-ins for Wiltron's 7-in.-high 610C mainframe make it one of the most versatile in the industry. And Wiltron is right at the top of today's sweeper technology with a plug-in that zips from 10 MHz to 18.5 GHz in a single sweep and weighs 14 lb. Other plug-ins cover 100 kHz to 22 GHz, and all units provide a front-panel slope adjustment to compensate for the frequency response of the external circuitry.

You can take your choice of several different markers in the Wiltron line, from the standard patented intensity dot, rf or video pips to optional birdies, harmonic combs and fixed-frequency markers.

Finally, you may decide that what you really need is a sweeping function generator. If you do, look into those offered by Clarke-Hess, Dana/Exact and Interstate Electronics. ■■

Need more information?

The products cited in this report don't represent the manufacturers' full lines. For additional details, circle the appropriate information retrieval numbers. For data sheets and more vendors, consult ELECTRONIC DESIGN'S GOLD BOOK.

Ailtech Cutler Hammer Co., 815 Broadhollow Rd., Farmingdale, NY 11735. (516) 595-6471. (Richard T. Knadle Jr.). **Circle No. 401**

Clarke-Hess Communication Research Corp., 43 W. 16th St., New York, NY 10011. (212) 255-2940. (Kenneth K. Clarke). **Circle No. 402**

Dana Exact Electronics Inc., 455 S.E. Second Ave., Hillsboro, OR 97123. (503) 648-6661. (Joe Foster). **Circle No. 403**

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. **Circle No. 404**

Interstate Electronics Corp., 707 E. Vermont Ave., P.O. Box 3117, Anaheim, CA 92803. (714) 772-2811. (Pat O'Leary). **Circle No. 405**

Kay Elemetrics Corp., 12 Maple Ave., Pine Brook, NJ 07058. (201) 227-2000. (Jim Connors). **Circle No. 406**

Marconi Instruments, 100 Stonehurst Ct., Northvale, NJ 07647. (201) 767-7250. (Keith Elkins). **Circle No. 407**

Micro-Now Instrument Co., Inc., 6104 N. Pulaski Rd., Chicago, IL 60646. (312) 478-1151. (Clarence L. Arnow). **Circle No. 408**

Micro-Tel Corp., 6310 Blair Hill Lane, Baltimore, MD 21209. (301) 823-6227. (Richard S. Finke). **Circle No. 409**

Narda Microwave Corp., Plainview, L.I., NY 11803. (516) 433-9000. (Eugene Kushner). **Circle No. 410**

Philips Test & Measuring Instruments, Inc., 400 Crossways Park Dr., Woodbury, NY 11797. (516) 921-8880. (William E. Keller). **Circle No. 411**

Rohde & Schwarz, 14 Gloria Lane, Fairfield, NJ 07006. (201) 575-0750. (Allen Freeland). **Circle No. 412**

Singer Instrumentation, 5340 Alla Rd., Los Angeles, CA 90066. (415) 493-3231. (Al Hart). **Circle No. 413**

Systron-Donner, 735 Palomar Ave., Sunnyvale, CA 94086. (408) 735-9660. (J. Johnson). **Circle No. 414**

Telonic Industries, 21282 Laguna Canyon Rd., Laguna Beach, CA 92652. (714) 494-9401. (Bruce Brazelton). **Circle No. 420**

Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, IN 46219. (317) 357-8781. (Bob Shevlot). **Circle No. 415**

Vibration Instruments Co., 1614 Orangethorpe Way, Anaheim, CA 92801. (714) 879-6085. (Marvin P. Marsh). **Circle No. 416**

Wavetek Indiana, Inc., 66 N. First Ave., Beech Grove, IN 46107. (317) 783-3221. (Ed McDonald). **Circle No. 417**

Weinschel Engineering, 1 Weinschel Lane, Gaithersburg, MD 20760. (301) 948-3434. (Andrew Belski). **Circle No. 418**

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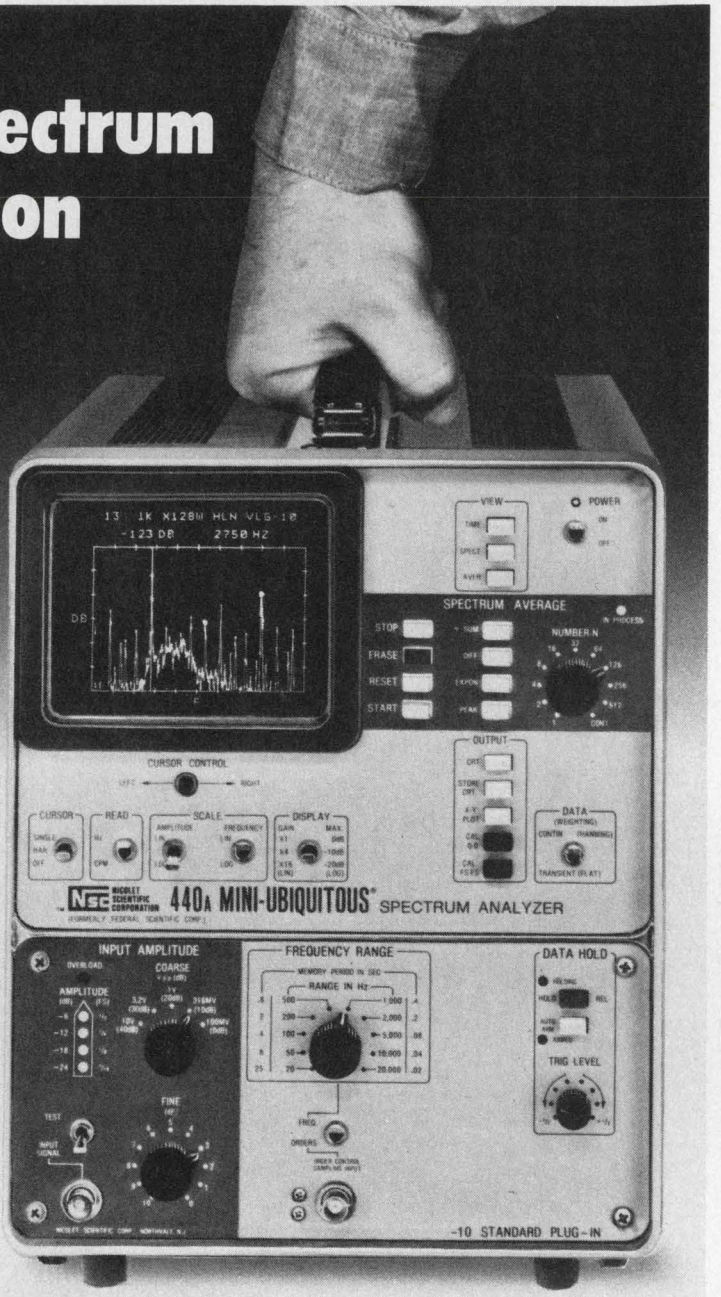

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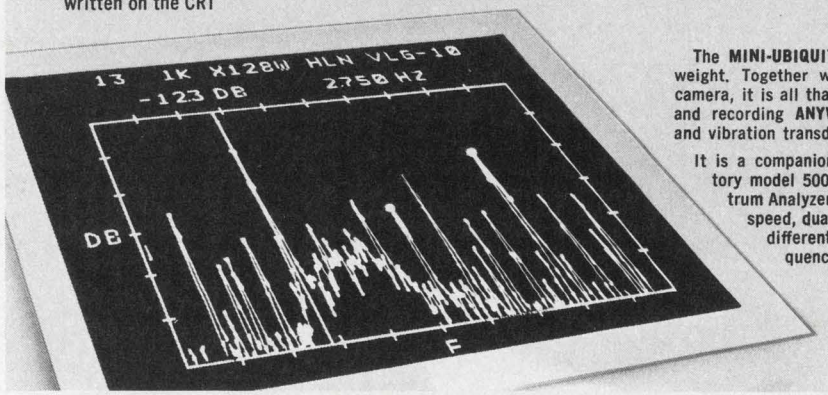

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INFORMATION RETRIEVAL NUMBER 33

Technology

Get to know the optocoupler and you'll eliminate problems caused by misapplication. And, careful definition of critical specs will cut costs.

Even the best-made optocouplers can prove troublesome in high-volume applications if you fail to specify them accurately and to control the quality of incoming devices. Out-of-tolerance couplers may cause reduced circuit performance, haphazard performance or outright circuit failure.

Five different types of optocoupler outputs are available—transistor, Darlington, SCR, diode/amplifier and diode/gate (see table). But no matter which you use, there are two basic ways to guarantee optimum performance:

1. Identify all the critical parameters—leakage, lifetime, bandwidth, coupling efficiency, speed, cost—and specify the tolerances needed.
2. Control the critical factors through a combination of tests and vendor selection.

Since requirements vary with application, so will quality control methods. Don't expect the same test procedure to be optimum for both under-the-hood automotive applications and office machine equipment. And, don't demand unnecessarily tough specs from a supplier. You may find that in production the resulting device is of such low yield that the manufacturer can fill only half your needs—or worse, can only supply the couplers spasmodically when he gets yield.

Tips for specifying tests

When special performance measurements are required, keep in mind the following:

- Most static parameters can be measured automatically and inexpensively.
- Dynamic parameters, high dielectric stresses and very low leakage currents require expensive manual testing.
- Destructive testing—which includes most burn-in, mechanical, environmental and some high-stress dielectric testing—costs even more.

Some rules of thumb that can keep costs down and performance consistent include these:

- Use standard second-sourceable parts when possible.
- When forced by technical or economic reasons to deviate from standard parts, tighten the specs only on parameters that can be tested automatically and loosen them on all other parameters.
- If a tight tolerance on some parameter is required, ask your first and second-choice suppliers what absolute limits they would prefer, given a spec "X" percent wide.
- Some dynamic parameters, such as switching speeds, correlate well with static terms, such as h_{FE}. Know which ones they are, since static screening costs much less than dynamic testing.

Define these tradeoffs in the initial design stages, where you can evaluate the costs of a premium-spec device against the cost of components needed to design around it. Otherwise you may be mired down in hardware problems at the production stage. The solutions then may require premium devices and end up costing you both time and extra money per unit.

Manufacturers will generally not allow themselves to be tied to fixed, tight limits on optocouplers without imposing price penalties. The only other way a user can control quality is to determine the best manufacturers on the basis of the construction techniques used (the manufacturer will advertise them if they are good) and the ready availability of data on stress-test results. Most data will provide single-stress, worst-case failure rates and thus supply a basis for estimating device stability.

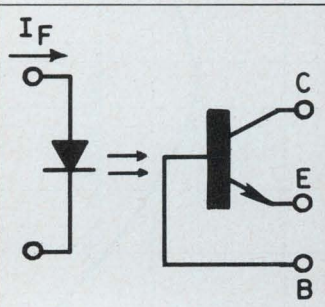
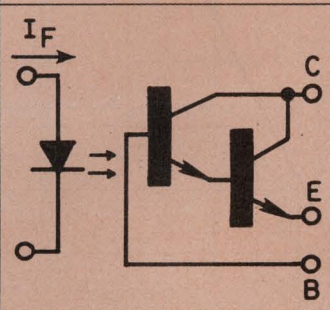
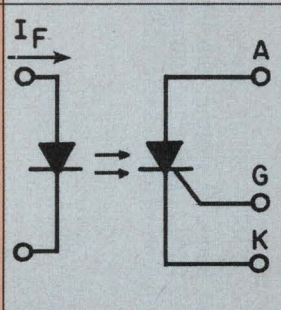
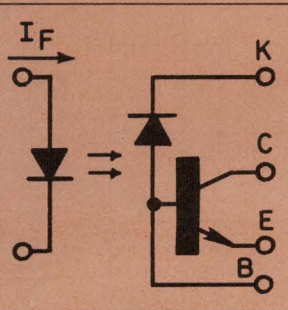
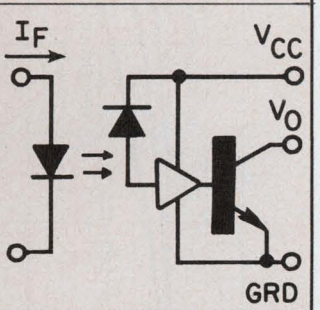
Evaluate the useful coupler lifetime

The light output of the LED in a coupler decreases as the LED is operated.* This is not normally expected of semiconductors, and you're asking for trouble if you don't evaluate the effects of such a fall-off on your system. When you evaluate a coupler for light fall-off (loss of

William Sahm, Consulting Applications Engineer, General Electric, W. Genesee St., Auburn, NY 13022.

*The March, 1974, issue of "Elteknik Med Aktuell Electronik" contains a detailed comparison of LEDs and couplers. This article, "Hur Lang Lever Lysdioden," was written by Hans Nettel. The article provides a greater insight into stress/degradation and manufacturer variability than is possible in the scope of my article.

Comparison of different optocoupler types

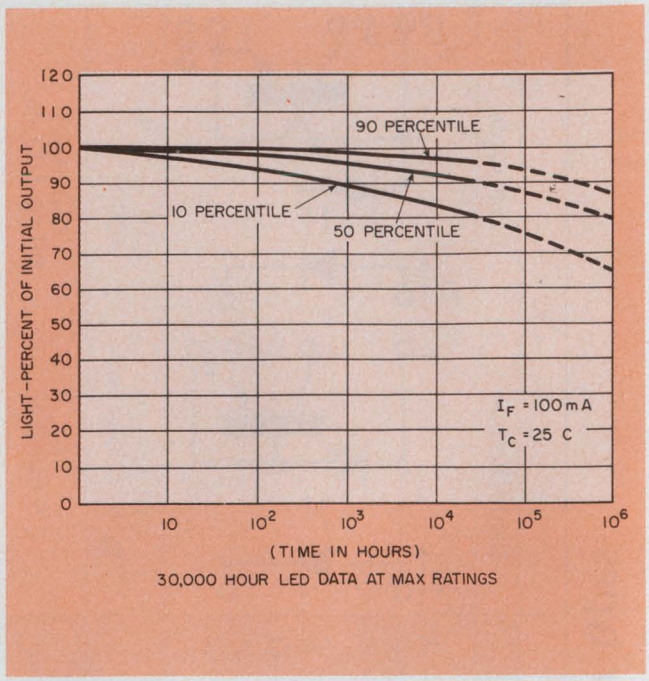
Parameter \ Coupler Type	Discrete			IC	
	Transistor	Darlington	SCR	Diode/Amplifier	Diode/Gate
					
Efficiency	$CTR = I_C/I_F$ 10% to 100% min	$CTR = I_C/I_F$ 100% to 500% min	$I_{FT} = f(R_{GK})$ 20 mA max	$CTR = I_C/I_F$ 7% to 500% min	$CTR = I_O/I_F$ 600% min
Speed	t_{on}, t_{off} 1 to 5 μs	t_{on}, t_{off} 50 to 200 μs	t_{on} 5 to 20 μs typ	t_{pd} 0.5 to 60 μs	t_{p1h}, t_{ph1} 50 to 100 ns
Parasitics	C_{ISO} R_{ISO} 1to 3 pF, 10 to 100 GΩ	C_{ISO} R_{ISO} 1 to 3 pF, 10 to 1000 GΩ	C_{ISO} R_{ISO} Coupled 100-500 V/μs dv/dt 1 to 3 pF, 10-1000 GΩ	CMRV 20-60 V rms @ 2 MHz	$CMRV_H$ $CMRV_L$ 2-60 V rms @ 2 MHz
Off voltage	B_{VECO} BV_{CEO} typ 5-7 V min, 25 V min	B_{VECO} BV_{CEO} typ 5-7 V min, 25 V min	V_{DM} V_{RM} 200-400 V min	$V_{KB(max)}$ $V_{CE(max)}$ 7 to 18 V	$V_{CC(max)}$ $V_{O(max)}$ 7 V
On voltage	$V_{CE(SAT)}$ typ. 0.1 V	$V_{CE(SAT)}$ typ. 0.7 V	V_{TM} 1.3 to 1.5 V max	$V_{CE(SAT)}$ 0.1 to 0.2 V typ	V_{OL} 0.6 V max
Leakage	I_{CEO} 50-500 nA max	I_{CEO} typ 100 nA max	I_{DM} typ 50 μA max	I_{CEO} 0.5 to 250 μA max	I_{OH} 250 μA max
Maximum power input or output	P_{do} typ 400 mW max	P_{do} typ 400 mW max	P_{do} typ 400 mW max	P_{do} typ 100 mW max	$N_{(FAN\ OUT)}$ 8 max
Reverse voltage (min)	$V_{R(MAX)}$ 3 to 6 V	$V_{R(MAX)}$ 3 to 6 V	$V_{R(MAX)}$ 3 to 6 V	BV_R 5 V	BV_R 5 V
V_F (max forward voltage)	1.5 to 2 V	1.5 to 2 V	1.5 to 2 V	1.7 to 1.8 V	1.7 to 1.8 V
Maximum power P_{dI} input or output	100 mW	100 mW	100 mW	35 mW	$I_{F(MAX)}$ 10 mA
Typical cost (1000 pcs)	$0.75 to $2	$1.35 to $2	$2.70 to $3.50	$1.80 to $4.50	$1.95 to $5

coupling efficiency), bear in mind the following:

- Rates of fall-off vary widely from manufacturer to manufacturer.
- Liquid epitaxial processed material is much superior to any other process.
- Tight process control is required both in chip manufacture and in packaging to provide consistently good results.
- In a good device, stress—temperature and bias current—must be increased greatly to produce appreciable acceleration of the phenomena.
- Short, high-current pulse operation causes much less fall-off of output than expected.

For a benchmark, a good product design will normally have less than 10% of the device population drop more than 20% in light output after 1000 hours of steady-state, maximum-rating testing. This extrapolates to about a 100-year half-life at maximum ratings for 90% of the units (Fig. 1).

Another life effect to be wary of is familiar to most SCR users: Due to voltage acceleration of inversion-channel formation, high-voltage (> 100 V) device ratings should be based on the life-test results of high-temperature blocking tests, not on breakdown voltage. Devices made by vendors who should have known better have been specified as superior but haven't been able to survive a weekend under testing at maximum temperature and half-rated voltage. Obvious problems like this are easily found in cursory evaluations, but if not found, they can be deadly in production.



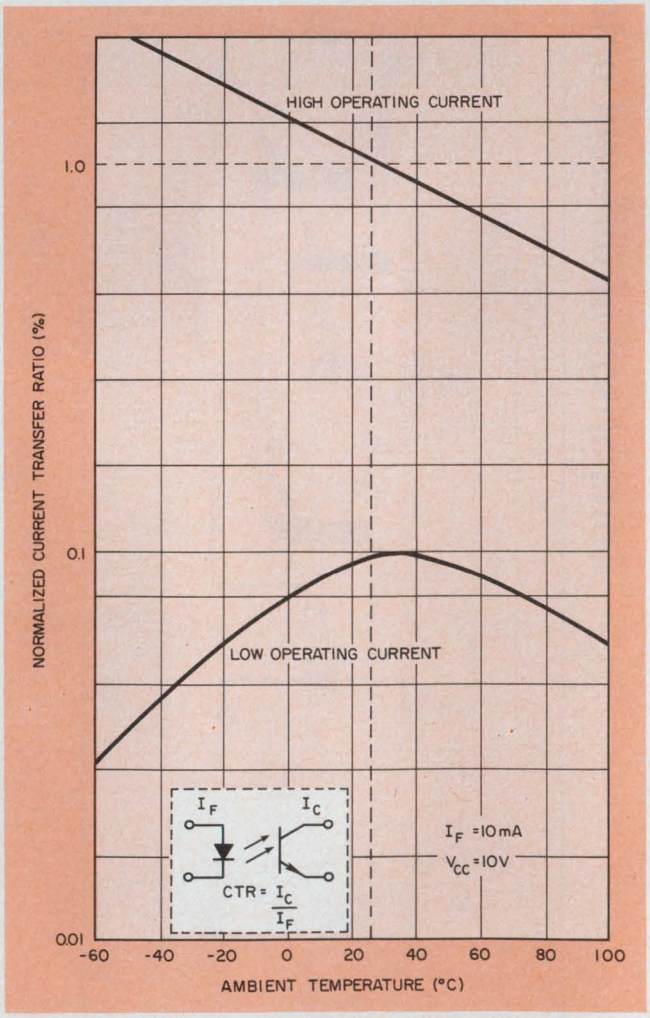
1. **After 30,000 hours of testing,** the light output of a LED decreases. The percentile curves indicate the statistical distribution of changes in LED output.

Isolation: Will it hold up?

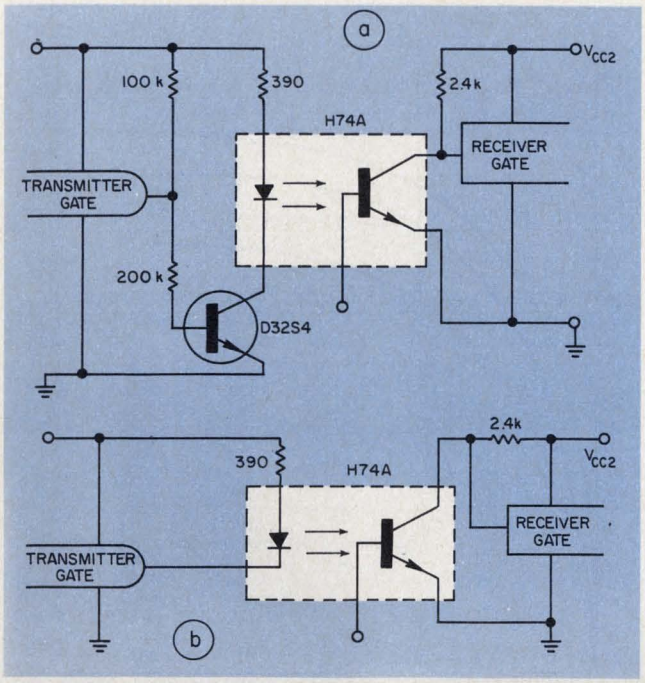
Isolation voltage and maximum dielectric capability are well specified when tested on a one-shot basis. But which of these should be used on a transient repetitive basis and which for steady-state? The answers depend on the voltages at which corona initiates and extinguishes. Since the corona is not easily detected and it bears no strong correlation with the maximum spec value in different mechanical designs, you must lab test it yourself.

Environmental effects can normally be handled with straightforward design procedures—good temperature control, clean circuit-board construction and careful circuit layout. Also there are two commonly unforeseen problems. First, leakage current increases faster than expected for semiconductor devices since a base-to-emitter resistor usually isn't used in transistor and Darlington coupler applications. Second, coupling temperature coefficients aren't always the same for different manufacturer's devices at low current levels. Both of these potential problems are easily avoided when known (Fig. 2).

Logic applications of couplers are widespread,



2. **The normalized current-transfer ratio of a coupler** changes rapidly with temperature because of leakage-current changes, especially in Darlington couplers.



3. **Logic-compatible couplers** require additional circuitry to obtain drive current from CMOS levels (a). However, they can be driven from TTL directly (b).

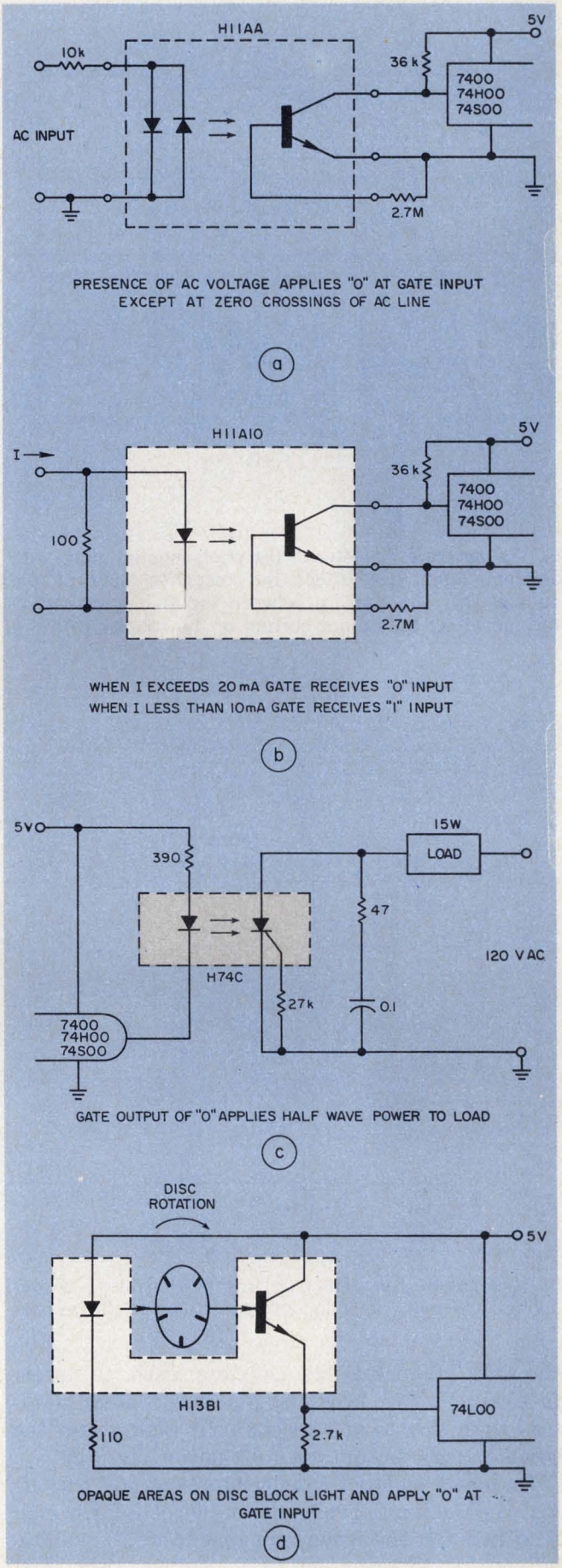
as is a largely undefined but highly touted TTL compatibility. When a coupler is TTL-compatible, it must operate with standard tolerance pull-up resistors, over standard supply-voltage tolerances, over required temperature ranges and at worst-case logic levels. To date, only some couplers, made by GE, Hewlett-Packard, Litronix, and Monsanto appear specified to meet these constraints over the 7400 logic series temperature range of 0 to 70 C.

The IC gates have a vast speed advantage (although they're still slower than IC logic), but they cost more and need careful stabilization to avoid latch-up or oscillation at high temperatures. The transistor-output coupler, which costs less, has very slow switching speeds. And, no coupler is truly CMOS compatible (this would require LED operation at 30 μA), although under special conditions with certain gates, coupling may be achieved with some of the IC and Darlington output couplers (Fig. 3).

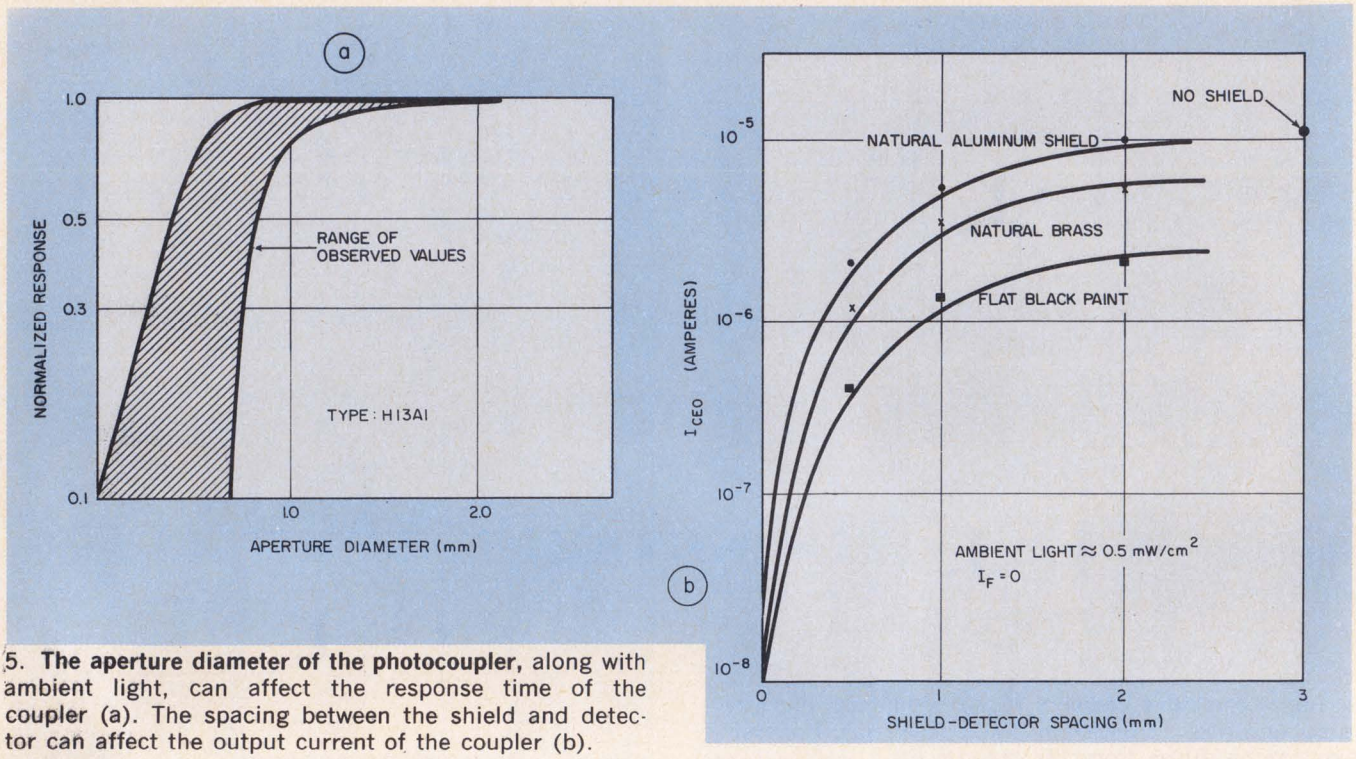
Use of a transistor buffer biases the LED up to the current where efficient light generation takes place (Fig. 3a). Common-mode noise rejection (where the slowness of the phototransistor becomes an asset for high-frequency noise immunity) must also be evaluated in the design of logic coupling circuits.

