VOL. 17 NO.

Electronic Design 24

OR ENGINEERS AND ENGINEERING MANAGERS

NOV. 22, 1969

Buying instruments can be easy— if you have a complete source of comparative data. This issue's Product Source Directory includes data on 1200 DVMs, oscilloscopes, spectrum analyzers, VTVMs and frequency counters built by more than 100 companies. For specs, prices and other data to make you a better buyer, see pg. D1.

NEW Calibrated TDR with 35 ps risetime and 12.4 GHz sampling in one easy-to-use plug-in

See More... Do More with the HP 180 Scope System! Now, in one measurement, you can find out what, where, and how much—when you design connectors, circuits, antennas, strip lines and similar components. No interpolation or extrapolation needed. Now HP has combined high resolution time domain reflectometry and 12.4 GHz sampling in the HP 1815A double-size plug-in that fits the standard 180A Oscilloscope mainframe or the 181A Variable Persistence and Storage mainframe.

The 1815A in conjunction with the 1817A remote feed-through sampler and the 1106A pulse generator provides calibrated 35 ps risetime TDR—with capability of resolving discontinuities down to *a quarter of an inch apart*. New signal averaging circuitry reduces noise and jitter at a ratio of 2 to 1 or more.

And the 1815A not only provides more accurate answers, it provides them faster and easier. Why waste your valuable time? Get direct readouts in reflection coefficient (rho) and feet (meters optional) for instant answers that previously required time-consuming calculations. Get direct, front panel calibration of dielectric constants for air and polyethylene, or use a variable control to set the dielectric constant between $\epsilon = 1$ to $\epsilon \cong 4$.

In addition, the 1815A/1817A combination can be externally triggered to provide 12.4 GHz (28 ps) sampling capability. The signal averaging technique allows you to use the entire bandwidth capabilities of the plug-in/sampler — undistorted by noise and jitter.

If you don't need the full capability of the 1815A, a lower cost and lower frequency sampling head (1816A) and tunnel diode pulse generator (1108A) are available for 4 GHz 90 ps risetime sampling and 110 ps TDR (60 ps pulses).

Prices: 1815A, $1100; 1817 Remote Sampler, $1500; 1106A Tunnel Diode Pulse Generator, $550; 1816A Remote Sampler, $850; 1108A Tunnel Diode Pulse Generator, $175.

Isn't it time you took a step forward in your oscilloscope measurements? Call your HP field engineer and he'll tell you about the all-solid-state, proven HP 180 scope system, which now includes TDR and sampling. Or, write for data sheet to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

STEP FORWARD

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

INFORMATION RETRIEVAL NUMBER 234

089/6

From near the banks of Loch Walden we bring you a GRrrrand new product, the 1192 - a wee bonnie counter that'll make your pocketbook smile. But don't let its size or price fool you; it's a real performer. For instance, it measures frequency (from dc to 32 MHz), period (single and multiple), time interval, frequency ratio, and, of course, it counts. Units of measurement and decimal point are automatically displayed. As little as 10 mV will trigger its input (up to 25 MHz), and you can control trigger threshold and attenuation. You get better than average stability with its internal crystal oscillator.

The 1192 can be ordered with 5, 6, or 7 digits, with or without BCD output, and for bench or rack use. A new companion scaler, the 1157-B, extends the upper frequency limit to 500 MHz. This unit mounts side by side with the 1192 in a common cabinet to form the 1192-Z.

Prices* for the 1192 range from $575 for the 5-digit bench model without data output to $845 for a 7-digit rack model with data output. Add the scaler for another $850. That gives you a 500-MHz counter for as low as $1425. How's that for a bonnie bargain? If you order two or more, the unit cost is even less with GR's quantity-discount plan. Discounts range from 3% for 2-4 units to 20% for 100 units.

For free literature (postpaid) or an all-expense-paid demonstration, write or call General Radio Company, West Concord, Massachusetts 01781; telephone 617 369-4400. In Europe (except Scotland), write Postfach 124, CH 8034 Zurich 34, Switzerland. In Scotland, write General Radio Company (U.K.) Limited, Bourne End, Buckinghamshire, England, for special attention.

*Prices apply only in the USA.

GENERAL RADIO

Wee Bonnie Counter

You SEE what you're measuring when you use our 710/800 Spectrum Analyzer for waveform analysis . . . you BELIEVE what you're measuring, because the CRT display is completely calibrated—in volts/cm or 10 dB/cm vs. frequency over the entire frequency range of 10 Hz to 50,000 Hz.

Point-by-point measurements of complex waveforms are obsolete. With the 710/800 you SEE the entire spectral picture at one time displayed over a 60 dB dynamic range without the use of mechanical drives or external recorders.

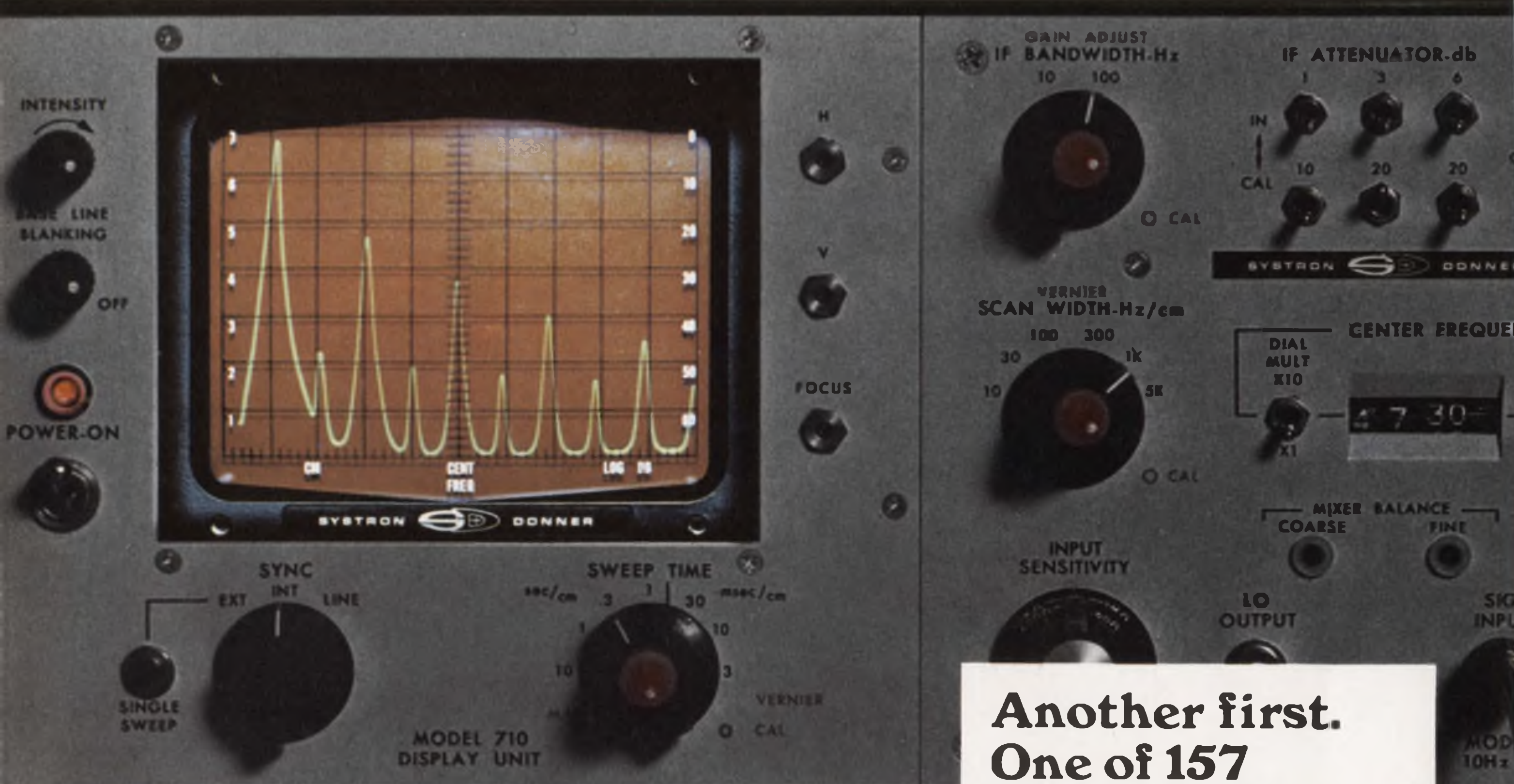
Frequency display adjustment is as simple as a flick of a switch, permitting narrow band (100 Hz) to wide band (50,000 Hz) coverage with 10 Hz or 100 Hz filter resolution.

Selectable input impedance, 30nV sensitivity and internal battery make the truly portable 710/800 one of the most versatile instruments of its kind. And best of all it's priced to fit a wave analyzer budget—$2495.

If your application includes wave analysis or RFI/EMI investigations, see for yourself how the 710/800 can save you valuable time and money. Ask for a demonstration; for literature, call or write Microwave Division, Systron-Donner Corporation, 14844 Oxnard St., Van Nuys, Calif. 91409. Phone (213) 786-1760.

Seeing is believing...

...with the new Model 710/800— a swept wave analyzer with CRT display



Frequency display of 1 kHz triangular wave showing harmonics to 10 kHz.

SYSTRON DONNER

Another first. One of 157 Systron-Donner instruments

- Electronic counters
- Pulse generators
- Microwave frequency indicators
- Digital clocks
- Memory testers
- Analog computers
- Time code generators
- Data generators
- Digital voltmeters
- Spectrum analyzers
- Digital panel meters
- Microwave signal generators
- Laboratory magnets
- Data acquisition systems
- Microwave test sets

Electronic Design 24

VOL. 17 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

NOV. 22, 1969

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover designed by Clifford M. Gardiner, Art Director

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BOURNS INC

12 Ways to Solve *Cermet* POTENTIOMETER PROBLEMS

...All with TC of 100 PPM/°C Standard

Model 3009

3009Y(RJ11) 3009P

- Low Cost Industrial (RJ11 Pin Configuration)
- Power 0.75 watt at 25°C
- Resistance: 10Ω to 1 Meg.

Model 3069

3069P

- Low Cost Industrial
- Mil-Spec Immersion
- Power 0.75 watt at 25°C
- Resistance: 10Ω to 1 Meg.

Model 3282

3282L 3282H 3282P 3282W

- Meets requirements of MIL-R-22097
- Power 0.5 watt at 85°C
- Resistance: 10Ω to 1 Meg.

Model 3012

3012L 3012P

- Meets or exceeds MIL-R-22097, Style RJ11
- Power 1.0 watt at 70°C
- Resistance: 10Ω to 1 Meg.

Model 3052

3052L 3052P 3052S

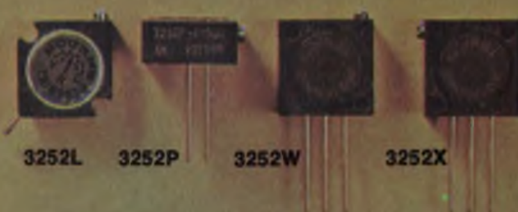
- Meets or exceeds MIL-R-22097, Style RJ12
- Power 1.0 watt at 70°C
- Resistance: 10Ω to 1 Meg.

Model 3262

3262W 3262P 3262X

- Meets or exceeds MIL-R-22097
- Power 0.25 watt at 85°C
- Resistance: 10Ω to 1 Meg.

Model 3252



3252L 3252P 3252W 3252X

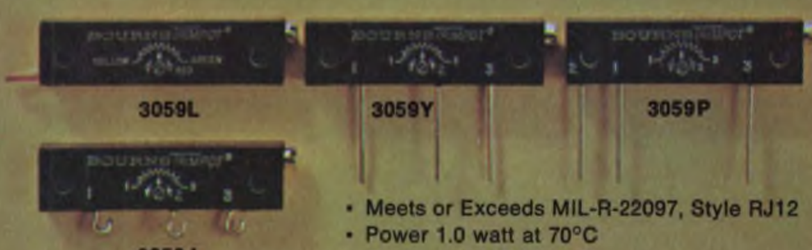
- Meets or exceeds MIL-R-22097, Style RJ22
- CRV 1.6% over entire resistance range
- Power 1.0 watt 70°C
- Resistance: 10Ω to 2 Megs.

Model 3099

3099

- First Dual In Line Cermet Available
- Std DIP size (TO-116)
- Sealed to meet MIL-R-22097 Immersion
- Power 0.75 watt at 25°C
- Resistance: 10Ω to 1 Meg.

Model 3059



3059L 3059Y 3059P 3059J

- Meets or Exceeds MIL-R-22097, Style RJ12
- Power 1.0 watt at 70°C
- Resistance: 10Ω to 1 Meg.

Model 3292

3292L 3292P 3292W 3292X

- Meets or exceeds MIL-R-22097, Style RJ24
- Power 0.5 watt at 85°C
- Resistance: 10Ω to 1 Meg.

Model 3082

3082P

- Only .10″ x .15″ x .50″
- Power 0.3 watt at 85°C
- Resistance: 10Ω to 1 Meg.

Model 3329

3329P 3329H 3329W

- First Commercial single turn to meet or exceed MIL-R-22097
- Only 0.25″ dia. x 0.18″ high
- Power 0.5 watt at 70°C
- Resistance: 10Ω to 1 Meg.

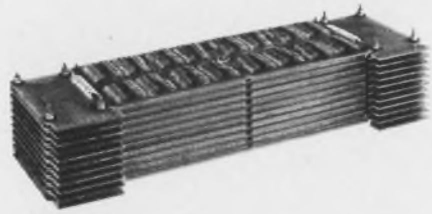
For a detailed package of technical data on the entire line of TRIMPOT® cermet potentiometers write or call the factory, your local field office or representative!

BOURNS

INFORMATION RETRIEVAL NUMBER 4

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

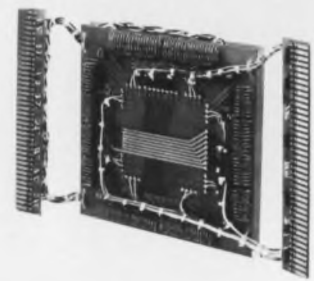
High speed commercial memory system — **NANOMEMORY 2600**. Full cycle time of 600 nanoseconds, and word capacities of 16K by 18 or 8K by 36. It's all done with a second-generation 2-1/2D drive system with efficient circuit and logic design, for reduced component count and high MTBF, and wide operating margins — the real feature of the 2-1/2D configuration. It is easily expandable in the field, and comes in a standard 19" rack.



Perfect for high speed, large capacity mainframe memory systems... **NANOSTAK 3020**... technology breakthrough in 3W, 2-1/2D stacks. Stackable, compact size is an amazing 25% of competitive planar stacks and offers a significant advantage in form factor for system packaging. Extremely fast 650 nanosecond cycle time for 8K or 16K by 40, or 32K by 20 word memories.

Five new memory cores for your next stack or system. All are medium or high drive, all coincident current, and all are fast switching for your high speed applications. Four new cores available in 18 mil, 20 mil, and two types of 30 mil sizes for use from 0° to 70°C. Also, a new wide temperature range 18 mil core for severe environments of −55° to +100°C.

Compact, ATR compatible memory system **SEMS-6** for use in military and rugged commercial aircraft applications. Reliable performer is optimized around 8K or 16K with maximum capacities of 8K by 40 or 16K by 20. Full cycle time of 2 microseconds, with access time of 700 nanoseconds. Meets MIL-E-5400, low power consumption and lightweight.



Rugged design for ground based mobile equipment, **NANOSTAK 020** commercial memory stack. High speed 850-nanosecond full cycle time for 4K memories. Features 3W, 3D organization with word capacities to 16K by 40. Built-in reliability and dependability. Available with wide temperature range cores for operation in severe environments.

Who else but Electronic Memories could introduce five brand spanking new memories—at once

Only Electronic Memories, the technology leader, could introduce five important new memories at once. Each one offers significant advances to provide you with faster, more reliable, and lower cost memories. Each one is loaded with outstanding new design features to give you faster access, larger capacity, and more economical operation. From cores and stacks to megabit memories, Electronic Memories has the memory products for your next, faster, more powerful computer system. For more facts and figures, just write.

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INFORMATION RETRIEVAL NUMBER 5

INFORMATION RETRIEVAL NUMBER 6 ▶

Bodine helps data devices tell it like it is...

Bodine fractional horsepower drives. Small. Quiet. A complete line designed to power information-handling devices precisely, accurately, dependably. Motors built with all the integrity you've designed into your product—that deliver as specified with fewer callbacks and service problems. If this is the kind of power you're looking for, you'll find no better source.

Over 3,500 standard specifications to choose from. Bodine also builds custom fhp motors to meet design requirements. Our engineers will be happy to help you pinpoint the right one for your particular application need. Computers, business machines, instrumentation, copiers—whatever your product, specify Bodine fhp drives. We've been the power behind the leading products for some 63 years. Write for bulletin. Bodine Electric Company, 2500 W. Bradley Place, Chicago, Illinois 60618.

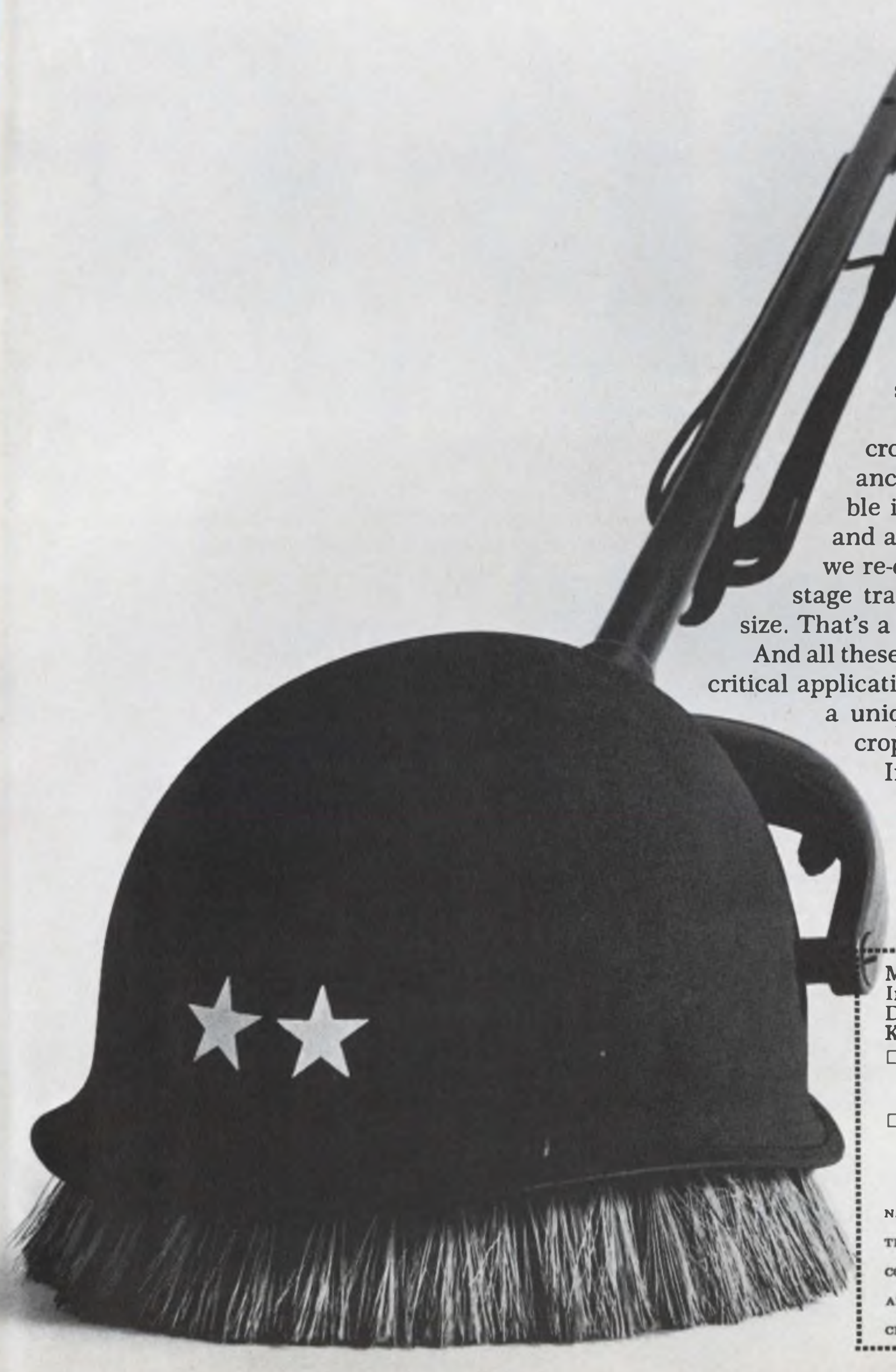
Bodine Motors Wear Out—It Just Takes Longer

BODINE MOTORS/CONTROLS

Ask about Bodine SCR motor speed controls

We polish off miniature ferrite devices no one else can make.

INDIANA GENERAL *We make it easy for the design engineer.*



For a single qualified source for special, difficult to make ferrite assemblies, you'll probably take quite a shine to Indiana General.

We're not competing with the volume suppliers of wound components. Instead, we've got a unique capability that *combines* skills in ferrite materials, design, assembly, and testing.

We've successfully explored cross-field modulators for missile guidance systems; ferrite cross cores in variable inductors for a motor control circuit; and a new, low-pass RFI filter. In one case, we re-designed an existing broadband interstage transformer from TO-5 down to TO-18 size. That's a 5-to-1 size reduction.

And all these projects involved precision-regulated, critical applications. All involved a problem requiring a unique solution. Any time those criteria crop up, chances are you should talk to Indiana General.

Start the conversation with our coupon. And let us consult, or quote, on your next special project assignment. The one no one else will tackle. Even the one that seems impossible.

Mr. K. S. Talbot, Manager of Sales
Indiana General—Electronic Products
Div. of Electronic Memories & Magnetics
Keasbey, New Jersey

☐ Please send me an application form for a miniature ferrite device design evaluation.

☐ Please calculate design possibilities, based on the attached requirements and data: Application description, performance specifications, drawings.

NAME__________

TITLE__________

COMPANY__________

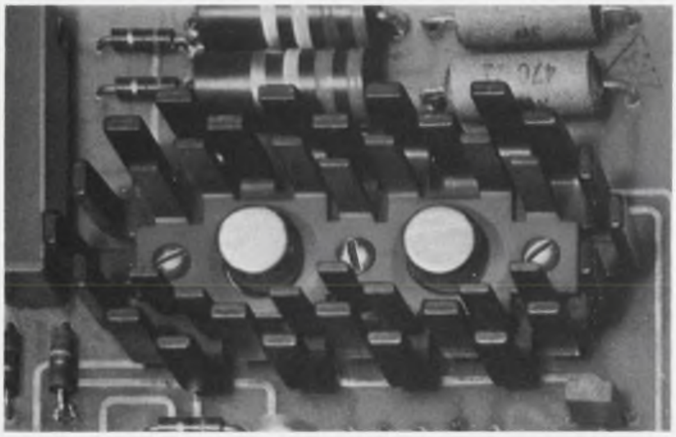
ADDRESS__________

CITY_____ STATE_____ ZIP_____

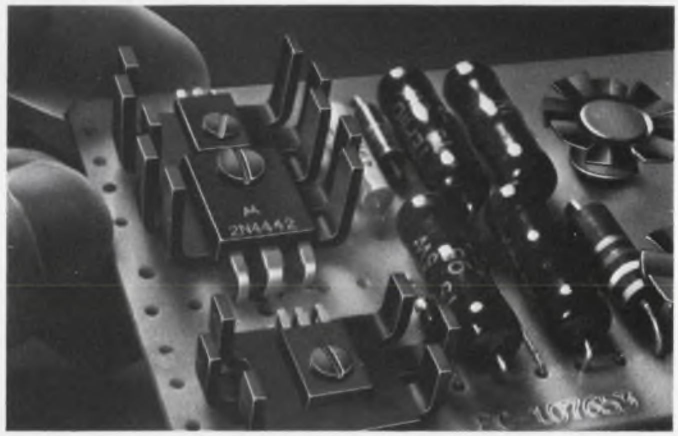
INFORMATION RETRIEVAL NUMBER 7

Tips on cooling off hot semiconductors

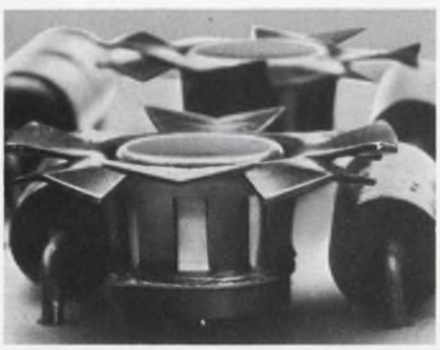
As power levels go up and up and package size shrinks, circuit designers are keeping semiconductors cool with IERC Heat Sinks/Dissipators. Reducing junction temperature gives many benefits: faster rise and fall times, faster switching speed and beta, fewer circuit loading effects and longer transistor life and circuit reliability.



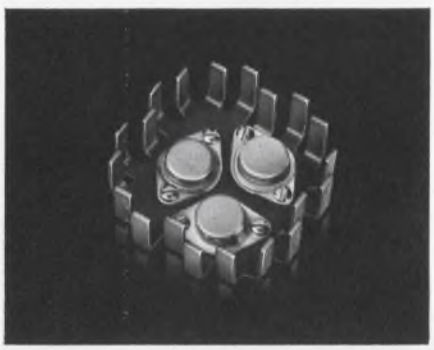
Thermal mating of matched transistors, such as these TO5's shown on a dual LP, maintains matched operating characteristics. The LP's unique multiple staggered-finger design (both single and dual models) maximizes radiation and convection cooling, results in a high efficiency-to-weight and -volume ratio.



Power levels of plastic power devices such as X58's, MS9's, and M386's can be increased up to 80% in natural convection and 500% in forced air when used with PA and PB Dissipators. PA's need only .65 sq. in. to mount; PB's 1.17 sq. in. Staggered finger design gives these light-weight dissipators their high efficiency.



TO5's and TO18's in high density packages can be cooled off with efficient push-on Fan Tops that cost only pennies. T-shaped, need no board room, let other components snuggle close. Spring fingers accommodate wide case diameter variations. Models for RO97's, RO97A and D-style plastic devices also.



High power TO3's, TO66's, TO6's, TO15's, etc. can be operated with much more power when used with HP's. These compact, lightweight staggered finger devices accommodate from one to four TO3's. Provide the same heat dissipation as an extrusion that's three times heavier and one-third larger.

Heat problems? IERC engineers welcome the opportunity to help solve your heat dissipation problems. As the world's largest manufacturer of heat sinks/dissipators for lead and case mounted semiconductors, they can come up with a practical, low cost solution.

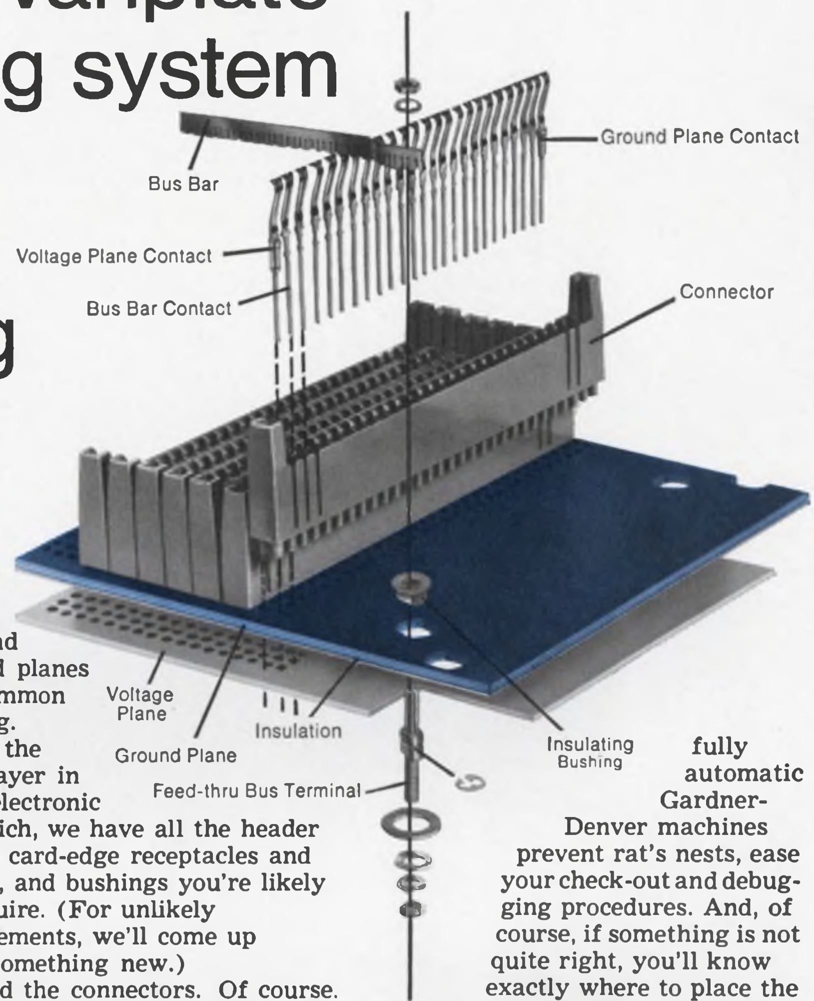
Free four-page Short Form Catalog. Send for your copy today.

Heat Sinks/Dissipators **IERC**

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION / A CORPORATE DIVISION OF DYNAMICS CORPORATION OF AMERICA / 135 WEST MAGNOLIA AVENUE, BURBANK, CALIFORNIA 91502

INFORMATION RETRIEVAL NUMBER 8

How our Variplate™ connecting system keeps your fifty-cent IC's from becoming four-dollar headaches.



IC's don't cost much. Until you use them. You can buy, say 20,000 IC's for the innards of a compact computer, packed in the transistor cans, flat packs, or Dual-in-Line (DIP) packages, for a unit cost of less than fifty cents.

Great.

But then you have to connect them.

Not so great.

Because those 20,000 IC's have anywhere from 200,000 to 280,000 leads waiting to be connected. Fine leads. Closely spaced. And, of course, you want to pack the IC's as densely as possible. So it's really no surprise that your *in-place* cost of an IC can climb to $4.00.

