VOL. 28 NO. 12
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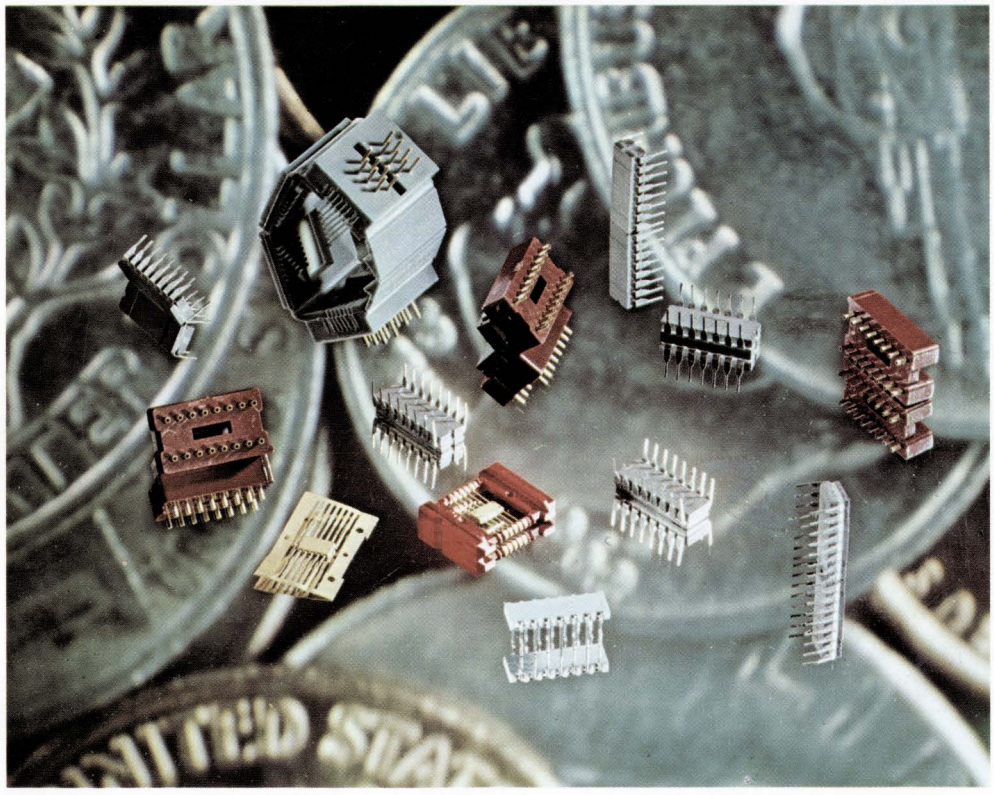
THE ELECTRONIC ENGINEER



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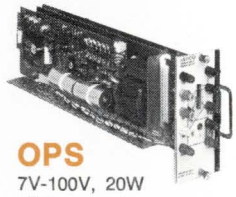

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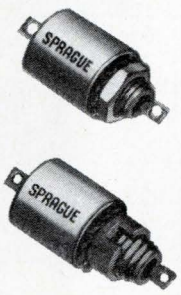

Series JX2000 Subminiature Filters for d-c applications are rated for 50 and 100 VDC operation @ 125 C. This broad line includes L and Pi circuit configurations rated from 0.1 to 2.0 amperes, as well as feed-thru capacitor styles with a rating of 7.0 amperes.

Series JX3000, especially developed for 125 VAC - 400 Hz (or 60 Hz) applications, are available as L and Pi circuits with current ratings of 0.1 to 1.5 amperes, as well as feed-thru capacitors with a current rating of 5 amperes. All units are designed to operate over a temperature range of –55 C to +125 C.

INFORMATION RETRIEVAL NO. 4

4SF-9109

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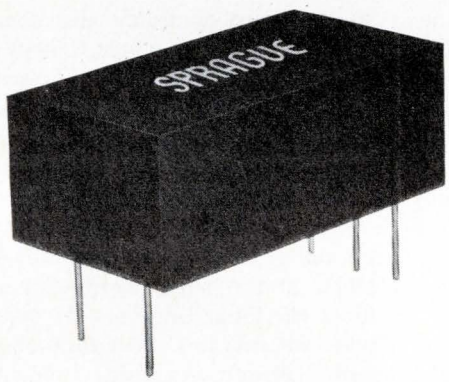

Developed for a variety of bandpass signal control applications. Combine both high performance and small size. Offer circuit designers a ±7.5% bandwidth, 20 db gain, and center frequencies from 400 Hz to 14.5 kHz. Precise capacitor and resistor components plus integrated amplifiers provide extremely stable performance at temperatures from −25 C to +75 C. Available in encapsulated construction. Meet vibration, shock, moisture resistance, thermal shock, and immersion cycling requirements of MIL-F-18327.

INFORMATION RETRIEVAL NO. 5

4SF-9163

For complete technical data on any of the above, request engineering bulletins as follows: EMI D-C Filters, Bulletin 8130A; EMI A-C Filters, Bulletin 8131; Active Filters, Bulletins 8700 and 8701. Write to: Technical Literature Service, Sprague Electric Co., 233 Marshall St., North Adams, Mass. 01247.

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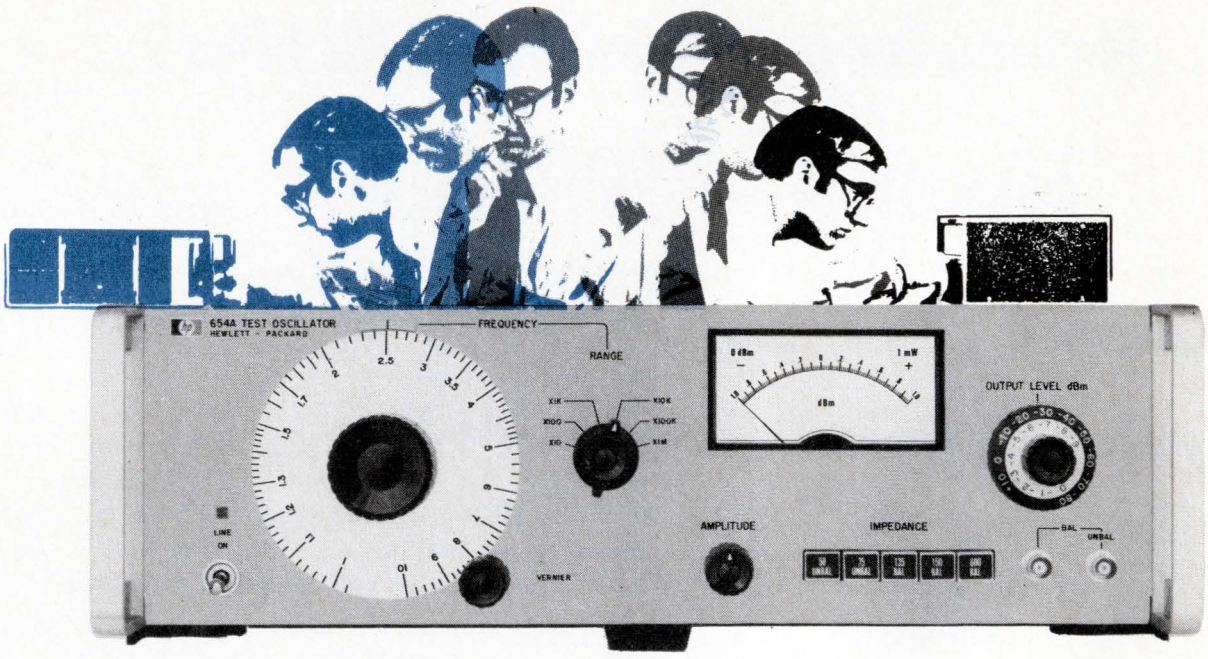

HP Test Oscillators... the step-savers!

Dollar for dollar, HP's 650 series of test oscillators provides the best performance in the 10 Hz to 10 MHz range—and saves you steps while doing it.

This series matches your performance requirements with the right price to give you the test oscillator that best suits your needs.

In the 650 series, you get test-quality amplitude and frequency stability. Once you have these oscillators set up you don't have to waste steps constantly checking them!

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Anyone have a special television application? Well, that's where the step-saving HP 653A comes in. It has the inherent accuracy and ease of operation of the 654A. It also has many special built-in video capabilities for A2 type television system measurements. Too many to cover here—but if you want more information, just ask. (Price $990)

If you want to put your test oscillator dollar to the best use, and save steps at the same time—call your local HP Field Engineer or consult your HP catalog. For data sheets, write Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

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SIGNAL SOURCES

THE ELECTRONIC ENGINEER

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COVER

The price of a TTL circuit varies from supplier to supplier. Starting on page 53 is a side-by-side price comparison of the two most popular lines, SUHL and Series 7400. These tables will show you how you can cut costs by shopping for your TTL devices.

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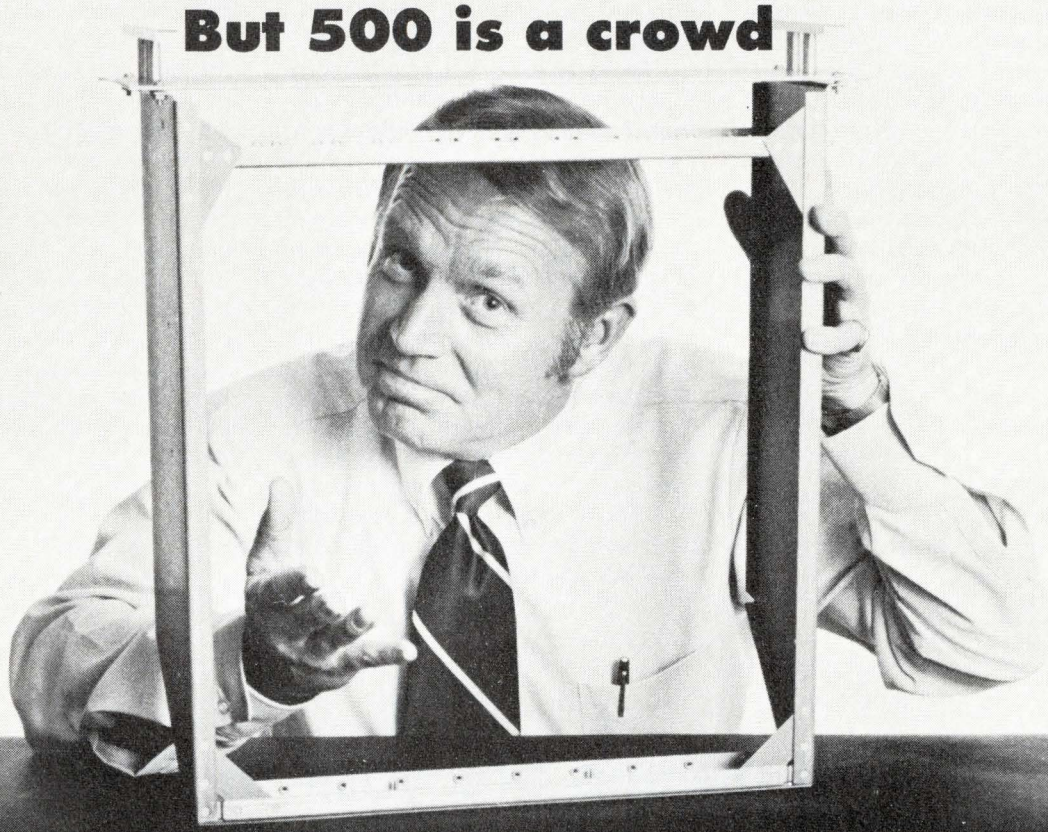
1000 IC's are company, But 500 is a crowd



dipstik™ makes the difference!

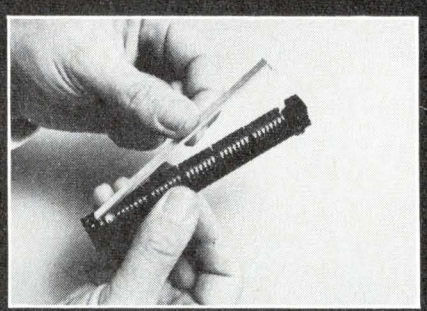
IC packaging has finally caught up with IC design. A 5¼" rack will hold 500 IC's mounted on printed circuit boards or 1000 IC's mounted in Dipstiks . . . a 100% packaging density improvement.

Dipstik, a unique, solderless cartridge for mounting IC's, eliminates many of the problems and costs associated with PC boards. Problems like: cold solder joints, lifted pads and traces, plated-thru holes that don't quite make it, and degraded circuits due to long lead lengths. Cost such as: PC artwork and production, long breadboarding and design time. Even soldering and de-soldering of IC leads.

Quick; each Dipstik takes only seconds to load. Reliable; low insertion forces and high retention forces of the Dipstik protect the fragile IC leads from damage. Flexible; Dipstiks even handle discrete components where necessary. Inexpensive; about $6.40 or less per Dipstik (at 500 level).

DROP IN: Up to 5 dual in-lines (up to 88 pins total).

CLAMP IN: The heatsink which holds the IC's firmly in place.



SNAP IN: Insert the loaded Dipstik in the connector block and give the cover screws a twist.

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The HP 1900 is the first pulse system to combine **state-of-the-art** performance with **plug-in** versatility.

The result? A single system that meets your most advanced testing requirements and still gives you the flexibility to meet the varying challenges of day-to-day changes.

With the 1900 pulse system, you can start with a 25 MHz plug-in that gives you up to one full amp output. Try this one when you are testing magnetic memory cores, MOS devices, or any other place where high current requirements have been tough to meet... up till now!

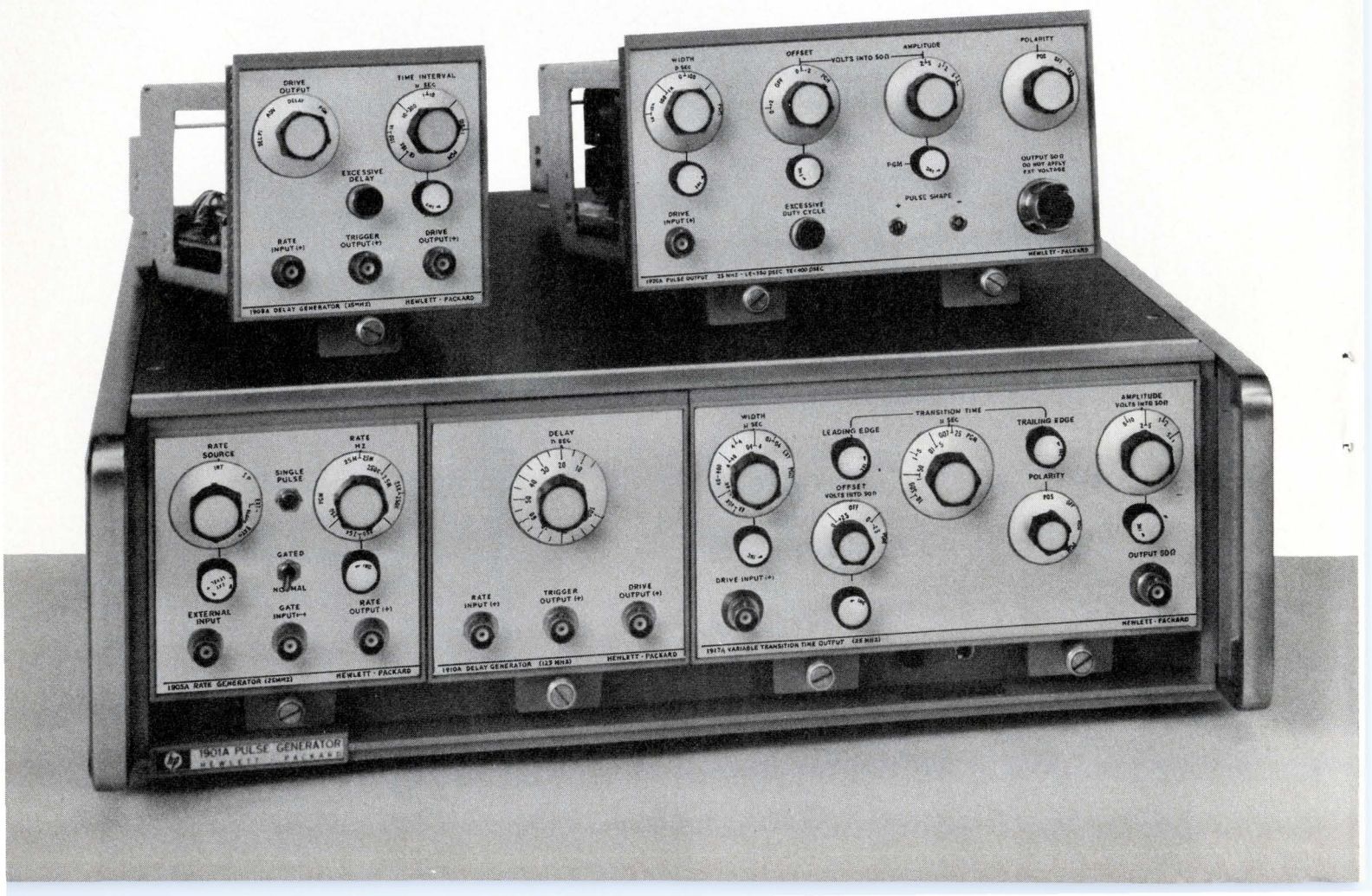
The same plug-in also provides a pulse with variable rise and fall times from 7 ns to 1 ms. An adjustable voltage output of up to 25 volts and the ability to amplify RZ or NRZ word formats. It all adds up to a plug-in designed to provide power to spare, plus the capability to handle a wide variety of testing requirements.

Or perhaps speed is what you need. Another plug-in gives you a **350 picosecond** fixed risetime pulse that you can control in width, offset, amplitude and polarity. Whether you're testing storage time in ultra-fast diodes or checking propagation delay you can be sure of getting the accuracy you require.

And when you need extremely short duration pulses at a rep rate of from 0 to 25 MHz, you'll appreciate the 400 picosecond falltime of this pulse. Just adjust for zero width and you are ready for impulse testing. This is the plug-in that will give you the ability to test the most advanced circuits available today . . . or tomorrow.

To give you complete control over the digital format of either of these plug-ins the 1900 system also provides a word generator. They combine to let you generate and shape the specific word that best fits your system.

If pulses are your problem···
meet HP's plug-in solution.



You can get 2- to 16-bit word lengths at a 0 to 50 MHz clock rate. A pseudo-random noise output and RZ and NRZ formats at the flick of a switch add to its capabilities. And, you are compatible with ECL, TTL, DTL, MOS, core memories or any other type of circuit you are testing.

To all of this performance add optional analog programming and you have the most advanced state-of-the-art pulse system available today!

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SIGNAL SOURCES

But this is only the start of the HP 1900 pulse system's capability. You can select from two mainframes to meet your power requirements. Both are available with the inexpensive optional programming wiring that allows you to make the 1900 completely automatic.

The four additional plug-ins consist of a rate generator, two delay generators and a low-power variable transition time output (0.2 to 10V). Any number of plug-ins or additional mainframes can be added to your system. They can be stacked, mixed, cascaded or programmed to meet any configuration requirement . . . now or in the future.

Isn't it time you had the benefit of both state-of-the-art performance and plug-in versatility?

For more information on the pulse system that will enable you to keep up with the changing times, call your local HP Field Engineer. For data on all of HP's pulse generators, consult your 1969 HP catalog starting on page 342. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

Price: Mainframes, $450 and $750. Plug-ins, from $150 to $1750.

Circle 9 on Inquiry Card

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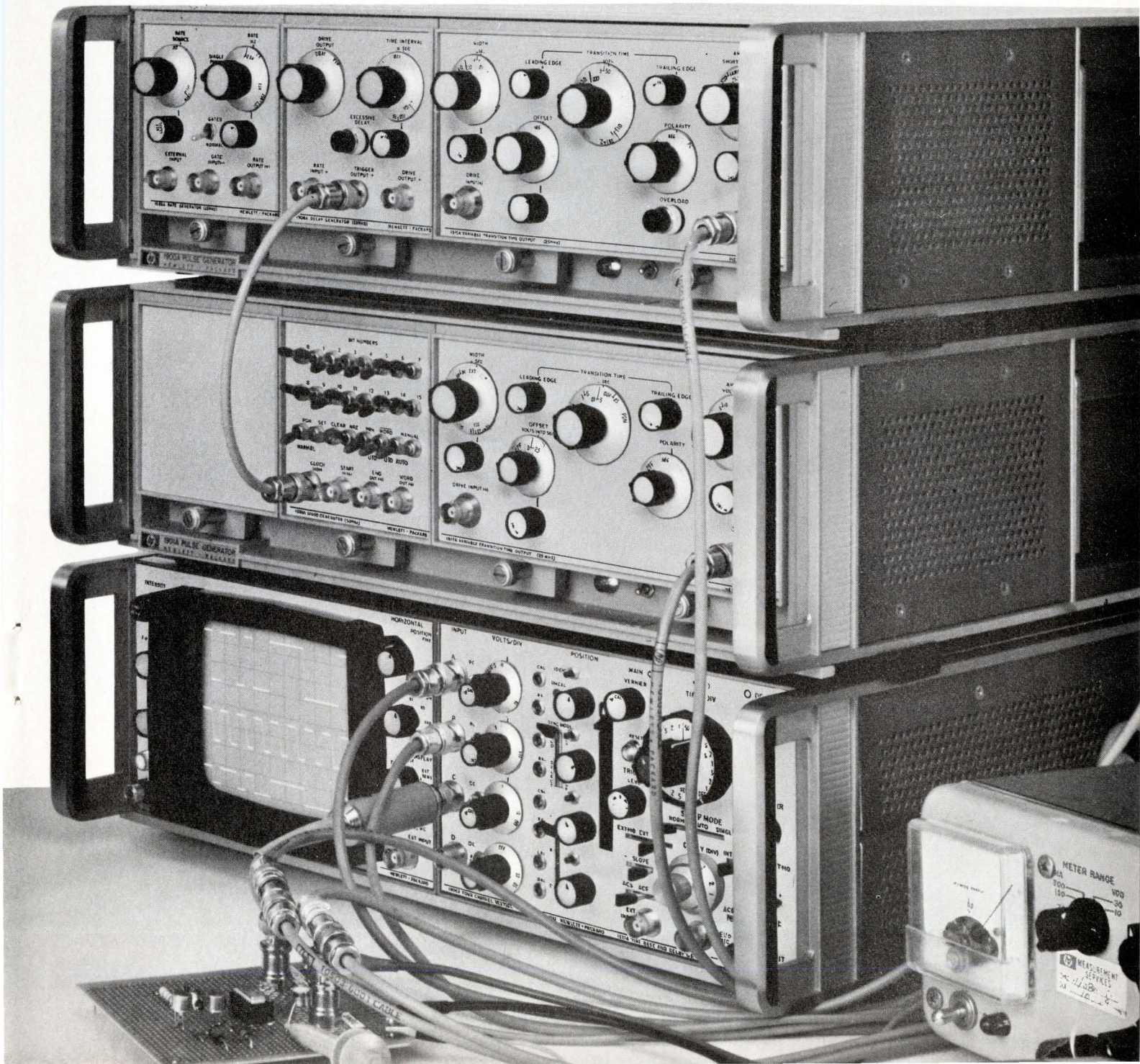

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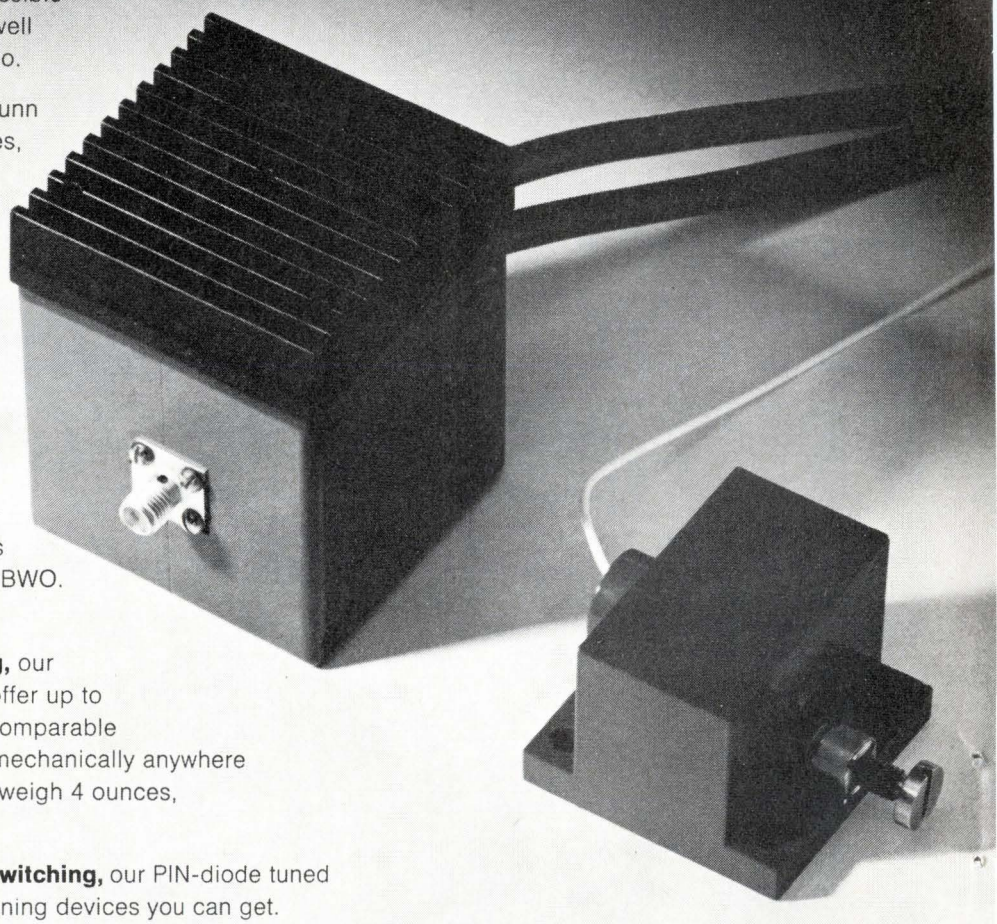
Everyone knows Varian sells the widest possible range of thermionic oscillators. But not so well known is the variety we sell in solid state, too.

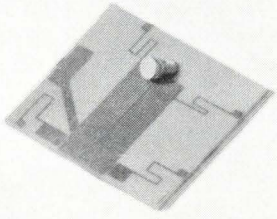
Consider our line of electronically tuned Gunn effect oscillators. They employ GaAs diodes, operating directly at the frequency you need, with no chains or multipliers. They all compare in cost to thermionic oscillators, with all the system-simplifying advantages only solid state offers. Plus the same guaranteed performance you've come to expect from Varian.



For wideband tuning we have an X band YIG-tuned oscillator that provides current-controlled frequency adjustment from 8.0 through 12.4 GHz. Only 2½ inches per side, it weighs less than 24 ounces. And its noise figure is significantly below that of a BWO. C and Ku band oscillators soon to come.

For rapid, continuous narrowband tuning, our varactor-tuned X and Ku band oscillators offer up to 1% frequency adjustment at tuning rates comparable to those of a reflex klystron. F_C can be set mechanically anywhere in the entire frequency band. X band units weigh 4 ounces, measure 1⅔ by 1⅔ by 1⅓ inches.

And for millisecond discrete frequency switching, our PIN-diode tuned oscillators are by far the smallest switch-tuning devices you can get. These S band microstrip midgets measure only 1 by 1 by ¼ inches, weigh a fraction of an ounce, and offer options of 2, 4, or even 8 step-frequency changes across their entire range. Other frequency bands can be readily developed. Let's talk. The man who gives you the choice you really need in electronic tuned oscillators is at our more than 30 Electron Tube and Device Group Sales Offices throughout the world.



Or contact our Solid State Microwave Division, 611 Hansen Way, Palo Alto, California 94303.

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Circle Reader Service No. 42

EDITORIAL

Don't bring back the transistor radio

Whether or not you are using integrated circuits made with metal-oxide semiconductor field-effect transistors (MOS-FETs), you are still probably aware that MOS technology is quite new. Only three years have passed since most manufacturers of MOS integrated circuits finally mastered the technology required to make a drift-free oxide. As soon as they learned how to apply this technology to ICs, they started delivering the first products. And, as with all the other semiconductors that preceded MOS, these products commanded a rather substantial price, finding their way into exotic space or military products that could afford that price.

Now we see the first signs of maturity in the MOS industry—the standard products. You would think, therefore, that these standard products would be used by forward-looking American companies in their "top-of-the-line" products, just as forward-looking manufacturers of color TV sets started two years ago to use integrated circuits in their "top-of-the-line" models.

Not so. Most of the standard MOS circuits produced in the U.S. (although they may be assembled in the Far East) go to Japan, mostly to manufacturers of electronic calculators. If this fact doesn't impress you, remember that it was a fledgling Japanese electronic industry that, in the mid-1950's, decided to use transistors in the manufacture of inexpensive radio receivers. And they did it so successfully that hardly any transistor radios are made today in the United States—save for some parts for automobile radios, or expensive tuners for hi-fi sets.

Do you see the parallel now? We see the same danger signs that we either didn't detect, or were unable to forestall fifteen years ago. It was in 1954 that Zenith first developed a portable transistor radio, quickly followed by Motorola, RCA, GE and other companies that were already in the radio market. But their effort was short-lived because these companies made transistor radios in the same way they had made radios with electron tubes—they designed high quality circuits, and requested the semiconductor manufacturers to either design or select transistors that could meet their specs.

The Japanese engineers, on the other hand, followed the opposite approach. They studied those transistors that were most common (and sold for less) and designed their receivers around them. Add to that the low labor cost Japan had at that time, and the result is history. Japanese transistor radios are glued today to the ears of our teenagers, and ride on camels in the dunes of North Africa. Of this fantastic market of more than one billion transistor radios, one of the largest any industry has ever seen, the United States has received only a small segment of the potential market.

What is the parallel, you may ask, between transistor radios and calculators? If the price of calculators goes down from the $2,000 they cost today to, say, $400, there will be a world market for more than one million calculators. And, just as most of the people who buy transistor radios today would have never bought a tube radio, calculators will be bought not only by those who use a slide rule or an adding machine today, but even by school children.

It is this market the Japanese electronic engineers are designing for. And to suit their cost goals they design them around the least expensive logic block of today: the MOS standard circuit. It is much unlike our method, which consists of coming up with an efficient system design, and then ordering an expensive circuit to suit.

Are we going to react to the challenge of calculators just as we did to transistor radios? Perhaps we ought to learn again the meaning of a word Japanese children are taugh in grade school; 安 *, a word we often take for granted.

Alberto Socolovsky
Editor

*Yasu. It means economy.

UP TO DATE

Canned color TV: The battle lines begin to form

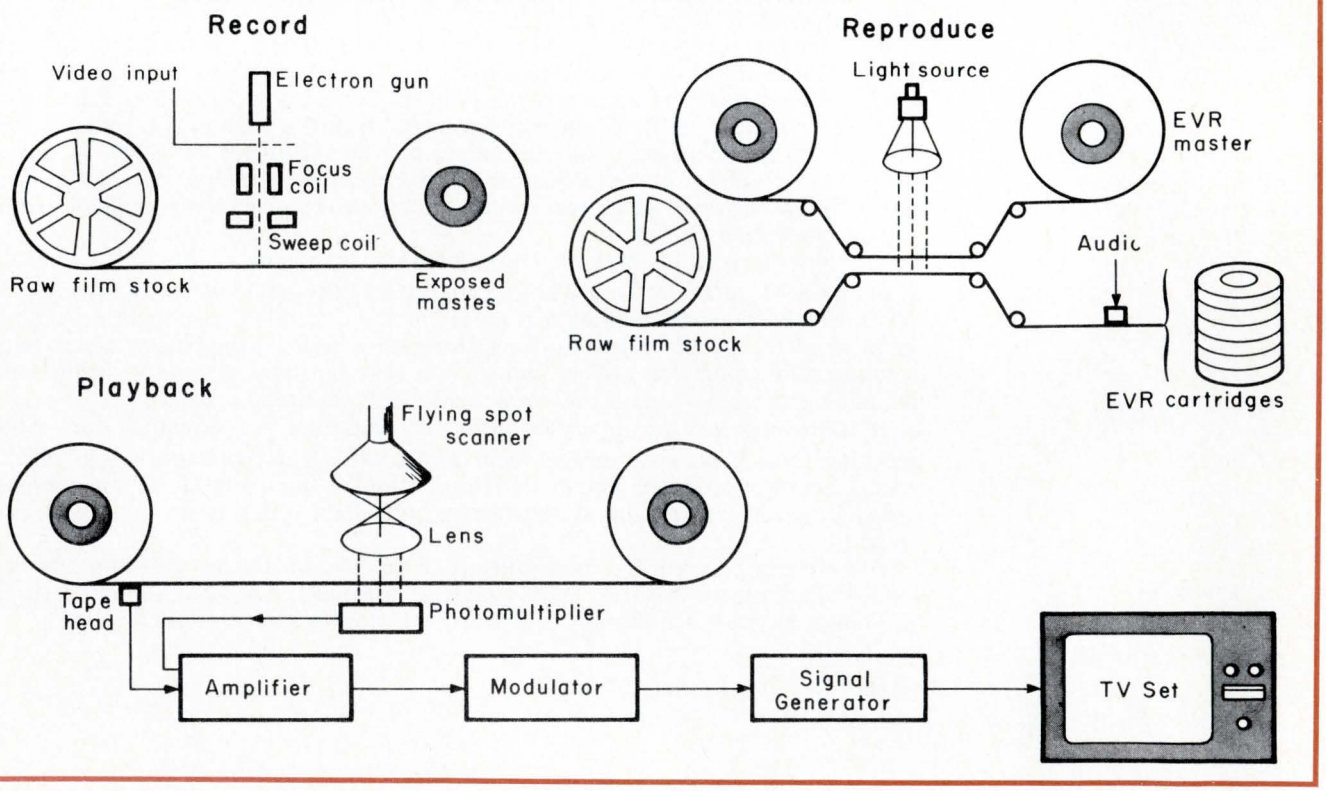
Robert Patton, Eastern Editor

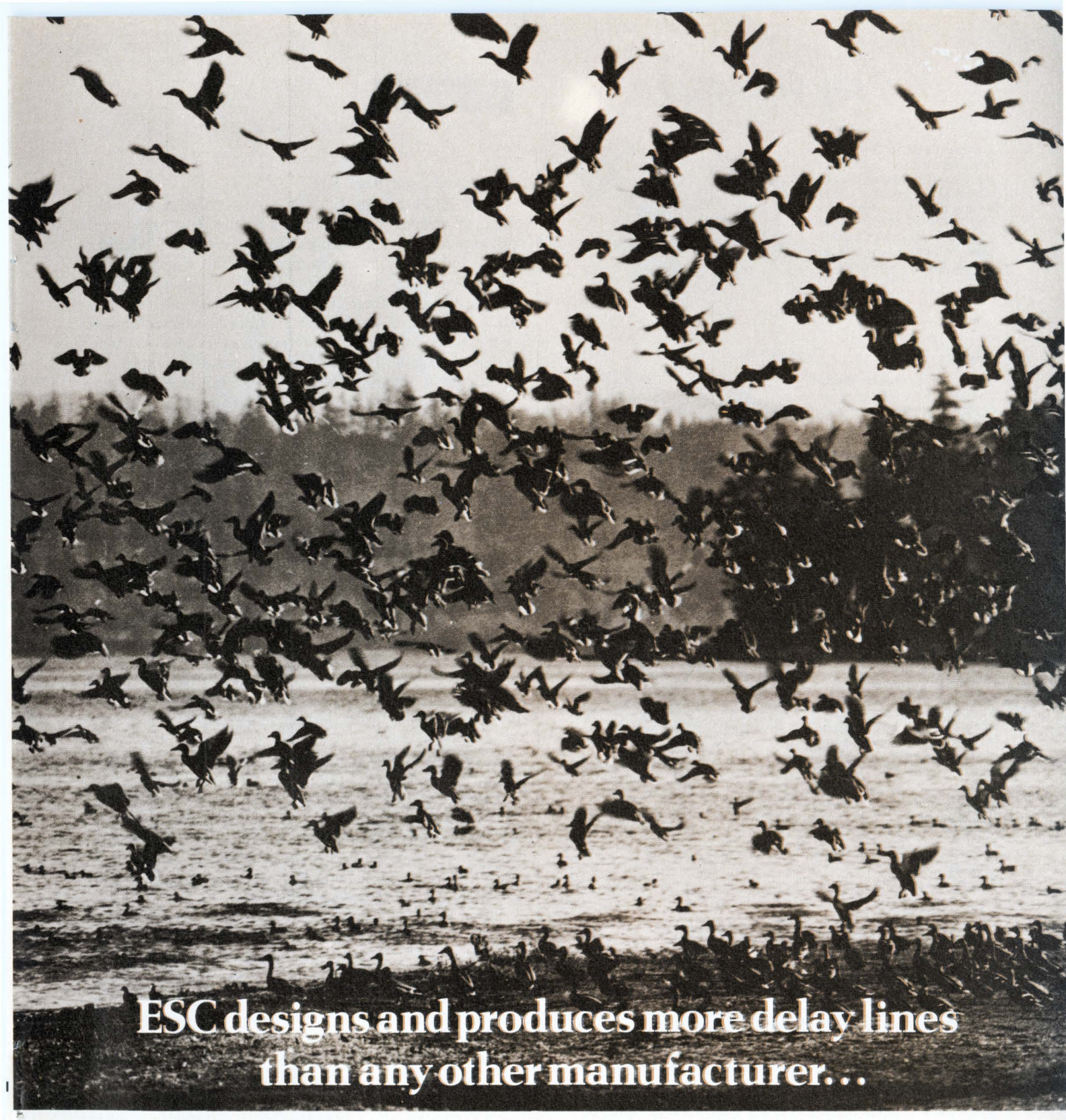
Not too long ago, industry seers were predicting a vast consumer market for videotape equipment. But their vision failed to capture the imagination of the consumer. Why? Largely because of cost. Even if the consumer were prepared to pay the relatively stiff price of the necessary equipment, he would balk at the even stiffer price of the tapes. (*continued on page* 12)

CBS Lab's EVR is the only system other than videotape that is fully operational today. Program material, in the EVR system, is carried on photographic film with a mag. tape sound track. During playback a flying spot scanner and a photomultiplier translate filmed information into electrical signals, windows on the film supply the sync signals, and a conventional tape head picks off audio from the sound track. The first EVR players, which will be offered by Motorola next year, are commercial units that will cost about $800, but nothing in the EVR system precludes the development of consumer versions selling at less than half of the price of these heavy duty units.

Electron beam recording is the key to the high resolution achieved in a small frame size on the EVR tape. Performed in a vacuum, the recording operation sweeps, focuses, and modulates an electron beam to "paint" images onto the film master in exactly the same way that a TV picture tube operates. Once the master is ready, duplicates can be manufactured at high speed using a conventional light source to expose raw film stock and a magnetic head to record the sound track. The EVR format consists of two tracks of program material, both picture and sound, although in the color version (reported operational, but still under wraps) one track is sacrificed to provide the color information.

Like SelectaVision, EVR film production requires sophisticated and expensive equipment that rules out do-it-yourself efforts by the end user.





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ESC Electronics Corporation
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UP TO DATE

(*continued from page* 10)

Now RCA has introduced a new concept in packaged TV entertainment, billing it as the most significant advance in home entertainment since color TV. Whether RCA will follow in the footsteps of the videotape advocates remains to be seen, but they do have some things going for them. Called SelectaVision®, the new RCA system uses an unperforated plastic tape embossed with phase holograms. Materials cost is low—in fact, almost negligible. Furthermore, because the tapes are embossed at high speed from a durable metal master, they can sell for $10 per recorded half hour.

Whether or not SelectaVision will ultimately capture the imagination—and the dollars of the buying public—remains to be seen. While the cost barrier that stopped the entry of videotape equipment into the mass consumer market appears to have been breached, a big advantage of videotape has been lost. Users of RCA's SelectaVision cannot generate their own program material. Thus, while RCA marketing people are quick to suggest that the Saturday afternoon golfer will be happy to lay out a few dollars to watch Jack Nicklaus or Arnold Palmer give a lesson in technique, they seem to have overlooked that the same golfer may also like to take a look at his own swing.

Another ingredient for commercial success that is still lacking is picture quality. The only prototype systems that exist have serious deficiencies. Even the monochrome version lacks the clarity and resolution that today's consumer demands, and the color version is, at this stage, little more than a laboratory curiosity. Furthermore, neither version boasts a sound track. But RCA is going ahead with some strong marketing plans and their engineers are confident that they will be able to deliver a marketable system by 1972. As a first step, RCA plans to market a $400 cartridge player backed up by an initial offering of 100 tapes.

RCA's confidence, however, is matched by the skepticism professed by one of their potential competitors. Last year CBS Laboratories introduced a system dubbed EVR (Electronic Video Recording). The CBS approach uses an electron beam to record visual images on a photographic medium. During playback, a flying spot scanner converts these filmed images back into video signals. Motorola, under a licensing agreement, will be offering EVR equipment commercially next year for about $800.

No experimental curiosity, EVR is a working system that offers broadcast quality picture and sound. Furthermore, a color version is in the works, and CBS expects to demonstrate broadcast quality color before the end of 1969.

From the sidelines it appears that a full-scale battle is shaping up between CBS and RCA. On its side, CBS has a system that can offer high quality color *now*. But the RCA system offers the promise of far lower cost for recorded materials than their competitor's. CBS may get their prices down but they are ultimately limited by the relatively high priced photographic medium that EVR is tied to. The big question is whether

RCA will deliver the quality that they promise. If they can, whatever market exists is probably theirs.

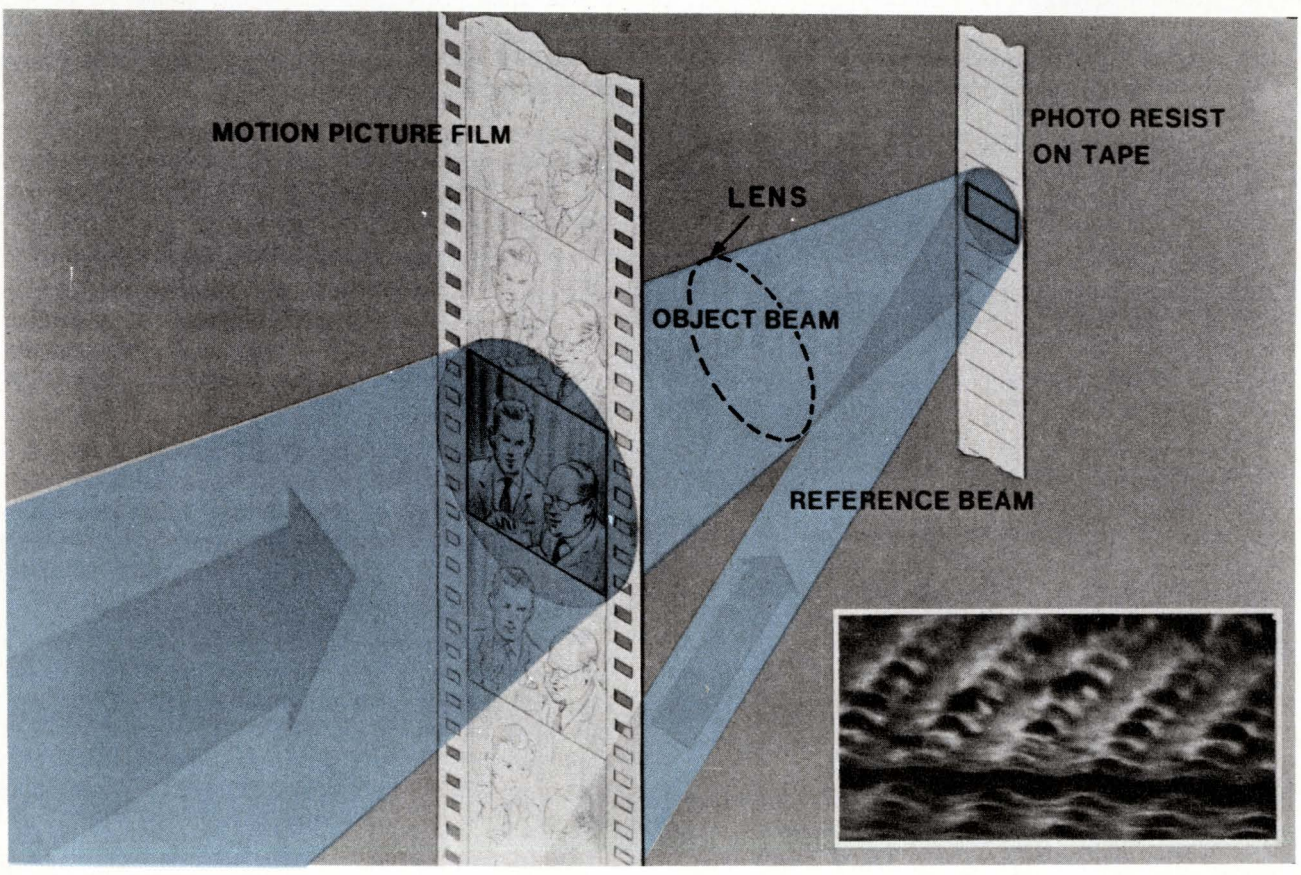
The only other possible combatant in this arena is Sylvania, which is presently working on a 8-mm film version of the color slide theatre that they are now marketing. If fruitful, this approach would allow the consumer to record his own material with ordinary home movie equipment—something that is not possible with either the RCA or CBS system. But, while RCA and CBS have already shown their systems, Sylvania's efforts have been restricted to the lab and the feasibility of their approach is yet to be demonstrated.

RCA's SelectaVision® is based on a Fraunhofer holographic recording technique. A laser sends a coherent plane wave through the photographic film from which the holographic master is made. Each point on the film then becomes the center of an expanding wave with an intensity that is a function of the film density at that point. A lens placed in the path of this object beam converts it back to a series of plane waves, each at an angle that depends on the position of its source on the film plane.

A reference beam consisting of a second coherent plane wave is directed in from one side and meets the object beam at the photoresist coated surface of the holographic recording medium. The reference and object beams interfere at the surface of the photoresist. This creates a fringe pattern of light and dark areas with a spacing that is a function of the angle between the reference beam and the specific element of the object beam. The smaller this angle, the greater the spacing between successive interference fringes.

After exposure, the tape is chemically developed to etch away areas that have not been hardened by the laser beam. This forms a 3-dimensional pattern of hills and valleys (see inset lower right corner), the spacing of which carries the recorded information. This tape is next plated with nickel and then stripped away leaving an embossed nickel master. The embossed patterns are then transferred to any number of transparent vinyl tapes of the same dimensions. The ease with which this can be accomplished at high speed is a major plus for the RCA system. Thousands of SelectaVision program tapes can be made in this fashion from a single nickel master.

At home in the user's set, a beam from a low power helium-neon laser passes through the tape to reconstruct the image for pickup by a low-cost TV camera built into the home player unit.



An idea whose time has come? Ion implantation

Stephen A. Thompson Western Editor

Engineers at the Hughes' facility, Newport Beach, Calif., have moved ion-implanted MOS (IMOS) from the laboratory to the production line. The LISR 0064, 64-bit, IMOS, dynamic shift register is in stock and can be purchased in small quantities for $200 apiece. It is a low threshold, bipolar compatible device. According to Irwin A. Lucks, MOS Product Marketing Manager, it is guaranteed to operate at 20 MHz, and can go as high as 30 MHz. This compares favorably to the best previously available shift registers which operate up to 5 MHz.

A dual, 64-bit shift register is on the way, with market entry slated for early 1970. It is faster, and will be pin compatible with standard dual 64's now on the market.

Hughes has built some IMOS 10-channel multiplexers that operate at up to 15 MHz, as compared to the 3 MHz models currently available. But these improved models may be bypassed by the introduction of a multiplexer with more capabilities some time next year. Hughes also hopes to make available by the third quarter a 2048-bit ROM. Though specs are not available, access time is said to be excellent.

Although these four devices have been fabricated in lot runs, except for the LISR 0064, none are off-the-shelf items. Hughes would consider IMOS production of these or other devices, such as RAMs or counter circuits, in quantities of 5,000 or more. Preliminary negotiations are being conducted with several customers for device production. Following an approximately four month period to obtain custom IMOS prototypes, 10,000 devices could be delivered within the following six weeks.

Extremely limited production capability exists at present, because the implantation steps are being done by the research system process pictured on page 73 of **The Electronic Engineer,** January 1969. This process allows only one wafer at a time to be processed. By the first of the year a much higher production capability is predicted after the installation of a multiple wafer holder, but that is still an interim measure. The real jump in capability will occur between the first and third quarter, when a Hughes-designed production system will have been purchased and installed.

Costs of IMOS devices are expected to be about 10 to 20% higher than for other devices initially. However, any prediction depends on the complexity of the variables. As serious production begins, competitive costs have been predicted.

Mr. Lucks says that the biggest problem now is that IMOS performance is so good that adequate test equipment is difficult to obtain. Because of this, Hughes has been forced to build much of its own. Clock generators and word generators capable of testing MOS processes at MOS voltage levels don't exist at present.

Complementary IMOS technology is also on the way. P-channel devices are standard now. N-channel devices, which are within the company's capability, are still in the tweaking stage.

INFORMATION RETRIEVAL
Integrated circuits, Semiconductors

HEW proposes X-ray standards

A proposed standard to establish a maximum level for receiver X-ray emissions was announced by the Department of Health, Education, and Welfare (HEW). It would apply to all TV sets coming off assembly lines after January 1, 1970.

The standard would become effective upon republication in the "Federal Register" after at least 30 days have been allowed for public comment.

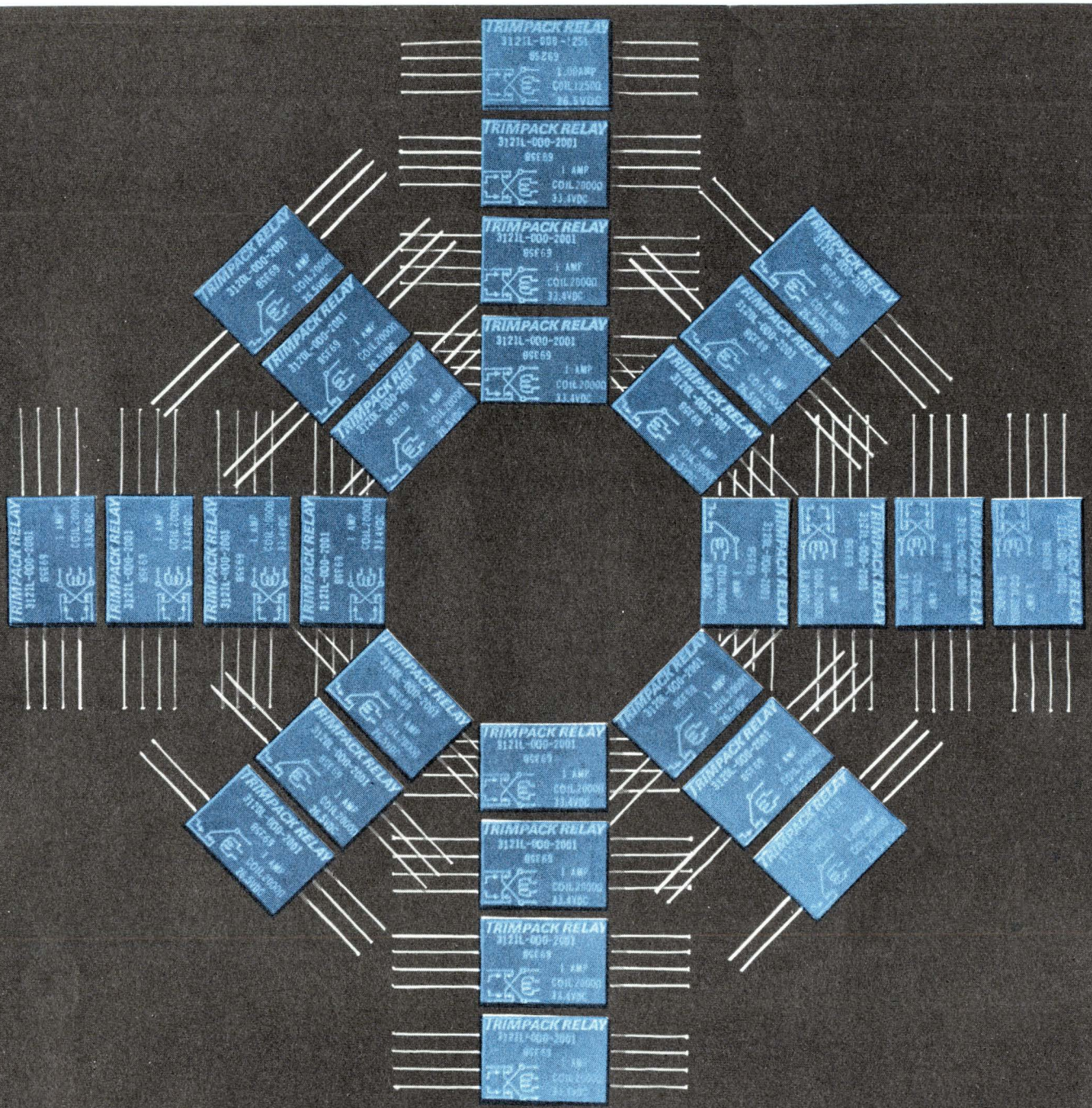
The proposed standard would limit X-ray emissions to a maximum of 0.5 milliroentgen per hour at five centimeters from any external surface of a set operating at a maximum of 130 line volts, under three operating conditions listed below. Each of these conditions has a high X-ray generation potential.