Choose couplers carefully for power control

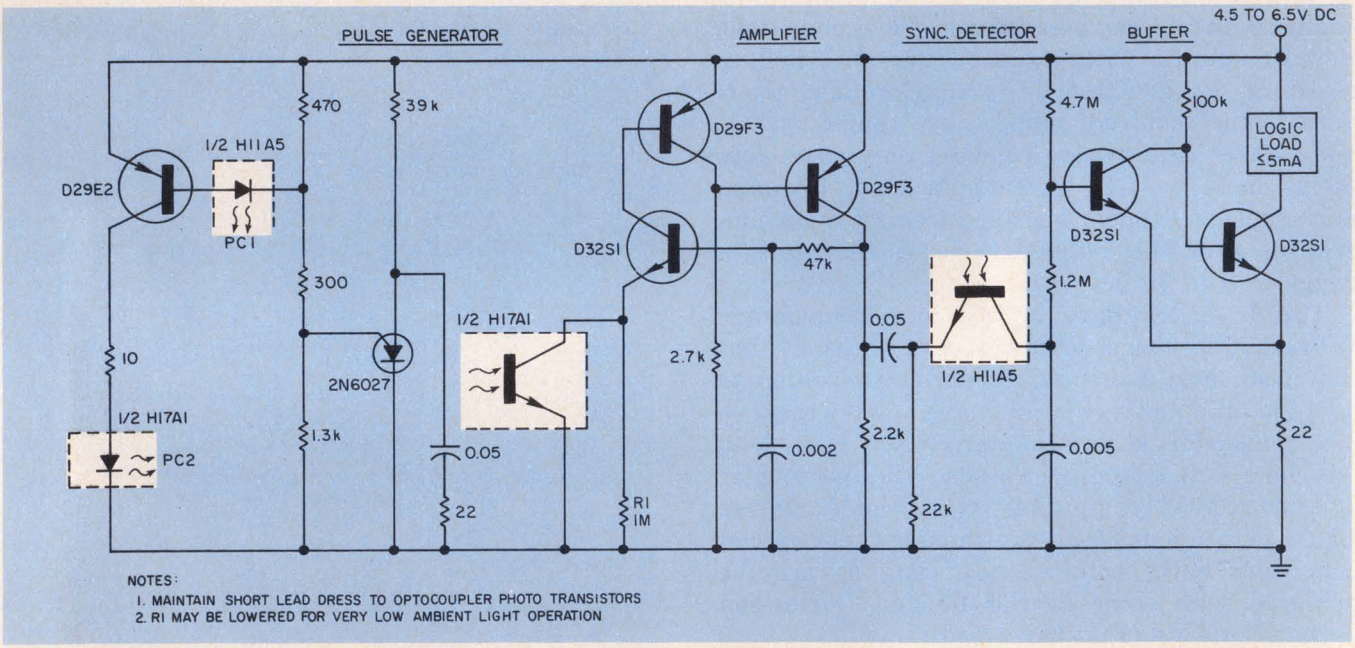
Control of power circuits with logic requires isolated devices both to provide logic-level inputs from power and mechanical sources and to control power sources from logic outputs. Fig. 4



4. **Optocouplers can do many jobs.** They can sense ac power (a) and dc power (b). You can also use couplers to control power (c) or sense motion (d).



5. **The aperture diameter of the photocoupler,** along with ambient light, can affect the response time of the coupler (a). The spacing between the shield and detector can affect the output current of the coupler (b).



6. **This circuit can detect objects** moving along a production-line belt. Detection ranges of up to 3 ft are possible if you use different LED and phototransistor combinations to get more sensitivity.

shows TTL-compatible couplers used to interface logic with power circuits. The system monitors both power and mechanical inputs and the common-logic output controls power circuits.

In power-to-logic coupler applications the effects of the huge transients on power lines, which feed through the isolation capacitance, must also be considered.[1] For the SCR coupler (Fig. 4c), false triggering could result from these transients, since they have a high dV/dt that can couple into the input circuit.

The interrupter coupler for sensing mechanical motion (Fig. 4d) is affected by two external sources. Fig. 5a shows the effect of aperture (window) size on coupling efficiency and indicates that reflection and diffraction effects roughly double the apparent light path width. This effect can sometimes be minimized at very low cost if you mask the light-detector device, although it will cost in output where lenses are

used. Ambient light also plays a part in choosing the surface finish of the light shield (Fig. 5b). Also, certain materials are opaque to the eye but are infrared transparent—and thus make poor light shields.

A typical industrial application (Fig. 6) required a circuit that could reliably and rapidly sense the presence of small parts on a 1.5-in.-wide moving belt and provide an output to 5-V logic. Cost of the control circuit, both initial and life cycle, is also important. Basically this is an interrupter module application. The relatively long distance that must be spanned and a high long-term reliability indicate the LED should operate in a pulse mode. Speed of response then dictates use of a phototransistor detector biased from a very low source impedance.

Pulse operation permits use of the low-cost plastic interrupter module, and it eliminates the need for an expensive optic system and assembly alignment. Synchronous detection of the phototransistor output prevents leakage current, ambient light and temperature from degrading system performance.

A phototransistor coupler provides an ideal switch for synchronous signal detection. A programmable unijunction transistor (PUT) oscillator provides the least expensive pulse generator to drive both the interrupter and the coupler LEDs. A cascode-input amplifier, with heavy low-frequency negative feedback, provides the required low source impedance bias for the interrupter phototransistor, as well as regulating the dc bias point to minimize ambient light, leakage and temperature effects. Three plastic-cased transistors provide the amplification. The amplifier output, synchronously detected by PC_1, provides a negative output when the interrupter module's light path is unblocked. The system is fail-safe, since any malfunction will cause a zero or positive output signal. A simple two-transistor buffer amplifier with hysteresis provides the 5-V logic output, while permitting the use of a small detector capacitor to preserve system speed.

The cost of components for the system is less than $5 at the 1000-piece level. Compared with the simple combination of a 10,000-hour, 5-V lamp and a photo-Darlington needed to guarantee TTL compatibility, this system saves about $2. It provides better resolution, minimal ambient light problems, longer life, comparable speed and is more fail-safe than the lamp system. You can upgrade the interrupter module to a LED55C and a L14G1, or add lenses to the H17A1, and increase the range to about 3 ft. ■■

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1. Martzloff, F., "Surge Voltages in Residential and Industrial Power Circuits," *IEEE*, July/August, 1970.

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OUTPUT
6A
FUSE
FUSE
POWER SUPPLIES
SIM
12-12
GND
INPUT
VOLT
1
2
3
4
5
6
7

Debug that microcomputer system with a mini.

With the mini acting as an artificial memory, you can probe the microcomputer conveniently while it operates.

Small memory and a lack of peripheral equipment often hinder applications software development for microprocessor-based microcomputers. You can overcome the problem with hardware simulators, or you can use software tools, such as cross assemblers and editors on large machines —but all of these will add to the development cost. If a minicomputer is available, why not build a hybrid simulator and give the microcomputer an artificial memory?

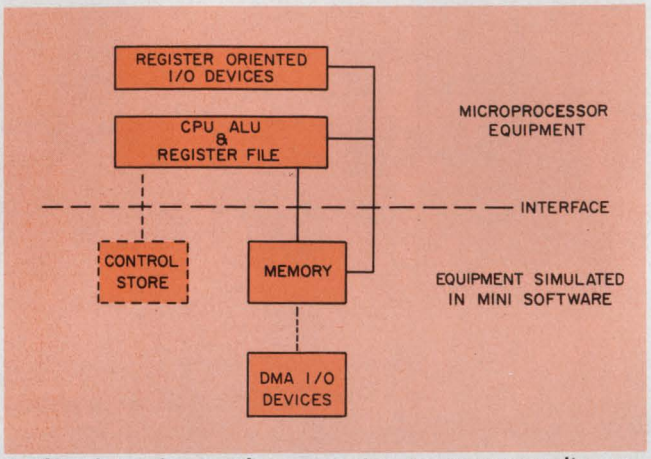
It will not only simulate the memory functions but will also leave the hardware functions intact. The microcomputer has controlled access to the mini's memory and the user can view the result (Fig. 1).

Thanks to the mini's high-speed peripherals and the fact that most microcomputer activity centers on the memory, a good deal of the step-by-step diagnostic and debugging capability inherent in hardware or software simulators is retained. In addition there is no need to buy PROM and RAM chips, which, in small quantity, often exceed the cost of the microprocessor by several times.

Because the hybrid simulator is a compromise between a hardware and software model, it has some disadvantages. The simulated memory is quite slow. When testing real-time routines, the programs run slow and the processor under simulation may not keep pace with external events.

Another disadvantage is that software access to CPU internal registers is complicated. The data can be saved for analysis only if you write special register-saving routines in the microcomputer language, and integrate them in the simulated memory. Finally the function of the interrupt system can be supervised only to the extent allowed by memory access.

The interface that couples the mini and microcomputer enables data and address transfers between both devices. The type of mini used is not too important. However, since most microcomputers are byte-oriented, a 16-bit host can simplify the address mapping. Each microcomputer address must be mapped to a new available address in the mini. With 16-bit machines, a single word holds two microcomputer bytes.



1. **Simulator for a microcomputer memory** permits system development without resort to emulators. The microprocessor chip is connected to its intended peripherals so its action remains realistic.

Mini determines interface needs

The actual interface design depends largely on the type of mini used. The following mini I/O operations are necessary:

INPA—Read address, 12 bit word for a 4-k simulation.

INPD—Read data and R/W request, 10-bit word formed by 8-bit data and 2-bit R/W request indicator.

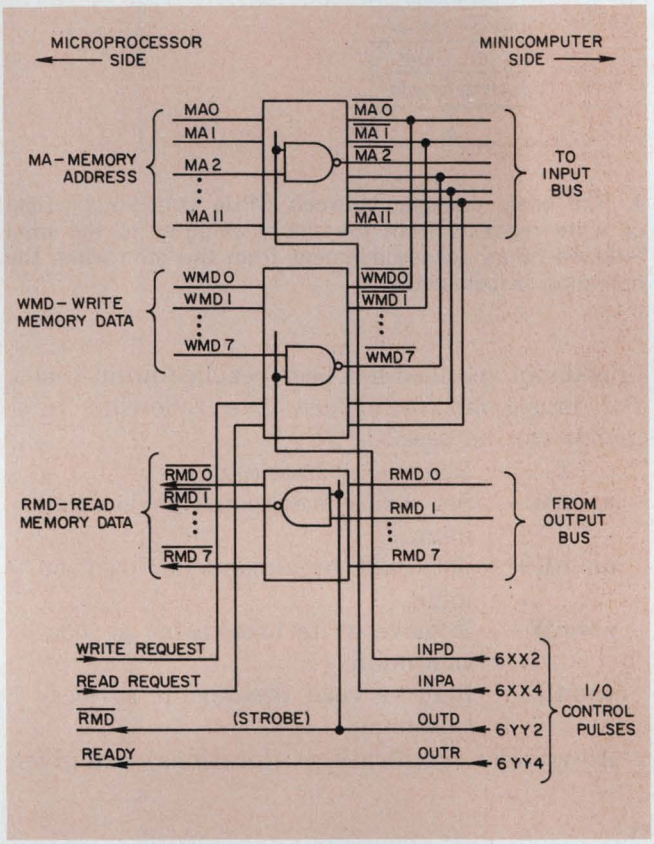
OUTD—Output data (8 bit word).

OUTE—Ready output pulse; one bit indicates the end of a read or write operation.

The structure of the interface between an 8008-based microcomputer and a PDP-8 minicomputer is shown in Fig. 2. The read/write request line connected to the minicomputer input synchronizes operations between the two processors.

Open-collector devices capable of sinking 25 mA drive the input lines of the PDP-8. Either discrete transistors or high-current ICs will do the job.

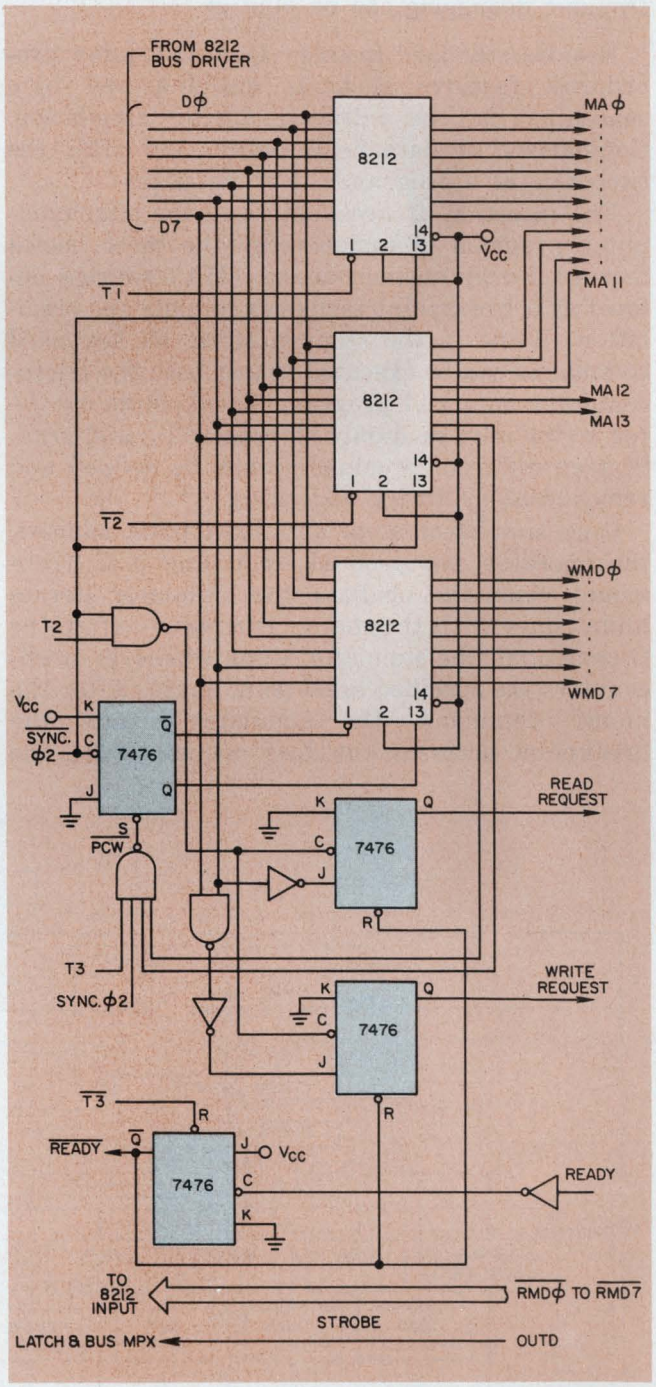
Raic Dusan, Research Engineer, ISKRA, Ljubljana, Yugoslavia.



2. **The mini senses microcomputer addresses** and supplies the necessary data. The mini response is slow compared with that of the microcomputer; hence the two must operate asynchronously. Read/write request lines provide the controls. Signals at the microcomputer side are latched.

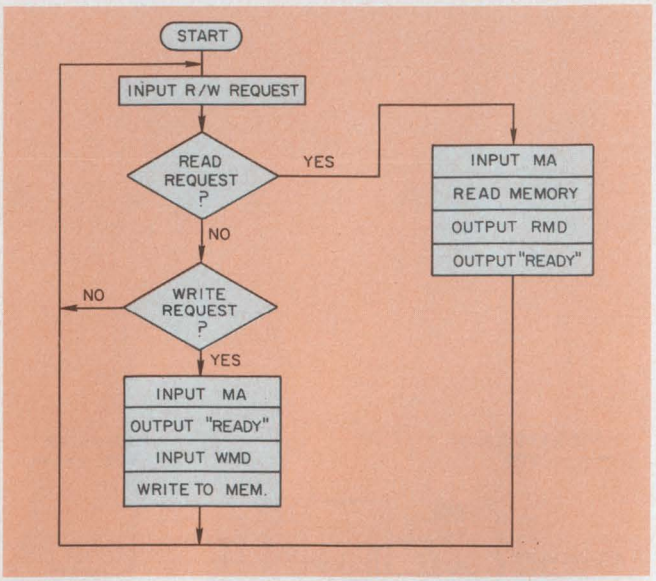
The 8008 microprocessor requires additional circuits for normal operation. These circuits provide address latching, multiplexing and bus drive.[1,2,3] Universal I/O drivers (Intel 8212) perform the functions (Fig. 3). Also used are outputs from a two-phase clock and internal state decoder, both normally associated with the microprocessor.

The simulator, which operates on a request-sampling basis, leaves the minicomputers's interrupt system free for other purposes. In addition to simplifying the simulator coding, this design also makes the simulator independent of the minicomputer operating system.



3. **Address and data latches permit normal operation** of the 8008 CPU when attached to the PDP-8 mini. The inputs from the 8008 include the clock ($\phi 1$, $\phi 2$) and decoded processor state (T1, T2 and T3).

Since the simulated memory is slow, the microcomputer should be able to communicate with the memory asynchronously. In the case of the Intel 8008, this is achieved by a "ready" pulse from the mini that tells the processor that the memory operation has been completed. The simulator first reads the read/write request bits to see what is to be done. If there is no request, it waits in an endless loop. In the case of a request, it performs the appropriate memory action and ends with the issuance of the ready (OUTR) pulse (Fig. 4).



4. **The basic dialogue between CPUs** consists of read or write requests from the microcomputer to the mini followed by an acknowledgment from the mini when the operation is completed.

Dynamic debugging can be built in

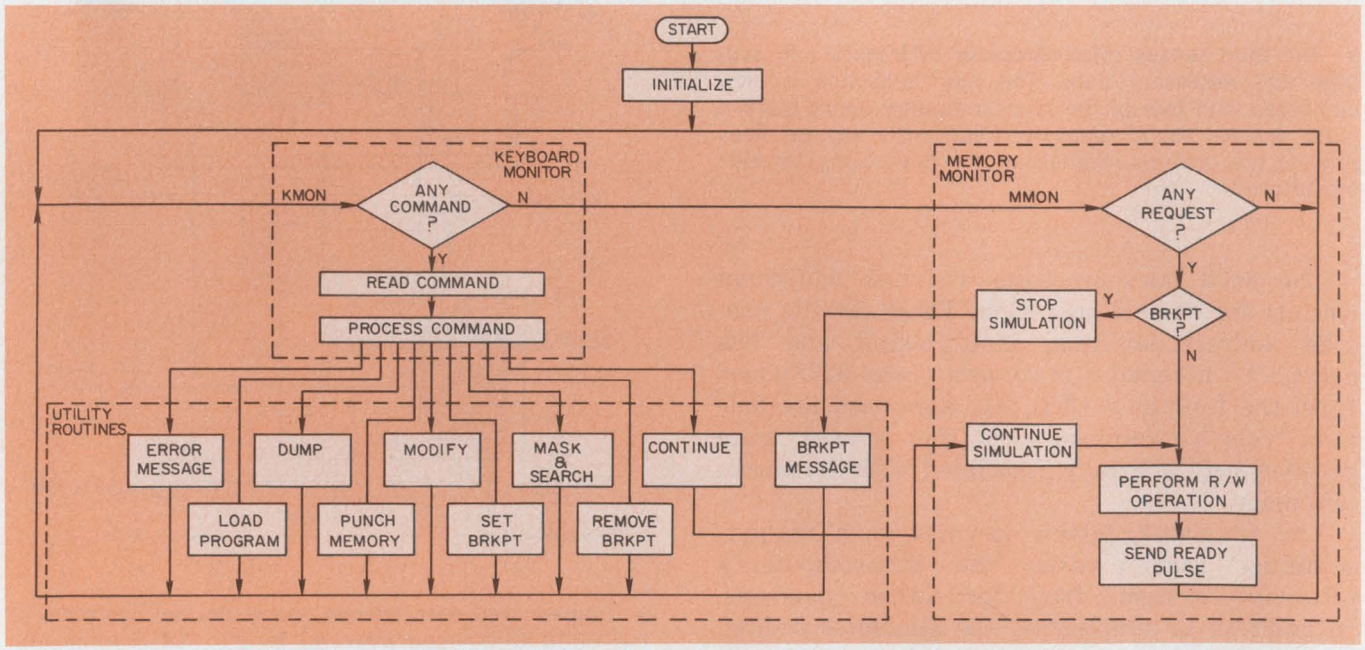
Besides standard memory load and dump procedures, features such as masking and byte searching can be initiated during simulation. Comparison of data fields before and after the execution of a program is also possible.

The insertion of breakpoints in the microcomputer program is undoubtedly the most useful feature. Every memory-access (MA) address defined as a breakpoint temporarily halts the simulation. While in the stopped state, all keyboard commands can be executed to test both the microcomputer data and program. Breakpoints can be for write-only, read-only or both write and read. Sixteen different breakpoints can be defined and removed at arbitrary addresses.

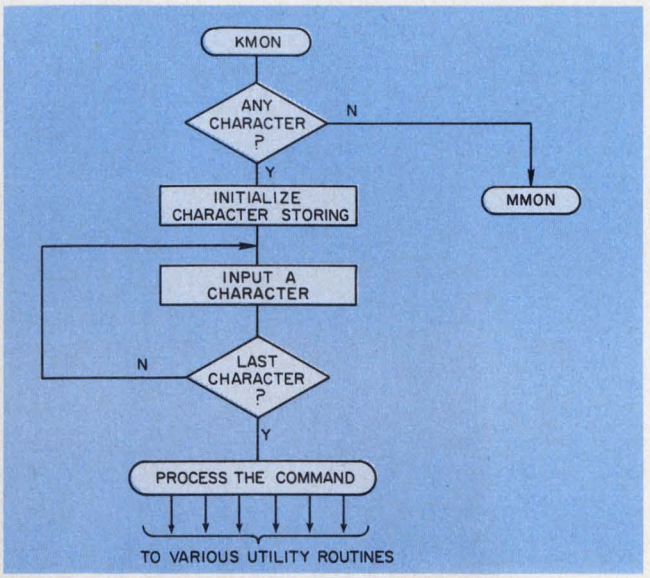
Once simulation stops on a breakpoint address, the operator can proceed by typing a C (continue) command or have the simulator iterate nnnn times with the nnnnC command. After the C command, the simulator stops whenever it encounters the specified breakpoint again. After the nnnnC command, the simulator counts the breakpoint accesses but does not stop until the breakpoint specified has been reached nnnn-times. For breakpoint definitions, the following commands can be used:

Z	Remove all breakpoints.
nnnnW+	Set write breakpoint at location nnnn.
nnnnR+	Set read breakpoint at location nnnn.
nnnnW−	Remove write breakpoint at location nnnn.
nnnnR−	Remove read breakpoint at location nnnn.

All address specifications (locations) are given



5. **The program loops between keyboard** and memory monitor. Most of the keyboard monitor routines and utilities come from the mini's debugging routines. The memory-monitor program is written.



6. **The keyboard monitor,** upon receiving control, decodes an input string (if present) and performs the desired action. Following execution of the command, a jump back to the loop starting point completes the cycle.

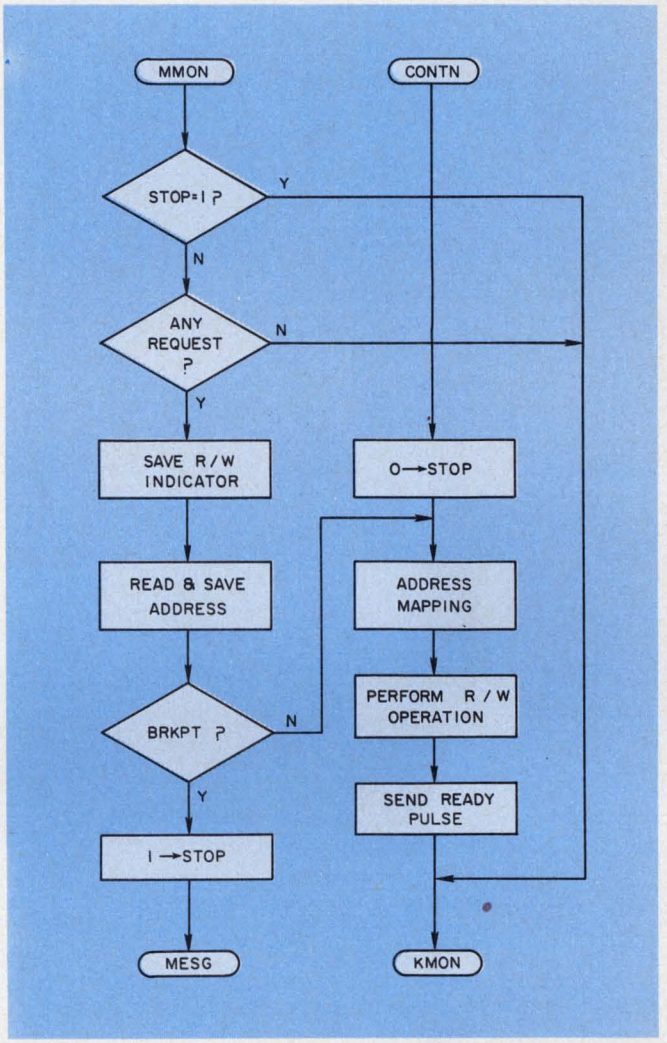
in original address space (MA) of the microcomputer and are mapped to mini addresses when executed in the simulator.

Mini's software speeds implementation

The software part of the simulator (Fig. 5) is made up of three components: keyboard monitor, memory monitor and utility package. You can build a keyboard monitor and the majority of utility routines by small modifications to an existing debugging routine for minicomputer programs. Nearly every type of minicomputer has some software package of this type. For the PDP-8, the ODT-8 routine is used. The format of the simulator is nearly the same as that of the ODT. Programs for the memory monitor and some utility routines associated with it are the only ones that must be written.

The software operation is as follows: After the initializing sequence, the program starts to loop between the keyboard and the memory monitor. At the keyboard side, the loop is interrupted by the first character to be entered (Fig. 6). Characters are read one after another until some terminating character ends the string and passes control to the command-processing routine. The appropriate utility action, called from this routine, executes the command and then ends with a jump back to the starting point of the loop.

On the memory-monitor side, the loop is interrupted by memory read/write requests issued at the microcomputer side (Fig. 7). Each request is tested in the breakpoint table. When its address is found to have been defined as a breakpoint, the



7. **The memory monitor,** which simulates the microcomputer memory, loops until it receives a read/write request. The monitor converts microcomputer addresses to mini locations.

memory monitor proceeds to the stopped state (STOP = 1). Meanwhile the loop keeps running, and all keyboard commands can be issued. The memory monitor does not leave the stopped state until some "C" command is given.

Written in PAL-3 assembly language, both monitors require about 80 locations. Some of the most useful utility routines require 300 core locations. ■■

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2. Lewis, D., Siena, W., "How to Build a Microcomputer," *Electronic Design* No. 19, Sept., 1973, pp. 60-65.
3. "8212 Eight-bit I/O Port," Intel Corp., 1974.

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H-3-4

Look at calculator languages.

You'll find algebraic notation easier to use, but with practice you can work faster with a reverse-Polish machine.

There's more to evaluating a calculator language than mere counting of key strokes. Any realistic evaluation must take into consideration the answers to questions like these:

- Is it easy to learn the language?
- In long calculation sequences, are the language rules likely to confuse?
- Are you only an occasional calculator user or do you use one continually?
- Is speed important and are you willing to devote the effort to attain high speed?
- Are there special features needed for your work?

A recent study that compares the key-stroke requirements of calculator languages appears to give reverse-Polish notation (RPN) a slight edge.[1] However, mere analysis of the number of key strokes needed for relatively simple arithmetic operations is not by itself conclusive.

Consider the three calculator languages that are generally available: reverse-Polish notation, used almost exclusively by the Hewlett-Packard family; algebra-with-hierarchy, as used on the Texas Instruments SR-50, and ordinary algebra, as used on most other calculators. Which is best?

New users usually find algebra systems easier to learn than RPN. With algebra systems, you present numbers and operations to the calculator in the way you learned them when you studied algebra. This is a major selling point of manufacturers that make algebraic calculators.

But don't conclude that RPN is difficult to learn. It takes only a little skill and some practice. If you use the calculator more than occasionally, you will have no trouble. RPN follows the "computer-way" of calculating; thus experienced machine-language computer programmers have little trouble with it.

As an occasional calculator user, however, you are more likely to work your way out of a problem with an extra pair of parentheses, which costs only two extra key strokes. Though this is equivalent to the use of an extra [ENTER] followed by a [ROLL] key stroke in RPN, the RPN procedure is not as "natural" to an untrained operator as the use of parentheses.

Thomas S. Budlong, Director Product Planning, Compucorp, Los Angeles, CA 90064.

Making a valid comparison

Of course, for a valid comparison, all the systems must be well-designed. For example, in an RPN system the stack registers should be at least four levels deep, and these registers should be used only for arithmetic functions. In both ordinary and hierarchic algebraic systems, at least two levels of parentheses or their equivalents should be available. And for all systems, no operation should require more than one key stroke. Single-stroke capability is commonly available in moderately priced calculators.

Once an arithmetic system is learned, short sequences and expressions almost never cause confusion. But a long sequence may force you to break it into small parts to get the answer.

The ordinary algebra system is the least likely to get you into trouble. Operations are performed in the order that you put them in. There is little possibility to mistake what's going to happen next. At most, to avoid confusion, extra parentheses may be needed when they are not in the written expression. However, extra key strokes will also be needed then. Or a slight rearrangement of the equation may help some other sequences.

Algebra-with-hierarchy systems can be just as easy to work with as ordinary algebra after you develop the confidence that the calculator is following your instructions. The hierarchy, in which multiplications and divisions are done first, causes delayed operation. An expression such as $2 + 3 \times 4$ can be done without putting parentheses around 3×4 or without rearranging the equation, as ordinary algebra systems require. But in longer sequences—especially those that involve the function a^x, which is a level of hierarchy above multiplication and division—the calculator can at times fall considerably behind the key strokes, but it will catch up. And if you're not confident about how the calculator works, you can become confused.

RPN usually requires some prior thought to plan the order of operation for long sequences (Table 1). In the example in the table, three numbers are keyed in before a single operation key is used. Though some sequences are naturals for RPN, others can defy your best efforts. This often happens when all levels of the stack are filled. Part of your calculation can be lost in overflow if you then attempt to enter more data. Of course, the quickest way out of such a situation is to break the expression into smaller parts and save the intermediate answers for later recombination.

Experienced RPN users can move numbers through the system quite rapidly. But this requires practice—sometimes several months of it. With experience, an RPN operator can expect ultimately to go faster than the skillful algebra

Some calculator language details

How RPN works

As numbers are keyed into an RPN calculator, they enter a so-called push-down stack of registers. A common configuration has a four-level stack. The top level is connected to the display. Numbers already in the registers move down one level when a special [ENTER] key is pressed. A number in the lowest level overflows and is lost.

The four basic function keys are [+], [−], [×] and [÷]. Sometimes a^x and other two-variable functions are also provided. When pressed, they cause the following actions:

- The designated function is performed on the number in the display with the number in the second level of the stack.
- The result of the operation is displayed, and the numbers in the lower stack levels each move up one level.

For continuous sequences, the result of an operation should enter the second stack level to allow a new number to be keyed into the display. Though this can be done by pressing [ENTER], a well-designed RPN system automatically does this when the next number is keyed in (See Table 1).

Because numbers are entered first and the function to be performed last, the designation "reverse" is used. And "Polish" comes from the system's inventor, a Polish logician, Jan Lukasiewicz.

How algebraic systems work

The algebraic systems use an [=] instead of [ENTER] key. Numbers and functions are keyed in the same sequence as they appear in equation form. And parentheses keys separate strings. For example $2 \times 3 + 5 \div 4 - 7 =$ would be keyed in as

2 [×] 3 [+] [(] 5 [÷] 4 [)] [−] 7 [=].

Parentheses also can be nested several levels deep.

In ordinary algebra systems the functions are carried out in the same order that they are presented to the calculator—which can give incorrect results if parentheses are not used.

Algebra-with-hierarchy systems, however, assign a lower hierarchic level to [+] and [−] functions than to [×] and [÷]. The latter two, in turn, are lower than a^x. When an add command is followed by a multiply command, the multiplication is done first, then the addition. However with an ordinary algebra system, the add command would be carried out as soon as the multiply was keyed.

For example, for entry of 2 [+] 3 [×] 4 [=]?, ordinary algebra would add the 2 and 3 as soon as [×] was keyed, and this sum would then be multiplied by 4 when [=] was pressed; an incorrect result, 20, would be obtained. Algebra-with-hierarchy, however, holds the [+] operation when [×] is pressed and waits for the completion of the multiplication. Thus 3 [×] 4 is done first, and the 2 is then automatically added; the correct result, 14, is then obtained.