Fortunately, we have a system that can keep your in-place cost down: the Variplate interconnection system.

With the Variplate system, you can pack those IC's—and all the pc boards and other components you have—as densely as the application demands. You can do it on automated equipment—and we'll even do the wiring for you.

All the components you need.

The system begins with the base plate, a self-supporting structural member. It carries the insulated contact modules, accommodates secondary components and hardware, and provides for mounting to support framework.

The plate can be a single metal sheet that provides a ground plane, or it can be a sandwich that provides both voltage and ground planes for common bussing.

For the next layer in your electronic sandwich, we have all the header plates, card-edge receptacles and guides, and bushings you're likely to require. (For unlikely requirements, we'll come up with something new.)

And the connectors. Of course. Our own respected Varimate™, Varicon™, and Varilok™ connectors, or standard fork-and-blade, terminal stud, card-edge, or bus strip contacts. Your choice.

No holes barred.

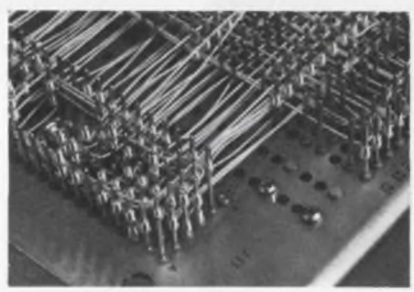
We put all these components together in any size, any shape, and almost any density of package you require. Plates can be any size. Contacts can be spaced on .100″, .125″, .150″, or .200″ centers, in square or offset grids—on non-standard configurations where you need them.

What you get is a solid electrical and mechanical foundation for your electronic network, so precisely made that any automated assembly equipment can take over from there.

However.

You'll save time and money if you let us go one step further and wire your network for you. Our fully automatic Gardner-Denver machines prevent rat's nests, ease your check-out and debugging procedures. And, of course, if something is not quite right, you'll know exactly where to place the responsibility.

Altogether, it's quite a system. And worth all the work we've put into it. Because if we can save you just a nickel on the cost of installing each of your 20,000 IC's you can add a thousand dollars to



your company's profits.

We're sure we can save you that nickel, and more. For more information, write, wire, call, or TWX us for our Variplate interconnecting systems catalog. Elco Corporation, Willow Grove, Pa. 19090. 215-659-7000; TWX 510-665-5573.

ELCO Variplate Connectors

INFORMATION RETRIEVAL NUMBER 9

Visicorder--recording

When we designed our original Honeywell Model 906 Visicorder back in 1956, we didn't start with an idea of how it would work.

We started with the idea of what it should do: give you *immediate* readout of high-frequency analog data.

So instead of using a conventional recording technique (with chemicals, ink or vapor), our Model 906 was designed around a whole, new, unconventional technique . . . of recording on light-sensitive paper, which then developed on exposure to an ambient light.

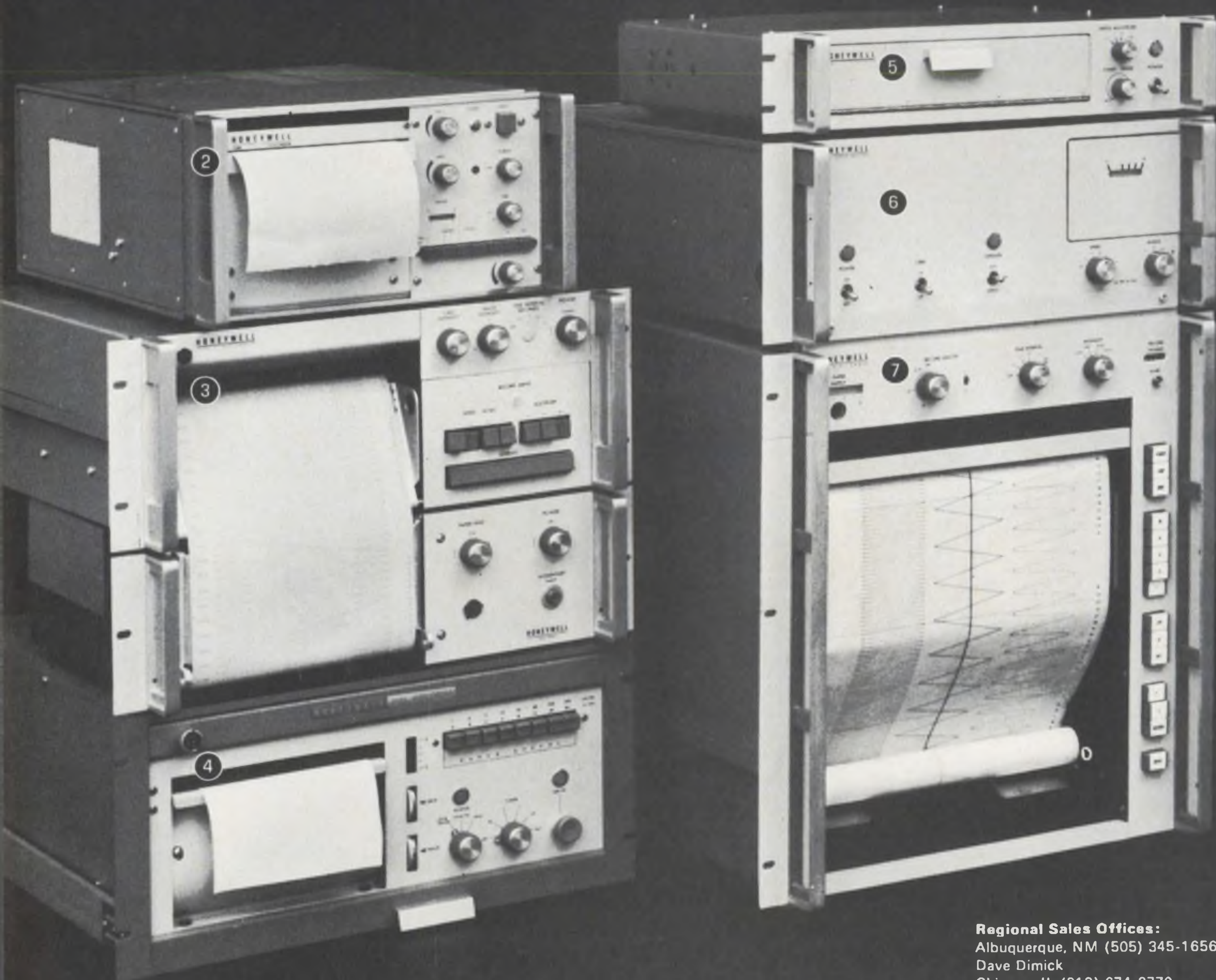
Since then, we have seen this "unconventional" technique become the most widely accepted system in oscillography, an accomplishment that might have been enough to content most manufacturers.

But not Honeywell. We expanded this technique to fit virtually any application, by introducing Visicorders of greater capacity.

Then we introduced Visicorders with added convenience features and increased versatility, including a new fiber-optics recorder.

And then we introduced a complete range of accessories, such as our microfilm recorder accessory (that provides expanded resolution,

1 Model 906: 6" compact, "handyman" Visicorder
2 Model 2206: 6" battery-powered, portable, Visicorder
3 Model 1508A: 8" Visicorder with takeup unit
4 Model 2106: 6" laboratory Visicorder
5 Model 1204: Visiprinter accessory
6 Model 2400: Microfilm recorder accessory
7 Model 1912: 12" high-performance Visicorder



Regional Sales Offices:
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solutions since 1956

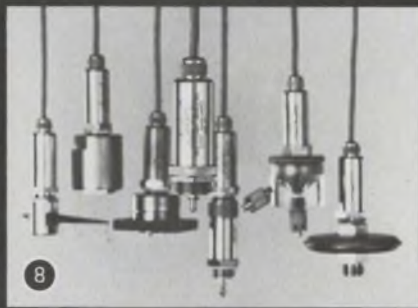
reduced record storage space, increased economy, and a permanent record); and our Visiprinter, a digital printer accessory that allows you to record digital data, along with the analog traces on any Visicorder.

And then, finally, we complemented this line with a variety of signal conditioning instruments, including amplifiers, attenuators, strain gage and thermocouple control units. Plus a wide selection of thermocouples and Statham transducers.

Until now, today, when we can honestly say that we offer the world's finest and most complete line of direct recording light beam oscillographs, systems and accessories. Which means that a Honeywell engineer can provide the solution to *any* recording problem, no matter the size or complexity.

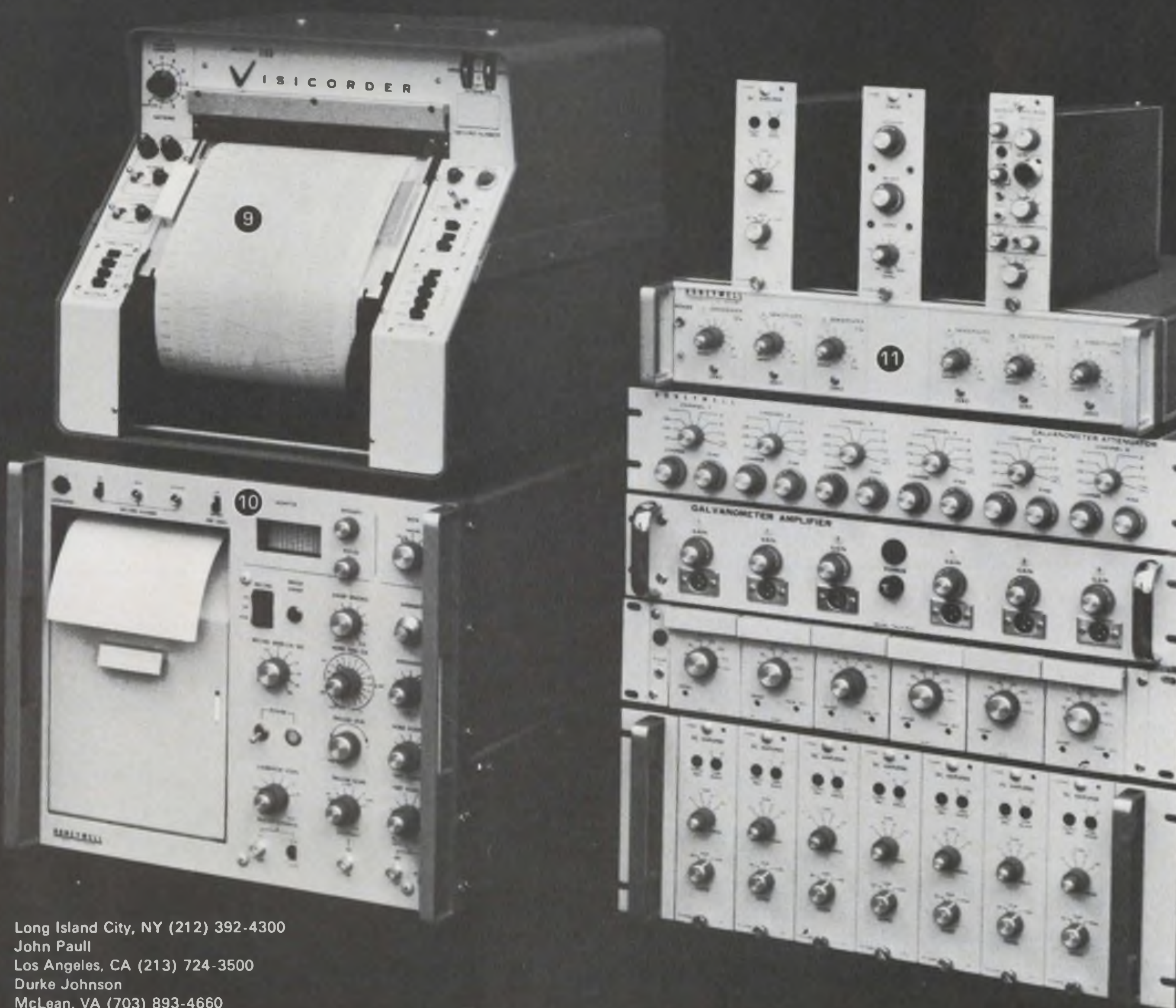
And that from small portables to 36-channel Visicorders, DC to 1 MHz, Honeywell can deliver, install and maintain any size system.

For more information, call your nearest regional sales manager listed below, or write: Honeywell Test Instruments Division, P.O. Box 5227, Denver, Colorado 80217 (303) 771-4700.



8 Statham Transducers
9 Model 1108: 8" general purpose Visicorder
10 Model 1806: Fiber-optic recording oscillograph
11 Signal Conditioning

Honeywell



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Durke Johnson
McLean, VA (703) 893-4660
Bill Schmick

INFORMATION RETRIEVAL NUMBER 10

Our Driver Manual.

(It's a free license to control all driving situations.)

Fault-free control of load driving can be yours when the motor matches (or exceeds) your product or system requirements and avoids the performance compromises inherent in common motors.

The Motor Catalog offers you literally thousands of choices — size, type, horsepower, torque, input — to obtain exactly the motor you need. In addition, there's comprehensive theory and applications information.

IMC Magnetics Corp., Eastern Division, 570 Main Street, Westbury, N.Y. 11591, Tel. (516) 334-7070, TWX 510-222-4469 imc

INFORMATION RETRIEVAL NUMBER 11

Designer's Datebook

DECEMBER 1969

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JANUARY 1970

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Dec. 4-5

Vehicular Technology Conference (Columbus, Ohio) Sponsor: IEEE, R. E. Fenton, Ohio State University, 2015 Neil Ave., Columbus, Ohio. 43210

CIRCLE NO. 760

Dec. 8-10

National Electronics Conference (Chicago) Sponsor: ITT, IEEE, et al, National Electronics Conference, Inc., Oakbrook Executive Plaza No. 2—Suite 629, 1211 W. 22 St., Oak Brook, Ill. 60521

CIRCLE NO. 761

Dec. 8-10

International Symposium on Circuit Theory (San Francisco) Sponsor: IEEE, R. A. Rohrer, Fairchild Semiconductor Inc., 4001 Junipero Serra Blvd., Palo Alto, Calif. 94304

CIRCLE NO. 762

Dec. 10-12

Asilomar Conference on Circuits and Systems (Pacific Grove, Calif.) Sponsor: IEEE, Santa Clara Univ., et al, Shu-Park Chan, Univ. of Santa Clara, Santa Clara, Calif.

CIRCLE NO. 763

Jan. 14-16

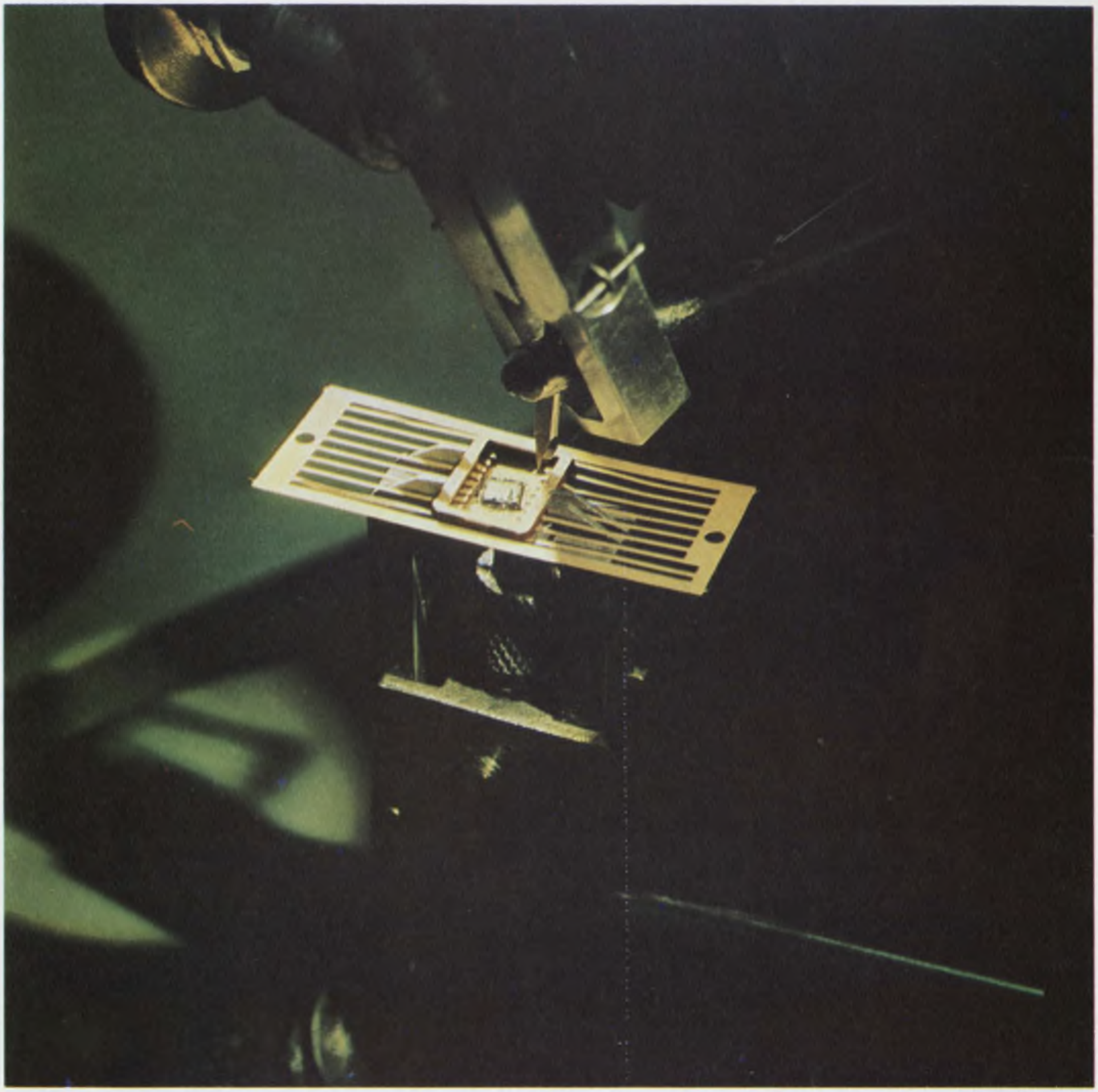
International Conference on Systems Sciences (Honolulu, Hawaii) Sponsor: IEEE, Univ. of Hawaii, R. Chattopadhyay, Univ. of Hawaii, 2565 The Mall, Honolulu, Hawaii. 96822

CIRCLE NO. 764

Jan. 25-30

Winter Power Meeting (New York City) Sponsor: IEEE, Technical Conference Services, 345 E. 47 St., New York, N.Y., 10017

CIRCLE NO. 765



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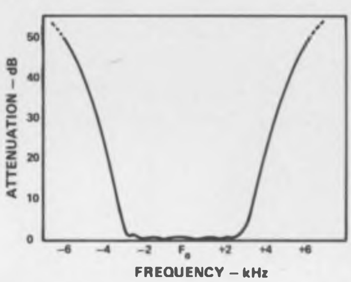

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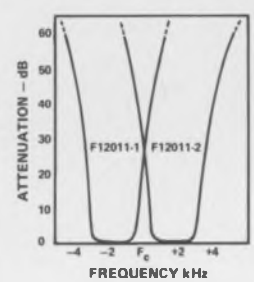

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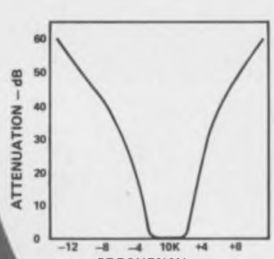

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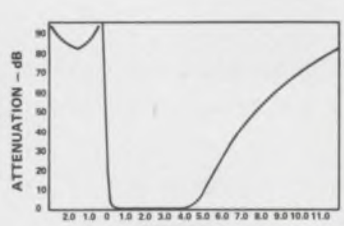

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MOS BRIEF 8 DIGITAL DISPLAY SYSTEMS Write: National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, California 95051

Dale Mrazek
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MOS BRIEF 8

DIGITAL DISPLAY SYSTEMS

TTL-compatible MOS storage circuits solve a dilemma that has plagued display designers: the question of how to generate the display. Eliminating digital-to-analog conversion allows a data system to remain digital right up to the display drivers, but may exchange one economic headache for another. If the data source generates the digital control signal, its cost and that of communications links rise. Doing the job in the terminal, on the other hand, has made displays costly in the past.

MOS read-only memories reduce, to a few relatively inexpensive integrated circuits, the hardware required to convert a character communications code to signals that will control a display. Display rates fast enough for most applications can be achieved, when the MOS ROMs are controlled by bipolar logic circuits. And when the ROMs and bipolar ICs can be coupled directly, without the use of special voltage translators, the character generator becomes that much more inexpensive.

Two cases in point are shown in Figures 1 and 2. The MOS read-only memories can be bought for less than 2¢ per bit of storage. A small additional investment in MOS registers and TTL counters will produce a display-control system, such as the one in Figure 3. This system adds data buffering, message storage and display refresh to the basic character-generation function.

Ordinarily, read-only memories are custom-made and programmed for special applications. A large order must be placed to amortize the setup costs and bring the price below 2¢ per bit. These ROMs are different. They are mass-produced as preprogrammed, off-the-shelf kits. Each kit contains three 1024-bit ROMs programmed to generate 64 alphanumeric display symbols when addressed by the ASCII code. The kit for raster-scan displays is SK0001 and the kit for vertical scanning is SK0002. Figure 4 shows how the characters in the raster-scan font look on a television-type display.

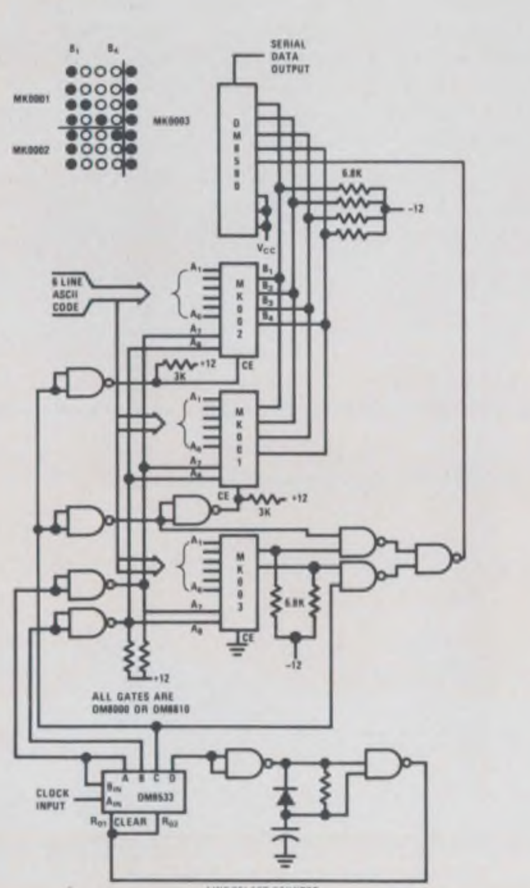

FIGURE 1. Raster-Scan MOS/TTL Display Character Generator. (SK0001)

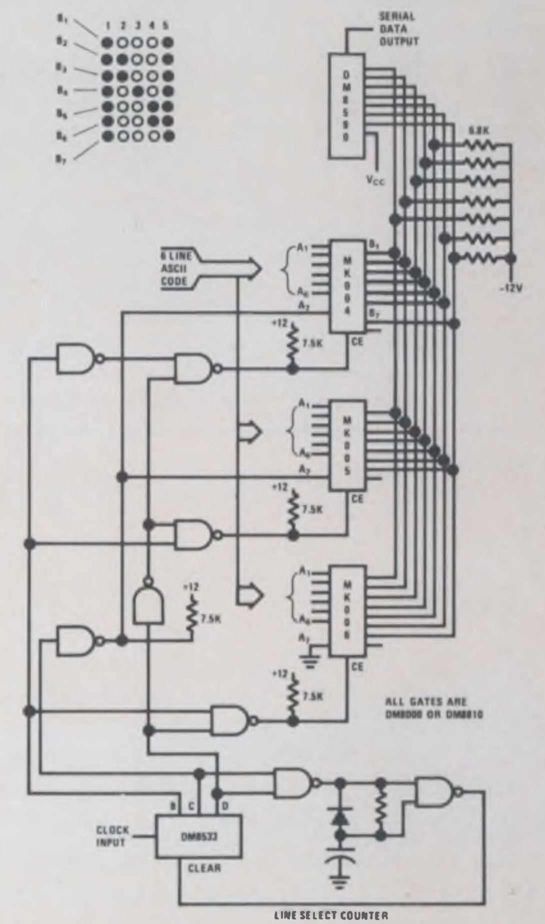

FIGURE 2. Character Generator for Tape Printers and Other Vertical-Scan Applications. (SK0002)

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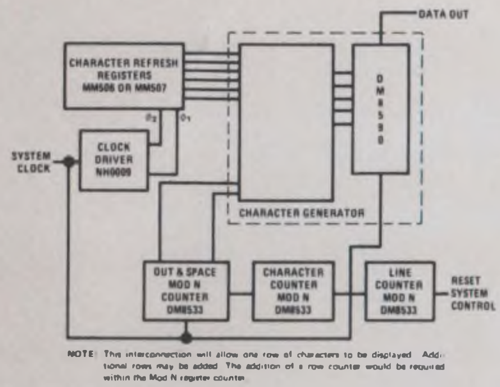

FIGURE 3. MOS/TTL System for Generation and Display Refresh.

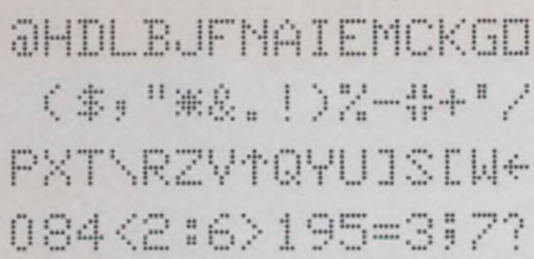

FIGURE 4. Raster-Scan 64-Character Display Font. Similar Standard Symbols Are Produced by the Vertical-Scan Memory Kit.

Some of the characters in the vertical-scan font look a little different, but the same symbols are generated and the displays are just as clear. Special symbol fonts can be made to order, on request.

Cathode-ray tubes can be controlled with the serial output of either character generator. Symbols are seen as bright dot patterns on the screen when the output is used to gate the CRT's electron beam. The raster-scan system of Figure 1 is ideal for low-cost television displays, while the vertical-scan system of Figure 2 is applicable to tape printers, billboards, and Broadway-type lamp displays, as well as CRT displays. The techniques should also be adaptable to electroluminescent panels and other advanced types of scanning displays.

Characters generated by the vertical scanning kit are displayed in five columns of seven bits per column. These are selected in the right order, under control of the DM8533 binary counter. The counter and gates are connected so that the first and third columns of the 5 x 7 patterns come from the top ROM (MK004 in Figure 2), the second and fourth columns from the center ROM, and the fifth column from the lower ROM. The counter toggles the system and also causes spacing bits (logic "0") to be loaded between characters on the CRT or other display. Its modulus establishes the number of spacing bits between the end of one character and the start of the next.

A DM8590 parallel-in/serial-out shift register arranges the parallel outputs into the serial gating-control stream. This TTL register is fast enough to permit the memories to operate in less than 1 μsec.

To generate raster-scan characters requires the selection of seven 5-bit lines. Therefore, the DM8533 in Figure 1 is used to count off the lines as well as the spacing interval between characters. After counting six intervals of N bits (five dots plus a spacing interval), the counter clears and counts six intervals again. The first four bits of the top four lines in each 7 x 5 display pattern are selected from the top ROM (MK001 in Figure 1), the first four bits of the bottom three lines come from the center ROM, and the last column of seven dots is generated by the lower ROM.

One method of implementing a complete system is blocked out in Figure 3. All functions are controlled by the system clock so that proper alignment of the symbols on the display is assured. The dot and space counter provides addressing control to the character generator, the character counter keeps track of the number of symbols displayed on each line in the display, and the line counter monitors the number of lines being displayed.

Other display functions can also be provided inexpensively with MOS memories. The MM520, for instance, can be the basis for a graphical display generator. If you like, we'll send data on our bipolar-compatible ROMs and shift registers, along with further information on MOS/TTL coupling techniques and the kits and devices used in these display systems.

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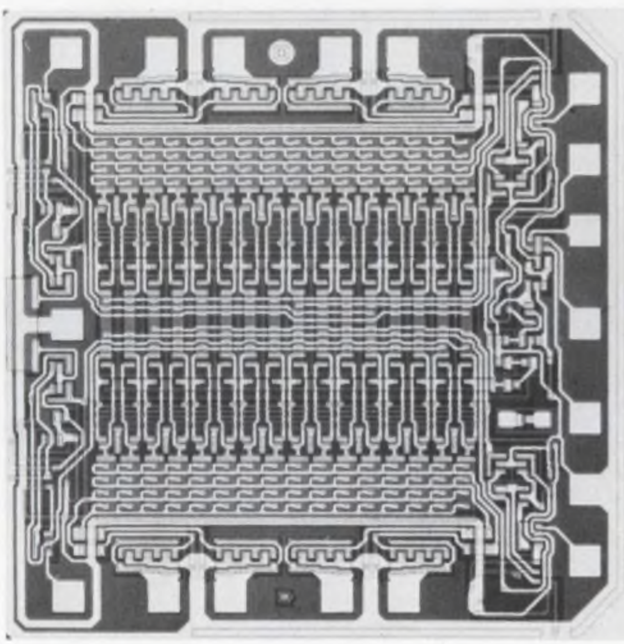
News

Executives from top corporations in the United States attended a recent symposium and got a preview of science and technology in the decade ahead. p. 25.



Magnetic memories face a major challenge from fast, semiconductor units. p. 36.

Mobile coronary-care unit brings immediate treatment to heart-attack victims. p. 40.

Also in this section:

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LOOK FOR CLARE ON GENERAL PURPOSE RELAYS

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INFORMATION RETRIEVAL NUMBER 15

Ambitious space astronomy program proposed to NASA

A group of the nation's leading astronomers has proposed a long-range space astronomy program for the 1970s.

The group, which makes up the Astronomy Missions Board of the National Aeronautics and Space Administration, was asked by NASA in the fall of 1967 to consult the scientific community and to:

- Formulate the major unsolved problems of astronomy.
- Define the measurements from space that would assist in their solution.
- Specify the types of instruments, spacecraft and missions needed to perform the required measurements.