1. Sets produced after January 1, 1970 should be capable of meeting the 0.5 milliroentgen per hour standard at maximum electric power line voltages, even though a set owner accidentally should maximize the receiver's X-ray emission potential by maladjusting external controls.

2. Sets produced after June 1, 1970 should be capable of complying with the standard with both external and internal controls adjusted to maximize X-ray emission potentials. Increases in picture tube high voltage settings, for example, have resulted in excessive X-ray emissions.

3. Sets produced after June 1, 1971 should not emit X-radiation above 0.5 milliroentgen per hour in event of a component or circuit failure which would maximize the X-ray emission. Compliance with this condition might require the production of receivers with devices for shutting off the set or limiting high voltage when a critical circuit fails.

Additional information can be found in the "Federal Register."

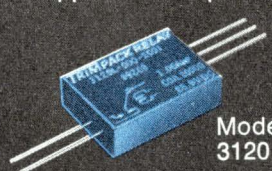


*BOURNS TRIMPACK RELAY TRIUMPH!

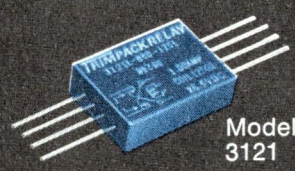
The new Model 3120 SPDT and 3121 DPDT TRIMPACK relays are just 0.80″ long, 0.57″ wide and—**note this**—only 0.25″ high. Designed especially for PC board application, their .100 pin spacing and unique low profile accommodates the usual ⅜″ spacing between PC boards to permit closer board stacking.

Another exclusive feature is that both new units are rated at 1.0 amp at 26.5 volts DC. The miniature size and outstanding power rating combine to make another Bourns first: THE MODEL 3120 AND 3121 TRIMPACK RELAYS HAVE THE **LOWEST PROFILE** IN THE INDUSTRY TODAY WITH A 1.0 AMP CAPABILITY.

The Model 3120 sensitivity is rated at 100 milliwatts; the 3121 is 160 milliwatts. Both have an operating temperature range of —65 to +125°C and they meet all applicable requirements of MIL-R-5757.



Model 3120



Model 3121

Complete data on the new **low-profile** Model 3120 and 3121 TRIMPACK relays are available upon request to the factory or your local Bourns sales representative.

BOURNS

BOURNS, INC., TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

Get plugged in on Beckman's new systems idea: Inclusivity.

The idea of "inclusivity" applies to compatibility of system modules. For such modules to be truly flexible and versatile, they must be compatible with one another; they must be compatible with modules made by all other manufacturers; and they must be compatible with the widest possible range of applications.

Beckman introduces inclusivity in its Model 3701 Universal Output Coupler (UOC), a system instrument that provides the interface between any known source of digital data and any known peripheral output device.

The UOC multiplexes up to ten sources of parallel data, with up to 32 bits per input word. Header data may be entered by front-panel switches. Other switches establish record length. Output rates range up to 100,000 characters per second.

Circle 13 on Inquiry Card

UNIVERSAL OUTPUT COUPLER SPECIFICATIONS

INPUT:	Up to 10 channels Up to 8 bits/character; 9 characters/word; 32 bits/word maximum
OUTPUT:	Up to 9 bits/character or up to 32 bits/word, in any format
INPUT COMMANDS:	Record; Channel Hold; Channel Skip; Format Control (changes between 2 formats on a channel to channel basis); Start; Stop; Error
OUTPUT COMMANDS:	Ready; Begin Scan; Scan Complete
DIMENSIONS:	19″ wide x 7″ high x 22″ deep
OPTIONS:	Input multiplexer cards; Output device control cards for incremental magnetic tape, continuous magnetic tape, paper tape, teletype, on-line to computer.

For full information on the Model 3701 or any of our systems modules, contact your local Beckman sales representative or the factory direct.

Beckman® INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
2500 Harbor Boulevard
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Major products include: voltage-to-binary converters, voltage-to-BCD converters, current-to-binary converters, current-to-BCD converters, frequency-to-BCD converters, events accumulator, binary-to-BCD converters, digital comparators, digital clocks, digital recorders, analog multiplexers, digital multiplexers, data formatter, teletype formatters, data processors

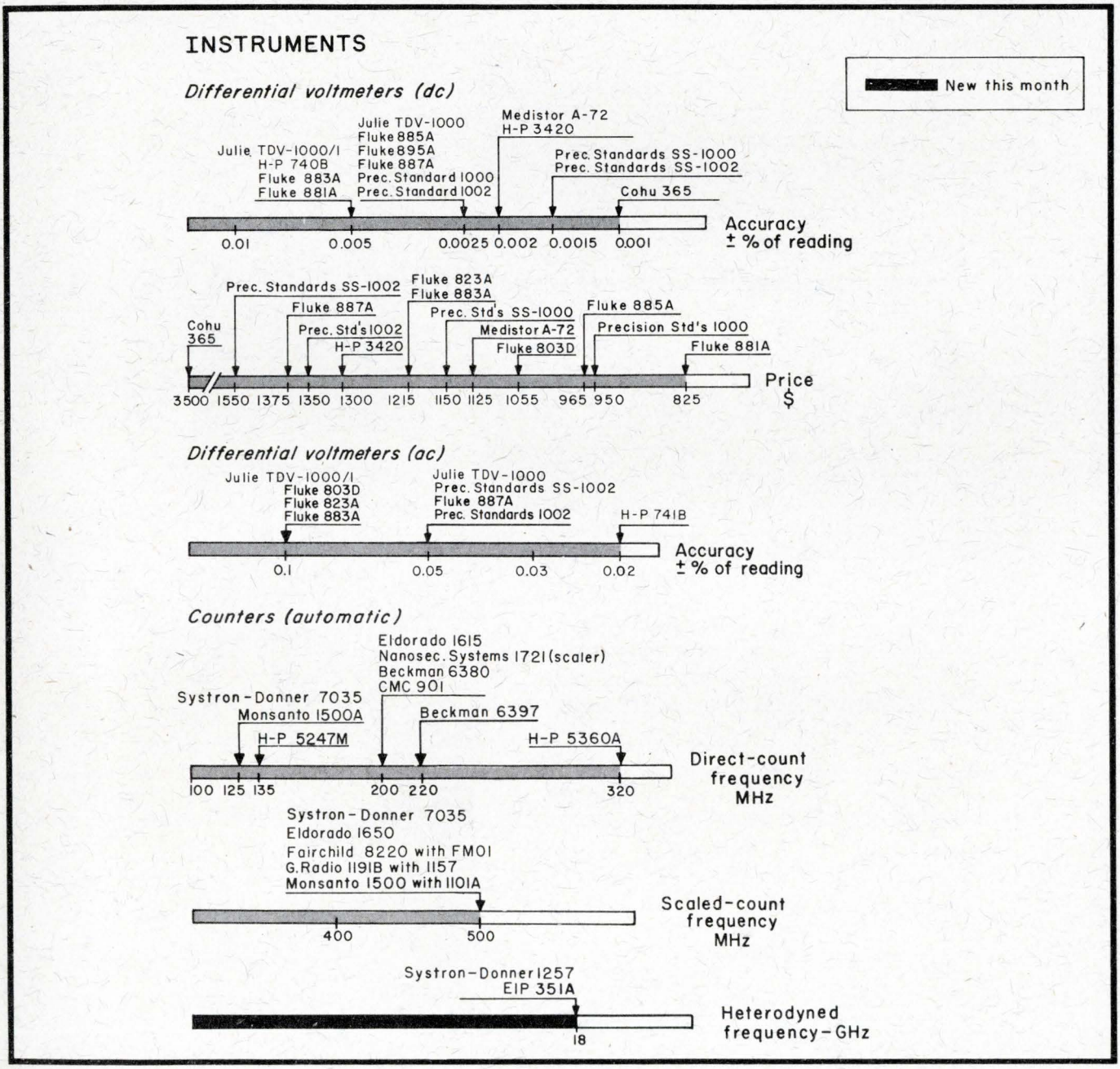
FOREFRONT

The EE Forefront is a graphical representation of the practical state of the art. You will find here the most advanced components and instruments in their class, classified by the parameter in which they excel.

A word of caution

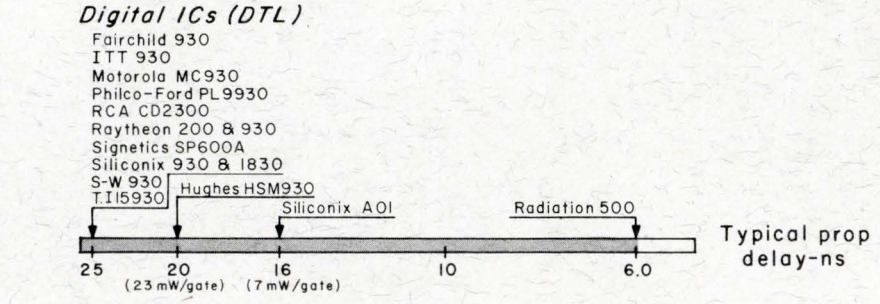
Keep in mind the tradeoffs, since any parameter can be improved at the expense of others. If there is no figure-of-merit available, we either include other significant parameters of the same products, or we provide additional bar graphs for the same products.

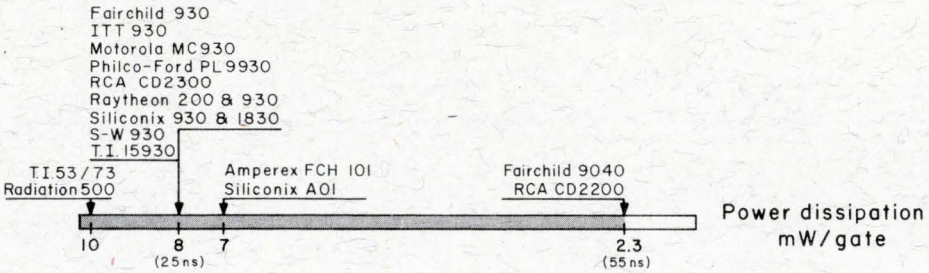
Do not use these charts to specify. Get complete specifications first, directly from the manufacturers.



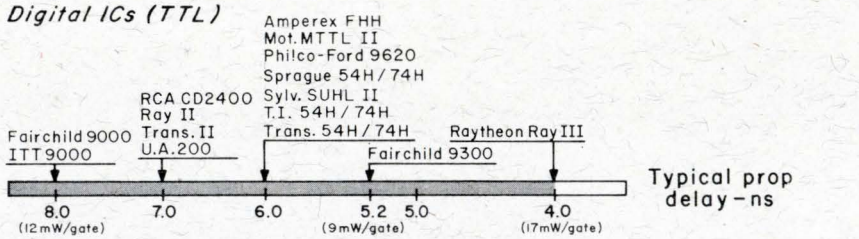
INTEGRATED CIRCUITS

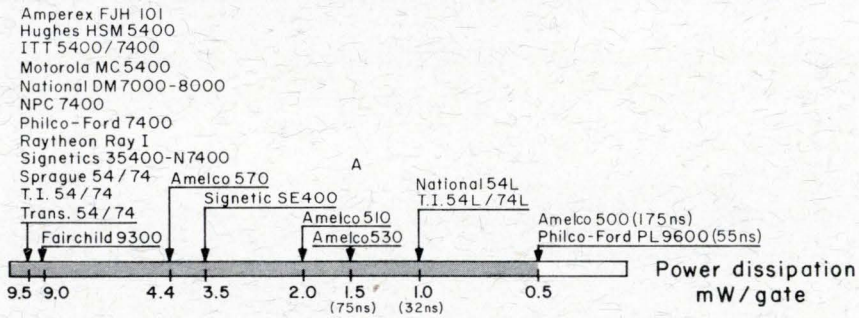
Digital ICs (DTL)



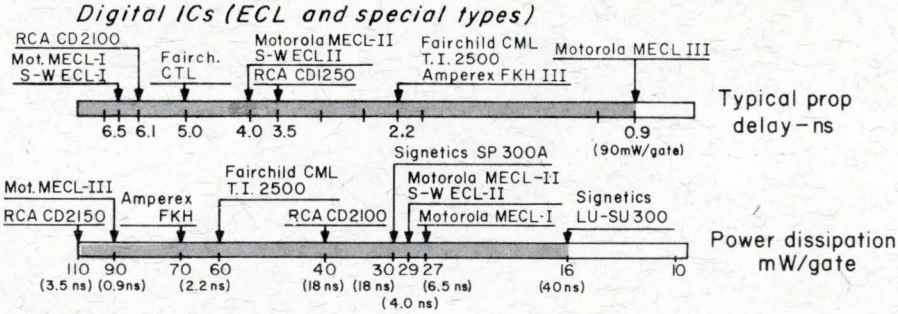


Digital ICs (TTL)

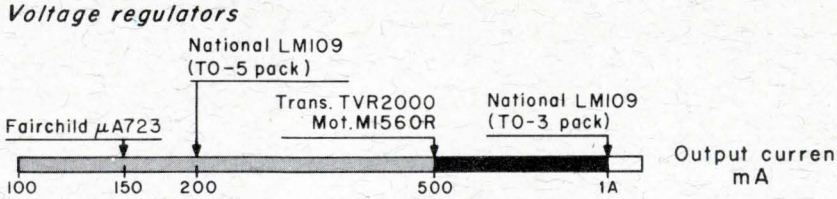




Digital ICs (ECL and special types)



Voltage regulators



Programming was pretty slow...
Now, the Beckman 6401 is programmable to 136 MHz

In the Model 6401 Programmable Counter and Timer, Beckman offers a general purpose laboratory and production instrument that does what you want it to, at a price you can't resist... $1375.

The 6401 provides direct frequency measurements to 136 MHz and complete programmability from contact closures. And the 6401 makes new measurements that were "unheard" of in the Good Old Days —like pulsed RF frequency or burst frequency measurements and period measurements from both channels for calibrated phase timing.

Timing measurements are a breeze with the exclusive trigger point monitor lamps in the 6401 for optimum attenuator and trigger adjustments. And maximum utilization of field replaceable IC's assures highest reliability and the lowest cost of ownership.

The 6401 is provided in a compact 3½" rackable package to conserve systems panel space, with 1-2-4-8 BCD outputs and scope markers as standard features. Options for serial input and output data, for nine digit display, and oscillator options with stabilities to 5 parts in 10^{10} per 24 hours are available.

Regardless of what "programmable" meant in the good old days, take advantage of what Beckman has to offer today. For complete information, contact your local Beckman office, sales representative or the factory direct.

Specifications

Measurement Modes: Frequency: Input A, 0-136 MHz; Input B, 0-10 MHz. Burst Frequency: 0-136 MHz. Time Interval: A to B, 0.1 μsec to 10^8 sec. Period: Input A, 0-10 MHz. Period Average: Input A, 1 to 10^8 in decade steps. Ratio: (Fx ÷ Fy) x M with Fx = 0 to 136 MHz, Fy = 0 to 10 MHz, M = 1 to 10^8. Totalize and Scale: Input A, 0-10 MHz scale; 136 MHz count, 1 to 10^8 in decade steps. *Sensitivity:* Inputs A & B, 100 mV rms. *Crystal Frequency:* 10 MHz. *Stability Aging Rate:* Temperature: 2.5 x 10^{-6} from 0°C to 50°C; Line Voltage: 1 x 10^{-7} for ± 10% line voltage change. *Oscillator Output:* 10 MHz. *External Oscillator Input:* 10 MHz. *Time Base Output:* 3 V p-p. *Display:* 8 digits with overflow indication. Storage ON-OFF. Sample Rate: fast recycle and .1 sec to 10 sec display. Gate Lamp. *Remote Programming:* by switch closure to ground; BCD data at rear panel. *Temperature:* 0-55°C. *Power:* 115/230 V ± 10%; 50-400 Hz. *Price:* $1375. *Options:* ACL: Laboratory Stability Oscillator, 3 parts in 10^9 per 24 hrs; $400. ACN: Ultra-high Stability Oscillator, fast warm up, 5 parts in 10^{10} per 24 hrs; $800. 9 digits: $100. Rear Inputs (A and B): $50.

Beckman® INSTRUMENTS, INC.
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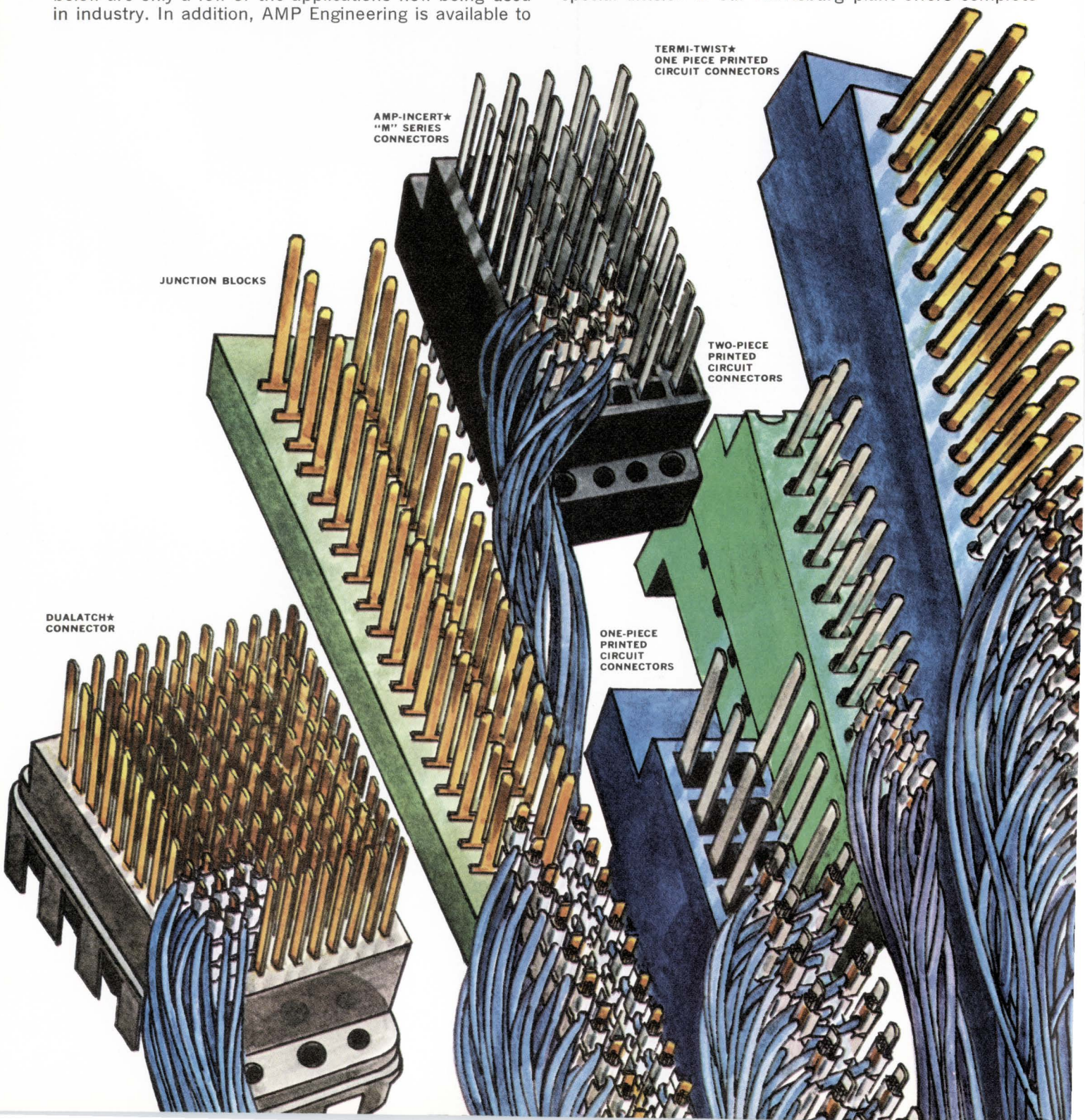
The AMP point-to-point most versatile

One Technique Covers Widest Range Of Interconnection Requirements

Whatever your interconnection requirements, TERMI-POINT★ products can move in to fulfill them over the widest variety of applications. The components shown below are only a few of the applications now being used in industry. In addition, AMP Engineering is available to be applied against any particular or unusual interconnection problems you may have in point-to-point wiring.

AMP Pre-Wired Panels And Component Service

If you prefer AMP to pre-wire panels or connectors, a special division in our Harrisburg plant offers complete



wiring technique is the in the world

facilities from taping specifications to finished product. Fully tested panels will be shipped ready for installation to give you the benefits of automated wiring at lowest applied cost. Quotes on your point-to-point wiring requirements will be supplied on request.

Write For Special Point-To-Point Wiring Report And Complete Product Information

Send for our 6-page special report, "A Stored Energy Connection for Point-to-Point Wiring" plus complete information including specifications and test data on TERMI-POINT Clips, Tools and companion products. Write ..... **INDUSTRIAL DIVISION, AMP INCORPORATED, HARRISBURG, PA. 17105.**

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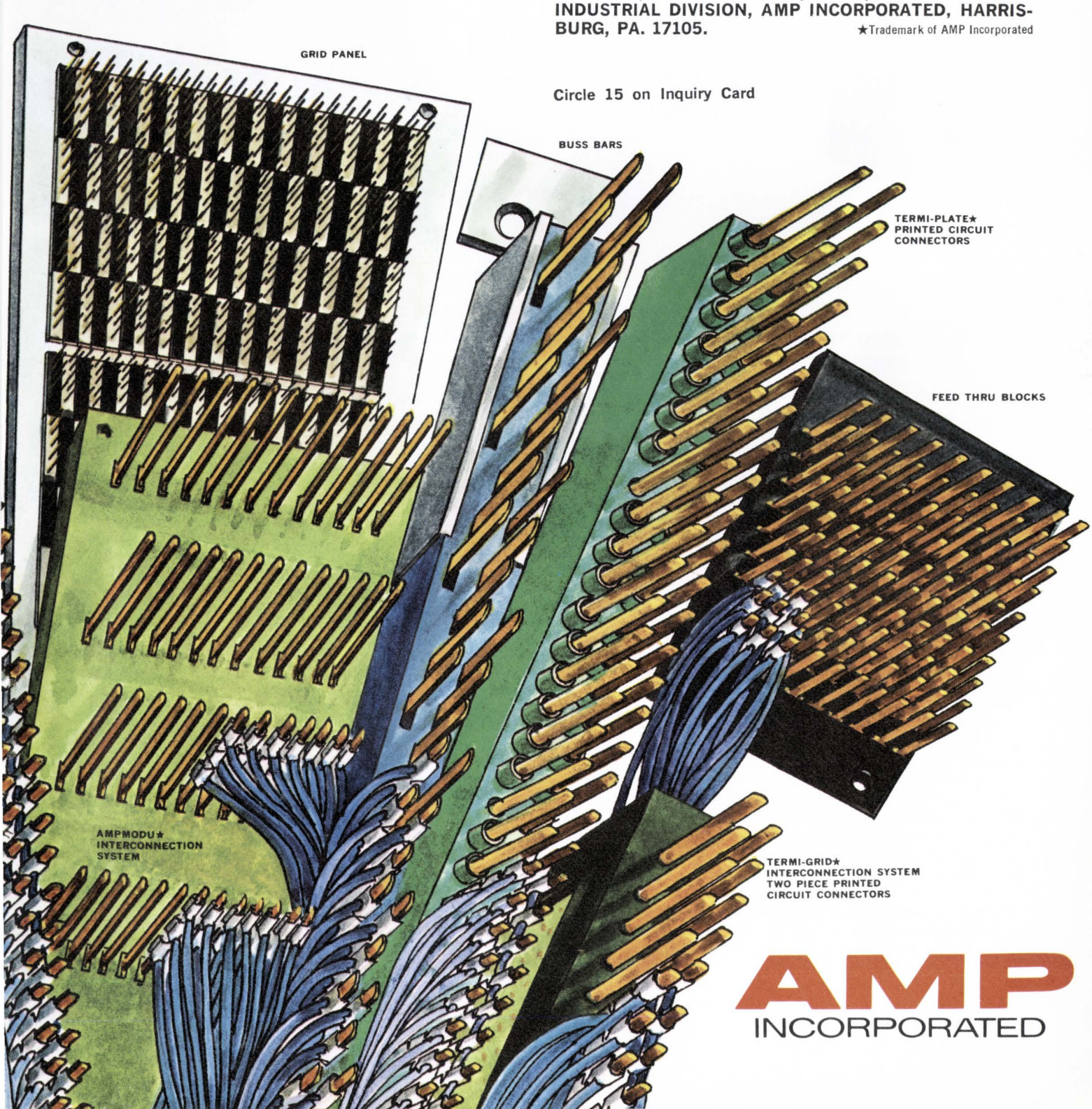
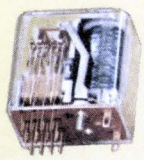


AMP INCORPORATED

Now in the Potter & Brumfield family!

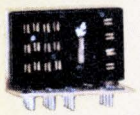
Parelco cradle and SLIMLINE® relays give you many design options



Reliable cradle relay switches up to 8 poles from dry circuit to 10 amperes

Compact, versatile, dependable . . . these features have won for the R10 cradle relay wide recognition in a host of critical applications such as computers, data processing equipment and precision instruments.

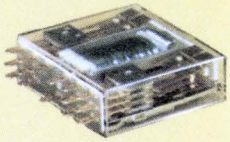
Contact arrangements up to 8 PDT (AC relays up to 4 PDT) are available. Six contact styles including single or bifurcated may be specified for switching currents from dry circuit to 10 amperes. Mechanical life is rated at 100 million operations with electrical life ranging from 100,000 to 100 million operations, depending on load and voltage.



Design innovations, resulting in the optimum distribution between the magnetic core, the pole piece cross sections and coil volume, with a low reluctance armature bearing produce a large force-displacement product. The result: high contact pressure and generous over-travel.

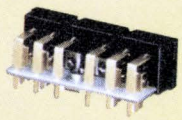
Designers are given many options of terminals and sockets for a wide variety of mountings. A new, right-angle socket (shown above) allows for the R10 to be mounted on a PC board at minimum height.

High density PC board stacking is practical with SLIMLINE® relays

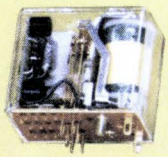


The Slimline (R40) has the lowest profile of any industrial relay available anywhere (dry reeds excepted)! When mounted flat on a printed circuit board, its 0.43″ height allows for board spacing on 0.60″ centers.

Two or four Form C contacts are available in a package measuring only 1.200″ x 1.40″ x 0.43″. Select from five different contacts with switching capacities ranging from true dry circuit to 10 amperes. For low levels, bifurcated contacts may be specified.



Choose from solder or printed circuit terminals . . . or specify sockets having straight or right-angle terminals. Coil voltages range from 3.0 VDC for IC interfacing to 115 VDC. Mechanical life is rated at 100 million operations. Write or call today for complete information.



Small, variable time delay will switch 4 PDT at 10 amperes

Here is the only solid state variable time delay capable of switching (with a choice of contacts) 4 Form C from dry circuit to 10 amperes. Our R12 Series utilizes the field proved R10 relay plus a high quality solid state circuit. Features include: no false operation, small size, high resolution 15-turn potentiometer, timing ranges from 0.1 to 120 seconds (to 300 seconds on special basis).

SPECIFICATIONS

Repeatability	±2%
Timing	Adjustable with 15-turn potentiometer.
Reverse polarity	Protected.
Timing capacitor	Mil type.

For complete information about the full line of Parelco and Potter & Brumfield relays, call your nearest P&B representative or write direct: Potter & Brumfield Division of American Machine & Foundry Company, Princeton, Indiana 47570. 812/385-5251.

West Coast states, call or write Parelco Operations, 26181 Avenida, Aeropuerto, San Juan Capistrano, California 92675. 741/493-4507.

STANDARD PARELCO RELAYS ARE AVAILABLE FROM P&B DISTRIBUTORS

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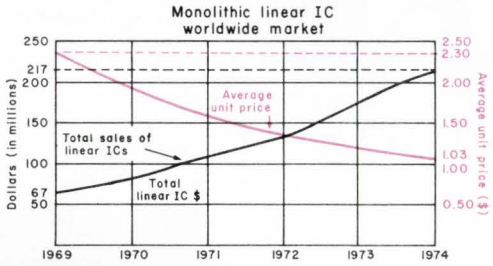
POTTER & BRUMFIELD

THE WESTERN COLUMN

Linear growth is non-linear

As Fairchild Semiconductor did during the week before WESCON, Motorola is taking its turn at holding linear IC seminars across the country. They are telling engineers about the new building blocks introduced this year, and their applications. Clay Tatom, Manager of Linear IC Product Planning claims the number one spot for Motorola in both dollar and unit sales for 1969.

Looking ahead at the total linear IC market Jim Burns, Manager of Linear IC Product Marketing and Planning, presented the attached chart. He anticipates that sales of linear ICs will increase more rapidly than those of digital ICs, but that digital will continue to hold the lion's share of the market. One feature of the growth of linear sales will be a much deeper penetration into the consumer market.



Although not stated at the briefing, if sales rise from 67 to 217 million dollars, and the average price drops from $2.30 to $1.03, this implies a 723% increase in units produced. This translates an increase in industry production of just over 48½% compounded annually for five years.

If the prediction holds, manufacturers will have to build new production lines, or use the existing ones more efficiently. Either way, Motorola should be very happy, because mass production in their thing. Prospective entrepreneurs should also be happy contemplating all the niches they could carve out for themselves.

Stephen A. Thompson, Western Editor

AIAA airs everything from cosmos to connectors

The AIAA Sixth Annual Meeting and Technical Display held at Anaheim, California, was a very thought-provoking affair. The new key word in the air is ecology. At last, people are thinking more about this closed system—Earth.

Many participants thrashed about with the problem of how to clean up the mess in the air transport system. The problem is that nobody controls enough of the action to implement anybody's solutions. One could only conclude that it is going to get a lot worse before it gets any better.

Two outstanding ambassadors of the Soviet Union, Cosmonauts Beregovoy and Feoktistov, showed warmth and humor while providing thoughtful answers to random questions. General Beregovoy could foresee a time when cosmonauts and astronauts would fly together. He indicated that if both space programs could have started cooperatively, the problems we have now would have been solved already.

Dr. Feoktistov outlined what he believed were at least five major directions space exploration should take:

1. Creation of large stations for scientific exploration in polar orbits.

2. Creation of astrophysical unmanned stations in orbits of many thousands of miles. Their main task would be exploration of deep space.

3. Creation of manned space ships for flights in the regions of Mars, Mercury and Venus.

4. Creation of powerful automated stations for exploration of the far planets and solar system exploration vertical to the plane of earth orbit.

5. Development of systems of applications satellites for meteorological and geological uses, etc.

A member of the panel on "What Type Space Station Program Should We Have in the 1970's?", Mr. William B. Bergen, President of the North American Rockwell Aerospace and Systems Group, contended, "We do real well at the tough jobs . . . but where we have trouble is with the little things, like connector pins, wiring, relays, and circuit breakers. These are the areas where we need breakthroughs."

In a subsequent interview he pointed out that, obviously, vendors would rather develop something that could be sold by the thousands to many customers, as opposed to relays for 15 Apollo's.

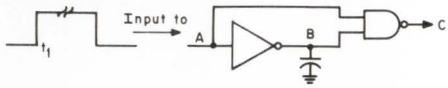
Stephen A. Thompson, Western Editor

←Circle 16 on Inquiry Card

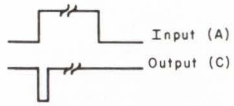
SPEAK UP

Wrong edge

Sir:
In the IC Idea "Edger develops fast pulses" (The Electronic Engineer, July 1969, p. 79, No. 923) it appears that the outputs from the two NAND circuits (first and third outputs) are interchanged. If we follow the signal through that circuit



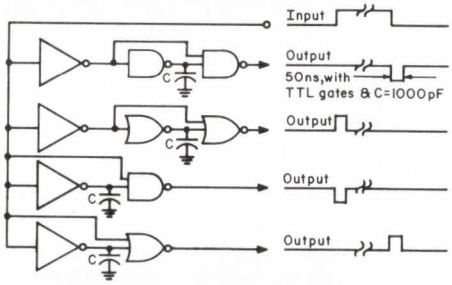
we have, at t_1^-; A = 0, B = 1, C = 1
at t_1^+; A = 1, B = 1, C = 0



. . . and so forth. Otherwise, it was a good set of circuits, worthy of my vote.

R. de Cote
Chief Engineer
M.R.A., Inc.
Flushing, N.Y.

EDITOR's NOTE: Mr. de Cote is right; the outputs look like this:



Also, thanks to many other readers who pointed out the same error (and voted for the circuit). Incidentally, the input inverters were shown in the original circuit as NANDs and NORs, because you can use any such gates as inverters.

Ask Mr. Lissajous

Sir:

This is in reference to the IC Idea 916, "Zero-beat detector" in the May 1969 issue (p. 91) of **The Electronic Engineer.** Of course you can put a lot of ICs to work to compare two 15-kHz signals. But since Mr. T. K. Aaltonen mentioned that a dual-trace scope was not accurate enough, how about a single-trace, old fashioned? Ask Mr. Lissajous for details.

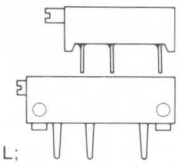
Ingo O. Kurth
Design Engineer
Communications
Hazeltine
Little Neck, N.Y.

Can a low-cost trimmer succeed in a high-class job like this?

Mohawk Data-Recorders speed input preparation by transferring data direct from source document to computer-compatible magnetic tape. Dale Econo-Trims are used here to control gain in a number of amplifier circuits.

Dale Econo-Trims do!

Specify Dale Econo-Trims for handling important circuit adjustments at a budget price. They combine dependability with prices that start under a dollar. Mohawk Data Sciences uses the 2317 Econo-Trim to control gain in vital tape readback amplifiers. Sealed to withstand automatic soldering, fluxing and total immersion, this ½-watt wirewound is noted for its good setting stability. It's just one of 12 Econo-Trim models now available. You can select from ½, ¾ or 1 watt models...film or wirewound elements...sealed or unsealed. Count on good delivery, too—less than 2 weeks in 1,000 piece quantities. Give Econo-Trims the chance to succeed in your circuits. They can help you get ahead, too!



SPECIFICATIONS

2300-2400 Series/Wirewound
8300-8400 Series/Film

Dimensions: 2300 & 8300 = .36" H x .28" W x 1.00" L; 2400 & 8400 = .31" H x .16" W x .75" L

Standard Resistance: Wirewound models = 10 ohms to 50K ohms; film models = 10 ohms to 2 Meg.

Resistance Tolerance: Wirewound models = ±10%; film models = ±10% 100 ohms thru 500K ohms, ±20% all other values

Power Rating: 2300 = 0.5 watt at 25° C; 2400 = 1 watt at 40° C; 8300 & 8400 = .75 watt at 25° C

Operating Temperature Range: 2300 & 8300 = −55° C to 105° C; 2400 & 8400 = −55° C to 125° C

Mechanical Adjustment: 2300 & 8300 = 15 turns; 2400 & 8400 = 20 turns

Mechanical Stops: None. Clutch permits overtravel without damage

Models: Sealed or unsealed. Gold-plated PC terminals or gold-plated hook type solder lugs (2300/8300 only).

Get samples and a quote quick—
Call Dale Now: 402—564-3131

DALE®

DALE ELECTRONICS, INC.
1304 28th Ave., Columbus, Nebr. 68601
In Canada: Dale Electronics Canada, Ltd.

SEE OUR SPECIFICATIONS IN THE MICROFILM CATALOG FILE V·S·M·F

SPEAK UP

Wrong statement

Sir:

In the article "Simplify design with computer graphics", [The Electronic Engineer, Dec. '68, page 69], the program in Fig. 3 has an incorrect entry for Branch One. It should read

'B1 N (0,2), R=2000, E=20'

instead of

'B1 N (0,1), R=2000, E=20'

Richard Jacob Stein
CRT Engineer
Tektronix, Inc.
Beaverton, Ore.

A sense of purpose

Sir:

"Electronics on the moon" [**The Electronic Engineer,** August 1969, p. 7], points out that electronics should be relative to life, not life relative to electronics. I hope this small editorial will have a big impact on most engineers! Great! With this sense of purpose, we may have less frustrated engineers.

Kai L. Lee
E.E. - R&D
U. C. Lawrence Rad. Lab.
Livermore, Calif.

One step backward

Sir:

Impending mass layoffs of EEs, raises reflecting no more than a cost of living increase, forced relocation at a personal loss, and uncompensated overtime make me sick!

"One giant leap for mankind . . . One step backward for engineers," your excellent article in the September issue of **The Electronic Engineer,** p. 39, was rather candid about our bleak outlook.

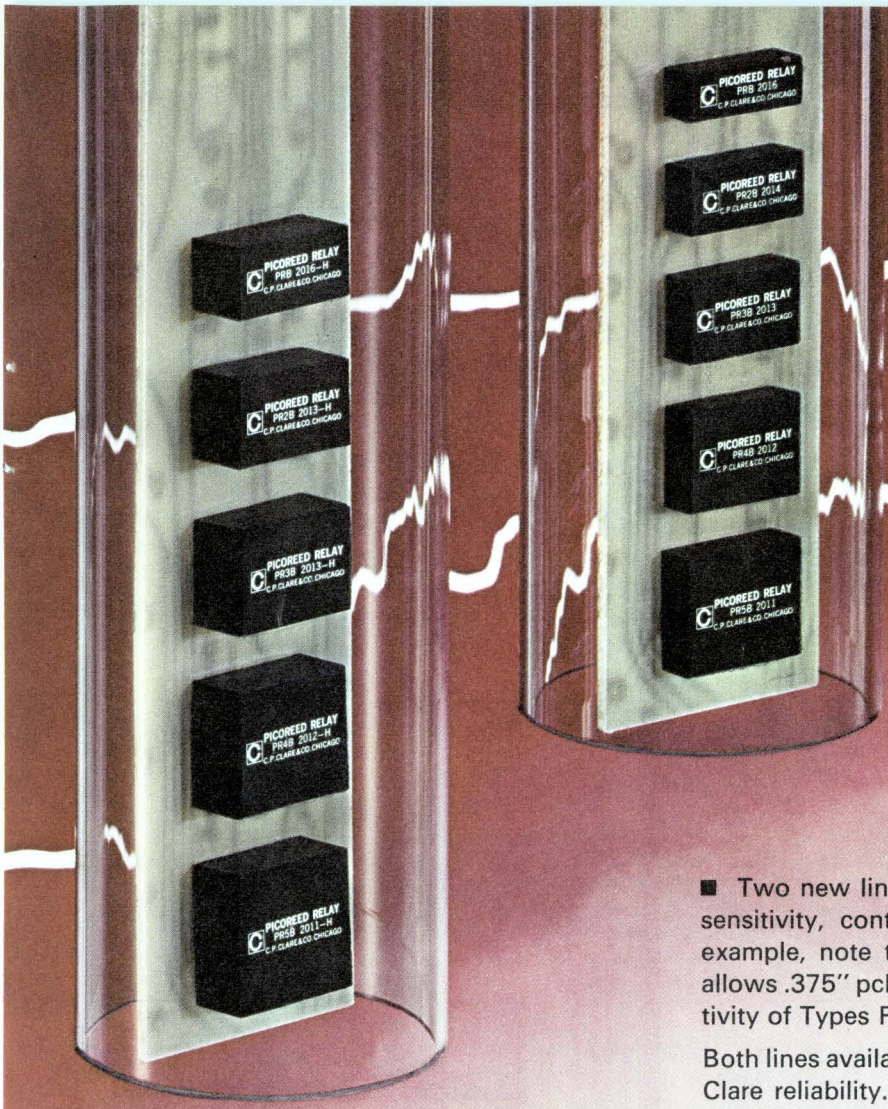
I am still young and never hope to take an "inferior job with less pay." . . . I am leaving my "profession" for another profession.

Will unions help? Maybe . . . some day. Would I enter EE again if I had to do it all over? Never, nor my kids.

Paul Singier
360 Pleasant St.
Raynham, Mass. 02767

EDITOR'S NOTE: Mr. Singier is currently taking business courses, and studying evenings toward a law degree. Actually, it will not be necessary for him to "leave" the profession, since good electronic engineers with background in either business or law are always in great demand. They become managers, patent lawyers, or why not? — better engineers.

Letters to the editor are published at the discretion of the magazine. Please say so if you do not want to be quoted. Signed letters have preference over anonymous ones.



NEW

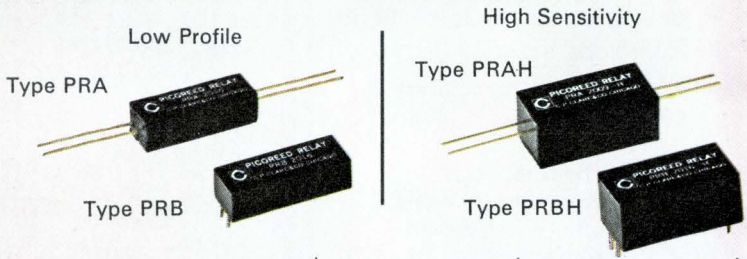
...from CLARESEARCH

...Ultraminiature reed relays

■ Two new lines of Picoreed® relays give you a wider choice in sensitivity, contact configurations and space-saving size. For example, note the new low profile of Types PRA and PRB—allows .375" pcb mounting centers. And note the new high sensitivity of Types PRAH and PRBH.

Both lines available in one to five Form A contacts with traditional Clare reliability. 100,000,000 operations at signal levels. 5 volt (must-operate 3.75v), compatible with standard 5 v DTL and TTL logic families. 6, 12 and 24 volt standard relays also available.

For information, circle Reader Service number, or write for Data Sheet 971A. C. P. Clare & Co., Chicago, Illinois 60645...and worldwide.



Electrical and Dimensional Characteristics	Types PRA/PRB—Low Profile		Types PRAH/PRBH—High Sensitivity	
	Form 1A	Form 5A	Form 1A	Form 5A
Operate time, including bounce	500 μs	600 μs	600 μs	900 μs
Average nominal power for 5 volt units	65 mw	250 mw	46 mw	140 mw
Pcb mounting centers	.375"	.375"	.500"	.500"
Length	.781	.800	.800	.800
Width*	.250	.675	.400	.800
Height	.187	.225	.350	.350

*Widths vary according to number of switches. One through 5 available.

LOOK FOR CLARE ON THE RELAY

a GENERAL INSTRUMENT company

CALENDAR

JANUARY

				1	2	3
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11	12	13	14	15	16	17
18	19	20	21	22	23	24
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Jan. 5-7: AMA Conference—International Corporate Insurance & Management Concurrent Briefing Sessions, Roosevelt Hotel, N. Y. Addtl. Info.—AMA News Relations, American Management Association Bldg., 135 W. 50th St., New York, N. Y. 10020.

Jan. 14-15: ASTM Committee B-1 on Wires for Electrical Conductors, Shoreham Hotel, Washington, D. C. Addtl. Info.—Frank Hamilton, P. R. Director, ASTM, 1916 Race St., Phila., Pa. 19103.

Jan. 14-16: 3rd Hawaii International Conference on System Sciences, Honolulu, Hawaii. Addtl. Info.—Dr. Richard H. Jones (HICSS), Info. Science Program, 2565 The Mall, University of Hawaii, Honolulu, Hawaii 96822.

Jan. 25-30: 1970 IEEE Winter Power Meeting, Statler Hilton Hotel, N.Y. Addtl. Info.—W. C. Hayes, Publicity Chairman, 1970 Winter Power Meeting, 33rd St. & 7th Ave., N.Y., N.Y. 10017.

Jan. 27-29: 1970 Annual Symposium on Reliability, The Ambassador Hotel, Los Angeles, Calif. Addtl. Info.—W. R. Abbott, Program Chairman, Lockheed Missiles & Space Co., Dept. 60-01, Bldg. 104, Box 504, Sunnyvale, Calif. 94088.

FEBRUARY

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22	23	24	25	26	27	28

Feb. 10-12: Aerospace & Electronic Systems Convention (WINCON), Baltimore Hotel, Los Angeles, Calif. Addtl. Info.—G-AES, L. A. Council.

Feb. 11-13: AMA Conference—Annual Personnel Conference, Palmer House, Chicago. Addtl. Info.—AMA News Relations, American Management Association Bldg., 135 W. 50th St., New York. N. Y. 10020.

Feb. 12-14: 2nd National Conf. & Exposition on Electronics in Medicine, Fairmont Hotel, San Francisco, Calif. Addtl. Info.—Mr. Jerry Brown, Nat'l Expositions Co., 14 West 40th St., New York City, N. Y.

Feb. 18-19: Instrumentation Fair, International Hotel, Los Angeles, Calif. Addtl. Info.—Instrumentation Fair, Inc., c/o Larry Courtney Co., 16400 Ventura Blvd., Encino, Calif. 91316.

Feb. 18-20: Int'l Solid State Circuits Conference, Sheraton Hotel, Univ. of Penna., Phila., Pa. Addtl. Info.—T. Bray, Gen'l Elec. Col., Bldg. 3, Rm. 261, Electronic Park, Syracuse, N. Y. 13201.

Feb. 25-26: Instrumentation Fair, Fairgrounds of San Mateo, Calif. Addtl. Info.—Instrumentation Fair, Inc., c/o Larry Courtney Co., 16400 Ventura Blvd., Encino, Calif. 91316.

Feb. 25-27: AMA Conference—Annual EDP Conference, Americana Hotel, New York. Addtl. Info.—AMA News Relations, American Management Association Bldg., 135 W. 50th St., New York, N. Y. 10020.

'70 Conference Highlights

IEEE—Institute of Electrical and Electronics Engineers Int'l Convention & Exhibition, March 23-26; New York, New York.

WESCON — Western Electronic Show and Convention, Aug. 25-28; Los Angeles, Calif.

Call for Papers

June 15-19: 1970 Int'l Symp. on Information Theory, Noordwijk, The Netherlands. Submit a 300 word abstract (no equations) by January 1, 1970 to Dr. P. E. Green, Jr., MIT Lincoln Lab., Lexington, Mass. 02173.

May 11-14: 1970 IEEE G-MTT Int'l Microwave Symposium, Newport Beach, Calif. Submit five copies of a 500-1000 word summary with six illustrations by January 30, 1970 to Dr. Raymond H. DuHamel, Chairman, Technical Program Committee, Granger Associates, 1601 California Ave., Palo Alto, Calif. 94304.

Circle 23 on Inquiry Card →

Our new line of PM oiltight pushbuttons is a whole new look. Square. Smart in appearance. Yet functional in performance.

The advanced square design of our Mini-Squares contributes a modern computer look to control panels. Moreover, they provide panel designers with new flexibility in format, new savings in space.

But there are important functional advantages, too. Such as more target area for fingers. And more space for legends up front, on the button face. A space large enough to divide into two, three, even four sections—and still contain readable information.

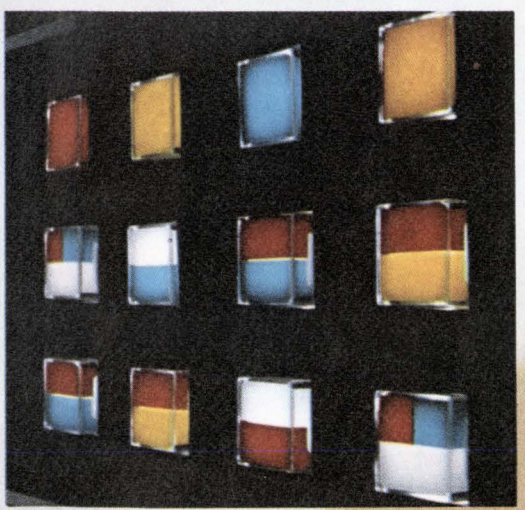
Which brings us to another Mini-Square exclusive. Our PMs are the only small oiltight pushbuttons to offer more than two light indications. In fact, they can supply up to four separate light indications—all on the same button face. (We design the face to fit your needs.)

Modular switching elements permit many control possibilities. Up to four single-pole, double-throw circuits on a single switch; momentary and alternate action.

Rugged performance is another Mini-Square feature. Reliable oiltight performance. The same tested quality engineered into all MICRO SWITCH oiltight switches.

Call your MICRO SWITCH Branch Office or Distributor (listed in the Yellow Pages under "Switches, Electric") for more information on our complete line of Mini-Squares. They're so right for today, they could start a whole new trend!

INTRODUCING PM "MINI-SQUARES." THE NEWEST LOOK IN OILTIGHT PUSHBUTTONS.



MICRO SWITCH Type PM Oiltight Pushbuttons include both lighted and unlighted pushbuttons and indicating lights. Lenses and buttons are available in a variety of colors. Bezels are available in black and metallic finishes; in half-guard and full-guard style, or unguarded for indicator lamps. For complete information, ask for Product Sheet PM.

MICRO SWITCH
FREEPORT, ILLINOIS 61032
A DIVISION OF HONEYWELL

WELCOME

This column welcomes new companies or new divisions in the electronics industry.

Memory subsystems source

Hauppauge, N. Y., is the home of Solid State Data Sciences Corp., a new company engaged in marketing memory subsystems based on arrays of 512 bit MOS chips.

The fledgling firm will not sell separate MOS chips, but instead will offer an entire random access, read-write memory subsystem consisting of an MOS array interconnected with clock driving circuits and sensing hardware. The system will have an access time of 500 nanoseconds and power dissipation of 1 milliwatt per bit. Plans for putting the system on the market are scheduled for early 1970. Its exact price has not yet been determined, but a spokesman for SSDSC indicated that cost will be competitive with the lower performance core memories. Customized subsystem design for use in computers, computer terminals and data terminals is presently underway.

Advantages in using the company's systems approach to LSI subsystems include greater reliability in testing, greater flexibility, the ability to control the design of a specific chip, and the ability to tailor the chip to a specific application.

The financing of Solid State Data Sciences Corp. was handled by Leeam Lowin, a Wall St. investment firm. It is a privately owned company.

Circle 421 on Inquiry Card

Instrumentation men make ICs

Silicon General, Inc., located in Westminster, Calif., was founded by James S. Johnson—founder and former president of Datapulse—who will serve as president of the new company. The objective of the company, Johnson states, is "to become a prime source for both special and standard integrated circuits. The potential is here for an alert, fast-acting company with the engineering and manufacturing capabilities and a willingness to cope with a wide range of IC requirements."