To obtain the correct answer with ordinary algebra, the key sequence would have to be rearranged to 3 [×] 4 [+] 2 [=], or expanded to include parentheses:

2 [+] [(] 3 [×] 4 [)] [=].

Table 1. Solve (7 + 8 × 4)/5 by RPN

Key strokes	Stack level				Comments
	Display	2	3	4	
7	7	0	0	0	Key 7 into the display.
ENTER	7	7	0	0	Copy the display into the next level of the stack.
8	8	7	0	0	Key in 8.
ENTER	8	8	7	0	Enter the 8 into the stack.
4	4	8	7	0	Key in 4.
×	32	7	0	0	Multiply the two top stack levels and move the stack up one level. The 7 is now in place to be added to the display.
+	39	0	0	0	Add the two top stack levels. The stack again moves up one level.
5	5	39	0	0	Keying in a number after +, −, ×, or ÷ automatically puts the display in the stack.
÷	7.8	0	0	0	Divide the display by the next level. This is the answer.

user. However, the occasional user probably will not acquire enough practice to become fast with RPN.

Special features can be important

Most algebra systems offer one or more special features. The most common and useful is "constant operation." In the simple sequence [7] [×] [8] [=], the [7] [×] is retained after the initial calculation. To multiply 7 by another number, say 5, requires entry of only [5] [=]. For multiplication of a long string of numbers by the same number, this feature can be a big timesaver.

Table 2. Author's subjective evaluation

	RPN	Ordinary algebra	Algebra with hierarchy
Learning ease	5	10	8
Confusion avoidance	7	10	8
Speed of calculation	10	8	8
Special features	10	10	10
Number of key strokes	10	9	9
Total	42	47	43

For simple addition of a list of numbers, RPN is best. After the first [ENTER] key stroke, subsequent entries are simply followed by [+]. No other key is required to display the result.

If there are enough stacks in RPN—or parentheses levels in algebraic—long sequences can be interrupted to obtain intermediate calculations. In RPN you roll the stack down one level, and in algebraic you open a level of parentheses. When you complete the intermediate calculation, you then roll the stack back up or close the parentheses. But take care not to exceed the limits on available stacks or parentheses levels. For such cases, a stack or parentheses-level indicator is a valuable convenience.

But only your personal requirements can tell you whether a particular special feature makes one system a better choice over another.

Confused? Too much to consider? Then fill out a table and score the factors on a scale from 1 to 10. The author's subjective preferences are shown in Table 2.

Usually the over-all differences are small. A system seldom wins decisively. The final choice is still based on your own judgement. ■■

Reference

1. Ball, John A., "Reverse-Polish or Algebraic Entry —Which Is Best?" *Electronic Design*, Jan. 18, 1975, pp. 50-52.

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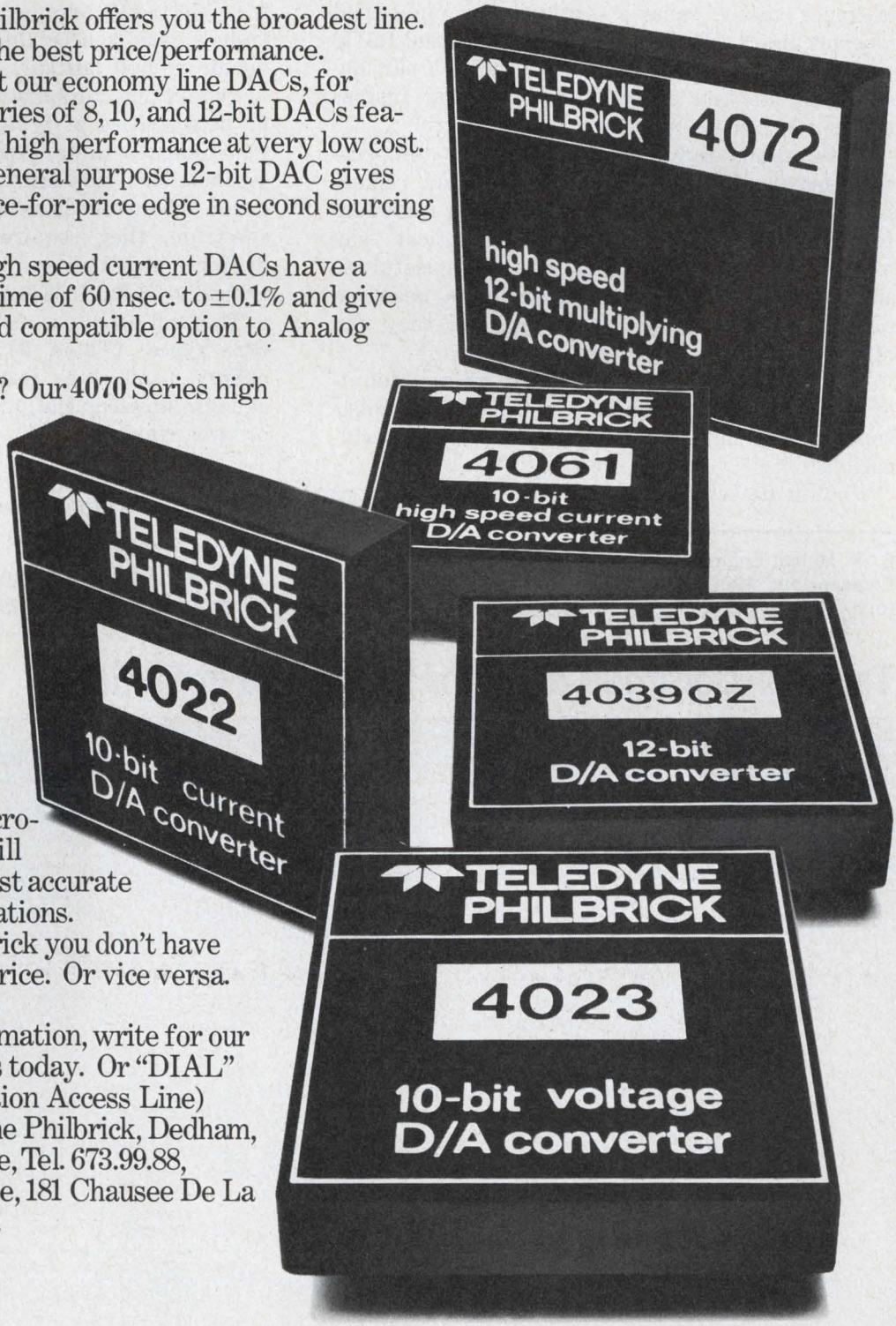


INFORMATION RETRIEVAL NUMBER 37

Use low-cost IR detectors to solve many tough temperature-measurement problems. These sensors allow noncontacting measurement of hard-to-reach hot spots.

Available low-cost infrared detectors give the engineer many sensing options for industrial measurements. With these IR elements and fairly simple signal-conditioning circuitry, you can design reliable and economical measuring instruments for remote monitoring and control.

Applications range from noncontact temperature sensing of inaccessible targets and remote counting of moving objects to detecting intruders for security alarms and locating optical telemetry paths. IR detectors are also useful to analyze gases, such as engine exhausts, based on absorption of infrared radiation, and they can measure power in laser beams.

IR sensors are generally either photon counters or heat-sensitive materials. Table 1 describes some of the more common performance specifications.

Photon detectors fall into three family types (Table 2). They count energy in terms of the free electron currents created when radiation from a heat source interacts with the semiconductor crystal lattices.

Photon detectors are very sensitive with specific detectivities of typically 10^{11}. They also have fast time constants, typically measured in microseconds. But they are only sensitive to a narrow range of wavelengths at the low end of the IR spectrum, they require cryogenic temperatures during operation and are relatively expensive, typically—$400 to $600.

Thermal detectors can be divided into five general types (Table 3). They absorb infrared energy, and the resulting temperature rise changes an electrical property, such as resistance or capacitance.

C. S. Molee, Engineering Manager, **Mark Muller,** Product Engineer and **Alan Eschbach,** Senior Project Analyst, Victory Engineering, Victory Rd., Springfield, NJ 07081.

Thermal detectors respond slowly

Traditional thermal detectors have slow responses, typically measured in milliseconds. Sensitivities are only moderate, with specific de-

Table 1. Common detector terms and definitions

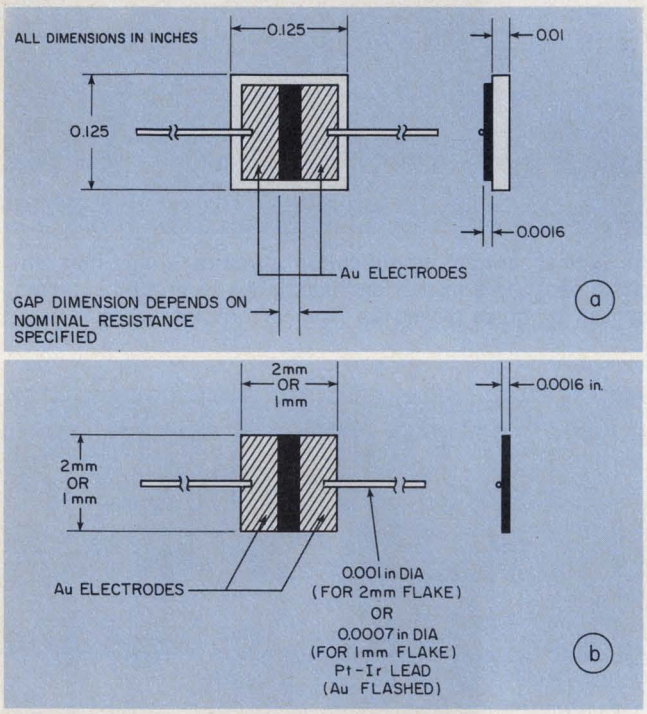
Term	Symbol	Definition
Responsivity	ρ	The ratio of output signal to incident radiation; usually expressed in volts per watt.
Noise	V_n	Extraneous voltage generated by a detector.
Johnson or thermal noise	V_j	Noise due to random motion of electrons in a resistance element. The root-mean-square Johnson noise can be approximated as $V_j = \sqrt{4KTR\Delta f}$. Boltzman's constant, K, is 1.38×10^{-23} joules/kelvin, T is the absolute temperature in degrees kelvin, R is the resistance in ohms, and Δf is the electrical bandwidth of the circuit in Hz.
Noise equivalent power	NEP	The incident radiation in watts required to produce an output signal equal to the detector noise.
Detectivity	D	The reciprocal of NEP.
Specific detectivity	D*	Detectivity normalized for a detector area of 1 cm^2 and a bandwidth of 1 Hz. It is equal to $D\sqrt{A\Delta f}$, where A is the detector active area in cm^2 and Δf is the bandwidth in hertz. When reporting D*, the wavelength or the black-body temperature and chopping frequency at which the data are taken must be specified.
Time constant	τ	The period required for a detector to reach 63.2% of its final output value following the application of steady-state incident radiation. The time constant equals $1/2\ \pi f_{co}$, where f_{co} is the chopping frequency in Hz at which the frequency response begins to roll off at 3 dB/octave.

Table 2. Types of photon IR detectors

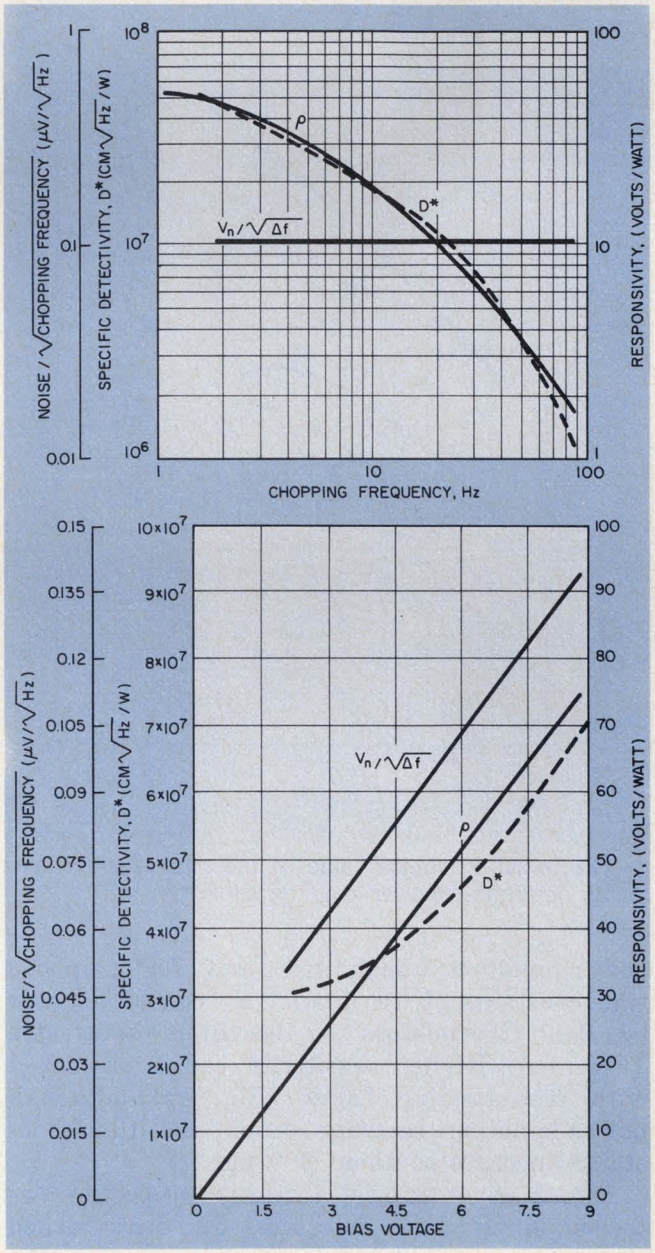
Type	Material
Photovoltaic detectors	Silicon (Si) Gallium arsenide (Ga As) Germanium (Ge) Indium arsenide (In As)
Photoconductive detectors	Silicon (Si) Lead sulfide (Pb S) Lead selenide (Pb Se) Indium antimonide (In Sb) Germanium—Gold doped (Ge:Au) Germanium—Cadmium doped (Ge:Cd) Mercury—Cadmium-telluride (Hg:Cd:Te)
Photoelectromagnetic detectors	Indium antimonide (In Sb)

Table 3. Types of thermal IR detectors

Detectors Type	Materials
Thermocouple and thermopile detectors	Various metallic alloys Nickel (Ni) Bismuth (Bi) Antimony (Sb) Various semiconductors
Thermistor detectors	Mixtures of metal oxides, such as those of nickel, cobalt and manganese
Ferroelectric detectors	Barium-strontium titanate
Golay Cell detectors	Xenon gas
Metal strip detectors	Blackened strips of thin metal



1. **Typical thermally sensitive flakes** of metal oxides are only 0.125 in. square when mounted on a ceramic substrate (a) and only 2 or 1 mm square, free-standing (b).

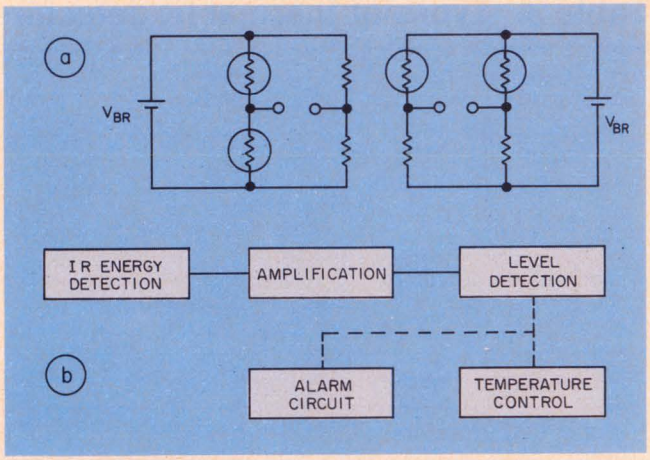


2. **Responsivity, noise and specific detectivity** are shown as functions of the chopping frequency (a) and as functions of the bias voltage (b).

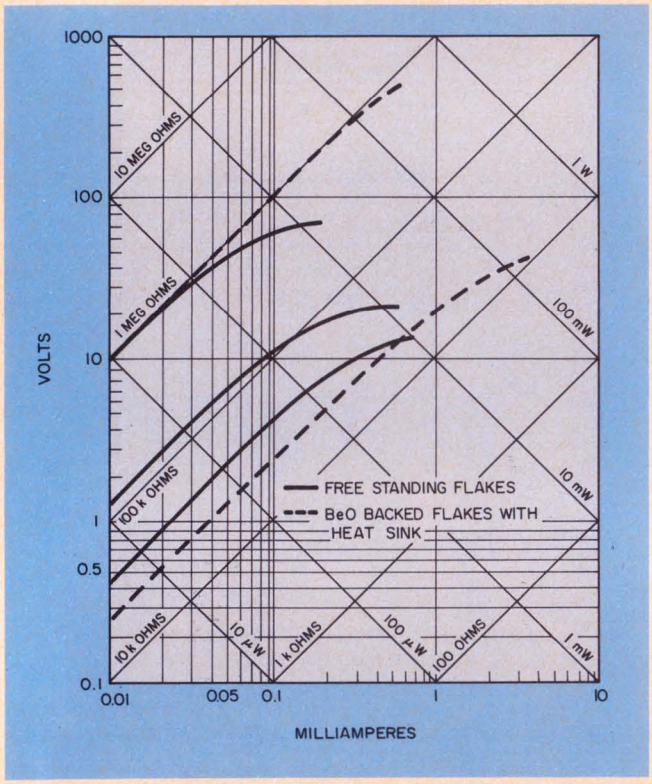
tectivities of about 10^7. They can, however, respond to the full infrared spectrum, and their cost is moderate, typically—$100 to $300.

A newer series of thermal IR detectors can be formed from thick-film thermistor flakes composed of metal oxides such as manganese, nickel, cobalt and titanium. The resistance of these flakes decreases sharply with absorbed energy. They offer high sensitivity along with low cost (typically $40 to $60), high mechanical durability and good electrical characteristics. These sensors can be used for IR detection in applications that previously required more sophisticated and expensive transducers.

For instance, applications that call for high



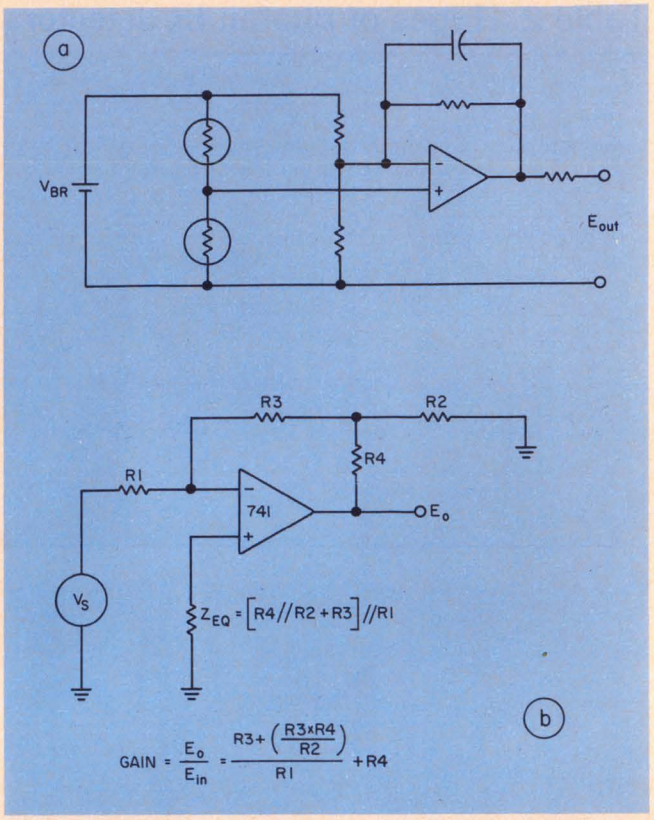
3. **Matched sensors can be used** as adjacent arms of a balanced bridge to reduce drift or provide high sensitivity (a). Bridge outputs can be conditioned to serve many alarm and control functions (b).



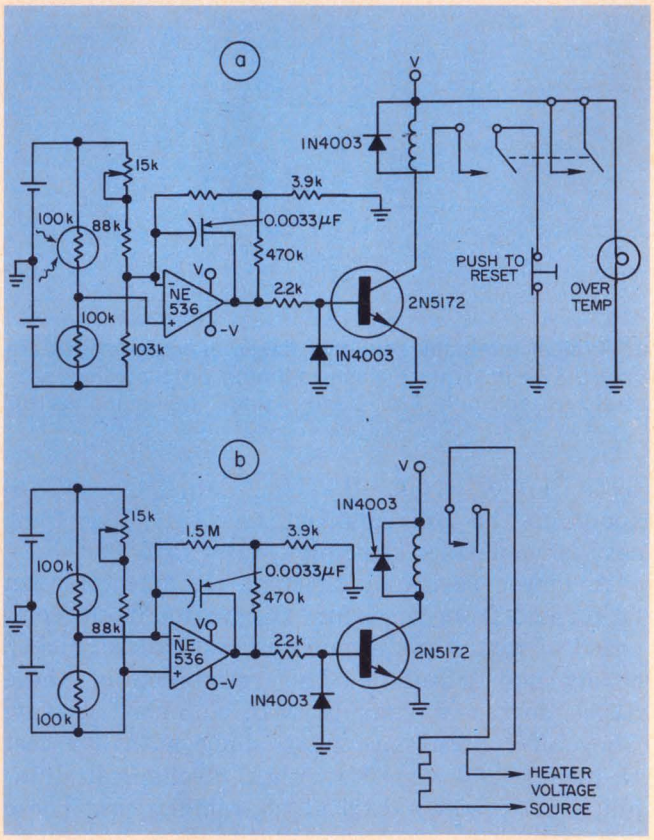
4. **The initial-resistance value** of the heat-sensitive elements determines power-handling capacity.

power-handling capabilities and for response time-constants of less than 1 ms can be handled by flake thermistors on beryllium substrates (Fig. 1a). Higher sensitivity can be achieved with free-standing flakes (Fig. 1b), although power-handling capacity drops and time constants increase to about 300 ms.

Fig. 2 gives typical infrared properties for free-standing flake detectors. Substrate-backed elements have similar characteristics, except that responsivity decreases at low chopping frequencies. The noise characteristics of both types ap-



5. **Typical bridge amplification circuits** sometimes include capacitors in the feedback loops to minimize errors caused by noise picked up from external sources.



6. **An overtemperature alarm circuit** (a) and a temperature-control circuit (b) can be built with very few components, since the heat-sensitive elements don't need any critical conditioning.

proach the Johnson level.

IR detectors, used in systems to detect and process IR energy, can be connected in balanced-bridge circuits that are part of more complex signal-processing circuits (Fig. 3).

IR energy detection can be accomplished if you use a single thick-film flake, apply a bias voltage and monitor the output current. More often, though, dual matched thermistors in common headers are used. For applications such as counting or temperature measurement, one of the two flakes is exposed to the IR radiation, while the other is shielded from impinging energy and used to compensate for ambient effects.

For gas analysis, a light beam can be split, with the two thermistors used to sense rays passing through and bypassing the sample. Composition can then be inferred from calibration of the bridge unbalance that results from the difference in optical absorption. In either case, the magnitude of the bridge voltage, V_{BR}, can be determined from the voltage-current curves for the elements (Fig. 4). Avoid excessive bias voltage, though, or self-heating of the flakes can invalidate any reading.

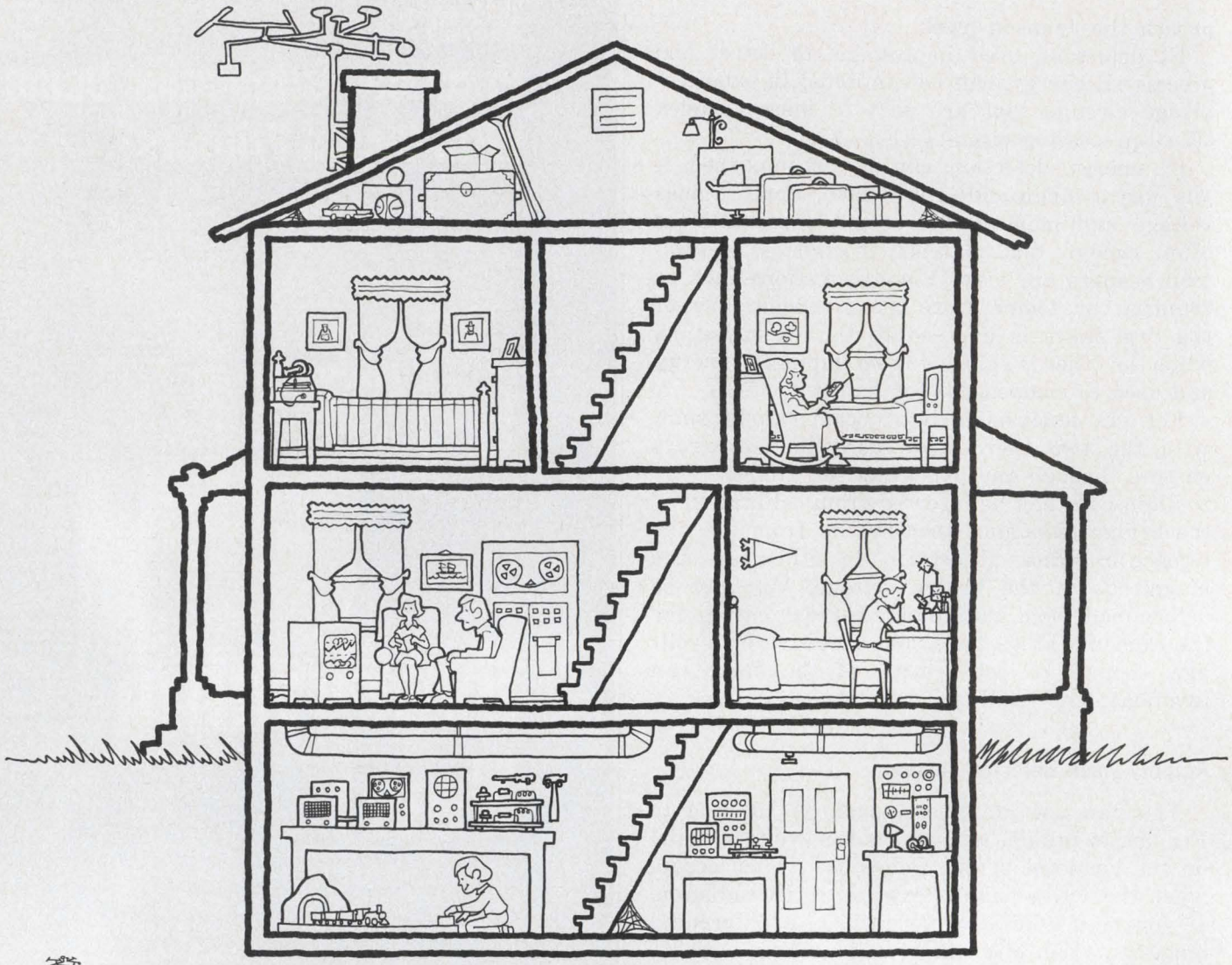
Amplify weak detector signals

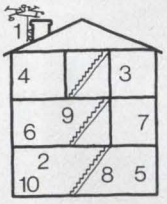
You can use amplifiers, such as the one in Fig. 5a, to provide a useful output voltage based on the low-level bridge imbalance, which occurs when the active flake is exposed to IR radiation. If you need additional sensitivity, a differential amplifier (Fig. 5b) can be used. Along with increased gain from the differential amplifier circuit you can use more realistic resistor values in the feedback network.

Level detection circuits that sense IR radiation can include a transistor switch, which triggers any type of control element when the magnitude and polarity of the amplifier output voltage reach predetermined values. For instance, if the transistor turns on a latching relay, the circuit can operate as an over-temperature fail-safe device.

A practical over-temperature alarm circuit and a simple temperature-control circuit use capacitors in the amplifier feedback loops to reduce circuit noise (Fig. 6). Higher resistance flakes can be used to increase sensitivity to IR energy. However, when the high resistance flakes are used in this type of circuit serious noise problems may develop. The IR-sensitive resistances in the bridges will be functions of the IR source temperature, the distance to the source.

For best results, choose stable, low-drift components to minimize drift. In many cases, you may need special optics to increase the over-all sensitivity. The optics can range from simple reflective mirrors to lens and filter systems. ■■





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Here are 10 hobby and project books that let the engineer use his special talents for improving his home or just having fun.

1. **HOW TO SELECT AND INSTALL ANTENNAS,** #0786-8, $4.90. All aspects of antenna selection and installation. Instructions for putting up UHF, VHF, FM antennas or complete master TV systems.

2. **20 SOLID-STATE HOME AND HOBBY PROJECTS,** #0134-7, $4.55. Two-station intercom, electronic siren, power regulator, metal detector, water-operated alarm, etc. Complete instructions, parts lists, diagrams.

3. **25 SOLID-STATE PROJECTS,** #5881-0, $4.90. Auto burglar alarm, programmable auto-speed-minder, indoor-outdoor electrothermometer, telephone call timer, electronic dice, TV remote-sound system, etc., etc.

4. **50 IC PROJECTS YOU CAN BUILD,** #0723-x, $4.55. Hi-fi headphone amp, auto tachometer, intercom, TV commercial killer, etc. Each project can be put together in one night with these simple instructions.

5. **BUILDING THE AMATEUR RADIO STATION,** #0709-4, $4.30. Complete construction of amateur radio station. Schematic and wiring diagrams and chassis layouts for Novice and General Class stations.

6. **COLOR TELEVISION: Principles and Servicing,** #5929-9, $5.70. Receiver troubleshooting and servicing techniques. Charts listing trouble symptoms, causes, and remedies. Instructions for using the latest test instruments.

7. **HOW TO BUILD A LOW-COST LASER,** #5934-5, $4.55. How to build a laser at home, from readily available parts, for approximately $100! Includes a collection of laser experiments.

8. **BENCH-TESTED COMMUNICATIONS PROJECTS,** #0788-4, $3.75. Telephone broadcaster, party line listening, canned light music, rollaway ham shack, VHF extender, 6-meter solid-state transmitter, etc.

9. **HOW TO BUILD A WORKING DIGITAL COMPUTER,** #0748-5, $5.45. Step-by-step instructions for building an inexpensive digital computer simulator. Includes parts lists, theory of operation, and fundamental programming techniques for solving simple problems.

10. **110 THYRISTOR PROJECTS USING SCR'S AND TRIACS,** #5096-8, $4.30. Burglar, fire and water level alarms, power control devices for electric tools, and other useful projects built and fully evaluated by the author.