The board recommended guidelines for "minimum balanced optimum programs."

A minimum balanced program was defined by the board as "a vigorous national space program utilizing the leading research teams in the field. This program would cost about $250 million a year in the mid-seventies.

The optimum program would proceed at the fastest possible rate consistent with available scientific and technical "manpower" and would cost $500 million in the same time period. Current expenditures in space astronomy average somewhat above $125 million a year.

The board recommended the following:

- An increased effort in X-ray and gamma-ray astronomy using Explorer spacecraft with substantially larger payload capability.
- An optical ultraviolet astronomy program leading toward the Large Space Telescope in the 1980s.
- Research and development of detectors and small cooling systems for infrared astronomy from spacecraft to complement ground and aircraft observations.
- Observation of astrophysical objects in the long-wave radio portion of the spectrum, which may require a six-mile-wide rhombic wire antenna developed in space or on the moon.
- More sophisticated spacecraft to extend observations of the solar surface and to study the effects of solar activity on the earth.
- Continued observations of the planets from earth orbit using Orbiting Astronomical Observatories and the Small Astronomy satellite.
- More advanced observation of the interplanetary medium, cosmic rays and magnetic field with astronomy instrumentation on planetary and Explorer spacecraft.

First ion-implant device being offered by Hughes

Ion-implantation MOS integrated circuits have finally become a commercial reality.

According to Irwin A. Lucks, MOS product marketing manager at Hughes Aircraft Co., Newport Beach, Calif., a 64-bit dynamic shift register is now available in limited quantities. The major advantage of the ion-implantation technique is that faster circuit speeds are possible, due to the almost entire elimination of parasitic gate overlap capacitances. The conservatively quoted speed of the Hughes LISR 0064 dynamic shift register is 20 MHz. Speeds of 30 MHz have been measured in the laboratory on some samples. This compares with average quoted speeds of 5 to 10 MHz for devices without ion implantation.

The price of the new devices will be about 10% higher than for standard MOS devices, Lucks says.

An additional feature of the Hughes shift register is that it is bipolar compatible.

The price of the new devices will be about 10% higher than for standard MOS devices, Lucks says.

He reports that during the first half of 1970 Hughes will be introducing a dual 64-bit dynamic shift register as its second ion-implantation device. This is to be followed by three more products later in the year.

Navy to modify plans for extra-lf network

Against mounting criticism of its plan to wire up a large part of Wisconsin as a global extra-low-frequency communications center, the Pentagon now reports a "technological breakthrough" will permit a less ambitious approach. Further, military officials have disclosed in Washington that other cities outside Wisconsin are under consideration. No details of the breakthrough have been given.

Navy officials are said to require the extra-low-frequency communications system—called Sanguine—to assure greater flexibility in transmitting orders to fleet ballistic-missile submarines at sea.

Transmissions from present high-power, low-frequency naval stations in the states of Washington and Maine can be received by U. S. submarines only while at periscope depth or at greater depth only if they employ a float-supported wire antenna. Both methods restrict operational capability, since the Polaris nuclear subs are believed capable of operating to depths of 1500 feet.

As originally planned, some 26 counties, or 20,000 square miles—nearly the entire northern part of Wisconsin—would have been implanted with a cross-wire grid to carry very-low-data-rate, extra-low-frequency signals produced by a chain of several hundred transmitters. Total power output was to have been at the "multimegawatt" level. That area was selected because it sits atop a prehistoric mountain range of impressive size and of solid rock. Projected cost was estimated at $1.5 billion.

Now the Pentagon says the Navy believes it can reduce the network area by two-thirds and em-

News Scope CONTINUED

ploy "much smaller, lower-power transmitters." It also asserts that the original system concept never really was to have been built. Rather, it served as a "base line" for subsequent research.

Deputy Defense Secretary David M. Packard has disclosed approval of a Navy request for $20-million in additional funds for Sanguine R&D in fiscal 1970. Roughly $38-million has been committed to date for the project.

Savings envisioned in connector field

For users of connectors and switches, the news from two recent enginering meetings is all good.

A speaker at the International Nickel Co. Corrosion Conference in Hasbrouck Heights, N.J., reported that design techniques should allow the use of base metals for electrical contacts in applications where gold plate is now the standard.

And industry and Government spokesmen at the Second Annual Connector Symposium in Cherry Hill, N.J., said that long-awaited relief from connector proliferation is at last in sight.

The high cost of gold, plus a variety of technical problems in producing top-quality gold plating, make base-metal contacts an attractive alternative. Research is under way, and engineers attending the International Nickel conference got a firsthand account from Dr. Morton Antler of the Burndy Corp. Research Div.

Future connector developments not requiring gold, Dr. Antler said, will depend on making full use of such variables as pressure, smoothness and corrosion-inhibiting treatments to penetrate base-metal surface oxides and thus provide a dependable connection.

Present designs rely principally on the inert chemical properties of thin gold plating. Base-metal platings can be thick.

A Pentagon staff engineer, Lester Fox of the Office of Assistant Secretary of Defense, told of a new military standard for connectors that will be coming off the Government presses soon. It lists "connectors preferred for use in new designs."

Although covering only circular connectors at its first printing, the new standard is expected to include all other connector types (rack and panel, PC board, flat cable, rf and edgeboard) within the next five years, according to Robert Tonar, project engineer with the Defense Electronics Supply Center in Washington.

Also in the works is a standardization document by the Electronic Industries Association for commercial and industrial edgeboard connectors. A member of the EIA standardization committee—Max Peel,, chief design engineer for connector products, Texas Instruments, Inc.—said he expected the new guidelines to be effective by the end of 1970.

The proposed document will establish mounting configurations, set values for four functional connector levels, recommend qualification tests and stipulate acceptance testing and acceptable quality levels.

Computers speed up the practice of law

Describing lawyers as "having both feet planted firmly on the ground and both eyes pointed to the past, F. Reed Dickerson, professor of law at Indiana University, declared the computer designer is forcing them to do an about face and speed up.

He spoke of this new aspect of computer use at the Joint Conference on Mathematical Aids to Design held recently at Anaheim, Calif.

The computer is having a strong impact on law and lawyers. Tax returns have been programmed for the speedy computation of minimum tax liability. Estate planning and tax strategies can be programmed.

Courts are using computers to schedule trials, keep juror lists and assign attorneys ot indigent defendants. Computerizing of title searches can simplify what is now a time-consuming process, although identification of land parcels may be complicated.

Information retrieval applied to statutes and decisions are now in the early stage of implementation.

Problems of privacy and liability will grow out of computer use and constitute a whole new branch of law. But Prof. Dickerson emphasized that the application of computers is opening a whole new area in the law.

New bipolar process developed at BTL

A new, isolated lateral transistor structure requiring only three photolithographic masking operations was introduced at the International Electron Devices Meeting by V. J. Glinski of Bell Telephone Laboratories, Murray Hill, N. J.

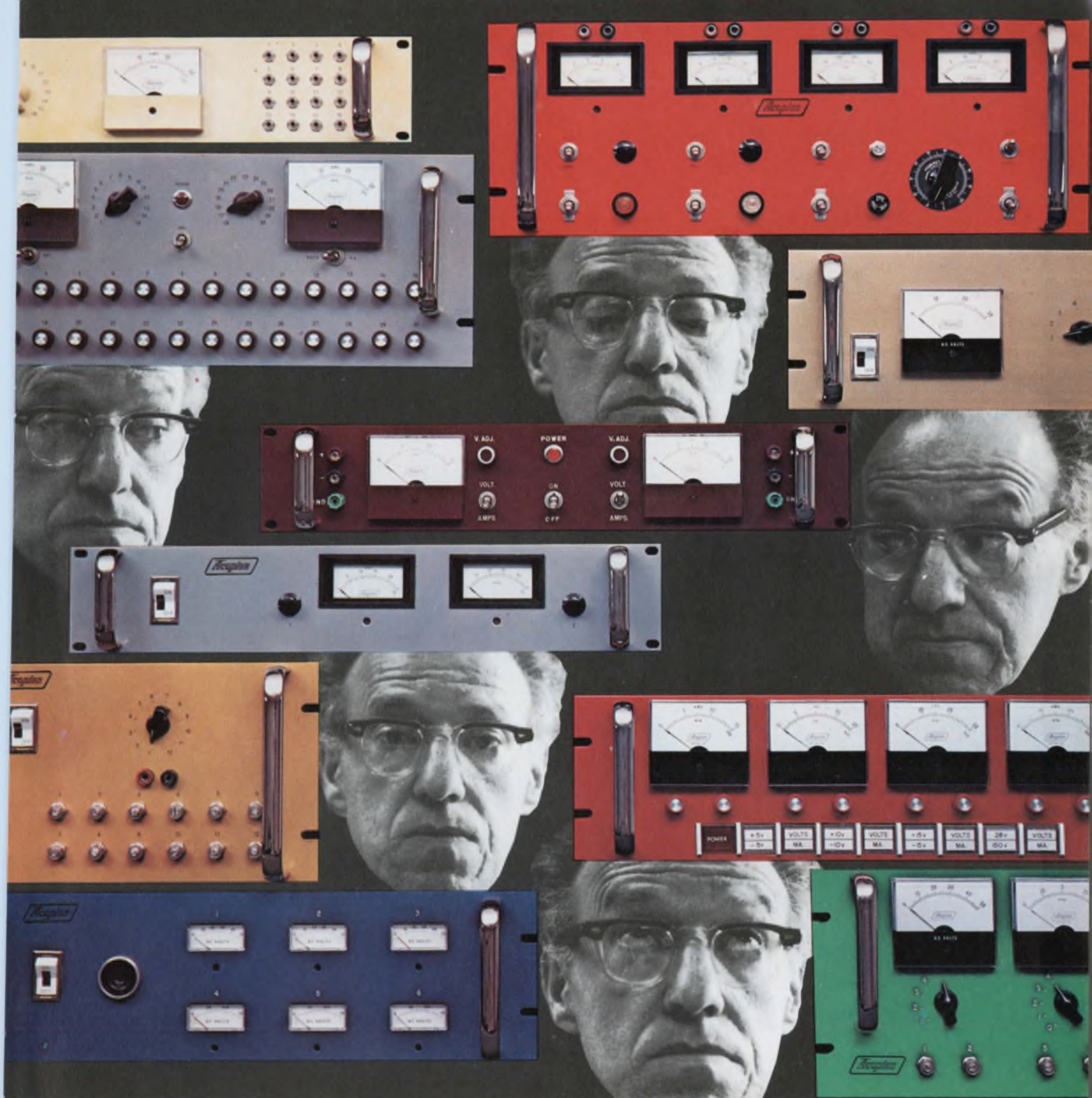
The new structure is said to offer great potential economy over present standard bipolar processing, which requires seven or more masking steps.

Speaking at the 3-day conference in Washington, Glinski described the new IC transistor as a shallow nonselective p-type base region diffused into a lightly doped p-type substrate, with n+ emitter and collector regions simultaneously diffused into and through the base region. The new process can be used to form transistors, resistors, and cross-unders.

Glinski says that transistors made this way occupy as little as 500 square microns of area. Characteristics are roughly $h_{FE} = 35$ and peak $f_T = 0.12$ GHz at 0.5mA for a typical device. He has built active nonlinear loads up to 200 kΩ using the process and says that resistors with values as high as 4 kΩ can be fabricated within 600 square microns of area.

GE decides to 'unbundle'

General Electric Co., which decided two months ago not to separate pricing of computer products and services for office uses, announced that it will separate them for computers that control industrial processes.



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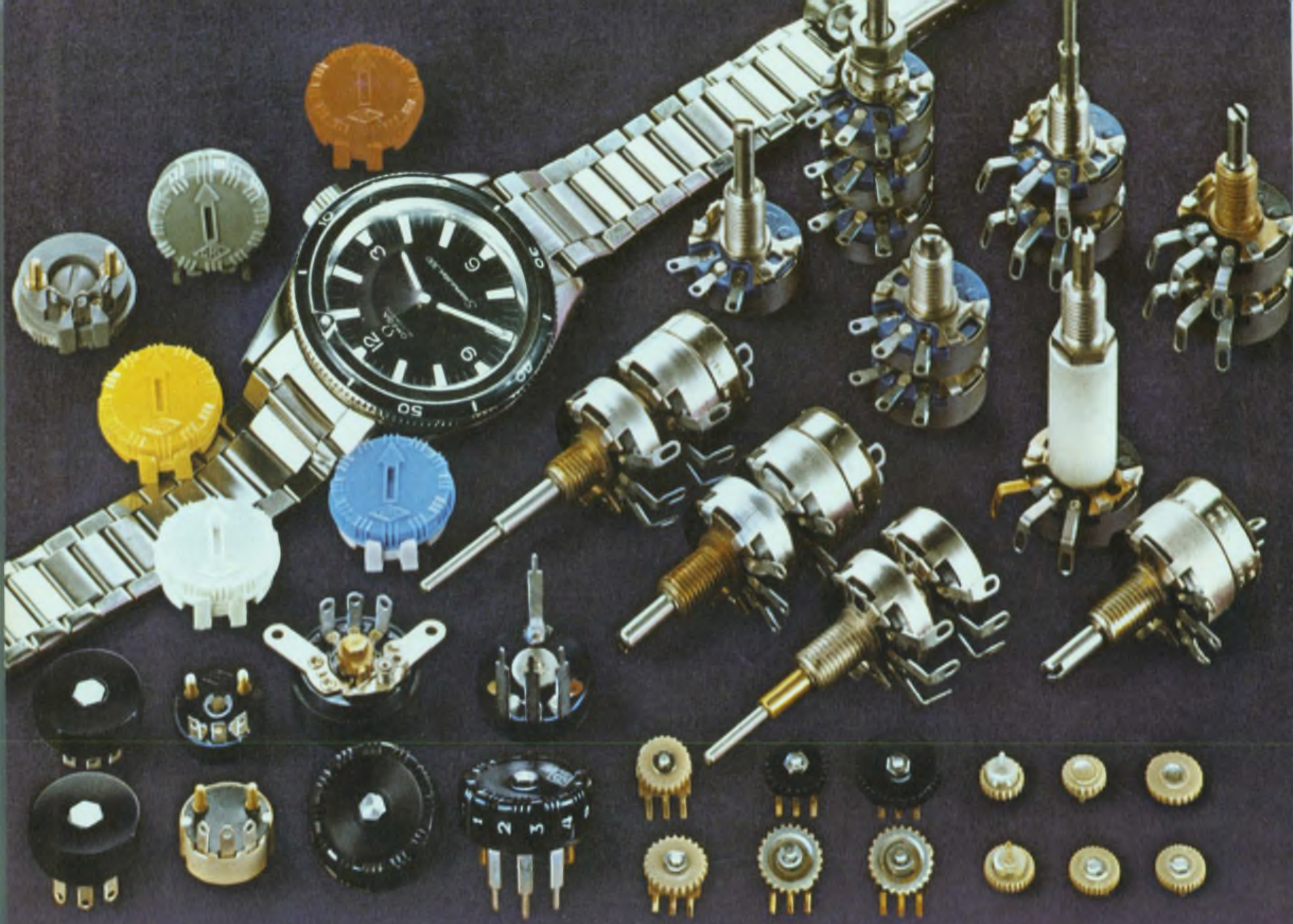

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Electronics in 1980—as experts see it

Ralph Dobriner
Chief News Editor

Will this nation be able to cope with the expected science and technology "explosion" in the decade ahead? What kind of improvements can we expect in future computer systems? Where will today's million-megawatt lasers be used?

These are some of the questions that furrowed brows when corporation executives gathered late last month at the Waldorf-Astoria Hotel in New York City to hear scientists and engineers make educated guesses about the next 10 years.

The two-day meeting, called "Technology Forecast for 1980," was sponsored Oct. 30-31 by Polytechnic Institute of Brooklyn.

Reading like a "Who's Who" of science and technology, more than 20 scientists and engineers from some of the top corporations in the U. S. presented views on a variety of subjects—from computers to cryogenics and from integrated circuits to lasers.

Speakers included Dr. Harvey Brooks, dean of engineering and applied physics at Harvard University; Jerrier A. Haddad, IBM vice president for engineering; Dr. John R. Pierce, executive research director at Bell Telephone Laboratories; Dr. Willis A. Adcock, vice president for strategic planning at Texas Instruments; Dr. Robert Kingston of MIT's Lincoln Laboratory and Dr. Brian Thompson, director of the Institute of Optics at the University of Rochester.

Their views are covered in the following pages.

A catastrophe due for R&D in U.S.?

A kind of Malthusian catastrophe for the nation's science and technology is foreseen by Dr. Harvey Brooks, dean of engineering and applied physics at Harvard University. Just as there is a widespread belief that the world's population growth will far outdistance the available food supply, Brooks believes that the rapid growth in science and technology during the next decade will sorely tax the nation's ability to fund these R&D programs.

The exploitation of a technology, he observes, requires considerable capital investment beyond the costs of research and development. The bottleneck is not really R&D costs but the proportion of *successful* development efforts that can be brought to the market.

Research and development expenditures, says Brooks, today are nearly 20% of the rate of capital investment in the country. It seems plausible, he notes, that the death rate among exploitable ideas will rise rapidly as development effort presses upon investment rate.

A key question, according to Brooks, is whether the nation can afford this "high mortality rate of unused opportunities," especially when increasing scientific knowledge should make it possible to choose among potentially attractive technological opportunities at a much earlier stage in their evolution.

Just as most nations are confronted with the "guns or butter" dilemma when contemplating war, so will they increasingly be faced with the economic necessity of allocating their finite resources—between solving air and water pollution problems, promoting space travel or developing high-speed ground transportation systems.

Top corporation executives "tuned in" on experts at technology forecast symposium.

Brooks also points to an equally important problem: the growth of different technologies that increasingly impinge on each other and on the environment.

For example, the continuing increase of population and of per capita income imply very rapid growth of many industries that contribute to pollution. This will have two effects, Brooks says.

One will be to produce more and more social pressures for the control of technology, both old and new, and its further proliferation.

In the past, he observes, technology was permitted to proliferate because it was generally accepted that its benefits outweighed its undesirable social, environmental or biological side effects. Now, there is increasing pressure toward shifting the burden of proof.

For this reason, Brooks predicts that the social barriers to innovation are likely to rise very rapidly, both through direct regulation or control, and through increases in the costs of proving the innocence of technology.

The second effect of technological overgrowth, however, according to Brooks, will be to greatly increase the demand for technologies that reduce the environmental consequences of existing or new technology.

"Society," he says, "will be willing to pay more for the benefits of technology through choosing more costly technologies which generate less pollution, for example."

He foresees a rapid development of research and monitoring techniques designed to anticipate or detect the effects of technological change at a much earlier stage than is possible now.

ICs are entering the dynamic teens

Integrated electronics is just ten years old, and forecasting its progress during the next decade, says Willis Adcock, vice president at Texas Instruments, is like "forecasting the teenage experiences for a ten-year-old boy."

Nevertheless, Adcock proceeded to forecast some major trends that are likely to affect the integrated-circuit industry during the next decade. He predicted:

- A continuing trend to ever higher levels of integration and the use of MOS-type devices of high complexity. Today, the average number of circuits per chip is below 10, and circuits of several hundred have been made in small quantities. By 1980, the number of circuits per chip will reach several thousand.
- Reliability will continue to increase with higher levels of integration. Today, the reliability of a typical 8-gate-per-chip function is from 0.004 to 0.003 failures per 1000 hours of operation.
- A greater need for computer-aided automation techniques for the design, manufacture and test of highly complex circuitry.
- The continuing emergence of silicon as the dominant semiconductor material.

One of the main forces behind integrated electronics and ever higher levels of complexity is the cost of interconnecting packages into the final system. New high-density interconnection methods, using batch fabrication techniques, will bring the cost down considerably, Adcock says.

He believes that the economics and reliability associated with complex ICs "provide the basis for predicting that semiconductor products will be widely used in the random-access computer memory market." During the past decade, solid-state devices have had great impact in the logic area; and magnetic devices—ferrite cores in particular—have dominated the random-access memory market.

DR. WILLIS A. ADCOCK

By 1980, over three-fourths of U. S. electronic circuits will be integrated, Adcock predicts. "This will require a tenfold increase in the number of integrated circuits for a total of four-billion functions per year."

He continues, "When the number of circuit functions per chip reaches the thousand level, computer-aided automation techniques will become mandatory for the design, manufacture and test of highly complex circuitry.

"Out of the response," he says "to this challenge for application of design automation will come the innovations of the Seventies and the groundwork for the innovations of the Eighties."

The mass fabrication of complex circuits using photolithographic techniques has reached a high level of refinement, Adcock notes. He predicts more refinements in the resolution capabilities of the photolithographic techniques that are used to determine the patterns for diffusion and metallization.

"The geometrical resolution," he says, "is the key factor for device performance and circuit density. These refinements in resolution are already approaching optical limits, and further improvements will come about using electron-beam beam techniques. This should improve resolution by a factor of 5."

Adcock sees a bright future for hybrid circuit technology.

He cited as an example a 104-gate, 32-bit active-element memory with a read time of 7 ns and a write time of 10 ns. The package has 36 pins and dimensions of 0.6 by 1 inch. Both the package and chips use two levels of metallization.

This is an example, he noted, of hybrid technology using high-level chips and a high-density interconnection technique on a ceramic substrate in place of a printed circuit board. The ultimate need, Adcock says, is to interconnect all the ac-

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tive circuits on a silicon slice.

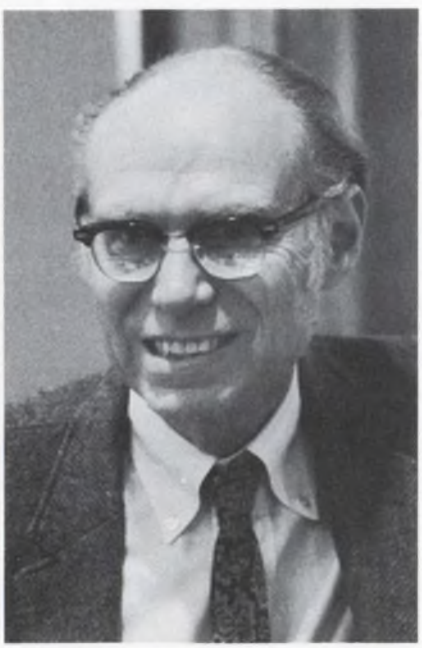
He also predicts that in the decade ahead more and more digital circuits will be designed to perform operations formerly done with linear circuits.

Communications: A dazzling pace

Some 15 years ago, before the advent of the space age, John R. Pierce, executive director at Bell Telephone Laboratories, predicted the practical use of communications satellites. Now, in 1969, he zeros in on cable television, Picturephone service and communications with computers as areas that could have a revolutionary effect on communications technology during the next decade.

Cable television, he notes, started as a potential revolutionary development but got bogged down in regulatory difficulties. "If these ever get solved, it could provide us with a medium that is as different from television as television was from movies," Pierce says.

"It's a medium in which you can have 20 channels into the home. Instead of wondering how to produce programs expensive enough to beat out other programs, broadcasters would be wondering how to produce programs cheap enough to use up the extra channels."



DR. JOHN R. PIERCE

Cable TV in suburban areas costs as much as installing a good TV antenna on every rooftop—and is a lot less unsightly, Pierce adds.

He cited the Picturephone as another potential revolutionary device. It was developed by Bell Telephone Laboratories about 10 years ago but didn't get off the ground. Now a transistorized commercial version will be marketed in some areas in 1970. Pierce predicts its eventual widespread use in the business and well-to-do market areas.

He observes that the leading factor that will cause a revolution in communications, during the next 10 years, is getting into real use things that we now have in principle. This would include medium and large-scale integration into Picturephones, telephones and other communications.

"The other revolution that we're in the midst of is the growth of computers," says Pierce. What we are seeing now, he says, is not bigger and better computers but in a way smaller and better computers and special-purpose machines. The general-purpose computers, he notes, just don't work very well; they are too hard to use.

"Data communication and communication with computers have been held up for a decade by a lack of cheap, reliable, small terminals. As a matter of fact, if the price of small powerful computers keeps going down," Pierce says, "pretty soon the terminal will cost more than the computer."

He cited the single-case teletypewriter as an example. "It costs the computer manufacturer about $500 dollars and it isn't exactly what you'd want in your home. It's too big, isn't reliable enough and requires too much maintenance." Pierce hopes that this obstacle will be overcome before 1980.

Will we have voice input for the computer? Pierce thinks not, but refuses to elaborate. He does, however, foresee voice output when bandwidth reduction techniques make it practical to store voice in digital form instead of on analog tape—which "is a sort of unpleasant liaison for a computer."

Pierce notes that present technological resources, and especially integrated circuits, can provide new switching, data handling and transmission capabilities where these can be used.

He foresees more electronic switching and probably time-division switching. This, he says, may be combined in some way with message switching in exploiting broad-band transmission channels.

Transmission costs will be scaled down considerably, according to Pierce, " if we get lots of information to transmit." This he says, could be brought about through the use of domestic satellites, waveguides and lasers.

Satellites can provide lots of communications if frequencies above 10 GHz are used—hundreds of millions of telephone circuits. The problem here is solving the delay and echo that would be prohibitive for telephone circuits, but maybe not for one-way Picturephone communications, Pierce observes.

Advances in the use of terrestrial communication systems above 10 GHz await progress in microwave integrated circuits and in the application of the solid-state art. Waveguide systems are being held back, not by technology but by the fact that we don't have large enough cross sections.

Laser systems of large capacity, says Pierce, will become technically feasible and perhaps in use by 1980, depending on advances in semiconductor lasers and in integrated optical circuitry.

For computers, only way is up

What will computer technology be like during the next decade? Jerrier Haddad, vice president of International Business Machines Corp., sees across-the-board improvements in hardware, software, programming, in digital data communications and in application ingenuity. He forecasts:

- A "roughly" fivefold improvement in the best performance of computers every five years.
- Fivefold improvement in the cost of computer systems to the

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- Continued improvement in the capacity of on-line storage systems and their performance.
- Increase in the performance and function handling capability of programming systems—most probably by breaking the problems down into subsystems.
- Batch-fabricated electronics that allow less and less expensive data entry and terminal equipment.
- Improvements in the cost and reliability of digital data communications, independent of distance.

In addition to these technological advances, Haddad believes that, as computers pervade the everyday life of more and more individuals and organizations, they'll affect human, as well as legal and economic, relationships.

"Clearly we can't forecast for 1980 without these considerations, too. These relationships are more complex, are deeper in effect than those items we can resolve in the laboratory. I believe that this is a strong motivational element which will sway the direction and the intensity of technical progress in the next decade," Haddad says.

The thrust of technical progress in the last two decades, he notes, has seen an improvement of between three and five or three and six in the power of the computer for every dollar of cost to the user, in each five-year period. Similarly, the raw performance of "horsepower" of the computer has improved by a factor of somewhere between three and five in each five-year interval.

"We can't look forward forever to increasing circuit performance because of things like speed-of-light limitation, or heat-per-cubic-inch limitation. Nevertheless, we can still see two or more rounds of performance improvement which may be technically feasible on a laboratory basis and probably on a commercial basis."

By the end of the decade, Haddad believes, subnanosecond circuitry should be practical. Along with electronic elements of higher speed, he foresees a continuation of the trend to parellelism of computing functions coupled with improvements in the technology.

JERRIER A. HADDAD

Looking ahead at the manner in which computers will be applied, he believes there will be an ever increasing requirement to put more of the data base of a business on line. "This not only means higher storage capacity of a file storage nature as opposed to a working memory or scratch-pad memory, but it also means the need for higher performance in terms of data rate and in terms of access speed," Haddad says.

"While there's no question," he notes, "that improvements to the electromechanical storage devices will occur, we can't assume that electronic nonmechanical devices won't come upon the scene as well,"

The mechanized data base will of necessity embrace a very wide range of technologies. Most important, this data base will be managed as a subsystem and be available to users on a priority basis and with security safeguards.

Perhaps the most difficult projection, according to Haddad, is the programming of software. "Of all the elements of the computing system," he says, "programming is that element which has the least developed scientific or technical discipline base. Therefore, it is very difficult, if not impossible, to design to a specification or even to measure the performance once you have the program developed. Since software is becoming so sophisticated and since so much of the design of the computer system is in the software as compared to the hardware, people in the computer field are very much aware of the necessity to improve the theoretical base. I believe it will happen, because so much depends on it."

Programming systems, he says, must be developed that are far more complex and efficient than they are right now. But even today, the size and complexity of some software systems are so great that no one man can know and become expert in the whole system.

As Haddad sees it, the only practical course is in the development of subsystems that have rigidly defined and rigidly enforced interfaces. Naturally this will require agreement as to which function should be in which subsystem now and as new functions are developed in the future.

"All in all," says Haddad, "human intellect must bring discipline to a field which doesn't have discipline enforced on it by nature's laws."

Lasers, lasers everywhere . . .

"By 1980 there will be optical and infrared laser sources which will generate any chosen frequency, or wavelength, or color; presettable or tunable at will."

This optimistic prediction was made by Robert Kingston, head of the optics division at MIT's Lincoln Laboratory. He further forecast that the powers available will be comparable with those from radio-frequency devices and, in many cases, orders of magnitude larger for pulsed sources.

The waveform or time distribution of short pulses, he continued, may be shorter by orders of magnitude than those available to the radio engineer, "thus allowing the ultimate in distance and time measurements."

Kingston believes that the application of lasers will continue to grow. "It makes available novel heating and fabricating techniques from precious cutting of materials to welding and perhaps tree trimming. It can yield rapid and precise measurements of distance or provide spectrometric measurements throughout the infrared and into the ultraviolet. It can measure time to 10^{-12} seconds and provide three-dimensional pictures."

Kingston concentrated on several recent developments in the areas of power, wavelength, and choice of waveform as having particular significance in the next decade.

Although limited to small fractions of a watt of continuous power in early devices, a carbon dioxide laser operating at 10 microns or 0.01-mm wavelength in the infrared has delivered 10 kW of power.

In the visible region, the argon laser may produce over 100 watts during the next year, Kingston says. In fact, it is possible to forecast powers at the kilowatt and higher levels for future continuous wave levels regardless of wavelength region."