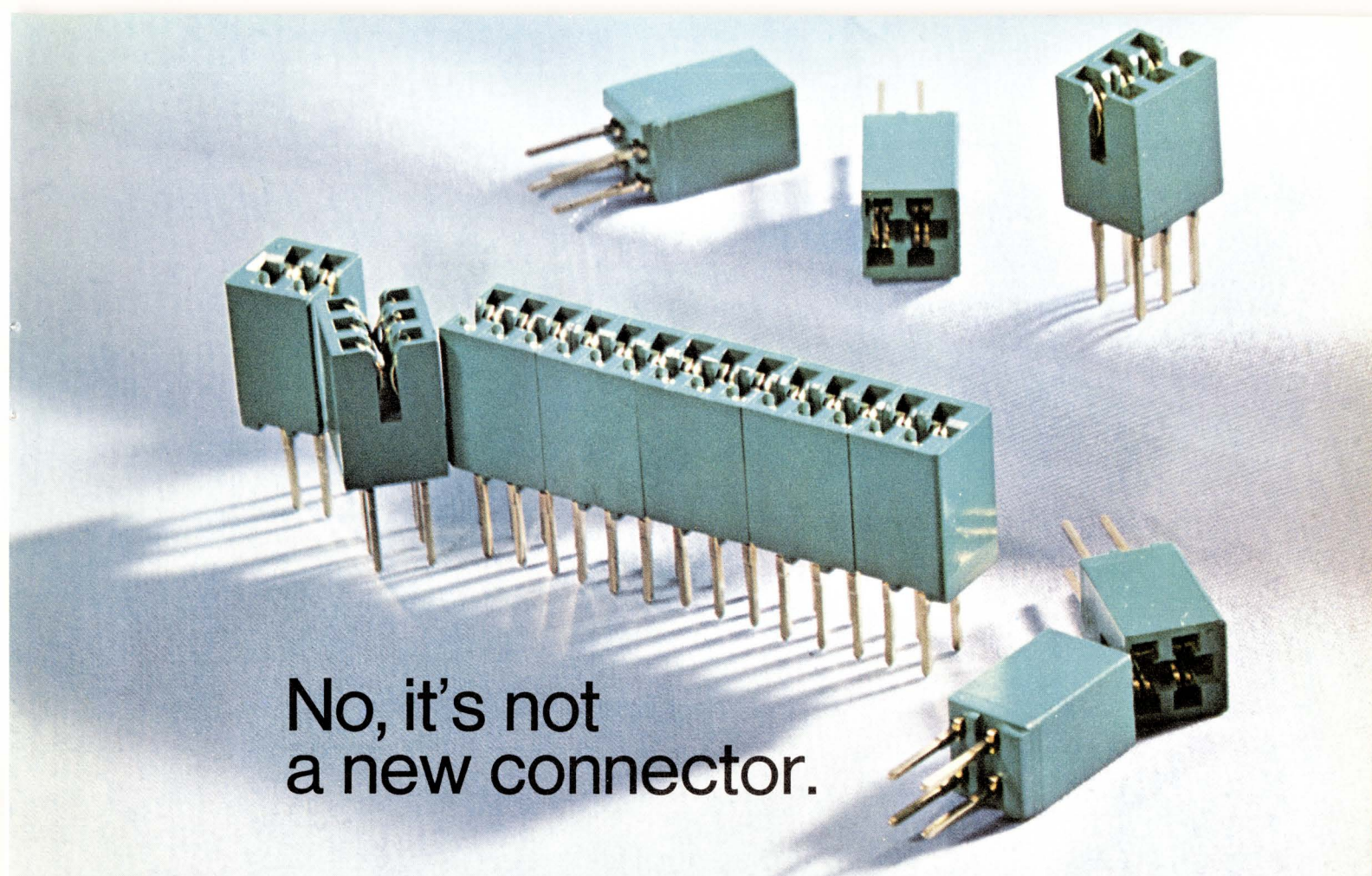
Silicon General will design, manufacture and market monolithic linear ICs and related prdoucts, including voltage regulators, balanced modulators, sense amplifiers and operational amplifiers. Another goal is the design of linear circuits with digital inputs.

The combination of digital and linear circuit items, Johnson states, is an area of the microelectronics field he and the contributing founders of the company found open for development, and an area in which the small, contemporary company can provide efficient and reasonable service.

Johnson believes that the market and talent of his company are extremely promising and that the instrumentation background of several of the key men involved will contribute significantly to the company's success. "Having designed equipment, instruments and systems ourselves, we are thoroughly familiar with the problems the designer encounters. This experience is an essential ingredient in our plan to provide ICs which offer better solutions to many of today's design needs."

Circle 422 on Inquiry Card

Circle 25 on Inquiry Card→



No, it's not a new connector.

It's a new kind of connecting.

The little connectors above are really one connector. You take as many pieces as you need, mix them together, and use them to connect any size of p.c. board to a mother board.

That's not spectacularly new. Connector modules for use in bread-boarding have been around for a while.

But these new Mojo™ Series 6308 p.c. connector modules* are not just for bread-boards and prototypes.

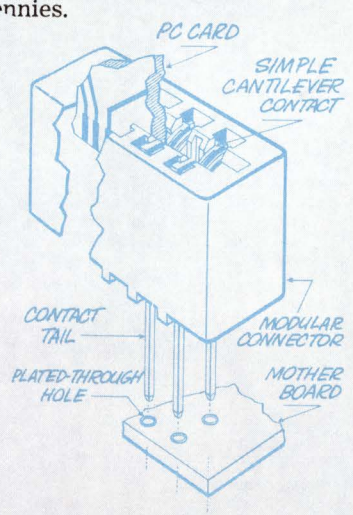
Not hardly.

When used with plated-through holes on the mother board, they are one of the slickest production tricks to come along in quite a while. Contact tails combine a square wire-wrapping post with a specially designed locking feature which, when press-fitted into a plated-through hole, provides a gas-tight and reliable electrical connection.

No, you don't have to solder.

Yes, you can wire-wrap if you want.

And, yes, you'll save time and money in moving from prototype into production. Because connectors of virtually any size can be built up economically from just two sizes of modules, you don't need a large inventory. Or custom connectors. And you only have to insert modules where connectors are required, saving a few more pennies.



And, no, you don't give up a bit of connector reliability. The exclusive swaged single-beam design of the dual-readout contact provides optimum spring rate and deflection characteristics. A preload applied to the contact nose in the insulator makes sure that the contact really holds on to the card, while keeping the contacts well apart when the card is removed from the connector.

Mojo™ p.c. connector modules:
Specs in brief

Material
Glass-filled DAP

Contacts
Cantilevered-beam, dual readout, bifurcated nose. .150″ centers. Center modules have 6 contacts. End modules have 4 contacts, molded-in card guide.

Tails
.031″ square wire-wrapping type

Mounting
Press fit, in .048″ dia. plated-through holes, 3/32″ to 1/8″ thick board.

For more information, write, wire, call, or TWX us for our Mojo™ p.c. connector module data sheet. Elco Corporation, Willow Grove, Pa. 19090. 215-659-7000; TWX 510-665-5573.

* Patent pending

ELCO Mojo™ p.c. Connectors

Not everyone needs a multimeter that can measure the resistance of a piece of solder.

But you may be looking for a digital multimeter that will measure relay contact resistance. Or check cable continuity. Or handle other applications that require 100 μohm resolution without error caused by lead resistance. If that's the case, you may be looking for our 5500/135 DMM.

And it's more than an ohmeter. You can turn it loose on dc volts, mV, dc/dc ratios, or square, triangular, sawtooth and sine waves. It will give you the true rms of an ac waveform, so accurately and distortion-free that we call it Computing RMS™ and have a patent pending on this revolutionary new technique.

But it is possible that the 5500 is more or less multimeter than you need. If that's the case, don't buy one. Buy one of our 32 others instead. We make them for labs and production lines, for use on the bench and in systems, militarized models, 4- and 5-digit, from $1150 to over $8000. (Actually, with our unique plug in modules, you can create some 300 different configurations. For every imaginable application. To fit every budget).

Which one suits you best? Ask for the decision maker. Our free brochure.

Dana Laboratories, Inc., 2401 Campus Drive, Irvine, California 92664.

DANA®

How to write reports that bring results

**Are your reports as good—
and as well received—as you'd like them to be?
Before you answer, consider how five steps can help you
to organize and write better reports**

Raymond E. Herzog, Supervisor, Technical Services
General Electric, Portsmouth, Virginia.

Engineers are not well known for their writing achievements. But with the "information explosion," and the need for quick, concise reading in our profession, it is becoming increasingly important that engineering reports be presented as clearly as possible.

Now, it's not that an engineer has to be a Hemingway. What *is* expected, though, is that an engineer be able to say what he means in his writing.

Perhaps you have found that some of your reports have been misunderstood or have not achieved their purpose. Or maybe you'd like your writing to be more concise and concrete. If so, here are five steps in organizing what you want to say that can improve your writing. As this article will show, these five steps are:

- Prepare the writer's thoughts to help him reach his objective.
- Catch the reader's attention so that he may *quickly* know the significance of what he is about to read.
- Arouse the reader's interest to let him know why he should read the report.
- Effectively present the text of what the writer wants to say.
- Ask the reader for action or bring him to a conclusion.

Let's now put these steps to work for us. We'll use, as an example, a design review you might prepare for a project leader.

Planning ahead

Step one in organizing a report can be stated as: "Know what you want to say before you say it." When your thoughts are incomplete and unorganized, it's easy for your writing to become confusing and illogical. So to help assure that you present your report logically, first write down the general topic of your presentation. *Write it in one sentence, before you start the report itself.* This capsule sentence is not part of the report, but it is the start of your writing and heads you toward the report's final objective.

The following might be such a theme sentence:

> ***The Equipment Engineering group reviewed the ABC design and recommends that it be used for project X.***

Catching the reader's attention

The second step in organizing your writing is to quickly tell the purpose of the report—the *who, what, when, why, where,* and *how* of the subject. Unless the reader knows right away what you're talking about, how can he follow the rest of your report?

Here, for example, is an opening that tells the *background* which led to a report, and then gives its *intention:*

> ***The Equipment Engineering group reviewed the ABC design on March 7 in accordance with Task Order #123. This report summarizes the review and gives our conclusions and recommendations.***

This immediately gets the reader's attention by telling him *who* did *what, when* and *why*. It also lets the reader know the purpose of the report as soon as he starts reading, so he can better understand its objective as he reads on.

Here is another opener that expresses the main idea

of the report, helping the reader to follow more easily the supporting presentations:

> ***The March 7th review of the ABC design shows that it excels in all requirements. As detailed in this report, the Equipment Engineering group strongly recommends this ABC design for project X.***

Another type of opening outlines the plan by which a report is to be developed. Readers will find this especially helpful for long reports.

> ***In this report, the Equipment Engineering group discusses:***
> ***1) results of the ABC review made on March 7th for Task Order #123***
> ***2) techniques used in conducting review***
> ***3) recommendations***

In the three expressive openers above, the reader knows what he *is going to read,* and therefore may better finish the report knowing what he has *read.*

Developing reader interest

The third step brings the reader into the picture telling him why the report is significant to him. For instance, he may have to decide or act on the report's recommendations. Or he may need to be reminded that he requested that the report be prepared. In brief, think of your reader's needs and make the report interesting to him.

Here are some examples that emphasize the report's significance:

> ***You will be pleased to know that the ABC design meets all requirements for project X.***
>
> or
>
> ***You will realize, as you read this report, that this is the design which you asked to be studied on Task Order #123.***
>
> or
>
> ***You will need this information to complete the work on project X.***

These interest arousers make the reader aware of the report's importance to him, and in so doing breathe a personal feeling into the reading.

Minding your writing manners

Are you watching your writing manners carefully? In organizing the test of a report, you should follow good writing practices (see "How to use words more effectively, **The Electronic Engineer,** Oct. 1968, pp. 41-44). And in this respect, more important than perfect English and grammar is perfect understanding. This is the fourth step—making the text of the report clear to the reader. Here are some techniques for doing this.

Word familiarity. Be sure that your reader is familiar with words that you use.

Word meaning. To convey a specific meaning, and for quick, concise reading, use a concrete, easily recognized work. Save abstract terms for a more philosophical treatment.

Verbal voice. The active voice emphasizes the subject and adds a dynamic tone to writing. Unfortunately, we write much of our business communication in the passive voice, which is less personal. The passive voice also subordinates the subject and lets the thought of a sentence develop slowly. You should use whichever voice creates the desired effect on your reader.

Sentence length. A variation in the length of sentences makes reading more interesting. Short sentences emphasize, where long ones conveniently bring together many ideas.

Paragraphs. There may be many different ideas in a single report. You can help your reader absorb these distinct thoughts by using good paragraphing. A single topic and its modifying sentences make up one paragraph. The topic sentence is usually either the first or the last sentence in a paragraph, since these positions get the reader's eye.

Concluding so you get results

The fifth and final step in organizing a report is to bring your reader to a rewarding conclusion. Rewarding to the reader in that he feels his time has been well spent. Rewarding to the writer in that the reader responds to the report as desired.

A report may bring either good results or confusion. Your final step can help assure the former. Let's consider the effectiveness of two typical report endings—the first, expressed in general, passive terms; the second, in a direct way.

general terms	***It is requested that this recommendation, if approved, be forwarded to proper personnel so that appropriate action may be taken to process it.***
explicit terms (preferred)	***You may show your approval of these recommendations by sending form 10 to Mr. S. T. Smith in the Program Office. Then, in accordance with department policy #456, Mr. Smith can place an order with the ABC Company.***

Wouldn't you be more likely to follow a request when direct physical steps are spelled out?

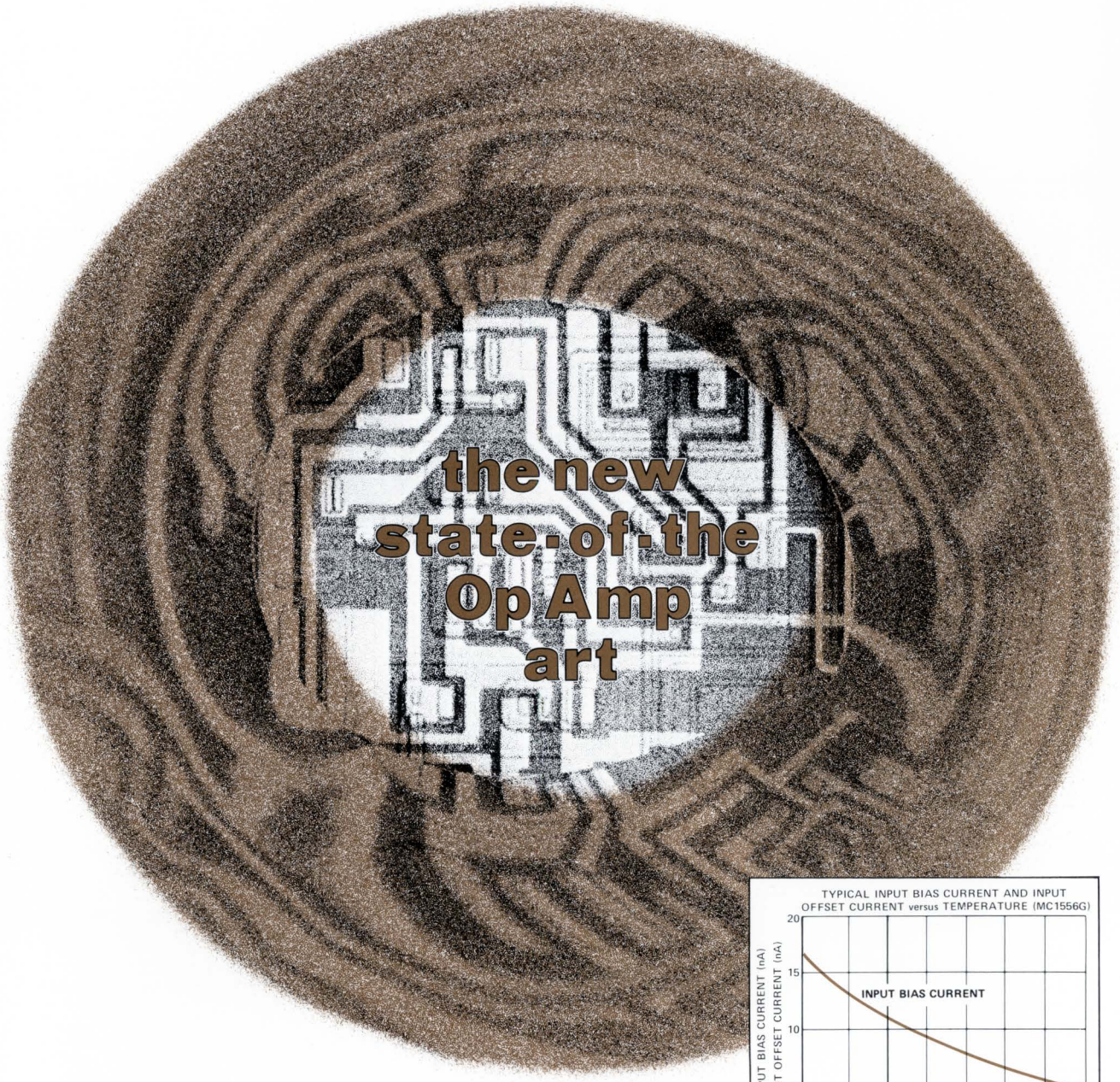
Wouldn't it work for you?

The ideas outlined in this article give you a checklist for writing. See how you can improve your reports by following these organizing steps:

- Before you start to write a report, first summarize in your mind the objective of your writing.
- Then begin the report by telling the reader the who-what-when-why-where-how.
- Develop his interest by bringing *him* into the picture.
- Keep good writing manners.
- And finally, end the report on a feeling of reader direction or satisfaction.

Organized writing can help make reports that bring results. Wouldn't it work for you?

Tear-off and file for future reference . . .



MC1556 combines most wanted features and makes other Op Amps obsolete!

Most high-performance op amps today are of monolithic construction — to save space and to increase reliability. A few are internally-compensated — to reduce the need for external componentry and the associated costs.

Only one offers all three features . . . high performance, monolithic construction *and* internal compensation. That's the MC1556, an operational amplifier that promises to be the new "Standard of the Industry." Here are some of the reasons why:

- High Input Resistance — 10 Meg Ohm (typ).
- Low Input Offset Current — 2.0 nA (max).
- Low Input Offset Voltage — 4.0 mV (max).
- Fast Unity-gain Slew Rate — 2.5 V/μs (typ).
- High Open Loop Gain — 100,000 (min).
- Large Power Bandwidth — 40 kHz (typ).
- Low Power Consumption — 45 mW (max).

For comparison of these and other parameters with those of other op amps plus a visual description of performance characteristics, see the back of this page.

The MC1556 and its reduced temperature - range counterpart, the MC1456, are characterized as operational amplifiers designed for use as summing amplifiers. integrators, or amplifiers with operating characteristics as a function of the external feedback components.

Both of these new linear circuits are currently available from distributor stock in the 8-pin (TO-5) metal package. 100-up prices are: MC1456 - $15.00; MC1556 - $28.00. For details, turn page: ➧

– where the priceless ingredient is care!

MOTOROLA
Integrated Circuits

Compare the performance of the MC1556 with other internally-compensated Op Amps. You'll see why the others are obsolete!

CHARACTERISTIC	SYMBOL	MIN	MC1556 TYP	MAX	MIN	MC1456 TYP	MAX	UNIT
Input Common Mode Voltage Swing	CMV_{in}	±12	±13		±11	±12		V peak
Common Mode Rejection Ratio f = 100 Hz	CM_{rej}	80	110		70	110		dB
Output Impedance (f = 20 Hz)	Zo		1.0	2.0		1.0	2.5	KΩ
Output Voltage Swing. R_L = 2.0 KΩ	V_{out}	±12	±13		±11	±12		V peak
Power Supply Sensitivity V^- = constant $R_S \leq$ 10K V^+ = constant $R_S \leq$ 10K	S+ S−		50 50	100 100		75 75	200 200	μV/V
Power Supply Current	I_D^+ I_D^-		1.0 1.0	1.5 1.5		1.3 1.3	3.0 3.0	mAdc

DEVICE	INPUT OFFSET CURRENT MAX @ 25°C	INPUT BIAS CURRENT MAX @ 25°C	INPUT OFFSET VOLTAGE MAX @ 25°C	OPEN LOOP VOLTAGE GAIN MIN @ 25°C R_L ≥2K	SLEW RATE, TYPICAL (UNITY GAIN)	POWER BANDWIDTH, TYPICAL (UNITY GAIN)	POWER CONSUMPTION MAX @ ±15Vdc	PRICE 100-UP
MC1556	2.0 nAdc	15 nAdc	4.0 mVdc	100K V/V	2.5 V/μs	40 kHz	45 mW	$28.00
MC1456	10.0	30	10	70K	2.5	40	90	$15.00
RM4131	10	50	2.0	50K	2.0	—	57	$20.00
MC1539*	60	500	3.0	50K	4.2	50	150	$ 7.50
MC1741	200	500	5.0	50K	0.8	5.0	85	$15.00
μA715*	250	750	5.0	50K	20	—	210	$48.00
LM107	10	75	2.0	50K	0.5	—	90	$33.00

*Not Internally Compensated

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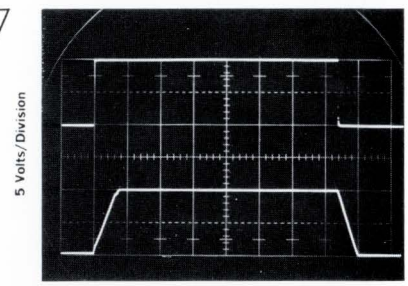

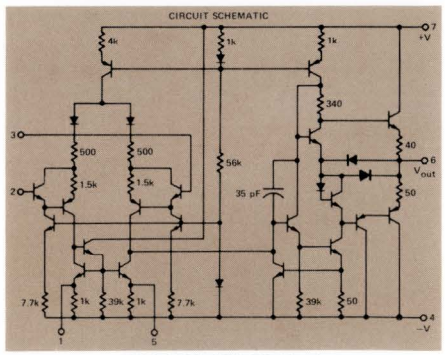

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Engineering power

William G. Howard, Jr.
LIC Research Manager

The Semiconductor Products Division of Motorola, Inc. has appointed William G. Howard, Jr. as manager of linear integrated circuit research where he will direct the development of new ideas and techniques applied to the design of LICs.

Mr. Howard stresses the importance of cooperation among the specific divisions within the company. The engineering and design of semiconductor products are best done in association with the production effort to maximize design effectiveness, and it is up to the research effort to supply the new LIC ideas and designs to keep the production line moving in new directions.

A self-imposed aspect of his responsibility is his belief in looking beyond the present product line in order to make his department beneficial to the company. Looking to future developments, Howard will concentrate on the design methods for LICs, because new methods lead to new products and to progress in his field. Howard believes in the use of computer-aided design to keep up with LIC developments.

Mr. Howard received his BS from Cornell in 1964 and his MS, also from Cornell, in 1965. His PhD was awarded from Berkeley in 1967, and all of his degrees were earned in the field of electrical engineering. He remained with the academic environment at Berkeley serving as an assistant professor of engineering until his recent appointment with Motorola.

Howard stresses to young engineers the importance of remembering the practical engineering problems and reminds them not to become too distracted by theory. Engineering is a "real world field" where people are working not only with circuits and computers, but with each other.

Get true-rms voltage regulation . . . inexpensively

Two common components—a light bulb and a phototransistor—team up to form the heart of an rms voltage regulator.

By Imre Gorgenyi, Applications Engineering,
Motorola Semiconductor Products, Inc., Phoenix, Ariz.

Holding the output of an ac voltage regulator to a preset true-rms value is not an easy task. Such regulators are usually complex, and thus too costly for many applications. But a novel design approach often reduces cost, and such is the case with the circuit described here. Though inexpensive, you can use this regulator wherever the primary need is to hold the load regulation constant while the input voltage changes.

The circuit also has application where the load regulation is adequate, but where you need good line regulation, and where a choke filter or constant voltage transformer would be too bulky. A good example of such a case is a 5-A battery eliminator or a power supply for constant loads at, say, 100 V and 2 to 3 A.

By using a step-up transformer, you will find other applications. With constant loads, you'll get good regulation at fairly high currents in the range of 1 to 20 kV. (Regulator transistors for such high voltages are not now available, but diodes are easy to find.)

The new regulator's operation hinges on the fact that the light output of an incandescent lamp is very sensitive to the rms value of the voltage across it. Thus, the circuit uses a lamp and a phototransistor as the sensing network. This optical coupling scheme gives you a bonus, in that the sensing and control portions of the regulator are electrically isolated from each other.

Projection-lamp regulator

Figure 1 shows a block diagram of the voltage regulator, along with its circuit realization. The lamp load is in series with a rectifier bridge, which must be able to carry the full load current at the highest line voltage applied. A unijunction transistor (UJT) and a timing capacitor (C) make up the phase-control circuit. The capacitor gets its charging current from a two-transistor constant-current source (Q_1 and Q_2).

An output-adjust potentiometer supplies a potential to base 2 of the UJT. Thus, if the line voltage rises, the UJT's interbase voltage rises with it, causing the UJT to fire later in the cycle. This, in turn, delays the firing of the silicon controlled rectifier (SCR) by shortening its ON time, thus reducing the power delivered to the load. The potentiometer serves two purposes: First, it lets you adjust the regulator's output voltage (by changing the voltage at which the UJT fires); second, it lets you compensate for differences in η (the intrinsic stand-off ratio) among various UJTS.

The heart of the system is the phototransistor, Q_3. It diverts part of the current flow to the timing capacitor in relation to the light input received from the lamp load. Because the phototransistor is very sensitive, it saturates easily. To prevent this, you must use an optical filter or iris (Fig. 2) to reduce the light intensity. Such a filter also serves as a coarse adjustment of the voltage output. Since the output-adjust potentiometer provides fine resolution, it is easy to make very close adjustments.

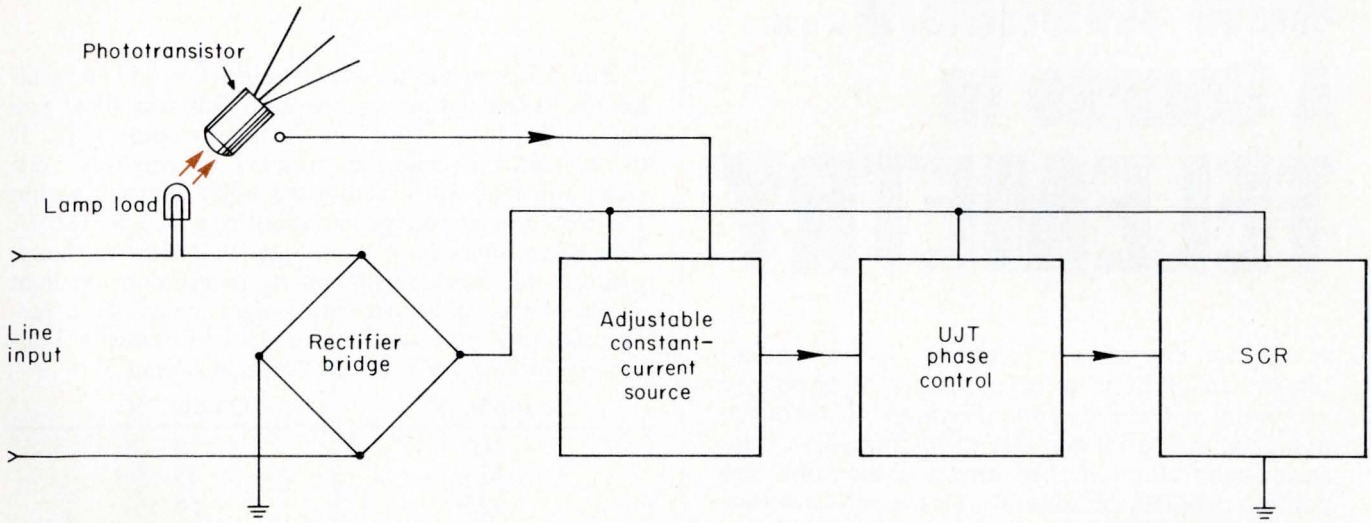
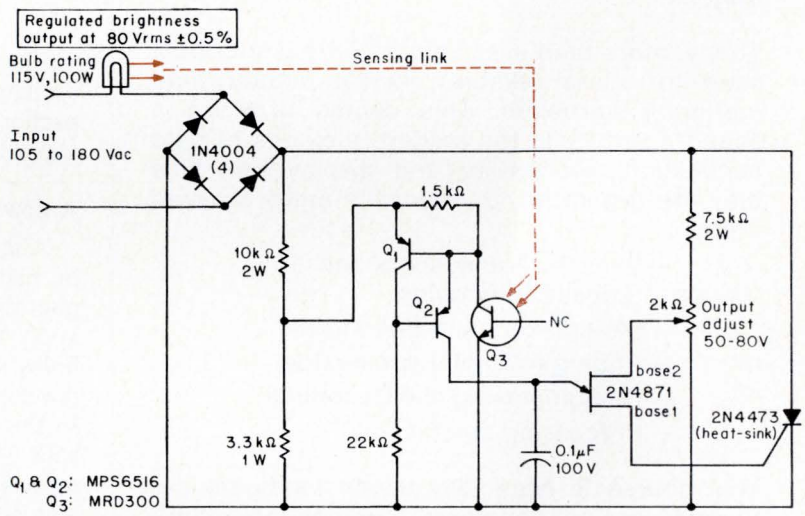


Fig. 1. The basic concept. A light bulb, a device very sensitive to the rms value of its input drive, passes any rms variations to a phototransistor. This optical coupling link is part of a feedback loop which acts to maintain a constant rms drive to the bulb. In this block diagram and its circuit realization, the rms sensing element—the bulb—is the load itself. Such a circuit is useful in equipment in which constant lamp brightness is essential: projectors, copying machines, and so forth.



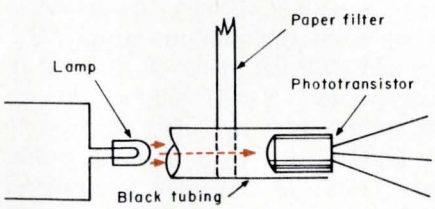


Fig. 2. Coupling the lamp to the phototransistor. The filter is very simple; almost any material having a small hole is suitable, including paper and cardboard, as long as it sufficiently attenuates the light intensity. You must check the filter experimentally. To do this, first use only one layer of paper. Then add more layers until you have coarsely adjusted the output voltage to the value that you need.

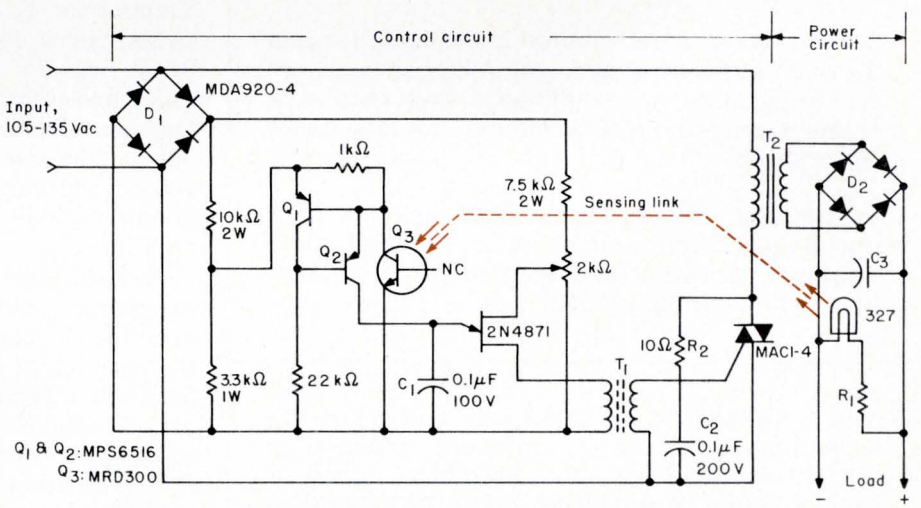


Fig. 3. A power-supply preregulator. This circuit uses the same principle as that of Fig. 1, except that the light bulb isn't the load itself, but is placed across the load. In such a position, it monitors variations caused by both line and load changes. If T_2 has a high turns-ratio, you have here a regulated high-voltage supply with a power capability determined by the bridge rectifier, D_2.

You can monitor the regulating action on an oscilloscope connected across the SCR. This will show you the phasing-back action as the line voltage rises. If the regulator is adjusted properly, a true-rms voltmeter will read 80 V across the bulb, constant within 1% for an input-voltage variation from 105 to 180 V. And if you don't have a true-rms voltmeter on hand, you can still check regulation by monitoring the light output of the lamp load with a light meter. As a further aid, this table shows average-reading meter indications for an 80-V true rms constant output.

Input, V	Output, V
105	63
115	59
125	56
135	54
150	52
180	48

The circuit has a long operating life. Resistors are ordinary 5%, composition-types; but the 0.1-μF capacitor must be temperature-stable, so use either a paper or a mylar unit.

A power-supply regulator

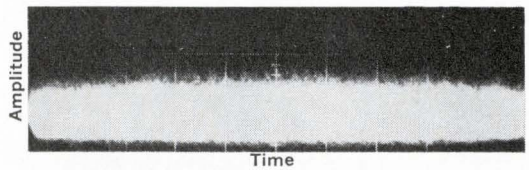
Although the circuit is inexpensive enough to use in many consumer products, such as projectors or photocopiers that require constant brightness, you can apply the same principle with loads other than light bulbs. Simply connect a pilot bulb across the load to develop the feedback signal for the phototransistor. In this way, you can build power supply preregulators with 1% line and 10% load regulations. This is an especially effective way to regulate the output of very high voltage supplies.

Figure 3 shows such a circuit. A small bridge rectifier, D_1, furnishes power to the control circuit only. Transformer T_2 isolates the control circuit from the sensing circuit; its primary should be designed for about 90 V rms. For low-voltage needs, the Triad F-90X series transformers are useful because of their many taps, one of which will give you the desired dc voltage output. The secondary of T_2 feeds a bridge, D_2; your voltage and current requirements determine the size of this rectifier, as well as the value and rating of capacitor C_3.

A small bulb, Type 327 (28 V, 40 mA), is the sensing element, and couples to the phototransistor, Q_3, as in Fig. 2. You should pick the value of R_1 so that the lamp glows dimly at the desired output voltage. Such a low filament voltage prolongs bulb life by orders of magnitude. Transformer T_1 is a small pulse transformer (Sprague 11Z12 or equivalent). Resistor R_2 and capacitor C_2 form a dv/dt suppression network to prevent false triggering of the triac by line transients.

INFORMATION RETRIEVAL:
Power supplies, Circuit design

Radar signal processing engineers:



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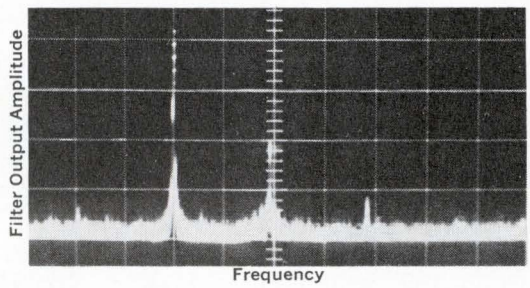

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Several programs are now starting to carry this technique and others further toward operational radar systems.

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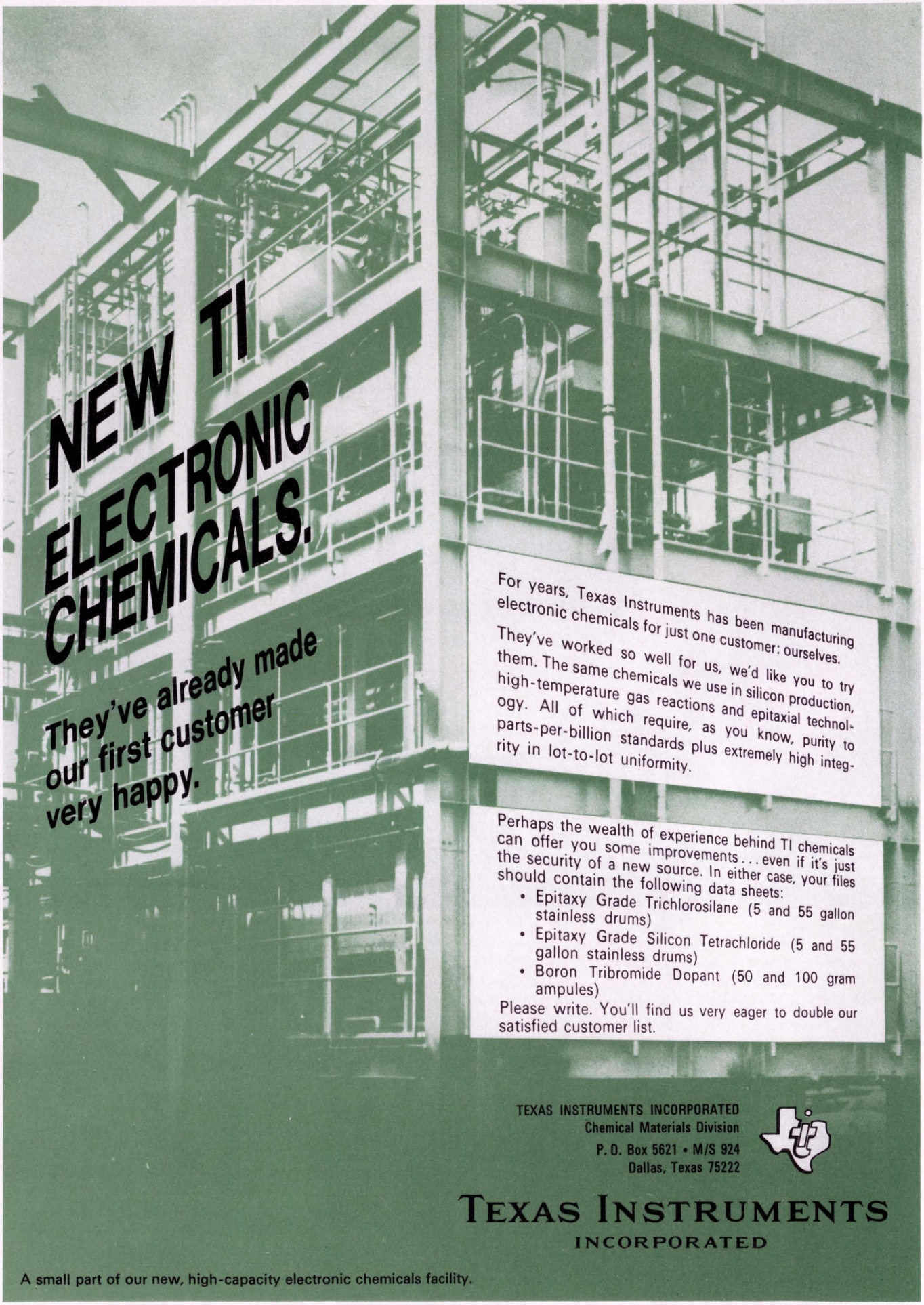
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COURSES

Project Management: Dec. 15-19, Washington, D.C., NSIA members and government personnel $275; nonmembers $300. Designed to provide a working knowledge of the current principles and practices of project management. Will review the impact of major DOD requirements on project management. The National Defense Education Institute, 11 Arlington St., Boston, Mass. 02116.

Electrical/Electronic Insulation: Jan. 12-16, Hotel Manhattan, N.Y.C. The course will cover basic concepts and definitions, dielectric conductivity, capacitance and loss, high voltage, wire and cable, insulators and insulating systems, dielectric materials and dielectric engineering. Fran Zimmer, International Plastics Industry Consultants, Inc., Hotel Manhattan, New York, N.Y. 10036.

Fundamentals of Thick Film Hybrid Microcircuit Technology: Jan: 12-16 State College, Pa., $500. If you're a non-expert in the field (engineer or otherwise) you'll appreciate this basic and informative course providing you with information on the development and design of thick film circuits. State of the art, 1315 South Allen St., State College, Pa. 16801.

An Introduction to Vibration and Shock Testing: Jan. 12-16, Springfield, Va.; Jan. 19-23, Van Nuys, Calif. Designed for quality assurance. evaluation and test personnel concerned with maximum reliability of missiles, aircraft, electronics, etc., where vibration and shock are hazardous environments. The seminar concentrates on modern practices and techniques. Tustin Inst. of Tech., Drawer Q, Santa Barbara, Calif. 93102.

Strain Gage Techniques: Jan. 19-23, Univ. of Miami, Coral Gables. Theory and application of the resistance strain gage. Conference Coordinator, Div. of Continuing Education, Box 8005, Univ. of Miami, Coral Gables, Fla. 33124.

Measurement Engineering: Jan. 26-30, Arizona State Univ., Tempe, $275. Emphasis on unity between theoretical and experimental approaches. The application of engineering principles to the design of measuring systems is stressed. Prof. Peter K. Stein, Engineering Center, Arizona State Univ., Tempe, Ariz. 85281.

Designing with Plastics: Jan. 26-30, Hotel Manhattan, N.Y.C. The course will cover criteria by which a product is produced in plastic from a technical, structural, economic and manufacturing standpoint. Fran Zimmer, International Plastics Industry Consultants, Inc., Hotel Manhattan, New York, N.Y. 10036.

Direct Energy Conversion: Jan. 26-30, Ariz. State Univ., Tempe, $275. The course will cover the physical principles underlying conversion devices and will present a unified theory of energy converters which enables them to be classified and compared. Dr. C. E. Backus, College of Engineering Sciences, Arizona State Univ., Tempe, Ariz. 85281.

Topics in Quantum Electronics: February 2-6, Univ. of Calif. Extension, Berkeley, $300. Topics include Q-switching and mode-locking of lasers, self-focusing and defocusing of laser beams, laser deflection and modulation, generation and propagation of ultra-short optical pulses, far infra-red sources, non-linear optics and high-power lasers. Continuing Education in Engineering, Univ. of Calif. Extension, 2223 Fulton St., Berkeley, Calif. 94720.

Computer-aided Circuit Optimization: Feb. 16-19, Tampa, Fla. The course will provide you with a working knowledge of optimization techniques in circuit design. Topics covered will include circuit analysis, modeling of solid state devices, sensitivity analysis, optimization techniques and applications. Dr. George W. Zobrist, Dept. of E.E., Univ. of S. Fla., Tampa, Fla. 33620.

Reinforced Plastics: Feb. 16-20, Hotel Manhattan, N.Y.C. Will provide participants with a working knowledge of reinforced plastic materials, production methods, applications and design. Fran Zimmer, International Plastics Industry Consultants, Inc., Hotel Manhattan, New York, N.Y. 10036.

Liquid Crystals Workshop: Feb. 19-20, Penn State Univ. Extension, Sewickley, Pa., $155. Will present a background of basic theory to give participants an understanding of the properties of liquid crystals. Penn State Continuing Education, New Kensington Campus, 3550 Seventh Street Rd., New Kensington, Pa. 15068.

READ THESE BOOKS

Maintainability: Principles and Practices

By Benjamin S. Blancher, Jr. & E. Edward Lowery. Published 1969 by McGraw-Hill Book Co., 330 West 42nd St., N.Y., N.Y. 10036. Price $12.50. 336 pages.

This book covers a subject which is never out of date. And obviously, as systems become larger and more complex, the maintainability becomes more critical. This book frankly discusses the problems of maintainability and how to circumvent these problems.

The book contains maintainability detailed check lists which are very useful. While some of the things may seem basic, they're usually the areas where the greatest problems keep appearing in new equipment. If maintainability and its problems are your responsibility then we recommend that you read a copy of this book.

Statistical Communication Theory and Applications

By Harold R. Raemer. Published 1969 by Prentiss-Hall Inc., Englewood Cliffs, N. J. 07632. Price $12.95. 482 pages.

This book centers on the application of statistical communication theory engineering systems analysis, specifically in the areas of radar and radio communications, i.e., those systems involving detection of radio signals and extraction of information from them. It is written for people who are not necessarily theorists, but would like to know how this theoretical discipline can be used in a simple way.

Basic theory is contained in the early chapters with treatment of more advanced topics later in the text. The advanced topics are applications oriented.

Understand and Using Unijunction Transistors

By Stu Hoberman. Published by Howard W. Sams & Co., Inc., Indianapolis, Indiana 46268. Price $2.50. 95 pages.

Computerized Approximation and Synthesis of Linear Networks

By Jeri Vlach. Published 1969 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $14.95. 477 pages.

Logical Design of Switching Circuits

By Douglas Lewin. Published 1969 by American Elsevier Publishing Co., Inc., 52 Vanderbilt Ave., New York, N. Y. 10017. Price $10.50. 368 pages.

Thin Film Dielectrics

Edited by Frederick Vratny. Published by the Electrochemical Society, Inc., 30 East 42 Street, New York, N. Y. 10017. Price $12. 669 pages.

Ohmic Contacts to Semiconductors

Edited by Bertram Schwartz. Published 1969 by Electrochemical Society, Inc., 30 East 42 Street, New York, N. Y. 10017. Price $10. 356 pages.

Thin-Film Transistors

By A. C. Tickle. Published 1969 by John Wiley & Sons, Inc., 605 Third Avenue, N.Y., N.Y. 10016. Price $9.95. 144 pages.

On permanent magnets and PM motors

Ceramic Permanent-Magnet Motors:

Electrical and Magnetic Design and Application, by James R. Ireland. Published 1968 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $9.95. 202 pages.

It isn't too hard to find books that will tell you how to design fractional horsepower and induction motors. It isn't hard either to find books that will explain all about permanent magnets. Mr. Ireland's book, however, is the first one that comprehensively discusses both ceramic permanent magnets and small motors that use such magnets for their magnetic field.

On first thought, one would assume that the design of the motor with permanent magnets should be simpler than that of a motor with coils since there is no need to design these coils (a calculation that must be done by trial and error). That is exactly the first myth that Mr. Ireland dispels. The field of a permanent magnet is not constant, and the author tells you why and how it varies. He also reminds you quite forcefully that all the power to the circuit must come through the armature.

Even if you don't design PM motors, and your interest is limited to permanent magnets, the book is still the best you can find on that subject. Basic, yet factual and, above all, very practical, the book takes you by the hand to show you how to design motors that are finding increasing applications to drive portable tools, small mechanisms, and automotive accessories.

Electronic Spectra of Transition of Metal Complexes

By B. Sutton. Published 1968 in England by McGraw-Hill, Ltd., McGraw-Hill Book Co., 330 West 42 Street, New York, N. Y. 10036. Price $8.50. 208 pages.

Mathematics for Science and Engineering

By Phillip A. Alger. Published 1969 by McGraw-Hill Book Co., 330 West 42 Street, New York, N. Y. 10036. Price $9.75. 374 pages.

Control Systems for Technicians

By G. T. Bryan. Published 1969 by Hart Publishing Co., Inc., 510 Sixth Ave., New York, N. Y. 10011. Price $12.50. 328 pages.

The Art of Computer Programming Volume 2 Seminumerical Algorithms

By Donald E. Knuth. Published 1969 by Addison-Wesley Publishing Co., Inc., Reading, Mass. 01867. Price $18.50. 624 pages.

Color TV Reception and Decoding Technique

By B. W. Osborne. Published 1969 by Hart Publishing Co., Inc., 510 Sixth Ave., New York, N. Y. 10011. Price $12.50. 168 pages.

Semiconductor Plasma Instabilities

By Hans Hartnagel. Published 1969 by American Elsevier Publishing Co., Inc. 52 Vanderbilt Ave., N.Y., N.Y. 10017. Price $11.00. 206 pages.

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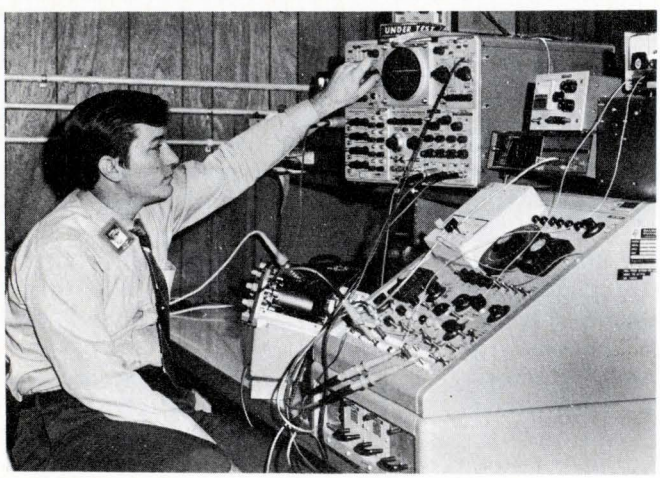
Storage CRTs for radar

Displays with a variable memory—here's the how and why of tubes that remember.

Terry Ballou, Display Systems Design Engineer
Dalmo Victor Co., Belmont, Calif.

Display storage tubes (DST), used in today's radar systems, are electrostatically or magnetically deflected, high light output display tubes. They give high resolution, variable persistence and writing speeds up to one million in./s. Manufactured in different sizes and shapes for various applications, their cost is greater than a conventional cathode-ray display tube.

Compared with a conventional CRT, a DST has additional elements and lenses (see Fig. 1) which give it the ability to store written information for controllable time periods. It can retain this information for periods lasting from seconds to minutes and, under the proper conditions, up to a week's time. This property gives the tube flexibility in a great variety of applications.



Today, DSTs are mostly found in military and commercial radar display systems, mainly because they offer the system designer a wider range of functions than the cathode-ray tube does. First, the DST can use a considerably lower sweep rate because of its ability to retain information. Also, since the high voltage needed for a given light output is less than that required for a CRT, a DST allows a smaller and more compact indicator package.

Because of its storage capability, the tube acts as an integrator. This means that the target (a constant) that was once obscured by noise (random) can now be seen with a DST. This increases the target detection capability of the system. As a result DSTs have been used to create new radar system modes of operation, such as high resolution mapping and new navigation modes. In addition, oscilloscopes for time studies use DSTs where retention of information is desired. Scope display photographs are taken more easily with a DST. They are also useful in transient studies, where the mechanical chart recorder was previously the only available instrument. DSTs improve the memory and scan circuits of certain computer systems as well.

Storage tube operation

The writing gun used in a DST has the same configuration as that used in a CRT. Mechanical spacings and sizes of the individual components define a particular gun's characteristics. The significant factor is that its electron beam is focused such that the electrons con-

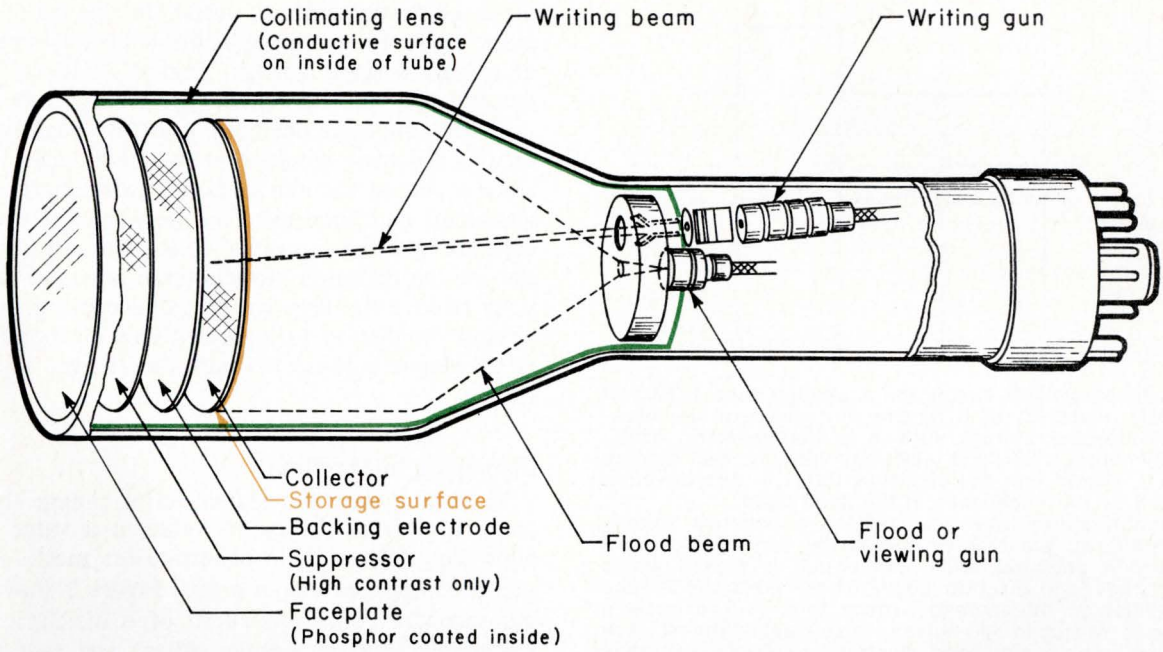


Fig. 1. Internal structure of a high-contrast display storage tube. By changing the voltage on the backing electrode you can control the number of electrons (from the flood gun) that reach the phosphor-coated faceplate. With a negative voltage level, the backing electrode prevents any electrons from passing through (cutoff), and the face of the tube is dark.