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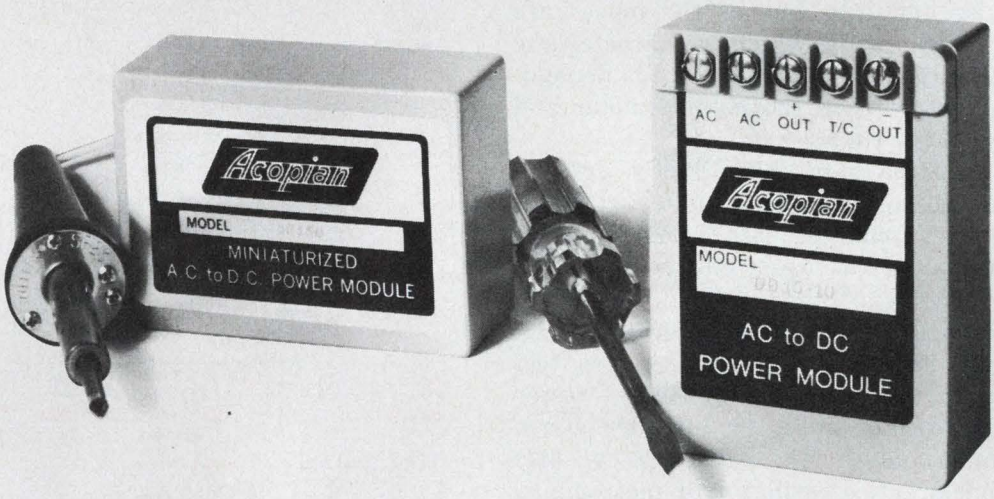

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300	3.5 x 2.5 x 1.63	105	DB15-30
350	3.5 x 2.5 x 1.63	110	DB15-35
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INFORMATION RETRIEVAL NUMBER 42

Ideas for Design

Inexpensive TTL chip makes a versatile oscillator circuit

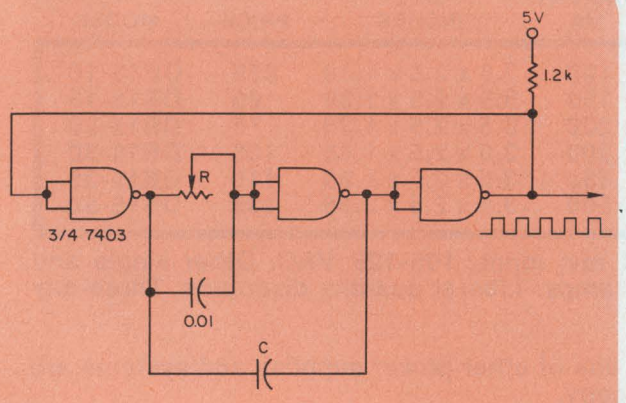
Three of the four gates in an SN7403 chip can be connected with a few RC elements to construct a free-running, adjustable square-wave generator (Fig. 1a). The SN7403 is an inexpensive TTL chip with four open-collector, two-input NAND gates.

The repetition rate of the generator can cover a range from a few pulses per second to megahertz. The rise and fall time of the pulses are measured in nanoseconds, which is characteristic of the TTL family. The repetition rate is dependent on the values of both the potentiometer and the capacitor (Fig. 1b).

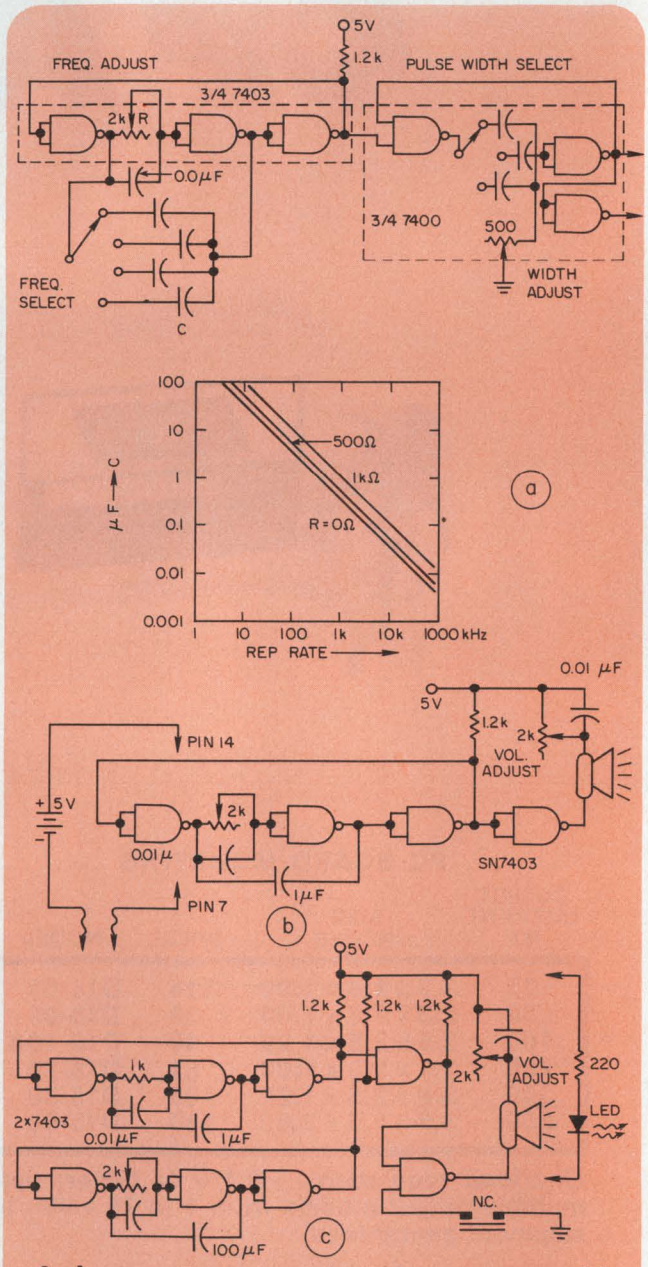
The open-collector gate can directly drive a low-power speaker of the type used in pocket radios. And when combined with a LED, the circuit also can give useful visual effects for use in the lab.

Possible applications for the generator (Fig. 2) include use as a low-cost square-wave test generator (a) or as a circuit continuity tester (b) or circuit-breaker audio or intruder alarm (c). With small changes, the generator can also serve as a code-practice oscillator or metronome.

Stamatios V. Kartalopoulos, The University of Toledo, Dept. of Electrical Engineering, Toledo, OH 43606. CIRCLE NO. 311



1. **The basic oscillator,** when combined with a low-power loudspeaker or LED, has many uses.



2. **A square-wave generator** (a) can cover a 4:1 range with a 2-kΩ variable resistor R. And frequencies from less than 1 kHz to over 1 MHz are obtained by changes in capacitor C. The generator, with small modifications, can serve as a circuit tester (b) or an alarm (c).

The sub-priced subminiature: TRW/Cinch Burgun-D* connector

You'll have to look closely to tell a TRW/Cinch Burgun-D* Subminiature Connector from the other four types of D-Subminiatures in our line. But there's a whale of a difference in price.

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Don't fish for additional information on TRW/Cinch Burgun-D's, phone your nearest stocking distributor or TRW/Cinch Connectors, 1501 Morse Avenue, Elk Grove Village, Illinois, 60007, (312) 439-8800.

*Trade Mark ITT Cannon CC-7503

TRW® CINCH CONNECTORS

INFORMATION RETRIEVAL NUMBER 43

Analog-input multiplier/divider provides 3-½-digit output

A simple two-quadrant multiplier/divider accepts analog inputs and provides a 3-1/2-digit BCD output. It features input impedances of 10 MΩ or greater on all inputs. The circuit uses only three ICs and is easy to adjust. The accuracy in the multiplier mode is 0.2%, and for the combined multiplication/division operation (XY·k/Z) is better than 0.5%.

Input Z is scaled by a factor k = 0.6, and it can be used as reference for the multiplication (XY) or as a one-decade divider with a range of 0.6 to 6.0 V. Input X can range from + 2 to 2 V, and Y must be limited to negative voltages with a 1-V maximum.

An LD110/111 a/d converter chip set, IC_1 and IC_3, forms two-thirds of this circuit. The additional LD111, IC_2, converts it to a multiplier/divider (Fig. 1). In IC_1, the X analog input determines the average height, V_{in}, of pulses of fixed width, T_m, which are digitized by IC_3. And IC_2 effectively modulates T_m with − Y·k/Z analog voltages to provide a digital output equal to XY·k/Z. The modulation is performed with a gate circuit external to IC_1.

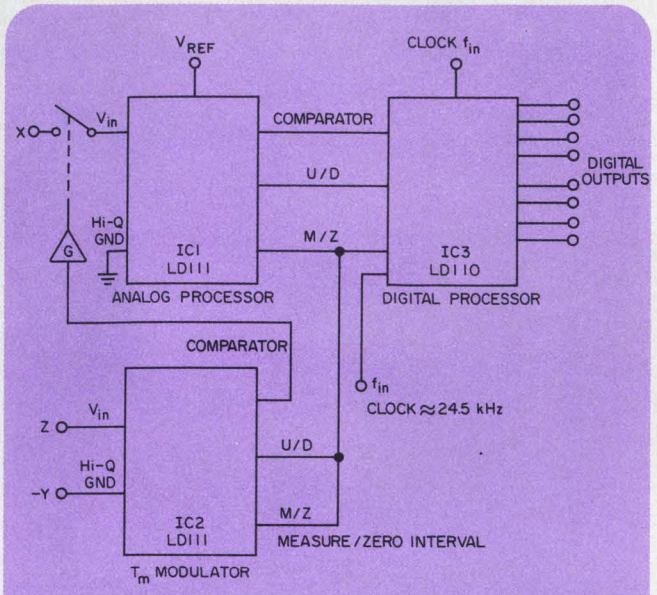
In the analog-processor circuit, IC_1, signal X is applied to an integrator during T_m—the so-called measurement interval—which alternates with a time interval called the fixed-zero interval that equals $2048/f_{in}$ (Fig. 2). Module IC_2 uses its integrating amplifier in a dual-ramp mode. The Y signal causes the IC_2 integrator to ramp up during the zero interval, and the Z signal causes it to ramp down during the measurement interval.

When the down slope reaches a comparator threshold, the signal path between the analog input X and IC_1 is opened by the 3N164 analog gate. Thus the pulse width of T_m is, in effect, modulated by the variable ratio − Y·k/Z.

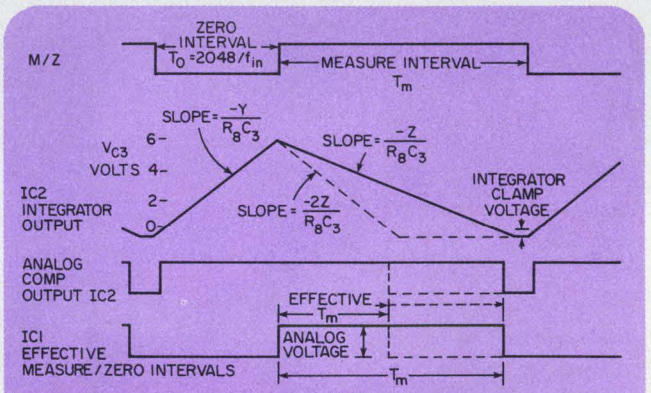
To obtain the 0.2% accuracy, four calibration steps are needed (Fig. 3):

1. Apply X = 2 V, Z = 0.6 V and Y ≅ − 0.9 V and adjust the full scale trimmer, R_9, so the circuit output is equal to − 2Y volts.
2. Keep voltage on X and Z, as in step 1, and apply approximately 0.02 V to the Y input. Adjust the zero trimmer, R_{10}, so the circuit output reads the new value of 2Y volts.
3. Repeat step 1.
4. Repeat step 2.

The combined resistance of R_9 and zero-trimmer R_{10} provides a small amount of charge to the IC_2 integrator, because the integrator is clamped below 0 V.



1. **This multiplier/divider** consists of a simple a/d converter plus a modulator. IC_1 and IC_3 form the converter. IC_2 is the modulator.



2. **The −Y/Z factor** controls the effective T_m value of IC_1.

If an input voltage, U, is applied to pin 2 of IC_1 and V_{ref} is made a variable, W, the transfer function would become

$$\frac{\frac{XY}{Z}\ 2U}{W} \cdot 4096 \cdot \frac{R_1}{R_2}.$$

This modification can provide extra flexibility for data reduction without need for additional circuitry.

Gary Grandbois, Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, CA 95054.

CIRCLE No. 312

(continued on page 94)

Gates introduces the future in energy cells.

There's now a new energy source that's a superb alternative: Rechargeable, sealed lead-acid batteries from Gates.

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Gates Energy Cells offer great packaging flexibility. In fact, our individual cell availability allows you to choose your own specific voltage (in 2-volt increments) and current, as well as configuration.

Just as important as what Gates Energy Cells have to offer is what they don't have to offer. Like outgassing problems. Or cell reversal. Or "memory" problems.

Because Gates Energy Cells are made from low-cost materials that are readily available, they're very high in watt-hr. per dollar value. Which means that if you specify them, you'll probably save your company more than a few dollars. And make yourself into something of a hero in the bargain.

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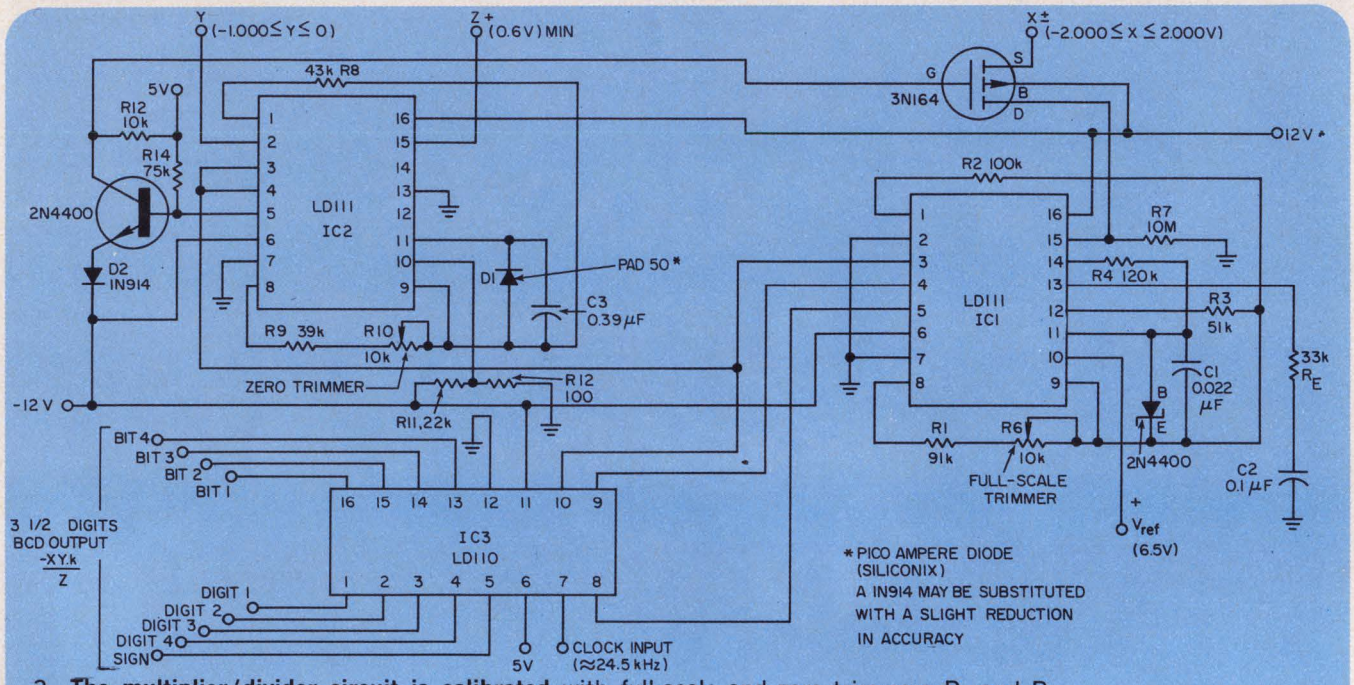


3. **The multiplier/divider circuit is calibrated** with full-scale and zero trimmers R_6 and R_{10}.

Audible alarm tells when car lights are on and ignition switch is off

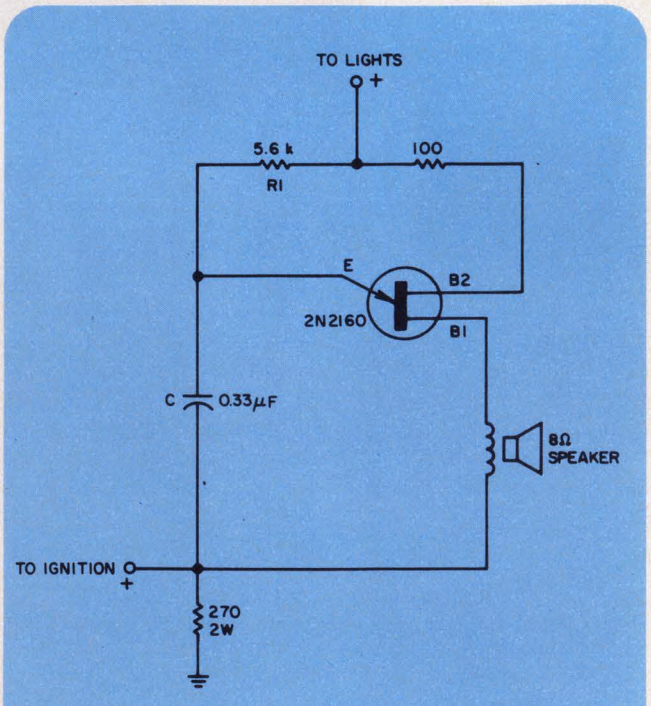
A reliable solid-state circuit provides an audible warning whenever the automobile ignition is off and the headlights or parking lights are on.

The circuit uses a unijunction transistor oscillator that is biased on when the ignition is off and the lights are on. The oscillator drives an 8-Ω speaker. The time constant of R_1C determines the frequency of oscillation. Many unijunction transistors will work in this circuit, including the 2N2160, 2N1671 and TIS43. The circuit, as shown, is intended only for vehicles with the battery negative at ground.

The input that goes to the lights can be connected at the light switch or to the instrument-panel fuse terminal. The input from the ignition can be connected to the ignition switch or to any fuse that is live only when the ignition switch is on, such as the radio or heater fuses. In most vehicles the fuse panel is more accessible than the switches. Solderless connections to the fuses can be made if wires are wrapped around the load end of the fuses and the fuse clips are used to hold the wires in place.

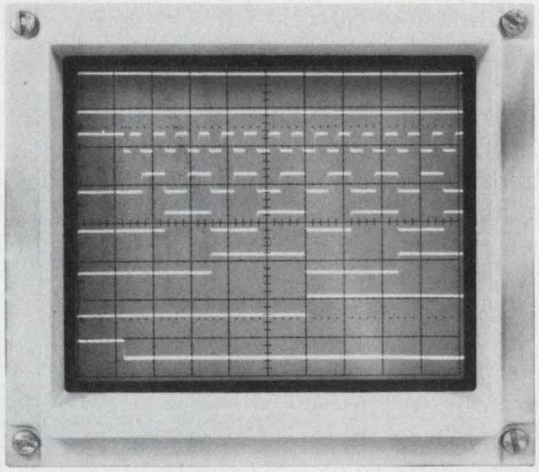
Jack Elias, Senior Development Engineer, Honeywell Inc., 1100 Virginia Dr., Fort Washington, PA 19034.

CIRCLE NO. 313



Lights-on alarm circuit derives positive source voltage from the vehicle's light circuit. A positive bias from the ignition switch keeps the circuit off.

If your bench scope says your ECL logic looks like this...



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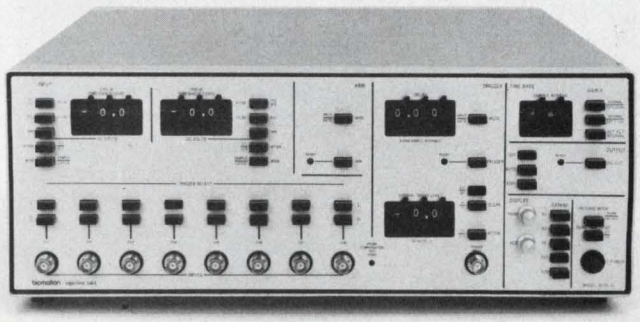
It's the new-and-faster way to turn your ordinary bench scope into a data stream display. It records 8 data channels at once and presents them in the same format you're used to seeing on data sheets.

The 8100-D features built-in combinatory logic setting to help you isolate your problem event *fast*. It has a big memory, too; can store up to 2,048 8-bit data words, including the often critical information that lies *just ahead* of the triggering event. And it also provides digital output for computer analysis or mass storage.

The 8100-D is a piece of diagnostic instrumentation that circuit designers and troubleshooters have been asking us for. We will be glad to send you all the splendid details. Just use the reader service number or get in touch with us directly. Biomation, 10411 Bubb Road, Cupertino, CA 95014. (408) 255-9500. TWX 910 338 0226.



biomation

INFORMATION RETRIEVAL NUMBER 45

Wide-range voltage-to-frequency converter uses only one dual op-amp IC

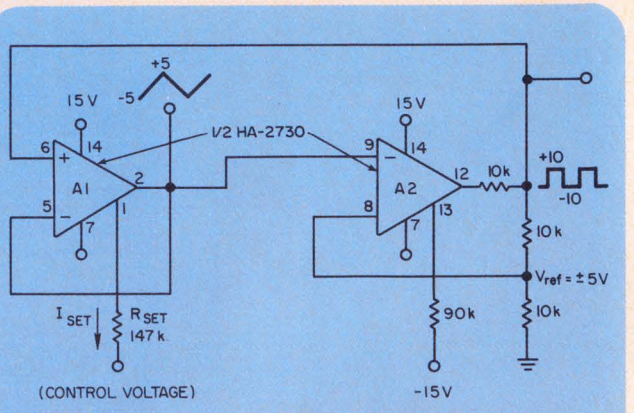
A voltage-to-frequency converter (Fig. 1) can be built with only one IC, five resistors and, surprisingly, no external capacitors. The cost: less than $15.

The circuit uses a programmable op amp, whose slew rate and other parameters vary linearly with a so-called set current (Fig. 2).

Several such programmable op amps are available. Of these, the HA2730—a two-amplifier monolithic chip with independent programming ports for each amplifier—can achieve 4-to-5 decades of programming range.

The converter circuit uses one amplifier, A_1, as a slewing amplifier and the other, A_2, as a comparator function. The output of A_2 applies large positive and negative voltage steps to A_1 to alternate the direction of A_1's output waveform. Amplifier A_2's positive-feedback network produces hysteresis, which controls the absolute value of A_1's output. And for optimum step response A_2's set current to pin 13 is statically programmed for maximum slew rate.

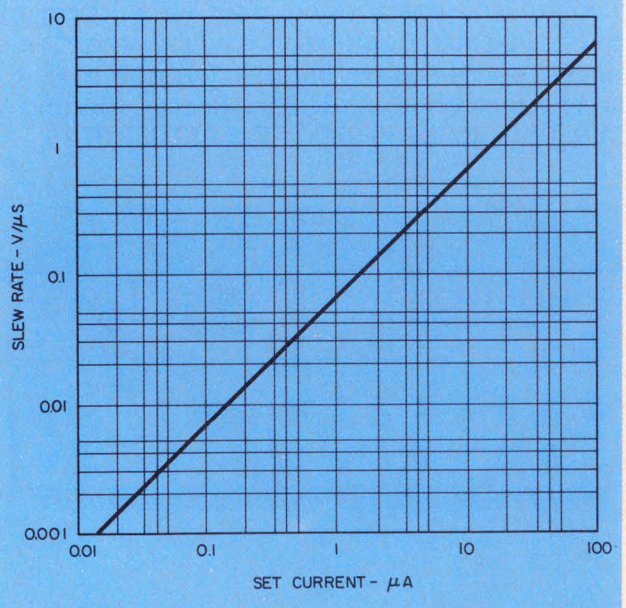
The control voltage, V_c, however, determines A_1's slew rate. And because A_1's output voltage swing is constant, modulation of its set current results in direct control of the circuit's frequency. Actually, A_1's internal compensation capacitor acts as the timing component. And an internal bipolar current source, whose current magnitude is directly proportional to the set current of pin 1, then determines the charge-discharge rate.



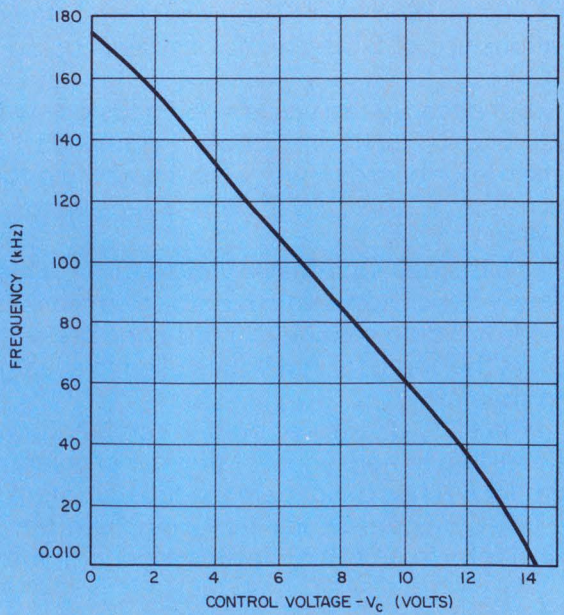
1. **Voltage-to-frequency converter** uses no external timing capacitor.

An experimentally determined curve (Fig. 3) shows a conversion nonlinearity of less than ±0.03% of full scale over 3 decades and ±1.5% of full scale over 4.3 decades of frequency. The frequency range is adjustable by a change in the resistance of R_{set}. Amplifier A_1's output

(continued on page 98)

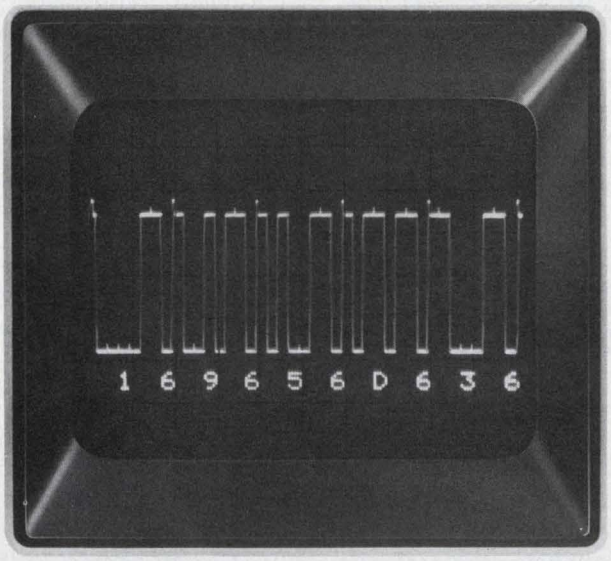


2. **The op-amp's slew rate varies in proportion to the set current** into pin 1 on A_1.



3. **A range of 4.3 decades of frequency control** is attained with this simple circuit.

And now, for debugging serial data,



Biomation brings you the 110-D.

Not just a new product. An entirely new kind of data recorder. From the folks who brought you the Glitch Fixer.

The best way to tell you about the Biomation 110-D's dramatic new way of debugging serial data is to show you the memo from our own engineering staff that sold us on the concept.

Purpose

Designed to monitor, store, and display serial data, either synchronously or asynchronously. Major uses as follows:

1. High speed synchronous data (up to 10MHz)

- Rotating memories (drums, disks, floppy disks).
- Digital tape decks—up to and including high performance 3200 bpi reel-to-reel decks.

110-D will "snapshot" data and display it free of the jitter normally seen when using scope.

- Shift register and delay line memories (MOS shift registers, magnetostrictive delay lines, glass delay lines, etc. such as found in CRT-type data communications terminals and other video-refresh applications.

110-D will snapshot changing data patterns and allow stored analysis, otherwise impossible with scope.

2. Low speed synchronous data

110-D utilizes static RAMs to prevent data loss at low speeds.

- Synchronous modem channels—data between modem and terminal, between modem and computer front-end, etc. Includes Bell 201-type modems and other proprietary synchronous modems.

Using a scope has same problems as above: changing data patterns and channel jitter makes analysis difficult or impossible.

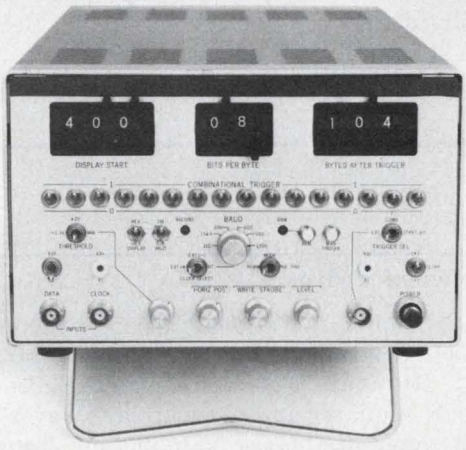
3. Low speed asynchronous data

- Asynchronous modem channels—Bell 103- and 202-type modems and equivalent units from independent suppliers. **110-D has switchable internal clock for sampling data at normal data baud rates.** Also has start-bit validation logic, for "framing" the data in start-stop data.
- RS232 data channels—includes nearly all computer terminals, both video and hard-copy. Teletype KSR-33 and Dataspeed 40 terminal are typical examples.

Asynchronous data is not only changing and jittering, but is coming in asynchronous bursts. The 110-D will time-compress the data to permit whole message groups to be easily observed.

Data from low speed computer peripherals—printers, card readers, card punches, paper-tape readers, etc. are often transmitted serially between them and the host main-frame. The 110-D is useful in developing and trouble-shooting these peripherals.

There isn't enough room on this page to give you the whole story. Please call or write us for all the technical data and for a "hands-on" demonstration of a whole new solution to serial data problems. Biomation, 10411 Bubb Road, Cupertino, CA 95014. (408) 255-9500. TWX 910 338 0226.



biomation

INFORMATION RETRIEVAL NUMBER 46

swing can be varied by a change in positive feedback in A_2. This change also affects the frequency range.

Additional circuit specs include an input voltage range of ±15 V, outputs of ±5-V-triangular and ±10-V-square waves, an input control response of 5 μs and an FM bandwidth of 60 kHz.

Ernie Thibodeaux, Senior Applications Engineer, Harris Semiconductor, P.O. Box 883, Melbourne, FL 32901. CIRCLE NO. 314

Build a linear, high-frequency detector with low offset and wide dynamic range

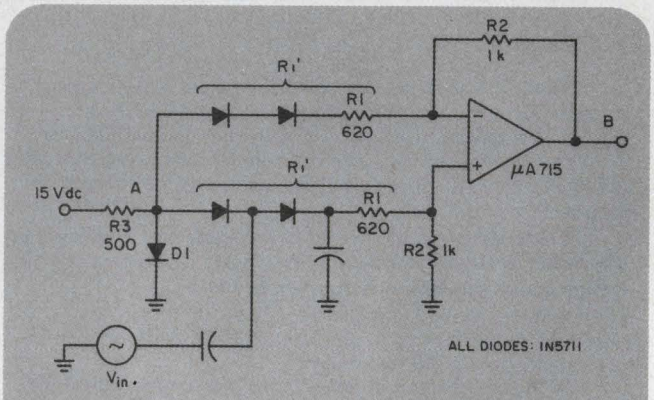
To get low dc offset drift over a wide temperature range in a detector circuit, plus good linearity, the diodes need not be used in the feedback loop. Thus the frequency range of the detector circuit is not limited by the gain-bandwidth of the op amp, but rather mostly by capacitance associated with the diodes. Such a detector circuit (see figure) can handle up to 5-MHz video bandwidth with a simple diode balancing and biasing technique.

The circuit's op amp inverting and noninverting gains are the same. Therefore input offset voltages from diode-resistance variations with temperature are amplified equally by both inputs. The result is very little net-offset change at the output.