As for peak powers in narrow pulses, the laser has a fantastic record, Kingston notes.

A neodymium-doped glass laser has produced pulses of 17 terawatts or a million megawatts, with a pulse duration of only three times 10^{-12} seconds. These pulses have actually created air breakdown at optical frequencies.

It is difficult to predict the ultimate limit in these powers, he says, since they are presently limited by breakdown or destruction of the optical materials in the

DR. ROBERT KINGSTON

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laser.

On the subject of available wavelengths, Kingston observes that the laser has now completely bridged the gap from the microwave region through the infrared and into the ultraviolet.

Several techniques are now available for producing any desired wavelength. These include:

- Harmonic generation and mixing where the intensity of the laser beam is such as to produce nonlinear effects in a solid or liquid.
- Varying the chemical constituents of the laser to control the wavelength.
- Mechanical or thermal tuning of the resonant cavity to produce fine tuning of the frequency within the material's range of operation.
- Use of organic dyes offering an infinite choice of frequencies in the visible region.

These techniques, says Kingston, make it possible to predict that "with an established requirement, sources may be developed which operate at any desired fixed wavelength and they may be fine-tuned about this wavelength with ease, just as in radio and microwave systems."

The last significant area covered by Kingston is that of pulse-length control, or the technique of generating extremely short pulses of light for measuring distance or studying rapid events.

He predicted the eventual use of these pulses, which are the order of several picoseconds (10^{-12} seconds) long in digital techniques as well as photography or measurement of fast events.

Progress, finally, for holography

A somewhat pessimistic view on progress to date in holography was offered by Prof. Brian J. Thompson of the University of Rochester's Institute of Optics.

In Thompson's view, "We have been so carried away by the scientific fascination of the holographic process that we have failed to define the science, determine the technology and create the correct environment for real progress toward significant applications."

He noted that during the past 20-year history of holography, over 800 papers have been written by some 500 authors. The results of this considerable expenditure of manpower so far have been disappointing.

Nevertheless, Thompson sees a bright future for holography. The most exciting area and the one where the commercial payoff looks most attractive, he says, is in data storage and retrieval.

Placing a multiplicity of images on a single frame of film was an early holographic application. However, the signal-to-noise problems and the high resolution necessary to store the hologram made this application little more than an interesting scientific experiment.

Recently the search for new recording materials and techniques is starting to change this situation, Thompson observed.

In a recent experiment, 1000 exposures were stored on the same area of photographic film by recording each as a uniquely coded hologram. However, the objects considered were only point objects. Signal-to-noise was 10 dB for any individual image.

Thompson speculates that a thousand 8-1/2-by-11-inch pages might be stored in a recording medium only 1 cm^2 in area and 1 cm thick.

Alkali-halide crystals having photosensitive color centers are being evaluated for line copy and color image storage. Photochromics are also being worked on actively.

DR. BRIAN THOMPSON

Several laboratories, he noted, have been studying the use of so-called Curie point writing on ferrimagnetic intermetallic compounds, particularly manganese bismuth. Exposure to light produces magnetic domains in the material because of heat produced in the film. The magnetic hologram can be read out by making use of the magneto-optic effect and the material can be erased and re-used. Resolution of 2000 lines per millimeter has been predicted.

Thompson sees the eventual use of this particular technology in an optical computer memory with storage of 100 million bits per square inch.

These applications, he emphasized, are purely speculative.

An experimental optical memory reported upon by IBM could lead to a computer storage device 1000 times faster than today's disc and drum, Thompson says.

The system uses a laser beam to project blocks of information contained in the hologram onto a light-sensitive detector. More than 100 million bits of computer information could be sorted on a nine-square-inch holographic plate.

Holographic displays are very clearly tied to the problem of storage, according to Thompson. "Projections of three-dimensional images so that they can be viewed by theater audiences and the not unrealistic question of 3D television are problems that are not yet solved or even close to being solved."

Computer-generated holograms may have a special role to play in the visual display field, Thompson observes. Images of hypothetic objects can be produced, or a given hologram may be scanned, fed into a computer, modified, and read out and then displayed to give control over the image.

A specific application would be in aircraft landing guidance. A three-dimensional holographic image of the flight deck of an aircraft carrier would be presented to the pilot during landing operation. The reconstructed image would be manipulated to account for change in azimuth angle and glide-path angle during landing. ■■

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TRIGGERING

The signals from both vertical plug-ins are coupled through a mainframe logic circuit and made available to each horizontal plug-in, selectable from LEFT channel, RIGHT channel, or slaved to VERTICAL MODE. The latter frees the operator from manual source changes during single-trace operation and, in conjunction with the P-P AUTO TRIGGER MODE in the time-base units, provides true hands-off triggering during routine measurements.

FOUR PLUG-IN CHANNELS

The modular approach is the answer to instrument flexibility. With dual-trace switching in the mainframe amplifiers, each plug-in can be "specialized" in function and operate in combination with other units. Thirteen plug-ins are currently available for the 7000-Series. Together, they represent the widest range of performance options for multi-trace, differential and sampling applications available today.

ınd Amplifier

MHz (2.4 ns tr) in the 9 ns tr) in the 7504. 5 mV/div at full band-

7A22 High-Gain Differential Amplifier

Bandwidth—DC to 1 MHz with selectable upper and lower —3 dB points.

Min deflection factor—10 μV/div at full bandwidth.

7B51/7B50 Time-Base Units for the 7504

5 ns/div maximum sweep speed. Operable singly or in combination for delaying sweep capability.

7M11 Delay Line Unit

Two 75 ns, 50-Ω delay lines. Trigger selection from either line.

7S11 Sampling Amplifier

Accepts the plug-in sampling heads for bandwidths to 14 GHz (25 ps tr).

7T11 Random Sampling Time Base

10 ps/div to 5 ms/div sweep range, accomplished with equivalent-time and real-time techniques.

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AUTO SCALE FACTOR READOUT

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DISPLAY

Three intensity controls ad and READOUT brightness focus control, a screwdriv and a two-position beam group.

BRIGHT TRACE

The acceleration potentials are 24 kV for the 7704 and 18 kV for the 7504 for improved trace visibility. Single-shot photographic writing speed is 3300 cm/μs (7704) measured with the standard P31 phosphor, the new C-51 camera and 10,000 ASA film. The display area is 8 cm x 10 cm with a parallax-free illuminated graticule.

DUAL-TRACE SWITCHING

Both the vertical and horizontal *mainframe* amplifiers are "dual trace" providing a unique level of flexibility with plug-in combinations. A relatively small number of plug-ins can then meet a wide range of application requirements. The CHOP and ALT modes permit simultaneous displays of delaying and delayed sweep, and, through switching logic, may be "slaved" to provide a functional dual-beam type of display.

7A13 Differential Comparator Amplifier
Bandwidth—DC to 100 MHz (3.5 ns tr) in the 7704; DC to 75 MHz (4.7 ns tr) in the 7504. Min deflection factor—1 mV/div at full bandwidth.

7B71/7B70 Time-Base Units for the 7704
2 ns/div maximum sweep speed. Operable singly or in combination for delaying-sweep capability.

7A16 Wide-B
Bandwidth—DC to 150 7704; DC to 90 MHz (3 Min deflection factor— width.

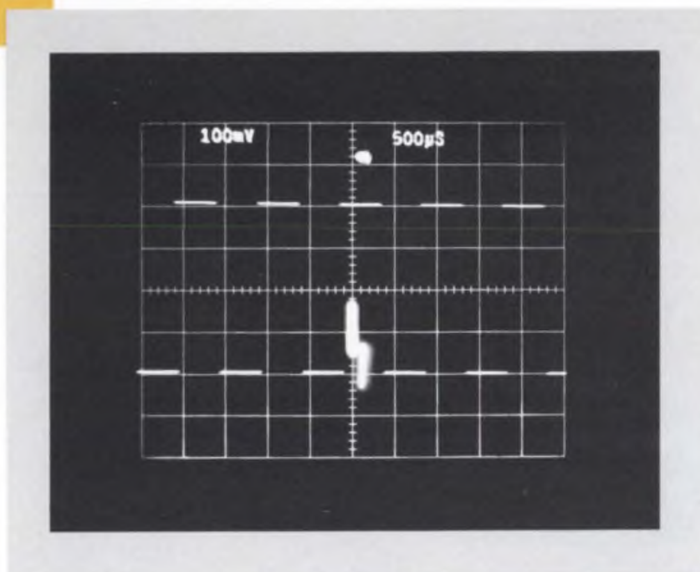
7A11 Captive FET Probe Amplifier
Bandwidth—DC to 150 MHz (2.4 ns tr) in the 7704; DC to 90 MHz (3.9 ns tr) in the 7504. Min deflection factor—5 mV/div at full bandwidth.

7A12 Dual-Channel Amplifier
Bandwidth—DC to 105 MHz (3.4 ns tr) in the 7704; DC to 75 MHz (4.7 ns tr) in the 7504. Min deflection factor—5 mV/div at full bandwidth.

7A14 AC Current Probe Amplifier
Bandwidth—25 Hz to 105 MHz depending on mainframe and current probe; two probes available. Min deflection factor—1 mA/div at full bandwidth.

C-51/C-50 Trace-Recording Cameras

Two new compact trace-recording cameras have been designed for direct compatibility with the 7000-Series Oscilloscopes. The C-51 and C-50 cameras are basically identical units, differing only in the lens system. The C-51 has an f/1.2, 1:0.5 lens; the C-50 uses an f/1.9, 1:0.7 lens. The C-51 is recommended for single-shot photography at the fastest sweep rates, the C-50 for more general purpose applications. Photographic writing speed of the two 7000-Series mainframes with the C-51 and 10,000 ASA film (without prefogging) is 3300 cm/μs (7704) and 2500 cm/μs (7504).



The cameras offer a new level of operational convenience for mistake-proof trace photography. The guess work normally associated with selection of f stop and shutter speed to match the ASA index and trace brightness is eliminated. After setting the ASA index, the built-in photometer allows a *visual* correlation of trace intensity to the correct f stop setting and shutter speed. After initial adjustment, a change of f stop or shutter speed will still maintain the same exposure. Focusing is accomplished by two beams of light projected on the CRT which, when superimposed, indicates optimum focus. The insert shows the photometer spot and the rangefinder focusing images.

SCOPE-MOBILE® CARTS

The 204-2 Scope-Mobile® Cart is specifically designed for the 7000-Series instruments. It provides a securing mechanism for the oscilloscope, nine positions of selectable tray tilt, a large storage drawer, storage for five 7000-Series plug-ins, and large locking-type wheels.

PROBES

The P6053 is a miniature fast-rise 10X probe designed for full compatibility with the 7000-Series instruments. Input R and C is 10 MΩ, 10.3 pF. Probe risetime is 1.2 ns or less.

The P6052 is a passive dual-attenuation probe designed for measurements below 30 MHz. A sliding collar selects 1X or 10X attenuation. Input R and C is 1 MΩ or 10 MΩ, 100 pF or 13 pF. Risetimes are 60 ns (1X) and 7 ns (10X).

7704 Oscilloscope	$2500
7504 Oscilloscope	$2000
7A11 Amplifier Plug-In	$850
7A12 Amplifier Plug-In	$700
7A13 Amplifier Plug-In	$1100
7A14 Amplifier Plug-In	$575
7A16 Amplifier Plug-In	$600
7A22 Amplifier Plug-In	$500
7B71 Time-Base Plug-In	$685
7B70 Time-Base Plug-In	$600
7B51 Time-Base Plug-In	$510
7B50 Tme-Base Plug-In	$450
7S11 Sampling Plug-In	$450
7T11 Sampling Time-Base Plug-In	$1100
7M11 Dual Delay Line Unit	$250
204-2 Scope-Mobile® Cart	$155
C-51 Trace-Recording Camera	$900
C-50 Trace-Recording Camera	$700
P6052 or P6053 Probes	ea $50

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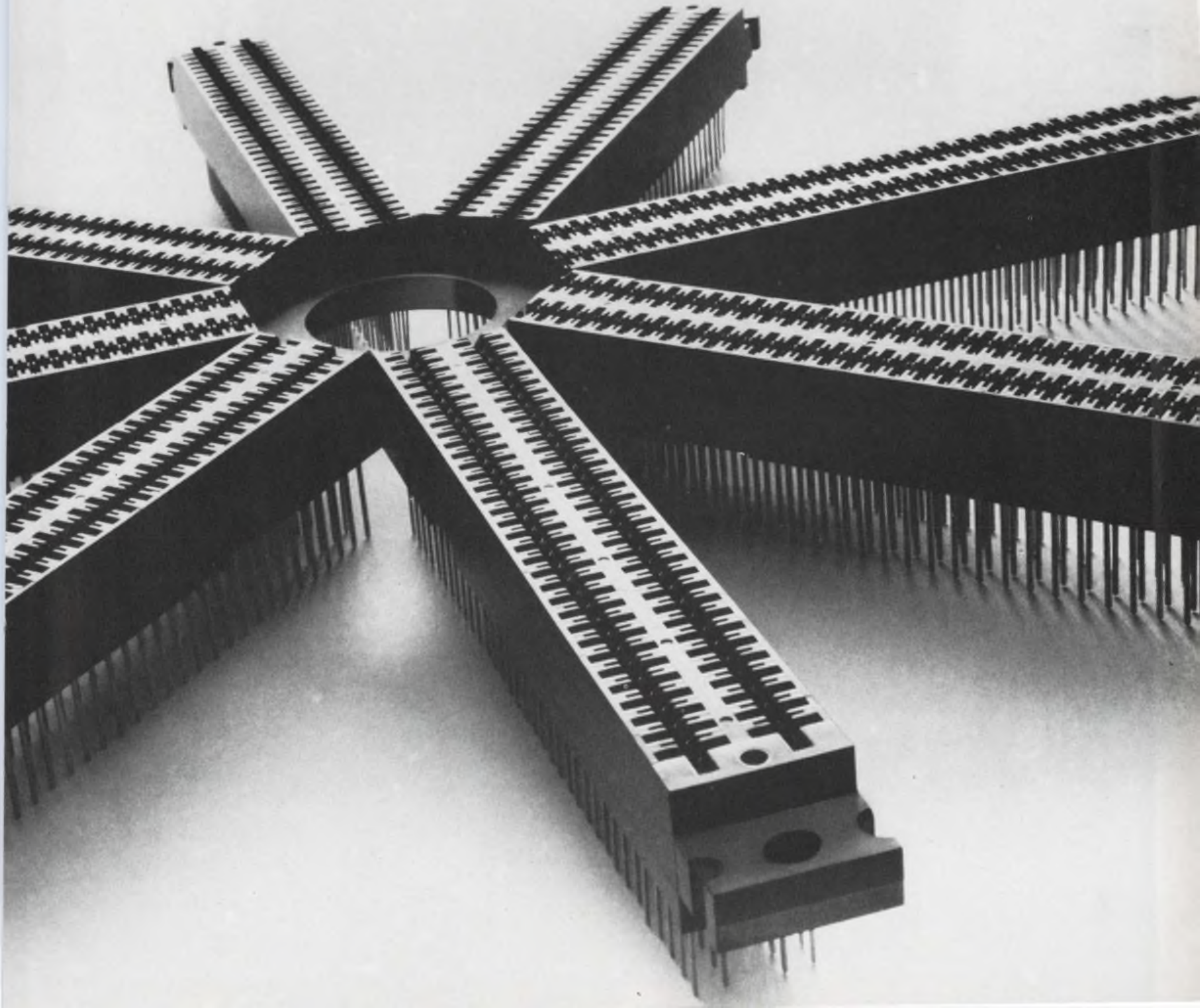

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Consider our tin oxide resistors, they're the best of the metal film class. Because the resistive tin film is completely oxidized and molecularly bonded to the glass core, our tin oxide resistors are impervious to moisture and environmental degradation. No other resistor can deliver the same stability and reliability over load life. They offer guaranteed moisture resistance across all ohmic values to set a standard of reliability that can't be matched by metal film, wire wounds, carbon comps or metal glaze resistors.

No other resistor can give the same value. Our tin oxide resistors offer long term economy over metal film, precision wire wound and metal glaze resistors. And our new C3 resistors, in addition to the benefits of small case size, compete costwise with carbon comps.

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At Corning we make components for guys who can't stand failures. Guys like your customers. Guys like you. Next time you're designing a system, reach for your CORNING® capacitor and resistor catalogs and call your local Corning authorized distributor for off-the-shelf delivery. They'll help you design-in an extra measure of performance.

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ELECTRONICS

INFORMATION RETRIEVAL NUMBER 22

AT THE ELECTRON DEVICES MEETING

Memory designers looking to semiconductors

Arrays reported offering high speed, reasonable cost and the way to improved system organization

Raymond D. Speer,
Microelectronics Editor

Semiconductor memories are coming on strong, according to Jan A. Rajchman, staff vice president, data processing research at RCA Laboratories, Princeton, N. J. Speaking at the IEEE International Electron Devices Meeting in Washington, Dr. Rajchman said that there would be a major take-over of small, fast memory applications by semiconductor memories in the near future.

Integrated magnetic systems—aperture plates, buried-conductor ferrite sheets, etc.—will fall by the wayside, the RCA executive said.

"Even plated wire," he went on, "which shows signs of being economically viable, faces severe competition from semiconductor memories. It is best suited for small, high-speed memory systems—precisely the area in which semiconductor systems do the best job."

Core memory sales, of course, especially in large memory systems of 10 to 20 million bits, will probably be enhanced by the arrival of the semiconductor systems. The RCA expert expects vigorous core markets in the next 5 or 10 years.

Dr. Rajchman predicted that MOS random-access memories would be available at roughly 2¢ a bit in sizes up to 100,000 bits in the next three years or so. They will not be as cheap as core memories—which will cost roughly 1.5¢ a bit—but they will be much faster, he said.

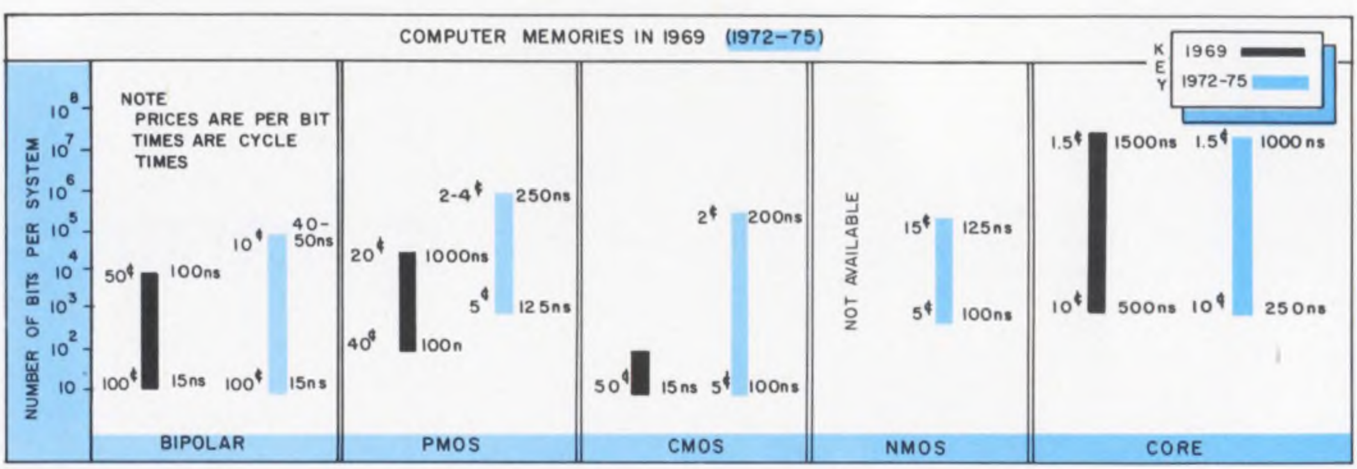
One executive at the meeting—Vir A. Dhaka, manager of technology at Cogar Corp., Poughkeepsie, N.Y.—agreed. He told ELECTRONIC DESIGN that he expects to see bipolar memory systems, such as Cogar plans to sell, going for as little as 10¢ a bit in 1972-73. These systems, he says, will have cycle times as low as 40 or 50 ns and will be available in up to 100,000-bit capacities. He expects MOS systems of approximately 1 megabit capacity by 1973, at as little as 1.5¢ a bit for n-channel MOS arrays. The technology manager predicts p-channel MOS cycle times of roughly 250 ns, and n-channel MOS cycle times of only half this figure.

Dhaka pointed out that few vendors have used the n-channel MOS technology because of process stability problems. Cogar intends to pursue this approach, he said, precisely because it will enable the company to build devices and systems of higher speed. Complementary MOS, Dhaka predicted, will be limited to special applications where its speed and extremely low standby power are required, such as in satellite systems. The complementary process is too expensive to allow wide use of such devices, he added.

'Cache' memory possible

RCA's Dr. Rajchman also predicted that combinations of memories—large-capacity, slow memories and small-capacity, fast "cache" memories—would prove an important application of semiconductor units. The cache memory is situated between the processor and the large main memory, and data to be processed is first transferred to the cache.

The combination, with proper design, behaves as a memory unit with the capacity of the large memory and the speed of the small cache memory. This is possible because, as Rajchman puts it, "the selection of data in a memory is usually not random; you deal with blocks of data, and if you put the



Computer designers predict falling prices and rising capacities in semiconductor memory. The vast number of variables involved make accurate predictions difficult, but designers expect bipolar system cycle times as low as 40 ns by 1975, for a system cost as low as 10¢ a bit. P-channel MOS and complementary MOS are expected to offer about the same system performance, with the extremely low-power complementary circuits being more expensive. The MOS cycle times shown are for systems employing bipolar decoding circuits.

right block in the fast cache memory during its processing, you benefit greatly in speed."

Content addressable coming?

Semiconductor memory arrays will make small content-addressable memories feasible, too, Dr. Rajchman said. Semiconductor arrays offer fast operation at a reasonable cost, and the new memory organization will enable computers to retrieve data both by memory address and by content, he asserted.

In a content-addressable memory, some of the bits of information stored at each address are reserved, to be used as "tag" bits. When a certain word of information is required from the memory, all addresses are interrogated at once. The address in which the proper tag bits are stored is flagged by special logic circuitry, and the information at that address is read out.

Content-addressable organization has not been feasible with core memory because the need for logic circuitry at each memory address makes such memory exceedingly costly.

Semiconductor integrated memories will succeed where integrated magnetic memories have not, Dr. Rajchman said, because they provide high speed, the technology required is available and the cost of the large semiconductor chips is reasonable.

"Right now," the RCA official said, "random-access memories of from 16 to 256 bits capacity are in production, at costs ranging from 25¢ to $1 per bit, depending on their speed."

The high speed of semiconductor memories is also attractive. As Charles Fa, technology vice president at Advanced Memory Systems, Inc., Sunnyvale, Calif., points out, bipolar memories have made possible cycle times of as little as 40 to 50 ns. These are just not attainable with magnetic memory. And the less expensive MOS semiconductor memories, which operate at roughly 1-μs cycle times, now compete in speed with the fastest core memory. The result is expected to be a marked de-emphasis on magnetics in the next few years.

Systems designers exult over the advantages offered by the new memories.

"Semiconductor memories are marvelous," Dr. Rajchman said. "You have tremendous nonlinearity in the flip-flops, tremendous gain, and since the memories are made of very pure materials and can be easily integrated, they are very reliable.

"The only problem that remains is that of making contact to the chip; this is by far the weakest part of the semiconductor memory. But in view of the strides made recently in thin-film work, the fantastic progress in diffusion technology and enormous gains in photolithography techniques, we can certainly master the challenge of connecting one chip to another. This won't be a great problem." ■■

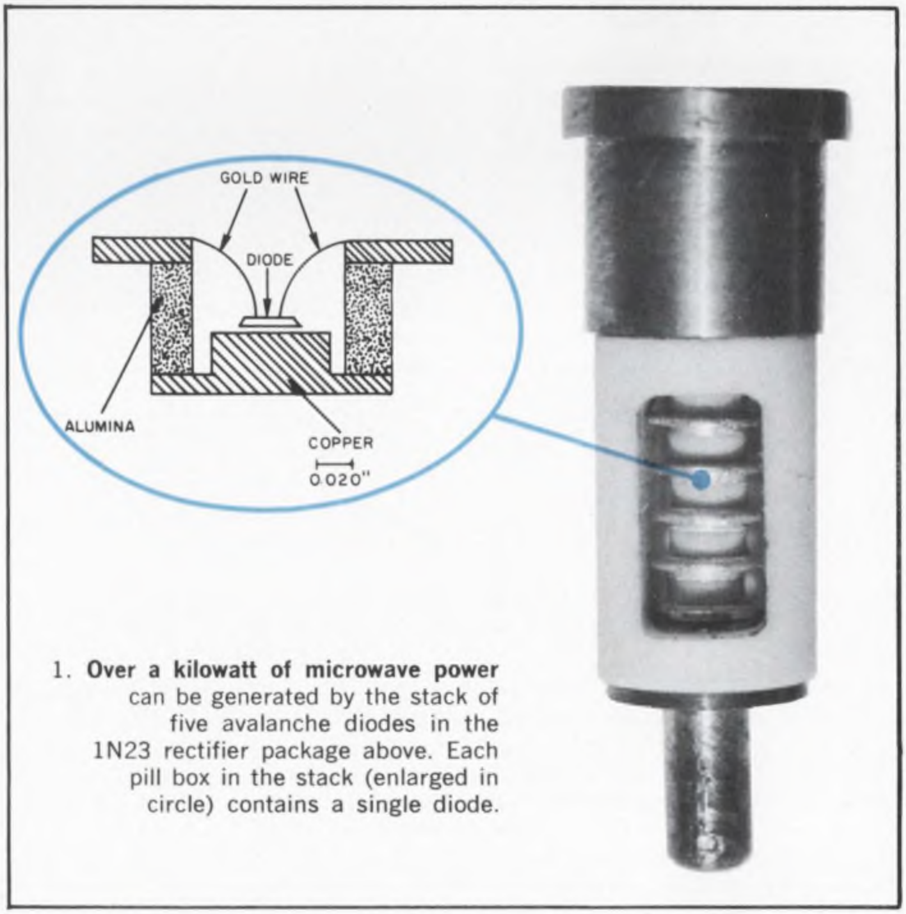
Microwave diodes break kilowatt barrier

Michael J. Riezenman
Technical Editor

By stacking five avalanche diodes in series and operating them in the high-efficiency mode, S. G. Liu and J. J. Risko, researchers at RCA Laboratories, Princeton, N. J., have obtained peak pulse powers of 1.2 kW at 1.1 GHz. The 1.2-kW figure was obtained at an efficiency of 25.6%. According to Dr. Liu, who described the work at the International Electron Devices Meeting, this is the highest power achieved so far with avalanche devices.

Significant advances in millimeter-wave IMPATT diodes were also announced at the IEEE meeting. A team of scientists from Bell Telephone Laboratories, Murray Hill, N. J., reported the development of 50 and 100-GHz silicon IMPATT diodes that, together with circuit improvements, have advanced the technology in this area.

In the avalanche-diode development, the highest duty cycle obtained with the stacked series was 0.1%. However, Dr. Liu explained that thermal considerations were the only real limitation. This



1. **Over a kilowatt of microwave power** can be generated by the stack of five avalanche diodes in the 1N23 rectifier package above. Each pill box in the stack (enlarged in circle) contains a single diode.

(**Microwaves diodes,** *continued*)

means, he said, that improved packaging techniques—such as the use of beryllium oxide for heat-sinking—should make higher duty cycles possible. He expects to reach 1.0% by using BeO.

If these efforts are successful, the stack should have applications in such low-power areas as aircraft radar transponders.

The series arrangement of the diodes is better than a parallel hook-up, the researchers said for these major reasons:

- The devices are current-controlled; so placing them in series makes it unnecessary to match them carefully.
- The devices have fairly low impedances; so putting them in series makes it easier to interface them with the higher-impedance external circuitry.

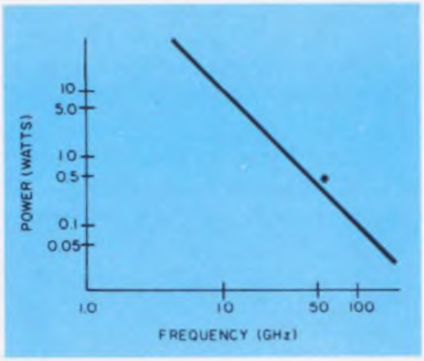
Diodes with breakdown voltages that varied from 130 to 140 V were found to work quite well together in series. And the maximum power put out by the five-diode stack exceeded the sum of the top powers put out by each diode.

Stacking pills for power

In fabricating the five-diode stack, the researchers mounted the diodes in individual pill boxes, and then stacked the pills in a modified 1N23 package (Fig. 1). This arrangement was considered good because it permitted the entire stack to be treated as a single circuit component, while allowing access to the individual diodes for testing and replacement.

In the experimental work, the frequency of the multiple diode was tuned mechanically, in steps, from 0.9 GHz to 1.3 GHz, with a power variation on the order of 2 dB. Most of the testing was carried out with 0.5-μs pulses at a repetition rate of 400 Hz. Current pulses up to 10 A were applied to the stack.

A major problem in getting large amounts of power out of any avalanche diode is the formation of microplasmas. These are structural defects that manifest themselves as non-uniformities in the current density across the diode junction. Since the diodes are operated far



2. **More than 100 mW** separate the new Bell Laboratories' diode (dot) from the state of the art.

into the avalanche region, high-power operation implies tremendous current densities in the diode.

If the current density across the junction is not uniform, the higher-density regions may overheat and cause the device to burn out. Reliable high-power operation demands the removal of these local hot spots or microplasmas.

Toward this end, the RCA researchers made their diodes with very deeply diffused junctions. Boron was diffused into an n-type epitaxial layer of silicon to a depth of 8 to 15 μm. This resulted in a diode with a graded p-region—one that seemed freer of microplasmas than abrupt-junction types.

Actually Dr. Liu is not certain whether it's the graded p-region that eliminates the microplasmas or simply the long time and high temperature associated with a deep diffusion. He reasons that a prolonged high-temperature diffusion might have a thermal curing effect on the junction, making it more homogeneous and eliminating the structural faults that cause microplasmas.