The flood gun side of the backing electrode has a layer of a dielectric material, and the writing gun is focused so that its beam converges on this dielectric. Electrons from the write gun travel fast enough to cause secondary electron emission in the dielectric. This emission from small areas of the dielectric raises the potential of these areas and allows flood gun electrons to pass through the backing electrode. These flood electrons now reach the phosphor and give a light output on the tube face.

By raising the voltage level of the backing electrode and then returning it to its normal level, you can achieve a cutoff condition again.

verge at the storage surface on the backing electrode.

A storage tube has an additional electron gun, as opposed to a CRT, in which the electrons are collimated (travel parallel) to the tube centerline. The additional electron gun provides a circular beam of electrons equal in diameter to the viewing area and it is commonly referred to as the "flood" or "viewing" gun.

The three elements contained in the front of the tube, the suppressor, the collector and the backing electrode, are constructed of electroplated wire mesh. This mesh can have as few as ten lines or wires per inch or up to as many as 1500 lines per inch. Design considerations, such as resolution, will determine the number of lines. The thickness of the wire is based on the desired transmission. A typical, medium resolution tube would have 500 lines/in. and a transmission of about 50%. Each wire mesh is welded to a metal ring which is mounted and insulated from the other two meshes on an assembly in the front end of the tube.

The backing electrode (BE) is the heart of a storage tube. The backing electrode mesh is similar to the suppressor and collector meshes with one major difference: it has an insulator, a few microns thick, evaporated on the flood gun side. This is called the storage surface. The insulating material used must have a high dielectric constant and a secondary emission ratio large enough to meet performance requirements. A common insulator is magnesium fluoride (MgF_2).

Secondary emission occurs when a free electron with enough energy strikes and dislodges an orbiting electron. Several factors determine the number of secondary electrons freed. These factors are the energy contained in the primary electron, the angle at which it strikes, and the type of material it strikes. The principle of secondary emission allows the storage operation in a DST.

The backing electrode and the collector function in the following manner. The flood gun cathode potential is ground or 0 V. The application of heater voltage causes electrons to leave the cathode. A positive potential on a grid within the flood gun accelerates them. The electrons path parallels the tube centerline because of the positive potential on the collimating lens and the collector. Since the collector is at a higher positive potential, it forms a lens effect between itself and the collimating lens.

Initially the BE potential is ground, allowing the maximum number of flood or viewing electrons to pass through both the BE and the collector. The high positive potential of the phosphor attracts them. All of the electrons do not strike the phosphor; some strike the collector and BE wires. Those that do not strike wires cause the phosphor to emit light. The electrons that strike the collector cause a collector current, and those striking the storage surface are diverted. The majority of the diverted electrons are collected by the collector. If the BE and the collector are 50% transmissive, approximately half of the electrons arriving at each grid strike the wires. The rest reach the phosphor to produce brightness and this is the maximum light output that can be obtained from the tube (saturation light output).

The BE can control the number of flood electrons which penetrate the mesh and arrive at the phosphor to create brightness. A negative voltage level, where no flood electrons pass through the BE, is defined as

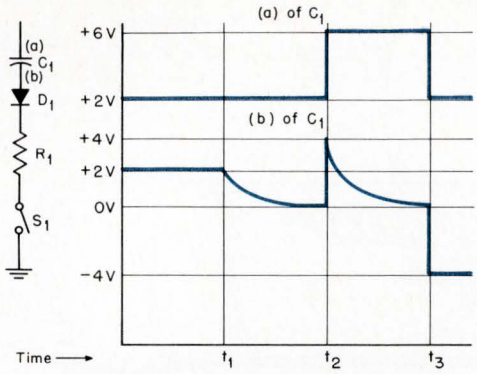


Fig. 2. An equivalent circuit for a storage tube is shown on the left. Plate (a) of C_1 is the wire mesh of the backing electrode; the storage surface is the dielectric of C_1. Plate (b) represents flood electrons striking the storage surface. D_1 shows that the electrons travel in one direction only and R_1 is the impedance of the flood beam.

The graph shows how you develop a negative voltage level (cutoff) on the storage surface by varying the backing electrode potential. At t_1 the switch is closed which turns on the flood electron beam. These electrons reduce the potential on the storage surface to 0 V. The backing electrode is raised to +6 V at t_2, also raising the storage surface voltage. Again, flood electrons reduce the storage surface potential to ground. Now, at t_3, the backing electrode returns to its normal level. The storage surface, which was at ground, is also reduced. This puts it at −4 V, which in this case is the cutoff potential.

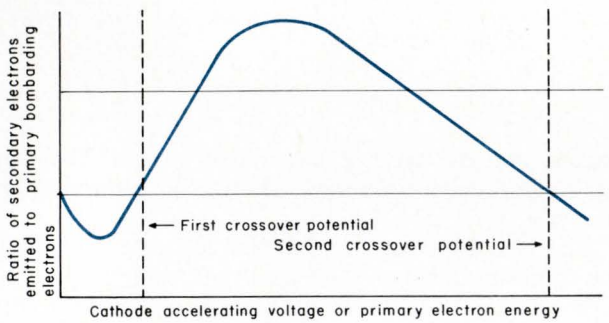


Fig. 3. A typical secondary emission curve for a dielectric material used in storage tubes. The curve shows that by bombarding the material with primary electrons at energies above first crossover you can raise the potential of the dielectric.

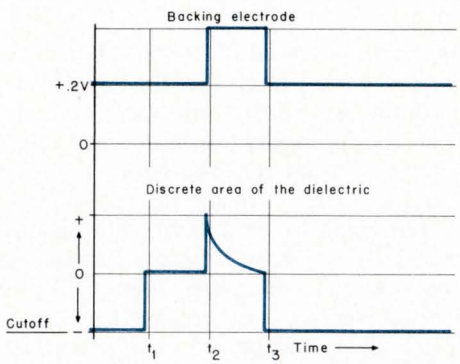


Fig. 4. One write cycle of a storage tube. At time t_1, the write gun bombards a small area of the storage surface. Because secondary electrons are freed, the voltage of the area rises to 0 V. Flood electrons now pass through the backing electrode and "write" on the tube face. At time t_2, the voltage of the backing electrode and storage surface is raised to +6 V prior to erasing the tube. When enough flood electrons have been attracted to the storage surface to return its voltage to zero (t_3), the backing electrode returns to 2 V and the storage surface goes to cutoff. This eases the written spot from the face of the tube.

mesh, or storage surface, cutoff. In this case, the electrons return to, or through, the collector because it is at a high positive voltage. Figure 2 shows how you develop this cutoff potential in a storage tube.

If the tube contained no gas, this negative charge on the dielectric would remain indefinitely. However, since a perfect vacuum does not exist, the collision of gas atoms and flood electrons between the BE and the collector generates positive ions. The negative potential on the dielectric attracts these ions and they gradually remove the negative potential causing the brightness of the display to increase. This ion bombardment is significant because it limits the storage time of the tube.

Displaying information

A method must be established to change the dielectric charge from the cutoff value to a value that will allow flood electrons to penetrate the mesh. A writing gun accomplished this in a DST. Figure 3 shows a typical secondary emission curve of a dielectric material commonly used in storage tubes. The first crossover voltage is in the order of 50 V.

Now, let us assume we start with the storage mesh at cutoff in Fig. 4. The writing gun at t_1 bombards a discrete area on the dielectric. The cathode voltage on the writing gun provides electron energy above first crossover to free secondary electrons from the dielectric. Theoretically, these electrons are collected by the collector mesh. The bombardment results in a positive

In addition to the tube using the backing electrode described in the article, a second type of storage tube is in use today. This unit, used by Tektronic Inc. in their storage oscilloscopes, has two stable states and is, in fact, called a bistable storage tube.

The bistable tube does not have a backing electrode; instead, it uses the phosphor coating on the faceplate as the dielectric storage surface. The two stable states are phosphor voltage levels corresponding to points 1 and 3 on the secondary emission curve in Fig. 3.

At these two points the ratio of secondary electrons to primary electrons is one, and the net transfer of charge from the phosphor is zero. Also, since the curve has a negative slope at these points, any small change in phosphor voltage is neutralized. For example, if the phosphor is at point 3 and its voltage becomes slightly more positive, the secondary emission ratio becomes less than one. This means that the phosphor now accumulates negative charges and returns to point 3 on the curve. These two states correspond to a write condition at point 3 and an erase condition at point 1.

In the erase state, the negative voltage on the phosphor repels flood gun electrons, darkening the tube. The write gun bombards the phosphor directly and causes secondary emission above the first crossover point. The loss of negative charges causes

change in voltage on the dielectric. If the writing beam bombards this spot for a sufficient amount of time, the voltage approaches zero and saturation brightness occurs. Except for the gas ion bombardment, which alters the storage surface voltage, the written spot would be stored indefinitely after the writing beam has been cut off. It is important to realize that the visual brightness of the stored image is not due to the writing beam electrons, but to the flood beam electrons exciting the phosphor. The write gun simply alters the charge on the dielectric and allows flood electrons to pass through.

The writing speed capability of storage tubes is about a million in./s. The system time constant determines the speed at which the charge on the storage surface can be altered. Controlling factors are storage mesh capacity, amount of writing beam, and the time of bombardment. A complete display of information can thus be written and retained for fixed time periods with a high brightness and detailed pattern.

Erase time is defined as the minimum pulse width at the smallest amplitude needed for complete single pulse erasure of the spot. The single frame erasing method shown in Fig. 4 is one desirable and useful mode of operation. However, many applications require some method of obtaining variable persistence.

Variable persistence

The DST accomplishes variable persistence by dividing the erase time pulse into many pulses. If the erase time is 10 ms, the erase pulse can be divided into ten 1-ms pulses. At t_1 of Fig. 5, a spot is written, and at t_2,

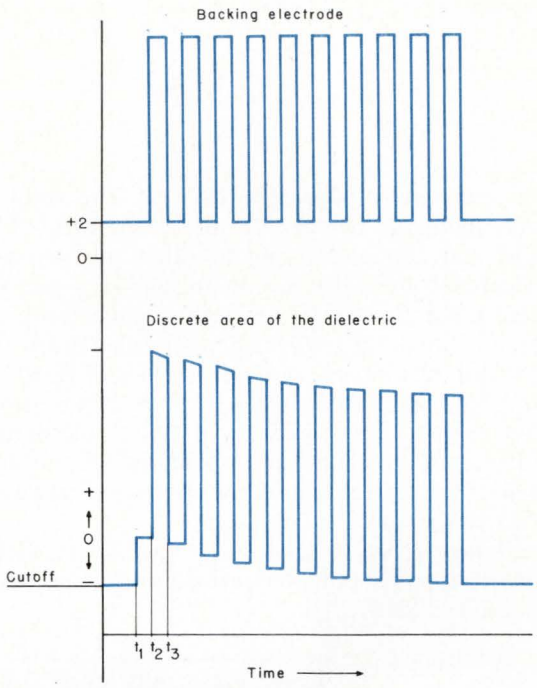


Fig. 5. The storage tube gives you variable persistence by dividing the erase pulse into many shorter pulses. At t_1, the write gun raises the storage surface voltage to 0 V resulting in the appearance of a spot on the faceplate. The first of ten short erase pulses is applied at t_2. As you can see, the voltage level on the storage surface becomes more negative after each erase pulse. This decreases the number of flood electrons that penetrate the backing electrode and cause brightness of the spot on the tube face. Finally, at the end of the tenth erase pulse, the storage surface is back at its cutoff level and the face of the tube is dark. By varying the pulse width, its amplitude, or the frequency of the pulses, you can control the length of the time the image remains on the tube.

the phosphor to charge to its second state at point 3. Here, the positive potential attracts flood gun electrons with enough energy to cause them to write on the face of the tube.

To erase this type of tube, the collector is pulsed negative. About one-half of the negative change is capactively coupled to the phosphor reducing it below the first crossover point. Since the collector is negative with respect to the phosphor, secondary electrons are now collected by the phosphor and it continues to charge in a negative direction to its erase state.

The bistable storage tube has several disadvantages compared with the backing electrode tube in the article. The bistable tube has just two stable states and these correspond to either full brightness or no brightness. The tube therefore cannot give you any gray scale or half tones. Also, because the tube is either full on or full off, you cannot vary the persistence as you can with the backing electrode tube.

In addition, certain problems associated with using the phosphor as a storage surface limit the thickness of phosphor that can be used on the tube. This means that the bistable tubes give you a lower light output and poorer contrast than you can get from the high-contrast tube.

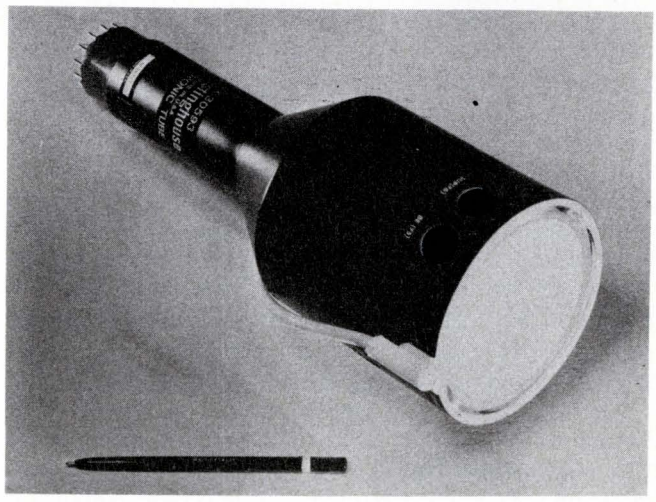


Fig. 6. The WX-30593 storage tube, made by Westinghouse Electronic Tube Div., Elmira, N. Y., can display both stored and nonstored information. Representative of the high contrast type described in the article, this tube has a writing speed of 5 x 10^5 in./s and a resolution of 60 lines/in.

the first erase pulse appears on the BE. The voltage of the area increases to that of the erase pulse. Flood electrons start to land trying to bring the voltage to zero. However, the pulse is only present for 1 ms. Since the erase pulse time is 10 ms, only a small portion of the charge is removed. When the first pulse drops (t3), the dielectric also drops. A small amount of flood electrons do land so that the dielectric does drop into the negative region. Each succeeding pulse allows more flood electrons to land and increases the negative potential of the dielectric until the spot is entirely erased after the tenth pulse.

Persistences from 16 ms to 60 s have been obtained with this technique. For practical purposes, the following equation holds:

$$\text{Persistence} = \frac{\text{Erase time}}{\text{Erase pulse duty cycle}}$$

$$\text{Where duty cycle} = \frac{\text{Pulse width}}{\text{Period}}$$

This method of obtaining variable persistence is probably the most commonly used in storage tube applications. By continuously applying the erase pulses, writing and erasing can occur simultaneously. With the single erase pulse, each must be accomplished separately.

A disadvantage of this typical DST is the background brightness created by the erase pulse. Whenever the dielectric is at 0 V or above, saturation brightness occurs on the display. If the erase duty cycle used is 10%, then the background brightness is at a level which is 10% of saturation brightness as long as the period exceeds the flicker frequency. The eye integrates the brightness from each erase pulse into some average light level. This can noticeably reduce the contrast of the tube at high erase pulse duty cycles or in applications with numerous duty cycles.

Some methods of eliminating background brightness exist that will not seriously alter the effect of the erase pulse on erasure. One method drops the phosphor voltage coincident with the erase pulse so that the brightness cannot be seen. An obvious drawback is the fact that the screen voltage is often above 5000 V.

Another method used places another mesh, referred to as the suppressor* between the backing electrode and screen. This mesh can be pulsed negative, coincident with the erase pulse, to prevent flood electrons from striking the phosphor. The pulse amplitude normally used on the suppressor is about 80 V. Tubes using this method are called high-contrast types.

Certain applications require the use of special techniques to extend the storage time capability of the tube. One of the factors that limits the storage time is the ions created by gas molecules colliding with flood electrons. Obviously, a decreased number of flood electrons increases the storage time. This can be accomplished by operating any electrode which controls flood gun emission at a predetermined duty cycle.** The tradeoff is output brightness, since it will decrease as a function of the same duty cycle.

External circuitry

Operation of a DST requires positive and negative dc operating voltages for the various electrodes. Regulation of the dc supplies is not critical. The writing gun, cathode-supply voltage is in the −500 Vdc to −3000 Vdc range depending on the specific tube type used. The flood gun supply range is usually between +200 Vdc to +300 Vdc. Resistive bleeders from the two supplies establish the other electrode voltages for both guns.

If a high-contrast tube is being used, the generation of the erase and suppressor pulses requires external circuitry. With a low-contrast type, a circuit can be added to disable the high voltage during the erase pulse and thus reduce background brightness and provide high-contrast operation. This is commonly called dunking.

The erase pulse circuitry should contain frequency, amplitude and pulse width control. Variable persistence can be obtained by many methods, but the most common fixes an initial amplitude and pulse width at a given frequency and then varies the persistence with frequency variation. For environments that require several fixed persistences, amplitude and frequency are usually fixed initally and then several different pulse widths provide the required fixed persistences. A frequency range of 100 Hz to 10 kHz, a pulse width of 3 μs to 100 ms, and an amplitude of 0 to 10 V is the average range of erase pulse operation. It, too, depends on tube type and system requirements.

A high contrast DST requires a suppressor pulse coincident with the erase pulse and having a width that is the same as, or slightly greater than, the erase pulse. It must also be a large enough negative pulse to change the suppressor potential (+60 to +80 Vdc) to −5 to −10 Vdc.

The tube's resolution capability determines the frequency of operation which usually covers a range of 5 to 250 lines per inch. Video frequency capabilities are best described by an example: Suppose a television raster has an horizontal sweep time of 50 μs, a horizontal line length of 5 in. and a tube with a resolution of 100 lines per inch. This means it sweeps across 500 lines in 50 μs so that a line occurs every 100 ns. This corresponds to 10 MHz.

* Westinghouse patent 3088048
** Hughes Aircraft Co. patent 2903618

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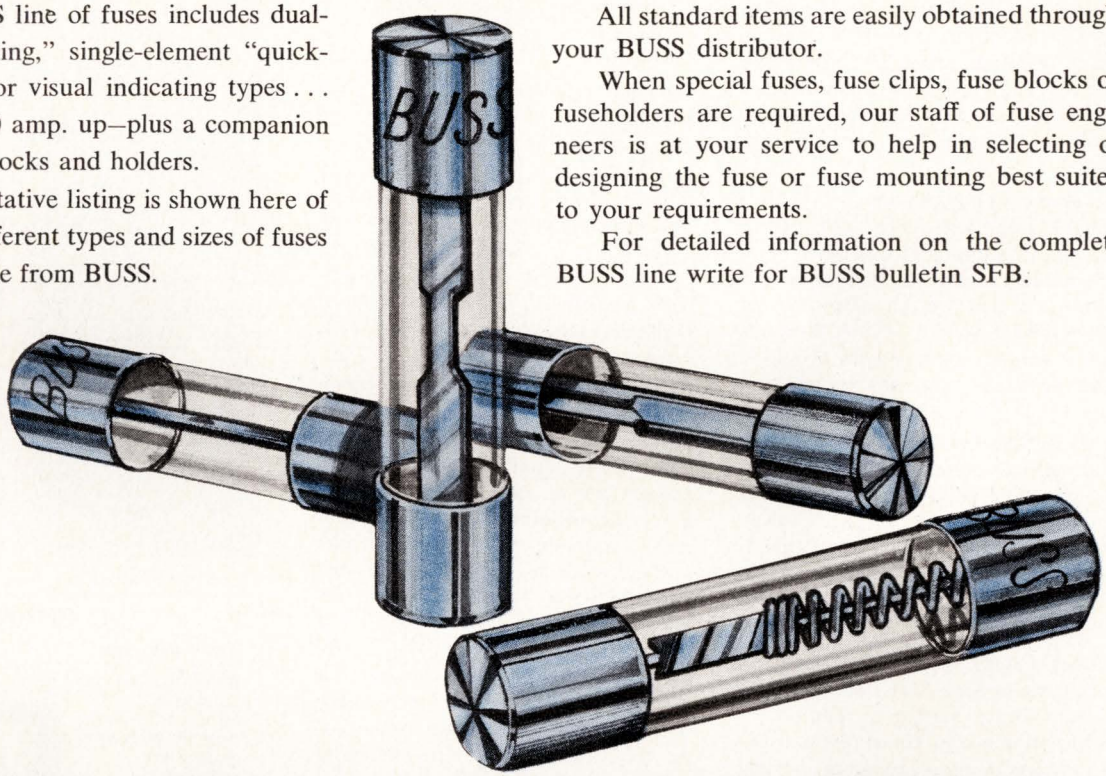

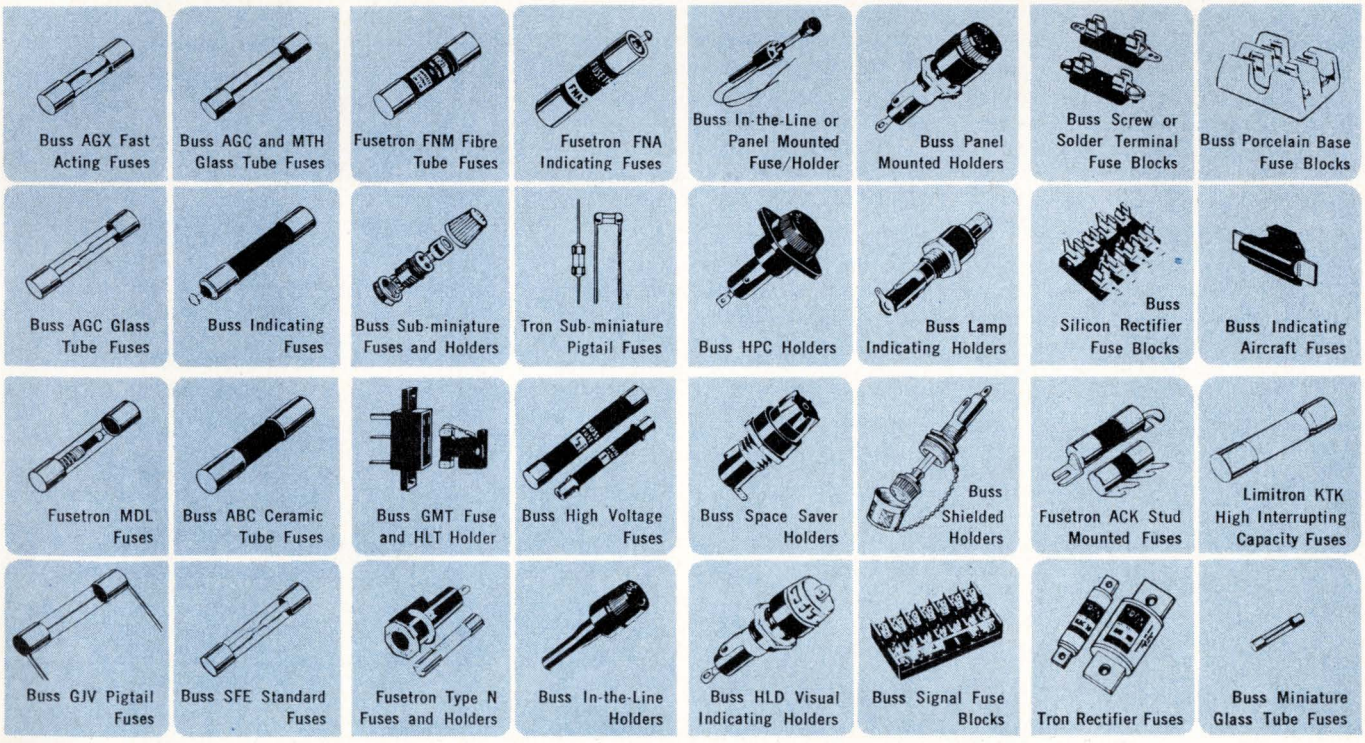

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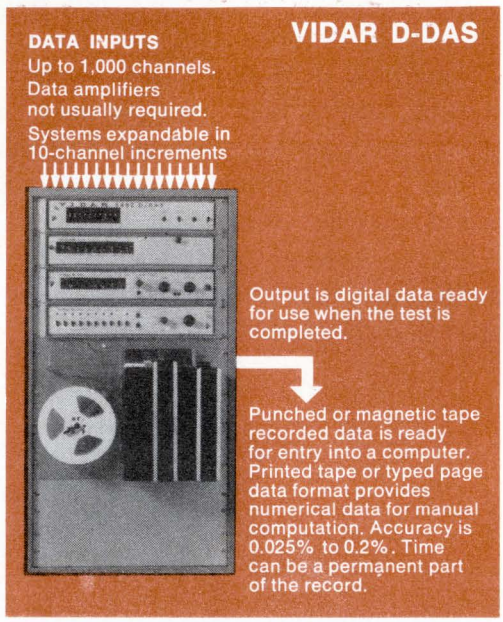

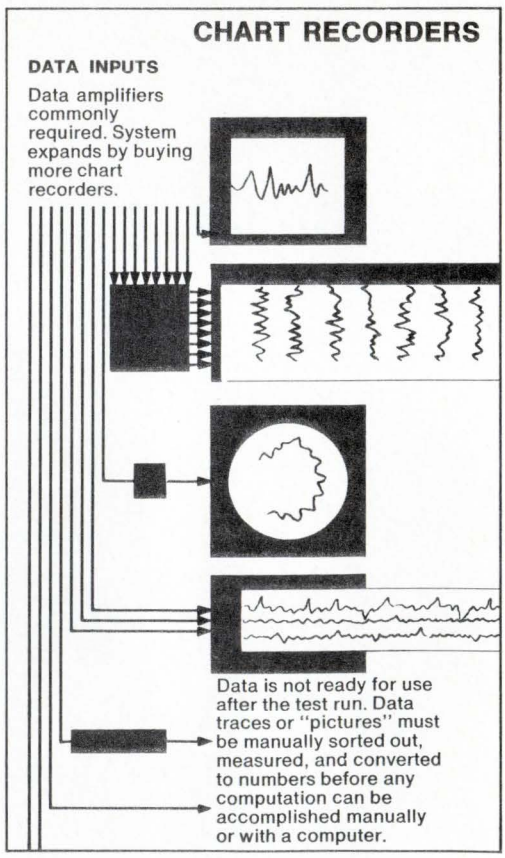

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The price of TTL

Two tables that list prices of the most popular TTL lines.

By Arthur J. Boyle, Technical Editor

Competition among digital integrated circuit manufacturers is as fierce as you will find in any market place. With this situation, you, as the user, can benefit by shopping for the best deal for your IC dollar.

Reading through the alphabet of logic types, the fastest growing share of today's market belongs to TTL. And, in TTL, the two most popular lines are Series 54/74, introduced first by Texas Instruments, and SUHL, developed by Sylvania. To these two lines, therefore, we have devoted the comparison tables of the following pages.

Rather than attempting to list every type of circuit available, we have instead compared prices in the most competitive area—standard circuits designed to operate over the industrial temperature range of 0 to 70°C (such as Series 7400). We have deliberately omitted such variations as Series 7400 high-speed and low-power types, and SUHL's high-fanout circuits.

The upper price level in each category is the maker's list price for that circuit in unit quantities. The lower price is for the same circuit in 100 piece lots.

Series 7400

Table I, Series 7400, lists pieces for three standard packages: a plastic dual-in-line, a ceramic dual-in-line, and a flat pack. The one exception to this breakdown is Sylvania's 7400 line, which is packaged in their own Cerdip package. Prices for Sylvania are listed under plastic since the Cerdip package competes in price with other manufacturers' plastic DIP.

As stated in the footnote to the table, the circuits listed for Fairchild in Table I represent a portion of their 9000 series and may not be exactly interchangeable with 7400. On the other hand, we understand that Fairchild plans to introduce a 54/74 line in the near future. The exact devices to be included in this line, as well as their prices were not available at this time.

SUHL

Table II, the SUHL circuits, also lists three package types. A flat pack and a ceramic and metal DIP are standard. Prices for a third package, listed as a low-cost DIP, are also included. For most manufacturers, this means SUHL in an all-ceramic DIP (such as Sylvania's Cerdip). The exception in this case is Motorola, whose lowest priced package is a plastic dual-in-line.

For more information on these manufacturers and their TTL product lines, please use the reader circle numbers below.

Amperex	201	Raytheon	
Fairchild	202	7400	210
ITT	203	SUHL	211
Motorola		Signetics	212
7400	204	Sprague	213
SUHL	205	Sylvania	
National	206	7400	214
Nucleonic	207	SUHL	215
Philco-Ford		Texas Instruments	216
7400	208	Transitron	
SUHL	209	7400	217
		SUHL	218

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INFORMATION RETRIEVAL
Integrated Circuits, Charts and nomographs

TABLE I. Standard series 74 circuits.

Circuit	Package	Amperex	Fairchild[1]	I T T	Motorola	National	Nucleonic	Philco-Ford	Raytheon	Signetics	Sprague	Sylvania[2]	Texas Inst.	Transitron
7400 – quad, 2-input pos. NAND gate	Plastic	1.85			1.45	2.25				1.86	1.86	1.86	1.86	1.70
	Dip	1.00			1.12	1.55	1.20			1.25	1.26	1.26	1.26	1.15
	Ceramic		2.35	1.83	3.15			1.85					2.33	2.33
	Dip		1.55	1.25	2.10			1.26					1.58	1.58
	Flat-		3.65		3.75					3.54	3.54		3.54	3.54
	Pack		2.50		2.50					2.40	2.40		2.40	2.40
7401 – quad 2-input pos. NAND gate with open collector output	Plastic	1.95			1.45					1.86	1.86		1.86	1.70
	Dip	1.05			1.12		1.20			1.25	1.26		1.26	1.15
	Ceramic			1.83	3.15			1.85					2.33	2.33
	Dip			1.25	2.10			1.26					1.58	1.58
	Flat-				3.75					3.54	3.54		3.54	3.54
	Pack				2.50					2.40	2.40		2.40	2.40
7402 – quad 2-input pos. NOR gate	Plastic	1.95			1.70	2.13				2.13	2.13	2.13	2.13	1.96
	Dip	1.05			1.30	1.45				1.45	1.45	1.45	1.45	1.32
	Ceramic			2.12	3.50			2.04					2.67	2.67
	Dip			1.45	2.35			1.41					1.81	1.81
	Flat-				4.05					4.06	4.06		4.06	4.06
	Pack				2.70					2.76	2.76		2.76	2.76
7404 – hex inverter	Plastic				1.80	2.33					2.33		2.33	2.14
	Dip				1.40	1.58					1.58		1.58	1.45
	Ceramic		2.85	2.26	4.05			2.22					2.91	2.91
	Dip		1.90	1.55	2.70			1.53					1.97	1.97
	Flat-		4.55		4.50						4.42		4.42	4.42
	Pack		3.05		3.00						3.00		3.00	3.00
7405 – hex inverter with open collector output	Plastic				1.80						2.33		2.33	2.14
	Dip				1.55						1.58		1.58	1.45
	Ceramic			2.26				2.22					2.91	2.91
	Dip			1.55				1.53					1.97	1.97
	Flat-										4.42		4.42	4.42
	Pack										3.00		3.00	3.00
7410 – triple 3-input pos. NAND gate	Plastic	1.85			1.45	2.25				1.86	1.86	1.86	1.86	1.70
	Dip	1.00			1.12	1.55	1.20			1.25	1.25	1.26	1.26	1.15
	Ceramic		2.35	1.83	3.15			1.85					2.33	2.33
	Dip		1.55	1.26	2.10			1.26					1.58	1.58
	Flat-		3.65		3.75					3.54	3.54		3.54	3.54
	Pack		2.50		2.50					2.40	2.40		2.40	2.40
7420 – dual 4-input pos. NAND gate	Plastic	1.85			1.45	2.25				1.58	1.58	1.58	1.58	1.45
	Dip	1.00			1.12	1.55	1.20			1.07	1.07	1.07	1.07	.98
	Ceramic		2.35	1.58	3.15			1.57					1.99	1.99
	Dip		1.55	1.07	2.10			1.09					1.35	1.35
	Flat-		3.65		3.75					2.99	2.99		2.99	2.99
	Pack		2.50		2.50					2.03	2.03		2.03	2.03
7430 – 8-input pos. NAND gate	Plastic	1.85			1.45	2.25				1.58	1.58	1.58	1.58	1.45
	Dip	1.00			1.12	1.55	1.20			1.07	1.07	1.07	1.07	.98
	Ceramic		2.35	1.58	3.15			1.57					1.99	1.99
	Dip		1.55	1.07	2.10			1.09					1.35	1.35
	Flat-		3.65		3.75					2.99	2.99		2.99	2.99
	Pack		2.50		2.50					2.03	2.03		2.03	2.03
7440 – dual 4-input pos. NAND buffer	Plastic	1.95			1.70	2.50				2.13	2.13	2.13	2.13	1.96
	Dip	1.05			1.30	1.70	1.20			1.45	1.45	1.45	1.45	1.32
	Ceramic			2.12	3.50			2.04					2.67	2.67
	Dip			1.45	2.35			1.41					1.81	1.81
	Flat-				4.05					4.06	4.06		4.06	4.06
	Pack				2.70					2.76	2.76		2.76	2.76
7441A – BCD to decimal decoder/driver	Plastic				8.25	15.20			14.65	10.36	10.36		10.36	9.45
	Dip				6.35	10.40			9.80	7.03	7.03		7.03	6.00
	Ceramic								16.30				12.96	11.35
	Dip								10.85				8.80	7.80

TABLE I. Standard series 74 circuits. (Continued)

Circuit	Package	Amperex	Fairchild[1]	I T T	Motorola	National	Nucleonic	Philco-Ford	Raytheon	Signetics	Sprague	Sylvania[2]	Texas Inst.	Transitron
7442 – BCD to decimal decoder	Plastic Dip												9.50 6.45	9.15 6.19
	Ceramic Dip			9.50 6.45									11.90 8.08	11.90 8.08
7443 – excess 3 to decimal decoder	Plastic Dip												9.50 6.45	9.15 6.19
	Ceramic Dip			9.50 6.45									11.90 8.08	11.90 8.08
7444 – excess 3 Gray to decimal decoder	Plastic Dip												9.50 6.45	9.15 6.19
	Ceramic Dip			9.50 6.45									11.90 8.08	11.90 8.08
7450 – expandable, dual 2-wide 2-input AND-OR-INVERT gate	Plastic Dip	1.95 1.05			1.45 1.12	2.50 1.70	1.20			1.86 1.25	1.86 1.25	1.86 1.26	1.86 1.26	1.70 1.15
	Ceramic Dip			1.83 1.25	3.50 2.35			1.85 1.26					2.33 1.58	2.33 1.58
	Flat-Pack				4.05 2.70					3.54 2.40	3.54 2.40		3.54 2.40	3.54 2.40
7451 – dual 2 wide 2-input AND-OR-INVERT gate	Plastic Dip	1.85 1.00			1.45 1.12	2.25 1.55				1.86 1.25	1.86 1.25	1.86 1.26	1.86 1.26	1.70 1.15
	Ceramic Dip			1.83 1.25	3.15 2.10			1.85 1.26					2.33 1.58	2.33 1.58
	Flat-Pack				3.75 2.50					3.54 2.40	3.54 2.40		3.54 2.40	3.54 2.40
7453 – expandable 4 wide 2-2-2-3 input AND-OR-INVERT gate	Plastic Dip	1.95 1.05			1.45 1.12	2.50 1.70	1.20			1.86 1.25	1.86 1.25	1.86 1.26	1.86 1.26	1.70 1.15
	Ceramic Dip			1.83 1.25	3.50 2.35			1.85 1.26					2.33 1.58	2.33 1.58
	Flat-Pack				4.05 2.70					3.54 2.40	3.54 2.40		3.54 2.40	3.54 2.40
7454 – 4 wide, 2-input AND-OR-INVERT gate	Plastic Dip	1.85 1.00			1.45 1.12	2.25 1.55				1.86 1.25	1.86 1.25	1.86 1.26		1.70 1.15
	Ceramic Dip			1.83 1.25	3.15 2.10			1.85 1.26						2.33 1.58
	Flat-Pack				3.75 2.50					3.54 2.40	3.54 2.40			3.54 2.40
7460 – dual 4-input expander	Plastic Dip	1.70 .95			1.10 .85	1.80 1.20	.94			1.39 .94	1.39 .94	1.39 .94	1.39 .94	1.26 .85
	Ceramic Dip		2.90 2.00	1.39 .94	2.45 1.65			1.39 .96					1.74 1.18	1.74 1.18
	Flat-Pack		2.90 2.00		3.00 2.00					2.65 1.80	2.65 1.80		2.65 1.80	2.65 1.80
7470 – J-K flip-flop	Plastic Dip	2.75 1.50								2.80 1.90	2.80 1.90		2.80 1.90	2.56 1.74
	Ceramic Dip			2.88 1.90				2.78 1.92					3.49 2.37	3.49 2.37
	Flat-Pack									5.31 3.60	5.31 3.60		5.31 3.60	5.31 3.60
7472 – J-K master slave flip-flop	Plastic Dip	2.75 1.50			2.00 1.55	2.60 1.77	1.70			2.60 1.70	2.60 1.77	2.60 1.77	2.60 1.77	2.40 1.62
	Ceramic Dip			2.50 1.70	5.10 3.40			2.59 1.79					3.25 2.21	3.25 2.21
	Flat-Pack				5.25 3.50					4.95 3.36	4.95 3.36		4.95 3.36	4.95 3.36
7473 – dual J-K master-slave flip-flop	Plastic Dip	4.40 2.35			3.40 2.60	5.90 4.00	2.85			4.29 2.85	4.29 2.91	4.29 2.91	4.29 2.91	4.12 2.79
	Ceramic Dip			4.20 2.85	7.50 5.00			4.25 2.94					5.36 3.64	5.36 3.64
	Flat-Pack				7.50 5.00					8.14 5.52	5.36 3.64			

TABLE I. Standard series 74 circuits. (Continued)

Circuit	Package	Amperex	Fairchild[1]	I T T	Motorola	National	Nucleonic	Philco-Ford	Raytheon	Signetics	Sprague	Sylvania[2]	Texas Inst.	Transitron
7474 – dual D-type edge-triggered ff	Plastic Dip	3.60 1.95			2.90 2.25	5.65 3.85	3.60			3.72 2.45	3.72 2.52	3.72 2.52	3.72 2.52	3.57 2.42
	Ceramic Dip			3.60 2.45	7.20 4.80			3.70 2.56					4.66 3.16	4.66 3.16
	Flat-Pack				7.35 4.90					7.07 4.80	7.07 4.80		7.07 4.80	7.07 4.80
7475 – quad bistable latch	Plastic Dip				5.15 3.95	10.00 6.90	5.80		9.50 6.35	6.56 4.35	6.54 4.35		6.56 4.45	6.31 4.27
	Ceramic Dip			6.40 4.35				6.45 4.48	10.55 7.00				8.19 5.56	8.19 5.56
7476 – dual J-K master-slave with separate preset & clear	Plastic Dip	4.25 2.55			3.50 2.70	6.20 4.20	3.75			4.51 2.95	4.51 3.06		4.51 3.06	4.83 3.26
	Ceramic Dip			4.35 2.95				4.45 3.07					5.63 3.82	5.63 3.82
7480 – gated full adder	Plastic Dip				4.05 3.40				5.65 3.80	5.02 3.40	5.02 3.40		5.02 3.40	
	Ceramic Dip			5.02 3.40					6.30 4.20				6.28 4.26	6.28 4.26
	Flat-Pack									9.52 6.46	9.52 6.46		9.52 6.46	9.52 6.46
7482 – 2-bit binary full adder	Plastic Dip										7.45 5.05		7.45 5.05	7.18 4.85
	Ceramic Dip			7.45 5.05				7.40 5.10					9.31 6.32	9.31 6.32
	Flat-Pack										11.98 8.13		11.98 8.13	11.98 8.13
7483 – 4-bit binary full adder	Plastic Dip					11.82 8.02			13.25 8.90		11.82 8.02		11.82 8.02	11.39 7.70
	Ceramic Dip			11.82 8.02				11.80 8.12	14.70 9.75				14.79 10.04	14.79 10.04
7490 – decade counter	Plastic Dip	7.80 4.20			6.10 5.15	11.10 7.55	7.55		11.05 7.40	7.66 5.20	7.66 5.20		7.66 5.20	7.22 4.99
	Ceramic Dip			7.65 5.70					12.25 8.15				9.57 6.50	8.80 5.95
	Flat-Pack				17.75 11.85					14.53 9.86	14.53 9.86		14.53 9.86	14.53 9.86
7491A – 8-bit shift register	Plastic Dip									10.38 7.05	10.38 7.05		10.38 7.05	9.96 6.77
	Ceramic Dip			10.38 7.05									12.96 8.80	12.96 8.80
	Flat-Pack									14.17 9.62	19.90 13.50		14.17 9.62	14.17 9.62
7492 – divide-by-twelve counter	Plastic Dip					12.20 8.30			11.05 7.40	7.66 5.20	7.66 5.20		7.66 5.20	7.35 4.99
	Ceramic Dip			7.66 5.20					12.25 8.15				9.57 6.50	9.57 6.50
	Flat-Pack									14.53 9.86	14.53 9.86		14.53 9.86	14.53 9.86
7493 – 4-bit binary counter	Plastic Dip				6.10 5.15	12.20 8.30			11.05 7.40	7.66 5.20	7.66 5.20		7.66 5.20	7.35 4.99
	Ceramic Dip			7.66 5.20	19.70 13.15				12.25 8.15				9.57 6.50	9.57 6.50
	Flat-Pack									14.53 9.86	14.53 9.86		14.53 9.86	14.53 9.86

TABLE I. Standard series 74 circuits. (Continued)

Circuit	Package	Amperex	Fairchild[1]	I T T	Motorola	National	Nucleonic	Philco-Ford	Raytheon	Signetics	Sprague	Sylvania[2]	Texas Inst.	Transitron
7494 – 4-bit SR Parallel-m, Serial-out	Plastic Dip										8.21 5.57		8.21 5.57	7.91 5.35
	Ceramic Dip			8.21 5.57									10.27 6.97	10.27 6.97
7495 – 4-bit Right-shift Left-shift Register Parallel-in, Parallel out	Plastic Dip					8.21 5.57					8.21 5.57		8.21 5.57	7.91
	Ceramic Dip			8.21 5.57									10.27 6.97	
	Flat-Pack										14.57 9.89		14.57 9.89	14.57 9.89
7496 – 5-bit SR Dual-Parallel-in, Parallel-out	Plastic Dip										9.84 6.68		9.84 6.68	
	Ceramic Dip			9.84 6.68									12.31 8.35	10.27 6.97

[1] Fairchild circuits are part of their 9000 series, they may not be exactly interchangeable with series 7400.

[2] Sylvania's Series 7400 circuits are packaged in their Cerdip pack which is an all ceramic dual-in-line. These circuits are shown in the plastic DIP category because they are price competitive with other manufacturer's plastic packages.

TABLE II-A. SUHL 1 circuits with standard fanout capability. Temperature range 0 to 70°C.

Ref. No. and Circuit Description	Package	Motorola	Raytheon	Sylvania	Transitron
SF 13 – Set-Reset flip-flop	flat pack	4.10 2.75	4.10 2.75	4.50 3.05	
	ceramic & metal DIP	3.60 2.40	4.50 3.05	4.50 3.05	
	low cost DIP	2.00 1.55			
SF 23 – two phase, SR clocked flip-flop	flat pack	4.10 2.75	5.55 3.75	5.55 3.75	5.55 3.75
	ceramic & metal DIP	3.60 2.40	5.55 3.75	5.55 3.75	5.55 3.75
	low cost DIP	2.00 1.55			5.30 3.60
SF 33 – single phase, SR triggered flip-flop	flat pack	4.85 3.25	6.15 4.15	3.95 2.60	6.15 4.15
	ceramic & metal DIP	4.25 2.85	4.80 3.25	5.95 3.95	6.15 4.15
	low cost DIP	2.40 1.85			5.85 3.95
SF 53 – J-K flip-flop, AND input	flat pack	4.80 3.20	4.80 3.25	4.80 3.25	4.80 3.25
	ceramic & metal DIP	5.15 3.45	4.80 3.25	4.80 3.25	4.80 3.25
	low cost DIP	2.60 2.00		3.55 2.50	4.60 3.10

Ref. No. and Circuit Description	Package	Motorola	Raytheon	Sylvania	Transitron
SF 63 – J-K flip-flop, OR input	flat pack	4.80 3.20	4.80 3.25	4.80 3.25	4.80 3.25
	ceramic & metal DIP	5.15 3.45	4.80 3.25	4.80 3.25	4.80 3.25
	low cost DIP	2.60 2.00		3.55 2.50	4.60 3.10
SF 83 – dual "D" flip-flop	flat pack	7.35 4.90		7.30 4.95	12.90 8.80
	ceramic & metal DIP	7.35 4.90		7.30 4.95	7.30 4.95
	low cost DIP	3.65 2.80		5.50 3.85	6.95 4.70
SF 103 – dual 35 MHz J-K ff, separate clock	flat pack	7.35 4.90	7.35 4.95	7.35 4.95	7.35 4.95
	ceramic & metal DIP	7.35 4.90	7.35 4.95	7.35 4.95	7.35 4.95
	low cost DIP	3.65 2.80		5.20 3.65	7.00 4.70
SF 113 – dual 35 MHz J-K ff, common clock	flat pack	7.35 4.90	7.35 4.95	7.35 4.95	7.35 4.95
	ceramic & metal DIP	7.35 4.90	7.35 4.95	7.35 4.95	7.35 4.95
	low cost DIP	3.65 2.80		5.20 3.65	7.00 4.70

TABLE II-A. SUHL 1 circuits with standard fanout capability. Temperature range 0 to 70°C. (Continued)

Ref. No. and Circuit Description	Package	Motorola	Raytheon	Sylvania	Transitron
SG 43 – dual 4 - input NAND/NOR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.20 2.15	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 53 – expandable, quad 2-input OR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.66 2.40	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 63 – single 8-input NAND/NOR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.20 2.15	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 73 – expandable, dual 2-input exclusive OR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.90 2.60	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	2.00 1.55		1.86 1.26	3.35 2.30
SG 83 – dual pulse shaper/delay AND gate	flat pack	4.10 2.75	4.10 2.75	3.95 2.65	4.10 2.75
	ceramic & metal DIP	4.10 2.75	4.10 2.75	4.05 2.70	4.10 2.75
	low cost DIP	2.20 1.70		2.60 1.85	3.90 2.65
SG 93 – exclusive OR with compliment	flat pack		3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP		3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP			1.86 1.26	3.35 2.30
SG 103 – expandable, triple 3-input OR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.60 2.40	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 113 – expandable, dual 4-input OR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.60 2.40	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 123 – expandable, single 8-input NAND/NOR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.60 2.40	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 133 – dual 4-input line driver/lamp driver	flat pack	4.10 2.75	4.10 2.75	3.65 2.40	4.10 2.75
	ceramic & metal DIP	3.60 2.40	4.10 2.75	3.80 2.50	4.10 2.75
	low cost DIP	1.80 1.40		2.76 1.90	3.90 2.65

Ref. No. and Circuit Description	Package	Motorola	Raytheon	Sylvania	Transitron
SG 143 – quad 2-input NAND/NOR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.20 2.15	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 153 – quad 2-input OR expander	flat pack	3.05 2.05	3.05 2.05	2.70 1.80	3.05 2.05
	ceramic & metal DIP	2.75 1.85	3.05 2.05	3.05 2.05	3.05 2.05
	low cost DIP	1.60 1.25		1.95 1.35	2.90 1.95
SG 163 – triple 2-input bus driver	flat pack	4.10 2.75	4.10 2.75	3.65 2.40	4.10 2.75
	ceramic & metal DIP	2.00 1.70	4.10 2.75	3.80 2.50	4.10 2.75
	low cost DIP	2.00 1.70		2.76 1.90	3.90 2.65
SG 173 – dual 4-input OR expander	flat pack	3.05 2.05	3.05 2.05	2.70 1.80	3.05 2.05
	ceramic & metal DIP	2.75 1.85	3.05 2.05	3.05 2.05	3.05 2.05
	low cost DIP	1.60 1.25		1.95 1.35	2.90 1.95
SG 183 – dual 4-input AND expander	flat pack	3.05 2.05	3.05 2.05	2.70 1.80	3.05 2.05
	ceramic & metal DIP	2.75 1.85	3.05 2.05	3.05 2.05	3.05 2.05
	low cost DIP	1.60 1.25		1.95 1.35	2.90 1.95
SG 193 – triple 3-input NAND/NOR gate	flat pack	3.50 2.35	3.50 2.40	2.55 1.70	3.50 2.40
	ceramic & metal DIP	3.20 2.15	3.50 2.40	3.45 2.30	3.50 2.40
	low cost DIP	1.80 1.40		1.86 1.26	3.35 2.30
SG 333 – quad 2-input NOR gate	flat pack			2.80 1.90	3.50 2.40
	ceramic & metal DIP			3.50 2.40	3.50 2.40
	low cost DIP			2.13 1.45	3.35 2.30
SG 353 – quad 2-input lamp driver	flat pack			3.80 2.55	4.10 2.75
	ceramic & metal DIP			4.10 2.75	4.10 2.75
	low cost DIP			2.88 1.97	3.90 2.65
SG 373 – hex inverter	flat pack	4.10 2.75		3.20 2.10	3.90 2.65
	ceramic & metal DIP	3.60 2.40		3.80 2.50	3.90 2.65
	low cost DIP	2.20 1.70		2.33 1.58	3.70 2.55

TABLE II-B. SUHL II circuits with standard fanout capability. Temperature range 0 to 70°C.