A plot of change in output offset voltage vs temperature for various output levels shows that for output levels of less than 100 mV, where output offset is usually critical, offsets are held to less than 3 mV over a 50-C temperature range.

Good linearity is achieved by the use of low forward-drop, hot-carrier diodes that have been biased on slightly by the voltage across D_1. Better than 3-dB linearity can be obtained over a 50-dB dynamic range from 25 to 70 C.

Christopher B. Schwerdt, Receiver Design Engineer, and Camie S. Marie, Westinghouse Electric Corp., Friendship International Airport, Box 746, Baltimore, MD 21203. CIRCLE NO. 315



Linear detector provides low offset over a wide temperature range for output levels to 100 mV.

IFD Winner of February 1, 1975

Robert C. Dobkin, National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. His idea "Function Generator Produces Sine, Square and Triangular Waves" has been voted the Most Valuable of Issue Award.

Vote for the best Idea in this issue by circling the number for your selection on the Information Retrieval Card at the back of this issue.

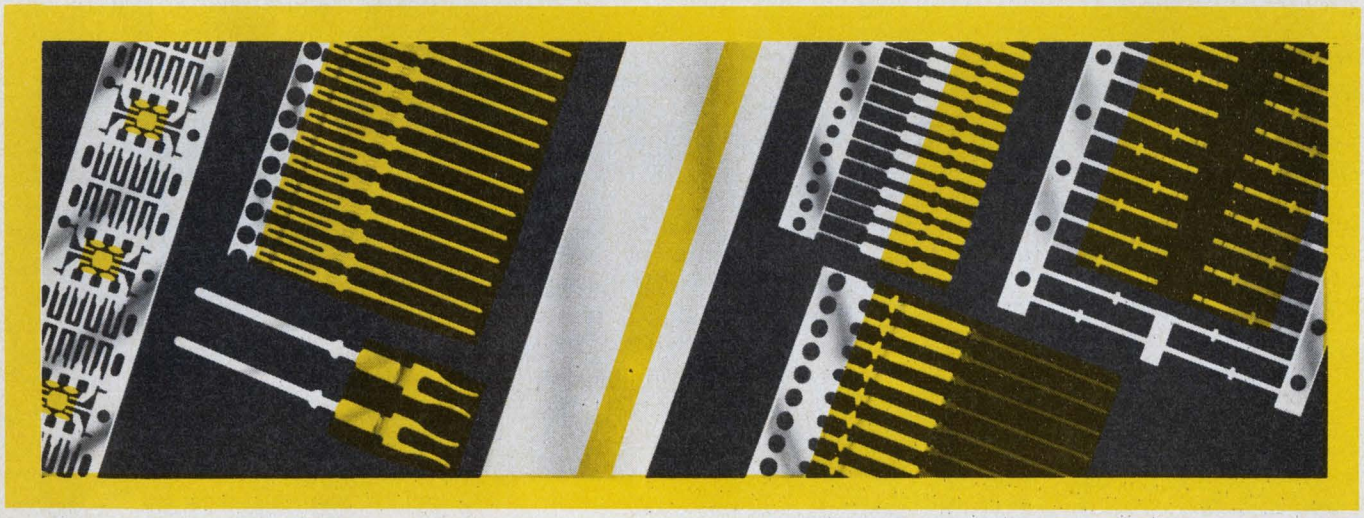
SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas for Design editor. Ideas can only be considered for publication if they are submitted exclusively to ELECTRONIC DESIGN. You will receive $20 for each published idea, $30 more if it is voted best of issue by our readers. The best-of-issue winners become eligible for the Idea of the Year award of $1000.

Save 40 to 60% on our "Gold Plate Special"

Nine times out of ten, barrel plating electronic contacts with gold or other precious metals means waste. Waste of material. Waste of money.

Our special SELECT-O-PLATE process, on the other hand, means practically no waste and money savings of 40 to 60%. SELECT-O-PLATE deposits precious metals (in thicknesses as thin as .000005") precisely where function requires and no place else; on the tips of contact points, or the center of lead frames, or on continuous coil-stripe or spot. We take every possible step to assure that plating quality matches your specifications. And your product's performance reliability either stays the same or improves.

There's a great deal more to tell you about SELECT-O-PLATE and how it can benefit your profit picture. If you'll call us or drop us a line, we'll send it to you.



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INFORMATION RETRIEVAL NUMBER 47

International Technology

Water pump driven by solar-cell panel

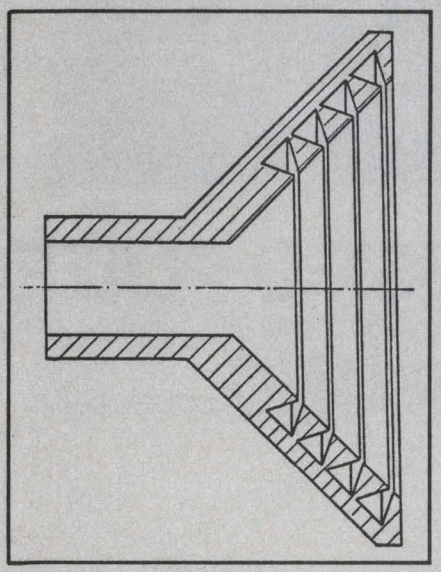
To demonstrate that solar cells can be used to drive mechanical equipment, a solar-energy water pump at the Laboratories d'Electronique et de Physique Appliquee at Limeil-Brevannes, near Paris, was built in co-operation with the Philips research organization.

A solar-cell panel, which is 5 m^2, delivers a maximum of 300 W to power an experimental pump that can raise water from a depth of 15 m. This is a situation comparable with that prevailing in the dry areas of many countries. With 3000 hours of sun per year, the pump is expected to deliver 1000 cubic meters of water a year for each square meter of solar panel. In the laboratory the pump delivered about half this amount.

This project also developed a new concept of handling power fluctuations in solar-cell installations. The short-term energy storage uses storage batteries, while the long-term storage uses the potential energy of water pumped into a tank. Solar cells have previously been used to provide power for isolated electronic equipment, such as radio and television relay stations and beacons for air traffic control.

Bandwidth increased on waveguide horn

A new slot pattern that increases the bandwidth of a waveguide horn for the fast-wave balanced-hybrid mode (HE_{11}) has been developed by Eljim in Nes Ziona, Israel.



The design, using tapered slots (see illustration), has demonstrated a low standing-wave ratio from 7.5 to 18 GHz and a bandwidth of 2.4:1. This is in contrast with the usual bandwidth of 2:1 for a shuttered horn. In theory, the bandwidth can be 3:1. The researchers intend to extend the band characteristics of the feed section behind the horn in an effort to achieve a practical 3:1 design.

Fused-silica device replaces lithium-niobate

Fused silica, a new substrate material for surface acoustic-wave devices, has been used by the Thomson-CSF ASM Div., Cagnes-sur-Mer, France, in a reflective-array signal compressor incorporating edge-bonded transducers.

The fused silica is low in cost, isotropic in nature and can easily be machined. It compares favorably with lithium niobate, the usual material used for this application.

By profiling the depth of grooves that form the reflective grating of the surface-wave device, a flat amplitude response has been obtained over a 60-MHz bandwidth at a 100-MHz center frequency.

Thomson researchers have determined that edge-bonded transducers, which generate the Rayleigh waves on the silica substrate, have a low conversion loss that makes these transducers competitive with interdigital types.

Liquid crystal stores high-contrast images

High-resolution, high-contrast images have been reproduced and stored for up to six months on a smectic liquid-crystal display at the Thomson-CSF research laboratories in Orsay, France.

The image was stored in a 16 × 14-mm cell made up of a 10-μm film of smectic liquid crystal sandwiched between a 10-Ω-per-square of conductively coated, transparent glass. The smectic liquid crystal is one in which the material is initially in an anisotropic state but is charged to an isotropic state when heated locally—in this case, by a laser beam. Upon cooling, the cell acquires a stable, scattered anisotropic texture.

The image was impressed on the cell by scanning with an IR laser. The optical transmission of the beam-addressed point was controlled by variations in the voltage applied to the crystal. A continuous gray scale was reproduced. Total erasure was produced in less than 100 ms by application of an ac voltage to the cell.

Images have been synthesized on the cell by application of an amplitude-modulated, 40-kHz carrier voltage.

SIEMENS

Low profile relays

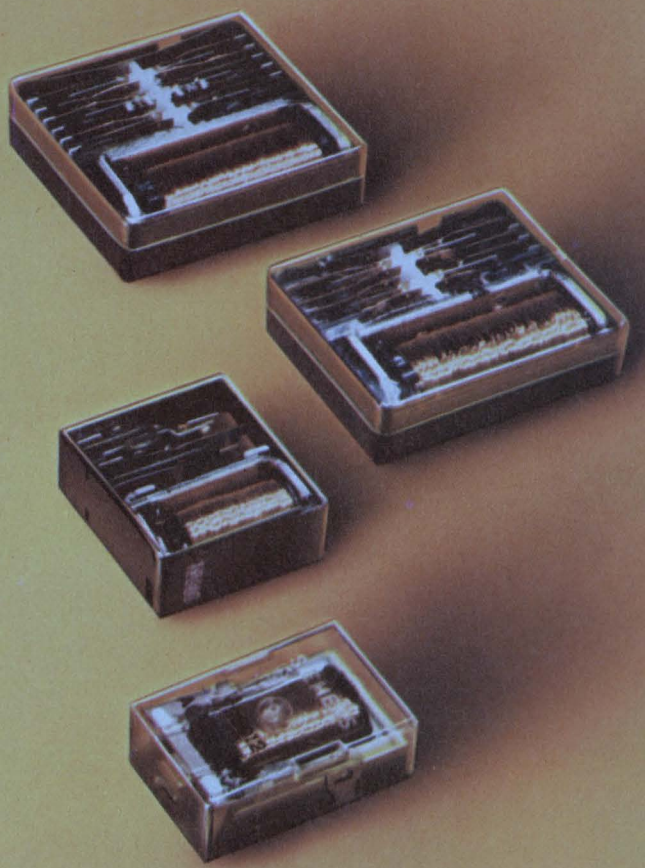
Space savings in a proven design.

Siemens low profile relays permit nearly double the PC board mounting density compared to standard height relays. And only the Siemens design covers the full range—1, 2, 4 and 6 PDT contacts, with a uniform height of only 0.4 inches. Space savings that add up to greater dollar savings through better cabinet utilization.

Bifurcated contacts (standard) of fail-safe design assure maximum reliability over a long electrical life. Millions in use over the past four years confirm this proven design. Typical applications include communications systems, data processing and automatic control systems.

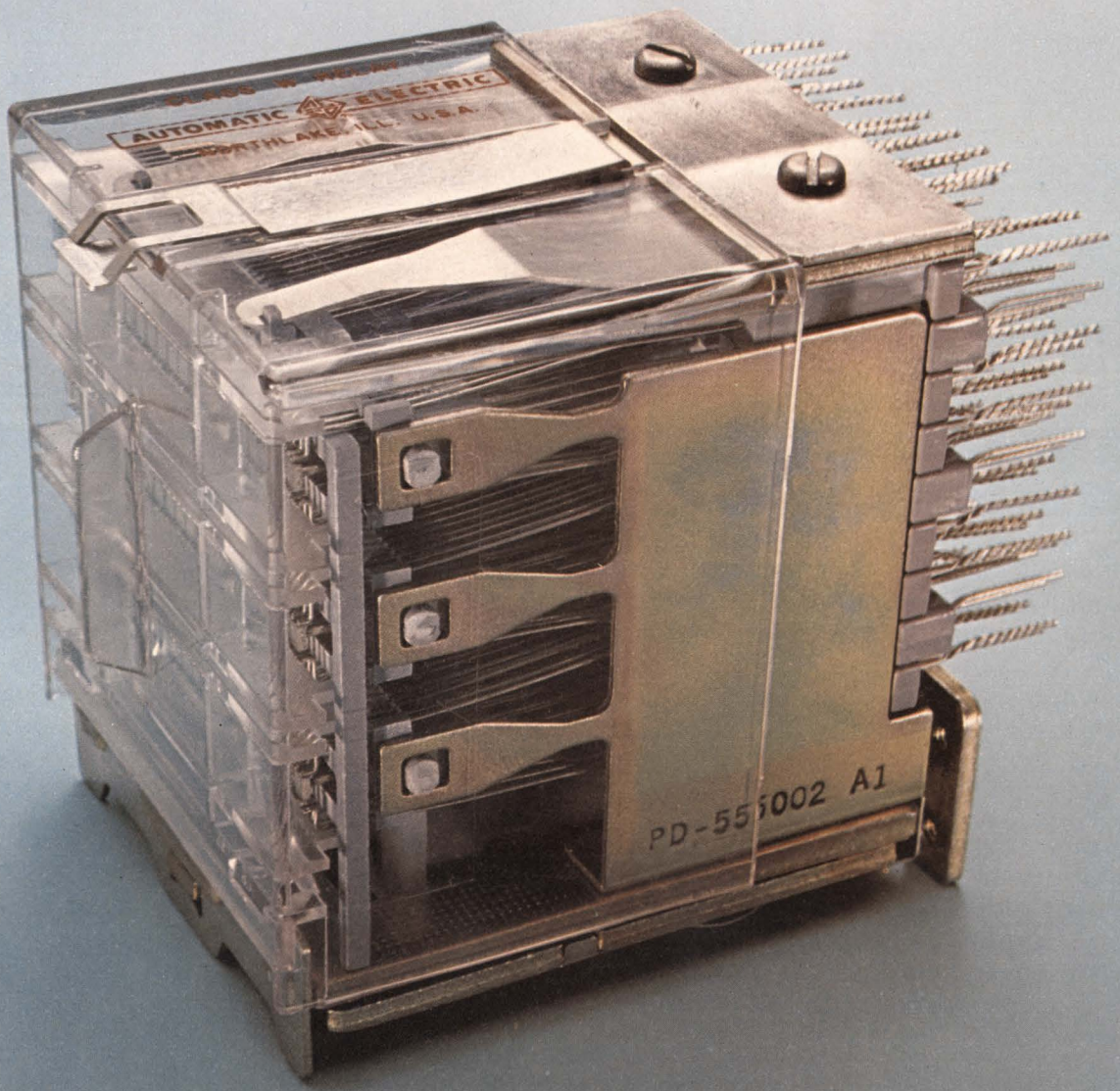
Delivery is assured as Siemens-designed low profile relays are available from more than one source.

Siemens low profile relays. Space savings in a proven design. Write for detailed literature.



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

Reliability is staggered steps and a hunk of DAP.



Over a billion operations from 51 poles.

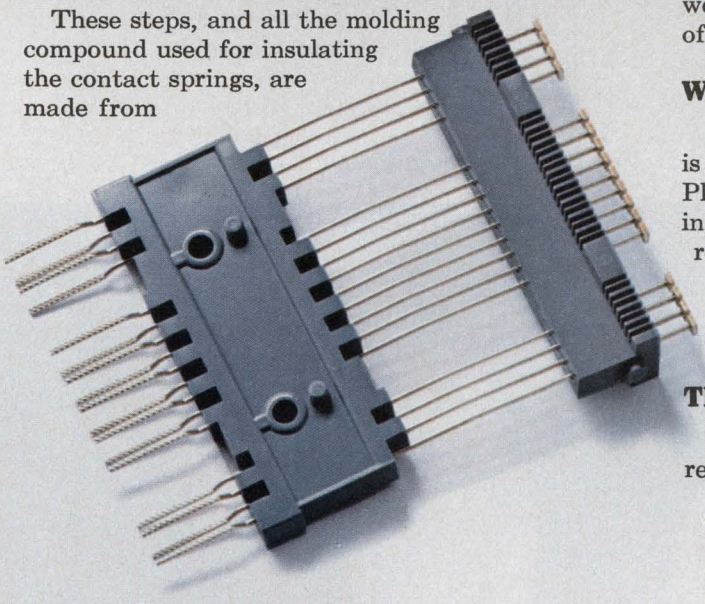
Our Class W wire-spring relay is different. In fact, there's nothing like it in the entire industry. Where else can you find a relay with 51 poles for transferring circuits and a mechanical life of more than a billion operations! That's about two and a half times the life of the best conventional relay around.

Another nice thing about our Class W is that it takes up a lot less space and costs less than using a bunch of other relays. That's because we build our Class W relay with one, two or three levels of contact assemblies, with 17 form C combinations per level. By the way, they're available with gold contacts for low-level switching.

Making it tough on creepage.

All those staggered steps you see on the side were put in to raise the breakdown voltage between terminals. These molded steps add extra creepage distance between the terminals. This really counts for high voltage testing, or when using our Class W in unfavorable ambient conditions.

These steps, and all the molding compound used for insulating the contact springs, are made from



diallyl phthalate. (They call it DAP for short.) It has great insulating properties and it wears like iron. Even if the humidity is high, you have excellent protection.

Redundancy—two springs are better than one.

Each of our long wire-spring contacts has an independent twin with the same function. One tiny particle of dust could prevent contact on other relays. Not with our Class W. You can be sure one of the twins will function. That's back-up reliability.

The twin contacts are twisted together at the terminal end. Then we give them a spanking (you might call it swedging) to provide solderless wrap.

We're for independence.

Our springs are longer, because the longer the spring, the more independent they get. And the better contact they make. Don't forget, the wire-spring relay is the most reliable way to get a permissive make or break contact. You can rely on it.

The middle contact springs have to be stationary. To make sure they stay that way forever, we actually mold them between two thick pieces of DAP on both ends. Just try to move one.

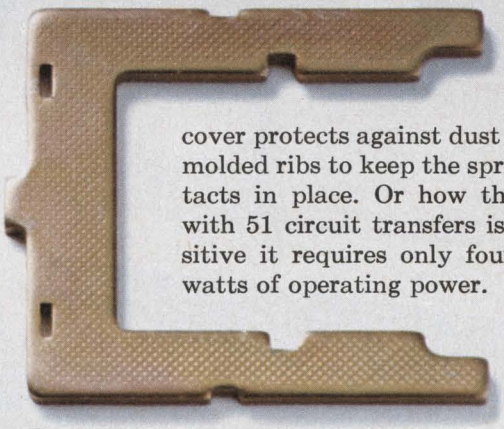
When we say flat, it's flat.

Each frame, banged out by a gigantic machine is extra thick and extra flat. Then they're planished. Planishing is another step we go through in forming the frame to add strength and stability by relieving surface strain.

We've made our spring-loaded pile-up clamp extra thick, too. Once it's tightened down, the whole pile-up is nice and tight, and stays tight.

There's more.

We could tell you a lot more about our Class W relays. Like how the tough high-temp molded



cover protects against dust and has molded ribs to keep the spring contacts in place. Or how this relay with 51 circuit transfers is so sensitive it requires only four to six watts of operating power.

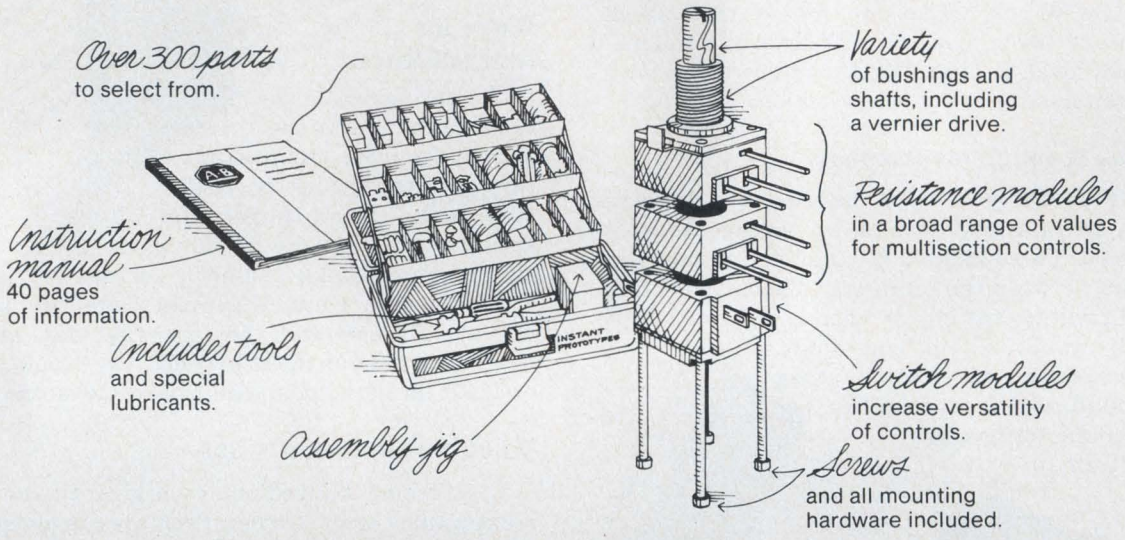
But why don't you let us prove how much reliability we put into our Class W? We'll be waiting to hear from you. Government Industrial Sales Division, GTE Automatic Electric, Northlake, Illinois 60164.

GTE AUTOMATIC ELECTRIC

INFORMATION RETRIEVAL NUMBER 49

Assemble prototype pots instantly.

New MOD POT Instant Prototypes equips you to put together virtually any pot you could want. And when you're ready for production, our distributors can quickly supply volume quantities to factory standards. Order a MPIP from your Allen-Bradley electronics distributor. $97.50 apiece. Or, ask him for complete information on MOD POT . . . publication 5217.



Quality in the best tradition.

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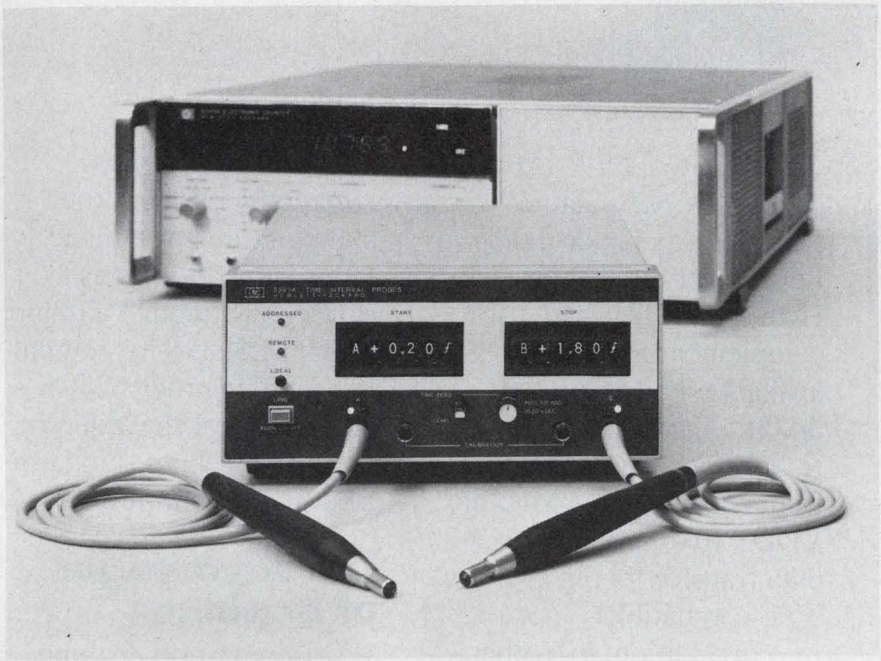
INFORMATION RETRIEVAL NUMBER 50

EC104

New Products

Active-probe system adds new dimension to time-interval studies



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. $1500; 30-60 days.

With a new piece of measurement gear, you bring a time-interval meter or counter to the signal, rather than the other way around. Hewlett-Packard's Time-Interval Probes, Model 5363A, sits between a signal and a counter and shrinks trigger-level errors, cuts signal loading and distortion, stretches the counter's dynamic range and brings other benefits.

It all adds up to more accurate measurements of rise time, propagation delay, pulse width and other time intervals.

The instrument consists of two active probes and what HP calls "a support box." The probes hook to your signals, and the box delivers outputs to your counter or scope. With this arrangement, the signal sees a high-impedance, low-capacitance front end (1 MΩ/10 pF), while the counter looks at a 50-Ω transmission line coming from the support box.

On the box are two digital thumbwheels that let you move the trigger levels up and down along the input signals in 10-mV steps from −9.99 to 9.99 V. You know that the trigger point corresponds to the dial setting because the 5363A calibrates itself—all you do is flip a CAL switch.

The unit runs through the calibration process in about 1 s, then lights an indicator to signal that it's finished. If you change the slope or the probe for some reason, just hit the CAL switch again.

Each thumbwheel can be set to work with either probe so you can use one wheel for "start" and the other for "stop" to make A-B measurements. Or you can use both thumbwheels with one probe to accurately measure a signal's transition times. Thus counters that couldn't do so before, can now measure rise and fall times. Signal slope—positive or negative-going—is also selected with the front thumbwheels.

Another feature of the HP 5363A—one that eliminates one source of error in start-stop measurements—is variable time delay. By insertion of a variable delay in the stop channel, with the delay adjustable by ±2 ns, you can dial out unwanted differential delays. Or you can use the delay to add offset so that you can measure down to zero ns.

For an extra $250, you can buy the HP interface bus option and let a processor or calculator control all of the 5363A's functions, except delay adjust. If the time-interval meter or counter is also programmable, you've got a complete time-interval system.

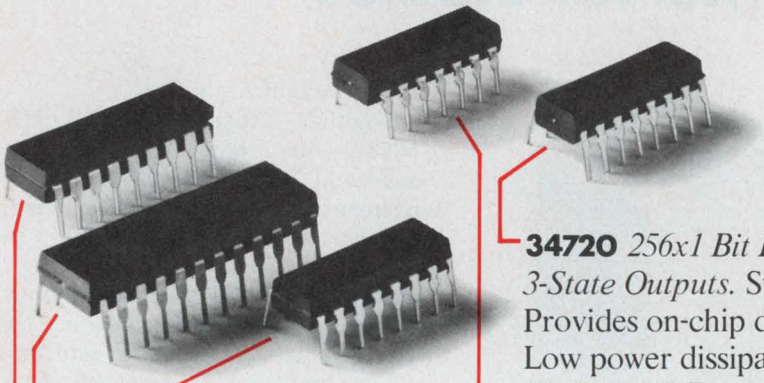
The Time-Interval Probes system isn't perfect, of course. Because of energy considerations, the input signal must remain above or below the trigger level for at least 5 ns. This limits the maximum input rate to 100 MHz. After calibration, the ambiguity in the trigger level is ±8 mV ±0.2 mV/°C.

Accuracy of the unit is the ambiguity divided by the input slew rate (at the trigger point) plus 1 ns. The accuracy spec doesn't hold in the regions within 8% from the signal's top or bottom or within 100 mV from the top or bottom, whichever is greater. With both thumbwheels set to the same value, the trigger points will be within ±3 mV of each other in a differential measurement.

Rise time of the HP 5363A is 1 ns. Counter outputs swing from −0.5 to +0.5 V into 50 Ω, with less than 2-ns rise time. Trigger-level outputs—useful for oscilloscope observations—are dc values that equal the level setting plus the ambiguity plus or minus 75 mV.

CIRCLE NO. 301

Introducing 5 new LSI reasons to choose Isoplanar CMOS.



Now you can get five new LSI CMOS devices from Fairchild you just can't get from anyone else.

All five are the product of Fairchild's Isoplanar process.

And all five are available in quantity today:

34702 *Programmable Bit Rate Generator.* Controls up to 8 transmission channels. Provides all 13 popular bit rates. Conforms to EIA RS-404. With on-chip pull-up circuitry. And TTL compatibility.

34703 *16x4 Parallel/Serial FIFO.* Provides serial or parallel input and output. With 3-state fully-buffered outputs. New slim 24-pin DIP. Expandable without any external logic.

34710 *16x4 Bit Clocked RAM with 3-State Output Register.* Features full buffering. Edge-triggered. Optimized for register stack operation.

34720 *256x1 Bit RAM with 3-State Outputs.* Static. Provides on-chip decoding. Low power dissipation. High-speed. True and complementary outputs available. Fully-buffered.

34731 *Quad 64-Bit Shift Register.* Handles shift frequencies up to 4 MHz at VDD=10V. Serial-to-serial data transfer. 14-pin package. TTL compatible.

In addition, five other LSI CMOS circuits will be available soon.

LSI, MSI or SSI. The choice is all yours.

If you like our new LSI, of course, you'll love our whole CMOS family.

Fact. We've got what you want. Fairchild offers all of the CMOS devices most popular today. Altogether, 65 devices available now in quantity.

Fact. We've got it your way. Ceramic and plastic DIP, Flatpaks, Chips, Commercial or Mil Spec with 38510 or our special Matrix VI processing. Any way you want it, we're ready to deliver it.

Fact. We're more compatible. While other manufacturers are busy redesigning their lines to catch up with our Fairchild 34000 Series, we're compatible with *all* other CMOS—and we've got the high performance and standardization you want *now.*

The advantages of Isoplanar.

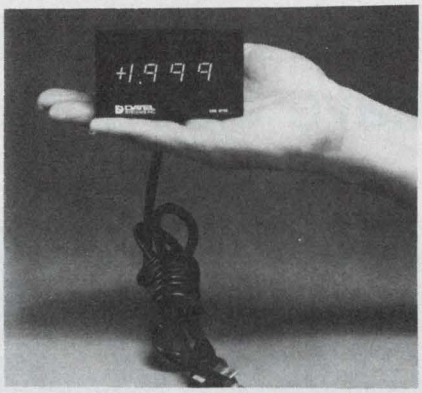
Here's another thing to remember.

LSI, MSI or even SSI—no matter what Fairchild CMOS you buy, you get the full advantages of our Isoplanar technology:

1. Highest guaranteed noise immunity.
2. Fully-standardized drive outputs for direct interface with low power TTL and low power Schottky TTL.
3. Propagation delay that's less dependent on loading—for increased system speeds.

And what makes it all extra nice, Fairchild's Isoplanar CMOS can replace any 4000 Series CMOS pin-for-pin.

Need a midget DPM? It's line powered



Datel Systems, 1020 Turnpike St., Canton, MA 02021. (617) 828-8000. $159.

This miniature 3-1/2-digit DPM, which runs on 115 V ac and is dubbed the Model DM-2115, is claimed to be the world's smallest line-powered DPM. The unit measures 1.75 × 2.25 × 3 in. and accepts true differential inputs within ±1.999 V. CMR is 70 dB up to 60 Hz and differential input impedance is 100 MΩ, min. Accuracy of the DM-2115 is within 0.05% of the reading, ±1 count, tempco is within 50 ppm/°C max or only five counts over the temperature range of 0 to 50 C. The unit has automatic polarity and overflow display and selectable decimal points. Power consumption is 3-1/3 W. Display is 0.43-in. LEDs.

CIRCLE NO. 304

Unit monitors transients on 3-phase lines

Micro Instrument Co., 580 Opper St., Escondido, CA 92025. (714) 746-2010. $3750; stock.

With three differential input circuits capable of either line-to-line or line-to-ground measurements, Model 520 SCR transient recorder measures peak transients and surges from dc to 1 μs. The new instrument has a fourth recording channel to give the user a selection of measurements including frequency, undervoltage and current. Accuracy is +3% fs. Signals are preconditioned through memory circuits and presented on a four-channel strip-chart recorder having speeds for 1, 7 or 30 days continuous monitoring.