In any event, the deep diffusion works, because diodes diffused to depths below 8 μm were very susceptible to burnout as soon as they were pulsed with a high current.

Millimeter-frequency advances

Dr. R. Edwards delivered the paper reporting Bell Telephone Laboratories' millimeter-frequency advances. As he explained it, most engineers recognize that the power available from a millimeter-wave IMPATT diode is inversely proportional to the square of the frequency. The line in Fig. 2 shows the best performance previously available—it passes through 10 W at 10 GHz and through 100 mW at 100 GHz. The dot at 55 GHz represents a 450-mW device that operates with an efficiency of 7 to 10%. (Note that the dot at 450 mW is actually 120 mW above the line, although the logarithmic graph makes it appear quite close.)

In addition a 74-mW diode operating at 107 GHz was developed. Its best observed efficiency was 2.2%.

The millimeter-wave diode developments—impressive as they are as pure R&D efforts—have great potential significance in communications ttchnology. As Roland H. Haitz of Texas Instruments' Physics and Engineering Div. in Dallas has pointed out, the diodes have increased the practicality of large-scale communications through millimeter waveguide. Haitz was particularly impressed by the achievement of 10% efficiency at 55 GHz.

Bell Laboratories has been experimenting with buried millimeter waveguide for some time now in anticipation of increased communications needs. The extremely high information-carrying capacity of a millimeter-wave carrier, combined with the great problems of atmospheric attenuation at those frequencies, has made the use of buried waveguide a viable approach for providing long-haul communications in the future—and this despite its enormous cost. The development of efficient, reliable, solid-state sources has moved this possibility a step closer to reality.

Slimming the silicon

The diodes fabricated to generate the 50 and 100-GHz oscillations, were silicon devices of the p^+-n-n^+ type. At these frequencies, the parasitic series resistance of the n^+ substrate is a serious problem and steps must be taken to reduce it.

The most straightforward way to reduce the series resistance is to make the substrate as thin as possible. The Bell researchers did this by mechanically polishing the silicon slice prior to metallizing it. Slices with thicknesses in the range of 5 to 10 μm were successfully made in this manner. ■■

LOW PROFILE

hot-molded trimmer for close circuit board stacking

Basic Type Y unit shown actual size

With wheel for side adjustment

With attachment for horizontal mounting and wheel for side adjustment

With attachment for horizontal mounting

Type Y single turn trimmer is especially designed for use on printed circuit boards. It has pin-type terminals for use on boards with a 1/10″ pattern. And the low profile easily fits within the commonly used 3/8″ space between stacked printed circuit boards.

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While featuring a new low profile, this new Type Y trimmer retains the popular Allen-Bradley solid resistance element, which is produced by A-B's exclusive hot-molding technique. With virtually infinite resolution, adjustment is smooth at all times. Being essentially noninductive, the Type Y can be used at frequencies where wirewound units are inadequate. The Type Y is rated 1/4 watt at 70°C and is available in resistance values from 100 ohms to 5.0 megohms. Standard and special tapers are available.

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Type Y with handy snap-in panel mount, supplied with spacers for use on panels up to ⅛″ in thickness

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QUALITY ELECTRONIC COMPONENTS

EC 69-55A

The hospital comes to the patient.

Mobile coronary-care unit developed to bring intensive cardiac treatment to heart-attack victims.

David N. Kaye
West Coast Editor

You may be one of the 300 lucky people whose lives are expected to be saved this year, if you should suffer a heart attack in the Los Angeles area served by the special mobile coronary-care ambulance being tested by Daniel Freeman and Centinela Valley Community hospitals.

In less than 10 minutes from the time the doctor calls the hospital, within a 5-mile range, the patient is aboard—not an ordinary ambulance but actually a traveling hospital room with complete electronic instrumentation for diagnosis. The doctor or nursing specialist can begin treatment at once.

And speed is essential, according to Mrs. Sandra Polin, coordinator of the two-year study program now in its first year. An estimated 65% of all heart-attack deaths occur within the first hour, and between 17% and 25% occur enroute to the hospital in an ambulance.

Diagnostic equipment used

The cardiac monitoring and intensive-care instrumentation carried on the ambulance is the same equipment found in the normal hospital coronary-care unit. Dallons Instruments, a div. of International Rectifier Corp. in El Segunda, Calif., donated most of the instruments.

In order to make a precise analysis of the patient's condition on the way to the hospital, the test ambulance is outfitted with a five-inch cardioscope with heart-rate meter; a defibrillator; a pacemaker; an elapsed time-indicator; and an electrocardiograph (ECG).

A cardioscope is a cathode-ray-tube device that picks up the electrical signals generated by the heart. Any arrhythmia (deviation from the normal pattern) indicates a problem. Each type of problem yields its own characteristic trace on the cardioscope.

Counting and averaging the patient's pulse rate is the function of the heart-rate meter. A direct readout of the average rate is given, and an alarm is automatically triggered if the heart rate goes either above or below adjustable safe limits. At the same time, it turns on auxiliary equipment, such as the ECG recorder, to provide a permanent record of the attack.

Any electrical signals that can be detected and displayed on a cardioscope can be recorded on a strip of paper by the ECG. This permits analysis by the cardiologist at the hospital of what has transpired since the patient reached the ambulance.

When the heart ceases operating in a normal rhythmic pumping action, a common treatment is electric shock. The defibrillator provides a brief electric shock, sometimes as large as 3000 volts, that makes it possible for the heart to be restarted in a productive, rhythmic blood-pumping action.

The pacemaker of the human heart generates the electrical signal that causes the heart to contract at the proper moment, billions of times during a normal life. If the natural pacemaker stops sending its signals, the electronic pacemaker in the ambulance is used to provide the impulses to the heart.

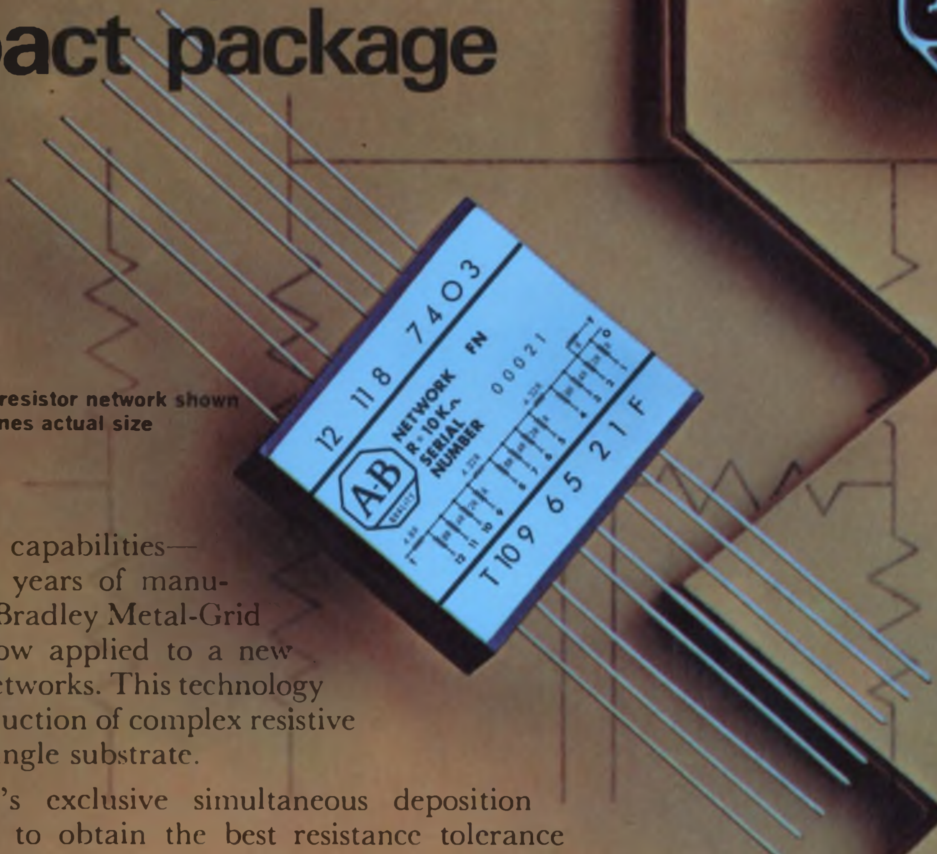
Finally, the elapsed-time indicator is a timing device automatically triggered by an emergency condition. It permits the medical personnel to determine exactly how long the condition has existed.

An additional but very important piece of equipment carried on the ambulance is a portable combination cardioscope and defibrillator. The unit weighs about 35 pounds and is called the Physio Control Lifepack. It is made by Physio Control Corp. in Seattle, Wash.

Dr. Walter S. Graf, chief of cardiology at Daniel Freeman Hospital and president of the Los Angeles County Heart Association, and two members of the coronary-care-unit team view the converted step van.

ALLEN-BRADLEY
Metal-Grid resistor networks
combine a new measure of

precision, stability and performance in a sealed, compact package



Precision Metal-Grid resistor network shown approximately 1½ times actual size

The advanced capabilities—developed from years of manufacturing Allen-Bradley Metal-Grid resistors—are now applied to a new line of resistor networks. This technology enables the production of complex resistive networks on a single substrate.

Allen-Bradley's exclusive simultaneous deposition method is used to obtain the best resistance tolerance and temperature coefficient matching. The reliability of interconnections on the common resistance plane is incomparable. Uniformity and quality are inherent in A-B networks. To illustrate, 2 PPM temperature tracking is normal.

A-B Metal-Grid networks offer a wide range of values—with individual resistances as low as 25 ohms and as high as 30 megohms. Both the inductance and capacitance are low, permitting efficient operation at high frequencies.

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BRIEF SPECIFICATIONS

Resistor Networks

Tolerances: ±1.0% to ±0.01%

Resistance Matching: to 0.005%

Temperature Range: −65°C to +175°C

Temp. Coef.: to ±3 ppm/°C

Load Life (Full load for 1000 hr @ 125°C): 0.2% maximum change

Ladder Networks

Full Scale Accuracy: 12 bits or less, better than ±¼ least significant bit. More than 12 bits, better than ±½ least significant bit.

Frequency Response: Less than 100 nanosecond rise time or settling time.

Temp. Coef.: Less than 10 ppm/°C

Temperature Range: −65°C to +175°C

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EC69-57A

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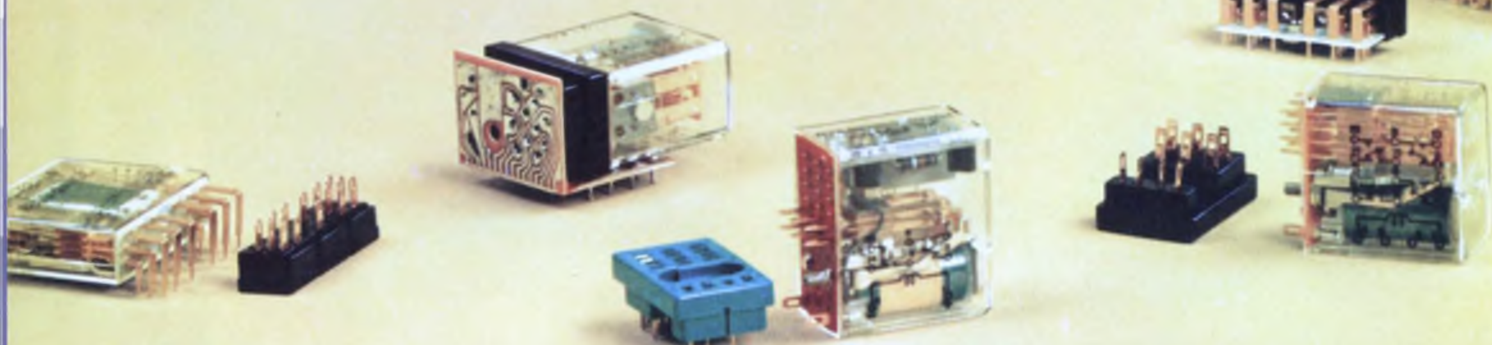


Reliable cradle relay switches up to 8 poles from dry circuit to 10 amperes

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.

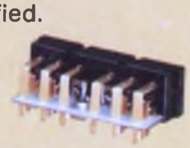
Design innovations, resulting in the optimum distribution between the magnetic core, the pole piece cross sections and coil volume, with a low reluctance armature bearing produce a large force-displacement product. The result: high contact pressure and generous over-travel.

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.

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(**ambulance,** *continued*)

Electronic monitoring equipment is mounted inside the van within convenient view of personnel on either side of the stretcher.

The nurse on the ambulance can take the unit right into the patient's home and, if necessary, administer treatment immediately.

An electronic monitoring system in the ambulance can automatically transmit the patient's electrocardiogram directly to the coronary-care unit in the hospital. Two-way voice communication between hospital and ambulance provides consultative assistance if necessary.

Past and future trends

Coronary-care-unit ambulances were first developed by the Royal Victoria Hospital, Belfast, Ireland, and since by St. Vincent's Hospital and Medical Center in New York City. These vehicles are ordinary ambulances, which contain some extra equipment. Yet in the first two months of service by the New York ambulance, 77 calls were answered with 74 of the victims recovering.

Earlier this month the Orange County Medical Association displayed, in Santa Ana, Calif., a coronary-care helicopter. This machine, also equipped with Dallons instruments, is the first prototype of a flying coronary care unit. It would be able to cover far more territory, far more quickly, than a land vehicle.

But many problems are yet to be solved if helicopters are to become practical. For example:

- Must the helicopter land? Or can some kind of sling or gondola be used to raise the patient to it?
- Must special instruments be developed for airborne use? Or can the standard hospital models suffice?
- Who will pay for the use of the helicopters?

Meanwhile, in Los Angeles, Mrs. Polin points out, "In this pilot program an area will be served which has a population of about 800,000 people. Last year this area had about 2,240 cardiac deaths. We feel that we can save at least 300 of those people." ■■

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Both relays are available with DPDT contacts or DPST, normally open or normally closed. Equipped with .250" quick connect terminals. Screw terminal adapters are available.

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ABC Relays Heavy Metal Dust Cover

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Start with the basic 12-bit H112 controller – 4K ICM-160 core memory, control logic, power supply and drawer. Costs under $5K.

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Washington Report

CHARLES D. LAFOND
WASHINGTON BUREAU

Will Nixon cut defense budget?

Let's hope President Richard M. Nixon likes puzzles—because he has to solve the biggest puzzle since he took office when he prepares the fiscal 1971 budget request for Congress.

He has several problems to juggle. His first goal will probably be to keep the total under $200 billion. It has never before passed that level. Then there is an inflationary trend that steadily eats into the buying power of his appropriations. And there is a vast number of rigidly fixed annual expenditures. In addition, everyone is clamoring for increased nonmilitary outlays for a number of national projects, such as poverty, pollution, and transportation. If he wants a fiscal surplus next year—as he undoubtedly does—there appears to be only one answer: severely cut the defense budget. Yet Washington observers who have followed the machinations within the Pentagon and on Capitol Hill during the fiscal '70 budget battles are aware that every military cut is achieved only at the expense of a lot of bloody noses. Defense Secretary Melvin Laird, even while paring $3 billion from military expenditures, has known all along that, with previous commitments, he would have to seek a supplemental appropriation to meet the needs of the current year—possibly as much as $5 billion. And those same Congressmen who fought so hard to limit defense funding also are the first to cry "political bias" when defense cutbacks are made affecting facilities in their states or districts.

The Nixon Administration budget may have some built-in reduction potential. Three programs alone yield $2 billion plus annual decreases if they were eliminated: the Sentinel ABM, MIRV, and the B-1 manned strategic bomber. All could, and probably will, be used as cards on the table during arms-limitation talks with the Soviets. But there are few here in Washington who believe that, if such negotiations are held, they will yield early agreement on specific strategic weapons systems. Even 1972 may be an optimistic date, they predict.

Army needs integrated surveillance

What the Army needs in field electronics during the next ten years is integrated communications systems. This is the belief of Maj. Gen. Walter E. Lotz, chief of the Army's Electronics Command at Fort Monmouth, N.J., and key note speaker before the recent Electronic and Aerospace Systems Convention in Washington. (EASCON '69)

Our ultimate need, General Lotz said, is for systems that might unite the functions of surveillance, target acquisition, night vision, and navigation. He noted gains from today's technology, but suggested that in retrospect our efforts are "rather provincial."

He recounted developments already achieved with sniperscopes, counter-mortar radars, and airborne viewers. "The challenge now presented," he said, "is to coalesce the capability of all of these devices into a single integrated system to extend human sensory preception."

The general said that the broad family of PCM (pulse code modulation) sets comprising the second-generation Army Area Communications System will be operational within the Army in the next few years and will greatly improve long-range reliability and quality.

But present systems rely too heavily on manual switching for tactical voice circuits.

This is slow, inefficient, and costly in manpower. A solution is under way with the Tactical Automatic Switch system, although this approach is not fully digital. There are many other remedial steps being taken, he noted, but they are all interim steps in achieving long-range objectives.

The Mallard Project is one of the most important of these. This integrated approach will bring the entire Army in the field into one single communications design—achieving common equipment and training among the various U.S. services and our allies—the United Kingdom, Canada, and Australia which will help develop and use the system.

Side-looking radar to hunt oil

For the first time, an aircraft will employ a side-looking radar to map a broad area in a quest for oil. Some 20,000 square miles along the eastern slope of the Andes in Ecuador will be surveyed from the air during the next six months. Under a $248,000 contract, Raytheon's Autometric Operation, Alexandria, Va., will transform the radar imagery into mosaics and then into fully interpreted overlays to assist geologists in selecting potential oil sources below the surface of the region.

Side-looking radar will be used because it can penetrate the heavy clouds that almost perpetually cover the area of interest. When the mosaics are assembled, Autometric analysts will compile overlays to depict drainage, geology, geomorphology, soils, and vegetation of the area.

Raytheon says the mapping will be performed from 18,000 feet, and the aircraft will record 6400 square miles in four hours.

Automatic mail terminal planned

A basic design contract for a fully automated "mail terminal" has been awarded Martin Marietta's Orlando, Fla., Div. by the Post Office Dept.'s Bureau of Engineering and Research. The eight-month, $355,000 effort is intended to produce a prototype design for an advanced mail handling, sorting, and distribution facility at a proposed new jetport in the Orlando area in the late '70s or early '80s.

Although a firm physical design for the mail terminal will be made, only an overall general equipment design for the automated hardware will be drawn up, since most of the latter is believed to require considerable development.

Boeing wins lunar rover contract

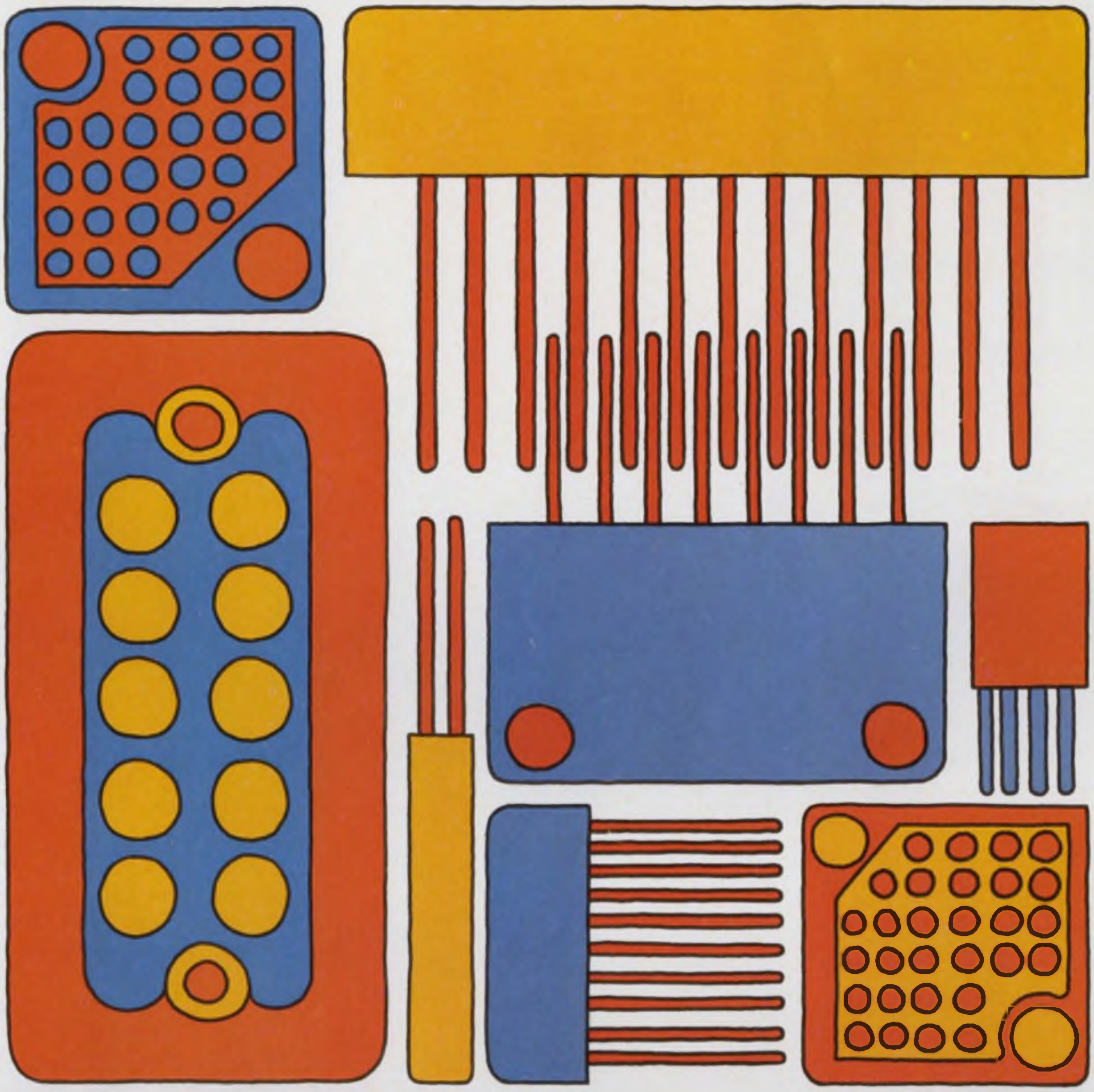
The Boeing Co. has won a $19-million NASA award to build four vehicles to transport astronauts over the moon's surface. Bendix was the loser but is still in competition with Grumman for a follow-on dual-mode roving vehicle that will be used in post-Apollo missions in the mid '70s.

The Boeing rover is planned for use in the mid-'71 period and will give a limited-range (3 to 5 mile) capability to two spacemen. The craft's range is actually nearly 60 miles, but communications and astronaut life-support consumables will limit the trips away from the lunar module.

As prime contractor, Boeing will build the main frame, integrate all systems, and test the craft. The principal subcontractor is AC Electronics Div. of GM, which will develop the complete suspension and drive system and the control system. Each wheel will be powered by an electric motor; primary power will be from a battery pack. The vehicle will weigh about 400 pounds.

Aerial mass transit termed practical

A mass-transit system using vertical takeoff and landing (VTOL) aircraft controlled by computer is feasible and economical, according to a recent study made by 19 visiting engineering professors at Stanford University. The study was made under the auspices of NASA and the American Society of Engineering Education. The system was designed for San Francisco but could be applied to any large urban area.



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INFORMATION RETRIEVAL NUMBER 29

Sitting pretty

A seat on top of a toy block doesn't seem like a dignified spot for the Directory Manager of ELECTRONIC DESIGN . . . It's all a fake, as you have probably guessed. This is the first issue in which Greg Guercio's new Product Source Directory appears, and it's on test instruments. The block Greg is sitting on is covered with photos of all kinds of instruments, and it is only about four inches square; Greg was photographed 10 feet away, the block close up—and Greg's photo was cut out and superimposed on the block.

How did Greg get into the directory business? The story starts back in the middle 50s when Greg was working as a representative for an electronics company, and he and an associate noted how hard it was for designers to get hold of—or even get information about—products they needed in their work.

The cover you never saw

Originally the cover for the Oct. 25 issue of ELECTRONIC DESIGN was to have shown aluminum wires bonded to an IC chip. The picture was sent to us by Fairchild Semiconductor, Mountain View, Calif., to illustrate the special report in that issue, "Chip Bonding: Promises and Perils." But before the presses started to roll, East Coast Editor Jim McDermott dug up the radar story behind the recent midair collision at Indianapolis, and a picture of the wrecked jet was substituted at the last minute.

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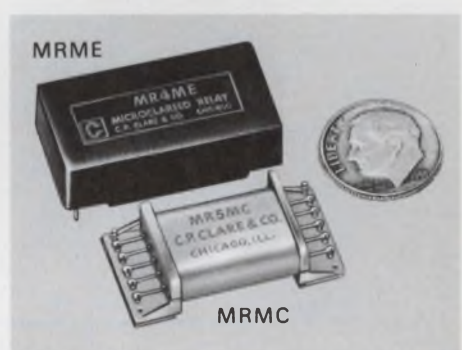
For information, circle Reader Service number, or, call your Clare Sales Engineer or local Clare Distributor. Or write for Data Sheet 961. C. P. Clare & Co., Chicago, Ill. 60645...and worldwide.



- Inherent reliability with no maintenance (Contacts sealed in glass)
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  .125 amp., 28 v: 10 x 10^6 operations
  low level: 100 x 10^6 operations
- 1 to 5 contacts per module—open coil or molded epoxy modules

LOOK FOR CLARE ON THE RELAY

a GENERAL INSTRUMENT company

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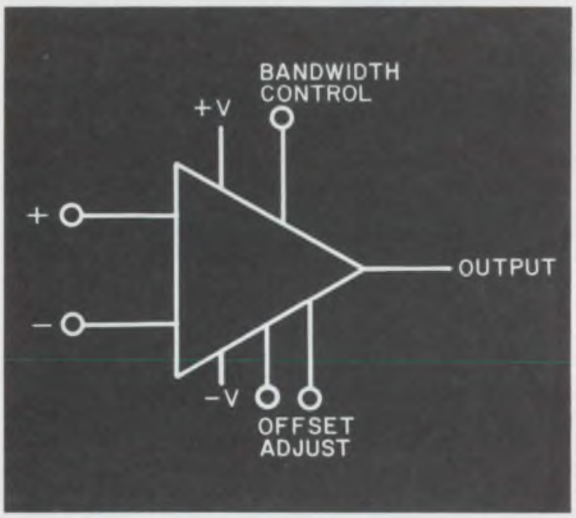
OP AMP FAMILY



FASTEST SLEW RATE

	RA 2520	RA 2510	RA 2500
● Slew Rate	±120v/μs, Av=2	±60v/μs, Av=1	±30v/μs, Av=1
● Voltage Gain	15000	15000	30000
● Large Signal Bandwidth	2000kHz	1000kHz	500kHz
● Gain Bandwidth	24mHz	12mHz	12mHz
● Offset Current	10 nA	10 nA	10 nA
● Offset Voltage	4 mV	4 mV	2 mV
● Output Current	±20 mA	±20 mA	±20 mA
● Input Impedance	100 megohms	100 megohms	50 megohms
	Non-Compensated	Fully Compensated Stable at Unity Gain	

HIGHEST IMPEDANCE

RA 2600
- Input Current = 2 nA
- Input Impedance = 200 megohms
- Slew Rate (at unity gain) = ±7v/μs
- Gain = 200,000
- Gain Bandwidth = 12 mHz
- Short Circuit Protected
- Fully compensated (stable at unity gain)

LOWEST NOISE

RA 909A
- Equivalent Noise Input = 1.0μV RMS
- Gain Bandwidth = 7 mHz
- Slew Rate (at unity gain) = +5,-2.5v/μs
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EDITORIAL

Product-selection headaches and how to cure them

This issue of ELECTRONIC DESIGN contains the first in what is going to be a continuing series of Product Source directories. Each of these will list comparative specifications and prices for products in one or more categories frequently purchased by design engineers.

When used wisely, the directory information should take many headaches out of the designer's specifying and purchasing chores by providing in one place sufficient data for narrowing the choice to two or three possible products. A final decision can then be made from studying manufacturers' literature.

To make the directories as easy to use as possible, various features are built into them, and others are planned. For example, all directory pages will be blue so that they can be recognized quickly.

Also, all products will be listed in ascending or descending order of some major parameter, and the table column containing the parameter will be easily identifiable.

Additional features of the directories will be the inclusion of complete names and addresses of all manufacturers in the particular product category, as well as cross indexes for locating manufacturers' model numbers within the tables.