Ref. No. and Circuit Description	Package	Motorola	Philco-Ford	Raytheon	Sylvania	Transitron
SF 93 – dual "D" flip-flop	flat pack				8.05 5.45	8.05 5.45
	ceramic & metal DIP				8.05 5.45	8.05 5.45
	low cost DIP				6.00 4.20	7.65 5.20
SF 123 – dual 50 MHz J-K ff separate clock	flat pack	8.15 5.45		8.15 5.50	8.15 5.50	8.15 5.50
	ceramic & metal DIP	8.15 5.45		8.15 5.50	8.15 5.50	8.15 5.50
	low cost DIP	4.30 3.30			5.70 4.00	7.75 5.25
SF 133 – dual 50 MHz J-K ff common clock	flat pack	8.15 5.45		8.15 5.50	8.15 5.50	8.15 5.50
	ceramic & metal DIP	8.15 5.45		8.15 5.50	8.15 5.50	8.15 5.50
	low cost DIP	4.30 3.30			5.70 4.00	7.75 5.25
SF 203 – single 50 MHz J-K ff AND input	flat pack	6.80 4.55	6.15 4.10	6.80 4.60	5.60 3.80	6.80 4.60
	ceramic & metal DIP	6.30 4.20	6.15 4.10	6.80 4.60	5.60 3.80	6.80 4.60
	low cost DIP	2.90 2.25			4.10 2.85	6.50 4.50
SF 213 – single 50 MHz J-K ff OR input	flat pack	6.80 4.55	6.15 4.10	6.80 4.60	5.60 3.80	6.80 4.60
	ceramic & metal DIP	6.30 4.20	6.15 4.10	6.80 4.60	5.60 3.80	6.80 4.60
	low cost DIP	2.90 2.25			4.10 2.85	6.50 4.40
SF 253 – J-K flip-flop AND input	flat pack	5.90 3.95	6.15 4.10	5.90 4.00	5.90 4.00	5.90 4.00
	ceramic & metal DIP	6.30 4.20	6.15 4.10	5.90 4.00	5.90 4.00	5.90 4.00
	low cost DIP	2.90 2.25				5.60 3.80
SF 263 – J-K flip-flop OR input	flat pack	5.90 3.95	6.15 4.10	5.90 4.00	5.90 4.00	5.90 4.00
	ceramic & metal DIP	6.30 4.20	6.15 4.10	5.90 4.00	5.90 4.00	5.90 4.00
	low cost DIP	2.90 2.25				5.60 3.80
SG 203 – expandable, single 8-input NAND/NOR gate	flat pack	3.95 2.65	3.25 2.25	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP		3.25 2.25	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 213 – expandable, dual 4-input OR gate	flat pack	3.95 2.65	3.25 2.25	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	4.20 2.80	3.25 2.25	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 223 – quad 2-input NAND/NOR gate	flat pack	3.95 2.65	3.20 2.15	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	3.90 2.60	3.20 2.15	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 233 – quad 2-input OR expander	flat pack	3.05 2.05	2.70 1.70	3.05 2.05	2.70 1.80	3.05 2.05

Ref. No. and Circuit Description	Package	Motorola	Philco-Ford	Raytheon	Sylvania	Transitron
SG 233 – quad 2-input OR expander (continued)	ceramic & metal DIP	2.75 1.85	2.70 1.70	3.05 2.05	3.05 2.05	3.05 2.05
	low cost DIP	2.00 1.55			1.95 1.35	2.90 1.95
SG 243 – dual 4-input NAND/NOR gate	flat pack	3.95 2.65	3.20 2.15	3.95 2.65	3.10 2.05	3.45 2.65
	ceramic & metal DIP	3.90 2.60	3.20 2.15	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 253 – expandable quad 2-input OR gate	flat pack	3.95 2.65	3.25 2.25	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	4.20 2.80	3.25 2.25	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 263 – single 8-input NAND/NOR gate	flat pack	3.95 2.65	3.20 2.15	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	3.90 2.60	3.20 2.15	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 273 – dual 4-input OR expander	flat pack	3.05 2.05	2.70 1.70	3.05 2.05	2.70 1.80	3.05 2.05
	ceramic & metal DIP	2.75 1.85	2.70 1.70	3.05 2.05	3.05 2.05	3.05 2.05
	low cost DIP	2.00 1.55			1.95 1.35	2.90 1.95
SG 283 – expandable dual 4-input AND/OR gate	flat pack		3.65 2.45	4.10 2.75	3.65 2.45	4.10 2.75
	ceramic & metal DIP		3.65 2.45	4.10 2.75	3.80 2.50	4.10 2.75
	low cost DIP				2.60 1.85	3.90 2.60
SG 293 – dual 2 and 3 input OR expander	flat pack		2.70 1.70	3.50 2.40	3.05 2.05	3.95 2.65
	ceramic & metal DIP		2.70 1.70	3.05 2.40	3.80 2.50	3.95 2.65
	low cost DIP				2.33 1.68	3.75 2.55
SG 303 – expandable, triple 3-input AND/NOR gate	flat pack	3.95 2.65	3.25 2.25	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	3.95 2.65	3.25 2.25	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.40 1.85			2.33 1.58	3.75 2.55
SG 323 – triple 3-input NAND/NOR gate	flat pack	3.95 2.65	3.20 2.15	3.95 2.65	3.10 2.05	3.95 2.65
	ceramic & metal DIP	3.90 2.60	3.20 2.15	3.95 2.65	3.80 2.50	3.95 2.65
	low cost DIP	2.20 1.70			2.33 1.58	3.75 2.55
SG 343 – quad 2-input NOR gate	flat pack				3.10 2.05	3.95 2.65
	ceramic & metal DIP				3.80 2.50	3.95 2.65
	low cost DIP				2.33 1.58	3.75 2.55
SG 383 – hex inverter	flat pack	4.25 2.85		4.40 3.00	3.65 2.05	4.35 2.95
	ceramic & metal DIP			4.35 2.90	4.15 2.75	4.35 2.95
	low cost DIP	2.55 1.95			2.60 1.85	4.15 2.80

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Data smoothing: ironing out the wrinkles

Plotted data sometimes shows a disappointingly rough, erratic shape. Data smoothing forces such scattered points to conform to a more natural curve, and a computer greatly simplifies the task.

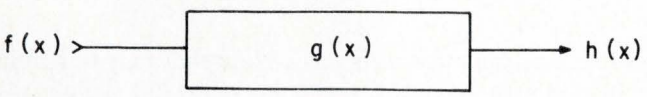
By Paul H. Dillinger,
Fairchild Semiconductor, Mountain View, Calif.

It would be convenient if data always fell into line, so that all subjectivity could be removed from curve plotting. Since this seldom occurs, we develop methods for smoothing the data we have. This article presents an algorithm for smoothing data and furnishes a computer program for performing the actual calculations.

Two general types of scattered data are shown in Fig. 2. Type 1 is data that looks fairly good, but contains some misaligned points. These are the result of misreading a dial, miscalculations, and so forth. Type 2 data is simply scattered in the region of the true curve. Factors such as poor instrument resolution, low signal-to-noise ratio, or a change in some other variable during the measurements can cause this kind of data spreading.

Given an input $f(x)$ and a system $g(x)$, the output $h(x)$ is described by the convolution integral,[1]

$$h(x) = \int_{-\infty}^{\infty} f(x)g(u - x)\,du$$



In this discussion $f(x)$ represents the original data, $g(x)$ the operation performed, and $h(x)$ the smoothed data.

Since $f(x)$ is a discrete function consisting of a

[1]For a discussion of convolution integrals, see R. M. Bracewell, *The Fourier Transform and Its Application*, New York: McGraw-Hill, Chapter 3.

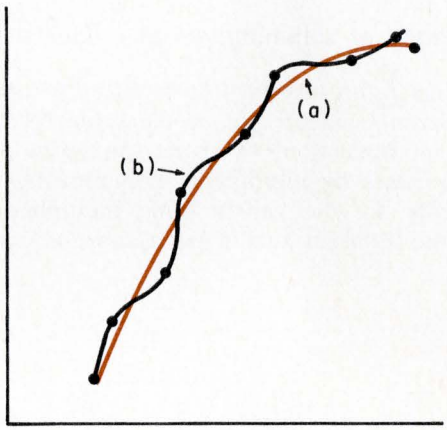


Fig. 1. Two attempts to plot identical data points. Even though the plot (b) goes through every data point, it is difficult to believe that the function behaves in such a way. The curve (a) is probably a much better approximation to the actual function.

The underlying assumption of data smoothing is that curves, in general, should be smooth. Data that plots continuously, in a straight line or a gradual curve, inspires confidence; experience has taught it is usually more in accord with nature than data resulting in zig-zags. It is thus wise to avoid sudden bends, erratic changes, or discontinuities.

For example, identical data points are connected differently in Fig. 1. The plot (a) is preferred, even though the (b) plot goes through every data point.

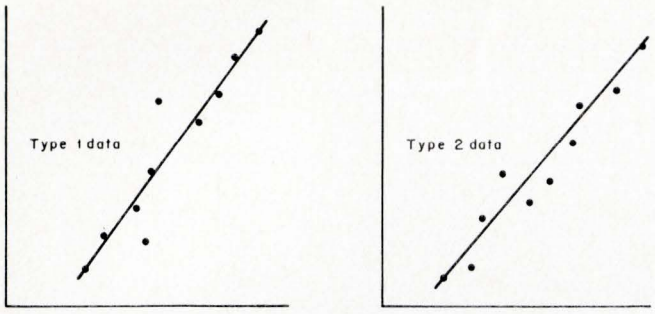


Fig. 2. The general types of data-point scattering. Type 1 points are far out of alignment, probably because of an error such as a misread dial or a miscalculation. Type 2 data consists of points scattered about the true curve.

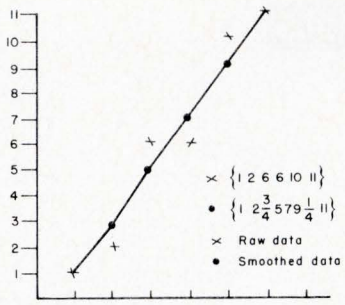


Fig. 3. This shows how a data smoothing program generated a set of data points that are easily connected to give a better picture of the appearance of the function.

finite sequence of numbers $\{a_1\ a_2\ a_3\ \ldots\ a_n\}$, the integral over an infinite interval reduces to a summation over a finite interval:

$$h(x) = \int_{-\infty}^{\infty} f(x)g(u-x)\,du \rightarrow \sum_j f_j\, g_{i-j}$$

The questions to be answered are:

(a) How is the summation to be performed?
(b) What is the function, g, that tends to smooth a sequence with which it is convolved?
(c) What modification of the end points is required due to the finiteness of the series?

The method of summing: serial products

To find $\sum f_j\, g_{i-j}$, take the serial product of $f(x)$ and $g(x)$. Serial products are of the same form as polynomial multiplication.[2] You get the serial product of two sequences by multiplying polynomials, where the coefficients are the values being multiplied. For example, the serial product of $\{a_1\ a_2\ a_3\ a_4\ a_5\}$ and $\{1\ 2\ 1\}$ is:

$$\begin{array}{rrrrrr}
 & & & a_1x^4 + a_2x^3 + a_3x^2 + a_4x + a_5 & & \\
 & & & 1x^2 + 2x + 1 & & \\
\hline
 & & a_1x^4 & a_2x^3 & a_3x^2 & a_4x \quad a_5 \\
 & 2a_1x^5 & 2a_2x^4 & 2a_3x^3 & 2a_4x^2 & 2a_5x \\
a_1x^6 & a_2x^5 & a_3x^4 & a_4x^3 & a_5x^2 & \\
\hline
\end{array}$$

$$a_1x^6 + (2a_1+a_2)x^5 + (a_1+2a_2+a_3)x^4 + (a_2+2a_3+a_4)x^3 + (a_3+2a_4+a_5)x^2 + (a_4+2a_5)x + a_5$$

and the resulting sequence is:

$$\{(a_1)\ (2a_1+a_2)\ (a_1+2a_2+a_3)\ (a_2+2a_3+a_4)\ (a_3+2a_4+a_5)\ (a_4+2a_5)\ (a_5)\} \qquad \text{sequence A}$$

The form of the above sequence is important and will be referred to later.

In the following numerical example, the x's are omitted, since they never actually enter into any calculation and serve only a place-holding function:

[2] *Ibid*, p. 30.

$$\{1\ 4\ 2\ 5\ 1\} \cdot \{1\ 2\ 1\} = \{1\ 6\ 11\ 13\ 13\ 7\ 1\}$$

since

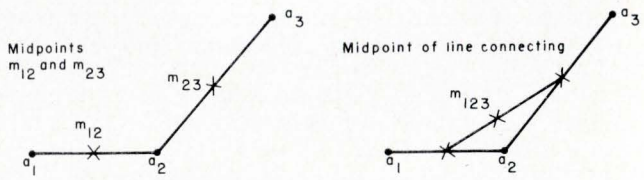
$$\begin{array}{rrrrrrr}
 & & 1 & 4 & 2 & 5 & 1 \\
 & & & & 1 & 2 & 1 \\
\hline
 & & 1 & 4 & 2 & 5 & 1 \\
 & 2 & 8 & 4 & 10 & 2 & \\
1 & 4 & 2 & 5 & 1 & & \\
\hline
1 & 6 & 11 & 13 & 13 & 7 & 1
\end{array}$$

Note that the resulting sequence is two places longer than the original sequence.

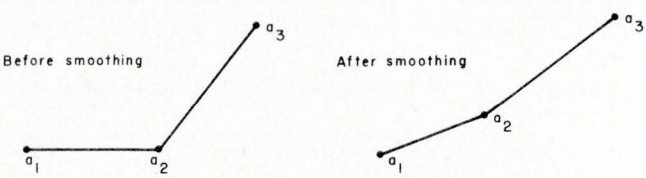
Smoothing sequence g (x)

A good data point is one that reflects the information contained in both the previous and the subsequent point. If a data point fails to reflect this information, then you are inclined to move it more in line with its two nearest neighbors. It follows that the required smoothing sequence is the one that geometrically averages three points. The sequence that does this is $\{1\ 2\ 1\}$.

Why the sequence $\{1\ 2\ 1\}$ works best can be shown graphically. The geometric average of two points is the midpoint of the line connecting them, and the average of the midpoints is the midpoint of the line connecting them.



The new value for a_2 is m_{123}. Note that it is now more in line with a_1 and a_3 as in the following sketch.



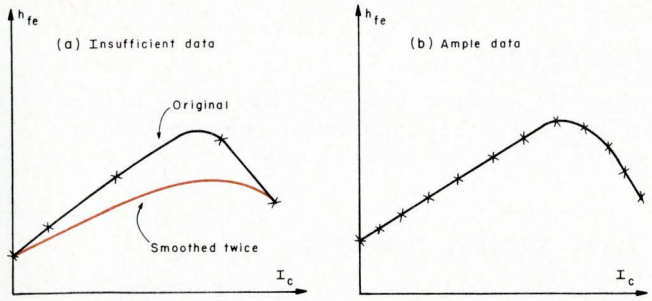


Fig. 4. With insufficient data, as in (a), smoothing tends to create a smooth curve that departs radically from a representation of the real world. Ample data, as in (b), gives a curve that approximates the original.

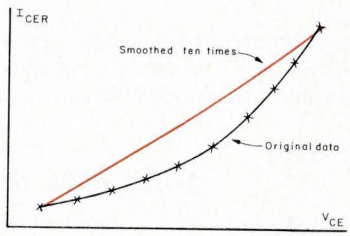


Fig. 5. Oversmoothing has the same effect as insufficient data: it tends to straighten any curve, and can cause a substantial departure from the true function.

Analytically

$$m_{12} = \frac{a_1 + a_2}{2}$$

and

$$m_{23} = \frac{a_2 + a_3}{2}$$

The midpoint of the midpoints is thus given by:

$$m_{123} = \frac{m_{12} + m_{23}}{2} = \frac{a_1 + 2a_2 + a_3}{4}$$

Note that the numerator $(a_1+2a_2+a_3)$ is of the same form as the middle three terms in sequence A. Thus, finding the geometric average between three points is the same as taking the serial product of the data by $\{1\ 2\ 1\}$. If you compare the expression for m_{123} with sequence A, you'll see that the serial product is four times too large. To correct for this, merely divide each term in the serial product by four.

Modification at the end points

There are two reasons for adjusting the ends of the new sequence. First, the ends of the new sequence are not of the form $(a_1\ 2a_2\ a_3)$ and therefore do not give the smoothing required. Second, the resulting sequence is longer than the original data. The increased length results when you assume that the length of the data is infinite, and thus attempt smoothing where data does not exist. This creates an extra data point at each end of the sequence.

Since they reflect non-existent data, the points must be removed. This leaves two new end points, which are replaced by the original data end points because they are not in the $\{1\ 2\ 1\}$ form—a reasonable substitution, since these points certainly contain *some* information, which is better than no data at all.

Summary

Here is the general procedure for smoothing:

original data:	$\{a_1\ a_2\ a_3\ a_4\}$
smoothing sequence:	$\{1\quad 2\quad 1\}$
produces:	$\{b_0\ b_1\ b_2\ b_3\ b_4\ b_5\}$
$\div 4$	$\{c_0\ c_1\ c_2\ c_3\ c_4\ c_5\}$
remove end points:	$\{c_1\ c_2\ c_3\ c_4\}$
replace new end points with original:	$\{a_1\ c_2\ c_3\ a_4\}$

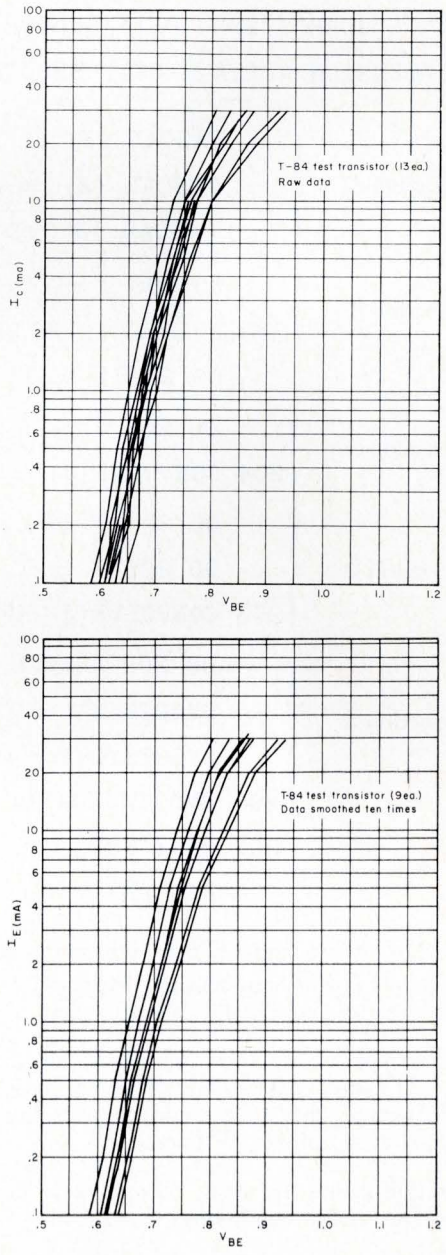


Fig. 6. This data was taken on a Fairchild Model 500 transistor tester, and smoothed by an SDS 930 computer using the program described in the text. When you connect the original data points with straight lines, the plots are tangled. The smoothed data removes the confusion.

The Smoothing Program

Here is a subroutine that takes a string of data (100 points max), and returns the original data along with the smoothed data. You can smooth the data NSMOOTH number of times with one calling of the subroutine. The program is written in FORTRAN II; its various sections are explained below.

Use:

```
CALL  DATA SMOOTH (NDATA, DATA, SMOOTH, NSMOOTH)
```

Where:

NDATA	is the number of data points (100 max.)
DATA	is the vector containing the raw data.
SMOOTH	is the vector containing the smoothed data. (This need not be zeroized before use.)
NSMOOTH	is the number of smoothings desired.

```
      SUBROUTINE  DATA SMOOTH (NDATA, DATA, SMOOTH, NSMOOTH)
    DIMENSION  DATA (100), SMOOTH (100), PASCAL (3), CONVOLVE (102)
```

Section A

```
      PASCAL (1) = 1.0
      PASCAL (2) = 2.0
      PASCAL (3) = 1.0
```

Section B

```
      DO 200 I = 1, NDATA
  200 SMOOTH(I) = DATA(I)
      DO 202 I = 1, NSMOOTH          202 DO LOOP starts
```

Section C

```
      DO 204 J = 1, NDATA+2
  204 CONVOLVE(J) = 0.
```

Section D

```
      DO 206 J = 1, NDATA
      DO 206 K = 1, NDATA
  206 CONVOLVE(J+K-1) = SMOOTH(J)*PASCAL(K)+CONVOLVE(J+K-1)
```

Section E

```
      DO 208 J = 1, NDATA
      SMOOTH(J) = CONVOLVE(J+1)/4.0
      SMOOTH(1) = DATA(1)
  208 SMOOTH(NDATA) = DATA(NDATA)
  202 CONTINUE                       202 DO LOOP ends
      RETURN
```

Section A sets the { 1 2 1 } smoothing sequence. The name *Pascal* was selected because { 1 2 1 is} really the third line of Pascal's triangle.

Section B is a DO LOOP that places all of the data into an array called SMOOTH. This preserves the original data. The 202 DO LOOP repeats the smoothing NSMOOTH number of times.

Section C sets the array, CONVOLVE = 0. It clears it for zero initial conditions.

Section D is the actual convolution. The computation in line 206 takes on a slightly different form from that of normal multiplication, in that the calculations are made up of the diagonals, as shown here:

```
                a  b  c  d e Data
                   1  2  1 Smoothing sequence
             ---------------
                a  b  c  d e
             2a 2b 2c 2d 2e
          a  b  c  d  e
             ---------------
                and so forth
```

Section E divides each smoothed point by four, and places the data back into SMOOTH. Then, the first data point is placed into SMOOTH(1), and the last data point is placed into SMOOTH(NDATA).

The following numerical example is shown in Fig. 3.

serial product:	{1	2	6	6	10	11}		
				{1	2	1}		
			1	2	6	6	10	11
		2	4	12	12	20	22	
	1	2	6	6	10	11		
produces:	{1	4	11	20	28	37	32	11}
÷ 4	{0.25	1	2.75	5	7	9.25	8	2.75}
remove end points:	{1	2.75	5	7	9.25	8}		
replace new ends:	{1	2.75	5	7	9.25	11}		
Plotting both,	{1	2	6	6	10	11}	old data	
	{1	2.75	5	7	9.25	11}	smoothed data	

Words of caution

You never get something for nothing, and this technique proves no exception. There is a small price that must be paid to achieve the desired smoothing.

First, you must take the data at uniform intervals. A slight amount of irregularity can be tolerated, but unequal intervals can easily exaggerate the smoothing and cause the intervals to be smoothed irregularly. If the plot is to be on a logarithmic scale, then any convenient multiples of values may be used (e.g., 1, 2, 4, 8, 16, and so forth, or even 6, 8.4, 11.7, 16.4, 23.0—multiples of 1.4), as long as they appear evenly spaced.

Second, you must take enough data points—the more the better. Taking too few points causes extreme smoothing and distortion results. For examples, see Figs. 4 and 5.

A third problem is over-smoothing. Figure 5 shows the effects of smoothing ten times. All the original data, except the end points, were lost. A rule of thumb is that the more linear the function, such as base-to-emitter ON voltage $V_{be(ON)}$, the more smoothings it can take. With sufficient data points, non-linear curves such as plots of beta (h_{fe}), can be smoothed two or three times without ill effects. Any curve smoothed often enough will result in a straight line between the two end points.

Finally, there is a problem concerning the end points. Since the final smoothed data has the same end points as the original data, the question immediately arises: What if the end points themselves are bad data points? If an end point is a poor data point, the curve will shift inordinately at that end. The amount of shift will depend on the degree of smoothing.

There are two ways to minimize the chance of end point problems. The first is to take many data points. By sheer brute force the good data will not move as quickly under smoothing. The second way to minimize the effects of poor end points is to take data slightly beyond the range of interest on both ends. Any tendency to oversmooth because of the poor quality of the new end point data will be minimized over the range of interest.

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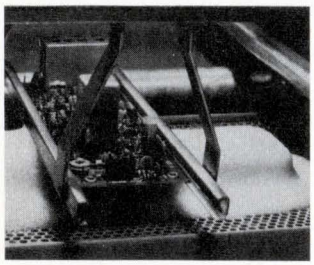

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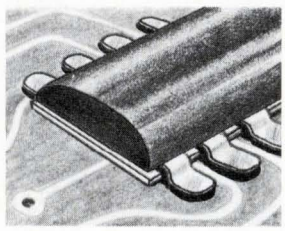

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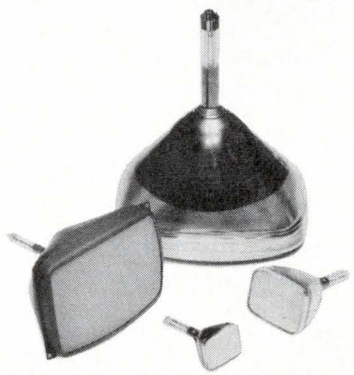

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Amplifiers

Feedback amplifiers are a snap, John De Falco, Honeywell, "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 98-101. A topological flow-graph analysis of a voltage-series feedback amplifier is used to find output and input impedances. Feedback amplifiers are more difficult to analyze than ordinary amplifiers, but this method allows the analysis to be done in the shortest time.

Consider dual JFET input stages, Fred Palenschat, Gamma Scientific, Inc., "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 86-88. Compared to discrete JFETs, dual JFETs have matched characteristics that minimize wide parameter spreads and wide divergence of pinchoff voltage as a function of temperature. Careful design reduces possible latchup or breakdown of input stages to acceptable levels, so that they can be considered for amplifiers requiring low offset voltage and good temperature tracking. Design examples are given.

New log amp cascades to desired range, Richard Hughes, U.S. Naval Weapons Center, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 86-89. A five-step procedure for using differential amplifiers in cascade to obtain a logarithmic amplifier is set forth. Rise times as low as 10 nanoseconds and equal operation on positive or negative signals are obtained.

Charts and Nomographs

***The price of TTL,** Arthur J. Boyle, Tech. Editor, "The Electronic Engineer," Vol. 28, No. 12, Dec. 1969, pp. 53-59. The fastest growing logic form in digital integrated circuits appears to be TTL. These tables give a price comparison in the most competitive area, commercial grade Series 7400 and SUHL devices.

Circuit Design

SCR model simplifies computer programs, D. N. Harstad, Sandia Labs., "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 92-95. A reasonably accurate model of SCRs is obtained for use in circuit-design programs. It is based in piecewise approximations and was originally developed to be used with SCEPTRE.

Cut binary-to-BCD conversion costs, Roland Anderson, Bunker-Ramo Corp., "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 104-110. Equations for each decade of the BCD number are developed step-by-step from the general expressions for binary numbers. Nonsequential circuits using only full adders and 1- to 4-input TTL gates are developed that reduce the overall IC packages needed, while keeping conversion speed up.

Communications

Plan national private-line microwave net, Michael Riezenman, Technical Editor, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 32-34. A nationwide private-line microwave communications network is being constructed that features dedicated communications for its subscribers, as opposed to telephone type networks where anyone can call anyone else. Analog and digital services are available, and customers may even be charged by the bit transmitted. Cost benefits are also outlined.

Preparing a technical paper?, Roger D'Aprix, Xerox Corp., "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 112-113. A few words of advice about how to prepare a paper are presented with a check list of things to be sure you have done for either an oral or written presentation.

Computers and Peripherals

Selecting servomotors and servosystems, Richard E. Whipple, Honeywell Inc., and Billy L. Rhodes, Electro-Technology, "Electro-Technology," Vol. 84, No. 3, Sept. 1969, pp. 59-67. Greatly increased use of servomotors in computer peripheral equipment and in machinery and industrial control applications has led to many changes in their design and performance. This article discusses the evolution of a new generation of high performance servos, tells how to select servomotors and lists some useful definitions used to describe performance characteristics of servomotors.

Speeding up ferrite-core memories, Robert M. Whalen, IBM, "Electronics," Vol. 42, No. 21, Oct. 13, 1969, pp. 108-110. By making ferrite cores smaller for memories, the memory speed is increased. But, as the cores become smaller mechanical problems increase, raising their cost.

Magazine publishers and their addresses

EDN
Cahners Publishing Company
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Institute of Electrical & Electronics Engineers
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New York, N. Y. 10017

The Electronic Engineer
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Philadelphia, Pa. 19139

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ABSTRACTS

Build digital models of analog systems, M. Silberg & C. Luke, IBM, "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 90-95. IBM's Continuous System Modeling Program (CSMP) package is recommended for analog simulation of circuits, even for those with no programming experience. Once the circuit has been put into block diagram form, the language permits functional blocks and their interconnections, and other parameters, to be specified. An example is given.

'Cache' turns up a treasure, Donald H. Gibson, Systems Development Div., IBM, & W. Lee Shevel, Component Div., IBM, "Electronics," Vol. 42, No. 21, Oct. 13, 1969, pp. 105-107. One method of getting memories to act faster, or at least appear to do so is to use a second memory. This smaller memory can serve as a chance to store data needed by the computer.

Desktop computers and minicomputers, Hardware Report, "Electro-technology," Vol. 84, No. 4, Oct. 1969, pp. 53-60. This report discusses the evolution of computers and especially the small desk-top types. It covers the units now available and their features. A table of characteristics and a handy source guide is included.

Integrated Circuits

Large scale integration in systems design—bipolar technology, Wm. E. Wicks, Texas Instruments, Inc., "Electro-technology," Vol. 84, No. 4, Oct. 1969, pp. 61-67. The author begins with a discussion of the evolution of electronics, from the vacuum tube to Large Scale Integration. He then discusses the manufacturing techniques for bipolar LSI arrays. Testing, packaging and interfacing methods are also covered. Finally, he comments on the future potential of LSI, including radiation hardened structures.

The Hall Effect: Success at 90, Jim McDermott, East Coast Editor, "Electronic Design," Vol. 17, No. 21, October 11, 1969, pp. 38-45. After several false starts, Hall Effect devices seem to be taking hold. In addition to generators and magneto-resistors, there are two new devices: the magneto-diode and magnistor. Problems of the devices are discussed, including cost, stability and sensitivity. A key factor is that IC technology has enabled the required circuitry to be fabricated on the same substrate as a Hall generator.

Computers make a big difference in MOS designs, Lawrence Curran, Asso. Editor, "Electronics," Vol. 42, No. 21, Oct. 13, 1969, pp. 82-92. Because of the increasing demand for custom MOS circuits, the computer has been doing most of the design job. With a minimum of design information the computer can partition the circuit, and when necessary, design special new cells. After a quick review of its design by engineers, the computer prepares instructions for fabrication.

Chip bonding: promises and perils, Raymond Speer, Technical Editor, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 61-79. This extensive report covers three chip bonding techniques: spider bonding, beam-leads, and flip chips. All are adapted to fast, reliable, automated bonding techniques. Pros and cons of each are discussed with manufacturers and users. Vendors extol the virtues, but users are still skeptical. Each method increases the cost of the chip, but pays off in packaging. However, sophisticated handling equipment is required in both manufacture and packaging. Designers are faced with some new problems too, such as poorer heat dissipation caused by poorer thermal paths.

Microwaves and Microwave Products

Merging technologies—microelectronics and microwaves, James E. Cunningham and Harry F. Cooke, Texas Instruments, "EDN," Vol. 14, No. 19, Oct. 1, 1969, pp. 61-68. Only recently has it become possible to build complex microwave equipment with solid-state components. Such a capability comes from advances in microwave devices and circuit design, and from advances in microelectronic packaging techniques. The author discusses the new microwave, solid-state devices and their impact on microwave technology. Much of the article devotes itself to microwave integrated circuit technology: circuit layout, substrates, thin- and thick-film construction, and module packaging.

Tubes still pack most muscle, Allan Scott, Varian Associates, "EDN," Vol. 14, No. 19, Oct. 1, 1969, pp. 55-59. This article compares solid-state and tube devices. Such a capability comparison is necessary in order to select the most suitable device for any particular application. For example, transistors are suitable for low-noise, low-level amplifiers at frequencies to about 4 GHz; above this frequency you must use a TWT amplifier. And you must use tubes at frequencies above 2 GHz for medium-power amplifiers with outputs in excess of 1 W. Also, the author demonstrates how system requirements determine the choice of an oscillator device. Here you must consider such factors as noise and frequency coherence, as well as power level. The several charts which accompany the article show average power capabilities and efficiencies for both amplifiers and oscillators versus frequency.

***Storage CRT's for radar,** Terry Ballou, Dalmo Victor, "The Electronic Engineer," Vol. 28, No. 12, Dec. 1969, pp. 46-50. Storage display tubes with a variable persistence capability find widespread usage in radar systems. This article shows the construction of such a tube and describes the properties that make it so useful.

Power Supplies

Get true-rms voltage regulation . . . inexpensively, Imre Gorgenyi, Motorola Semiconductor, "The Electronic Engineer," Vol. 28, No. 12, Dec. 1969, pp. 38-40. This is a description of a voltage regulation technique useful from low voltages to many kilovolts. The circuit is novel in that it uses an incandescent lamp as the rms sensing element. The lamp's brightness output is fed back to a phototransistor, and thus closes the regulator's control loop.

Semiconductors

Trade-offs in varactor-tuned oscillators, William D. Heichel and Thomas R. Bushnell, Watkins-Johnson, "EDN," Vol. 14, No. 19, Oct. 1, 1969, pp. 73-74. This article lists 13 parameters of varactor-tuned oscillators. A table indicates the effect on each of the 12 other parameters, when one of the 13 is improved. A series of short paragraphs—each corresponding to a parameter shown in the table—supplements the table's information.

Solid-state power electronics in the U.S.A. H. F. Storm, General Electric Co., "IEEE Spectrum," Vol. 6, No. 10, Oct. 1969, pp. 49-59. The author reviews the capabilities of semiconductor devices in the power conversion field. Included are ratings for silicon rectifier diodes, thyristors, tridcs, and transistors, and a discussion of numerous applications.

Solid-state at microwave frequencies, Robert E. Koeper, Managing Editor, "EDN," Vol. 14, No. 19, Oct. 1, 1969, pp. 45-52. This presents a series of brief descriptions of semiconductor devices for microwave frequencies. The components described include bulk-effect and LSA devices, Impatt and Trapatt diodes, transistors, tunnel diodes, PIN diodes, Schottky-barrier diodes, and varactors. The article includes a short table of representative solid-state microwave components classified as oscillators and sources, harmonic generators, mixers, switches, delay lines, attenuators, couplers, and amplifiers.

Systems

Why doesn't radar prevent midair collisions?, Jim McDermott, East Coast Editor, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 25-31. Some of the limits of ground equipment, money, and bureaucracy are examined against the background of the recent Indianapolis midair collision. Conflicting points of view and allegations cloud the issue of what performance is available and what can be done to improve it.

Test and Measurement

***Data smoothing: ironing out the wrinkles,** Paul H. Dillinger, Fairchild Semiconductor, "The Electronic Engineer," Vol. 28, No. 12, Dec. 1969, pp. 61-65. How would you like to always have nice neat curves of your data? The author presents an algorithm for smoothing data and describes a computer program that performs the math involved.

Taking the heat off thermocouple failures, Ronald S. Harmon, Leeds & Northrup Co., "Electronics," Vol. 42, No. 21, Oct. 13, 1969, pp. 96-100. Thermocouples used in process control applications can open. Hence, no readings or inputs to computers are available. This means that the thermocouples have to be monitored in some manner as a safeguard against failures. This article describes a fast, practical test method.

Miscellaneous

***How to write reports that bring results,** Raymond E. Herzog, General Electric Co., "The Electronic Engineer," Vol. 28, No. 12, Dec. 1969, pp. 33-34. While engineers are not thought of as particularly good writers, they must in the course of their duties, resort to the written report. Here's an article that shows you how to make those reports more effective.

One Step Ahead of Need (Never Two), Richard L. Turmail, Management & Careers Editor, "Electronic Design," Vol. 17, No. 20, September 27, 1969, pp. 78-82.
The editor interviews Paul Butler, Assistant LM Program Director for SCAT, which had the responsibility for assembling and testing the LM. Paul discusses some of the problems that were overcome and some of his philosophy about engineers, including his opinions that engineers work for challenge, not money, and that payment of his salary entitles the company to a professional performance without additional rewards.

Convert Boolean algebra to arithmetic, B. Engel & P. Thorne, Baltimore City Hospitals, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 82-84. The reader is introduced to a method of avoiding difficult manipulations of Boolean expressions. They can be converted into equivalent arithmetic expressions and manipulated algebraically. Examples are given.

Are you engineering your career?, Richard Turmail, Management & Careers Editor, "Electronic Design," Vol. 17, No. 22, October 25, 1969, pp. 98-103. This article surveys 515 engineers by age, title, salary, experience, and education. Questions concerning likes and dislikes are aired. An engineer can get a general feeling of his position from the data, but cannot pinpoint himself with the accuracy of a salary curve.

Are engineering unions the answer?, P. S. Bayer, News Editor, "EDN," Vol. 14, No. 19, Oct. 1, 1969, pp. 89-97. Will unionization degrade or improve the status of engineers as professionals? Will such organization improve our economic status and job security at the expense of individual creativity? Statements by representatives of several engineering unions, the Engineers Joint Council, the National Society of Professional Engineers, and the IEEE present some pros and cons as well as some ramifications of engineering unionization.

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The winning Idea for the July 1969 issue is, "Delay circuit makes handy timer."

Our winning author is G. Detlof, an engineer at Tel. AB L.M. Ericsson, in Stockholm, Sweden. Ericsson is a well-known manufacturer of telephone and electronic equipment. Mr. Detlof has chosen the Simpson Model 270 multitester as his prize.

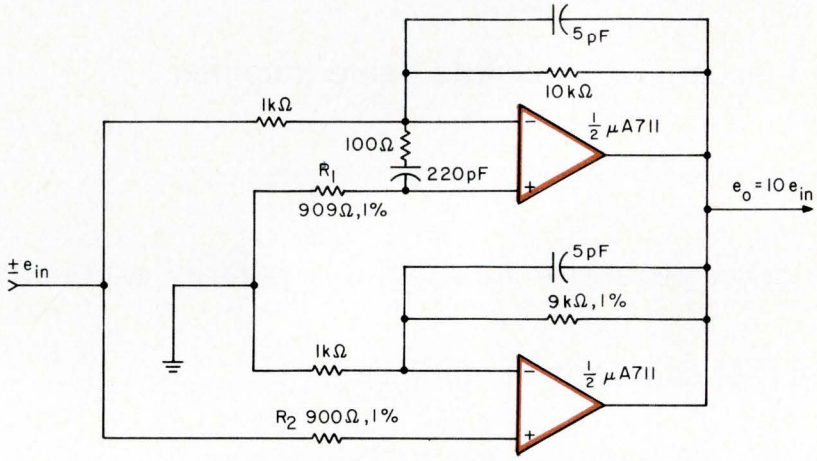
967 An inexpensive, absolute value amplifier

Harry C. Morgan
Consultant, Anaheim, Calif.

Absolute value amplifiers are precision rectifiers in which the high gain of an op amp minimizes the errors caused by the rectifiers. Such circuits commonly use two op amps, two diodes, six precision resistors, and three 5% resistors.

The illustration shows a different type of absolute value amplifier—one which dramatically reduces parts cost. A single-chip Fairchild μA711 dual comparator replaces the two op amps. Because the comparator amplifiers share a single output stage, the rectification function is performed saving the two diodes. And the circuit eliminates two resistors, because it clips the negative swing inside the comparator.

You must adjust resistors R_1 and R_2 for zero output. Calibrated



with dc levels, the circuit operates to beyond 5 MHz. Because the compensation circuit introduces a 1-μs delay, waveform-area accuracy is 0.1% at 1 kHz, improving as the frequency decreases.

The circuit as shown has a 10X gain. At gains lower than this, instability can develope because of phase shift in the amplifier. Capacitive loading should eliminate this difficulty, however.

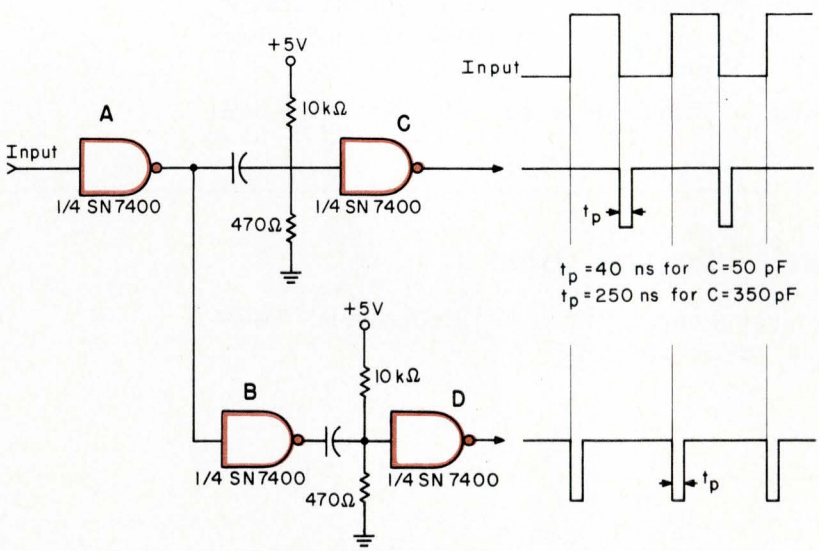
968 Fake one-shot lowers system costs

James J. Klinikowski
Kollmorgen Color Systems, Tatamy, Pa.

Here's a circuit that gives you short duration, fixed width pulses suitable for timing markers, counter drive pulses, reset pulses, and so forth. And this circuit saves you money because its capacitor, two resistors, and two NOR gates replace a relatively expensive IC one-shot multivibrator.

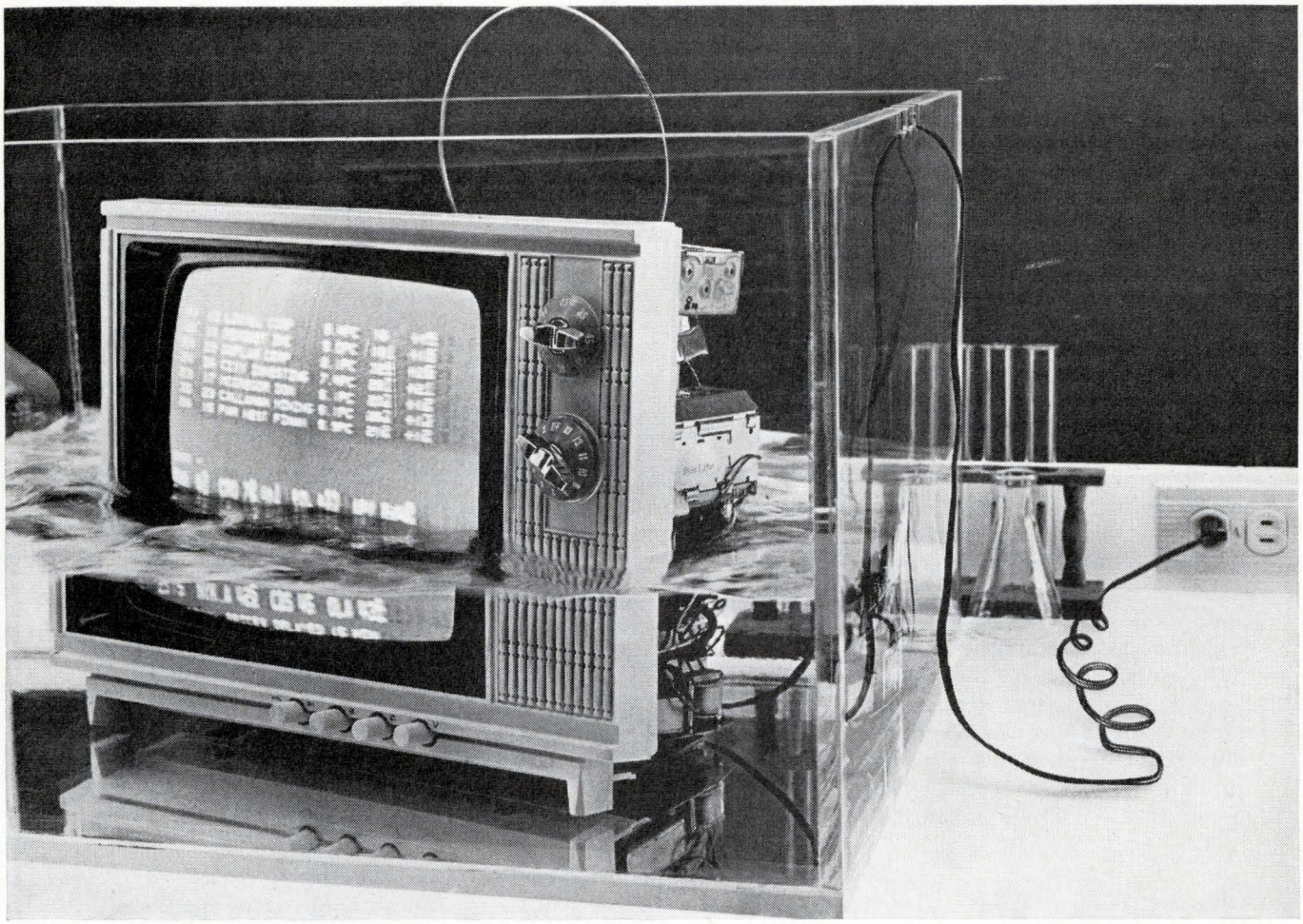
The illustration shows two such simulated one-shots used to derive a two-phase timing signal from a single-phase clock input. This circuit uses a Texas Instruments SN7400 quad NOR gate.

Resistive voltage dividers hold the inputs of gates C and D below their voltage thresholds. But when the output of gate A or B goes positive, the capacitor charges and briefly raises the input of gate C or D, respectively, above threshold.



This causes a narrow output pulse.

To drop enough voltage across the grounded resistors and thus guarantee threshold crossing, gates A and B should be TTL or similar low output-impedance devices.



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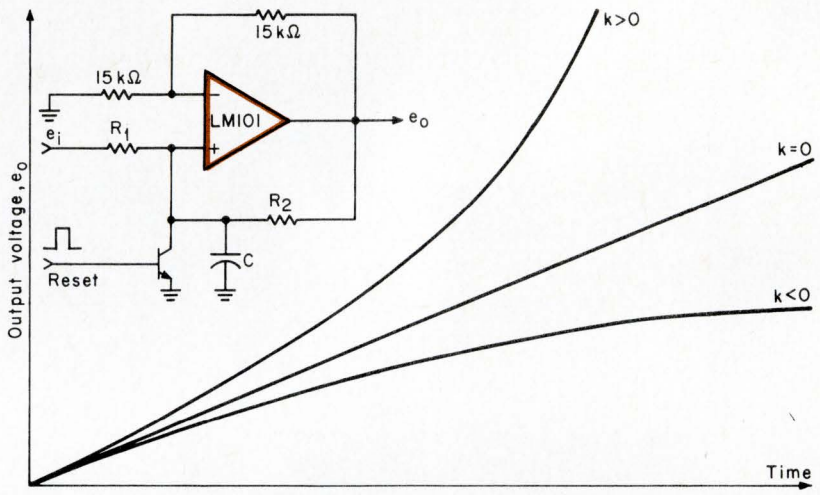
969 Function generator has variable polarity exponents

William Neeland
Kaiser Aerospace and Electronics, Palo Alto, Calif.

You can generate a linear sawtooth waveform in many ways (as, for example, with a constant-current source charging a capacitor). But suppose, instead, you have need of an exponential sawtooth for nonlinear function generation—how would you generate such a signal? One way is to use the circuit shown here: its output is an exponential function in which you can vary the magnitude and sign of the exponent.



Resistors R_1 and R_2 control the amount of positive feedback around the op amp—a National Semiconductor LM101—and thus also the circuit's exponential output. The output is of the form ϵ^{kt} where

$$k = (R_1 - R_2)/R_1 R_2,$$

and $e_o = 2e_i(\epsilon^{\frac{kt}{C}} - 1)/kR_1$.

You generate exponentials of various powers by adjusting the ratio of R_1 to R_2.

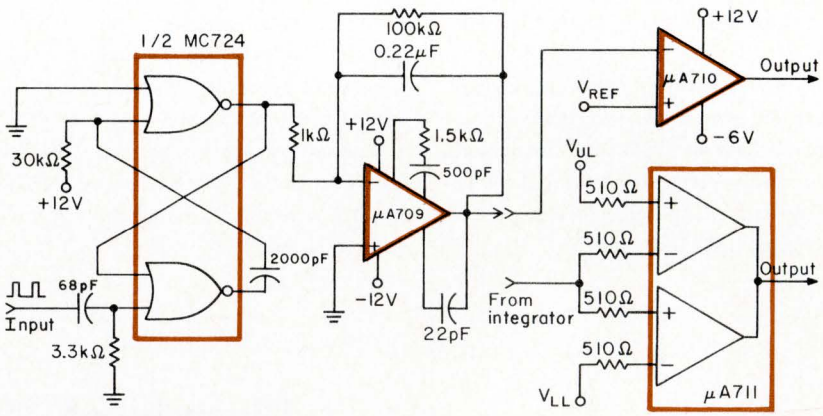
If $R_1 = R_2$, then $k = 0$ and the equation for e_o reduces (by l'Hospital's rule) to that of a linear sawtooth waveform: $e_o = 2e_it/CR_1$.

970 Rep rate comparison made simple

S. Shou
Westel Co., Redwood City, Calif.

Most usual methods of comparing the repetition rates of pulse trains to some reference frequency employ counting and gating circuits. But such components are not necessary if you use analog-to-digital conversion techniques.

An example of such A/D circuitry is shown here, in which a voltage level corresponding to the input pulse rep rate is compared to a level which corresponds to the reference frequency.



The pulse train input triggers a single-shot multivibrator made from half of a Motorola MC724 (a quad, 2-input NOR gate). This single-shot's output—a pulse of constant width—feeds a Fairchild μA709 op amp wired as an integrator. You must allow the integration enough time so that the integrator's output voltage is proportional to the input pulse repetition rate.

The integrator feeds one input of a μA710 voltage comparator, which has its other input connected to a reference voltage. This reference level corresponds, through calibration, to the desired comparison frequency. The comparator's output switches to a logic 1 (or HIGH) whenever the input rep rate is equal to or greater than the reference frequency.

If you wish to monitor the upper and lower excursions of the input rep rate, substitute a μA711 dual comparator for the μA710, and use two reference levels which correspond to the frequency limits.

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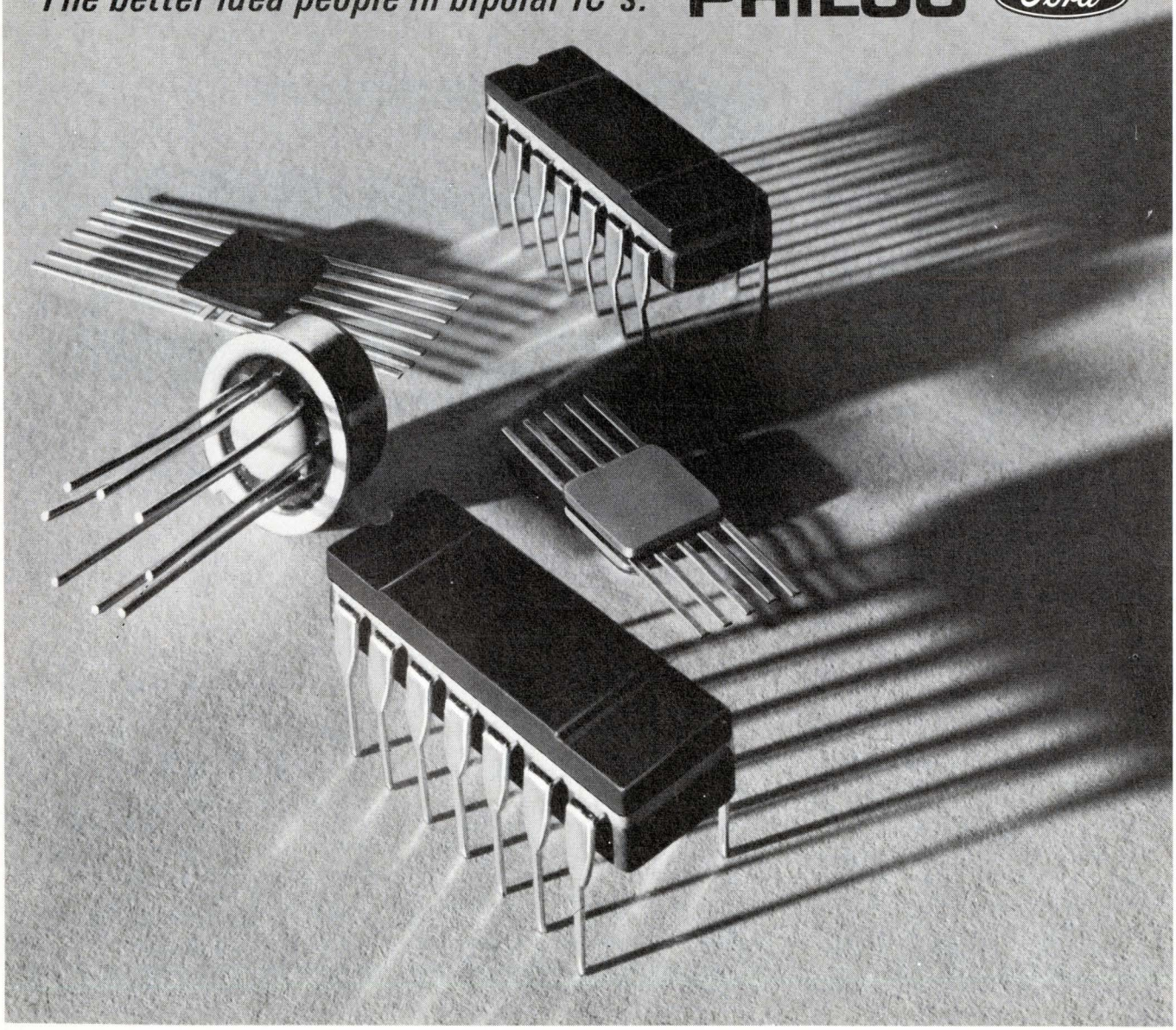


Solid state vs electromechanical: three new keyboards

About a year ago, Honeywell introduced a solid-state keyboard that eliminated contact bounce and rfi, and held out the promise of reduced cost to the OEM. Compatible with logic circuits, the keyboard used a solid-state switching arrangement built around a magnetically actuated IC that combined a Hall generator, a trigger circuit, and an amplifier. Now Honeywell engineers have drawn upon MOS technology to improve the capabilities of the original keyboard and to further reduce its cost.