CIRCLE NO. 305

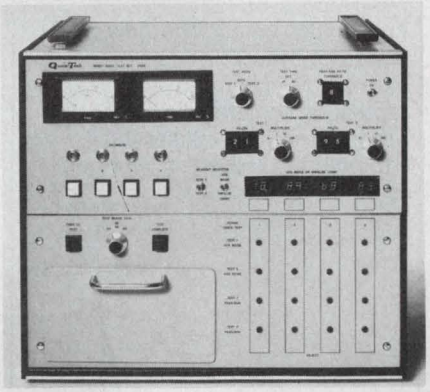
6-digit unit counts directly to 600 MHz

Ballantine Labs, P.O. Box 97, Boonton, NJ 07005. (201) 335-0900. $795; 2-4 wks.

Model 5760A 6-digit counter weighs only 6-1/2 lb. and direct counts to beyond 600 MHz, said to at least halve the time required for full resolution. The display (0.43-in., 7-segment LEDs) holds the counter's last reading while the next one is being made. The high-impedance input (1 MΩ/25 pF) covers the range from 10 Hz to 180 MHz with a sensitivity of 35 mV rms up to 40 MHz, increasing to 100 mV rms at 180 MHz. The 50-Ω input is used from 10 to 600 MHz with a sensitivity of 35 mV rms up to 400 MHz and 65 mV rms up through 600 MHz.

CIRCLE NO. 306

Burst noise test set has 4 input channels

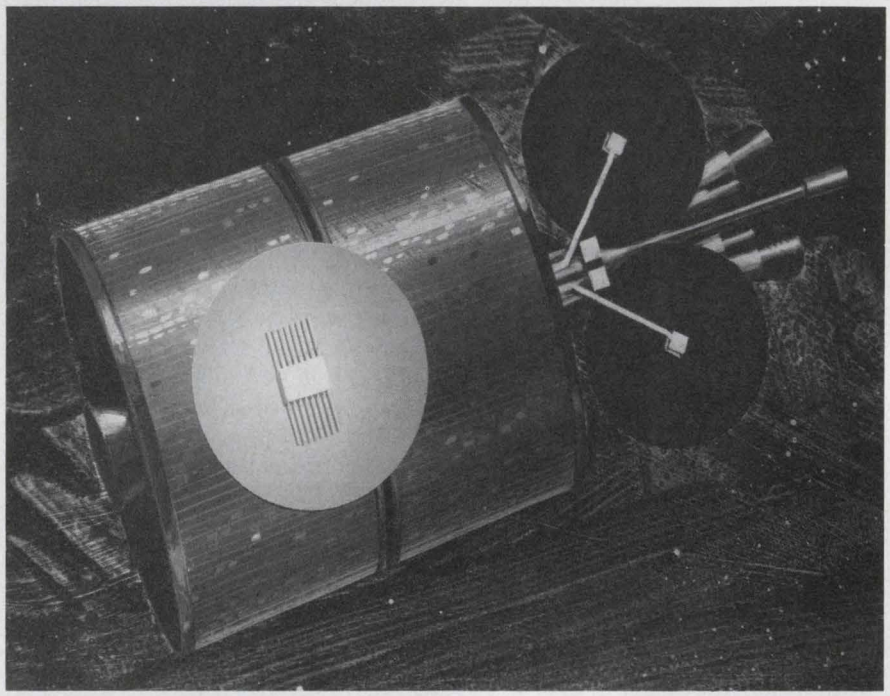


Quan-Tech Div. of Scientific-Atlanta, Randolph Park West, Route #10, Randolph Township, NJ 07801. (201) 887-5508. $9700; 12 wk.

The Model 2494 burst (popcorn) noise test set detects the presence of "popcorn" noise. It provides the threshold circuitry needed to segregate units on the basis of average noise voltage levels as well as peak voltage to average voltage ratio. Since the detection of burst noise requires a relatively long observation period, the 2494 is designed to measure four devices simultaneously in order to provide reasonable operator productivity. In addition to the GO, NO-GO information, a two-digit LED readout reads average noise voltage or the number of times the noise voltage exceeds the ratio threshold for each of the four test channels.

CIRCLE NO. 307

Data-communication ICs have 500-MHz bandwidth



Motorola Semiconductor Products, 5005 E. McDowell Rd., Phoenix, AZ 85008. (602) 244-6900. See text: stock.

Whereas propagation delay and toggle rate have always been the key specs defining the speed of digital ICs, bandwidth becomes important if the application is data communications. The first logic-function ICs for data communications are now available from Motorola. They all have a bandwidth of at least 500 MHz. Bandwidth here is defined as the highest rep-rate signal that a circuit can pass while maintaining a specified minimum output logic swing.

Called the MC1601-1605, the five chips are all compatible with both the MECL III and MECL 10K logic families. The 1601, 1602 and 1603 are multiple-input OR/NOR gates. They have typical rise and fall times of 0.75 ns. The propagation delay for all three is also 0.75 ns, typical. Power dissipation ranges from 600 mW for the 1601 down to 320 mW for the 1603.

Similar rise and fall times and propagation delays hold for the MC1604, a triple line receiver. Dissipation runs 460 mW, and, as with the three other chips, the 500-MHz bandwidth is specified for an output logic swing of 600 mV.

The MC1605 is a type D master-slave flip-flop. It toggles at 500 MHz and also has rise and fall times of 0.75 ns. Propagation delay increases to 1.2 ns on set or reset. With a clock input, the propagation delay is typically 1.4 ns and dissipation 525 mW.

Unlike those of other MECL III and MECL 10K devices, the outputs of the 1601-1605 cannot be wire-OR'd without significant loss of bandwidth.

Packaging is in the standard MECL III/10K 16-pin ceramic flat pack. At the high frequencies for which the chips are designed, DIP packaging is not satisfactory. Flat packs have shorter leads and hence lower inductance and reduced cross talk.

All of these circuits are also available in unpackaged chip form. When chips are used, optional pads

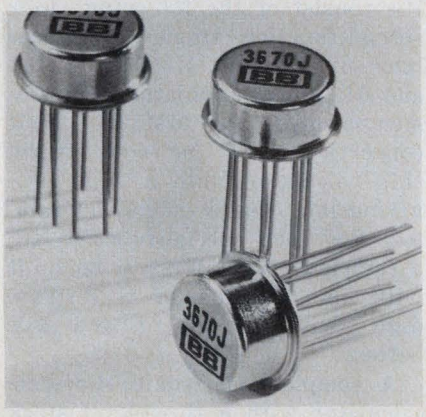
are included on chip to permit use of an additional −3.2-V-dc supply voltage. This can reduce on-chip power consumption by roughly 25%.

These circuits are the first of a new family of high-bandwidth functions, to be expanded during the next several months. They are expected to find application not only in data communications but also in such high bit-rate applications as real-time analyzers, oscilloscopes and laser systems.

Pricing of the 1601-1604 is $16.90 (1-24) down to $14.50 (100-999). The MC1605 costs $24.60 (1-24) and $22.40 (100-999).

CIRCLE NO. 303

Instrumentation amp has FET input



Burr-Brown, International Airport Industrial Park, Tucson, AZ 85734. (602) 294-1431. $26.60 to $14.70 (100); small quantity from stock.

The 3670—the first FET-input IC instrumentation amplifier—allows gain adjustments of 1 to 1000 V/V to be made with a single resistor. The amplifier has a maximum input bias current of 10 pA, an input impedance of 10^{13} Ω and CMR ranges from 60 to 100 dB. Three models are offered. The lowest cost unit is the 3670J which has a gain nonlinearity of 0.2% at a gain of 1000 and an offset voltage drift of 50 μV/°C (RTI). The 3670K and 3670S have a gain nonlinearity of just 0.1% at the same gain, and a voltage drift of 25 μV/°C. The J and K versions are specified for a 0 to +70 C temperature range while the S version is specified at −55 to +125 C. All three models deliver a rated output of ±10 mA at ±10 V, and they come in a TO-100 package.

CIRCLE NO. 308

256-bit bipolar RAMs cut dissipation

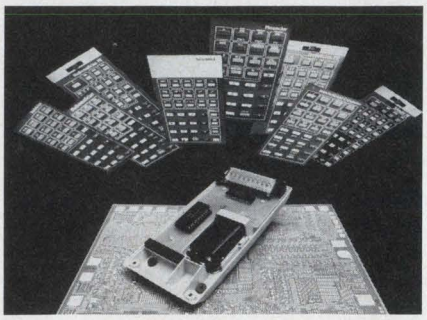
Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. $13.50 to $35.00 (100 up).

A pair of 256-bit bipolar RAMs —the Am27LS00 and Am27LS01 —employs low-power Schottky processing to reduce power requirements by 50 to 60% while maintaining top speeds. The ICs have a guaranteed access time of 45 ns over the commercial temperature range, and 55-ns access over the military-temperature range. Typically, devices dissipate 275 mW compared with 500 to 700 mW for competitive units. Organized 256 × 1-bit, the RAMs come either with a three-state output (27LS00) or with an open-collector output (27LS01).

CIRCLE NO. 309

INTEGRATED CIRCUITS

Calculator chips simplify designs



National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 732-5000. $16.25 to $22.50 (1000); stock.

A series of programmable ICs simplifies the design of business and scientific calculators. The new ICs consist of the following: four special-function single-chip calculator circuits (the MM5760, 62, 63 and 64) and a calculator programmer circuit (the MM5765) that converts any of the new single-chip calculators into a fully programmable "learn mode" calculator. For each special-function IC, a complete calculator can be built with the addition of a display, digit driver, keyboard and 9-V battery.

A complete electronic slide-rule calculator with a three-level stack and a complete set of log and trig functions employs the MM5760 chip. If a programmable version is required the addition of the MM5765 calculator programmer circuit to the MM5760 slide-rule circuit produces a programmable machine with a 102 step memory.

The MM5762 business and financial calculator circuit offers single-key computation of present and future value of compound interest, deposit or sinking-fund amounts, payment or loan installments, and sum-of-the-digits calculations.

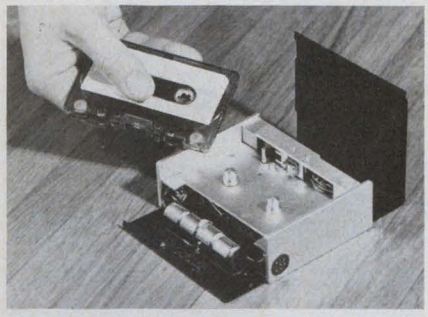
The MM5763 statistical calculator circuit includes linear correlation and regression, y-intercept, mean and standard deviation, summation of X or Y values, and other single-key functions.

The MM5764 international conversion calculator chip automatically converts from one measuring system to another for length, volume, area, or temperature—a total of 96 different functions.

CIRCLE NO. 310

DATA PROCESSING

Portable instrument recorder responds to mV



Spence Systems, 425 E. Green St., Pasadena, CA 91101. (213) 684-2246. $3200 to $5200.

The Microlog is an instrument grade four-channel recorder. Dimensions of the portable unit are less than 4-1/2 × 3-1/2 × 1-1/2 in. and the weight is 14 oz. Recordings of millivolt analog signals can be made onto any high quality cassette tape at frequencies down to dc. The recorder is powered by four small mercury batteries, which give a running time of 24 hours continuously or up to 30 days incrementally with a C120 cassette. The user can choose specifications for each channel such as FM, direct recording, timing pulser, event marking, incremental operation, etc., through use of small plug-in modules. S/n exceeds 30 dB. Playback is on a separate rack-mounted unit at up to 60 times recording speed for rapid data retrieval.

CIRCLE NO. 320

Scanner-digitizer offers 400-line resolution

Celco, 70 Constantine Dr., Mahwah, NJ 07430. (201) 327-1123. From $175,000; 6 mos.

A scanner called Masterscan can digitize images of up to 14 × 14 in. while scanning the area with 16 M points. The unit will calibrate itself and reduce an artwork master of 14 × 14-in. to a digital record in 16 s. The system offers 4000-line resolution. Automatic lens selection is available for different output formats, and 10 × 10-in. coverage. Masterscan includes machine-language software, computer selection and interfacing by the manufacturer.

CIRCLE NO. 321

Core memory includes reconfiguration control

EMM Commercial Memory Products, 12621 Chadron Ave., Hawthorne, CA 90250. (213) 644-9881. $3315; June.

Standard capacity for the Micromemory 3000QD is 32 k words by 16, 18, or 20 bits per word. This can be altered to 64 k × 8, 9 or 10 bits by use of an external control signal. The three-wire, 3D core memory offers an access time of 300 ns. A plug-in card measuring 11.75-by-15.4 in. includes memory and support circuits. Only external power (15 V, 5 V and −15 V) is needed.

CIRCLE NO. 322

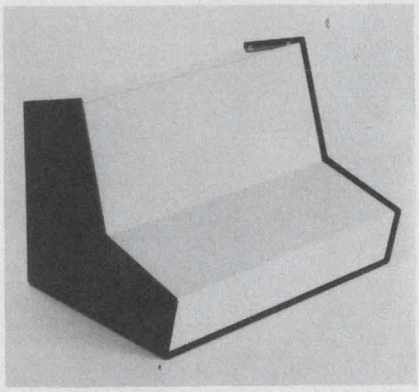
Wang Basic computer comes in a faster model

Wang Laboratories, 836 North St., Tewksbury, MA 01876. (617) 851-4111. $5800; 4 to 6 weeks.

The System 2200C computer boasts greater throughput than its predecessor, the System 2200B. As before the unit has rapid access to its 4 to 32k working memory; uses simple Basic language; and interfaces with a complete line of peripherals. Faster program overlays at double the tape loading speed make disc loading six times faster. A number of new Basic statements add to the system's already extensive vocabulary. The CRT screen can prompt the operator on how to recover from errors in application programs with the ON ERROR GOTO statement. COM CLEAR optimizes use of memory space. RETURN CLEAR improves subroutine efficiency. With DEFFIN'HEX, the user can enter customized codes for special characters directly from the keyboard. Older system 2200A and 2200B CPUs can be field-upgraded to a System 2200C for a retrofit charge.

CIRCLE NO. 323

Standard enclosures with custom features

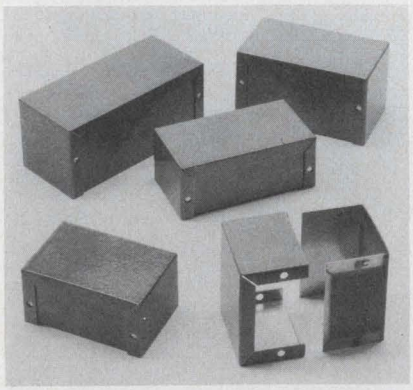


Bud Radio, Inc., 4605 E. 355 St., Willoughby, O. 44094, (216) 946-3200. Your Bud Distributor has it.

Compucab by Bud. Dual-slope, off-the-shelf enclosures with custom-designed configurations. Use for a range of instruments. Maximum visibility — no fasteners on panel area. All aluminum. Cover and back in smooth white enamel. Base and sides, black textured enamel. Knockouts in rear panel. Rubber feet furnished. Two styles. Shipping economies. For the name of your local Bud Rep or Distributor —

PHONE (800) 645-9200, TOLL FREE

Compact enclosures, versatile, economical



Bud Radio, Inc., 4605 E. 355 St., Willoughby, O. 44094, (216) 946-3200. Available in 18 sizes.

Miniboxes from Bud. Use as separate housings or as part of a larger assembly. Flanges give assured shielding. Projecting covers on cowl-type units minimize glare, protect controls, dials. .040 and .050 aluminum alloy. Immediately available. Shipping economies. One of nearly 3000 products from Bud Radio. For the name of your local Bud Distributor or Rep —

PHONE (800) 645-9200, TOLL FREE

DATA PROCESSING

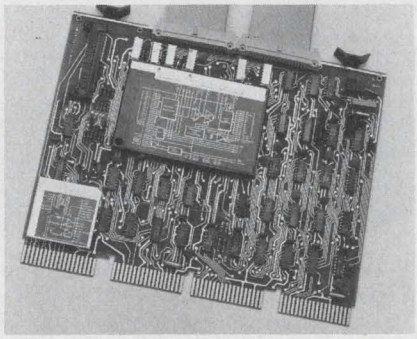
Rf modems provide coax cable links

Catel, 1400-D Stierlin Rd., Mountain View, CA 94043. (415) 965-9003. See text; stock.

An rf modem, the FMTT 2200, provides a pair of channels in the 2-to-300-MHz range for coaxial cable links. The unit accepts inputs from modems, facsimile devices or voice multiplexers and provide the necessary modulation and demodulation. Units are available for audio or TTL modes and come in rack or flat-mount configurations. A modem pair for audio use costs $845; for TTL data at 75 kbit/s the price is $895.

CIRCLE NO. 324

PC board acquisition systems plug into minis

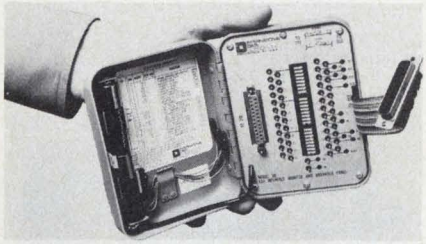


Adac Corp., 29b Cummings Park, Woburn, MA 01801. (617) 935-6668. See text; 6 to 8 wks.

The Model 600-11 data-acquisition system for the PDP-11 series computers is contained on a single 8.5 × 15-in. PC board. The Model 600-11 has a high speed (100 kHz throughput rate) 12-bit a/d converter, high speed sample and hold and 16 channels of multiplexer that can be expanded to 64 channels. Program interrupt is also included. The unit needs no external power supply, as it takes the 5 V which is available from the computer, and converts it to ±15 V with a dc to dc converter. An optional programmable gain amplifier with gains of .1, 2, 5 and 10 extends the effective, dynamic range to over 40,000 to 1. The Model 600-11 is priced at $1800 for the 16-channel version. The Model 600-8E, also card mounted, provides equivalent performance for PDP-8e minis and costs $1900.

CIRCLE NO. 325

Data interface analyzer shows status of all lines



International Data Sciences, 100 Nashua St., Providence, RI 02904. (401) 274-5100. $160; stock.

The Model 60 test set provides access to all 25 conductors of the EIA RS-232 interface. Twelve LEDs monitor the status at the source of 12 primary signals and two additional LEDs sense either positive or negative voltage levels greater than ±3 V. Twenty-four miniature switches allow all interface conductors (except frame ground on pin 1) to be individually interrupted for isolated testing and observation of terminal or modem signals. Pins on each side of each switch and small jumper cables are provided to allow cross-patching and monitoring of signals. The Model 60 is self-contained in its own metal case. Two penlite batteries provide over 100 hours of continuous operation.

CIRCLE NO. 326

Now a 'millicomputer' overlaps mini and micro

Computer Automation, 18651 Von Karman, Irvine, CA 92664. (714) 833-8830. See text.

Neither micro nor mini, the NAKED MILLI is almost micro size yet has almost mini performance. The NAKED MILLI has a large instruction set (93) and can perform a 16-bit add function in 6 microseconds. Standard features include programmed I/O, Direct Memory Address (DMA) and Direct Memory Channel (DMC). Optional features are real time clock, power/fail restart, autoload and Teletype/CRT serial interface. The processor uses bipolar TTL, and is available with core, RAM, ROM and PROM memories in sizes from 1k bytes to 32k bytes per memory module. In large quantities, the processor plus 1 kbyte of memory sells for $560; the processor alone costs $275.

CIRCLE NO. 327

Single local device replaces two modems

Computer Transmission Corp., 2532 Utah Ave., El Segundo, CA 90245. (213) 973-2222. Under $300; 30 to 45 days.

A dial-up data set simulator can now eliminate two data sets and provide direct communication between local terminals and computers or communications devices. Called Connectran, this low-priced device can, under operator control, link a central computer, concentrator node, packet node or multiplexer with a terminal located within a range of up to 1250 ft by means of an 11-pair twisted cable. Only one unit is needed at the terminal end. The Connectran emulates all originating and answering data set functions and operates at data rates up to 9600 bit/s depending on distance. Simple pushbutton operation enables the terminal operator to access a computer port. At the same time the unit notifies the operator if the port is busy.

CIRCLE NO. 328

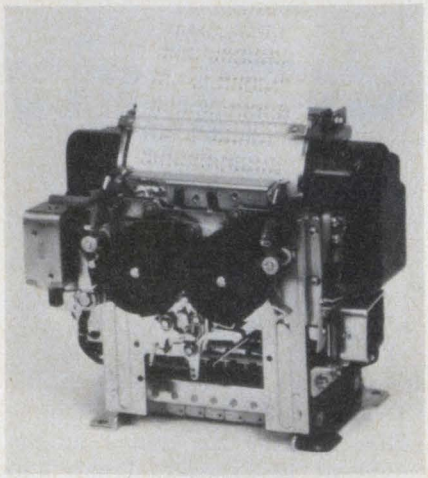
CRT terminal price drops below $1000

Lear Siegler, Electronic Instrumentation Div., 714 N. Brookhurst St., Anaheim, CA 92803. (714) 774-1010. See text.

Designed to sell for less than $1000, the ADM-3 CRT terminal displays a 12 × 80 line and can operate at rates up to 19,200 baud. The terminal has 53 keys, plus a special shift key, and can generate up to 128 ASCII codes. The display set is 64-character ASCII on a 5 × 7 matrix; capacity is expandable to 1920 characters, and data rates are switch-selectable. A rear-panel switch selects either an RS-232 or a current-loop interface. Quantity discounts are available.

CIRCLE NO. 329

Small column printer is also reliable



C. Itoh Electronics, Inc., 280 Park Ave., New York, NY 10017. $50 (qty); 3 to 3-1/2 mos.

Designed for a MTBF of 5M lines, the AN-101F prints up to 21 columns at approximately 1.2 line/s. The drum mechanism used has a 42-character font and prints from a black-and-red inked ribbon. Signal inputs must be in parallel form. The over-all unit weighs 6.7 lbs. and operates from 17 V dc.

CIRCLE NO. 330

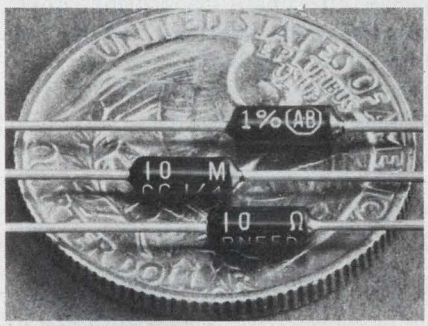
Chip thermistors come with leads and coating

Western Thermistor Corp., 303 Via El Centro, Oceanside, CA 92054. (714) 433-4484. Under $1.00: 1 M Ω (100 up); 4 wks.

Low-cost chip thermistors with leads and phenolic coating have resistance of over 1 M Ω. The unit's nominal temperature coefficient (NTC) is −5.4%/°C at 25 C with a 0°/50° C ratio of 14.3. Maximum diameter over coating is 0.1 in. Thermistors with 10 M Ω at 25 C are expected to be in production in March, 1975. NTC will be as high as −5.8%/°C and Betas to approximately 5800 K.

CIRCLE NO. 331

Cermet-film resistors available to 10 MΩ



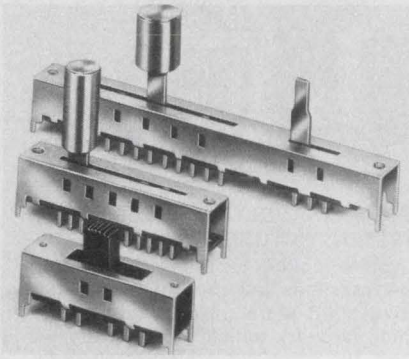
Allen-Bradley Co., 1201 S. Second St., Milwaukee, WI 53204. (414) 671-2000. $0.17 (1000 up); 6 wks.

The maximum resistance value of the new Type CC cermet-film resistor has been extended from 1 to 10 MΩ—in the same 0.250 L × 0.090 D-in., capless, 1/4-W package. Allen-Bradley claims that no other metal-film resistor is offered in so wide a range in this single small size. Standard tolerance is 1%. Temperature coefficient is ±100 ppm/°C. Recent developments in Allen-Bradley resistive inks have made it possible to provide this higher resistivity without a sacrifice in performance. The resistors have baked on alphanumeric markings with the resistance value shown in two places for easy identification. Performance characteristics are substantially superior to the established reliability specification MIL-R-39017 and the high-stability specification MIL-R-10509, according to Allen-Bradley.

CIRCLE NO. 332

COMPONENTS

Slide switches come in multiposition versions

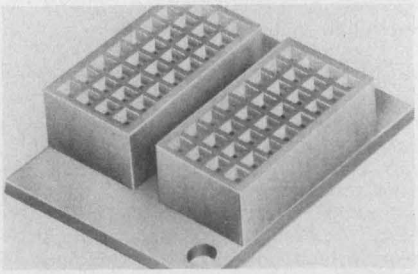


Alco Electronics Products Inc., 1551 Osgood St., North Andover, MA 01845. (617) 685-4371. $0.60: Mod. SS-24 (500 up); stock.

Multiposition slide switches complement other slide components on PC boards and eliminate wiring errors. They are available in three styles: SS-24 (DP4T) with black phenolic actuator and SS-110-13 (SP10T+3) and SS-111 (SP11T) with aluminum or anodized, black, detachable knobs and with or without hairline indicator. Knobs must be ordered separately. All styles feature make-before-break action. Minimum life expectancy is 20,000 operations. Rated load is 300 mA at 30 V dc.

CIRCLE NO. 333

Breadboard socket uses solderless connections

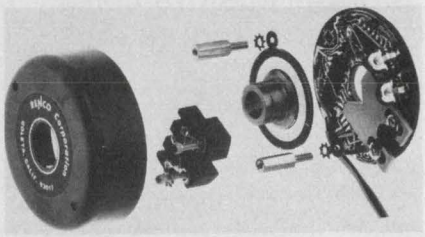


Vector Electronic Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342. (213) 365-9661. $2.63 (unit qty); stock.

A new DIP socket for breadboarding allows convenient interconnection without soldering. The socket, Model 570G-1, consists of two nylon-based 0.85 × 0.47 × 0.30-in. termination blocks spaced to accommodate any standard 14 or 16-pin DIP component. Four tie-points per contact allow solderless interconnections with ordinary 22-AWG hook-up wire.

CIRCLE NO. 334

Tachometer assembled into customer's product

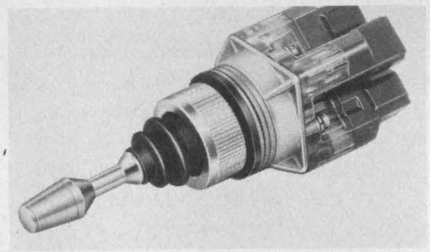


Renco Corp., 26 Coromar Dr., P.O. Box 246, Goleta, CA 93017. (805) 968-1525. From $47.36 (OEM qty).

The KT23A modular tachometer is available in resolutions from 100 to 1000 counts per revolution. The tachometer/encoder is supplied in three subassemblies: code disc and hub, light source and sensing electronics. The customer assembles and integrates these elements onto the shaft within the casement of his final manufactured product. The modular elements are prealigned to minimize the time and expense of final integration. The tachometer is 2-1/4 in. in diameter and 3/4-in. high. It can be supplied for shaft diameters from 1/4 to 5/8 in.

CIRCLE NO. 335

Joy stick operates in up to 9 positions

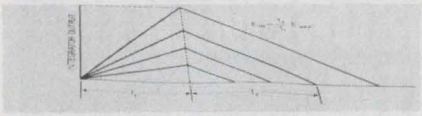


Square D Co., Dept. SA, 838 W. National Ave., Milwaukee, WI 53201. (414) 384-8100.

Class 9001 Type M miniature joy-stick operators are available in three, five or nine-position models. The nine-position type uses the 45 degree diagonal as well as the vertical and horizontal positions. These devices can be obtained with momentary or maintained contacts and with or without a latch. Devices with a latch cannot be operated until the latch button in the center of the handle is depressed. Up to four contact blocks can be mounted on the back of the operator with either NO or NC contacts. Pressure wire or slip-on terminals are used.

CIRCLE NO. 336

Dual-slope a/d's run from 5-V logic supplies



Datel, 1020 Turnpike St., Canton, MA 02021. (617) 828-8000. From $79 (1 to 9); stock.

A series of modular, dual-slope, a/d converters has ratiometric operation and can operate from 5-V-dc supplies. The ADC-ER series modules produce either parallel binary or BCD outputs as well as −5 V dc power for driving transducers. Four-wire ratiometric operation lets you make accurate measurements with external references that could vary as much as 50% from nominal. Five models are available: 2-1/2 and 3-1/2 digit BCD versions and 8, 10 and 12-bit binary units. All modules give sign-magnitude coding with automatic polarity. Accuracy is 0.05% of reading ±1 count and resolution is 1 mV for BCD outputs and 250 μV for binary outputs. Temperature coefficient of gain is ±35 ppm/°C and offset TC is ±30 μV/°C. Conversion time is 76.7 ms for binary outputs and 43.3 ms for BCD. All modules have differential inputs with a 100-MΩ input impedance and a 70-dB common-mode rejection. The high normal-mode rejection of 40 dB for line frequency is achieved by use of a signal integration time equal to a multiple of line frequency. The modules measure 4 × 2 × 0.4 in. (10.16 × 5.08 × 1.02 cm), consume 1.25 W and operate over 0 to 70 C.

CIRCLE NO. 337

Electronic tach delivers control signal to 50 mA

Electro Corp., 1845 57 St. Sarasota, FL 33580. (813) 355-8411. $275; 4 to 6 wk.

The Series 76600 Electro-tach controller is a fast response frequency-to-dc converter. It provides outputs of up to 50 mA and has a separate 0-to-1-mA meter output. Four full-scale frequency ranges that span 45 Hz to 25 kHz are available. Both low (10 mV rms) and high-level (5 V dc) inputs are accepted by the tach. High level signals may also be used to gate low-level input signals. Plug-in modules simplify frequency selection and spares requirements. Internal jumper-zero and span controls permit wide selection of outputs.

CIRCLE NO. 338

Active bandpass filter has wide dynamic range

A. P. Circuit Corp., 865 West End Ave., New York, NY 10025. (212) 222-0876. $650; 2 wk.

A variable-frequency tuned bandpass filter, Model 301, offers a typical dynamic range of 90 dB, a tuning range extending from 0.1 Hz into the audio frequency spectrum, and a low noise level. The frequency can be adjusted continuously in five decade steps. A single potentiometer continuously controls each decade of frequency. The bandwidth is set by another potentiometer within a range of Q from 5 to 100. Very low signal levels can be amplified up to 40 dB (× 100), or strong signals attenuated, by a variable-gain input amplifier.

CIRCLE NO. 339

F/v converter delivers 0.05% linear signals

Richard Lee, Box 724, New Providence, NJ 07974. (201) 665-1333. $37 (100-up).

The Model 713 frequency-to-voltage converter produces 0 to 1 mA for operating panel meters, I to F converters, etc., and simultaneously provides 0 to 1 V across 1000 Ω for operating DPMs, recorders, etc. Low-level, repetitive signals of 10 mV rms will produce a 0.05% linear output from the 713. Full scale is determined and set by the user over any input frequency range to 15 kHz. Only one supply voltage (+12 V dc) is required for operation. The unit measures only 1.5 × 1.5 × 0.6 in.