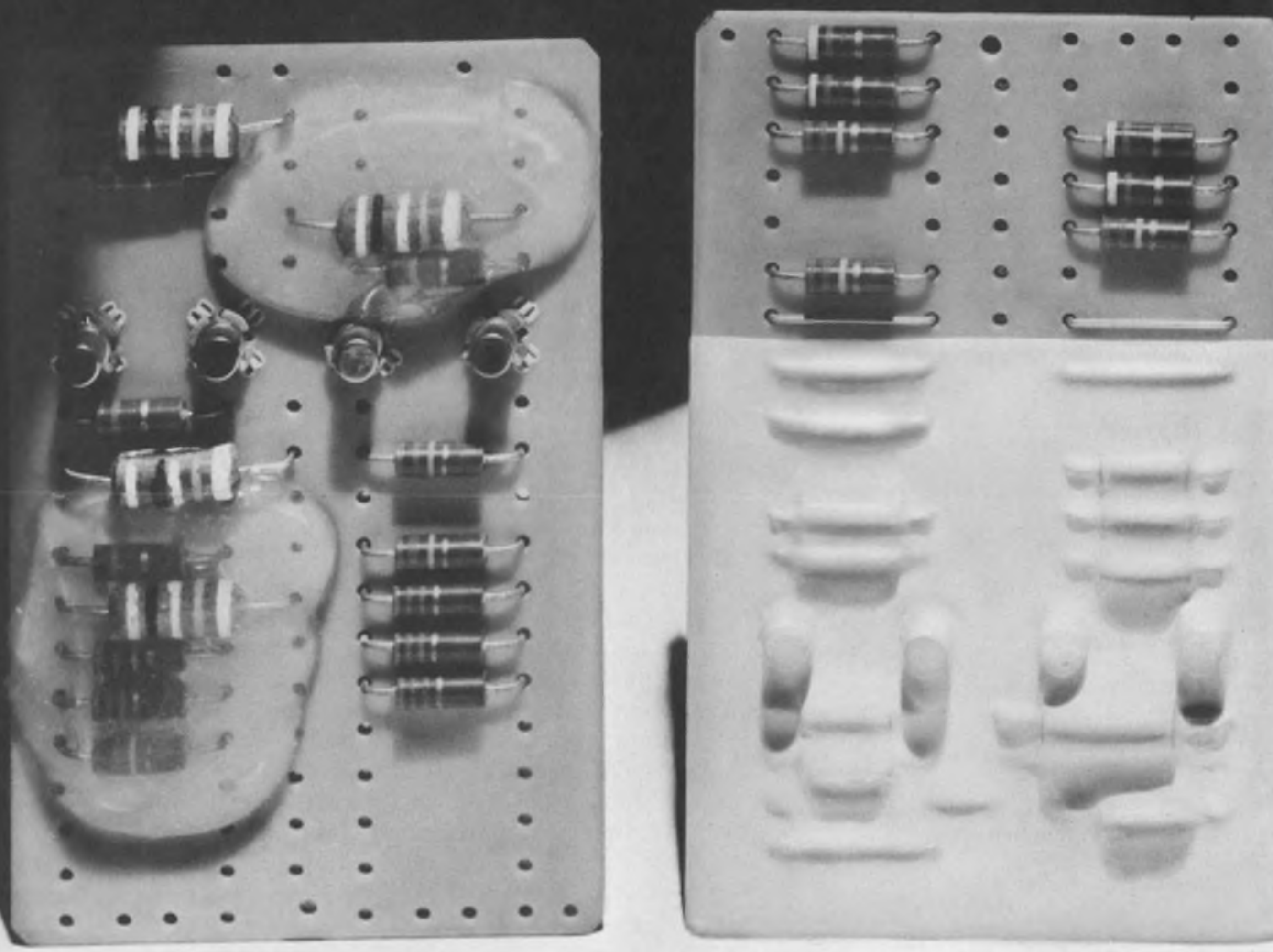
As the total number of published directory pages grows, locating a particular product category could become increasingly complicated. To ease this problem, indexes will be published periodically for all directory material. These indexes will refer to product tables by means of the number appearing at the upper right of each table. For example, the oscilloscope table appearing on page D40 of this issue is table 9.

So if you clip the directory pages from each issue and set up your personal Product Source directory file, keep the tables in numerical order, according to these numbers.

When using the directories, remember that their purpose is to help you, the design engineer. And should you have any comments, criticisms or suggestions for improvement, let us know. Maybe we can work together to serve you.

FRANK EGAN

Dow Corning presents four new star performers on the electronic circuit.



Now you see it

New Dow Corning® 3144 noncorrosive RTV adhesive/sealant is translucent to clear. You should see the job it does for corrosion-sensitive electrical or electronic equipment. It's a high-strength adhesive, too, cures at room temperature, and remains stable when the heat's on (long term to 250°C, short term to 300°C).

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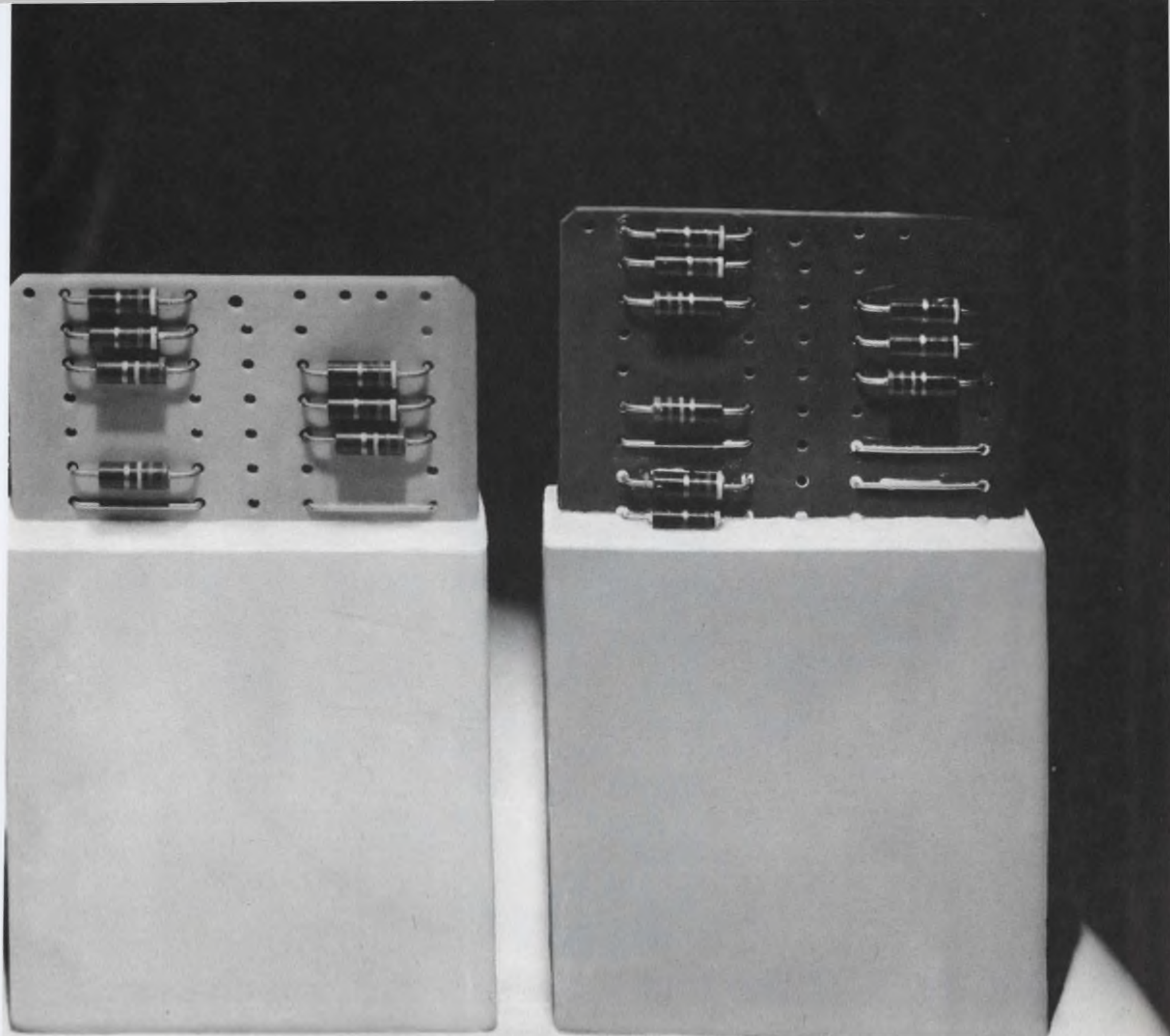
In case you have something to cover, use new opaque (white) Dow Corning® 3141 noncorrosive RTV coating. A new cross-linking prevents the buildup of corrosive by-products during cure. It's easily processed, easy to repair, and stays rugged in harsh environment.



Effective immediately

New Dow Corning® 3101 low-density potting and encapsulating resin is ready for service right after cure. No postcure is necessary. And it cures in unlimited thicknesses in 24 hours at room temperature. It's great for potting aerospace electronic systems or for anywhere you need low-density and reversion resistance.

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There are many more encapsulants, coatings, and adhesive/sealants where these came from. Learn about them. On your letterhead, write Dept. B-9300, Dow Corning Corporation, Midland, Michigan 48640.

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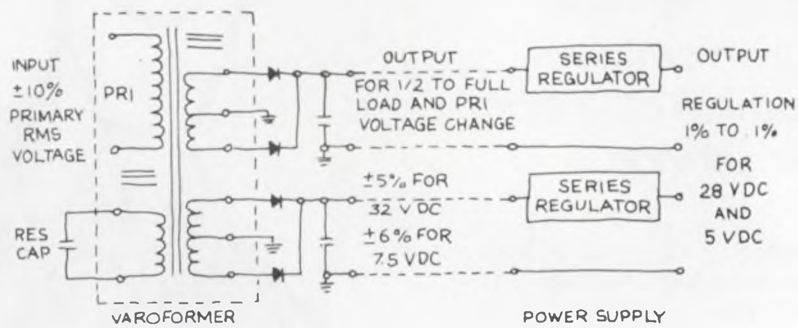

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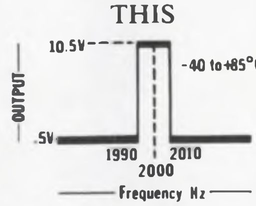

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INFORMATION RETRIEVAL NUMBER 51

CROWBAR...?

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Long established as preferred system supplies for component aging, production testing, and special applications, these supplies have now been redesigned and expanded to meet the stringent demands of today's power supply user. Advantages include low ripple (peak-to-peak as well as rms), well-regulated constant voltage/constant current DC with outputs to 60 volts and 100 amps.

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Prices start from $350. For complete specifications and prices, contact your local HP Sales Office or write: Hewlett-Packard, New Jersey Division, 100 Locust Avenue, Berkeley Heights, New Jersey 07922 or call (201) 464-1234 . . . In Europe, 1217 Meyrin, Geneva.

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CROWBARS
A Technical Discussion

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Circle # for details 326

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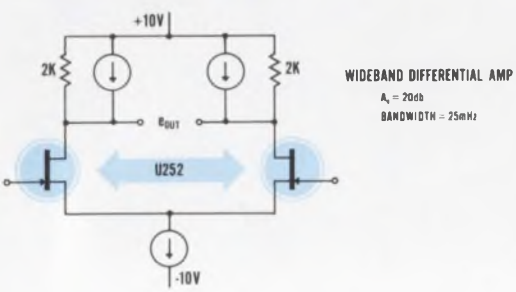
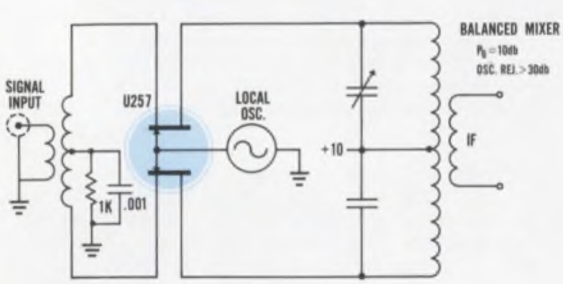


CHARACTERISTIC	SYMBOL	MIN	MAX	CONDITIONS
Transconductance	g_{fs}	5,000 μmho		
Input Capacitance	C_{iss}		5 pF	$V_{DG} = 10V$
Offset Voltage	$\lvert V_{GS1} - V_{GS2} \rvert$		10 mV*	$I_D = 5$ mA
Differential Voltage Drift	$\lvert V_{GS1} - V_{GS2} \rvert / \Delta T$		20 μV/°C*	

* The U253 has an offset of 20 mV and a differential drift of 40 μV/°C Max.

Balanced Mixer The FET's square law characteristic allows this mixer to handle large dynamic signal power while producing low spurious products. Oscillator power drive requirements are extremely low, thanks to the FET's high input impedance.



CHARACTERISTIC	SYMBOL	MIN	MAX	CONDITIONS
Transconductance	g_{fs}	5,000 μmho		
Input Capacitance	C_{iss}		5 pF	$V_{DG} = 10V$ $I_D = 5$ mA
Offset Voltage	$\lvert V_{GS1} - V_{GS2} \rvert$		100 mV	

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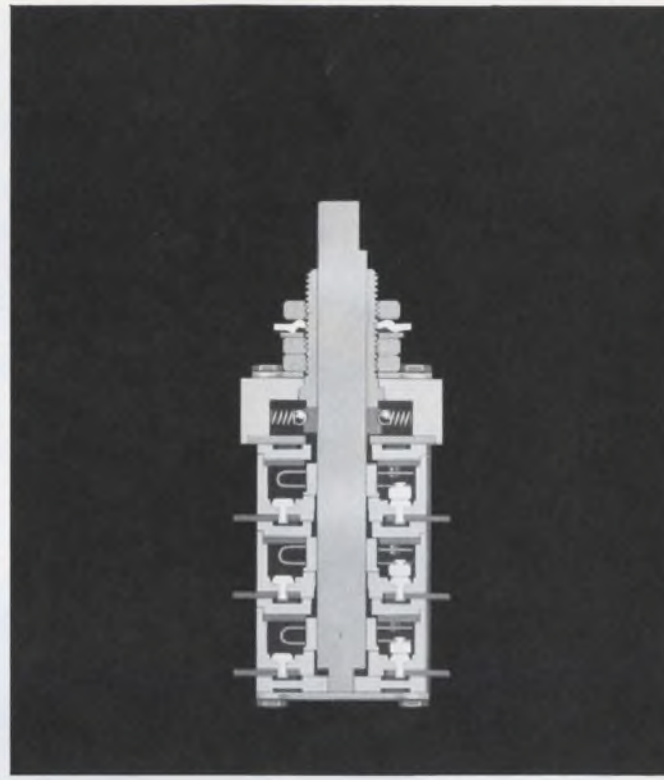

JANCO BUILDS ROTARY SWITCHES JUST A LITTLE BETTER THAN TODAY'S REQUIREMENTS!

[HERE'S THE INSIDE STORY]

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Upon examination you would immediately recognize a design simplicity meticulously constructed into a totally enclosed, explosion-proof package affording you the highest degree of protection when operating in a volatile, chemically mixed atmosphere at sea level or altitudes. It is this same design simplicity that utilizes the U-shaped rotor concept which results in low contact resistance throughout the life of the switch.

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Before reaching the optimum in design simplicity a manufacturer must reach for the optimum in materials. Janco Rotary Switches are totally enclosed in high impact, glass-reinforced alkyd MAI-60 for superior mechanical and electrical characteristics. Current conduction is handled by Beryllium copper and solid silver alloy contacts.

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If you are interested in rotary switches that are built to exceed present day requirements, Janco Corporation will send you a wall chart of basic Janco rotary switches. From this chart you can determine the correct switch for your requirements . . . the proper degree of indexing, exact make or break current capacity, and whether single or multi pole construction is available. This chart is your building block to a rotary switch that is built a little better than today's requirements. Send for it today.

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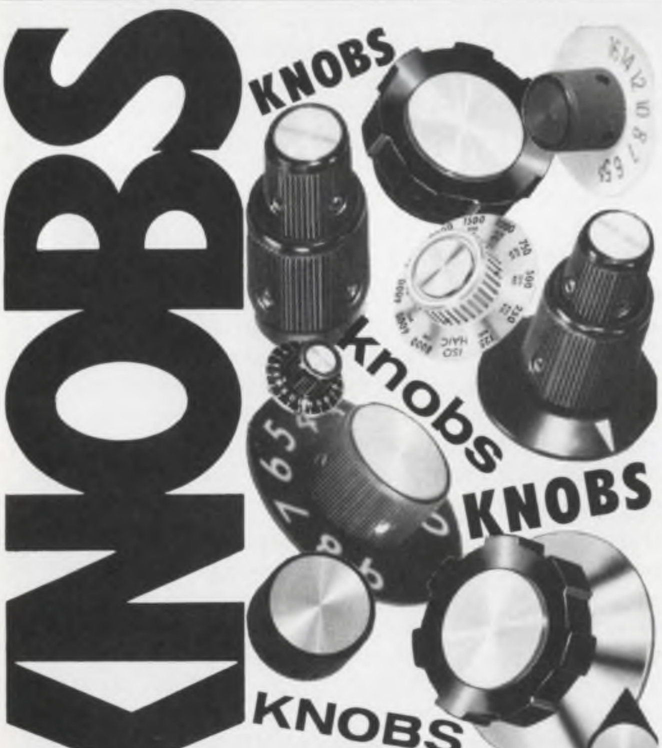

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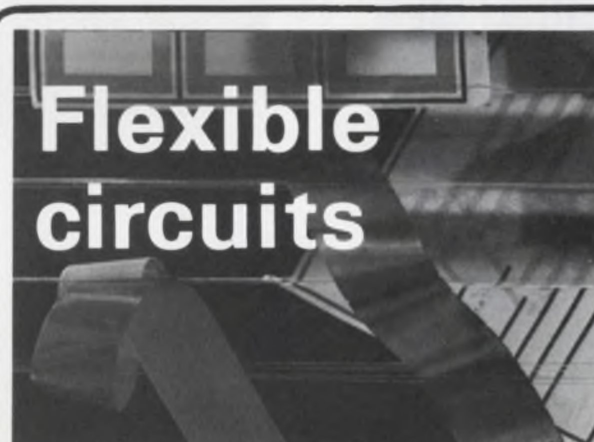

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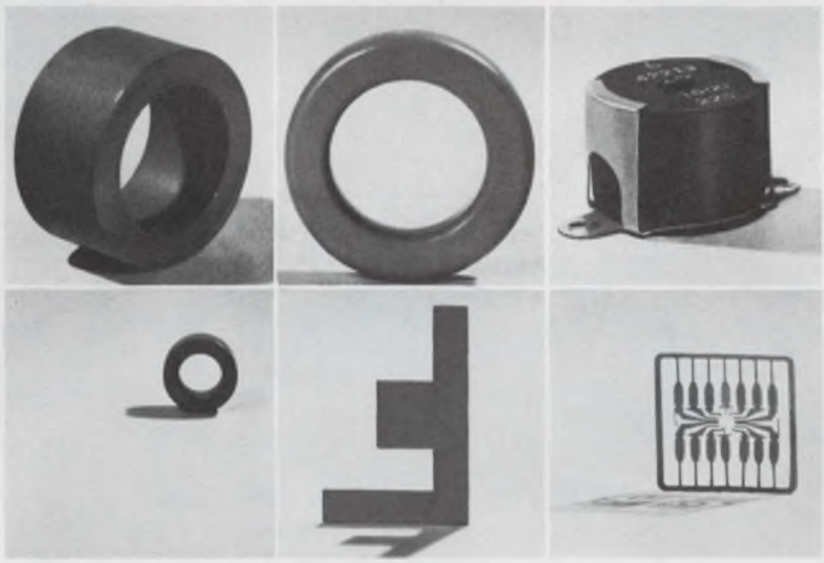

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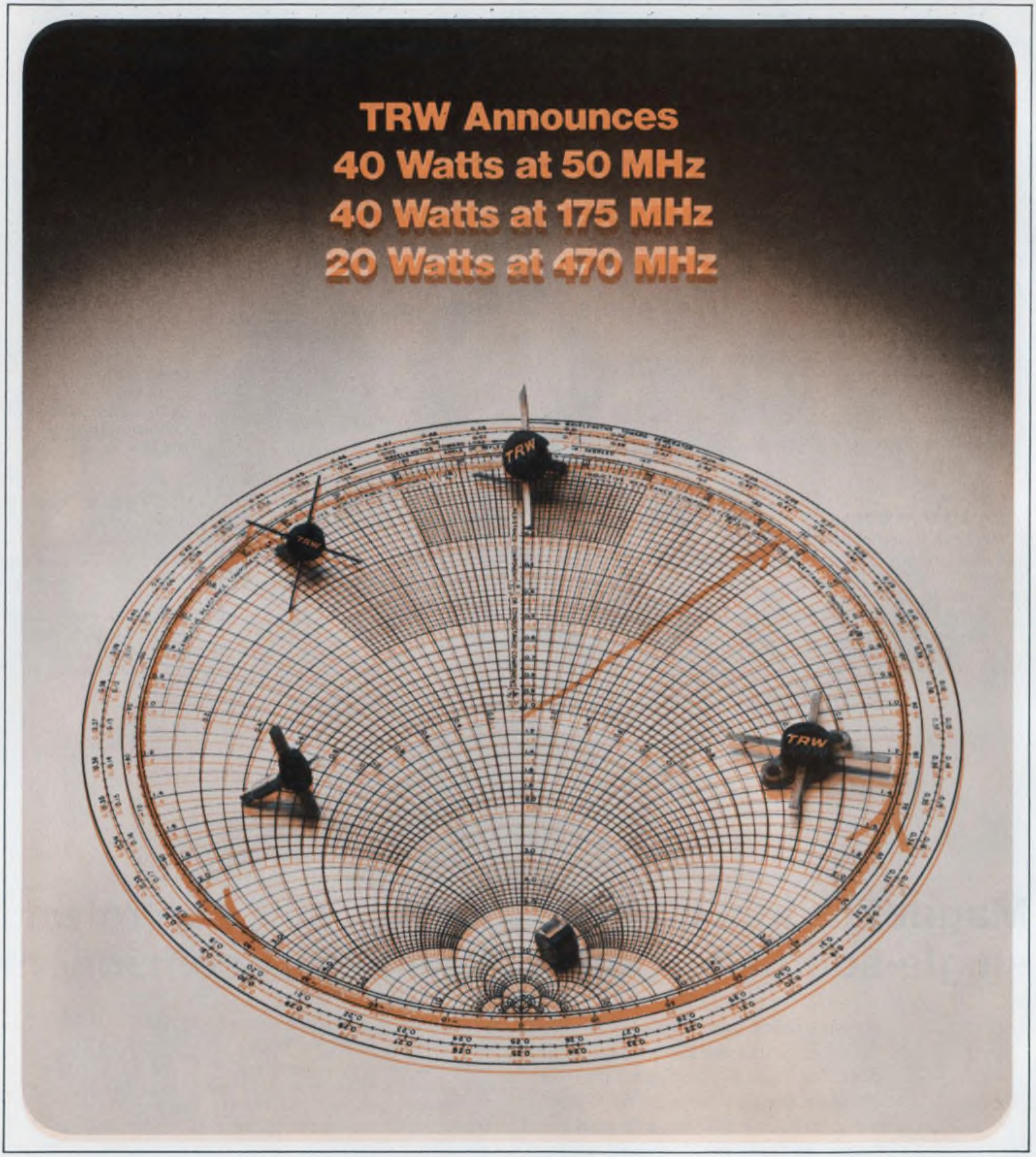

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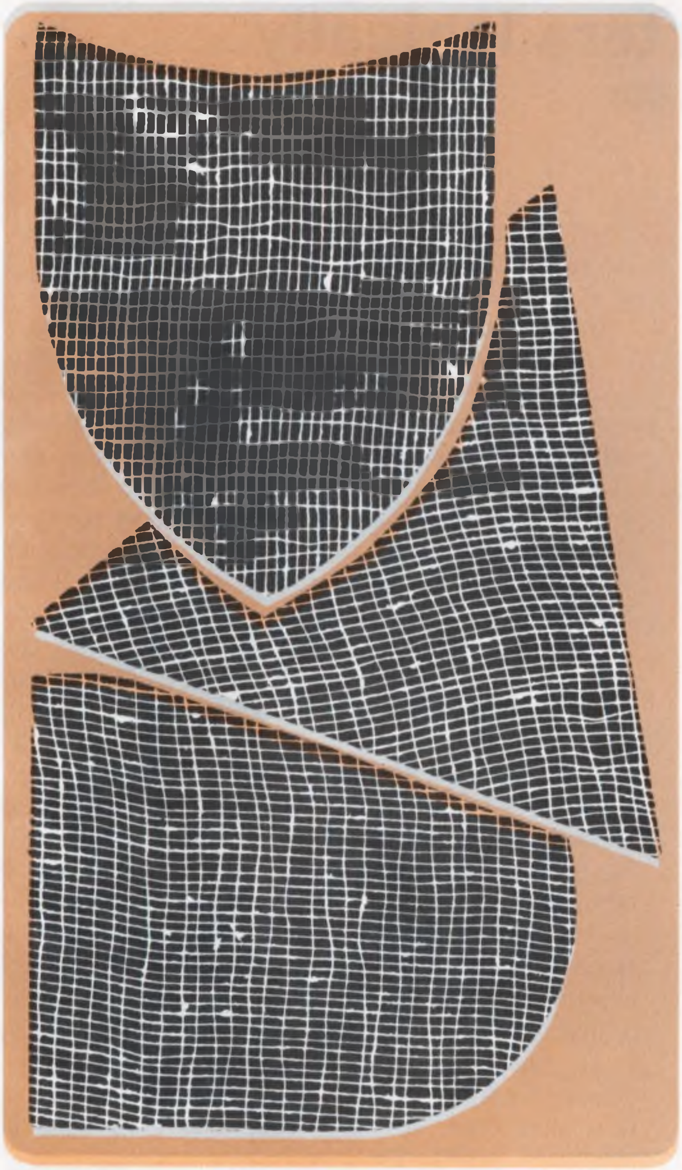
Technology



Build digital converters with off-the-shelf integrated circuits and concentrate your efforts on logical design. p. 66.

Semiconductor officials discuss corporate growth, and the president of one young company is interviewed. p. 84.

Also in this section:

Design digital converters logically.

Use off-the-shelf ICs and concentrate your efforts on logical design.

Part 1 of a three-part article

Digital converters make possible the interchange of data that is otherwise in incompatible forms. Familiar types are the A/D or D/A converters that allow a digital machine to operate between an analog input and output.

The basic types of digital converters discussed in this article are the code and parallel-serial converters. Other types[1,2,3] are not covered here, but the conversion principles also apply to their design.

Code converters are used to translate numbers from one form to another. A number can be written in any one of several binary codes, in decimal code or in binary-coded decimal (BCD) form. If a number in one form is to be operated on in another form, a conversion must be performed.

Parallel-to-serial converters are used to translate data inputs from parallel form, in which all bits arrive simultaneously, to serial form in which all bits arrive sequentially. Serial-to-parallel converters perform the reverse process.

Detailed circuit design may be eliminated from the building of digital converters by using off-the-shelf integrated circuits.[4] The converters described here are constructed from DTL (diode-transistor logic) gates, but the design principles are applicable to other types of integrated circuits. (See Fig. 1.)

Convert decimal to BCD . . .

Figure 2 shows the truth table and simplified matrix diagram for the basic decimal-to-BCD code converter. That is, a converter for changing the input in the decimal number system to an output in the BCD system. Note that each ONE in the output truth table is represented by a corresponding connection in the simplified matrix (logical OR) diagram. A ZERO in the output truth table is indicated by the absence of a connection in the matrix. Thus, $F_8 = 8 + 9$ means that output line F_8 will be HIGH when either input decimal line 8 or 9 or both are high. Similarly, F_4 will be HIGH when decimal line 4 or 5 or 6 or 7 or all are HIGH, and so on.

Implementation of the code converter of Fig. 2 by means of a diode matrix is illustrated in Fig. 3. In this case, each connection on the simplified matrix diagram is replaced by a diode between corresponding horizontal and vertical lines, and toggle or push-button switches are used as a numerical input keyboard. Synchronization between keyboard and input signals F_i is accomplished by means of a strobe sampling technique (Z_2 and Z_3). The +12 Vdc necessary for diode matrix operation is reduced to +5 Vdc for use with the DTL logic by zener diode 1N3825A. This eliminates the need for two power supplies.

. . . and convert BCD to decimal

Figures 4 and 5 show two different types of BCD-to-decimal converters designed with DTL logic. The one in Fig. 4 displays the numbers 0 through 9 by means of a seven-position readout device that is relay operated. For example, the truth table in Fig. 4 indicates that all outputs except for 3 are HIGH when the decimal "0" is desired. This means that relay coils 1, 2, 4, 5, 6, 7, are energized and all output segments in the display except number 3 are lighted. A "0" is thus displayed. Another relay (not shown) is necessary to display a decimal point.

Figure 5 is a BCD-to-decimal converter for use with an output printer that operates from a higher-voltage +28 Vdc power supply.

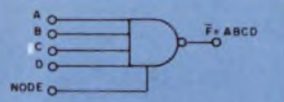
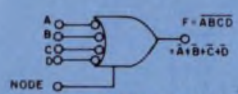
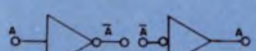
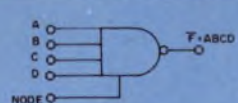
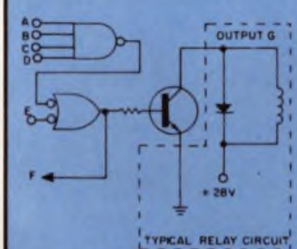
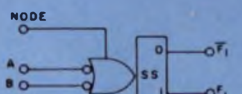
Figure 6 shows the conversion of binary to BCD. ■■

(illustrations continued on pages 68, 69 and 70)

A. H. Frim and **M. M. Miller,** Radio Corp. of America, Defense Electronic Products, Aerospace Systems Div., Burlington, Mass.

References:

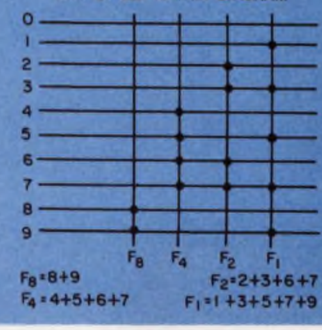
1. Huskey and Korn, *Computer Handbook*, McGraw-Hill Book Co., Inc., New York, N.Y. 1962.
2. Korn and Korn, *Electronics Analog and Hybrid Computers*, McGraw-Hill Book Co., Inc., New York, N.Y. 1964.
3. Bartee, Lebow, and Reed, *Theory and Design of Digital Machines*, McGraw-Hill Book Co., Inc., New York, N.Y., 1962.
4. A. F. Frim, M. M. Miller, "Design Digital Comparators Logically," *Electronic Design* November 7, 1968 (ED 23), pp. 52-57 and November 21, 1968 (ED 24), pp. 56-63.