In the new keyboard, a single MOS encoding circuit, developed for Honeywell by Texas Instruments, performs functions that could require more than 100 discrete components in a typical communications keyboard. But the big advance is flexibility for the designer. For example, you can now specify a keyboard with both ASCII and BCD capability, with three or four modes, or perhaps with a standard typewriter configuration. Each key on the new keyboard can generate up to four levels of code and the system is compatible with any system logic. At no extra cost, you can specify keytop character pairings of codes to suit your specific needs, whether logically or non-logically paired.

Honeywell has its sights zeroed-in on a 1971 price of $88 each—in 2500-pc. quantities—for a 50-key, fully encoded array. Prototypes are about $200 each, and should be available this month.

Another keyboard entry, this one from Transducer Systems, Inc., is neither mechanically nor magnetically actuated. Instead, the Series K-9000-A uses TSI's proprietary *proximity key* for data entry. This key operates as a non-mechanical, non-contacting, bounce-free switch.

TSI's alphanumeric keyboards are solid state throughout, and offer bounce-free operation via the manufacturer's **proximity key** switch for data entry. Individually moveable and replaceable keys give you flexibility in use, and easy maintenance.

These keyboards (ten to 73 keys) have eight data lines (seven lines ASCII plus a parity line) and a strobe line. The maximum data entry rate is 40-chars./s, and TTL ICs are used throughout. Electronic shift and shift lock are standard, as is the electronic interlock. This interlock, or two-key rollover, inhibits the strobe if you should inadvertently strike two keys at the same time.

Optional features of the TSI keyboards include multiple key outputs (up to eight per key), special codes or code combinations, and so forth.

Key layouts and combinations are flexible; you can specify the configuration that you need, including that of a standard typewriter keyboard.

The Model K-9000-A, in a 50-key version, sells for about $75 each in 1000-pc. lots, unencoded. And you can buy the same board fully encoded, including the two-key rollover,

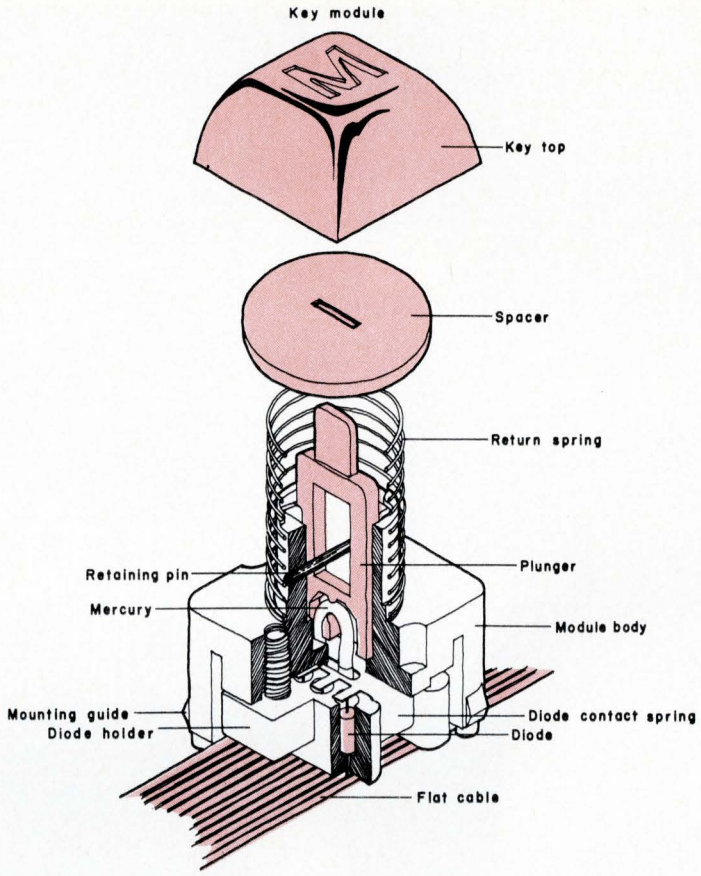
for $150 (1000-pc. lots).

Although some companies may be ready to lay the mechanical keyboard to rest, Mechanical Enterprises of Alexandria, Va., has other ideas. Their brain-child is an electro-mechanical keyboard of modular design with no printed circuit boards and no soldered connections.

Called the Mercutronic Coding Keyboard, it uses plug-in key modules with built-in encoding diodes. Mercury switching within the modules eliminates the problems of contact bounce associated with other mechanical switches. Each individual key module simply snaps into the keyboard base, making contact with a continuous, flat 11-wire cable. A user can change his keyboard configuration or replace a key module at any time without the use of special tools and without factory assistance. The keyboard is normally supplied in ASCII code (upper and lower case) but the versatility of the encoding module allows the use of any code up to ten bits. Available as plug-in modules are such options as strobe signal, shift and lock, and strobe-signal inhibit (when more than one key is depressed).

For a 50-key, fully encoded array, this keyboard will cost you $75 ea., in lots of 1000 pcs. But the two-key rollover option adds $40, which means that a more realistic price is about $115.

For further information on the Mercutronic Coding Keyboard contact Richard A. Thomas, Mechanical Enterprises, Inc., 5249 Duke St., Alexandria, Va. 22304, or call (703) 751-3030. Additional information on the Honeywell Keyboard can be gotten from Fran Kafka, Micro Switch, Div. of Honeywell, 11 Spring St., Freeport, Ill. 61032, or call (815) 232-1122. And for more information on TSI's keyboard, contact Burton F. Drill, Transducer Systems, Inc., Easton and Wyandotte Rds., Willow Grove, Pa. 19090, or call (215) 657-0800.



Plug-in key modules are the secret of the Mercutronic Coding Keyboard's versatility. Encoding diodes are built-in, and mercury switches give bounce-free switching. Standard typewriter keyboard configurations are available.

For Mechanical Enterprises, Inc.:
Circle 221 on Inquiry Card

For Honeywell Micro Switch Div.:
Circle 222 on Inquiry Card

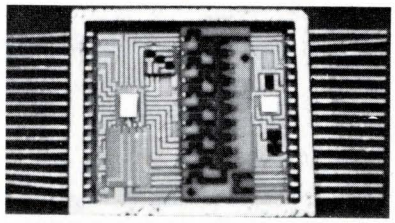
For Transducer Systems, Inc.:
Circle 223 on Inquiry Card

Digital to analog converter

Here is a circuit that gives you a complete D/A converter in a 1 x 1 in. package. Fairchild combines hybrid MOS/LSI, linear and thick film technologies to make this unit, the SH 8090. Dual metalization of the master substrate provides the interconnect patterns required for a device of this size and complexity.

The unit has 10 bit resolution with 9 bit accuracy. The converter uses MOS logic levels, and you can enter the digital word in serial or in parallel. Maximum clock frequency is 100 kHz, giving you a word rate of 10,000 serial words/s, or 100,000 parallel words/s. Settling time is 6 μs in serial operation and 12μs for parallel.

Analog output of the device is 0 to −5 V ±5 mV. The output is short



circuit protected and is provided with an offset null capability.

Basically, the unit consists of Fairchild's 3750 MOS chip, a thick film resistor array and a μA 741 op amp as the output stage. The resistor array is mounted on alumina, which in turn is mounted on the master substrate (also alumina). This approach allows testing of the array before it gets mounted and results in increased yields.

The SH 8090 has an operating temperature range of −20 to 85°C and it comes in a hermetically sealed flat pack.

Prices are $225 ea., 1-24 pcs.; $195 ea., 25-99 pcs.; and $140 ea., 100-999 pcs. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-3563.

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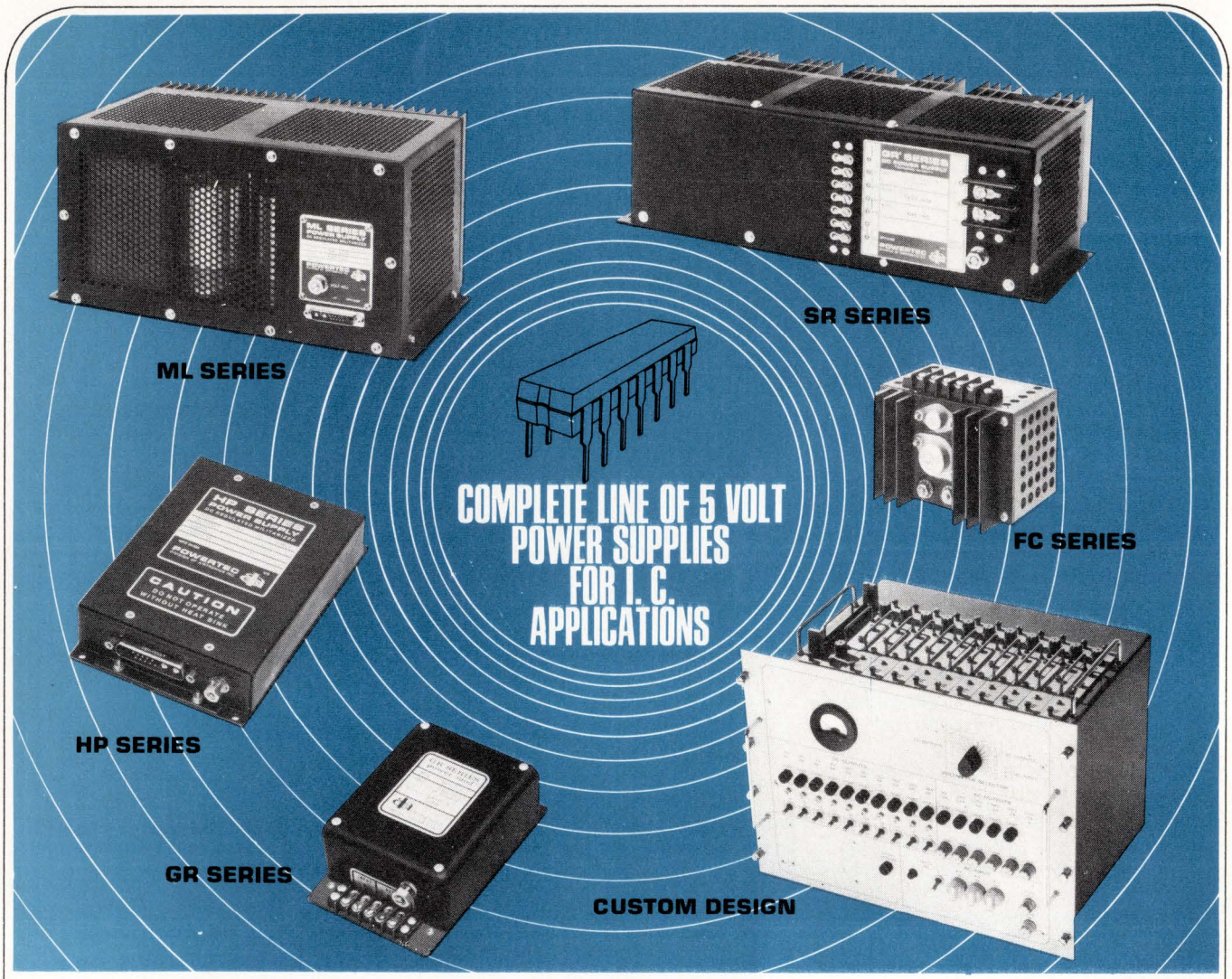

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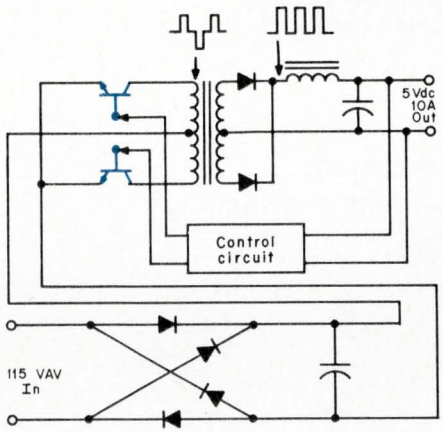
Miniature power supply improved by switching transistors

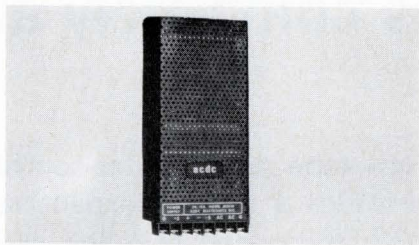
ICs have shrunk circuit size literally out of sight, but, at the same time, the power supplies for them cannot be arbitrarily reduced. ACDC Electronics, now located in Oceanside, California, recently introduced its JR miniature, 0.1% regulated dc power supply. Requests for evaluation samples have consumed production to date.

The 5 V, 10 A model is housed in a 1⅜ by 3⅛ in. package that weighs 1½ pounds. Different outputs cover the range from 3 to 20 V. The power density is about 1.9 W/in^3, which is almost double the best previously available, according to K. R. Kilpatrick, Vice President and Director of Marketing.

The JR is a switching type of regulated supply. Line voltage is immediately rectified and rough filtered. The keys to improved performance are two RCA switching transistors that switch the voltage into a high frequency transformer at 25 kHz. High frequency operation allows a much smaller transformer to be used.

Until recently, power transistors that would handle 300 V peak-to-peak and operate at these frequencies were not available. The electronically controlled transistors produce a pulse width corresponding to the desired output of the transformer. Loop response is faster than 1 ms.





Weighing less than 1½ pounds, ACDC Electronic's new 50 W power supplies are expected to find service where size and weight are important.

Basic diagram (left) of ACDC's JR type power supply. Key switching transistors are colored.

The ac-to-dc conversion efficiency is between 70 and 80%. High efficiency means a lower heat rejection requirement, allowing a smaller package size.

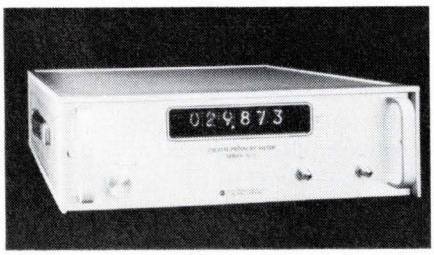
The supplies are priced at $225 in quantities of 100 or more and are now available within 60 days from ACDC Electronics, Oceanside Industrial Center, Oceanside, Calif. 92054.

Circle 407 on Inquiry Card

Digital pressure meter pushes state of the art

As instruments become more sophisticated, it is sometimes difficult to determine who approximates an absolute measurement better, the manufacturer or the Bureau of Standards. Non-Linear System's Digital Pressure Meter, the X-5, is an example of an instrument that is within the accuracy of the pressure standard. There is no standard adequate to test the instrument.

The two pressure standards commonly recognized are the dead weight piston gauge, which has an accuracy of about ±0.015% of reading, and the dual-cistern mercury manometer which is good to about ±0.005% of reading. Both are time consuming to use. The X-5 has a combined error of ±(0.01% full-scale +0.005% of reading) for three months.



Heart of the instrument is a new forced-balance transducer which is position insensitive. Special alloys are used to minimize temperature effects. Pressure is converted to an analog voltage, then a high resolution DVM converts the voltage to digital format and displays it.

Three pressure ranges are offered with direct digital readout in psi or inches of mercury. The lowest range extends from 0.001 to 33.000. Two more ranges extend to 60.000 and 100.000 inches of Hg. Sampling rates are as high as 30 per minute. Moving the instrument one foot vertically at sea level will change the last digit.

It has applications in barometric pressure readings, altimeter calibration, air data computer calibration, and engine pressure ratio system calibrations. Price is $6,000 from Non-Linear Systems, Inc., Box N, Del Mar, Calif. 92014. (714) 755-1134.

Circle 408 on Inquiry Card

Laser trimming system is completely automatic

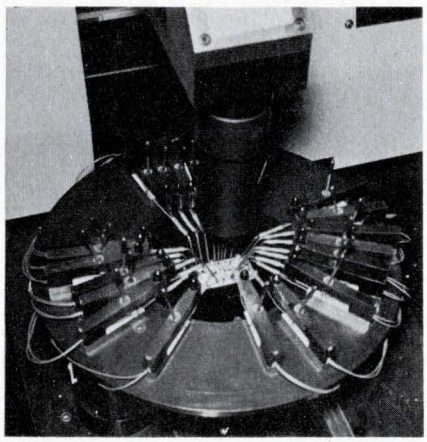
New tape or computer-controlled system provides a rapid, inexpensive method of trimming both thick- and thin-film resistors.

The problem of how to trim hybrid circuit resistors has continued to plague manufacturers. The most popular of the methods currently available (abrasive, electric discharge, laser, rf and ultrasonic) has been the abrasive trimming method, despite its inherent disadvantages. It has a slow trimming rate, leaves the resistor material's edge exposed, must be shut off mechanically, and is a "dirty" operation. Also, although the initial equipment cost is not great, the process can be expensive due to excessive downtime for probe and nozzle set-up and for the constant loading and unloading of substrates.

Laser trimming systems solve many of these problems. They trim by vaporizing the material under their beam. As they move on, the material at the edge of the focused spot solidifies, resealing the edge.

They are fast, but are still limited by the Z-Y table speed and the circuitry's response time. High accuracy trims are possible due to fast shutoff. And response times are fast because the beam can be electronically controlled.

Laser trimming is a very clean process and active circuits can be trimmed. And finally, even though the system cost is many times that of abrasive trimming systems, many feel it is actually less expensive because little time is wasted with "non-trimming" activities such as set-up time.



Why, then, is abrasive trimming more popular than laser trimming? The main reason seems to be the high initial cost.

Now, however, a completely automatic laser trimming system has been announced that takes full advantage of the capabilities of YAG and CO_2 lasers. The system has a probing station which probes all the resistors on a substrate at one time and sequences from one resistor to the next electronically. Other system components are a high-speed (4 in./s) X-Y stage for positioning the laser beam over the substrate; a programmable bridge for blank test, trim stop and final test; a system for electronically shuttering the laser beam; and a punched tape reader for program control with the option of using a small process control computer for program control.

The Mark VII Nd:YAG system can trim both thick- and thin-film resistor materials to $\pm 0.5\%$ for as low as \$0.002/trim. It can make more than two trims per second (7200 trims/hour). The 7200 trims/hour are performed on all the resistors on a substrate. Only one substrate handling operation and one set-up are needed to trim an entire substrate as contrasted with the many handling operations necessary with the abrasive trimmer. An economic comparison of the two systems is shown in the accompanying chart. The company states that it is a direct trim/hour comparison and does not include the value of the time saved by eliminating the extra substrate handling and set-up operations.

The Mark VII has programmable switching speeds of less than 100 μs. Typically, it can be programmed to trim eight resistors on a single 3/4 in. substrate, to within 0.5% of eight different values, in less than 1 s.

There are two basic systems available, each using essentially the same components. The Mark VII-ML moves the laser beam over a fixed, probe-contacted substrate and the Mark VII-MS moves the probe-contacted substrate under a fixed laser beam.

While the company will supply the system with a Q-switched CO_2 laser, they recommend that you specify it

with the Nd:YAG laser. Even though the YAG laser is currently about one and one-half times as expensive as the CO_2 type for a given power output, they feel that the YAG has the following advantages:

1. The YAG beam can be focused to a spot size ten times smaller because the YAG's output is at 1.06 μm versus 10.6 μm for the CO_2's.

2. The high peak power of the Q-switched pulse is what enables the laser beam to vaporize the resistor material while maintaining a low average power to minimize substrate heating. While both types are Q-switched, the YAG laser has rep rates of 10 kHz or more, while the CO_2 laser's rep rate is about 5 kHz.

3. Another factor is the beam turn-off time which helps determine the system's accuracy. The YAG's response time is about 1 μs. Response time of the CO_2 type is about 200 μs. Thus, at a Q-switch rate of 5 kHz there is an ambiguity of ± 1 pulse in turning off the beam after the stop value has been sensed.

4. Relative material removal effectiveness of the YAG unit is better than the CO_2's when they are both focused to equivalent power density. This is because the YAG's shorter wavelength radiation is more readily absorbed by the resistor material under the focused beam.

5. Finally, the YAG's head measures only 4 x 4 x 15 in. as compared to a typical CO_2 head measuring 4 x 6 x 48 in.

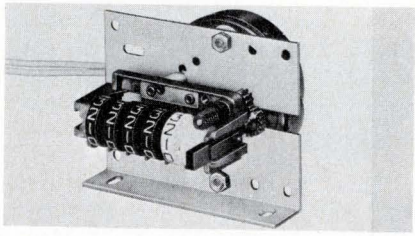
	Mark VII Laser Trimmer	Abrasive Trimmer
System cost	$60K	$18K
One shift op. (2000 hr/yr)		
Depreciation (Three year straight line depreciation)	$20.0K	$ 6K
Operating cost	.5	4
Operator	7.0	7
Labor burden	7.0	7
Total $/yr	$34.5K	$24K
Trims/hr	7200	1000
Trims/yr	14.4×10^6	2.0×10^6
$/trim	0.0024	0.0120

Micronetics, Inc., 60 Arsenal St., Watertown, Mass. 02172.

Circle 400 on Inquiry Card

ELAPSED TIME INDICATOR

Pushbutton resettable.

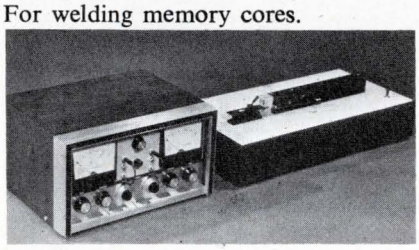


Model T30A indicator with pushbutton reset is available in either four or five digits with a choice of scales in hours, minutes or seconds. Tenths are shown in red. The indicator has a universal bracket for easy mounting and interchangeability. Costs $12.53 in 100 lot quantities. ENM Co., 5306 W. Lawrence Ave., Chicago, Ill 60630. (312) 282-8787.

Circle 401 on Inquiry Card

NEEDLE-WIRE WELDER

For welding memory cores.

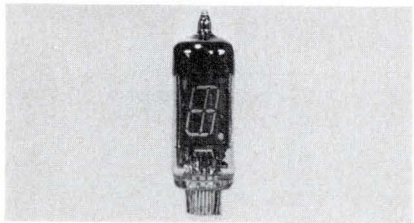


Model 1550D is a butt welder for memory core needle-wire assemblies. It can join (in smooth, round welds) 0.002 through 0.006 dia. high carbon steel needles to 44 gage through 36 gage magnet wire. Its simplicity of operation lets the operator produce 2500 assemblies in an 8 hr. shift after only a short training period. Trueline Instruments, Inc., Box 1357, Englewood, Colo. 80110. (303) 781-6621.

Circle 402 on Inquiry Card

DIGITAL INDICATOR

Wide spectral BW

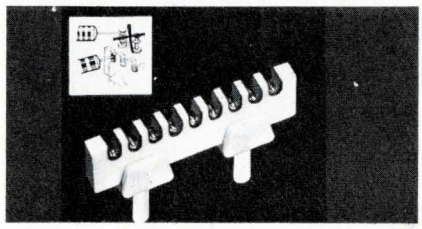


DG-19 series "Legi" 8 segment digital indicator provides a low voltage, low power, planar readout device. Digits, symbols and letters are composed of efficient phosphor-coated segments providing clarity between digits at up to 40 ft. distances. Gridded design offers good strobing characteristics for the most economical design. Legitron, 3118 W. Jefferson Blvd., Los Angeles, Calif. 90018.

Circle 403 on Inquiry Card

CERAMIC TERMINAL STRIPS

Simplify component replacement.

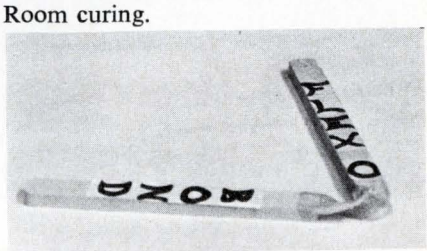


These Alcostrips feature a permanent bond between metal and ceramic, and are fired to prevent metal from loosening. They can be mounted flush or elevated. Tinned copperplate on silvered ceramic facilitates component and lead soldering. Alcostrip Div., Alco Electronic Products, Inc., Box 1348, Lawrence, Mass. 01842. (617) 686-3887.

Circle 404 on Inquiry Card

HIGH STRENGTH ADHESIVE

Room curing.

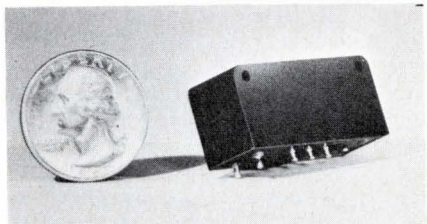


Flexobond has high strengths, particularly when used with rubber type material, many thermoplastic and thermosetting plastics, and other typically more difficult to bond plastics. It is useful as a thermal and mechanical shock resistant bonding agent for metals and in areas where high peel strength is required. Allaco Products, Inc., 130 Wood Rd., Braintree, Mass. 02184.

Circle 405 on Inquiry Card

LIGHTWEIGHT RELAY

Operates over a wide freq. range.



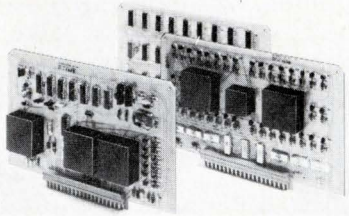
Model 501 Omni-Hertz Relay operates over a wide range of frequencies, performing equally well on ac or dc. No iron or copper is used in its manufacture. SPDT contacts are provided and carry a rating of 5 A at 28 Vdc or 110 Vac. Operating time is in the range of 0.25 to 0.5s in both directions. Allard Instrument Corp., 770 Main St., Westbury, N.Y. 11590. (516) ED 4-8742.

Circle 406 on Inquiry Card

SYSTEMS EQUIPMENT

S/D CONVERTER

On three 5 x 8½ in. PC cards.

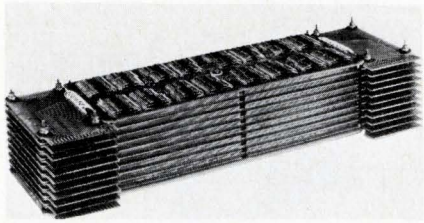


Model A602-SA solid state synchro-to-digital converter is smaller, less expensive and weighs less than an equivalent conventional unit. It measures 3 wire synchro inputs and converts them to a 13 bit binary output with a peak error from all causes of 0.044° (± LSB). Astrosystems, Inc., 6 Nevada Dr., Lake Success, N. Y. 11040. (516) 328-1600.

Circle 246 on Inquiry Card

MEMORY STACK

For 650 ns full cycle operation.

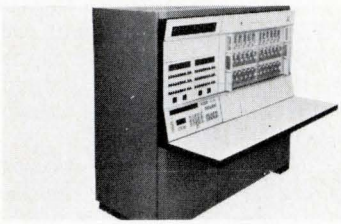


This 2½ D commercial unit is for high speed, main frame large-capacity memory systems. The Nanostak NS-3020 has a 3-wire, 2½ dimension organization with 20 mil cores. Word capacities available are 8,192 and 16,-384 for up to 40 bits and 32,778 for 20-bit word lengths. Electronic Memories, 12621 Chadron Ave., Hawthorne, Calif. 90250. (213) 772-5201.

Circle 249 on Inquiry Card

ANALOG/HYBRID COMPUTER

Totally modular system.

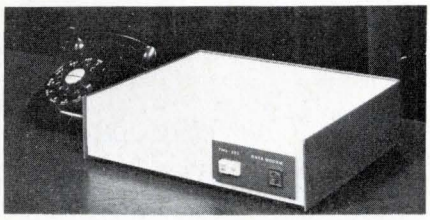


New AD/five 10 V-reference computer is a totally modular system that permits ease of expansion at a relatively low cost. It can be "married" to any digital computer to form a single hybrid system. When not serving as a multiple-console hybrid, it can function as a stand-alone analog computer. Applied Dynamics, Box 1488, Ann Arbor, Mich. 48106. (313) 971-4444.

Circle 252 on Inquiry Card

DATA SETS

Interface with teletype machines.

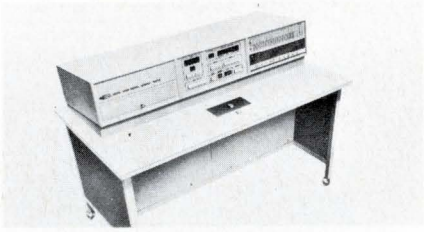


The TMX-202G is a desk-top, single-channel-end FSK data set that operates at rates to 1800 bps. The digital interface meets RS-232, CCITT V24, or Mil-Std-188B specs. Calculated MTBF is about 20,000 hrs. The TMX-202C data set provides up to 12 full-duplex FSK channel ends within a single 19-in. rack module, 8¾ in. high by 21 in. deep. Collins Radio Co., 19700 Jamboree Blvd., Newport Beach, Calif. 92663.

Circle 247 on Inquiry Card

DIGITAL MODULE TESTER

Has built-in computer.

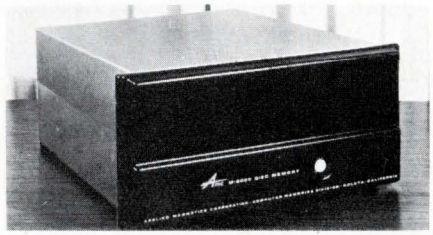


New tester is for automatic functional checkout of ICs, arrays, PC cards, and complete subsystems. Model 4400 generates and monitors up to 20,000 tests/s, enabling up to eight different test stations to be multiplexed. It performs Go/No Go testing and alternately acquires parametric readings of either current or voltage at any pin or bias supply within the system. Datatron Inc., 1562 Reynolds Ave., Santa Ana, Calif. 92705.

Circle 250 on Inquiry Card

DISC MEMORY

For small computers.

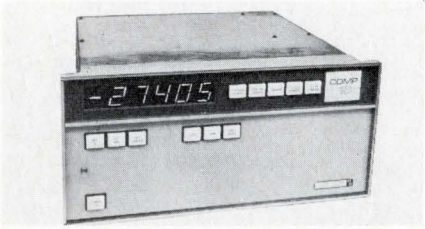


Model M200C is a fast access, head-per-track type mass memory. It is available in four capacities ranging from 426,000 to 3,408,000 bits. Average access time is 8.7 ms. The number of data tracks varies from 16 to 128 with 26,624 bits/track. Three timing tracks are included providing a bit clock, sector and origin pulse. Applied Magnetics Corp., Computer Memories Div., 75 Robin Hill Rd., Goleta, Calif. 93017. (805) 964-4881.

Circle 253 on Inquiry Card

MINI-COMPUTERS

For ruggedized environments.

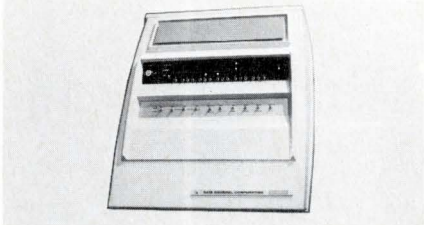


Comp-16 and Comp-18 computers have a 1.0 μs full memory cycle time, 6 memory index registers, simple (but powerful) command structure, parallel I/O bussing, octal readout on the front panel, DMA interface, and lithium core, expandable to 65,536 words (either 16 or 18 bits). The basic Comp-16 costs < $10,000. UniComp, Inc., 18219 Parthenia St., Northridge, Calif. 91324. (213) 886-7722.

Circle 248 on Inquiry Card

GP COMPUTER

Sells for less than $12,000.

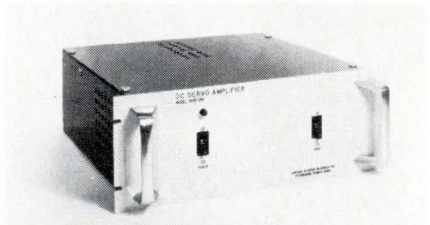


Add time of the Supernova "mini" computer using normal core memory is 800 ns. Using read-only memory (ROM), which is interchangeable with core, add time is 300 ns—one machine cycle. A basic setup has 4096 words of 16-bit core memory. High-speed ROM may be interchanged with core, and the two types can be mixed. Data General Corp., Southboro, Mass. 01772. (617) 485-9100.

Circle 251 on Inquiry Card

SERVO AMPLIFIER

High power.



Linear transistorized dc servo amplifier Model 2000SRA, is for driving dc torque motors, servo motors, and other loads requiring proportional power up to 2000 W. It delivers a cont. output of ±60 Vdc and ±35 A. Adjustable current limiting is included as a std. feature. Control Systems Research, Inc., 1811 Main St., Pittsburgh, Pa. 15215. (412) 781-1887.

Circle 254 on Inquiry Card

DATA TERMINAL

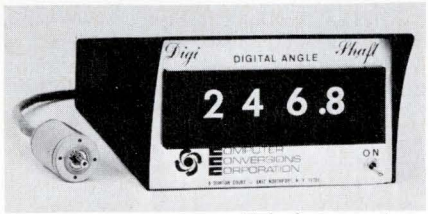
Portable, acoustically coupled.

New terminal operates on six ordinary batteries and weighs only 7½ lbs., including its attache carrying case. Designed for use with computer-controlled voice response systems, it converts an ordinary dial telephone into a remote I/O terminal. $230. Technitrend, Inc., 7300 N. Crescent Blvd., Pennsauken, N. J. 08110 (609) 665-4910.

Circle 255 on Inquiry Card

SHAFT TO DIG. CONVERTER

With 4 digit readout.

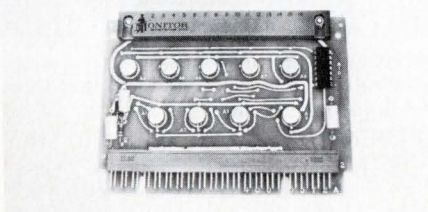


These SS shaft to digital converters, convert any shaft input into four character BCD information. Their output corresponds directly to the shaft angle. They simultaneously provide a 4 digit, 0 to 359.9° display, with a resolution of 0.1°, and an accuracy of ±0.1°. They can make 400 conversions/s. Computer Conversions Corp., 6 Dunton Ct., E. Northport, N. Y. 11731.

Circle 256 on Inquiry Card

ANALOG MULTIPLEXER

Handles high level signals.



The A70 is a 12-channel unit on a single 4.65 by 3.3 in. card. Digital input to each channel is buffered with a DTL/TTL compatible interface. Test points along the top edge of the card facilitate system checkout. Switching time is 1 μs. Monitor Systems, 401 Commerce Dr., Ft. Washington, Pa. 19034 (215) 646-8100.

Circle 257 on Inquiry Card

SERVO POWER AMPLIFIER

Drives dynamic loads to full ratings.

Model PA-201 has a heat transfer design that allows a continuous power rating of 100 W. Output current rating is ±5 A at ±20 V. It features high dc gain, 25,000 V/V, low input drift, and short circuit protection. Torque Systems Inc., Box 167, Waltham, Mass. 02154. (617) 891-5122.

Circle 258 on Inquiry Card

CORE MEMORY SYSTEM

Full cycle time is 900 ns.

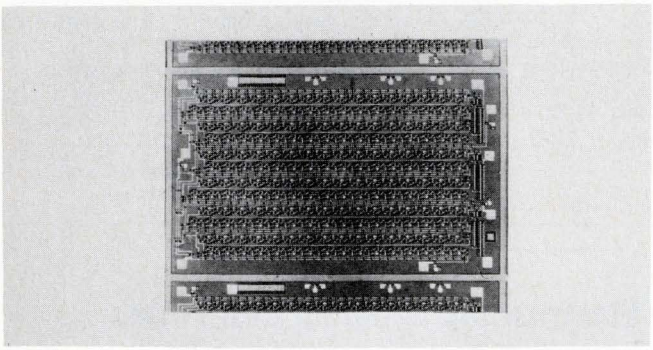
ComRac 1010 core memory system uses 3D selection, fast switching 20 mil cores, and ICs to achieve high speed, high reliability, and high density. Access time is 350 ns with memory capacities up to 32 k words by 36 bits. Information Control Corp., 1320 E. Franklin Ave., El Segundo, Calif. 90245. (213) 322-6930.

Circle 259 on Inquiry Card

NEW MICROWORLD PRODUCTS

TRIPLE 66-BIT DYNAMIC SHIFT REGISTER

With MOSFET gates.

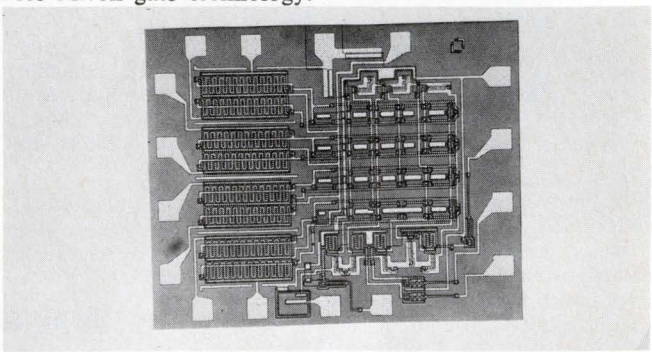


Each of the three registers on the MC1141 has an independent input and output, and common supply- and clock-lines. Each register also contains a single-ended output buffer. The unit operates from 10 kHz to 1 MHz in the temperature range of 0 to 75°C. It has a power dissipation of 1 mW/bit at 1 MHz, typical clock input capacitance of 80 pF, and diode-protected inputs. The MC1141G comes in a hermetically sealed, long-lead version of the TO-100 metal can, and sells for $21, 100 to 999 pcs. Immediate delivery is available. Technical Information Ctr., Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. 85036. (602) 273-6900.

Circle 224 on Inquiry Card

EIGHT CHANNEL MULTIPLEX SWITCH

Uses silicon gate technology.

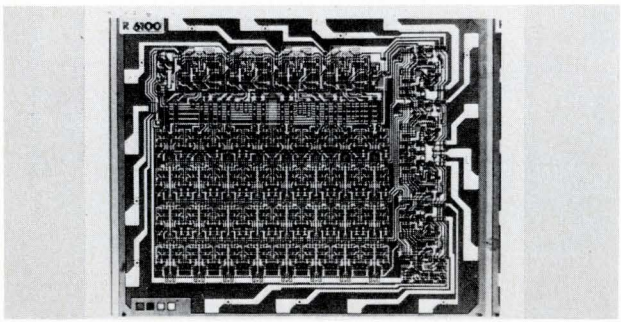


The 3708, a silicon gate oxide semiconductor (SGOS), has a channel switching speed of 0.4 μs typical. The device interfaces directly with npn current sinking logic elements (DTL and TTL) without the need of level shifting circuitry. It also gives you a binary coded logic control and output enable control, right on the chip. Three line decoding selects any one of the 8 channels at random. One type multiplexes at −5V to +5V signal levels, and a second unit from 0 to +5 V. In a 16-lead DIP, prices are −5 to +5 V unit, $75; 0 to +5 V unit, $65, 1-24 pcs. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-3563.

Circle 226 on Inquiry Card

BIPOLAR 64-BIT RAM

On a 90 x 105 mil chip.

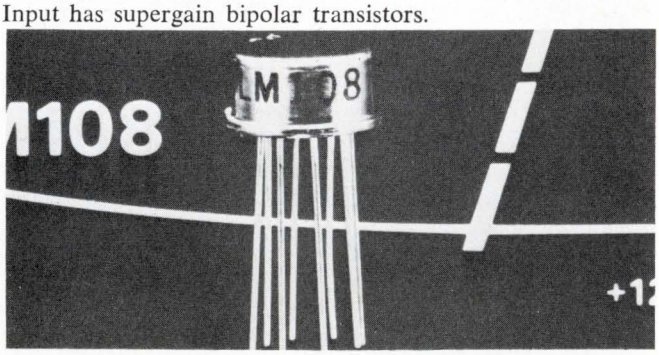


Model RR6100, is organized as a 16-word x 4-bit array and has a word accessability rate of < 45 ns. The write recovery time is < 35 ns, and the minimum write pulse width you need is < 30 ns. On-chip address decoding, chip enable, write enable, and uncommitted collector output give you simplified connections into larger arrays. The total chip dissipation is 420 μW max. The RR6100 comes in the 16-pin dual-in-line package. Price for military grade in quantities of 100-999 is $51.50. The commercial grade is $38 in the same quantities. Raytheon Co., Semiconductor Operation, 350 Ellis St., Mountain View, Calif. 94040. (415) 968-9211.

Circle 225 on Inquiry Card

MONOLITHIC OPERATIONAL AMPLIFIER

Input has supergain bipolar transistors.



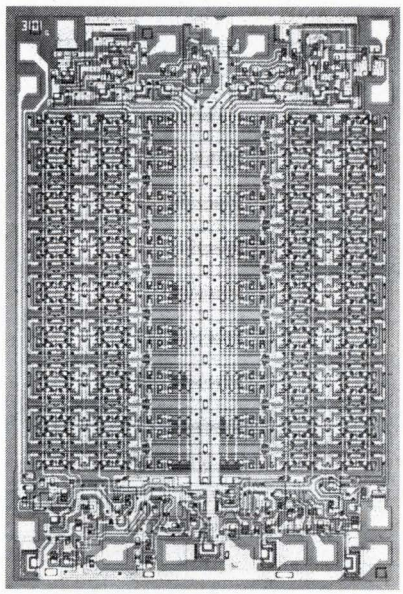
The LM108 out-performs FET amplifiers by a factor of 10 over the military temperature range. Maximum input bias current is 3.0 nA and offset current is less than 400 pA. The unit's dc performance so closely approaches that of the ideal op amp (zero input current, zero offset voltage, and infinite gain), that leakages in PC boards and available capacitors and resistors, limit its performance more than its own design. The LM108A has offset voltages less than 1.0 mV and drifts less than 5 μV/°C, from −55 to 125°C. Prices are LM108, $60; LM108A, $150; 100-999 pcs. National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. 95051. (408) 245-4320.

Circle 227 on Inquiry Card

FIRST FULLY DECODED 64-BIT BIPOLAR LSI

A winner for scratch pad memories i-3101

- Fast 60 nsec access
- Low power dissipation (6 mW per bit)
- DTL and TTL compatible
- OR-Tie capability



Guaranteed switching speeds

Test parameter	*Speed*	*Conditions*
Read cycle (chip select and/ or address to output delay)	60 nsec max	2.5v pulse in. 5 ns rise & fall from 1v to 2v
Write recovery time	45 nsec max	V_{CC}=5.0v T_A=25°C

Guaranteed DC characteristics

Test parameter	*Limit at 0°, 25° & 85°C*	*Conditions (V_{CC}= 5.0v ±5%)*
Input load current	—1.6 ma max	V_{in}=0.45v
Input leakage current	40 μa max	V_{in}=5.25v
Input clamp voltage	—1.0 v max	I_C=5.0 ma
Output "low" voltage	0.45 v max	V_W=V_S=0 v
Output leakage current	100 μa max	V_{cex}=5.25 v V_S=2.5 v
Power supply current	105 ma max	V_a=V_s=V_d= 0 v
Input "high" voltage	2.0 v max	
Input "low" voltage	0.85 v min	

Prices

1 to 9 units: $99.50
10 to 24 units: $73.50
25 to 99 units: $53.00
100 to 249 units: $43.00
250 or more units: $38.50

Available at over 40 locations

throughout the U.S. and Canada. For delivery, call your Intel distributor, Cramer Electronics or Hamilton Electro Sales.

If more convenient, write or phone us directly. Call collect (415) 961-8080.

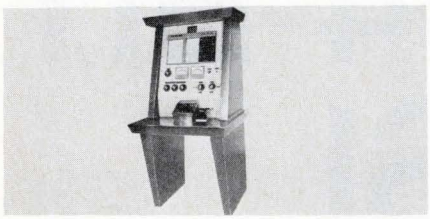
Intel Corporation is at 365 Middlefield Rd., Mountain View, Calif. 94040. Telex INTEL 34-8366.

intel

NEW MICROWORLD PRODUCTS

WAFER ANALYZER

Profiles impurity density.

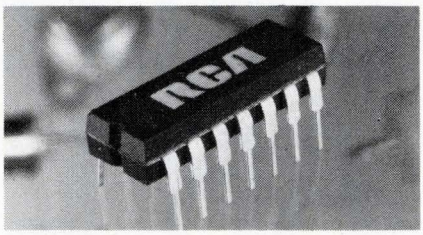


This device plots, in seconds, the impurity density vs. depth for semiconductor wafers. The instrument can measure densities as low as one atom in one billion over distances as small as 10^{-5} in. Research & Development Products Co., 170 Tenth St., Piscataway, N. J. 08854. (201) 968-1255.

Circle 228 on Inquiry Card

ZERO VOLTAGE SWITCH

In a 14-lead plastic DIP.

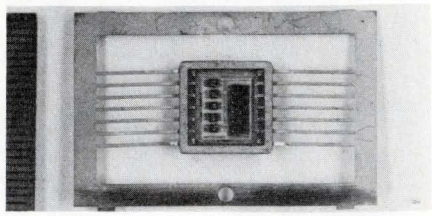


The CA3059 is for 50 to 400 Hz thyristor control applications. The device has a threshold detector and trigger circuit that pulses the triac gate at the zero-voltage point. Temperature range is 0 to 70°C. $1.95 ea., in 1000 pc. lots. RCA Electronic Components, 415 S. 5th St., Harrison, N. J. 07029.

Circle 231 on Inquiry Card

MATRIX DRIVER

Compatible with RTL, DTL and TTL.

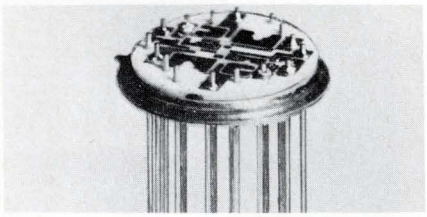


You can use the IT 303 in CRT and indicator drive circuits. The unit has five independent channels, and converts an input signal to a 90 V output drive. Price is about $15 on medium-quantity orders. Industro Transistor Corp., 35-10 36th Ave., Long Island City, N. Y. 11106. (212) 392-8000.

Circle 234 on Inquiry Card

LEVEL SHIFTER

Converts DTL/TTL levels to MOS.

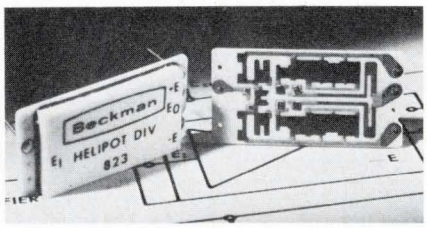


These units have a typical switching speed of 200 ns. The device operates over the military temperature range and uses a supply voltage of 40 V. You can get these circuits in TO-8 cans or DIP packages with two level shifters in each package. Mepco, Inc., Columbia Rd., Morristown, N. J. 07960. (201) 539-2000.

Circle 229 on Inquiry Card

OP AMP POWER BOOSTER

Unity voltage gain; dc to 4 MHz.

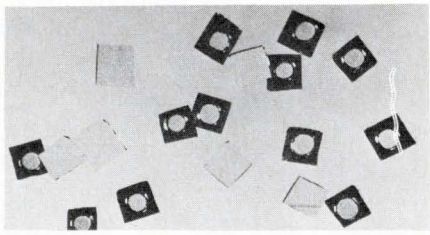


Model 823 is a hybrid, cermet thick film device. The unit has an output voltage swing of ±26 V and a slew rate of 160 V/μs. Temperature range is −55 to 125°C. $8.95. Technical Information Section, Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 02634. (714) 781-4848.

Circle 232 on Inquiry Card

PASSIVATED DICE

Made of silicon glass.



Typical size of these dice is 16.5 x 16.5 x 5 mil. They have <2 pF capacitance and recoveries < 4 ns. The dice meet or exceed Mil-S-19500 and Mil-STD-202 without further treatment or encapsulation. Price $0.15 ea. in 1000 pc lots. MicroSemiconductor Corp., 11250 Playa Court, Culver City, Calif. 90230. (213) 391-8271.

Circle 235 on Inquiry Card

PLASMA SYSTEM

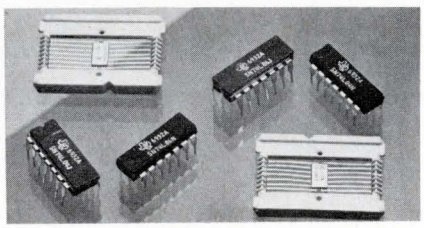
For R&D studies.

The Model 3001 is a complete system for work in the areas of rf sputtering, nitridation and oxidation, polymer surface treatment and other plasma reactions. The only other components you need are a vacuum fore pump and tank gases. Monte Toole Assoc., 25222 Cypress Ave., Hayward, Calif. 94544. (415) 783-2067.

Circle 230 on Inquiry Card

LOW POWER TTL CIRCUITS

Plastic/ceramic DIP or flat pack.

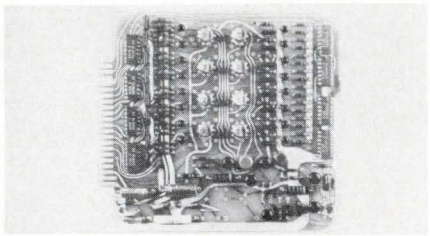


The SN54L04/74L04 is a hex inverter, while the SN54L86/74L86 gives you a quad, 2 input, exclusive-OR function. Power dissipations are typically 1 mW/gate for the inverter, and 3.75 mW for the exclusive-OR. Texas Instruments Inc., Inquiry Answering Service, Box 5012, MS 308, Dallas, Tex. 75222. (214) 238-3741.

Circle 233 on Inquiry Card

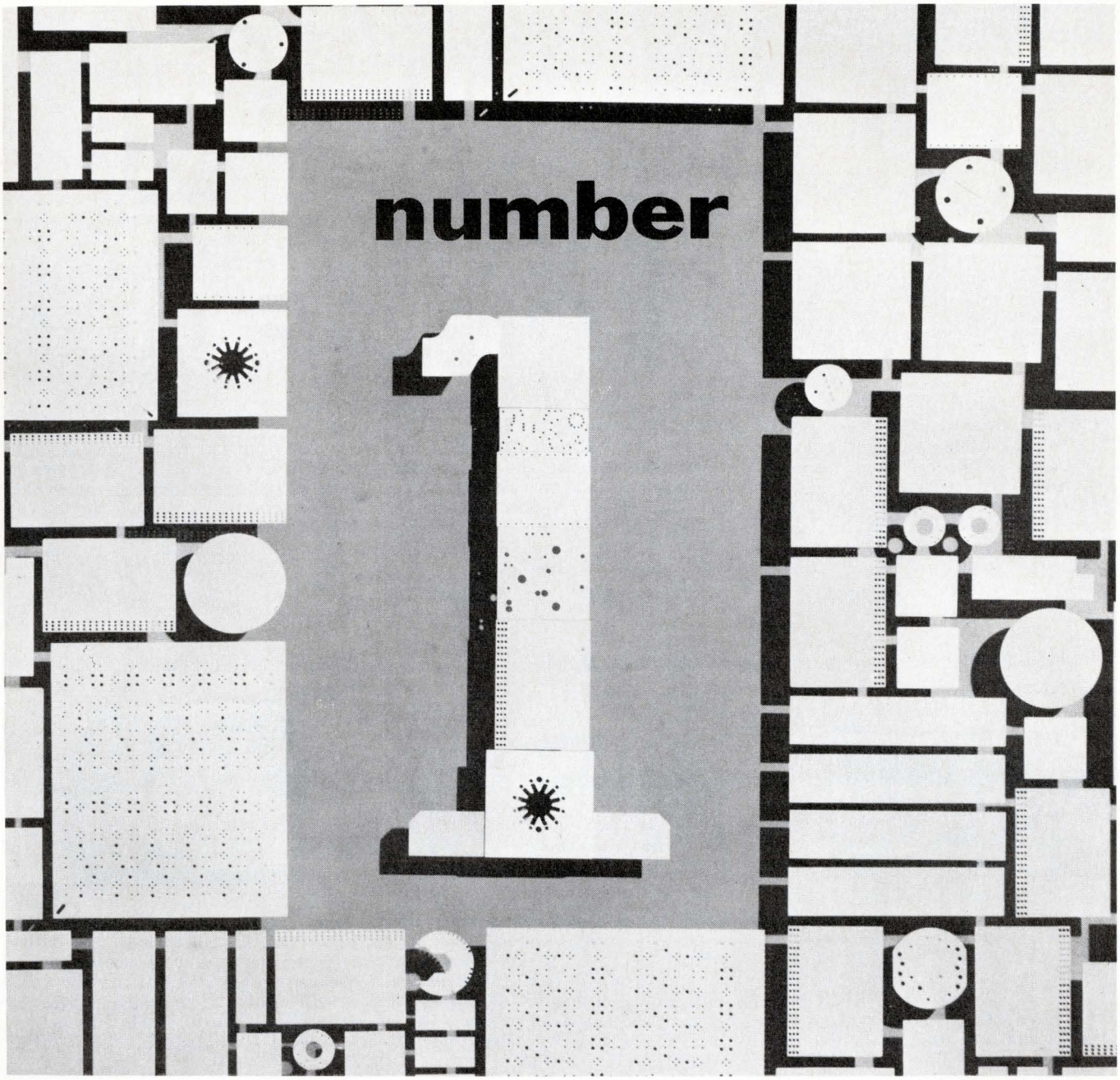
MOS MEMORY

To 1,600 bits.