CIRCLE NO. 340

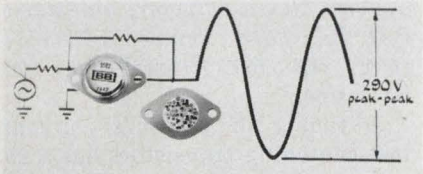
Watt transducers have optical isolation

Macrodyne, 1900 Maxon Rd., P.O. Box 1079, Schenectady, NY 12301. (518) 342-5619. From $150.

The WTM series of optically isolated watt transducers provides complete isolation with wide frequency response. Input signals are derived from current shunts and resistor dividers, completely eliminating transformer inputs and elements sensitive to magnetic fields. The units have an input frequency range that spans from dc to 2 kHz without loss of accuracy. The voltage and current product is computed through an optical isolator for each phase. The results are summed and filtered to yield instantaneous power. Power factor, reactive power and peak power may also be calculated.

CIRCLE NO. 341

High voltage amplifiers handle up to 290 V pk-pk



Burr-Brown, International Airport Industrial Park, Tucson, AZ 85706. (602) 294-1431. From $27 (100-up); stock.

The 3580 series of FET-input operational amplifiers provides output voltage swings of up to ±145 V. That's up to 290 V pk-pk from a TO-3 package. These new amplifiers are claimed to be the first high voltage units, either modular or IC, to have their own self-contained automatic thermal protection. Another feature of the 3580 series is that all units will dissipate over 3 W without a heat sink. Add a suitable heat sink, and they'll go up to 4.5 W. Depending upon model, CMRR varies from 86 to 110 dB and slew rate from 15 to 20 V/μs. The three models available include the 3580J (±18 to ±35 V dc supply), 3581J (±32 to ±75 V dc) and the 3582J (±70 to ±150 V dc).

CIRCLE NO. 342

Track/hold amplifier has teraohm input Z

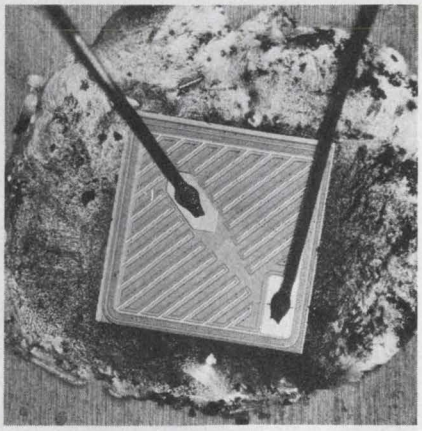
ILC Data Devices, Airport International Plaza, Bohemia, NY 11716. (516) 567-5600. From $200 (unit qty); 4 to 8 wk.

The DTH-8111 hybrid differential track-and-hold amplifier has an input impedance of 10^{12} Ω. Additional features are low hold drift of 0.25 mV/ms and an acquisition time of 10 μs. Its high input impedance makes it directly compatible with the company's 1507 series of eight-channel dual-input multiplexers. The unit can be supplied with selected accuracies to 0.01% and in track-to-hold steps of 0.02%. The amplifiers are designed to meet MIL-M-35810 and are processed to MIL-STD-883. Model DTH-8111 is guaranteed for operation from −55 to +85 C with operation to +125 C available on special order. The units are housed in 1 × 0.8 × 0.2 in. hermetically sealed DIPs.

CIRCLE NO. 343

DISCRETE SEMICONDUCTORS

High voltage transistors designed for CRT use

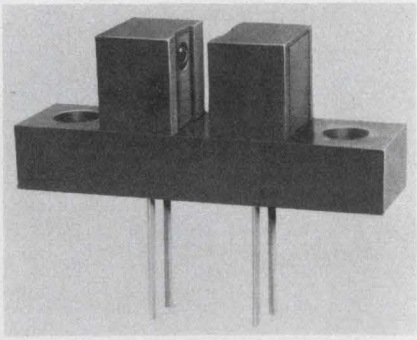


SGS-ATES Semiconductor, 435 Newtonville Ave., Newtonville, MA 02160. (617) 669-1610. 100-up prices: $2.40 (406); $2 (407); stock.

The BU 406 and BU 407 are npn transistors designed specifically for CRT horizontal deflection circuits. The BU 406 has a breakdown voltage of 400 V and a peak repetitive collector current of 10 A, while the BU 407 has a 330-V breakdown. These transistors are housed in TO-220 plastic cases.

CIRCLE NO. 344

Optoelectronic switches available in two models



Spectronics, 830 E. Arapaho Rd., Richardson, TX 75080. (214) 234-4271. $1.45 (1000-up); stock.

Two optoelectronic switches, designated SPX 1874 and SPX 1873, are direct electrical and mechanical replacements for General Electric types H13A1, H13A2, H13B1 and H13B2 and Monsanto MCA8/81 and MCT8/81 types, respectively. The switches are available in both phototransistor and photo-Darlington versions.

CIRCLE NO. 345

Power-switching transistors handle 25 A

General Semiconductor Industries, P.O. Box 3078, Tempe, AZ 85281. (602) 968-3101. From $7.50 (100-up); stock.

A family of npn high-current, fast-switching transistors has a 25-A maximum collector current. The 2N6338 through 2N6341 transistors can dissipate 200 W, have rise times of less than 0.3 μs and turn-off times of less than 1.25 μs. $V_{CE(SUS)}$ ranges from 100 V dc in the 2N6338 to 150 V dc in the 2N6341. The transistors are housed in TO-3 metal packages.

CIRCLE NO. 346

Hyperabrupt diode series handles 25 V

MSI Electronics, 34-32 57 St., Woodside, NY 11377. (212) 672-6500. $4.90 (100-up); 2 wk.

In the ZC800 through ZC806 series of hyperabrupt tuning diodes, the characteristics of these 25-V devices are preserved even for the large area 100 pF types. The diodes have capacitance values from 10 to 100 pF when measured at 2 V. The capacitance tuning ratio measured from 2 to 20 V is a minimum of 5:1. At 3 V and 8 pF, the Q is a minimum of 300 while at 3 V and 85 pF, the Q is 100 minimum when measured at 50 MHz. The diodes are packaged in DO-7 glass cases and meet or exceed the environmental specifications of MIL-S-19500. The ZC800 series is available in matched pairs and quads for preselector, synthesizer and electronic tuning applications.

CIRCLE NO. 347

Fast recovery diodes handle up to 60 A

Sescosem, 101 boulevard Murat, 75781 Paris Cedex 16, France.

The ESM 243, 244 and 245 series of fast recovery power diodes are available in the TO-126, DO-4 and DO-5 packages, respectively. The diodes recover in 100 to 500 ns and can handle loads of 60 A. The ESM 243 series handles from 50 to 400 V and has a 100 ns recovery time. The 244 units handle to 600 V and recover in 200 ns. The 245 series diodes handle up to 1000 V and can recover in 500 ns.

CIRCLE NO. 348

DISCRETE SEMICONDUCTORS

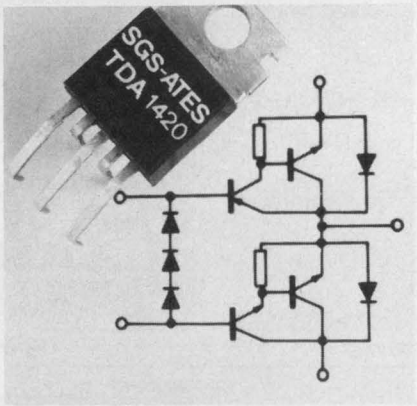
IR emitting diodes deliver 7.5 mW

RCA Electronic Components, 415 S. Fifth Street, Harrison, NJ 07029. (201) 485-3900. $3.50; stock.

The SG1009A IR emitting diodes have a typical power output at 940 nanometers of 7.5 mW at a dc drive current of 100 mA. The emitting source of the diode is a gallium arsenide pellet. The IR diode is supplied in a hermetically sealed two-lead TO-18 case.

CIRCLE NO. 349

Complementary pair now a monolithic



SGS-ATES Semiconductor, 435 Newtonville Ave., Newtonville, MA 02160. (617) 969-1610. From $1.60 (100-up); stock.

The TDA1420, a quasi-complementary Darlington pair, with biasing system is housed in a Pentawatt (five lead TO-220) package. Each Darlington can deliver a current of over 3 A and can withstand a supply voltage of 44 V. In addition to the 44 V, TDA1420, a 36-V version, the TDA1410, is also available.

CIRCLE NO. 350

30-A triac handles PIVs of 1100 V

AEG Telefunken, D 6000 Frankfurt, 70 AEG Hochhaus, West Germany.

The TW 12 N triac has a maximum admissible peak inverse voltage of 1100 V. The high PIV permits the triac to be connected directly to 380-V system supplies. The maximum admissible effective forward current is 30 A, and the surge current can reach 110 A.

CIRCLE NO. 351

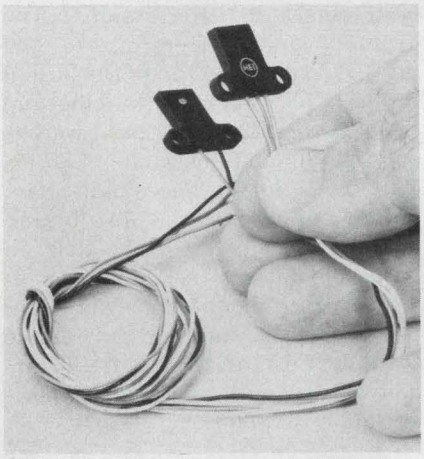
Optical switch modules have four sensor models

HEI, Jonathan Industrial Center, Chaska, MN 55318. (612) 448-3510. From $6.

A series of optical switch modules use separately packaged sensor and emitter units. The sensor module is available in four versions: phototransistor, photo-Darlington, photosensor with an amplifier and photosensor followed by a Schmitt trigger. There is only one emitter version available, and that uses a LED. Sensor modules may be purchased separately or in combination with the LED module. All units are prewired and have recessed mounting holes. The Schmitt trigger sensor version uses a hybrid circuit which can drive additional logic and/or low-level relays.

CIRCLE NO. 352

TC reference diodes function at 100 μA bias



Codi Semiconductor, Pollitt Dr., Fair Lawn, NJ 07410. (201) 797-3900. From $3.60 (100-up); stock to 3 wk.

A C8000 series of ultra-low, multicurrent, temperature compensated reference diodes operates at currents as low as 100 μA. The temperature coefficients of these devices are as low as 5 ppm/°C over an operating temperature range of −55 to +100 C. Since the devices are current regulated, shifts in the operating current by as much as ±50% cause very small changes in the temperature coefficient. The diodes are encapsulated in hermetically sealed DO-7 glass packages and can be supplied with long term stabilities as low as 10 ppm/year.

CIRCLE NO. 353

Planar triode aims for airborne use

Varian, 1678 Pioneer Rd., Salt Lake City, UT 84104. (801) 487-7561.

The Y-540 high-voltage planar triode can be used for switch or series regulator service in either radar or general-purpose airborne applications. Essentially a uhf triode, the tube can be operated in the nanosecond region. The Y-540 features an extended grid-anode insulator for 10-kV operation at sea level, and an arc-resistant extended interface matrix cathode. The new unit has an average transconductance of 30 mmhos (at I_b = 100 mA) and average amplification factor of 145. Maximum operating temperature is 250 C.

CIRCLE NO. 354

Diode switch/driver works from 3 to 300 MHz

Vitek Electronics Inc., 200 Wood Ave., Middlesex, NJ 00846. (201) 469-9400. $55; stock.

An rf/i-f diode switch/driver combination—the SDR-24-50—covers the 3-to-300-MHz frequency range. The SPDT operates from a 24-V supply, offers a minimum isolation of 60 dB and has a typical insertion loss of 0.75 dB. Connectors are BNC female types.

CIRCLE NO. 355

Ion laser uses 115-V supply

Lexel Corp., 928 E. Meadow Dr., Palo Alto, CA 94303. (415) 328-3466. P: See text.

A compact ion laser operates from a single-phase, 115 or 220-V, 50/60-Hz supply. The new unit is reportedly the only cw ion laser of its type that can be operated from standard supplies. The Model 75 laser comes in two versions: The krypton model offers up to 100 mW of red power, and the argon model offers 400 mW of blue and green power. The laser head weighs only 36 lb and measures 4.85 × 7.19 × 28.20 in. The single-phase power supply weighs 75 lb and measures 8.0 × 16.6 × 19.0 in. Available options include light regulator, rack-mounted power supply, automatic starting and remote turn-on. Cost of the Model 75 argon version with single-phase power supply is $6035.

CIRCLE NO. 356

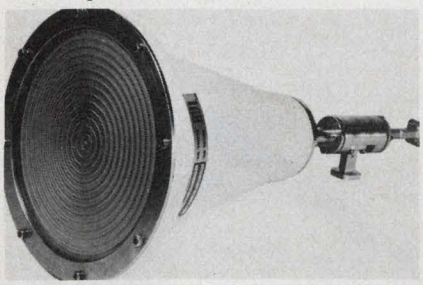
0.5-5-GHz crystal sig sources output 5-20 mW

Mik-Beth Electronics, Inc., 210 S. 31st St., Kenilworth, NJ 07033. (201) 241-8831. $575 (1-4); 8 weeks.

The MBE-S-FOX series of crystal-controlled signal sources covers the frequency range of 500 MHz to 5 GHz with output powers of 5 to 20 mW. Spurious rejection exceeds 65 dB for in-band and harmonic signals. Over the 0-to-60-C temperature range, stability is better than ±0.003%. Units operate from −20 V dc supplies and draw 80 mA. Output impedance is 50 Ω, and load VSWR is 1.5:1.

CIRCLE NO. 357

Mm antenna has dual polarization

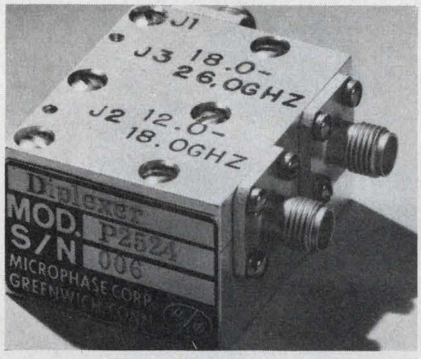


Alpha Industries Inc., 20 Sylvan Rd., Woburn, MA 01801. (617) 935-5150.

A horn-lens millimeter antenna —Model A858-6/881/884—features dual polarization and a frequency range of 33 to 40 GHz. The new antenna has a sidelobe level of −25 dB and beam efficiency in excess of 90%. Half-power beamwidth is 4 degrees, nominal gain is 32.5 dB and VSWR doesn't exceed 1.3:1. The antenna can accommodate standard TE_{11} circular waveguides.

CIRCLE NO. 358

Diplexer has low loss and sharp selectivity

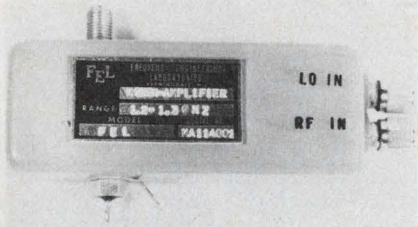


Microphase Corp., Box 1166, Greenwich, CT 06830. (203) 661-6200.

The Model P2524 diplexer features low insertion loss, sharp skirt selectivity and high interchannel isolation. The P-K band diplexer operates in severe military environments and at temperatures up to 125 C. Frequency coverage is 12.0 to 26.0 GHz, with crossover frequency at 18.0 GHz. Insertion loss at crossover frequency is 4.8 dB max. The unit has a crossover region of f_{co} ±3% and a passband insertion loss of 1.0 dB max. Selectivity is 60 dB min with f_{co} ±15%. Channel-to-channel isolation is 60 dB min from dc to 26 GHz, except in the crossover region.

CIRCLE NO. 359

Mixer/preamp holds noise to 9 dB max



Frequency Engineering Laboratories, Farmingdale, NJ 07727. (201) 938-9221.

A mixer/amplifier combines low noise with broadband frequency coverage. The MA-1200 series has an operating range of 100 to 1300 MHz, an over-all noise figure of 9.0 dB max and a gain of 46 ±0.5 dB. The unit's i-f response is 3 kHz to 3500 MHz and it outputs ±2 V into a 100-Ω load. The flat-pack mixer employs special ferrite-core techniques.

CIRCLE NO. 360

MICROWAVES & LASERS

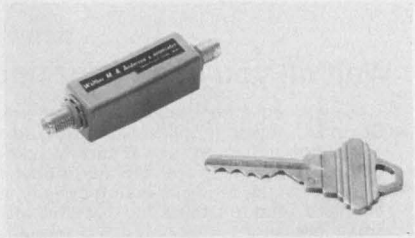
Gunn osc modulates at 10-MHz rates

Varian, 611 Hansen Way, Palo Alto, CA 94303. (415) 493-4000.

The 9082 series of Gunn oscillators provides FM capabilities—deviation exceeds 300 MHz pk-pk—at rates in excess of 10 MHz over the −40 to +85 C temperature range. The 9082 series features two tuning inputs, which reportedly provide the wide tuning ranges and high linearity normally achievable only with YIG devices. The slow tuning port of the VSX-9082N1, for example, has a linearity of ±0.2% maximum over the 8-to-12.4-GHz range. Hysteresis is 10 MHz maximum. The fast tuning port features a frequency range of ±155 MHz minimum, 3-dB bandwidth of 10 MHz minimum and 10-MHz sensitivity of 55 kHz/mA minimum.

CIRCLE NO. 361

Acoustic delay line meets MIL specs

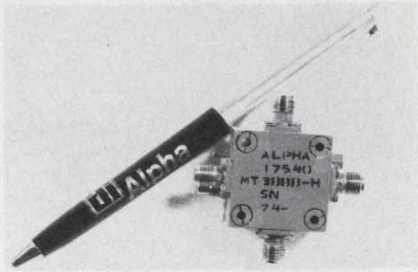


Walter M. A. Andersen & Associates, 4 Main St. Extension, Tariffville, CT 06081. (203) 658-7666.

An acoustic delay line, the Model CR02, can be obtained in a version that meets full MIL-spec requirements. The new unit offers a delay of 1.5 to 10 μs and delay tolerance of ±5 ns. Measuring 1.5 × 0.5 × 0.5 in., the delay line has a center frequency of 60 MHz, minimum bandwidth of 15 MHz and maximum insertion loss of 23 dB. Spurious signals are 26 dB below the fundamental frequency.

CIRCLE NO. 362

Compact transfer switch handles 1 W rf

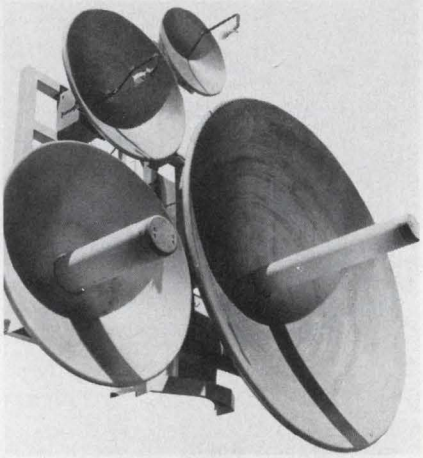


Alpha Industries, Inc., 20 Sylvan Rd., Woburn, MA 01801. (617) 935-5150. $273 (1-9); 4-8 weeks.

The MT3888 solid-state transfer switch with driver—measuring 1.0 × 1.0 × 0.75 in.—can reverse the order of connections between two input and two output ports. Operating from 0.5 to 18 GHz in decade bandwidths, the unit has a typical insertion loss of 1.4 dB and typical isolation of 40 dB. Switching speed is 800 ns, and 1-W rf powers can be handled. The unit operates from 5-V supplies and draws 85 mA maximum.

CIRCLE NO. 363

Antenna system yields 37-dB gain

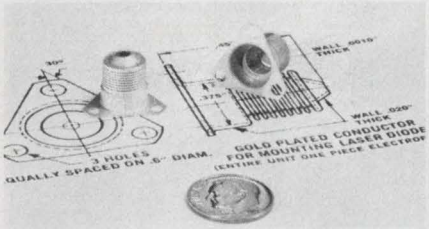


Watkins Johnson Co., 3333 Hillview Ave., Palo Alto, CA 94304. (415) 493-4141.

A directional antenna system, Model WJ-8332, covers the 1-to-18-GHz frequency range with gains of 23 to 37 dB, corresponding to a minimum beamwidth of about 2 degrees. The antenna can be positioned in elevation from −3 to +90 degrees and in azimuth from 0 to ±200 degrees. A control unit provides digital readouts of azimuth and elevation angles, and of the polarization angle of any individual band antenna.

CIRCLE NO. 364

Bellows allow component adjustment

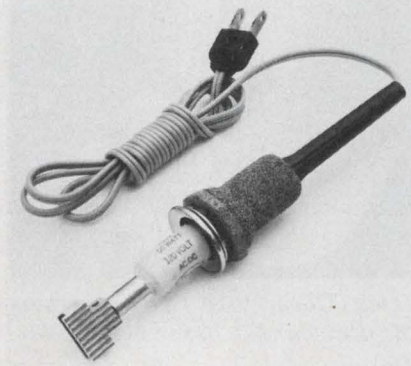


Servometer Corp., 501 Little Falls Rd., Cedar Grove, NJ 07009. (201) 785-4630.

Electronic designers may now adjust components in sealed enclosures via bellows that have a wall thickness that varies from 0.0005 to 0.020 in. The bellows are available in diameters from 0.125 to 1.25 in. Extension strokes equal to 80% of the bellow's free length are available, if constant pressure on the component is required. The parts are produced by electroforming, and thus, internal dimensions can be held extremely close. Conical interface surfaces can be produced where components with whisker type contacts must be self-aligning. The bellows can be clamped by a flange, solder assembled or welded in place. Gold plating is available where high conductivity is required.

CIRCLE NO. 365

Desoldering tip fits small 50-W iron



Micro Electronic Systems, Inc., 8 Kevin Dr., Danbury, CT 06810. (203) 746-2525. $15 (unit qty); stock.

The DIL-16-UN desoldering tip works with an Ungar 50-W-element iron. The tip desolders all the leads of a 14 or 16-pin IC simultaneously, and it enables the user to remove the IC without damage.

CIRCLE NO. 366

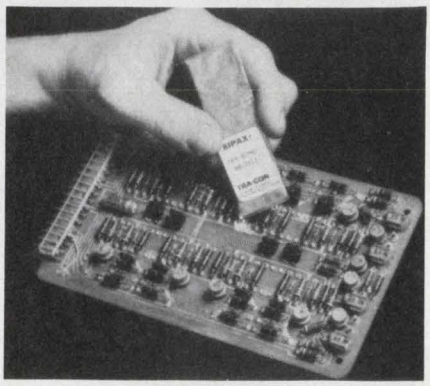
Shrink-tubing adhesive encapsulates splices

Alpha Wire Corp., 711 Lidgerwood Ave., Elizabeth, NJ 07207. (201) 925-8000.

Fit-750 is new polyolefin tubing lined with an adhesive, which can encapsulate and protect components. The tubing is positioned over a component or splice and heated with a heat gun to 135 F. The adhesive melts and the tubing shrinks to force adhesive into even microscopic crevices. When the adhesive cools, it provides a bond that seals out moisture. Tubing diameters range from 1/4 to 1-1/2 in. and tensile strength is 1500 psi. Flexibility is maintained to −55 C and the material is water, fungus and chemical resistant.

CIRCLE NO. 367

Epoxy system stakes parts to PC boards

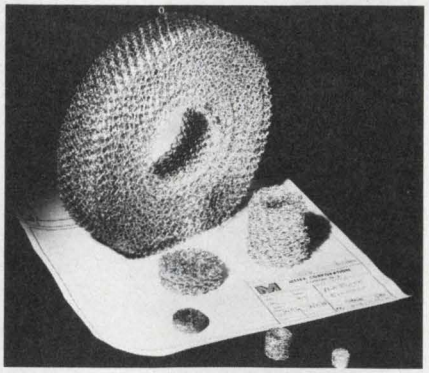


Tra-Con, Inc., 55 North St., Medford, MA 02155. (617) 391-5550. Stock.

Tra-Bond 2111 is a convenient way to "stake" delicate electronic components to chassis parts or PC boards. It's a specially formulated epoxy system with thixotropic additives. Tra-Bond contains no solvents, has a long pot life and cures at room temperature. It adheres to metals, ceramics, glass, wood, leather and many plastics. It is electrically insulating, and offers resistance to weathering, petroleum products, salts, mild acids and alkalis and many organic solvents.

CIRCLE NO. 368

Knitted-wire filter material resists 2000 F

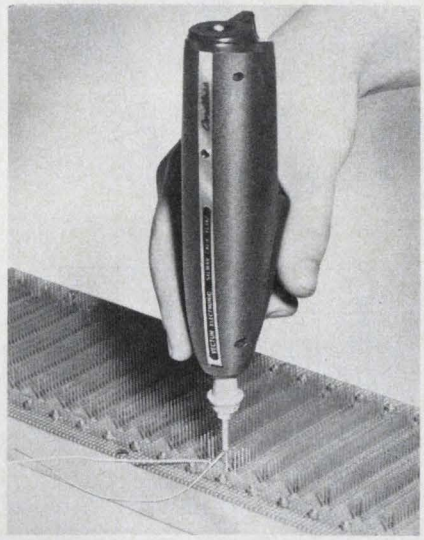


Metex Corp., 970 New Durham Rd., Edison, NJ 08817. (201) 287-0800.

Knitted-wire air filters can be made of any wire alloy. Materials that are resilient and can resist corrosion, vibration and heat up to 2000 F are available. The mesh is made with controlled filtration and pressure-drop characteristics to accommodate a wide range of applications, from tiny instrumentation to large gas turbine inlets.

CIRCLE NO. 369

Wrapping tool operates from battery



Vector Electronic Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342. (213) 365-9661. See text.

Designed for prototype or low-volume production, Vector's new P160-4 wrapped-wire tool and P160-2 wrapping bit is delivered from stock for $59.69, including battery, line cord and recharging unit. Typically competitive units sell in the $90-to-$125 range. Balanced for easy operation, the unit weighs only 9 oz. The tool wraps 0.025 to 0.028-in.-square posts with 26-to-30-AWG wire. The 0.070-in. bit radius allows wrapping posts spaced on 0.10-in. centers. A 0.590-in. bit depth permits multilevel wrapping. A Ni-Cd battery has a nominal duty cycle of 8 h without charging. Recharging time is 14 to 16 h.

CIRCLE NO. 372

Insulated wire meets UL and IPCEA standards

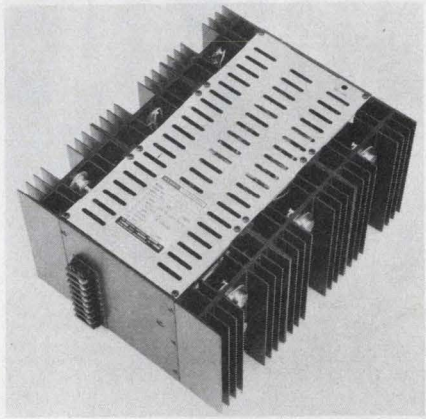
Haveg Industries, Inc., P.O. Box 7, Winooski, VT 05404. (802) 655-2121.

Exar cross-linked polymeric insulated wire is now UL listed for SIS and switchboard applications. Exar 250, and the more flexible Exar 350, both rated at 125 C and 600 V, are available in sizes 14 through 4 AWG as SIS-designated wire. In sizes 24 through 16 AWG, switchboard wire is supplied with a UL 3271 listing. The insulation also conforms to the vertical flame-resistance requirements of IPCEA standard S-19-81.

CIRCLE NO. 373

POWER SOURCES

Industrial power units offered at lower cost

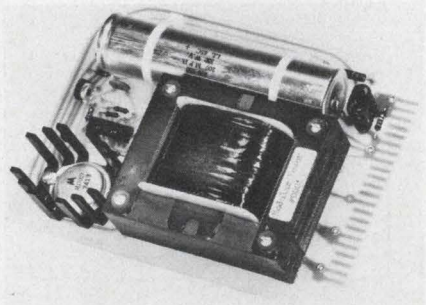


Abbott Transistor Labs Inc., 5200 W. Jefferson Blvd., Los Angeles, CA 90016. (213) 936-8185. $249 (1-4); stock.

Model RN20 Series, 60-Hz-to-dc industrial power modules, incorporates the same electrical performance and mechanical construction as the company's "R" series but at 20% less cost. The RN20 family provides 20 A at various voltages between 4.5 and 13 V dc. Line and load regulation are 0.1% and ripple is less than 0.02%. Standard features include short-circuit protection, input transient protection and remote error sensing. Tempco is 0.03%/°C.

CIRCLE NO. 374

Source powers self-scan displays

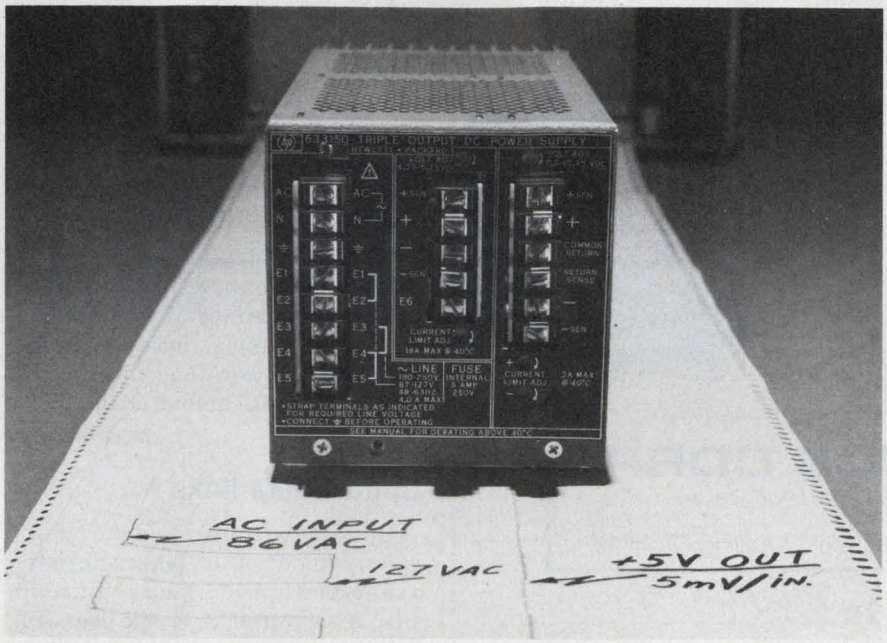


Modular Power, Inc., 4818 Ronson Ct., San Diego, CA 92111. (714) 279-1641. $52.50; 4 wk.

PCS-250/DI is designed specifically for self-scanning type visual displays. The unit provides up to 100 mA at 250 V dc. Ripple and noise specifications are 200 mV rms and tempco is 0.2%/°C. The supply features automatic current foldback. Size is only 4.5 × 5.95 × 2.25-in. and weight is 2.75 lb.

CIRCLE NO. 375

Triple-output dc source protects against brownouts



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 403-1501. $415 (25); 6-8 weeks.

Don't worry if your ac power line dips by 20%. Hewlett-Packard's new triple-output ac-to-dc supply will keep your load going. Don't sweat if the line voltage goes out completely—at least not for the first 20 ms. That's how long the HP 63315D will carry the load with no ac input.

More and more, memories in computers and terminals face loss of valuable data as the stability of prime power increasingly worsens. And, more and more, power supplies like the HP unit are being offered for brownout or blackout protection.