 NAND GATE (RCA 930/CD2300)	Output is LOW (ground) only when each and every input is HIGH (+5 Vdc). Output is HIGH whenever any input is LOW. An unconnected input is the same as a HIGH. Two identical gates per "chip".
 NOR GATE (RCA 930/CD 2300)	Output is HIGH (+5 Vdc) whenever any input is LOW (ground).
 INVERTER (RCA 930/CD 2300)	A HIGH input results in a LOW output, and a LOW input results in a HIGH output.
 NAND GATE (RCA 946/CD2302)	Similar to DTL 930. Has four 2-input gates per "chip" and no node input.
 NAND GATE (RCA 944/CD2307)	Similar to DTL 930. Has two 4-input gates plus node. Provides up to 100 mA of output current as opposed to 30 mA maximum for DTL 930. Generally used as a low-power lamp or relay driver. Also, has output with no internal pull-up resistor.
 $\bar{G}$=ABCD+$\bar{E}$ NAND GATE (FAIRCHILD SH2001)	High-voltage high-current driver. Delivers up to 250 mA output current. Comprises 4-input NAND with inhibit (NOR) input. Output is low when all NAND inputs are HIGH or when NOR input is LOW.
 MONOSTABLE MULTIVIBRATOR (FAIRCHILD DTL951)	Single-shot or monostable multivibrator. Provides complementary output pulses which are typically 100 nano seconds wide. Pulse width is adjustable by addin external discrete components. Output pulses are generated when either input swings from HIGH to LOW (+5 Vdc to ground), as illustrated below: 

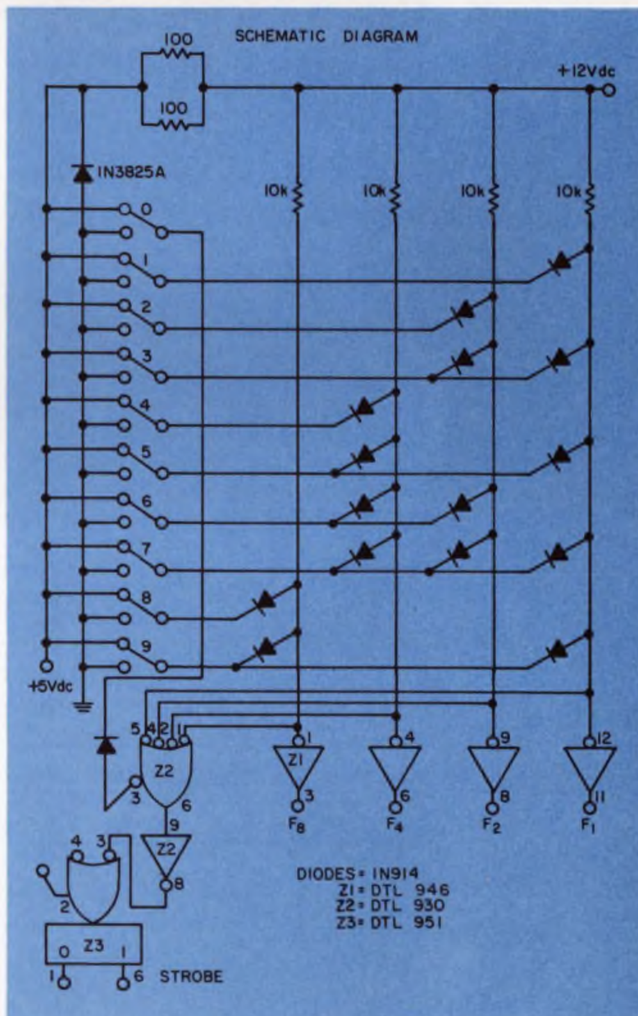
1. **These converter DTL symbols** and associated functions are used in logic diagrams.

TRUTH TABLE

INPUT DECIMAL	OUTPUT F_8	F_4	F_2	F_1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1



2. **The basic decimal-to-BCD-code converter** is described in a truth table or its related matrix diagram.



3. **A decimal-to-BCD converter can** be built in diode matrix form. Compare this to the matrix in Fig. 2.

4. BCD-to-decimal converter (7-position readout display)

Operation:

This converter uses 12 integrated circuits to drive a low-power 7-position readout display. If the BCD input is 0110, for example, where $F_1 = 0$, $F_2 = 1$, $F_4 = 1$, and $F_8 = 0$, then relays 2, 3, 5, 6 and 7 will be energized to display the numeric 6.

Truth tables:

Input F_8	F_4	F_2	F_1	Output 1	2	3	4	5	6	7
0	0	0	0	1	1	0	1	1	1	1
0	0	0	1	0	0	0	1	1	0	0
0	0	1	0	1	0	1	1	0	1	1
0	0	1	1	1	0	1	1	1	1	0
0	1	0	0	0	1	1	1	1	0	0
0	1	0	1	1	1	1	0	1	1	0
0	1	1	0	0	1	1	0	1	1	1
0	1	1	1	1	0	0	1	1	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	1	0	0

Input don't cares = ϕ = 10, 11, 12, 13, 14, 15

Karnaugh maps:

F_2F_1 \ F_8F_4	00	01	11	10
00	1		X	1
01		1	X	1
11	1	1	X	X
10	1		X	X

$1 = F_8 + \bar{F}_4\bar{F}_1 + F_4F_1 + F_2F_1$
$= F_8 + \bar{F}_4\bar{F}_1 + F_1(F_4 + F_2)$

F_2F_1 \ F_8F_4	00	01	11	10
00	1	1	X	1
01		1	X	1
11			X	X
1010		1	X	X

$2 = F_8 + \bar{F}_2\bar{F}_1 + F_4\bar{F}_2 + F_4\bar{F}_1$
$= F_8 + \bar{F}_2\bar{F}_1 + F_4(\bar{F}_2 + \bar{F}_1)$

F_2F_1 \ F_8F_4	00	01	11	10
00		1	X	1
01		1	X	1
11	1		X	X
10	1	1	X	X

$3 = F_8 + F_2\bar{F}_1 + \bar{F}_4F_2 + F_4\bar{F}_2$
$= F_8 + F_2(\bar{F}_1 + \bar{F}_4) + F_4\bar{F}_2$

F_2F_1 \ F_8F_4	00	01	11	10
00	1	1	X	1
01	1		X	1
11	1	1	X	X
10	1		X	X

$4 = \bar{F}_4 + \bar{F}_2\bar{F}_1 + F_2F_1$

F_2F_1 \ F_8F_4	00	01	11	10
00	1	1	X	1
01	1	1	X	1
11	1	1	X	X
10		1	X	X

$5 = \bar{F}_2 + F_4 + F_1$

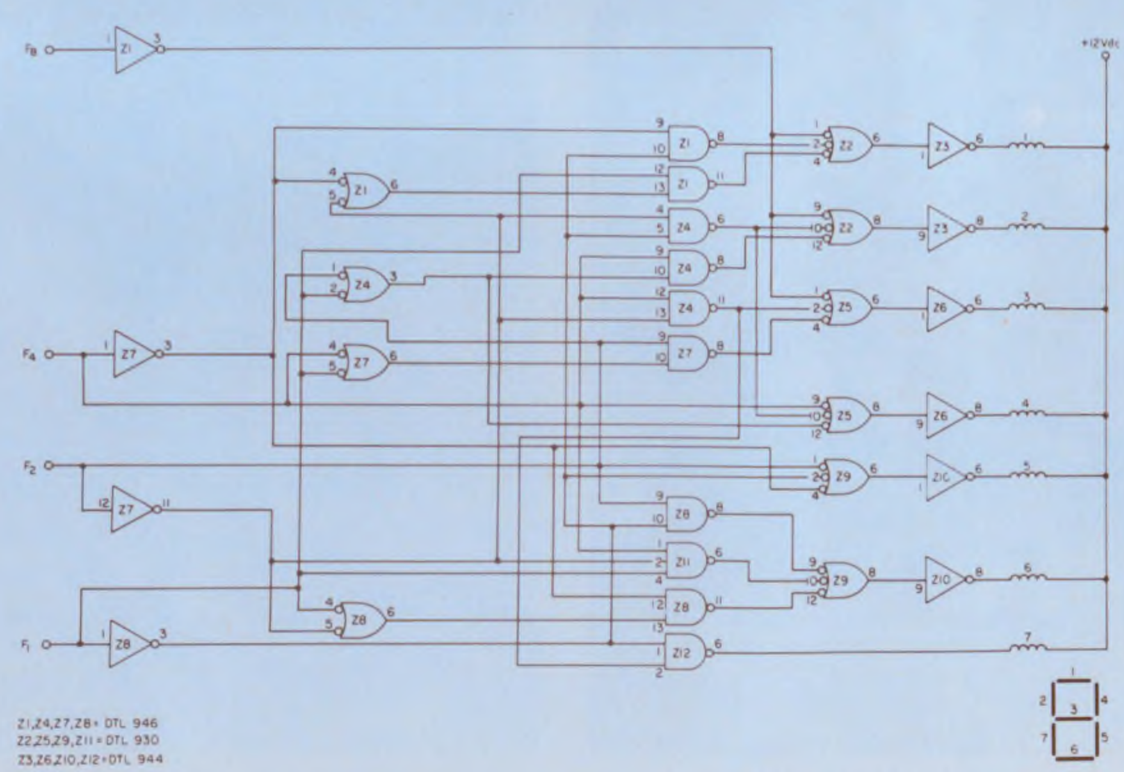
F_2F_1 \ F_8F_4	00	01	11	10
00	1		X	1
01		1	X	
11	1		X	X
10	1	1	X	X

$6 = \bar{F}_4\bar{F}_1 + \bar{F}_4F_2 + F_2\bar{F}_1 + F_4\bar{F}_2F_1$
$= \bar{F}_4(\bar{F}_1 + F_2) + F_2\bar{F}_1 + F_4\bar{F}_2F_1$

F_2F_1 \ F_8F_4	00	01	11	10
00	1		X	1
01			X	
11			X	X
10	1	1	X	X

$7 = \bar{F}_4\bar{F}_1 + F_2\bar{F}_1$
$= \bar{F}_1(\bar{F}_4 + F_2)$

Logic Diagram:



5. BCD-to-decimal converter (Output Printer)

Operation:

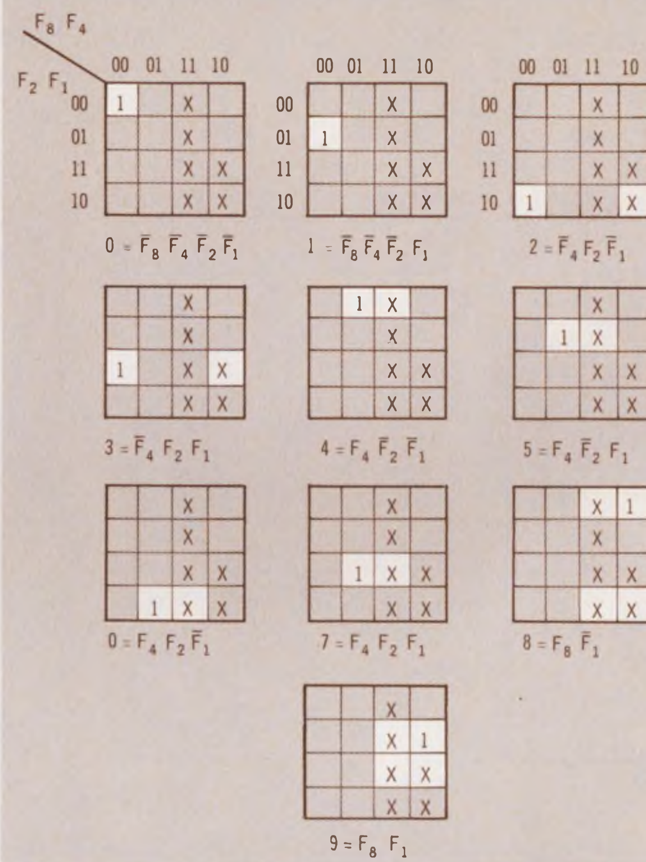
This converter uses 11 integrated circuits and 10 relays to drive the hammers of a high-speed rotating drum-type printer. For example, when the BCD number is 0001 and a strobe is applied, $\overline{F}_8$, $\overline{F}_4$, $\overline{F}_2$, and F_1 will be HIGH, so that Z2-8 is LOW, thereby energizing the 1 relay.

Truth tables:

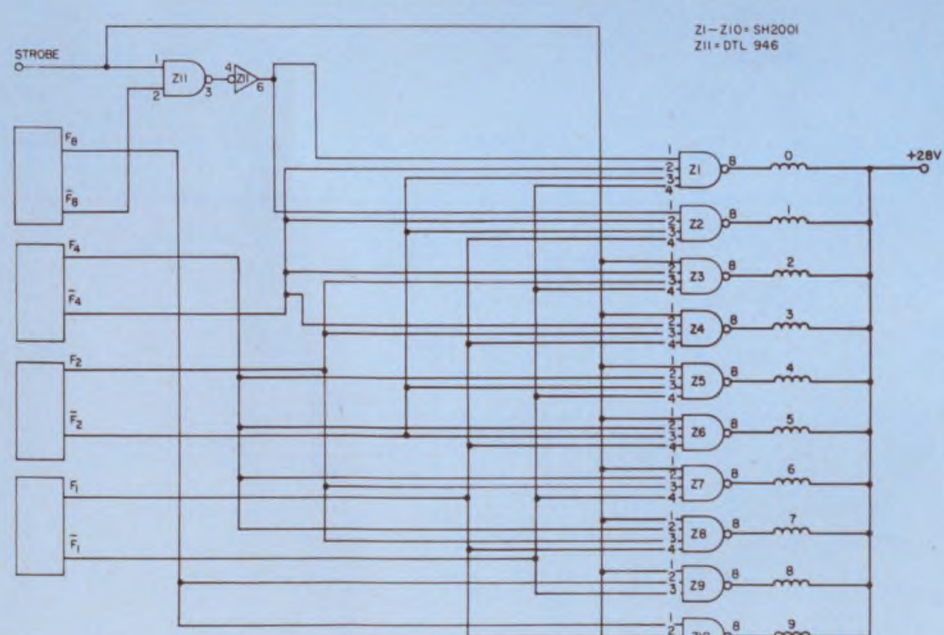
Input F_8	Input F_4	Input F_2	Input F_1	Output 0	1	2	3	4	5	6	7	8	9
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1

Input Don't Cares = 10, 11, 12, 13, 14, 15

Karnaugh maps:



Logic Diagram:



6. Binary to BCD (8421) decade converter

Operation:

The logic diagram below is for a single decade converter capable of handling a full 4-bit binary input (decimal 0 to 15). For the condition where the binary input is 1100, B_8 and B_4 are HIGH, and B_2 and B_1 are LOW. When B_8 and B_4 are HIGH, Z1-9 and Z1-10 are both HIGH, so that Z1-8 and Z1-12 are both LOW and therefore Z1-11 is HIGH ($F_{10} = 1$). At the same time, Z4-9, Z4-10, and Z4-12 are all HIGH, so that Z4-8 is LOW, Z3-10 is LOW, and Z3-8 is HIGH ($F_2 = 1$). A HIGH on F_{10} and F_2 signifies the digits 1 and 2, or decimal 12.

Truth tables:

Input				Output				
B_8	B_4	B_2	B_1	F_{10}	F_8	F_4	F_2	F_1
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1
0	0	1	0	0	0	0	1	0
0	0	1	1	0	0	0	1	1
0	1	0	0	0	0	1	0	0
0	1	0	1	0	0	1	0	1
0	1	1	0	0	0	1	1	0
0	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	0
1	0	0	1	0	1	0	0	1
1	0	1	0	1	0	0	0	0
1	0	1	1	1	0	0	0	1
1	1	0	0	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

Karnaugh maps:

$B_2 B_1$ \ $B_8 B_4$	00	01	11	10
00			1	
01			1	
11			1	1
10			1	1

$F_{10} = B_8 B_4 + B_8 B_2$
$= B_8 (B_4 + B_2)$

$B_2 B_1$ \ $B_8 B_4$	00	01	11	10
00				1
01				1
11				
10				

$F_8 = B_8 \bar{B}_4 \bar{B}_2$

$B_2 B_1$ \ $B_8 B_4$	00	01	11	10
00		1		
01		1		
11		1	1	
10		1	1	

$F_4 = \bar{B}_8 B_4 + B_4 B_2$
$= B_4 (\bar{B}_8 + B_2)$

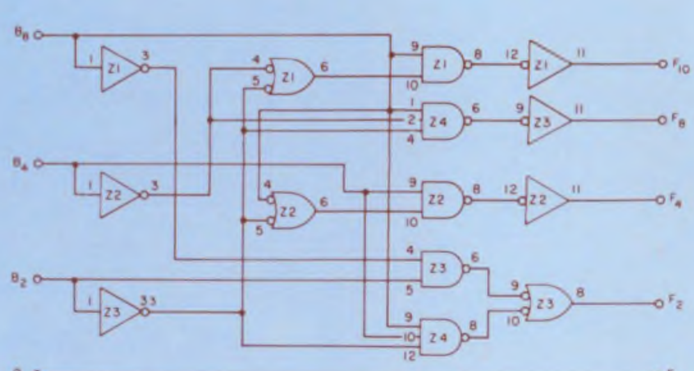
$B_2 B_1$ \ $B_8 B_4$	00	01	11	10
00			1	
01			1	
11	1	1		
10	1	1		

$F_2 = \bar{B}_8 B_2 + B_8 B_4 \bar{B}_2$

$C_2 B_1$ \ $B_8 B_4$	00	01	11	10
00				
01	1	1	1	1
11	1	1	1	1
10				

$F_1 = B_1$

Logic Diagram:



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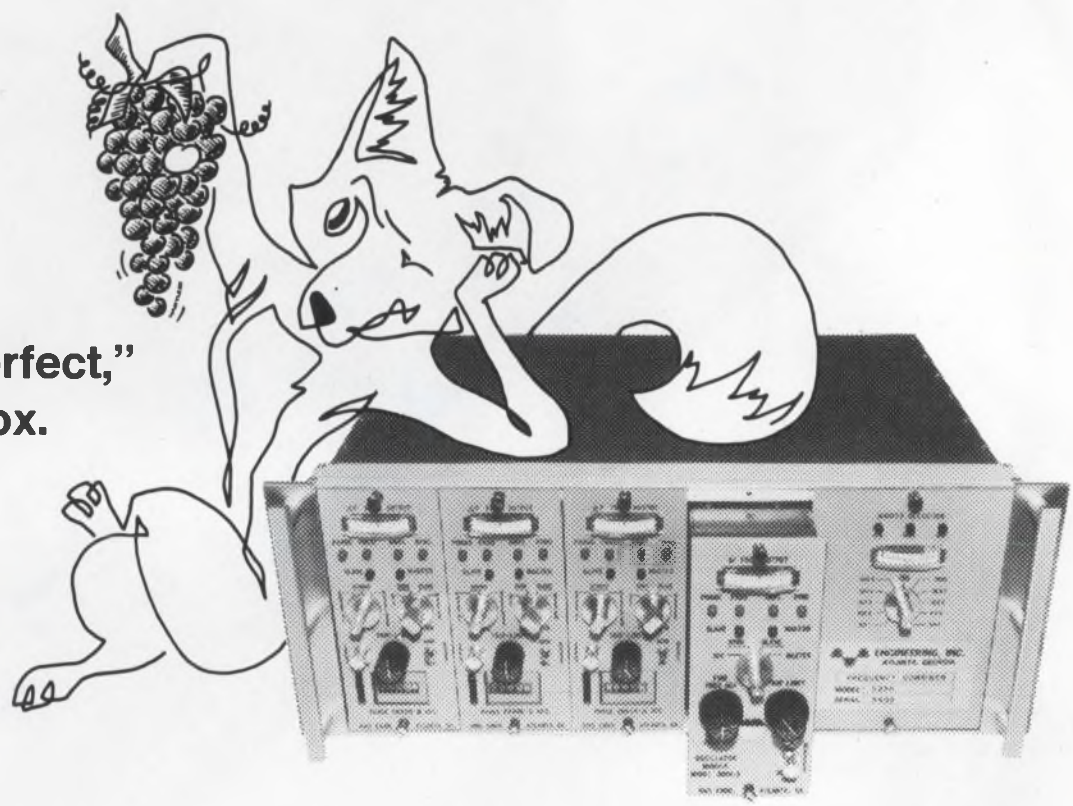

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Cut Butterworth filter phase distortion

by cascading the filter with an active all-pass network. One universal design is all you need.

The phase characteristic of the low-pass Butterworth filter is a nonlinear function of frequency. In some cases, such as voice communications, this presents no problems. In other cases, however, it is important to preserve the phase information of the signal being filtered. For such applications, it is desirable to have a filter whose phase shift is a linear function of frequency. Such a filter does not distort the phase of a signal; it merely causes a time delay.

The Butterworth phase characteristic can be linearized by cascading the filter with an active compensating network.

First: Describe the problem

The first step in the phase-correction procedure is to develop a power series representation of the Butterworth phase characteristic.

The transfer function of an nth-order low-pass Butterworth filter can be written as a product of $n/2$ second-order transfer functions with a first-order factor added when n is odd. Each of the second-order factors is of the form

$$F_i(s) = \omega_c^2/(s^2 + 2\delta_i\omega_c s + \omega_c^2) \qquad (1)$$

where ω_c is the Butterworth cutoff frequency and δ_i is the damping ratio associated with a second-order response (Fig. 1). Each of the second-order factors contributes a pair of poles to the over-all transfer function.

The first-order factor is $\omega_c/(s+\omega_c)$. It produces the pole on the real axis when it is used.

The phase shift of the complete filter is simply the sum of the phase shifts of each of the first- and second-order sections. For the first-order section, the phase shift is readily found to be given by $\phi =$ arc tan $(-\omega/\omega_c)$. For the second-order sections, the phase shift is given by

$$\phi_i = \text{arc tan } [-\omega\omega_c/Q_i(\omega_c^2 - \omega^2)] \qquad (2)$$

where $Q_i = 1/2\delta_i$.

Richard S. Aikens, Electrical Engineer and **Dr. James Brault,** Associate Physicist, Kitt Peak National Observatory, Tucson, Ariz.

By forming a power series expansion for the bracketed portion of Eq. 2 and substituting it into a similar expansion for the arc tangent function itself, the following equation for the phase of the ith second-order section is obtained:

$$\phi_i(\omega) = \sum_{j=1}^{\infty} \frac{1}{Q_i}\left(\frac{-\omega}{\omega_c}\right)^{2j-1} - \frac{1}{3}\sum_{j=1}^{\infty}\frac{1}{Q_i^3}\left(\frac{-\omega}{\omega_c}\right)^{3(2j-1)} + \frac{1}{5}\sum_{j=1}^{\infty}\frac{1}{Q_i^5}\left(\frac{-\omega}{\omega_c}\right)^{5(2j-1)} + \cdots . \qquad (3)$$

Similarly, the phase of the first-order section is given by

$$\phi(\omega) = -\omega/\omega_c - (1/3)\,(-\omega/\omega_c)^3 + (1/5)\,(-\omega/\omega_c)^5 + \cdots . \qquad (4)$$

It is only necessary to add together the series expansions of each of the sections comprising the filter to produce a complete power series for the phase shift of the low-pass Butterworth filter. Since Eqs. 3 and 4 contain only odd terms, the result will be of the form:

$$\phi_B(\omega) = k_1\omega + k_3\omega^3 + k_5\omega^5 + \cdots . \qquad (5)$$

Second: Describe the compensating network

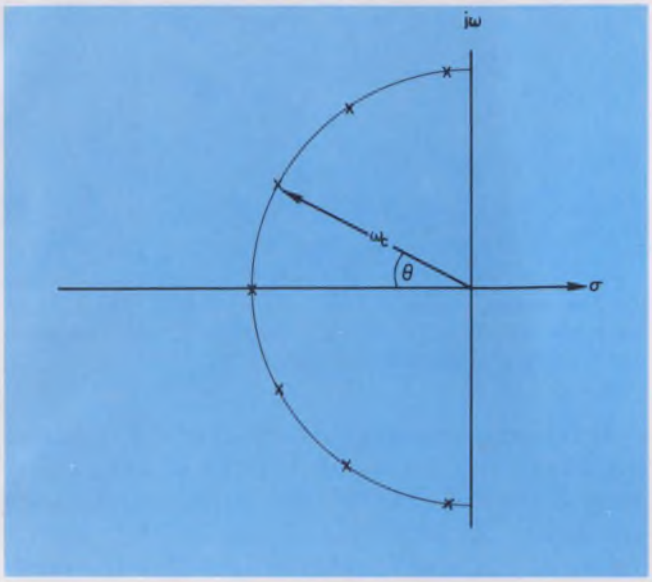
To linearize Eq. 5 it is clearly necessary to cancel out all of the coefficients except k_1. The network that does this must have an all-pass amplitude characteristic in order not to interfere with the desired Butterworth amplitude characteristic.

Actually, finding a network that can cancel out all of the coefficients is impossible. Fortunately, a rather good approximation of linearity can be obtained by constraining only two coefficients to zero.

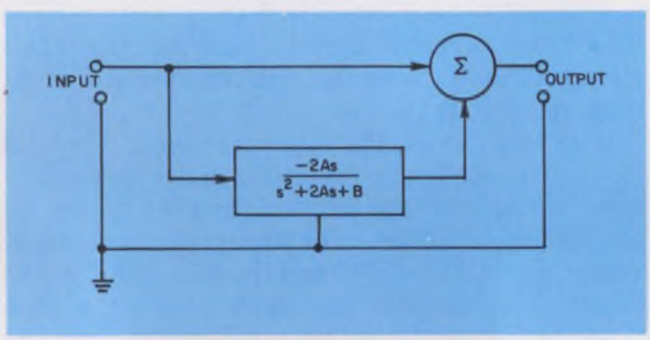
An all-pass transfer function that can do this job is $F(s) = (s^2-As+B)/(s^2+As+B)$, where A and B are both positive constants. Dividing the denominator into the numerator yields:

$$F(s) = 1 - 2As/(s^2+As+B). \qquad (6)$$

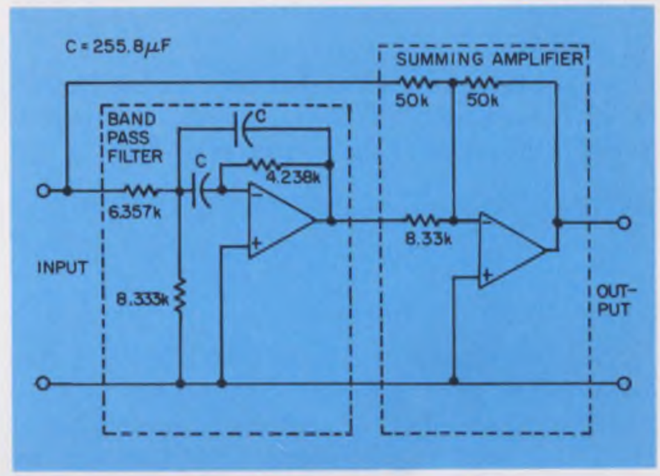
The second term of this expression is recognized as a band-pass function of the form



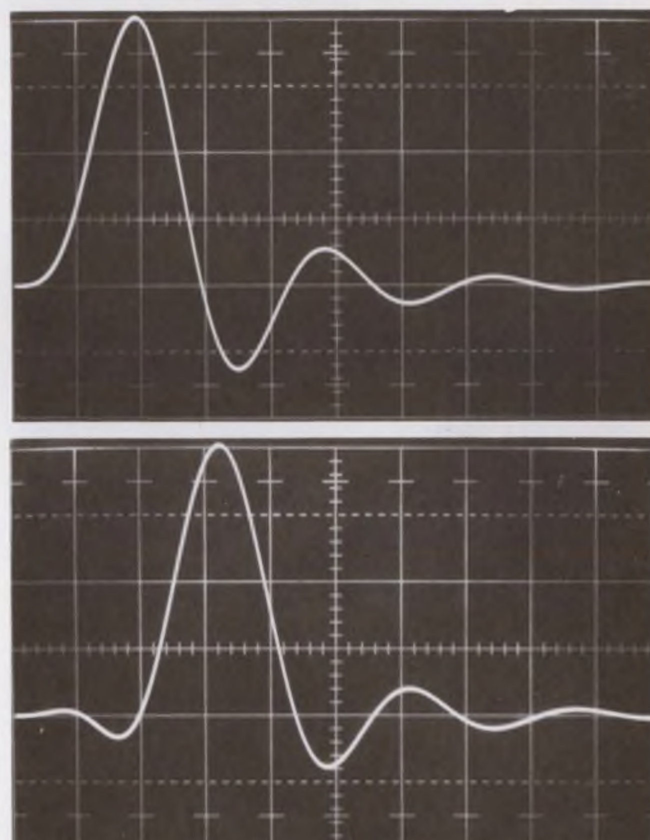
1. **The poles of a Butterworth transfer function** lie on a circle centered at the origin of the s-plane. The damping ratio, δ, of the pair of poles associated with each second-order response is given by $\delta = \cos\theta$.



2. **The all-pass transfer function** is represented by a band-pass network and a summer.



3. **Just change the capacitors** to scale this universal all-pass network to any frequency. The two active networks are realizations of the blocks of Fig. 2.



4. **Compare the impulse responses** of an uncompensated filter (top) and the same filter with all-pass linearizing network added (bottom). The filter is a seventh-order low-pass Butterworth with a cutoff frequency of 400 Hz. In both cases, the horizontal scale is 1.0 ms/cm and the impulse was 200 μs long. The impulse occurred at the extreme left. Note the improved symmetry and increased delay of the linearized filter.

Table Realizable values of Q_o and ω_o

η	ω_o / ω_c	Q_o
3	1.0210	0.551
4	1.1004	0.543
5	1.0761	0.541
6	1.0507	0.539
7	1.0178	0.538
8	0.9892	0.537
9	0.9644	0.536

$$F(s) = k\omega_o s/(s^2+\alpha\omega_o s+\omega_o^2) \quad (7)$$

where the resonant frequency is ω_o and the Q is $Q_o = 1/\alpha$.

By combining Eqs. 6 and 7, the following useful relationships can be obtained:

$$A = \omega_o/Q_o \qquad B = \omega_o^2$$
$$2A = k\omega_o \qquad k/2 = Q_o$$

An analysis similar to that used in the Butterworth case yields the following power series expansion for the phase of the all-pass network:

$$\phi_A(\omega) = (-2/Q_o\omega_o)\omega - (2/\omega_o^3)[(1/Q_o) - (1/3Q_o^3)]\omega^3 - (2/\omega_o^5)[(1/Q_o) - (1/Q_o^3) + (1/5Q_o^5)]\omega^5 + \cdots. \quad (8)$$

The procedure at this point is to add Eq. 5 (the power series for the Butterworth phase) to Eq. 8 and then to set all of the coefficients except that of the linear term equal to zero. Unfortunately, we have only two unknowns—ω_o and Q_o—hence we can constrain only two coefficients to be zero.