The MOS-85 is a sequential-access memory on a 5¾ x 5⅘ in. card. It comes in configurations ranging from 50 one-bit up to 200 eight-bit words. A typical module with 150 eight-bit words is $300 in quantities of 100. Delivery, 30 days. Cambridge Memories, Inc., Newtonville Ave., Newtonville, Mass. 02160. (617) 332-3100.

Circle 236 on Inquiry Card



Coors Porcelain Company is the Number 1 producer of high-alumina ceramics and a major producer of alumina-ceramic substrates for thick- and thin-film circuits. This produces a number of benefits for you. Namely:

LOW COST—Whether your substrate order is large or small, you'll always find fair, competitive prices at Coors.

QUICK DELIVERY—Large-quantity substrate orders normally require only 6 to 8 weeks to complete. Small orders and prototype quantities usually take 2 weeks or less. Stocked blanks are shipped within 48 hours.

HIGHEST QUALITY—Coors has long been known as *the quality* manufacturer of technical ceramics. This means you can be sure Coors substrates will have uniform surfaces, precise dimensions, maximum strength, maximum flatness, minimum camber, minimum waviness.

Coors can produce substrates to your specifications from either glazed or unglazed 96% alumina ceramic or unglazed 99.5% alumina ceramic. Both of these ceramics are dense, impervious, resistant to high temperatures, easily metallized, and have excellent electrical-insulation characteristics and good heat-transfer properties.

For details on Coors ceramic substrates, send for Bulletin 1400. Coors Porcelain Company, 600 Ninth Street, Golden, Colorado 80401.

9/2

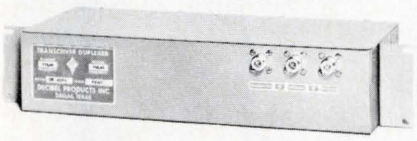
Coors/CERAMICS

Circle 60 on Inquiry Card

NEW LAB INSTRUMENTS

DUPLEXER

Field tunable.

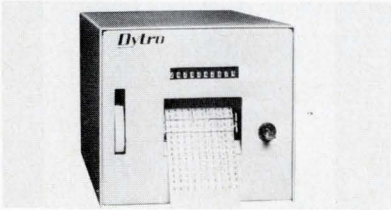


The DB-4096 is a 950-960 MHz duplexer with 3.6 MHz separation. The unit has 75 dB transmitter noise suppression and 75 dB receiver isolation. Included are silver plated cavaties, invar tuning rods and RG142/U cable. $375; immediate delivery. Decibel Products Inc., 3184 Quebec St., Dallas, Tex. 75247. (214) 631-0310.

Circle 237 on Inquiry Card

DVM COMPATIBLE PRINTER

Fixed or floating decimal point.

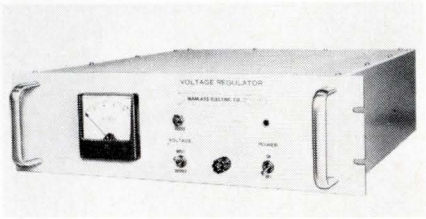


The Addressoprint 1100 accepts parallel BCD, parallel decimal, excess 3 and excess 3 Gray and serial codes. It has printouts up to 10 columns with 2, 10, or 12 characters/column. The unit also gives you a 1 out of 10 contact closure/decade for a remote display. Dytro Corp., 63 Tec St., Hicksville, N. Y. 11800.

Circle 240 on Inquiry Card

LINE VOLTAGE REGULATORS

For bench or rack mounting.

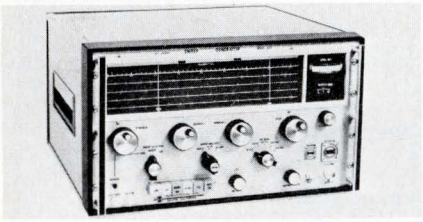


The R-1300 Series give line regulation better than 0.1%. Output is adjustable from 110 to 120 Vac, and all units have overload and short-circuit protection. Three models are available; 1 kVA for $375, 3 kVA for $575, and 5 kVA for $775. Wanlass Instruments, 1540 E. Edinger Ave., Santa Ana, Calif. 92707. (714) 546-5613.

Circle 243 on Inquiry Card

SWEEP GENERATOR

From 0.1 to 24 GHz.

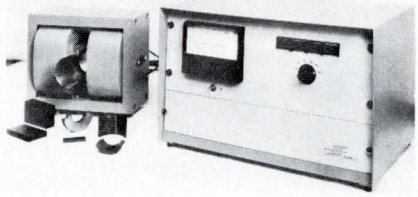


Series 101 sweeper divides its range into 5 bands. They are 0.1 to 4.2 GHz, 4.2 to 8.2 GHz, 8.2 to 12.4 GHz, 12.4 to 16.4 GHz and 16.4 to 24 GHz. You can adjust output power from −120 to +3 dBm. Prices range from $4,380 to $9,800, delivery 90 days. SpaceKom, Inc., Box 10, Goleta, Calif. 93017. (805) 967-7114.

Circle 238 on Inquiry Card

COERCIVITY METER

Measures permanent magnets.

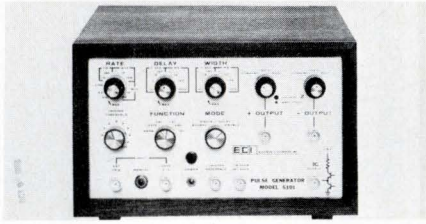


The MC-1 gives you measurements related to permanent flux density, coercivity, operating flux density and intrinsic coercivity. Standard H ranges are 1, 4, and 10 KOe full scale. B ranges are 1, 4, and 10 kG full scale. Magnetic Systems & Instruments Div., O. S. Walker Co., Inc., Rockdale St., Worcester, Mass. 01606.

Circle 241 on Inquiry Card

PULSE GENERATOR

Rep. rates of 1 Hz to 50 MHz.

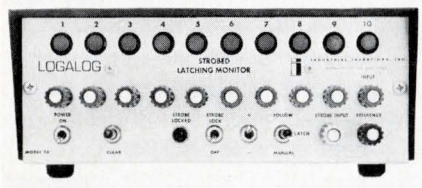


Model 5101 gives you a square wave, single pulse, single pulse delayed with respect to a trigger pulse, or a double pulse with desired delay between pulses. The output can be either positive or negative. Price is $525. Electronic Counters, Inc., 235 Jackson St., Englewood, N.J. 07631. (201) 567-5300.

Circle 244 on Inquiry Card

STROBED LATCHING MONITOR

For 10 binary data points.



The Logalog Model 33 continuously monitors 10 points and when strobed, stores and displays the data. The unit is compatible with TTL, DTL and RTL circuitry. With 5-way binding post inputs, $225. The 33B with BNC connectors is $240. Industrial Inventions, Inc., RD 2, 463 US 1, Monmouth Junction, N. J. 08852. (201) 329-6000.

Circle 239 on Inquiry Card

RECORDING OSCILLOGRAPH

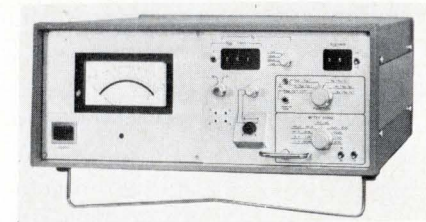
Has speeds from 0.1 to 100 in./s.

Type 5-134 records 6, 12, or 18 channels of data on 7 in. wide direct-print paper. Recording speed is servo controlled and the unit records continuously or in a burst mode. $2,495; delivery, 60 days. Bell & Howell Co., Electronic Instrumentation Group, 360 Sierra Madre Villa, Pasadena, Calif. 91109. (213) 796-9381.

Circle 242 on Inquiry Card

FET TEST SET

With plug-in modules



The IPT-200 tests N and P-channel, MOS and junction, and depletion and enhancement mode FETS. The first module available measures 100 pA leakage currents with a 2 pA resolution. A second module will measure leakage currents as low as 10^{-13} A. IPT Corp., 1140 W. Evelyn Ave., Sunnyvale, Calif. 94086. (408) 245-1000.

Circle 245 on Inquiry Card

Camera Shy?

Don't be. Here's a truly compact CCTV camera (2⅞" head) that delivers over 1,200-line horizontal resolution.

The Fairchild TCS-950B It's ideal for those who have shied away from high resolution cameras because of their large sizes and price tags. Fairchild's new TCS-950B gives the sharpness and clarity of over 1,200-line horizontal resolution and 700-line vertical resolution. With the smallest head on the market and exceptionally compact design, the TCS-950B is perfect for data transmission, microscopic component inspection, flight simulation, photo interpretation, medical observation and a multitude of other applications.

If your CCTV needs are varied and sometimes unusual, you should also consider the versatility available with the TCS-950B:

- Switchable scan rates (either or both scan directions).
- Interlaced or sequential frame scan.
- Video polarity reversal.
- Scan polarity reversal.
- Militarized construction.

Reliability of the TCS-950B is ensured by Fairchild's solid-state Micrologic® circuitry. For its size and high resolution performance, it's one of the lowest priced cameras on the market.

New: The TC-177. You'll get remarkably stable, crisp, high-contrast video signals from this self-contained camera. Features Micrologic® circuitry, 800-line resolution (standard); 2:1 interlace, EIA sync remote control, high resolution (over 900-line), video polarity reversal and other options available.

For specifications and performance data, contact:

FAIRCHILD

SPACE AND DEFENSE SYSTEMS

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

30 PARK PLACE, PARAMUS, NEW JERSEY 07652

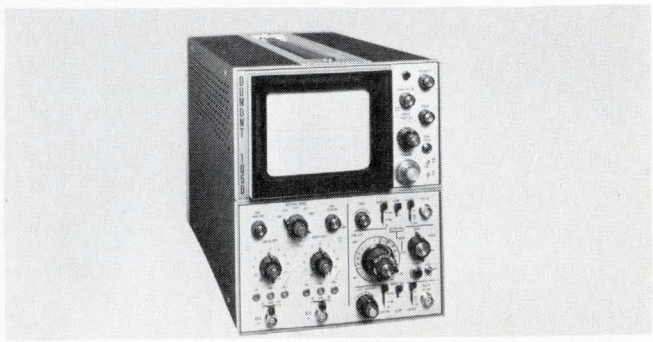
TEL. 201-262-7000 / TWX 710-990-6610

84B

NEW LAB INSTRUMENTS

DUAL CHANNEL OSCILLOSCOPE

From dc to 50 MHz in both channels.

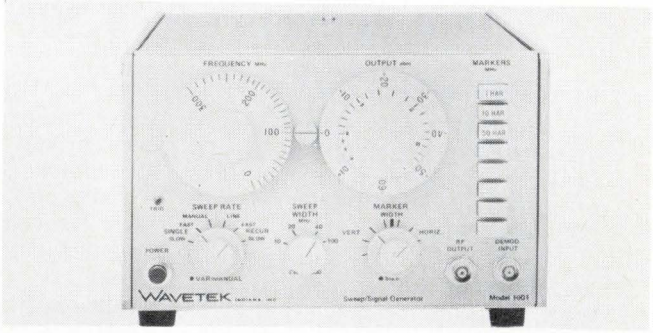


The Dumont 1050 has a unique triggering device that eliminates the trace flicker usually encountered in the dual trace mode with composite triggering. The unit maintains signal synchronization regardless of the vertical positioning of either trace, and eliminates the need to readjust the trigger level control to maintain the desired reference level after trace repositioning. The instrument is solid state throughout with FET input amplifiers and micrologic switching circuits. This gives you quick warm-up time and low trace drift. Dumont Oscilloscope Laboratories, Inc., 40 Fairfield Pl., W. Caldwell, N.J. 07006. (201) 228-3665.

Circle 302 on Inquiry Card

SWEEP GENERATOR

Operates from 5 to 300 MHz.



This instrument, Model 1001, is an electronically tuned and swept generator with an output of +13 dBm (1 V rms). You can program center frequency tuning, sweep width, and variable attenuation parameters. Output is flat ±0.25 dB at the maximum sweep width of 300 MHz. Output impedance of the unit is 50Ω. The unit gives you variable sweep rate, internal or external am or fm, marker size and tilt controls, and manual or single-shot sweep for use with X-Y recorders. Price of the 1001 is $995 with a delivery of 30 days. Wavetek, Box 651, San Diego, Calif. 92112. (714) 279-2200.

Circle 303 on Inquiry Card

SURFACE TEMPERATURE TRACKING SYSTEM

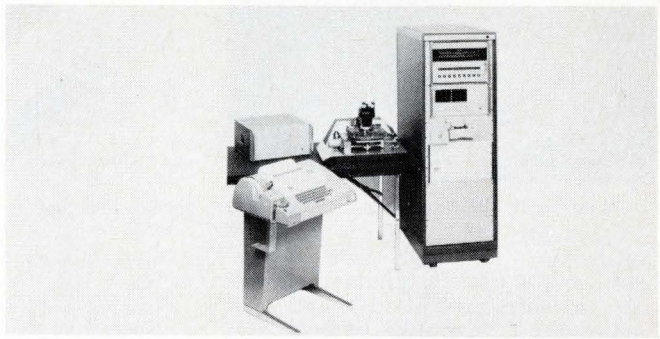
Measures substrate temperature during vacuum deposition.

The Temptrak is designed to give you two important temperatures in the vacuum deposition process; the temperature of the substrate surface before deposition starts and the true surface temperature during the actual growing of the thin film. The sensor is a deposited film thermistor 50 x 10^{-6} in. thick on a 0.040 in. thick glass substrate. The linear range is 50 to 300°C. The system consists of the temperature instrument, a dual vacuum chamber feedthrough, a sensor holder with coaxial cable, external coaxial cable, and 5 thin film sensors. Price of the total system is $590. Sloan Technology Corp., Box 4608, Santa Barbara, Calif. 93103. (805) 963-4431.

Circle 304 on Inquiry Card

LSI TEST SYSTEM

Has 64 channels with 10^5 bits/channel.

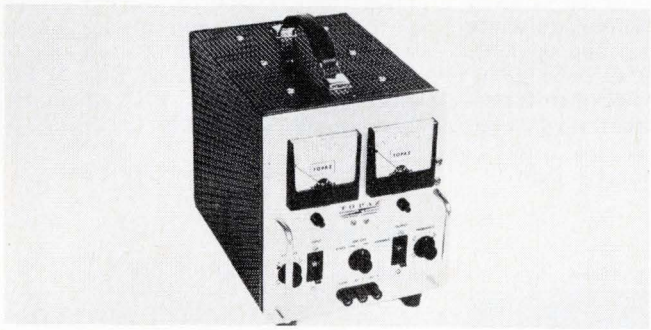


Model 10A is a high speed functional test system for LSI/MSI devices. The system drives the input of an LSI device with a preselected pattern of ones and zeros and compares device outputs with expected outputs. Active probe circuits located within 2 in. of the device perform this driving and comparing. The system is organized around a HP 2114A computer that contains the executive program for system operation. The logic chassis routes the computer signals to the appropriate system components such as power supply programming resistors and storage registers. Pacific Western Systems, Inc., 855 W. Maude Ave., Mountain View, Calif. 94040.

Circle 306 on Inquiry Card

BENCH POWER SUPPLY

Gives Mil-Std-704 power output.

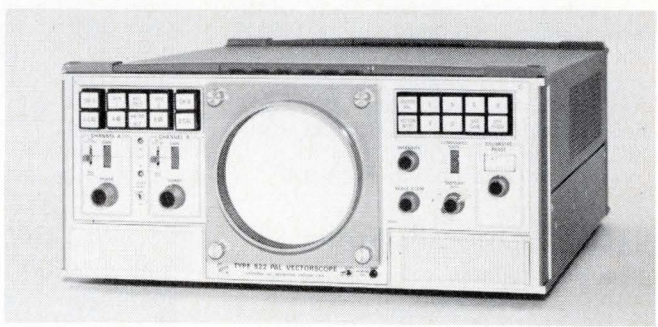


Here is a unit that delivers 1 kW of 400 Hz sinewave power while drawing less than 15 A from a 60 Hz input. The 1-FXD-400 gives you outputs of a fixed 115 Vac ±1% and a variable 100-130 Vac. Its output frequencies are a fixed 400 Hz ±½% and a variable 360 to 440 Hz. Total harmonic distortion of the output sinewave is < 2% at full load. A current limiting output gives protection against overload or short circuit, and you can operate the unit from 20 to 50°C. Models with other output ratings are also available, including a 3 KVA, 3-phase unit. Topaz Inc., 3802 Houston St., San Diego, Calif. 92110. (714) 297-4815.

Circle 305 on Inquiry Card

PAL VECTORSCOPE

For signals with a color subcarrier of 3.575611 MHz.



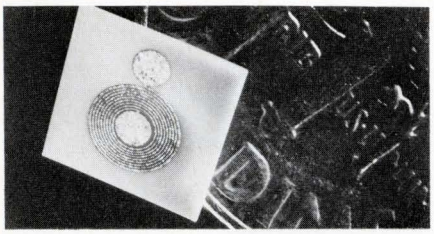
Type 522 measures luminance, hue, and saturation of 525 line 60 field PAL color TV signals. The instrument has dual inputs for time-shared comparison of input-output signal phase and gain distortion. A precision calibrated phase shifter with a range of 30° spread over 30 in. of dial length gives you excellent resolution for making small phase measurements. You can match cable length for time delay at the subcarrier frequency to less than 0.5° phase difference. The cabinet model is $2400 while a rack mount version costs $2425. Availability, first quarter of 1970. Tektronix Inc., Box 500, Beaverton, Ore. 97005. (503) 644-0161.

Circle 307 on Inquiry Card

NEW PRODUCTS

SPIRAL INDUCTORS

On a 0.01 in. thick alumina substrate.

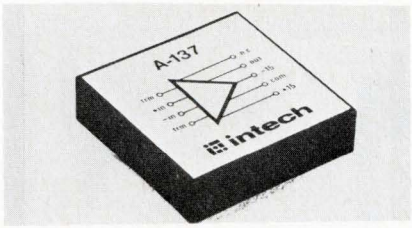


New thin-film series (MCH5800 through MCH5805) inductors feature small size, low cost, high Q (20 through 30), consistent inductance values (28 through 230 nH), and high self-resonant freq. (0.7 through 1.8 GHz). They are for use in uhf and microwave hybrid circuits for tuning and biasing. Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. 85036. (602) 273-6900.

Circle 260 on Inquiry Card

FET INPUT OP AMPS

Fast slewing, rapid settling.

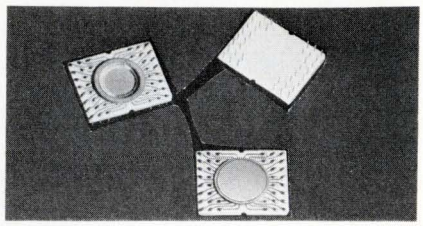


A-136 and A-137 op amps slew 100 V/μs min., settle to 0.01% of final value in 1 μs max., and have 94 dB min. CMR. Drifts of the A-136 and A-137 are 10 μV/°C and 5 μV/°C respectively. Output is 20 mA. The units also guarantee 10 MHz bandwidth, 10 pA bias current and 1.2 MHz full output freq. Intech Inc., 1220 Coleman Ave., Santa Clara, Calif. 95050. (408) 244-0500.

Circle 263 on Inquiry Card

HIGH-PURITY BERYLLIA

For metallized components.



A high-purity (99.5%) grade of beryllia is for use in metallized beryllia components. Resistivity is 10^{18} R.T. Ω-cm and conductivity is 150 BTU/ft^2-hr-°F-ft @ 25°C. These properties make Berlox K-150 ceramic good for ceramic-to-metal electronic components, such as heat sinks and packages for microelectronics. National Beryllia Corp., Greenwood Ave., Haskell, N.J. 07420. (201) 839-1600.

Circle 266 on Inquiry Card

VOLTAGE REGULATORS

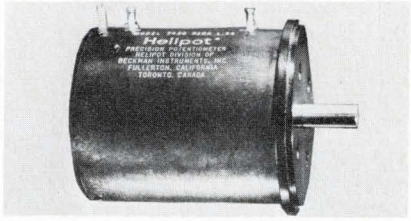
Thick film hybrid units.

VR series regulators come with fixed voltage outputs (variable by an ext. pot) of positive 5, 6, 9, 12, 15, 18, 22, 24, 28, 32, and 36 V and negative 12, 15, 24, 28, 32 and 36 V. They have: foldback current limiting, 0.01% line and load reg., 0.005%/°C TC, and up to 40 V input. $56.00. Transformer Electronics Co., Box 910, Boulder Industrial Park, Boulder, Colo. 80302. (303) 442-3837.

Circle 261 on Inquiry Card

PRECISION POTS

With servo mounts.

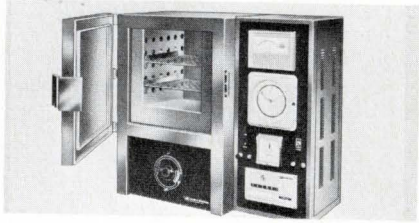


Series 7620, 10-turn, wirewound pots have a min. practical resistance tol. of $\pm$1% and independent linearity of $\pm$0.2%. Power rating is 5.0 W at +40°C derating to 0 at 85°C. New series offers a range of total resistance of 100Ω to 648,000Ω, and an amb. temp. range of −65°C to +85°C. $15.00. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 264 on Inquiry Card

THERMAL CHAMBER

Bench type model.

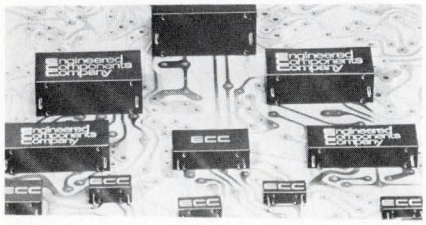


Small, economical thermal cycling chamber is good for handling about ½ lb. workloads of such items as modules and chips. Offering a temp. range from −65°C to +200°C, it has a SS indicating control instrument with two pots for cycling from high to low temp. and back again. Blue M Engineering Co., 138th & Chatham St., Blue Island, Ill. 60406. (312) FU 5-9000.

Circle 267 on Inquiry Card

RADIAL LEAD CAPACITORS

Require minimum PC board area.

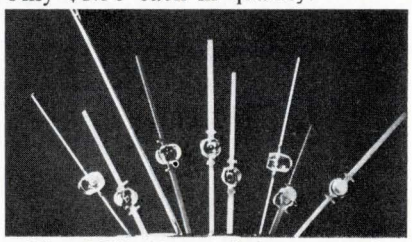


New radial lead capacitor series is rated at 50 V with nearly 100 std. values from 0.0010 to 5.0 μF. These capacitors meet applicable requirements of Mil-C-18312, Mil-C-27287 and Mil-C-19978. Lead breakout is on 0.100 in. increments. Engineered Components Co., 2134 W. Rosecrans Ave., Gardena, Calif. 90249. (213) 321-8294.

Circle 262 on Inquiry Card

SS LIGHT SOURCE

Only $1.50 each in quanity.

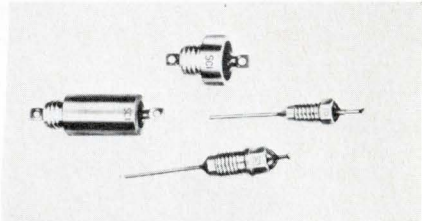


The MV 50 red light source is a diffused planar gallium arsenide phosphide light-emitting diode which peaks at 6,500 Å. It has a light output of 750 ft. lamberts with a forward current of only 20 mA. This provides direct compatibility with ICs. Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. 95014. (408) 257-2140.

Circle 265 on Inquiry Card

EMI FILTERS

Feature high insertion loss.



One of these miniature filters, Part 51-301-030 (at left) offers 20 dB at 30 kHz; 60 dB at 1 MHz; and 70 dB at 10 MHz through 10 GHz at a current rating of 10 A and a voltage rating of 100 V at 85°C or 50 V at 125°C. Cost is $12.80 each (1-49 pieces). Spectrum Control, 152 E. Main St., Fairview, Pa. 16415. (814) 494-5593.

Circle 268 on Inquiry Card

AC MOTORS

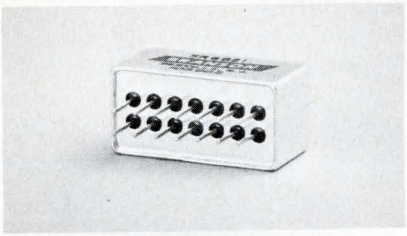
On a 1 23/32 in. dia. frame.

Type CFC line includes 3 hysteresis-synchronous versions with output speeds of 1200, 1800, and 3600 rpm, and 3 induction types producing 2.5 oz. in. at 3050 rpm, 2.0 oz. in. at 1400 rpm, and 1.0 oz. in. at 800 rpm. All motors operate on 115 Vac, 600 Hz, single phase. Weight is 11.5 oz. $58.00. Globe Industries Div., of TRW, Inc., 2275 Stanley Ave., Dayton, Ohio. 45404. (513) 228-3171.

Circle 269 on Inquiry Card

CRYSTAL CAN RELAY

Features welded seals.

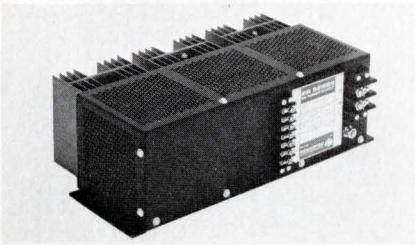


New Type SR and Type LS half crystal can relays meet requirements of Mil-R-5757 E/9. Elimination of flux contamination coupled with microsonic multi-bath cleaning produces contact resistance in critical low level circuits as low as 10 mΩ. Both the 2PDT and 4PDT non-latching units are included in the 0.4 x 0.4 x 0.8 in. size. Branson Corp., Vanderhoof Ave., Denville, N.J. 07834. (201) 625-0600.

Circle 270 on Inquiry Card

MODULAR POWER SUPPLIES

Series regulated.



SR Series includes 64 different "off-the-shelf" models ranging in voltage from 3.6 to 48 V and currents to 35 A. Specs include 0.075 reg. (load and line), ripple <5 mV pk-to-pk, transient response 20 to 50 μs and full current rating at 55°C. Powertec Div., of Airtronics, Inc., 9168 DeSoto Ave., Chatsworth, Calif. 91311. (213) 882-0004.

Circle 271 on Inquiry Card

WIREWOUND RESISTORS

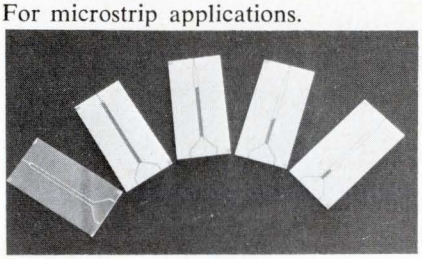
Have a ±10 ppm/°C temp. coeff.

New precision bobbin wirewound resistors come in six models, 0.15 through 0.50 W. They meet requirements of Mil-R-39005 and Mil-R-93. Feature non-inductive winding, complete welded construction and good moisture resistance. They are available in a tol. range from 0.05% to 1%. Resistance range is from 10Ω to 5.4 MΩ. Dale Electronics, Inc., Box 609, Columbus, Nebr. 68601.

Circle 272 on Inquiry Card

RESISTIVE SUBSTRATES

For microstrip applications.

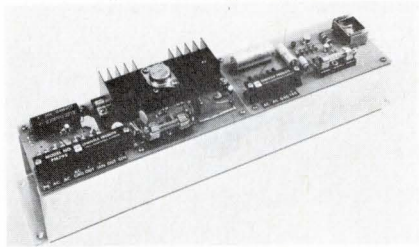


Both sides of these substrates are metalized with chrome film. Metalization is provided on 99.5% Al_2O_3 on 0.025 in. ground substrate with a surface finish of < 10 μin. There is a choice of resistivity of 50, 100, 200, or 400 Ω/sq. A 300 μin. gold conductor is metalized on the chrome. Available sizes are 1 x 1, 1 x 2 and 2 x 2 in. Tek-wave, Inc., Raymond Rd., Princeton, N. J. 08540.

Circle 273 on Inquiry Card

COMBINATION DC SUPPLY

Two voltages in one package.



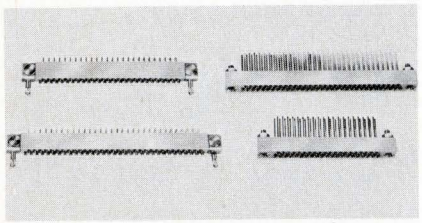
The PM796 consists of a 4.8 V to 6.3 V at 3 A logic power supply and a 180 V at 40 mA display power supply. Line and load reg. is ±0.05% on the 5 V sub-assembly and ±0.5% on the 180 V sub-assembly. Operating temp. range is 0° to 65°C and TC is 0.05%/°C. Computer Products, Inc., 2709 N. Dixie Hwy, Box 23849, Ft. Lauderdale, Fla. 33308.

Circle 274 on Inquiry Card

NEW PRODUCTS

PC CONNECTORS

Meet Mil-E-5400 (Rev. K).

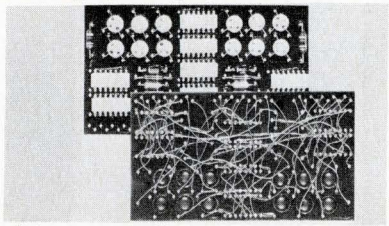


Series 8228 metal-to-metal connectors are available with 17, 29, 41, 53, and 65 Varicon™ contacts spaced on 0.050 in. centers. The plugs are designed for PC card mounting; the receptacles, which can be fitted with solderless wrap PC tab, or wire hole contacts, can be mounted on panels, mother boards, and racks. Series 8228 units also conform to Mil-E-8189 and Mil-T-21200. Elco Corp., Willow Grove, Pa. 19090. (215) 659-7000.

Circle 275 on Inquiry Card

CIRCUIT CARDS

With high packaging density.

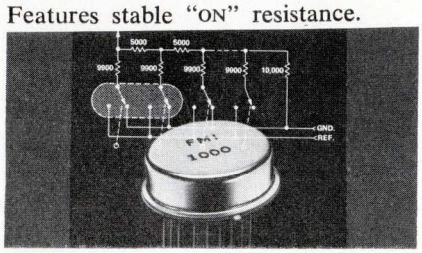


"Accra-point" process uses a stitch-wiring method to interconnect components. Packaging densities of 80 flatpaks or 54 DIPs on std. 4 x 9 in. boards are possible. It includes decoupling and bussed pwr. and gnd. Cost is $3.00/IC installed on PC board and interconnected. Process accepts all customer board size requirements. A-PAC Corp., 20729 Dearborn St., Chatsworth, Calif. 91311. (213) 341-9512.

Circle 278 on Inquiry Card

FET SWITCH

Features stable "ON" resistance.

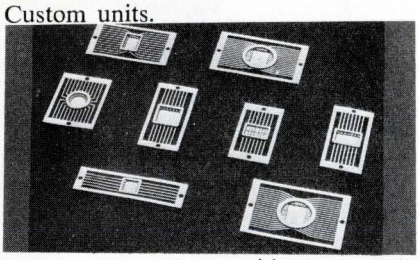


FM 1000 Series PREDictable FET (PRED-FET) switch guarantees precisely specified "ON" resistance which remains stable regardless of amb. temp. variations. It offers FET switching with precision resistance reliability. This capability is important in fast A/D or D/A conversion, multiplexing or chopping applications. Film Microelectronics, Inc., 17 A St., Highland Ind. Park, Burlington, Mass. 01803. (617) 272-5650.

Circle 281 on Inquiry Card

IC FLATPACKS

Custom units.

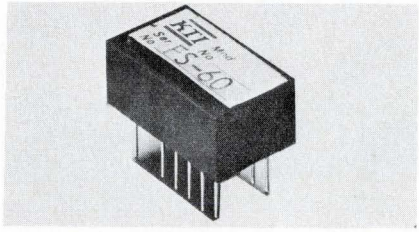


These flatpacks provide max. cavity space and bonding pads. Low-profile "Kovar"-to-glass (or ceramic) assemblies come in 7 std. styles. Many substrate sizes are avaliable from 0.148 x 0.183 to 0.250 x 0.300 in. with from 10 to 40 leads. Special versions may be ordered to meet virtually any application. Tekform Products Co., 2780 Coronado St., Anaheim, Calif. 92801.

Circle 276 on Inquiry Card

ACTIVE FILTER

Has low power consumption.

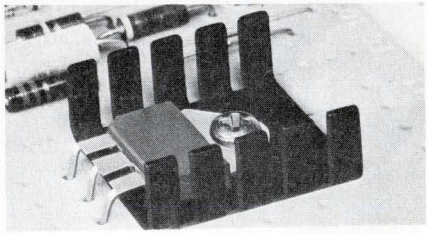


Model FS-60 hybrid IC filter requires only 0.3 mW of power at ±2 V, making it suitable for use in battery-operated equipment. It sells for $10 in large quantities. Operating in the freq. range from dc to 10 kHz, it has multiloop negative feedback for high stability and a Q range of from 0.1 to 500. Kinetic Technology, Inc., 3393 De La Cruz Blvd., Santa Clara, Calif. 95051.

Circle 279 on Inquiry Card

HEAT SINKS

Fit most semiconductor cases.

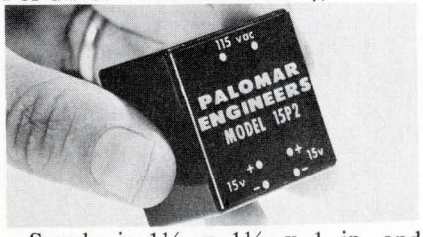


These heat sinks will fit most cases that use a single tab mounting hole. Included are SCRs, power transistors, triacs and quadracs. The 6106 series offers max. mounting surface with min. circuit board space requirements. The in-line veins reduce wasted space without sacrificing performance. Thermalloy Co., 8717 Diplomacy Row, Dallas, Tex. 75247. (214) ME 7-3333.

Circle 282 on Inquiry Card

OP-AMP SUPPLY

For direct PC board mounting.

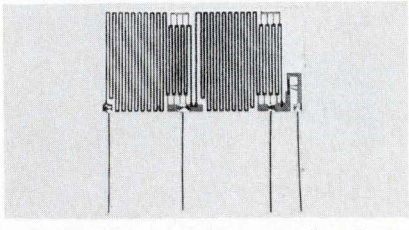


Supply is 1½ x 1½ x 1 in. and weighs 2.7 oz. It provides ±15 V at 150 mA from an ac source of 115 V, 50-400 Hz. Regulation is 0.05% (line and load). Ripple 2 mV rms. An octal plug base is available. Palomar Engineers, Box 455, Escondido, Calif. 92025.

Circle 277 on Inquiry Card

MINIATURE HV DIVIDERS

In an alumina substrate.

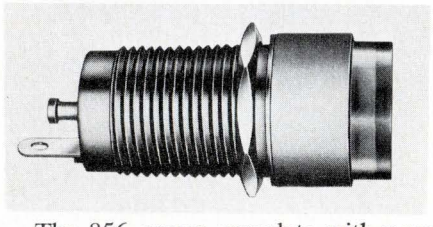


Series HD precision tapped resistors track to <25 ppm for changes in temp. and 10 ppm/V/in. (i.e., per inch of resistor track length) for changes in voltage. Unit shown is a 500 MΩ, 10 kV resistor with taps. Microtek-Electronics Inc., 138 Alewife Brook Pkwy, Cambridge, Mass. 02138.

Circle 280 on Inquiry Card

INDICATOR LIGHT

Lenses available in 10 styles.

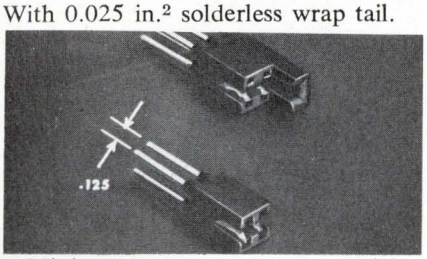


The 856 comes complete with new Q lens and accepts T1¾ based incandescent lamps or T2 based neon lamps. The Q lens is molded from Lexan. Bezel design permits 180° visibility, and is anodized aluminum with a matte silver appearance. The Sloan Co., Box 367, 7704 San Fernando Rd., Sun Valley, Calif. 91352.

Circle 283 on Inquiry Card

PC CONNECTOR MODULES

With 0.025 in.² solderless wrap tail.

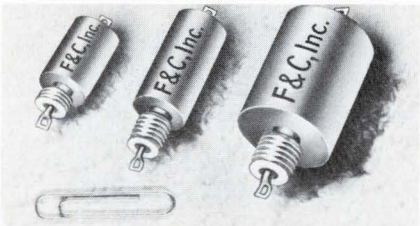


Miniature PC connector modules come in a two-position size, with or without card guides. Tail terminals are on 0.125 in. spacing for use on aluminum plate PC connector assemblies. Modules are for single or double readout of 1/16 in. PC boards. They have mounting bosses for press fit retention in 0.080 in. thick Al plates with 0.073 in. dia. holes. Cinch Mfg. Co., 1501 Morse Ave., Elk Grove Village, Ill. 60007.

Circle 284 on Inquiry Card

MINIATURE FILTERS

High volumetric efficiency.

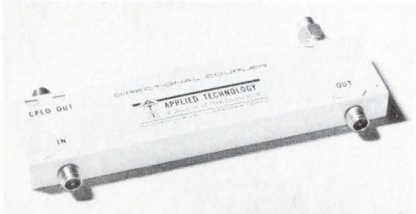


Series 1400 tubular filters are for use in systems where EMI/RFI energy must be eliminated. Using ceramic capacitor elements, these filters achieve space savings from 25% to 70% compared to comparable ceramic filters. They come in L, Pi and T configurations. Filters & Capacitors, Inc., 425 N. Fox St., Box 1272, San Fernando, Calif. 91341. (213) 356-3228.

Circle 285 on Inquiry Card

DIRECTIONAL COUPLER

Covers 1 to 12.4 GHz.

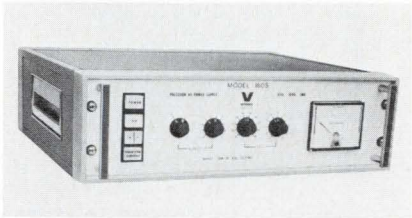


Model DCM1-20 provides 20 dB coupling with directivity better than 20 dB in L-, S-, and C-bands and better than 15 dB in X-band. Maximum VSWR is 1.5:1 and insertion loss ranges from 0.2 dB to 0.4 dB from L-band through X-band. Applied Technology, 3410 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. 94304. (415) 321-5135.

Circle 286 on Inquiry Card

HV POWER SUPPLIES

For CRTs and other displays.

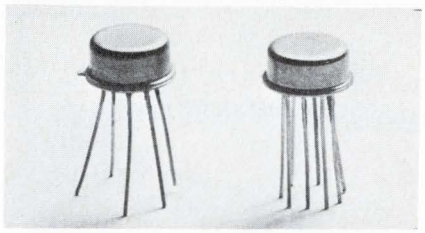


These precision supplies feature low ripple and accurate digitally-selectable output voltage. Output is continuously adj. from 1 kV to 20 kV at 3 mA on the Model 160, and from 10 kV to 30 kV at 1 mA max. on the Model 170. Accuracy of the output is within 0.25% of the selector switch settings. Output voltage is line and load regulated to within 10 ppm. Velonex, 560 Robert Ave., Santa Clara, Calif. 95050. (408) 244-7370.

Circle 287 on Inquiry Card

ANALOG IC KIT

Contains 10 different ICs.



Model KIC-1 analog IC kit contains 10 different analog ICs plus complete application information. It allows you to build 85 different analog type circuits. Kit contains: 2 analog multipliers, 1 analog comparator, 1 analog timing device, 1 bipolar regulator, 4 op amps and 1 application book. Optical Electronics, Inc., Box 11140, Tucson, Ariz. 85706. (602) 624-8358.

Circle 288 on Inquiry Card

REGULATED POWER SUPPLY

IC supply ripple is below 1 mV.

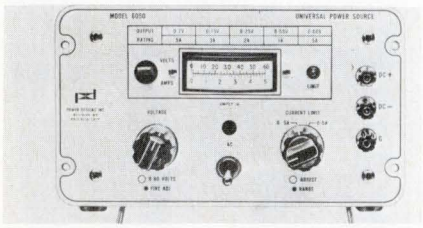
Model PS-30 provides a regulated (0.01%) continuously adjustable output covering the range from 0 to 30 V at currents from 0 to 1 A. Output voltage and current are monitored by a front panel meter and are isolated so that either terminal may be grounded. AUL Instruments, Inc., 139-30 34th St., Flushing, N.Y.

Circle 289 on Inquiry Card

NEW PRODUCTS

DC POWER SUPPLY

Replaces five conventional units.

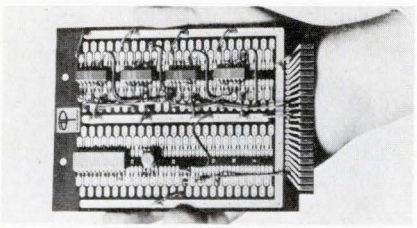


Model 6050 "Uniply" ™ delivers min. outputs of 0-7 V at 5 A, 0-15 V at 3 A, 0-25 V at 2 A, 0-50 V at 1 A and 0-60 V at ½ A. Control is completely electronic; no manual switching of operating ranges is necessary. Operation beyond ratings is instantly indicated by a flashing lamp. This supply is not limited in power output rating by min. ac line input voltage considerations. While it meets published ratings at 105 Vac line, its useful output can safely increase up to twice normal levels at higher line voltage levels. Power Designs Inc., 1700 Shames Dr., Westbury, N.Y. 11590. (516) 333-6200.

Circle 308 on Inquiry Card

PC CARD

Offers complete IC mix capability.

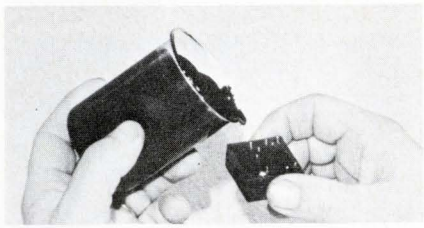


"Omnicard," an all-purpose system-design PC card has a continuous matrix of 768 DIL pilot holes which will accommodate all std. components. It accepts 14-pin (up to 12), 16-pin (up to 10), 24-pin (up to 6) and 28-pin DIP ICs (up to 6). It also takes 8- and 10-pin TO-5s and discrete components together with any mix or combination of DIP ICs—all on one card. AP Inc., 72 Corwin Dr., Painesville, Ohio 44077. (216) 357-5597.

Circle 309 on Inquiry Card

POTTING COMPOUND

With high thermal conductivity.

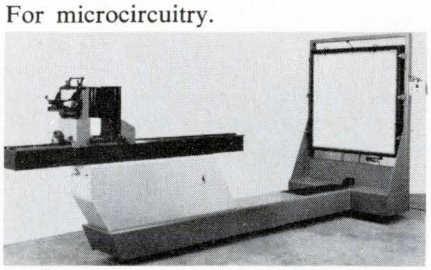


New two-component Epo-Tek 920-FL epoxy compound is a smooth-flowing paste when mixed, with a viscosity at 79°F of 14,000 cps. It has an 8 hr. pot life, and cures in 1 to 2 hr. at 60°C, and in 30 min. at 80°C. Thermal conductivity by the comparative method is 7.55 BTU in/ft² hr. °F. Dielectric constant at 1 MHz is 6.07, with a diss. factor of 0.021. Epoxy Technology, Inc., 65 Grove St., Watertown, Mass. 02172.

Circle 312 on Inquiry Card

PRODUCTION CAMERA

For microcircuitry.

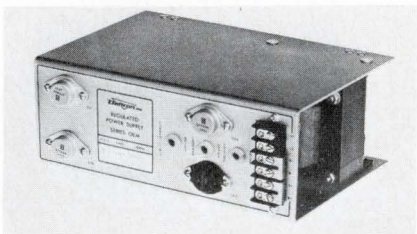


The high-precision microphotography Dekacon III Alpha camera is for the production of IC reticles for MOS, LSI, and large-area high-density microcircuits. It is especially recommended for IC reticle making using a Nikon 135mm Ulgra-Micro-Nikkor lens at 20X, 25, and 30 reductions. HLC Mfg. Co., Inc., 732 Davisville Rd., Willow Grove, Pa. 19090. (215) 657-1700.

Circle 310 on Inquiry Card

POWER MODULES

Continuous operation to 71°C.

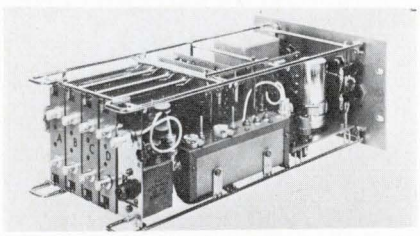


OEM Series provides 26 models from 3 to 48 V, from 0.70 to 9.0 A. All have remote programming and sensing, automatic recovery after removal of overload, self cooling, and fast response time for pulsed digital loads. Specs include 0.05% reg., 1 mV rms ripple and noise, 0.1% stab. and 10 μs recovery time. Deltron, Inc., Wissahickon Ave., North Wales, Pa. 19454. (215) 699-9261.

Circle 313 on Inquiry Card

ELECTRONIC CHASSIS

Speeds assembly.

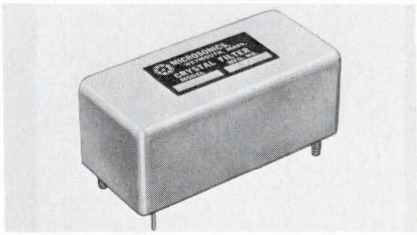


This welded wire chassis permits easy access for component insertion and assembly. Thus, assembly costs are lower and components can be added much faster. Skeletonized design also combines maximum strength with minimum weight and improved component cooling. E. H. Titchener & Co., Binghamton, N.Y.

Circle 311 on Inquiry Card

CRYSTAL FILTER

Features excellent selectivity.

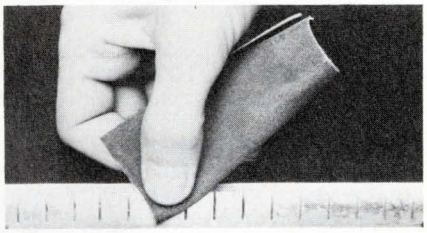


Model SB212A single side band filter has a carrier frequency of 1750 kHz with a 4 dB high and low BW of +3.5 kHz and +300 Hz respectively. The carrier rejection is 30 dB min. Temperature range is −40°C to +85°C and a ripple of 1.5 dB maximum. Microsonics, 60 Winter St., Weymouth, Mass. 02188.

Circle 314 on Inquiry Card

CONTACT CLEANER

No pressure required.

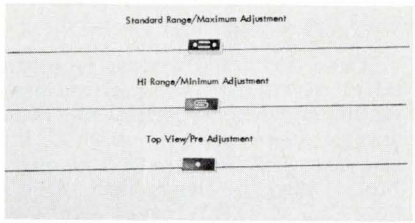


Ace Bright cleans off non-conductive films without damaging the base materials. It's easy to use, with light strokes across the area to be cleaned all that is necessary. For difficult jobs you just increase the number of strokes. Use it to clean relay contacts, contact fingers, RFI/EMI gasket contact surfaces, switch contacts, and sliding contacts. Metex Corp., 970 New Durham Rd., Edison, N.J. 08817. (201) 287-0800.

Circle 315 on Inquiry Card

RESISTORS

Adjustable molded metal film.

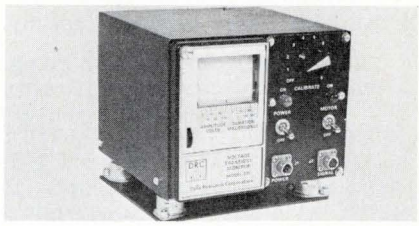


FixTrim® resistors exceed performance characteristics of Mil-R-55182 and Mil-T-10509. They may be used to replace set and lock trimpots or to minimize inventories of fixed trimming resistors. The new line has 14 values adj. from 10 Ω to 100 kΩ TCs available range from ±25 ppm/°C to ±100 ppm/°C from −55°C to +175°C. Angstrohm Precision Inc., 7811 Lemona Ave., Van Nuys, Calif. 91405. (213) 989-3064.

Circle 318 on Inquiry Card

TRANSIENT RECORDER

Connect to input power lines.

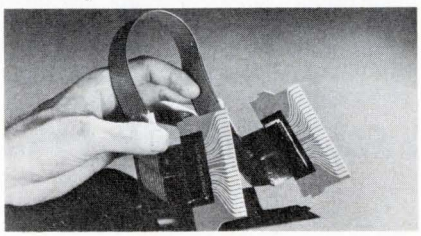


Recorder provides a long term, permanent record of the amplitude, duration, and time of occurrence of any power line voltage transient. Transients ranging from 5 μs to >128 ms in duration and 1 to 100 V in amplitude can be detected and recorded. Detection accuracy is ±1% for amplitude detection and ±3% for duration detection. Data Research Corp., 2601 E. Oakland Park Blvd., Ft. Lauderdale, Fla. 33306.

Circle 426 on Inquiry Card

FLAT CABLE HARNESSES

With impedances from 50 to 150Ω.

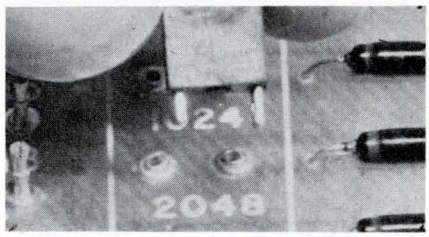


Mektron harnesses come with impedance controlled to ±5% or better and terminations with matched impedance. Desired values are achieved by varying the width and spacing of conductors and grounds. Crosstalk is held below 5% levels. Conductors are etched continuously from copper-clad rolls of Duroid 8150, a high-temp. poly-amide-imide insulation. Rogers Corp., Rogers, Conn. 06263.

Circle 316 on Inquiry Card

PC BOARD SOCKETS

Accept varying diameter leads.

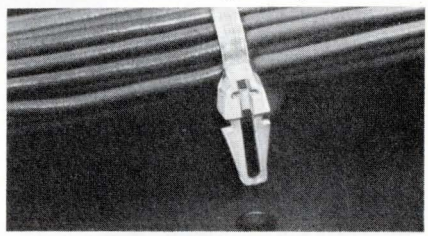


"Cirkut Sockets" are installed in circuit boards by a simple swaging operation. They are then wave or bit soldered. Sockets project only 0.040 in. above PCB surface, while actual mating of pin and socket occurs within the thickness of the board. Costs from $0.05 to $0.15. SAE Advanced Packaging, Inc., 1357 E. Edinger Ave., Santa Ana, Calif. 92707. (714) 547-3935.

Circle 319 on Inquiry Card

WIRE TYING STRAP

Doubles as mounting clamp.

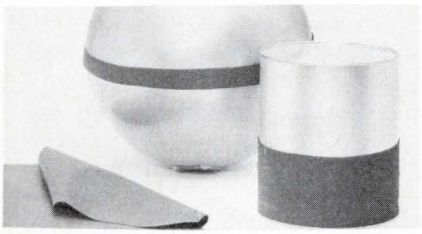


TY-54M cable tie eliminates all clamps, mounting bases, screws, bolts, rivets, and other hardware associated with installing wire bundles. It is a self-locking Ty-Rap® strap with a push-in mounting device in the head. Just tie the wire bundle with this strap, drill a 0.187 in. hole, and plug in the wire bundle. The Thomas & Betts Co., 36 Butler St., Elizabeth, N.J. 07207. (201) 354-4321.