Both ±15 and 5 V are delivered by the 63315D, which lists its normal operating range as 87 to 127 V ac or 180 to 250 V dc, and which keeps the output steady even in the face of a 600-V line transient.

The dc load current is shared by the 5, 15 and −15 V terminals. Any combination can be selected from 18 A at 5 V and 0.67 A at ±15 V, to 10 A at 5 V and 2 A at ±15 V. One caution in selection is to stay below the 110-W maximum rating of the HP source.

All outputs are regulated to 0.12%, with ripple and noise of 5 mV rms, 40 mV pk-pk, from 20 Hz to 20 MHz. Outputs are adjustable: 4.75 to 5.25 V for the 5-V level, and ±11.4 to ±15.75 V for the ±15 V.

Standard in the 63315D is current limiting of transient inrush currents and overcurrent, and protection against overtemperature, overvoltage and reverse voltage.

Self-restoring foldback is the method used to limit the current for shorts or overloads, and you can set the limits anywhere from 50% to 150% of rated value. A crowbar circuit watches for excessively high output voltages (6 to 7 V on the 5-V output; 16 to 18 V on the ±15). When tripped, the crowbar drops the outputs to less than 2 V.

Weight of the HP unit is just 10 lb. and size is 4.96 × 4.76 × 10.82 in. Cooling is by convection but you can remove the finned heat sink and mount the power supply against other structural surfaces if desired.

CIRCLE NO. 302

INFORMATION RETRIEVAL NUMBER 90 ►

Application Notes

Contact materials

A four-page reprint points out the electrical and thermal conductivities of the most popular contact materials as well as their corrosion resistance and mechanical wear properties. Deringer Manufacturing, Mundelein, IL

CIRCLE NO. 376

Equalizers and filters

"Group Delay Equalization in Communications Systems" features useful applications information as well as a tutorial look at the design of equalizers and filters. SEG Electronics, Richmond Hill, NY

CIRCLE NO. 377

Optical data links

Optical data link system parameters, fiber optic characteristics and typical performance capabilities are covered in a six-page bulletin. Meret, Santa Monica, CA

CIRCLE NO. 378

Wrought nickel silvers

Physical, mechanical and chemical data on wrought nickel silvers are provided in a 12-page catalog. The International Nickel Co., New York, NY

CIRCLE NO. 379

Electronic counters

Five application notes have been added to the series that detail how specific, frequently encountered measurement tasks can be performed by the company's Model 5345A 500-MHz electronic counters. An index to the series of 13 notes is also available. Hewlett-Packard, Palo Alto, CA

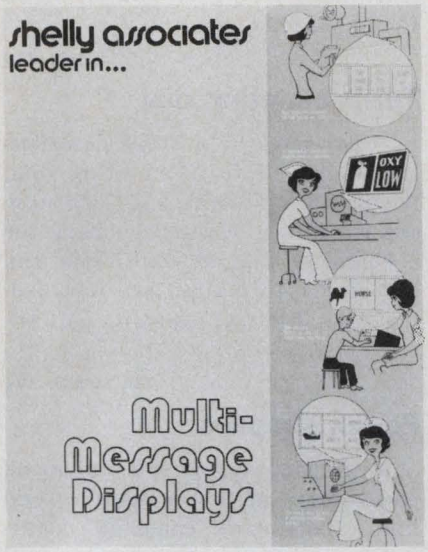
CIRCLE NO. 380

Pick the right capacitor

A simplified method of determining the proper capacitor for low-voltage dc power supply input filter applications is described in a bulletin. Sprague Electric, North Adams, MA

CIRCLE NO. 381

New Literature



Multimessage displays

Three families of multimessage displays, the SRO-64, SRO-90 and SRO-600 series, are described in a four-page bulletin. Electrical and mechanical characteristics are included. Shelly Associates, Santa Ana, CA

CIRCLE NO. 382

Data conversion products

Detailed specifications on data conversion products are given in a six-page foldout. Teledyne Philbrick, Dedham, MA

CIRCLE NO. 383

Resistors

Precision and power wirewound resistors are covered in a 36-page handbook. Included is a MIL style cross-reference chart. RCL Electronics, Irvington, NJ

CIRCLE NO. 384

Connectors and terminals

Solderless connectors and terminals are featured in a four-page brochure. Hoffman Industrial Products, Farmingdale, NY

CIRCLE NO. 385

Fire safety catalog

A redesigned catalog lists 600 publications and visual aids on fire safety, NFPA Publications, Boston, MA

CIRCLE NO. 386

Tape readers

Ruggedized punched tape readers for airborne, shipboard, mobile van, flight line and military applications are shown in a 36-page catalog. EECO, Santa Ana, CA

CIRCLE NO. 387

Epoxy adhesive

Two pieces of literature describe Ready-Bond JR 228. One provides technical specifications; the other features. Chomerics, Irvine, CA

CIRCLE NO. 388

Heaters and controls

A 120-page, four-color catalog contains a complete description of over 66 product lines of heaters, controls and accessories. Illustrated photos, diagrams, cross-sections and specifications are included. General Electric, Scotia, NY

CIRCLE NO. 389

Beryllium rings

Electronic and electrical applications of beryllium copper contact rings and springs are shown in an eight-page catalog. Instrument Specialties, Little Falls, NJ

CIRCLE NO. 390

Amateur radio equipment

Amateur radio equipment, including cw and SSB audio filters, electronic keyers, frequency standards, audio amplifiers, active filters, PC boards and components, are highlighted in a 16-page catalog. MFJ Enterprises, Mississippi State, MS

CIRCLE NO. 391

Components

System components for high-speed functional and dynamic testing are covered in an eight-page brochure. Tau-Tron, North Billerica, MA

CIRCLE NO. 392

IC industry report

Just off the press, a 76-page publication presents a clear unbiased picture of what happened in the integrated circuit industry in 1974, and what is in store for 1975. It costs $75 a copy; to order send check or company purchase order to Integrated Circuit Engineering, 6710 E. Camelback Rd., Suite 211, Scottsdale, AZ 85251

INQUIRE DIRECT

recruitment and classified ads

NEW LITERATURE

Thumbwheel switches

A 40-page catalog summarizes standard switches. Specifications, features, applications, photographs, outline drawings and prices are included. The Digitran Co., Pasadena, CA

CIRCLE NO. 393

Turns-counting dial

A two-page data sheet describes the Model 16 turns-counting dial. A photo, dimensional drawing, specifications, reference chart for a complete line of multidials and ordering information are included. Spectrol Electronics, City of Industry, CA

CIRCLE NO. 394

Power supplies

A 48-page designer's handbook and catalog of power supplies and line conditioners contains imaginative solutions to conventional power conditioning and ac-dc conversion problems. Tele-Dynamics, Fort Washington, PA

CIRCLE NO. 395

IEEE standards catalog

A 32-page IEEE standards catalog lists more than 350 standards publications by subject as well as in numerical sequence. Included are American National Standards published by IEEE. IEEE, New York, NY

CIRCLE NO. 396

Punched tape readers

Design features and specifications of dual-sprocket drive, photoelectronic punched tape readers with reading speeds from 100 to 600 characters per second are given in an eight-page bulletin. Decitek Div. of Jamesbury Corp., Worcester, MA

CIRCLE NO. 397

Solid-state replacements

An updated 156-page guide to RCA solid-state products lists more than 103,000 types which can be replaced with only 250 SK devices. Ratings, characteristics, dimensional outlines, terminal diagrams and a revised semi hardware replacement directory are included. RCA Solid State, Somerville, NJ

CIRCLE NO. 398

Vendors Report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

The Foxboro Co. Instruments and systems for process management and control.

CIRCLE NO. 421

Altair. Electronics, instrumentation and industrial process and control systems.

CIRCLE NO. 422

Franklin Electric. General-purpose motors.

CIRCLE NO. 423

Royal Industries. Automotive electronics, nuclear-energy products and plastic products.

CIRCLE NO. 424

Teleflex. Aircraft controls, monitoring and measuring devices for nuclear reactors, protective coatings and plastic extrusions.

CIRCLE NO. 425

Western Union Corp. Information networks, teleprinter networks, computer-communications networks, terminals for systems and communications satellite systems.

CIRCLE NO. 426

Nippon Electric. Communications, electronic data processing, components and consumer electronics.

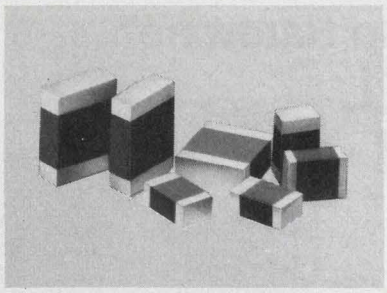
CIRCLE NO. 427

Fairchild Camera & Instrument. Semiconductor components, integrated circuits, discrete products, communications equipment, audio-visual equipment, transducers, magnetic recording and reproducing systems, space and defense systems and automatic testing equipment.

CIRCLE NO. 428

quick ads

New and current products
for the electronic designer
presented by their manufacturers.



HIGH Q MULTILAYER CAPACITORS feature very high quality factors at microwave frequencies. Offered in three standard sizes: .050 x .040, .080 x .050, .125 x .095. Capacitance values from 0.1 pf to 1000 pf with close tolerance and voltages to 1000 VDCW. Johanson/Monolithic Dielectrics Div., Box 6456, Burbank, Ca. 91510, (213) 848-4465.

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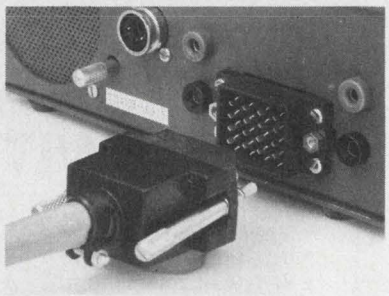

Rugged and low-cost 36-pin connector. Suberbly designed and produced with simplified construction. Cut your costs up to 50%. Moisture-resistant glass-filled nylon insulator Recessed contacts in both male and female housings. Hood provides positive cable strain relief. Interchangeable. E. F. Johnson Co., Waseca, MN. (507) 835-2050.

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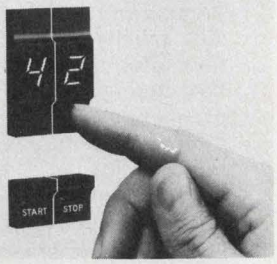
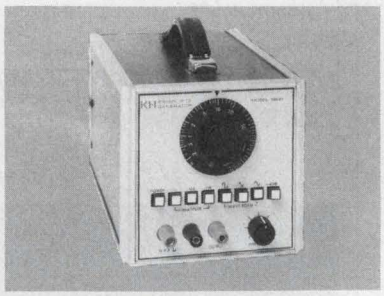


Solid-State Digital Advance Switch— The thumbwheel switch you activate with only a TOUCH! No rotating of cumbersome ratchet wheels. Simply touch the "touch plate" and the switch advances, step-by-step, until you remove your finger. Stepping rate 0.3 seconds/digit. Master Specialties, 1640 Monrovia, Costa Mesa, Calif. 92627.

INFORMATION RETRIEVAL NUMBER 607

Free catalog of 34,500 power supplies from the worlds largest manufacturer of quality Power Supplies. New '74 catalog covers over 34,500 D.C. Power Supplies for every application. All units are UL approved, and meet most military and commercial specs for industrial and computer uses. Power Mate Corp. (201) 343-6294.

INFORMATION RETRIEVAL NUMBER 602



Low Cost Function Generator, Model 5800; sine, square and triangle waveforms from 0.2Hz to 2MHz. 15 volts p-p outputs, 50 ohm output. Distortion typically less than .3%. 1000:1 tuning dial covers audio range on one band. Aux. output square wave. Price $245. Stock delivery. Krohn-Hite Corp. 580 MA Ave., Cambridge, MA 02139 (617) 491-3211.

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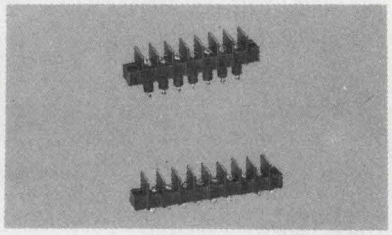

Compact Curtis Terminal Blocks of Unbreakable Thermo-Setting Plastic feature ultrasonically welded terminal inserts and full mechanical thread system. High-barrier CB/CFT blocks are rated 15 amp/300 volt with 5,500 volt breakdown. Feed-thru and surface-mount designs available. Curtis Industries, Inc., 8000 West Tower Avenue, Milwaukee, Wisconsin 53223, (414) 354-1500 or toll free (800) 645-9200 — New York call collect (516) 294-0990.

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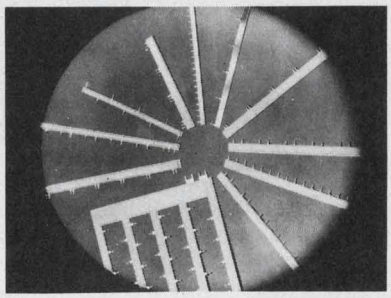

Mini/Bus® Evaluation Kit, $25, in stock. Lets you try Rogers' low-cost, noise attenuating, high packaging density power distribution system for PC boards. Millions in use. Standard parts on 2 weeks delivery, or less! Customer parts 4 to 6 weeks delivery. Rogers Corporation, Chandler, Ariz. 85224. Phone (602) 963-4584

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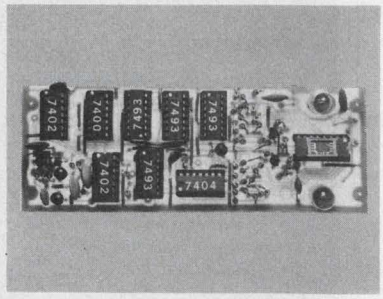

Low Cost Image Sensing Module contains a 1024 element (32-by-32) image sensor and all support circuitry on a single pc board. Digital video output may be displayed directly on an oscilloscope. Complete module (SE1024W) is $150. Kit (SE1024K) is $90. Cromemco, 26655 Laurel, Los Altos, CA 94022.

INFORMATION RETRIEVAL NUMBER 606

NEW TOPAZ AC LINE REGULATORS FEATURE: • 98% efficiency • Small size and weight • Very low distortion • Wide input voltage range • Excellent response Prices start at $245. Models from 500 VA to 24 kVA. Delivery from stock. TOPAZ ELECTRONICS, 3855 Ruffin Road, San Diego, CA. 92123

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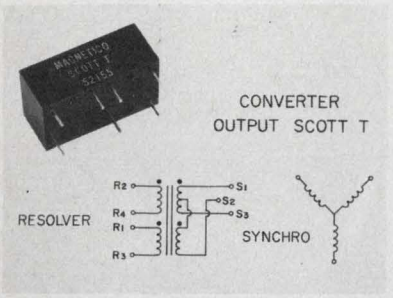

SCOTT T. TRANSFORMER: MAGNETICO Synchro driver is 7/8 x 1-5/8 x 11/16 high, rated at 1 volt amp., 2 arc minutes accuracy. P.N. 52155 is 5.9 sine and cosine to 11.8 v. L-L Synchro. P.N. 52156 is 5.9 sine and cosine to 90 v. L-L Synchro. MAGNETICO, 182 Morris Avenue, Holtsville, N.Y. 11742—516-654-1166.

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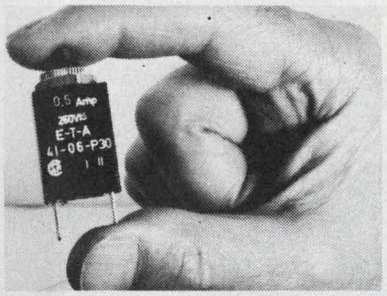

Overcurrent Protector, manual reset eliminates fuse replacement. Convenient panel mounting. 15 fractional ratings from 0.1 to 3 amp. Other models up to 400 amp. Trip-free and fool-proof, UL and CSA approved. High quality, low cost $1.29 ea. in 1000 lots. E-T-A Products Co. of America, 7400 N. Croname Rd., Chicago, Ill. 60648. Tel: (312) 647-8303. Telex: 253780.

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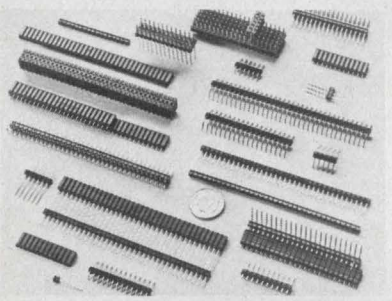

MALE & FEMALE HEADERS. Straight and right-angle male headers provide economical attachment of complete matrices of .025" square posts to PC boards. Female headers provide economical interconnecting to matrices of square or round posts. Off-the-shelf up to 36 contacts/row. Custom shapes: 4-6 wks A P PRODUCTS INC, Bx 11-D, Painesville Oh 44077

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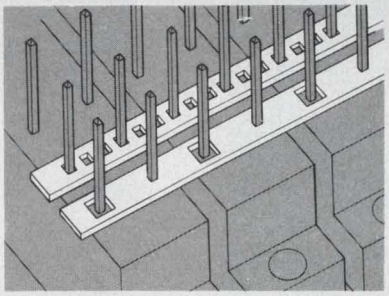

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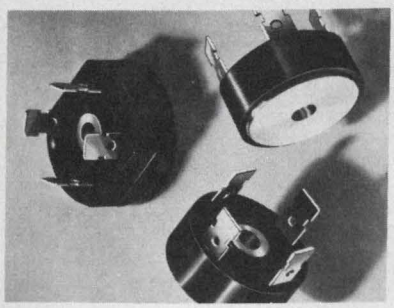

30 amp bridge rectifiers for UL applications from Tarzian has exceptionally long creepage path (¼"+), aluminum base for rapid heat dissipation. 400 Amp surge rating. 50-1000 PIV. Center hole or stud mount case $3.42 and up in 25 quan. Sarkes Tarzian, Inc., Semiconductor Div. 415 College Ave., Bloomington, IN 47401, 812-332-1435.

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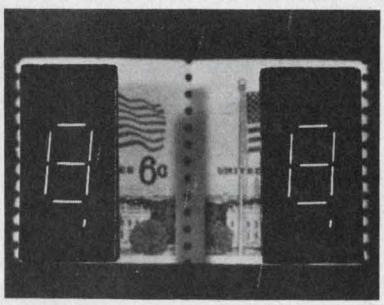

The Proven Incandescent Readout Standard 16 Pin DIP Flat Pack. All units 5 Volt 100,000 hrs. plus
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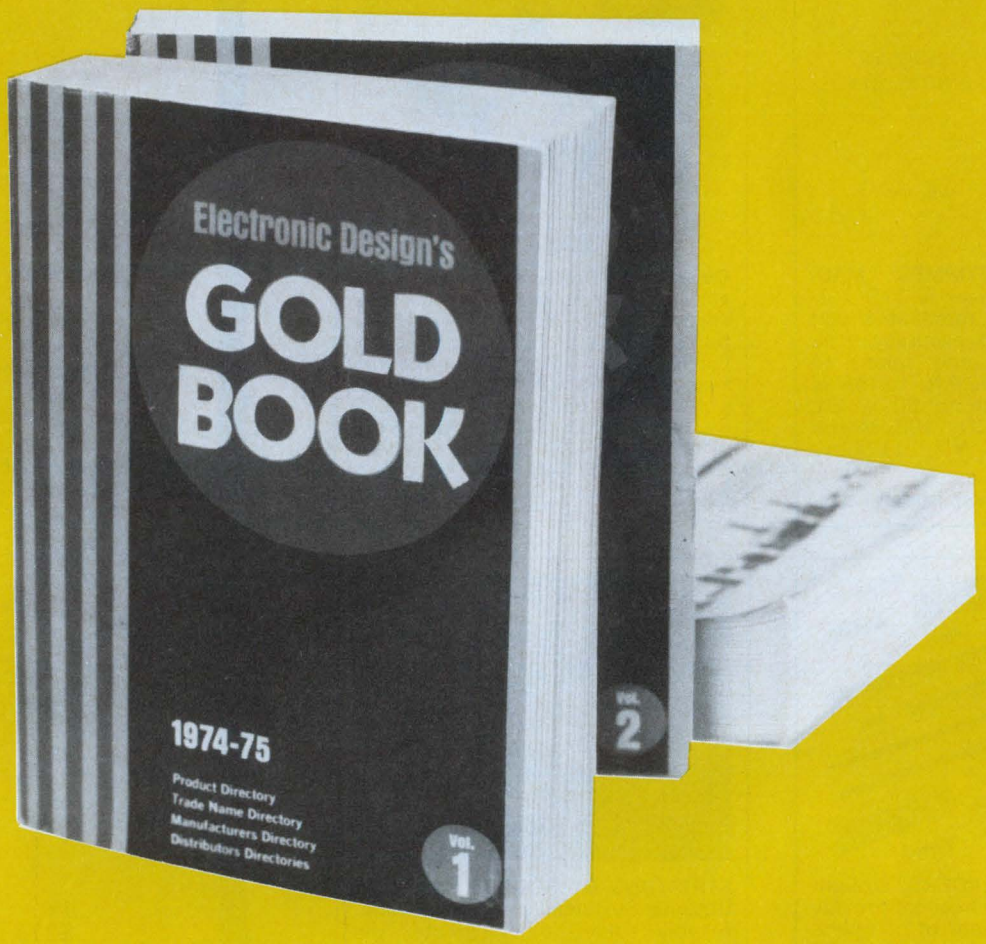

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COMPARISON OF ELECTRONICS INDUSTRY DIRECTORIES

(1974-75 editions)

	Electronic Design's GOLD BOOK	EEM Electronic Engineers Master	EBG Electronics Buyers Guide
CIRCULATION			
Total	Over 90,000	85,993[1]	30,017[1]
Non-U.S.[2]	13,200	None[1]	1,339[1]
CATALOG PAGES			
Number of pages	2,820	2,752	257[3]
PRODUCT DIRECTORY			
Total number of pages	469	195	305
Total number of products listed	4,799	3,235	4,267
Number of direct products listed	2,925	2,250	2,479
Number of cross-reference products listed	1,874	985	1,788
Is complete mailing address given each time a company is listed?	Yes	No	No
Is telephone number given each time a company is listed?	Yes	No	No
TRADE NAME DIRECTORY			
Total number of pages	28	19	18
MANUFACTURERS DIRECTORY			
Total number of pages	341	200	260
Number of manufacturers listed	7,528	3,165	5,800
Are distributors listed for manufacturers free of charge?	Yes	No	No
Does manufacturers listing include FSCM numbers?	Yes	No	No
Does manufacturers listing show facsimile equipment by make and call number?	Yes	No	No
DISTRIBUTORS DIRECTORIES			
Number of distributors listed in alphabetic section	5,780	1,720	None
Number of distributors listed in geographic section	5,780	1,720	None

NOTES:

[1] Standard Rate & Data; Oct. 24, 1974

[2] Includes Canada

[3] Includes fractionals

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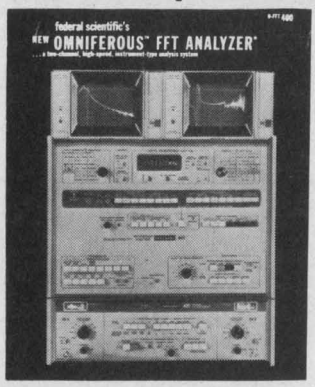
Design Data from

Dual Hi-Speed FFT Processor Easy to Operate



Conceived from the point of view of the operating engineer rather than the computer programmer, the new Omniferous™ FFT Analyzer *operates like an instrument*, calculates like a computer. This Series OF-400 Analyzer is a universal digital signal analysis system for real-time viewing of changing functions, a complete instrument with all signal conditioning and display calibration built-in. For the first time an operator can observe transfer function, cross-spectra or coherence as the signal is changing without waiting for the analyzer to perform successive laborious calculations.

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The system excels in high dynamic range, ease of use, display flexibiilty with two simultaneous display outputs, frequency coverage to 100 kHz, and reasonable cost. Designed by the originators of the famous Ubiquitous® family of real-time spectrum analyzers.

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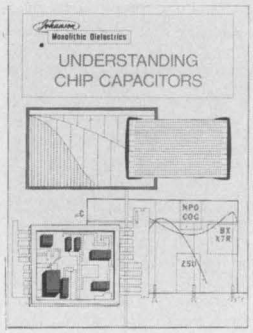
IMMEDIATE, CIRCLE NO. 170
ROUTINE, CIRCLE NO. 171

UNDERSTANDING CHIP CAPACITORS



This new thirty-two page reference book covers all phases of chip capacitor technology. The introductory section explains and illustrates in basic terms what chip capacitors are, their properties and how they operate. Included, as well, are six other chapters covering electrical properties, general classes of dielectrics, testing parameters, high reliability testing, general testing and quality conformance requirements, some answers on chips, and how to select the proper chips for specific requirements.

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CIRCLE NO. 172

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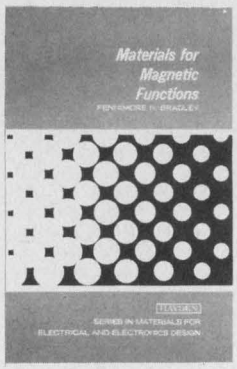

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by Fennimore N. Bradley

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CIRCLE NO. 173

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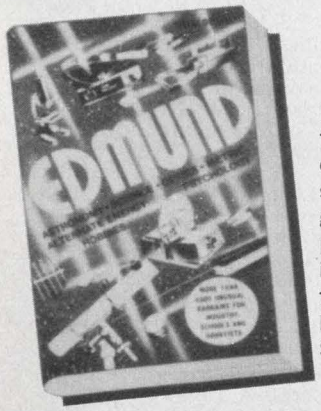

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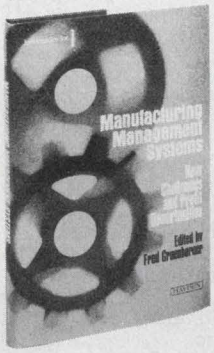

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Product Index

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Just How Broad is the MAGNECRAFT Stock Relay Line?

free wall chart!

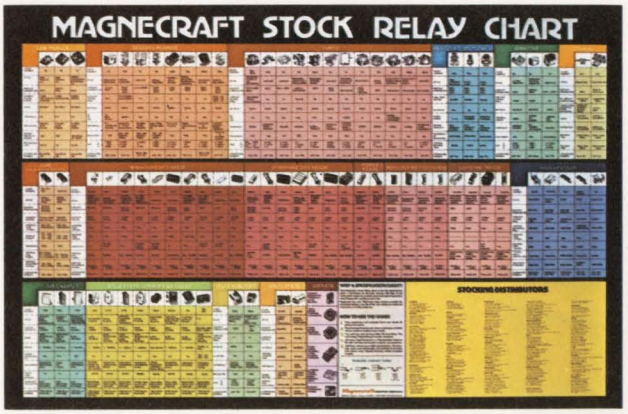
Magnecraft's stock relay line consists of 1200 versions derived from 17 categories - - - - - that is the largest and broadest line in the industry.

Oh? Did I read that correctly?

Yes, Magnecraft Electric provides 1200 relay versions in stock through our nationwide distributor network. Those 17 categories include; low profile, general purpose, power, mercury displacement, sensitive, coaxial, telephone type, air dashpot time delay, solid state, latching types, high voltage, mercury wetted reeds, dry reeds, and dip reed relays.

Magnecraft can offer you the design engineer, a quality product, local distributors, and the broadest relay line in the industry to choose from. If we don't have the relay in stock we will custom design a relay to meet your requirements.

Full color 22"x 34" relay specification chart.



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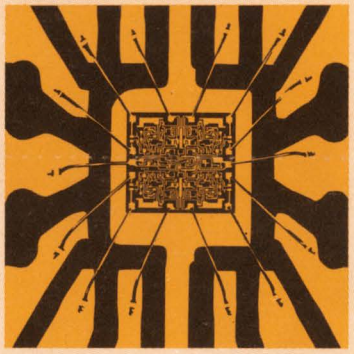
What's new in solid state...

RCA "Gold CHIP" LICs. Hermeticity in plastic at plastic prices.

Plastic LICs may have caused you some worries about field failures, actual or potential. But you didn't want to pay the price of ceramic or frit seal. Or, maybe the expensive hermetic packages you did use were damaged during insertion.



Now, the solution. RCA "Gold CHIP" linear integrated circuits. With gold metalization plus Chip Hermeticity In Plastic (CHIP). For reliability *plus* the economy and ruggedness of plastic.

Gold CHIP LICs have noncorroding gold metalization and leads. No aluminum with its potential problems. We make the chip itself hermetic. And put it in our advanced plastic package with proven outstanding reliability. Result: truly cost-effective hermetic LICs at the price of standard plastic LICs.

How reliable are they? We experienced *zero* failures in the following tests (data available): Temperature/Humidity/Bias, Operating Life, Thermal Fatigue, Pressure Cooker, Thermal Shock, Temperature Cycle.

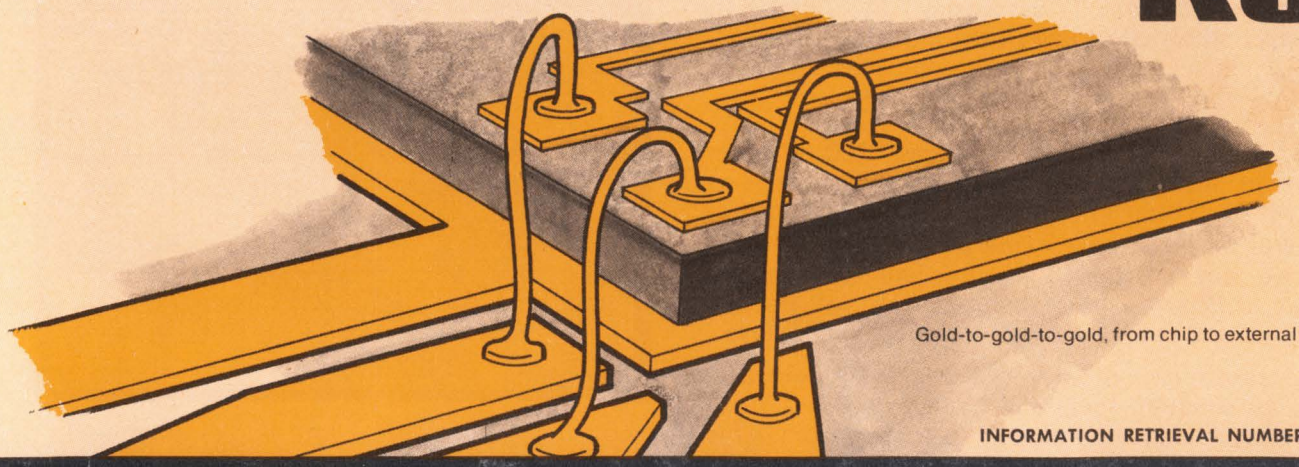
Free Gold CHIP Sample

Evaluate them yourself! We'll send you one of the 6 off-the-shelf "G" standards listed here, free: CA741CG op amp; CA747G dual op amp; CA324G quad op amp; CA339G quad voltage comparator; CA3724G high voltage transistor array; CA3725G high voltage transistor array. Just specify which one, on a self-addressed label.

To find out more, contact your local RCA Solid State distributor. Or RCA.

Write: RCA Solid State. Box 3200, Somerville, New Jersey 08876; Ste. Anne de Bellevue 810, Canada; Sunbury-on-Thames, U.K.; Fuji Bldg., Tokyo, Japan.

RCA



Gold-to-gold-to-gold, from chip to external world.

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RCA. Full house in Linear ICs.