Circle 427 on Inquiry Card

HIGH-LOSS SHEET

For microwaves.

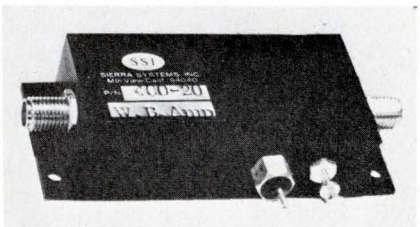


Eccosorb FDS is a flexible material based on silicone rubber. When bonded to a metal surface, it will effectively prevent the flow of microwave currents. Radiation patterns of antennas can be modified by using it to elements, dishes, horns, and so forth. Emerson & Cuming, Inc., Canton, Mass. 02021. (617) 828-3300.

Circle 317 on Inquiry Card

WIDE-BAND AMPLIFIER

Has 0.5 MHz to 400 MHz BW.

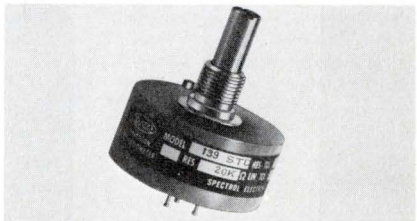


These rf amplifiers are constructed using hybrid thick film techniques. Model 400-20 has a 1 dB BW from 500 kHz to 400 MHz. Gain is 20 dB ±1 dB. Amplifier NF is a max. of 4 dB, and VSWR, both input and output, is 2:1 max. $275. Sierra Systems, Inc., 2255 Old Middlefield Way, Mountain View, Calif. 94040. (415) 969-3056.

Circle 320 on Inquiry Card

CERMET PRECISION POT

With a 5 W power rating.



Model 139 single-turn pot comes in a molded, glass-filled nylon housing. A heat-formed rear lid eliminates the use of adhesives. It has a range of 500 Ω to 1 MΩ, essentially infinite resolution, and a std. independent linearity of ±0.5%. Spectrol Electronics Corp., 17070 E. Gale Ave., City of Industry, Calif. 91745. (213) 964-6565.

Circle 428 on Inquiry Card

NEW PRODUCTS

RESISTOR MATERIALS

Have high power handling capacity.

"Birox" thick film resistor compositions come in resistivity values from 100 to 300 kΩ/sq. They are 1021, 100 Ω/sq.; 1031, 1kΩ/sq.; 1041, 10 kΩ/sq.; 1051, 100 kΩ/sq.; and 1053, 300 kΩ/sq. They are designed for screen printing with conventional woven screens. Dynamic chemical changes to the resistive material do not occur during firing. E. I. Du Pont de Nemours & Co., Electrochemicals Dept., Wilmington, Del. 19898.

Circle 290 on Inquiry Card

INSTRUMENTATION AMPS

Only 0.4 in. high and 1.5 in. sq.

These two amplifiers can be mounted on a PC card or inserted into a mating connector. Model 3264/14 has a max. input drift of ±10 μV/°C, and costs $29.90 ea. (in 100 quan.). Model 3263/14 has a max. drift of only ±3 μV/°C from −25°C to +85°C. The 3263/14 is $45 ea. (100 quan.). Output of each amplifier is ±10 V at ±5 mA. Burr-Brown Research Corp., International Airport Ind. Park, Tucson, Ariz. 85706.

Circle 292 on Inquiry Card

FERRITE MATERIAL

Computer grade.

New MMF 35-101 ferrite is completely compatible with widely used ferrites such as 4R5 and CN2002. MMF 35-101 maintains its low loss characteristics beyond 10 MHz and has excellent machinability. It can be supplied in ground core configurations, ceramic bonded, or even toroidally wound for direct use in pad assemblies. Michigan Magnetics, Vermontville, Mich., 49096. (517) 726-0590.

Circle 294 on Inquiry Card

MICROWAVE TRANSISTOR

In a 4 leaded microstripline pack.

Type 2N5717 is for use in class A or C power amp and oscillator circuits up to 3 GHz. Power input is 500 mW cw at 2 GHz with min. eff. of 15% in class A operation. It has 9 dB gain at 2 GHz and operates from a 28 V source. Semiconductors Inc., 14520 Aviation Blvd., Lawndale, Calif. 90260. (213) 679-4561.

Circle 291 on Inquiry Card

THICK-FILM PASTES

TC of < 100 ppm.

"Cermalloy," pastes are for cermet hybrid circuits and trimming pots. They are warranted "batch-to-batch reproducible" for resistive or conductive applications. Sheet resistivities range in seven discrete steps from 1 Ω/sq. to 500 kΩ/sq. Cermet Div., Bala Electronics Corp., 14 Fayette St., Conshohocken, Pa. 19428. (215) 828-4650.

Circle 293 on Inquiry Card

ADHESIVE HEAT SINK

Cools power transistors.

Kool-It is a one part adhesive for bonding components directly to metal chassis and/or heat sinks for more effective heat transfer. It has high thermal conduction and high electrical insulation. The room temp., air cured bond is tough, resilient and has good adhesion to clean metal surfaces. Vigor Tool Co., 53 W. 23rd St., New York, N.Y. 10010. (212) YU9-5522.

Circle 295 on Inquiry Card

CONDUCTIVE GLASS

For electronic displays.

New Nesatron low-resistance electrically conductive glass features a vacuum-deposited metal oxide film that heats at low voltage. While it is effective at relatively low voltages, it also has high light transmission—more than 80% at resistivities ranging from 10 to 1000Ω/sq. In contrast, visibility through most other coatings decreases as the resistivity decreases. PPG Industries, Inc., One Gateway Ctr., Pittsburgh, Pa. 15222. (412) 434-3011.

Circle 296 on Inquiry Card

DIFFERENTIAL AMPLIFIER

DC to 100 kHz at a gain of 1000.

Model 175 amplifier is not an op. amp. but a complete ready to operate (without ext. feedback resistors or roll-off capacitors) instrumentation amplifier. Features include: Input imp., 1 MΩ; gain adj. from 10 to 1000; noise, $<1\mu$V rms below 1 kHz or $<5\mu$V rms wideband at a gain of 1000; output, ±10 V @ 50 mA; CMRR, 90 dB; drift, typ. $<5\mu$V/°C. California Electronic Mfg. Co., Inc., Box 555, Alamo, Calif. 94507.

Circle 298 on Inquiry Card

FLAME SPRAYED FERRITE

Absorbs EM & X-radiation.

A new process allows thin ferrite coatings to be formed on complicated substrates. It is particularly effective on ceramic and glass. Ferrite is sprayed through a high temp. flame onto the surface of a substrate, forming a continuous, adherent coating. Several grades of ferrites are available to match different substrates. Samples can be produced on request. Stackpole Carbon Co., Electronic Components Div., St. Marys, Pa. 14857.

Circle 300 on Inquiry Card

PASTE SOLDER

For soldering stainless steel.

New solder, WCA, is for soldering 300 and 400 series stainless steel as well as other "hard-to-solder" base metals. WCA is effective in removing oxides from 300°F to 525°F. It is available with all standard soldering alloys such as the popular tin/lead, tin/silver, and tin/antimony classes. Fusion Inc., 4658 E. 355th St., Willoughby, Ohio 44094. (216) 946-3300.

Circle 297 on Inquiry Card

CHIP CAPACITOR

TC is 0±30 ppm (−55° to +125°C).

ATC 700 series NPO porcelain chip units measure 50 x 110 mils. Capacity range is 0.1 to 1500 pF; working voltage, 50; tol. 5, 10, and 20. Rugged silver metallization doesn't leach off when soldered. Pre-soldered terminations are also available for re-flow mounting. American Technical Ceramics, 1 Norden Lane, Huntington Sta., N.Y. 11746. (516) 271-9600.

Circle 299 on Inquiry Card

GENERAL PURPOSE RELAY

Switches low level loads below.

This bifurcated contact version of the company's KHP relay is enclosed in a white nylon dust cover. It is offered with DPDT or 4PDT contacts and coils for 6 to 120 V ac or dc operation. Relays of this design will be available at single lot prices of $5.75 to $6.85. Potter & Brumfield, Princeton, Ind. 47570. (812) 385-5251.

Circle 301 on Inquiry Card

Using spot ties for wire harnessing?

HERE IS THE GUDEBROD SYSTEM "S"

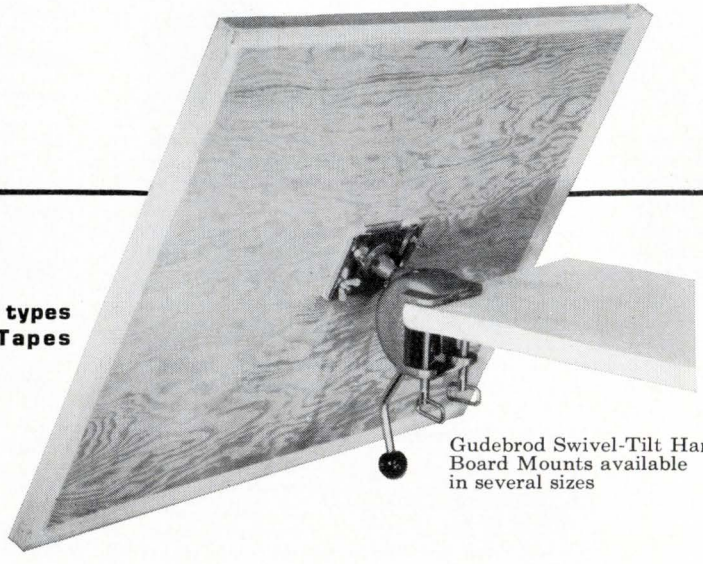
—SPEEDS THE WORK—SAVES MONEY, TOO!

GUDE-TIES CUT LENGTHS—Specifically produced for spot knotting these handy cut lengths of Gudebrod Flat Braided Lacing Tape are dispenser packaged for one hand, speedy withdrawal. Available in 6″, 8″, 10″, 12″, 15″, 18″, 20″ and 22″ lengths (other lengths on order). Meet or exceed MIL-T Specs, no-slip knots hold firmly without cutting insulation.

GUDE-SNIPS—These palm-of-the-hand snips cut cleanly, easily. For right or left hand use, spring action, DuPont Teflon bearing. Allow operator to have free use of fingers without constant reaching for knife or shears. Save motion, save time.

GUDEBROD SWIVEL-TILT HARNESS BOARD MOUNT—Balanced, two dimensional action brings every section of the harness within easy reach. No stretching, no straining. Knots are tied in an easy, natural position. Cuts fatigue—speeds work.

Here you have the Gudebrod System "S" for spot tie lacing, based on the high quality, high speed Gudebrod Lacing Tape—if you're interested in saving money while speeding the harness work, get in touch with us. (For continuous tying, ask about System "C".)



Gudebrod Swivel-Tilt Harness Board Mounts available in several sizes

Available also in other types of Gudebrod Lacing Tapes

GUDEBROD
Electronics Division

GUDEBROD BROS. SILK CO., INC. Founded 1870, 12 South 12th Street, Philadelphia, Pa. 19107

THE ELECTRONIC ENGINEER

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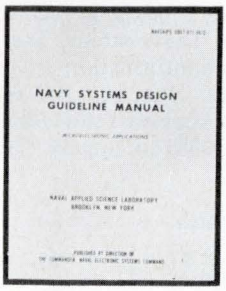
LITERATURE

Navy manual for microelectronics

If you use integrated circuits—whether the equipment you design is for the Navy or not—you'll find this Navy guidelines manual very helpful. Actually, the manual does not tell you how to design with microelectronic circuits. In that respect, it resembles more a course on microelectronics than a design manual. But, since it states specifically the types of microelectronic circuits and packages it recommends for the Navy, it will save you many



false starts. Included is material on manning, support, repair and maintenance important in Navy contracts and unavailable elsewhere. You can obtain a copy (while they last) of "Microelectronic Applications" Navy systems design guidelines manual, by writing on your company letterhead to Mr. Thomas E. McDuffie, Project Engineer, Naval Applied Science Lab., Brooklyn, N.Y. 11251. In addition to (not instead of) your letter,

Circle 322 on Inquiry Card

Software controlled system

A software package for a computer-operated circuit test system, designated the P484, is discussed in a 20-page catalog. Designed for applications in manufacturing and use of ICs, circuit boards and other circuit modules, the software package's salient features are listed. Testing procedures are described in the literature and operational illustrations are provided. Teradyne, 183 Essex St., Boston, Mass. 02111.

Circle 323 on Inquiry Card

Transistor chips

A 6-page catalog (CN-164) describes 26 different silicon planar epitaxial transistor chips for use in hybrid circuits. Probed-parameter electrical characteristics are listed, physical geometries are clearly illustrated and dimensions are included. Sprague Electric Co., North Adams, Mass. 01247.

Circle 324 on Inquiry Card

Connector wall chart

A comprehensive pin and socket connector and assembly tool wall chart includes specs and applicable circuit requirements for six rack-and-panel connector families. The chart contains photographs, line drawings, electrical characteristics and mechanical specs on the company's 17 series Min-Rac® connector line. The chart is fully cross-referenced by general application area. Amphenol Industrial Div., Bunker-Ramo Corp., 1830 South 54th Ave., Chicago, Ill. 60650.

Circle 325 on Inquiry Card

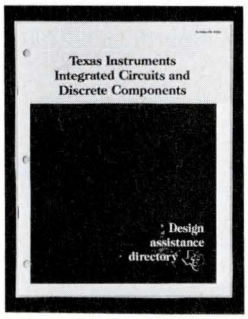
Test instruments

A 16-page bulletin (2080) introduces five new instruments and gives complete operating specs for equipment serving needs for industrial electronic and electrical testing, including radio and TV servicing, communications, air conditioning, refrigeration and heating. Instruments described include a model 202 Accu-Log VOM, portable chart recorders, multi-testers, a current leakage tester and a solid state VOM. Simpson Electric Co., Div. of American Gage & Machine Co., 5200 W. Kinzie St., Chicago, Ill. 60644.

Circle 326 on Inquiry Card

Design directory

A compilation of literature and services offered by Texas Instruments is contained in bulletin CM-102A. The 12-pager briefly describes the resources available, contains an explanation of their specific purposes and provides information on how to obtain them. An

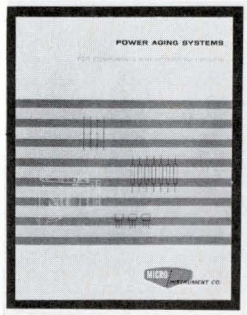


index guide to TI's application reports and notes is included, as is a comprehensive summary of the application publications. Texas Instruments, Inc., MS 308, Box 5012, Dallas, Tex. 75222.

Circle 327 on Inquiry Card

Precision instrumentation testing

A compendium of advanced testing and measuring devices describes power aging systems for components and ICs. Various life test systems are dis-



cussed and components and specs are included for each. Micro Instruments, 12901 Crenshal Blvd., Hawthorne, Calif. 90250.

Circle 328 on Inquiry Card

Power supply catalog

A 76-page catalog lists over 3,500 models of power modules and includes prices and application photos. The catalog features the company's new 60 Hz to dc model R line and new dc to 60 Hz model P and K lines. Hermetically sealed modules for aerospace applications, meeting, for example, Mil-E-5272C and Mil-E-5400 requirements, are also available. Abbott Transistor Labs. Inc., 5200 W. Jefferson Blvd., Los Angeles, Calif. 91106.

Circle 329 on Inquiry Card

Mounting PC boards

A 4-page data sheet describes a new and efficient way to mount PC boards to metal panels and chassis by using teflon spacer/bushings. Each item is fully described, and photographs, drawings, tables and schematic diagrams show how to install the spacer/bushings. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543.

Circle 330 on Inquiry Card

Relays

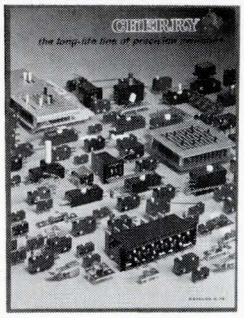
A 44-page catalog presents a complete line of mercury-wetted, mercury-displacement and dry-reed relays. General information is given for each line, and charts and illustrations provide detailed information on each product. Adams & Westlake Co., Sub. of Allied Products Corp., 1025 N. Michigan St., Elkhart, Ind. 46514.

Circle 331 on Inquiry Card

LITERATURE

Precision switches

Photographs, cutaway illustrations, descriptions, detailed specifications and application data for hundreds of standard switches and variations comprise a new 44-page catalog. A major part of the catalog is devoted to coil



spring snap-action switches and includes a switch selector-locator plus 20 pages of snap switch terminology and data. Cherry Electrical Products Corp., 1650 Old Deerfield Rd., Highland Park, Ill. 60035.

Circle 332 on Inquiry Card

Breadboard data

A versatile solderless breadboard providing over 2,000 instant plug-in tie points for use with all dual-in-line packages, TO-5's and discrete components is described in a 2-page data sheet. The sheet lists all dimensions and component capacity as well as materials specs. AP Inc., 72 Corwin Dr., Painesville (Cleveland), Ohio. 44077.

Circle 333 on Inquiry Card

MPP cores

A 76-page catalog and designer's guide on moly permalloy powder cores offers pertinent technical information to the design engineer. Charts and tables state the physical and electrical specs for 25 standard-sized cores, and "Q" curves show permeability available with each size. Arnold Engineering Co., Box "G," Marengo, Ill. 60152.

Circle 334 on Inquiry Card

Thru-lug terminals

Dimensions and specs for a line of thru-lug, double-ended, through-the-board terminals used for wire-wrapping or solder connections are discussed in a 2-page bulletin. Also offered is a series of bench presses tooled to meet customer needs. Berg Electronics Inc., New Cumberland, Pa. 17070.

Circle 335 on Inquiry Card

Microwave calibrations

What is the total (rms) uncertainty of the time and frequency standards at the National Bureau of Standards? It's 4.7 parts in 10^{12}. How many microwave standards does NBS have, what is their accuracy, and how many calibration services does NBS offer for microwave instrumentation? For the answers to these and other questions on rf measurements, get NBS' Technical Note 373, "Radio-frequency measurements in the NBS Institute for Basic Standards," sold for $1 by the Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

High voltage capacitors

Capacitors used in high voltage circuits of various types of electronic and electrical equipment are discussed in catalog MP101. The capacitors employ a solid dielectric system of reconstituted mica and thermo-setting resin and are suggested for military

and industrial applications. The reference provides environmental characteristics, salient features and applicable military specs for the capacitors. Performance curves, design data and type designations are included. Axel Electronics, Inc., 134-20 Jamaica Ave., Jamaica, N. Y. 11418.

Circle 336 on Inquiry Card

Electronic hardware

Solder terminals, insulated terminals, panel hardware, chassis hardware and related tooling are illustrated in a 33-page handbook in an "easy to specify" engineering drawing style. Information is given on Mil-T-55155 terminals, time-proven industry-standard terminals, spacers, handles and clinch nuts, all of which are stocked parts. Electronic Hardware Div., Positronic Industries Inc., 1906 Stewart Ave., Springfield, Mo. 65804.

Circle 337 on Inquiry Card

Defects in epitaxial wafers

The various defects occurring during epitaxial growth on silicon and their possible causes are described and classified in a 6-page article. Photomicrographs of representative silicon surface layers accompany the study. William J. Hacker Co. Inc., Box 646, West Caldwell, N.J. 07007.

Circle 338 on Inquiry Card

Ag/AgCl and hybrid electrodes

Product bulletin 123 (4 pages) introduces a family of sintered silver/silver chloride and hybrid electrodes for precision bioelectric recording and stimulation. Descriptions, applications and ordering information are included. Vivo Metric Systems, 10709 Venice Blvd., Los Angeles, Calif. 90034.

Circle 339 on Inquiry Card

Test methods

An 8-page booklet is suggested as a reference for testers and designers of rf equipment. Titled Test Method and Interfacing Notes, bulletin #102 has been prepared to aid engineers in the application of products and their subsequent testing. Schematics are included. Vari-L Co., Inc., Box 1433, Stamford, Conn. 06904.

Circle 340 on Inquiry Card

Negative drafting system

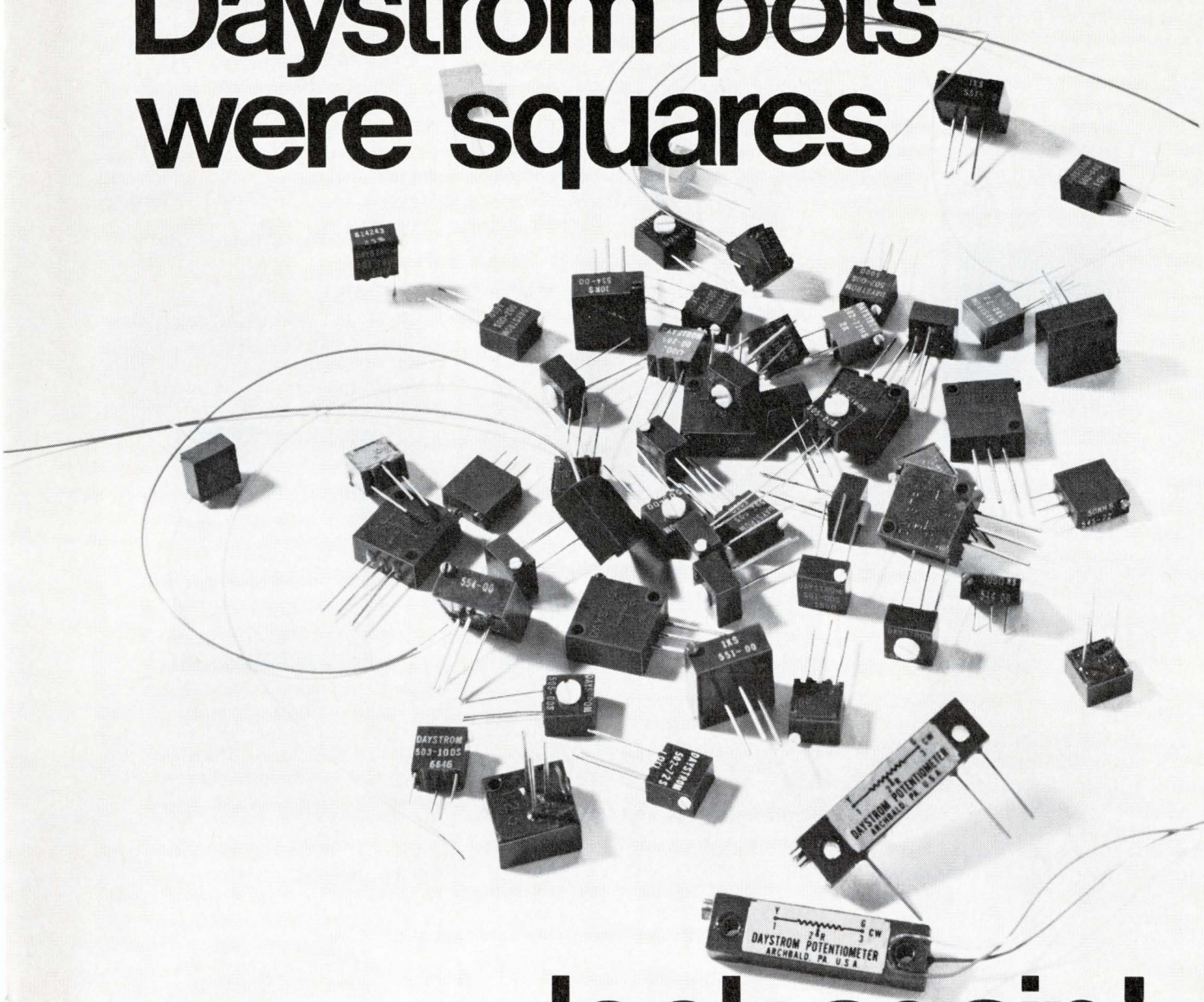
Technical bulletin 1002 (8-pages) describes and illustrates a new method of making negative artwork for printed wiring board prototypes without photography by using negative drafting symbols, components and opaque masking. The method allows the de-

signer to coat a copper-clad board with photoresist, to expose, develop and etch it, and to come up with a printed wiring board ready for drilling and assembly in as little as 90 minutes. Bishop Graphics, Inc., 7300 Radford Ave., North Hollywood, Calif. 91605.

Circle 341 on Inquiry Card

Circle 52 on Inquiry Card ⟶

If you thought all Daystrom pots were squares



...look again!

Rectilinear components are still a necessary requirement in many circuit applications. That's why Weston has rounded out its high-performance potentiometer line with two new rectilinear models. RT-12 styles 534 and 535 are designed for both general-purpose and military applications. They feature the same ±5% tolerance, 10 ohm to 50K range, and slip clutch stop protection that are standard with Daystrom Squaretrim® units, plus 24-turn adjustability and humidity proofing. Also new this year . . . models 553 half-inch and 543 three-eighth-inch Squaretrim potentiometers in military and commercial versions. Save board space as well as money with our field proven 501 Series multi-turn and 504 Series single-turn 5/16" Squaretrims offering values to 20K in a 0.02 cubic inch case. All Squaretrim Diallyl-Phthalate cased pots give you Weston's patented "wire in the groove" construction and your choice of flexible leads, pin and screw configurations. Whether your trimmer needs are military, industrial or commercial, you'll find the answer in this complete new low-cost line. Write today for data sheets and evaluation samples. DAYSTROM potentiometers are another product of WESTON COMPONENTS DIV., Archbald, Pennsylvania 18403, Weston Instruments, Inc., a Schlumberger company

WESTON®

LITERATURE

Electronic buyer's guide

A 1970 catalog of electronic equipment for industry and government lists a wide range of items for R&D, production, communication, education and controls. More specifically, the 600-pager lists IC devices, semiconductors, relays, transformers, resistors and various other electronic components. Other products in the roundup

include test instruments, power supplies and electronic counters. Specs, descriptions and illustrations are provided for each device. Featured in the catalog are a product index, a manufacturer's index and an index of products that meet military specs. Allied Electronics Corp., Box 8528, Chicago, Ill. 60680.

Circle 342 on Inquiry Card

Laser diodes

A data file comprised of six data sheets provides information on gallium-arsenide laser diodes, diode arrays, pulse generators and dc-dc converters. Included in the data are performance characteristics of the diodes and arrays and operating characteristics of the generators. The components are represented by photographs and dimensional outlines, and their operation is described in full. Laser Diode Labs., Sub. of The United Corp., Dept. B, 205 Forrest St., Metuchen, N.J. 08840.

Circle 343 on Inquiry Card

Process computer

The GE-PAC 30 mini-process computer series is the subject of a 16-page bulletin (GEA-8838). The bulletin describes equipment that employs ICs for high reliability in real-time applications. The series offers a choice of standard or custom read-only memories and uses plug-in modules for easy field modification. General Electric's Process Computer Dept., 2255 W. Desert Cove Rd., Phoenix, Ariz. 85029.

Circle 344 on Inquiry Card

Multiconductor cables

A 2-page data sheet describes a family of kits containing assortments of miniature multiconductor cables for use in research and product development labs. Six kits are described, each containing a different assortment of cables in sufficient quantities to aid in the development of prototypes. Caltron Industries, 2015 Second St., Berkeley, Calif. 94710.

Circle 345 on Inquiry Card

IC test rate increase

The development of plug-in input-output turrets enables the company's type 852 IC sorter to test and sort ICs up to 7,200 per hour. This new unit is described in a 2-page bulletin complete with photos and a brief description of its operation and construction. Daymarc Corp., 40 Bear Hill Rd., Waltham, Mass. 02154.

Circle 346 on Inquiry Card

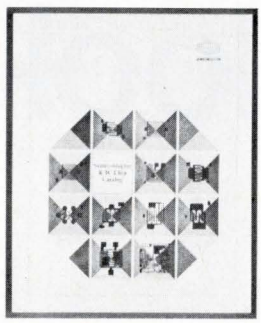
Relay and reed switches

A 4-page catalog introduces a line of mercury-wetted relays, reed relays, and reed switches. Contact ratings and operating parameters are given for each as well as physical characteristics and life and reliability data. New Product Engineering, Inc., Sub. of Wabash Magnetics, Wabash, Ind. 46992.

Circle 347 on Inquiry Card

Semiconductors and IC chips

This 6-page catalog describes silicon chips and wafers, and lists 13 separate categories of transistors and ICs with their type numbers and important parameters. Fifteen chip-die diagrams are illustrated with size and thickness



information. The catalog also covers parameter testing, shipping package information, AQL levels and customer services. Union Carbide Corp., Semiconductor Dept., Box 23017, 8888 Balboa Ave., San Diego, Calif. 92123.

Circle 348 on Inquiry Card

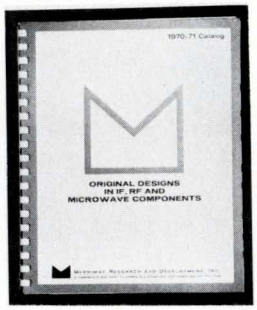
Metallizing process

Low temperature metallizing techniques for alumina ceramics and other dielectric materials are described in a 9-page bulletin (#18). The processes discussed are primarily for plating nickel on non-conductive materials. However, other applications are covered. Detailed instructions and procedures of the processes are included. Transene Co., Inc., Route 1, Rowley, Mass. 01969.

Circle 349 on Inquiry Card

Components

Rf, i-f and microwave components are the subject of a 100-page catalog containing complete price and technical information on the entire line. The catalog is divided into product



sections covering such items as quadrature (90°) hybrids, hybrid junctions, attenuators and mixer and phase comparators. Merrimac Research and Development Inc., 41 Fairfield Place, West Caldwell, N.J.

Circle 350 on Inquiry Card

Silicon power transistors

A 4-page catalog contains listings of a complete line of diffused mesa silicon NPN power transistors and radiation-hardened silicon NPN power transistors. Also included in the catalog are case drawings of the transistors giving complete dimensions and specs. Power Physics Corp., Industrial Way West, Box 626, Eatontown, N.J. 07724.

Circle 351 on Inquiry Card

Sealants for high vacuum work

Bulletin 43 deals with such sealants as oils, greases and waxes. The 8-pager provides a selection source of the right grade for a particular application. Salient features of the products are discussed along with suggested applications and technical data. James G. Biddle Co., Plymouth Meeting, Pa. 19462.

Circle 352 on Inquiry Card

Hybrid computation

Designated the EAI 590, a computing system, which is said to have the capability to handle a broad spectrum of scientific computation, is described in a 16-page brochure. The system combines analog and digital computing elements for greater efficiency, while allowing each subsystem to function independently. Suggested applications are included in the catalog. EAI, Inc., West Long Branch, N.J. 07764.

Circle 363 on Inquiry Card

RFI shielding tests

A 5-page report contains test findings on the effectiveness of foam/foil laminate RFI shielding. The sample tested was composed of a laminate of self-adhesive foam and beryllium copper foil designed to reduce RFI shielding problems found in modular compartment communications equipment. Results of the tests are included in the booklet, as is a shielding effectiveness level chart. Tapecon Inc., Box 4741, 475 River St., Rochester, N.Y. 14612.

Circle 364 on Inquiry Card

Magnetic tapes

Five new magnetic tapes designed to fulfill the requirements of today's technology are described in five 4-page brochures—bulletin kit 1652S. The products discussed include wideband instrumentation recording tape, "A" oxide audio magnetic recording tape. "B" oxide audio magnetic recording tape. "A" oxide standard telemetering and "B" oxide extended range telemetering. Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif. 91109.

Circle 365 on Inquiry Card

Biomedical research procedure

Catalog LS-100 describes an electromechanical procedure, coupled with pulsed constant-power polarization, which results in high resolution electrophoresis for biomedical research. Included in the description is a discussion of the equipment used in the process. Those involved in any kind of research, and specifically biomedical, should find this booklet a useful and informative reference. Ortec, 1000 Midland Rd., Oak Ridge, Tenn. 37830.

Circle 366 on Inquiry Card

Dielectric materials

A line of thermally conductive dielectric materials is described in a 4-page folder presenting illustrated application data on each product and information on typical uses, mix preparation and cure temperature. The products are designed especially for bonding, encapsulating, coating or sealing with electrical/electronic components where a high rate of heat transfer is a consideration. Emerson & Cuming Inc., Canton, Mass. 02021.

Circle 367 on Inquiry Card

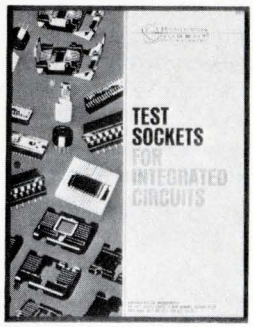
Semiconductor measurement

"Methods of Measurement for Semiconductor Materials, Process Control and Devices" is a 45-page booklet that will be of great use to readers involved in the evaluation of seminconductor reliability. It touches, for example, on little understood areas such as the evaluation of ultrasonic wire bonds and the measurement of inhomogeneities that affect silicon. Well worth the 50 cents it costs from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., ask for NBS Technical Note 495.

LITERATURE

Test sockets for ICs

This 12-page catalog introduces a new product line for the engineer concerned with fast, reliable test or temperature aging of ICs. All sockets, carriers and devices cataloged are specifically built for the easy insertion of devices over many thousands



of cycles with no loss of contact performance or device damage. A variety of accessories and universal type sockets are also included. Robinson-Nugent Inc., 800 E. Eighth St., New Albany, Ind. 47150.

Circle 353 on Inquiry Card

Computer terminal

A computer terminal that combines plotting and typing capabilities in a single mechanism is described in an 8-page technical brochure. The brochure contains specific examples of the terminal's plotting and typing capabilities, application information and a description of the software. Typagraph Corp., 7525 Convoy Court, San Diego, Calif. 92111.

Circle 354 on Inquiry Card

PC connectors

Complete with PC connector index, a 52-page guide describes a metal-to-metal connector series that conforms to Mil-C-5400, Mil-E-8189 and Mil-T-21200. Available connector types are discussed in detail with salient features and specs for each. Elco Corp., Research and Engineering Center, 155 Commerce Dr., Fort Washington, Pa.

Circle 355 on Inquiry Card

Aluminum knobs

A new 8-page catalog lists an expanded line of machine aluminum anodized knobs. Types of knobs included are standard series, concentric, spinner, skirted and knurled models, and sizes available are ½ in., ¾ in., 1 in., and 1¼ in. Natural, black, gold or two-tone models are available. Alco Electronic Products Inc., Box 1348, Lawrence, Mass. 01842.

Circle 356 on Inquiry Card

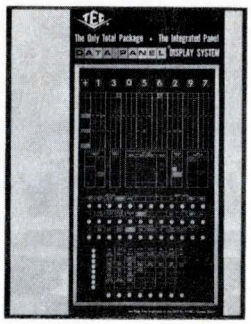
Strips for shielding and sealing

Conductive strips for EMI/RFI shielding, sealing, grounding and static discharge, are the subject of a 2-page data sheet, EMC 853. The material used in the strips is Consil, which is a composite, homogeneous material consisting of a lattice structure. It performs in temperature ranges of −65°F to +450°F and will not deteriorate electrically or become brittle in this aging environment. Spec tables are included in the literature as are physical and electrical properties. Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J.

Circle 357 on Inquiry Card

Information display system

Completely flexible information display panel systems for computers, process control or any system requiring man-machine interface are illustrated in this 12-page brochure. Complete information is provided on



the Data-Panel® Display System. Electrical/electronic interface capabilities are described, and illustrations show mechanical mounting and bezel options. Special Display Systems Mkt. Dept., TEC Inc., 6700 S. Washington Ave., Eden Prairies, Minn. 55343.

Circle 358 on Inquiry Card

Corona test report

A 55-page evaluation report on the performance and reliability of improved capacitors of Mylar dielectric has been prepared. The report includes photographs of corona and resulting acoustic activity at different voltage levels. Also included are results of several 60 Hz ac and dc life tests with the temperature both cycled and static, and the results of a physical environmental test program. Requests for copies should be made on company letterhead and addressed to Sales Dept., Electro Motive Mfg. Co., Willimantic, Conn. 06226.

Basic switches

This 6-page "ABC guide to Micro Switch basic switches" will help you to determine both rapidly and accurately the switch that will meet your requirements. Ten switches are illustrated and described, and a handy chart keyed to application needs helps you in the selection of your "basic switch solution." Micro Switch, Div. of Honeywell, Freeport, Ill. 61032.

Circle 359 on Inquiry Card

Stepping motors

Twenty new, stock model, stepping motors designed to position loads remotely in 20° or 30° increments are the subject of an 8-page catalog. Both unidirectional and bidirectional versions are discussed, and tables and graphs show performance characteristics under varying operating conditions. Ledex Inc., 123 Webster St., Dayton, Ohio 45402.

Circle 360 on Inquiry Card

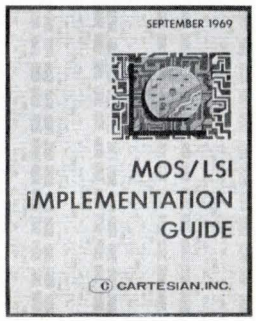
Components for communications

A 6-page article reprint describes and illustrates the use of bridges in quality control testing of communication components. Details on applications of the manufacturer's bridges, signal generators and detectors for capacitance measurements and for measurements of inductances are included. Siemens America, Inc., 350 Fifth Ave., New York, N.Y. 10001.

Circle 361 on Inquiry Card

MOS/LSI implementation guide

For those interested in designing their own MOS/LSI circuits and having masks and wafers fabricated by an outside source a new 12-page guide is available. The brochure covers tech-



nical aspects of MOS electrical characteristics, process parameters, design guidelines, design situations to avoid and suggested input protection. Cartesian Inc., 10432 North Tantau, Cupertino, Calif. 95014.

Circle 362 on Inquiry Card

Noise measurement

"How to Characterize and Measure Noise in Operational Amplifiers" is an 8-page paper giving you a unique outlook on the complex problems associated with noise measurement. The paper touches on such subjects as types of noise encountered, how to measure and minimize noise, noise specsmanship, noise problems in typical applications and test circuits for measuring noise. Applications article P/N-10. Philbrick/Nexus Research, Allied Dr., Dedham, Mass. 02026.

Circle 368 on Inquiry Card

Research seminar series

A 37-page publication contains a brief discussion of the topics dealt with at Owens-Illnois Technical Center during 1968. Subjects covered in technical depth at the seminar included experiments, ideas, hypotheses, theories and literature references pertaining to the scientific and engineering disciplines. Research Seminar Committee, The Research Library, Owens-Illinois Technical Center, Box 1035, Toledo, Ohio 43601.

Circle 369 on Inquiry Card

Binary ladder network

A 2-page catalog sheet describes the cermet thick film Model 815 binary ladder network. The information is complete with schematic and outline drawings, specifications and performance characteristics. This particular unit is designed for D/A and A/D conversion when a max. of 8-bits is required. Technical Information Section, Helipot Div., Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 370 on Inquiry Card

Plastic fasteners

Primary specifications, special descriptions and recommended applications for a complete line of fastener types are offered in a 24-page catalog/price schedule. New products have been added to the listing, including such items as molded nylon machine screw hex nuts, phenolic screw spacers and threaded stand-offs, PVC threaded rod and nylon wing screws. Product Components Corp., 13 Washington Ave., Hastings-on-Hudson, N.Y. 10706.

Circle 371 on Inquiry Card

Stepper motors

A new, low cost line of 5-volt, four phase and eight phase permanent magnet stepper motors is featured in a 16-page catalog. Three classifications are described—the ID line for industrial use, the PD line for instrumentation and computer applications, and the SMD line of servo mounts for Mil Spec requirements. Charts and tables illustrate essential design and operating characteristics. A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. 06720.

Circle 372 on Inquiry Card

Ceramic capacitor products

A 12-page catalog describes a complete line of monolithic ceramic capacitors and features the Kemet stable K series and capacitors manufactured to Mil-C-11015D and Mil-C-39014A requirements. These products feature high temperature solder construction, molded epoxy cases and in-process controls and inspections to stricter than Mil requirements. Union Carbide Corp., Electronics Div., Box 5928, Greenville, S. C. 29606.

Circle 373 on Inquiry Card

LITERATURE

Asynchronous buffer memory, with inputs and outputs DTL and TTL compatible, to provide intermediate storage of 32 8-bit digital words, 2-page data sheet. Mostek, 4403 N. Central Expressway, Dallas, Tex. 75205.

Circle 374 on Inquiry Card

Optical coatings, including multi-layer and thin-film, for solid state lasers—2-page data sheet. Korad, Subs. of Union Carbide Corp., 2520 Colorado Ave., Santa Monica, Calif. 90406.

Circle 375 on Inquiry Card

Vacuum fluorescent readouts, to meet requirements of multi-readout displays, feature compact size, greater visibility, reliability and low cost—2-page technical data sheet T438. Marketing services Div., Wagner Electric Corp., 1 Summer Ave., Newark, N. J. 07104.

Circle 376 on Inquiry Card

Cyclic A/D converters (model 850), provides conversion speeds of 1μs or less for 8 bits, don't require a sample and hold, and are asynchronous and accurate to within $\pm 0.2\%$ over the entire range—4 pages. Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304.

Circle 377 on Inquiry Card

Induction motors, including open drip-proof and enclosed fan cooled electric motors, available in standard and special designs. Dept. 14, Dynamatic Div., Eaton Yale & Towne Inc., 3122-14th Ave., Kenosha, Wisc. 53140.

Circle 378 on Inquiry Card

Photofabrication, a process which saves 58% of the cost of making small metal parts, uses a photographically produced master pattern, a photosensitive resist and an etching bath —Bulletin F3-248. Magnetics, Inc., Components Div., Butler, Pa. 16001.

Circle 379 on Inquiry Card

High temperature connectors, designed to meet MIL-C-5015 flameproof test conditions, operate at +35°F, catalog HT-2 (23 pages). ITT Cannon Electric, Div. of ITT Corp., Dept. M, 3208 Humboldt St., Los Angeles, Calif. 90031.

Circle 380 on Inquiry Card

Rotary thumbwheel switches, mini in size and designed without PC boards for use in multi-station (up to 34 stations) assemblies—6 pages. Electronic Engineering Co. of Calif., 1441 E. Chestnut Ave., Santa Ana, Calif. 92702.

Circle 381 on Inquiry Card

Electrical insulation selection chart (2 pages) contains data on various thermosetting electrical insulating tapes for OEM applications—DT-77A. Johns-Manville, Dutch Brand Div., Box HJW-29, 22 E. 40th St., New York, N. Y. 10016.

Circle 382 on Inquiry Card

Tunnel diodes, including amp, detector (back), mixer (back), and switching, are available in germanium, gallium arsenide and gallium antimonide with cutoff frequencies of 50 GHz. Publication 105 (4-pages). Aertech Industries, 825 Stewart Dr., Sunnyvale, Calif. 94086.

Circle 383 on Inquiry Card

Digital computer designed to be integrated into a system, instrument or control loop, features low cost and a programmed system of priority interrupt. Elron Electronic Industries, 9701 N. Kenton Ave., Skokie, Ill. 60076.

Circle 384 on Inquiry Card

Trigate pulse transformers for commercial and industrial SCR triggering applications have been designed for use on PC boards—engineering bulletin 40003B (4 pages). Technical Literature Service, Sprague Electric Co., Marshall St., North Adams, Mass. 01247.

Circle 385 on Inquiry Card

Power supplies, including ac line voltage regulators, and high speed programming units, have been designed for digital and servo system applications—catalog 691 (124 pages). Raytheon Co., Sorensen Operations, Richards Ave., S. Norwalk, Conn. 06856.

Circle 386 on Inquiry Card

Mini indicator lights that don't require added hardware are suggested for confined applications or where weight is an important factor—bulletin 69-005B. Shelly Associates, Inc., 111 Eucalyptus Dr., El Segundo, Calif. 90246.

Circle 387 on Inquiry Card

Metal lugs for stand-off, wiring and tie-point applications meet requirements of MIL-T-55155—catalog 294 (6 pages). Circuit Components Div., Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543.

Circle 388 on Inquiry Card

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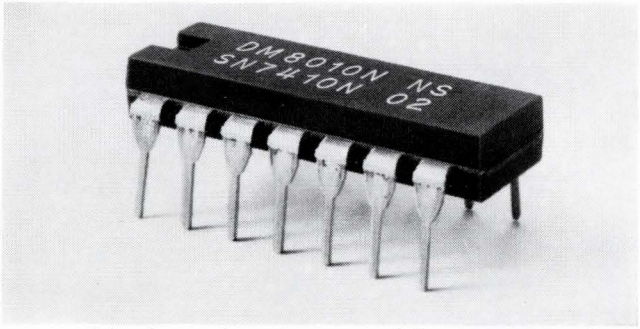
Index to Product Information

Listed below are all products and new literature that appear in this issue, along with the page number they appear on and their Reader Service Numbers (RSN). For more information, see the appropriate page and circle the corresponding number on the reader service card.

Why National Semiconductor buys Teradyne J259's by the dozen

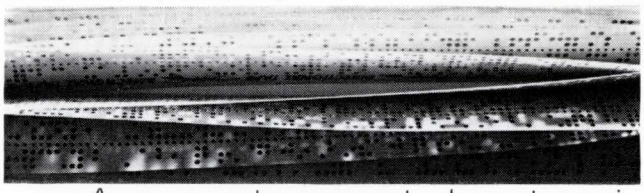
National Semiconductor can trace its considerable success as an IC manufacturer to many factors. One of the most important is the productivity of its testing facility, built around a lineup of 12 Teradyne J259 computer-operated test systems. "The Teradyne systems," according to Jeff Kalb, National's TTL product manager, "give us the economy of testing that is so important to profitable high-volume production."



National, along with most other major IC producers, has found that the J259 boosts productivity in many ways. No other test system, for example, gives its user as much multiplexing freedom as does the J259, which lets National leverage its investment by making each J259 support several test stations doing several different jobs.

Reliability is another all-important key to productivity. National experiences minimal downtime with its J259's. This is as it should be; we design and build our equipment to work shift after shift, year after year, in *industrial* use. Teradyne systems are right at home on production lines like National's, where the workload is heavy and continuous. And operation never has to be interrupted for calibration; the J259 has no calibration adjustments.

The J259's great versatility is also put to good use at National. The same systems that test wafers and packages also generate the distribution and end-of-life data that engineers need to control production processes and ensure high device reliability. Production, engineering, QC, and final test – all share simultaneously in the benefits from National's J259's.



A computer-operated system is only as good as its software, which in the case of the J259 is the best there is. National's J259's are orchestrated by Teradyne-supplied master operating programs for datalogging, classification, and evaluation. As Teradyne updates and improves its software, National is kept fully informed.

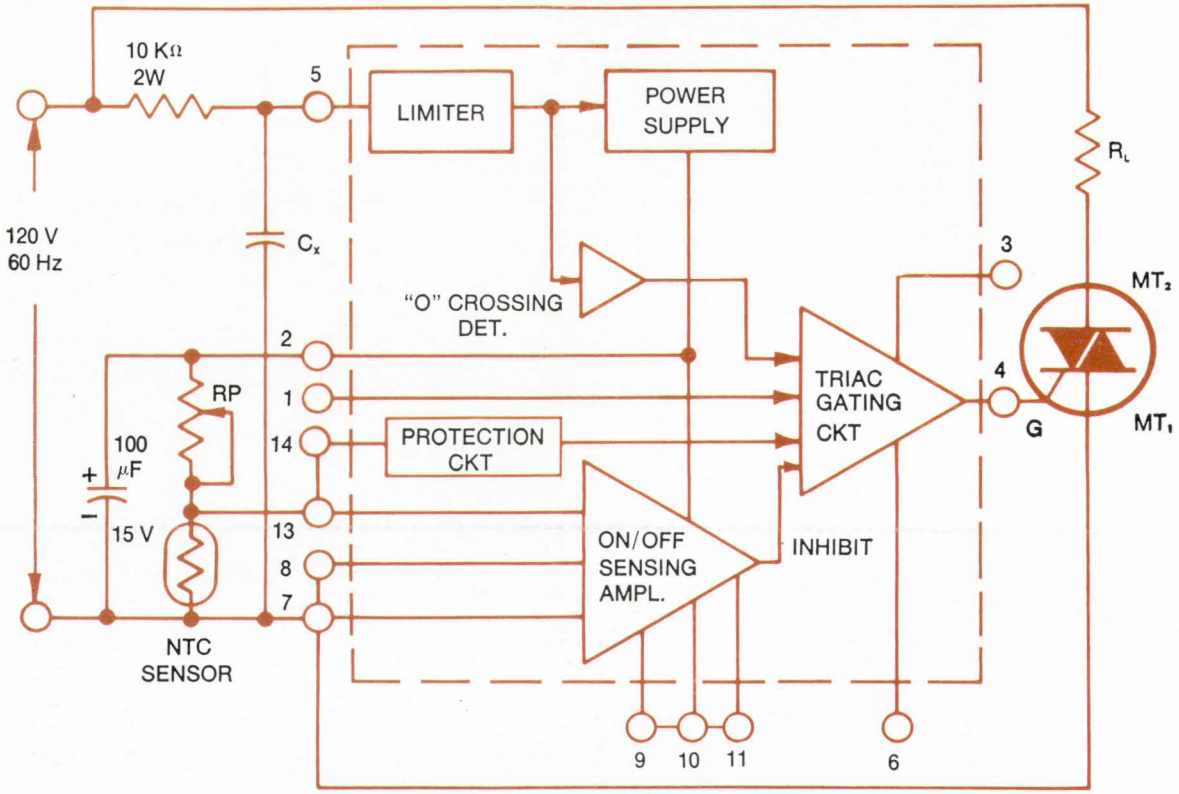
National's array of J259's handle the testing of its digital IC's smoothly and economically. For its linear-IC testing, National has turned to Teradyne's J263 computer-operated linear-IC test system.

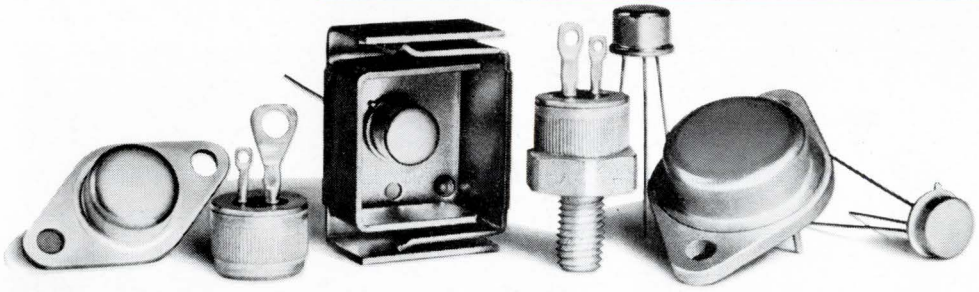
Teradyne's J259 makes sense to National Semiconductor. If you're in the business of testing circuits – integrated or otherwise – it makes sense to find out more about the J259. Just use reader service card or write to Teradyne, 183 Essex St., Boston, Mass.

Teradyne makes sense.

Circle 2 on Inquiry Card

New IC Switch from the Triac Leader





RCA-CA3059 Zero-Voltage Switch for New Economy, New Simplicity in Thyristor Trigger Circuits $1.95 (1000 units)

Here's RCA's economical, new approach to Thyristor triggering—the CA3059 monolithic zero-voltage switch, at $1.95 (1000 units). For efficient triggering of Triacs and SCR's with current ratings to 40 amperes—in applications such as electric heating, motor on/off controls, one-shot controls, and light-flashing systems—CA3059 offers these important new design advantages:

- Triggers Thyristors at zero-voltage crossing for minimum RFI in applications at 50, 60, 400 Hz.
- Self-contained DC power supply with provision for supply of DC bias current to external components.
- Built-in protection against sensor failure.
- Flexible connection arrangement for adding hysteresis control or proportional control.
- External provisions for zero-current switching with inductive loads.
- On/off accuracy typically 1% with 5 kΩ sensor; 3% with 100 kΩ sensor.
- Range of sensor resistance at control point—2 kΩ to 100 kΩ.
- 14-lead DIP package for −40°C to +85°C operation.

For further details, check your local RCA Representative or your RCA Distributor. For technical data bulletin, file no. 397, and Application Note ICAN4158, write RCA Electronic Components, Commercial Engineering, Section J-12 /CA0014, Harrison, N.J. 07029. In Europe, contact: RCA International Marketing S.A. 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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Circle 3 on Inquiry Card