This is actually no great problem, because the higher-order terms that cannot be controlled are not very significant in the first place. If the coefficients of the third- and fifth-order terms are constrained to be zero, the first non-zero coefficient is that of the seventh-order term; Eq. 3 makes it clear that the phase shift contribution from the terms above fifth power can be ignored.

Following the procedure just outlined, we can write:

$$k_3 - (2/\omega_o^3)[(1/Q_o) - (1/3Q_o^3)] = 0 \quad (9a)$$

$$k_5 - (2/\omega_o^5)[(1/Q_o) - (1/Q_o^3) + (1/5Q_o^5)] = 0. \quad (9b)$$

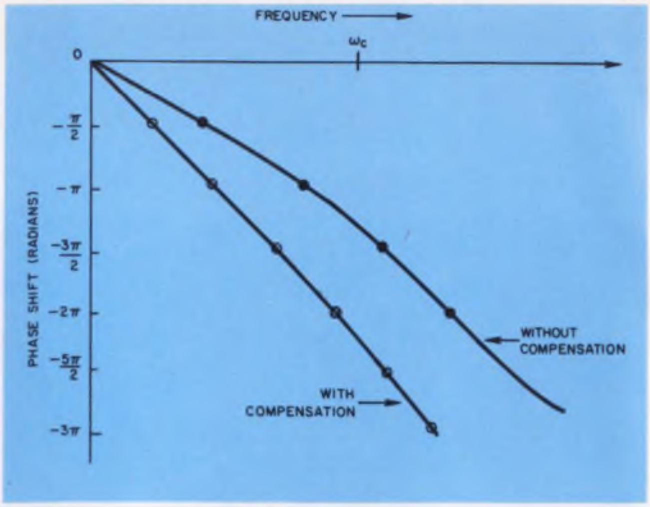
The coefficients k_3 and k_5 (from Eq. 5) can be shown to be as follows, with ω_c normalized to unity:

$$k_3 = 1/3 - [(1/Q_1) + (1/Q_2) + \cdots] + (1/3)[(1/Q_1^3) + (1/Q_2^3) + \cdots] \quad (10a)$$

$$k_5 = -1/5 - [(1/Q_1) + (1/Q_2) + \cdots] + [(1/Q_1^3) + (1/Q_2^3) + \cdots] - (1/5)[1/Q_1^5) + (1/Q_2^5) + \cdots]. \quad (10b)$$

The constant term starting each expression is only present for odd-order filters.

Substituting Eqs. 10 into Eqs. 9 and solving for ω_o and Q_o involves finding the roots of a sixth-degree equation in Q_o^2. A computer root-finding program was used to do the job, with the results shown in the table. The table shows ω_o (normalized to ω_c) and Q_o for various orders of Butterworth filters.



5. **The steeper slope** of the linearized filter phase characteristic is evidence of its increased delay. The filter is th same one described in Fig. 4.

It is interesting to note that all of the Q_o values are almost the same and that the ω_o values vary only slightly around ω_c, the Butterworth cutoff frequency. A detailed analysis of the possible values of Q_o showed that it is limited to the range $0.526 < Q_o < 0.577$.

Third: Design the compensating network

The transfer function of Eq. 6 can be represented by the filter and summing network of Fig. 2. If Q_o is assumed to be independent of n, a circuit can be devised to realize the transfer function. This circuit (Fig. 3) may be frequency-scaled to fit most requirements.

With this circuit, the incoming signal is passed through a band-pass inverting active filter, and then summed with the original signal by the second operational amplifier. For the given component values, $\omega_o = 1$, $Q_o = 0.542$ and the gain is unity. The capacitor values may be scaled to cover a wide range of frequencies by simply using the formula $C = 255.8/\omega_o$. The answer is in microfarads.

To linearize a given low-pass Butterworth filter, all one must do is use the table to calculate ω_o from n and ω_c and then scale the capacitors in the circuit of Fig. 3 to the necessary value.

Delay time is increased

When this phase-linearizing method is used, the over-all delay time of the filter is increased. By differentiating the first term of Eq. 8, we find that the all-pass network adds a delay of $T_A = 2/Q_o\omega_o$ to the normal Butterworth delay.

The total delay of a linearized filter is given by

$$T = [1+(1/Q_1) + (1/Q_2) + \cdots](1/\omega_c) + 2/Q_o\omega_o \quad (11)$$

where the unit first term is only retained for odd-order filters.

This method has been used to linearize an existing seventh-order filter with a cutoff frequency of 400 Hz. From the table, it is seen that this calls for $\omega_0 = 2558.0$ rad/s. Frequency-scaling the circuit of Fig. 3, then, $C = 0.1\ \mu F$.

Since examining the impulse response of a low-pass filter is one of the most meaningful ways of evaluating the phase characteristics of such a filter, a comparison was made of the filter response both with and without the all-pass network (Fig. 4). It is apparent that the added network has made the impulse response more symmetrical and has also substantially increased the delay time. The phase-shift characteristics of the compensated and uncompensated filters are shown in Fig. 5. The linearity improvement is quite evident; the increased delay time is shown by the steepened slope.

No unusual precautions need be taken in the construction of these filters, although resistors and capacitors with tolerances of one per cent have been used in the authors' work. The circuits were used to band-limit analog data before sampling it for conversion into digital form. In this application the circuits are called anti-aliasing filters because they eliminate any ambiguity that might arise in an a/d converter if the signal bandwidth exceeds one-half of the sampling rate.

The linearizing technique greatly reduced the distortion of the original data. ■ ■

Bibliography:

Huelsman, L. P. and Application Engineering Section, *Handbook of Operational Amplifier Active RC Networks*, Burr-Brown Research Corp., Tucson, Ariz., 1966.

Papoulis, A., *The Fourier Integral and Its Applications*, McGraw-Hill Book Co., New York City, 1962, pp. 94-120.

Van Valkenburg, M. E., *Introduction to Modern Network Synthesis*, John Wiley & Sons, Inc., New York City, 1965, pp. 373-392.

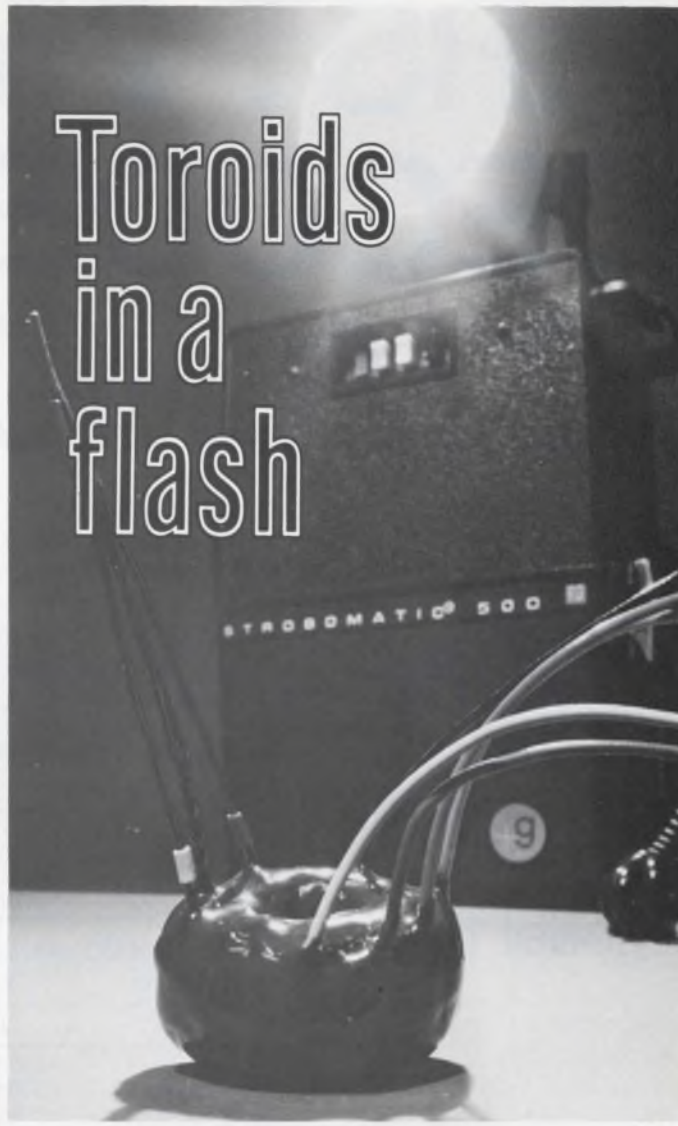
Test your retention

Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. Why is the second-order compensating network described in this article able to linearize much higher-order Butterworth filters?

2. How is the resonant frequency of the active band-pass network scaled for various Butterworth cutoff frequencies?

3. What effect does the linearizing procedure have on the over-all time delay of the filter?



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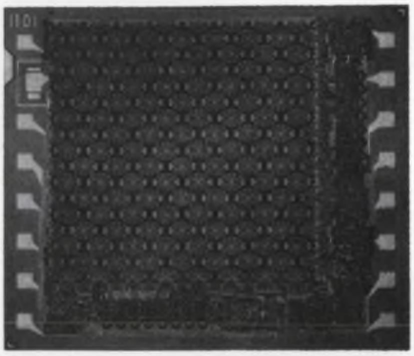

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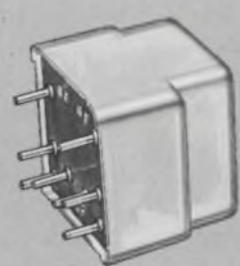

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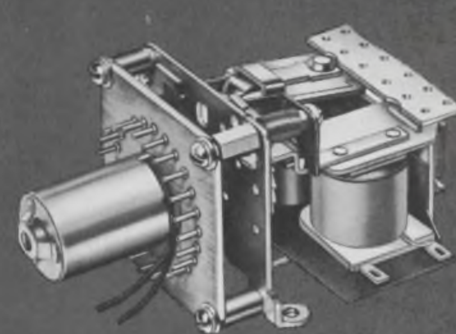

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Circle No.153 For Literature

Beware of electronic dirt.

At best it can cause erratic equipment behavior, and at worst it can ruin otherwise sound designs.

This article is based on portions of an upcoming book, "Cleaners and Cleaning," by H. Manko, to be published by Gordon and Breach.

Most design engineers do not recognize the danger of "electronic dirt." If they can't see it, they forget it. Yet much of the erratic behavior of equipment—normally termed "tempermental" —is a direct result of dirt. Noise in audio systems, warmup and stabilization periods in instruments, and the need for periodic recalibration and standardization in basic equipment can be drastically reduced through a thorough understanding of the role of electronic dirt.

Once its harmful effects are recognized, a program involving management, engineering and production must be set up to eliminate this invisible enemy.

All materials deposited upon a surface can be classified as dirt. These may be divided into particulate matter and foreign films. In the first group we find such items as dust, metallic chips, and other solid particles. The second group consists of wet or dried layers, usually in the form of liquid or pastes. These films are normally soluble and include such items as oils, grease, perspiration prints, and solution residues.

Nonsoluble films are the result of a chemical reaction that occurred on the surfaces after the deposition. A second chemical reaction would be required to remove such layers, and a chemist would have to be consulted. Physical abrasion could, of course, be used, but in electronics hardware this treatment could be too aggressive, causing damage. Since this type of contamination is always accidental—like an unintentional deposition of a plastic coating that cured in place —it does not pose everyday production problems.

The bulk of the dirt found on electronic assemblies, and the most harmful one, falls within the soluble film category. The elimination of these materials would render an assembly electronically clean, provided no particulate matter is present. Electronic cleaning, therefore, can be achieved through the application of appropriate solvents.

But relying on a final cleaning is not always feasible. Much harmful dirt might be lodged in inaccessible places. Parts of the assembly might not be totally immersible in the proper cleaning solution. Above all, the cost of this final wash might be prohibitive.

Cleanliness, therefore, must be planned throughout the entire design process. And most of the problem lies in lack of information on the subject.

A word about solvents

A solution is defined as a physical dispersion of the molecules of a solid (or, by extension, another liquid or gas) called the solute, in a liquid called the solvent. The mixture is called a solution and is a homogeneous system in which the molecules of the solute and the solvent are dispersed among each other. A solution cannot be separated by filtration, although there is no permanent chemical reaction. To separate the solute from the solvent, you must evaporate the solvent (distill it off) or cause crystallization of the solute.

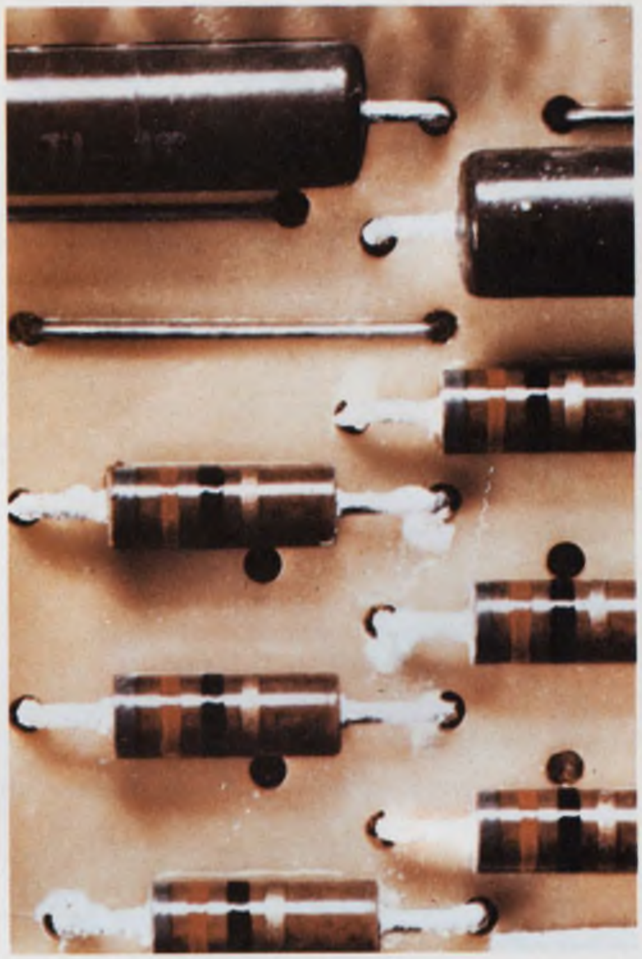
Solvents and solutes are classified into two major categories; polar and nonpolar. These terms refer to the molecular structure and its behavior in solution. While nonpolar materials are held together by an electromagnetic union, polar materials dissociate into electrically active particles, called ions held together by an electrostatic union. It is this behavior of dirt in solution that is critical to the electronics industry.

Polar materials are mostly salts, acids, and bases of both inorganic and organic origin. The most common polar solvent, and by far the best, is water. The two hydrogen atoms form the one electrically active pole, while the oxygen forms the opposing pole. This gives water its ability to dissociate polar materials into ions. The result is an electrically conductive solution, or electrolyte, which is also corrosive to many metals.

Nonpolar materials are mostly organic in nature and when dissolved in water do not ioinze. Thus, an aqueous solution of sugar is not elec-

H. H. Manko, Director, Research & Development, Alpha Metals, Inc., Jersey City, N. J.

trically conductive. Most nonpolar materials, such as oils, waxes, and rosin derivatives, are not soluble in water. Many of the nonpolar solids and liquids are actually immiscible with water. Nonpolar solvents are usually organic liquids, such as alcohols, ketones, and esters. Because they are all flammable, industry has sought, and finally found a family of halogenated hydrocarbons that is nonflammable. Perchloroethylene, Trichloroethane, and others are used as solvents in this function.



Cleaning in trichlorethylene only was the procedure used with this PC board. Since the procedure left all ionizable materials behind, all lead-rich surfaces were attacked by chlorides. The white corrosion products that formed can be seen on the leads. Close observation indicates leakage paths across the board surface under high humidity conditions .

Electronic cleaning

Only polar dirt becomes electronically active, due to the presence of ions. Nonpolar dirt is classified as an insulator. Unfortunately, one group is seldom found without some of the other interspersed in it. Thus, a cleaning operation requires a twofold action. It is customary to remove the nonpolar dirt first and to follow with a water wash.

The danger from contamination on device surfaces stems from the electrical conductivity of ionizable deposits. In the presence of humidity in the air, conductive films are formed that span over insulators and allow current leakage, which alters current flow in the circuitry. These moisture films, being humidity-dependent, change constantly, thus aggravating the phenomenon often referred to as electronic noise. Only by complete elimination of ionizables or barring moisture from the surfaces can this effect be negated.

Furthermore, there is a danger of corrosion to the conductors from the presence of electrolytes. This is especially important at dissimilar metal junctions, where there is an electromotive potential due to the position of the elements in the galvanic series.

The minimum quantity of contamination that will cause trouble varies from assembly to assembly, but it is always much less than can be detected by the naked eye. Thus, an assembly that looks clean is not necessarily electronically clean. As a result, cleanliness is best monitored either chemically or with instrumentation by measuring electrical conductivity or resistivity.

The sources of ionization contamination are many. They include processing solutions, plating solutions, soldering fluxes, and similar materials. Handling electronic components with bare hands can also contribute potentially hazardous materials. Human perspiration contains a large amount of ionizable compounds in the form of salts that are normally codeposited with oils and similar nonpolar films. All these materials have to be scrupulously removed, or else appropriate measures have to be taken in all intermediate manufacturing steps to ensure that the final

This printed-circuit board appeared clean after manufacturing. However, corrosion spots developed with time. They proved to be etching and plating solution residues that bled to the surface.

assembly is not contaminated.

But no matter what cleaning methods are incorporated in the manufacturing process, post-cleaning protection to the assembly is also important. Conformal coatings, or seal coats, as they are sometimes called, are organic materials —usually in the plastic family—that are deposited around the assembly in a thin envelope to achieve two particular goals. First, these protective coatings prevent moisture from penetrating onto the surfaces and lowering the resistivity if some contamination is left there by accident; and second, the coatings will help prevent recontamination of these surfaces through handling, sedimentation out of the air, and other sources.

The question of how clean any particular assembly must be in order to reliably perform its function is difficult to answer. But a few situations in which the author was involved as a consultant dramatize the point.

Case of the PC boards

A color television manufacturer decided to lower the price of his product. One area where no savings seemed possible was the printed-circuit boards used. However, an analysis of existing manufacturing processes revealed a large amount of ionizable materials left upon the PC-board surfaces. Unfortunately, the entire board could not be cleaned after soldering because of the nature of some of the components.

Since final cleaning was not possible, a total program for preventing contamination of the surfaces was instituted. The level of cleanliness of the various components prior to assembly was monitored carefully, and only chemically safe processing materials were permitted from that point on. No human handling was allowed without the protection of gloves or finger cots. As a result, the surface insulation was dramatically increased, and the manufacturer was suddenly in a position to select a much less expensive raw material for the PC board itself. In addition to the substantial savings due to the material change, a dramatic improvement in the performance of the set was also noticed. Incidents of burnout were virtually eliminated. In this high-voltage appliance, surface contamination was extremely critical.

Case of the audio noise

A manufacturer of communication equipment was building prototypes of personal communication equipment to be used by police departments. In spite of improved circuitry and many additional features, the equipment did not function as well as a competitor's. The basic problem was a continuous crackling on the audio circuits and an unreasonable amount of interference.

Since the units were intended to be carried on the policeman's person, they had to be no larger than the average cigarette pack. This required new soldering techniques not normally used in the manufacturer's plant.

Investigation revealed that there was no awareness of the need for cleanliness, so, in addition to the new soldering techniques, a philosophy of "clean work habits" was established. The improved surface insulation eliminated the noise problems, and a protective seal coat was placed over all assembled surfaces to avoid future contamination.

Case of the analog computer

An analog computer for scientific investigation gave serious trouble in the first two or three hours of its daily operation. Though located in a high-humidity area, it was placed in an air-conditioned laboratory. The computer manufacturer found a funguslike growth on the printed-circuit boards, and it was suspected that the flux residues served as a nutrient for this growth.

Investigation showed that the white layer on the PC boards was not a living organism but the result of crazing in the flux residues. Further investigation revealed a high per cent of ionizable materials on the surfaces. The PC boards were then thoroughly washed in a blend of polar and nonpolar solvents and returned for operation in the computer. The erratic behavior of the circuitry was eliminated.

The question was then asked: Why did the computer malfunction only in the first two or three hours of its operation daily, and why did cleaning help? As the result of an additional survey of air conditioning in the building, it was found that the refrigeration unit controlling both temperature and humidity was turned off in the evening and started up again in the morning.

It then became obvious that the moist air, which found its way into the computer, condensed on the still cooled surfaces of the PC boards in the evening and the moisture saturated the surfaces overnight. In the morning when the air-conditioning unit was restarted, it took two or three hours to completely dry out the surfaces of the PC boards to the point where the ionizable materials suspended in the surface moisture no longer carried any currents. These electrolyte films were at the root of the current leakage and the variation in computer functions. It was this continuous formation of moisture films on the surfaces that also caused a crazing of the rosin flux residues, which in turn produced the white film thought to be a fungus. ■■

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How do you make a young company grow?

"By managing everything better than the competition at a full running rate," says this semiconductor president.

Richard L. Turmail, Management Editor

If you want your electronics company to grow overnight like the fabled beanstalk, you've got to do more than throw your "beans" out of the window and wait to see what develops. One thing "more" that National Semiconductor did was to hire Charles E. Sporck as president and put him in charge of the "beans."

For nearly three years Sporck has helped his Santa Clara, Calif., company grow through the pains of intense competition in the highly technical business of electronics by adhering to the following rules:

- Pick a standard product that fits the strengths of your company's development.
- Study the marketplace, and fully understand what your customers really need.
- Insist that every product you produce makes a profit.
- Utilize the abilities of your employees that are the strongest, and don't be afraid to design company procedures to compliment employees' abilities.
- Give your professionals an opportunity to closely identify with their work by giving them a share of the company.
- Do away with departments that are not essential to the production of your product.

How does Sporck apply his rules for growth?

A profitable arrangement

The recent rise of National's star has been the direct result of Sporck's profit philosophy. He will tell you that the company's most influential criterion for justifying product direction depends on whether or not it is making money. "Because," he says, "we insist on making a profit on every product we produce. By preplanning, National avoids building the item that doesn't fit the criterion we use for arranging to be profitable."

What is demanded of a new product idea before National commits itself to production? Sporck says this:

- The product must be a standard one that has wide market usage. *Reason:* Of shortest supply in the electronics industry is engineering talent. We can't afford to put all of it to work on one customer.
- Pick a product that will fit the strengths in your company's development—one that is designed to give you minimum cost, highest yield, and the most economical die size. *Reason:* Introduction of a new product line forces a company to create an entirely new and extremely expensive organization. Sporck says, "We pick a product manager who's responsible for the process development and production of the line. We also choose a product marketing manager to interface with sales and advertising from a product point of view."

Get to know the territory

Any entrepreneur, electronics or otherwise, can tell you that becoming successful is one thing—but remaining a success is quite another.

How does a company, for instance, combat obsolescence on its road to bigger and better profits? According to entrepreneur Sporck, you've got to know the territory.

"We stay as close as possible to what's going on in the marketplace," he says, "not just from a marketing standpoint, but from a very deep technical understanding of what our customer really requires."

Sporck says that at National they're committed to building the popular circuits, including the circuit families of MOS, TTL, linear, and DTL.

"Eventually," he says, "we're going to build all of them. Our next task is to determine what, among those families, are the most popular circuits. We concentrate on what our major competitors make to find this out so that we can determine which ones we should be producing."

National's decisions on which of the circuits are the most popular are based on three sources of information. Sporck says they are:

1. Hourly evaluation from engineering.
2. Input from our manufacturing representatives and applications engineers in the field, who experience the market pressure of our competitors' products.

"Most management is immature in the semiconductor business."

"When you're small, you gamble every day; we have no big daddy to take care of us."

"A union would tend to separate engineering from management, when engineering has to be an integral part of management in order to function properly."

3. Internal evaluation of what logical circuits we should be designing.

"We ask ourselves," says Sporck, "what are the logical functions that our user can't do right now that he'd like to do? What are the sensible blocks we can devise that would be useful in the field and in product marketing?"

National's president says that this evaluation is in addition to the company's own proprietary effort, and that is to describe logical blocks and design them. To carry this out, Sporck says that weekly product planning meetings are held at which the three main functions of the company—product engineering, marketing, and circuit design—are discussed. Aside from strategic company decisions, which would include such commitments as whether or not to enter a new circuit family, the decisions that come from these product planning meetings are the most critical in the running of the company, because out of them come the product to which the company will commit its resources.

"Of course, we must have people with enough technical savvy to provide management with data that will enable them to draw viable opinions," Sporck reminds us. "Unless engineering input is allowed to penetrate the decision-making level, the company has no chance to avoid becoming obsolete market-wise."

Profit pressure at a running rate

But even with elaborate preparation for the production of a new product line, every electronics company stands the chance of failing in the attempt.

What does Sporck say to that?

"Maintain severe pressure on profit generation," he says. (Sure, but how specifically?)

"Our company," he explains, "operates in an environment where there is no alternative to profit commitments. If National does not make a profit, National ceases to exist. That fact of life creates a pressure environment that our staff is aware of daily. We point it out in both an informal and formal fashion.

"As a result of this profit pressure any step that we take in terms of product development must result in income to the company by a maximum of six months. Our people are evaluated on whether or not they obtain that profit goal. The percentage of profit of course varies depending upon the product line or the objective we are pursuing. We'll tolerate 1% profit if we're trying to penetrate a particular market."

"And if you don't make this goal?" ELECTRONIC DESIGN asked.

"If we fail to make a profit, either the company or the product manager is at fault, and one or the other has to be corrected. If the manager is at fault, he's out . . . Remember—we're talking about a product line where a manager has undoubtedly made a series of mistakes. We're not interested in operating in an environment where a person is afraid to make a mistake—not at all. We've got to allow the guy to make mistakes; otherwise he won't make any decisions. At the same time, the composite of his batting average determines whether his line is profitable or not, or if the company is in a product line it shouldn't be in at all."

He grinned. "Beyond that, we run like hell. We have to run because of the challenge we've set for ourselves: the rapid projected growth rate, plus making money on all lines while we're growing at this extremely fast rate.

"In other words, we have to do everything better than our competition, which means that whatever we do we have to do at a full running rate."

The managerial personality

Whether or not a chief executive has his production problems he will still have his "people problems." And Sporck believes that the wisest investment a company can make is in its people.

National's president tries to elude personnel pitfalls by picking as managers men who have been successful in previous managerial positions. And if an engineering manager who's technically competent has personality problems with members of his staff, Sporck says he adds to the mix a production man who's used to handling people.

"You can also modify the organization," he says. "That is, you can tailor it to a particular man, if necessary. In our industry you can't sacrifice a man's ability to contribute just because he's not well-rounded. One must be flexible enough to utilize unusual people."

Are good managers made or born?

Sporck says. "A good manager is not built from formal training, but rather from the environment he was exposed to during his first 25 years, independent from his schooling and work experience. For example: When I watch a group of Boy Scouts it's easy to pick out the ones who are natural leaders. They enjoy the responsibility and handle it well, and the other boys are content to follow.

"Whether a man is a good manager or not is pretty well decided before the age of thirty. He is a product of his environment while he was a child, and he either has a personality that's effective as a manager or he does not. You can improve his techniques, but his managerial, or entrepreneurial ability, stems overwhelmingly from his personality.

"The reason we have so many unhappy managers in the industry is because they've been led

National is in an expansive mood

National Semiconductor Corp. has set a course for itself that has been plotted on a wave of great expansion. Manning the helm are Peter J. Sprague, chairman of the board, and Charles E. Sporck, president. Since February, 1967, these two young executives have expanded their production facilities, which during the past year have doubled sales from just over $11 million to nearly $23 million, and increased its profits from $890,000 in 1968 to $1,468,000 in 1969. Sporck came to National after a long line of management positions at Fairchild Semiconductor, from production manager to general manager, and at General Electric Co. in a variety of production manufacturing posts.

Fiscal 1969 saw National grow from a company primarily engaged in product development to a high-volume manufacturer of semiconductors.

Back in 1959, as a force in the integrated-circuit business, National established a reputation as a maker of linear and MOS circuits. It is still very heavily committed to these markets, but in 1968 and 1969 its digital capacity increased, and digital bipolar ICs are now its largest line by sales and volume.

In its annual report of 1969, National states: "Price reduction in the marketplace has often raised the question as to whether it is possible for satisfactory profits to be generated on a consistent basis. National's answer is a firm, 'yes.' The leverage involved in our volume manufacturing and yield improvement has served to more than offset price deterioration."

By the beginning of National's second decade of operation, in 1970, its floor space will increase by 150% to more than 150,000 square feet. Personnel is presently holding at 850. A 115,000-square-foot plant, now being constructed on Kifer Road in Santa Clara, Calif., will become corporate headquarters when it is completed by the first of the year.

to believe that that is the course they must take—it's a status symbol. And they simply aren't happy with responsibility."

Sporck concluded, "As I see it, engineers have two courses—management or engineering. An engineer can make as valuable a contribution to the company as the president can, and a man should be compensated for his contribution to the company rather than his position. All of us are too susceptible to ranking salary with management positions."

Challenge vs options

A major recruiting tool at National is "a piece of the action."

"By far the most motivating factor is the challenge," Sporck admits. "But if you can offer your prospective staffer job enrichment, plus compensation, you're in pretty good shape.

"All our key people are offered stock options. Key people," he elaborated, "are the ones who've contributed the most to the company. Of the salaried personnel, about 80% have stock options. Since the amount of the stock option is directly related to an employee's contribution, there are some instances where individual engineers have larger stock options than their bosses."

Reserved for issue upon the exercise of options granted under National's stock option plan are 100,000 shares of common stock. The price to the individual is set at the market value, the day he was hired. The purchase price of the stock is determined by a committee consisting of three members of the board of directors who are not eligible to receive options under the plan, and each option is 100% exercisable five years after it has been issued.

"When a man is deciding what company to work for," Sporck says, "he might also consider that a company like National has a good chance to grow many times its size, and there's a good chance that the company's stock value will grow with it." Sporck reminds the job-hunting engineer that since a good company growth rate counteracts development stagnation, employees always have a chance to climb up that newly planted "beanstalk" and earn their share of the golden eggs.

And while we're talking about people, what about unions?

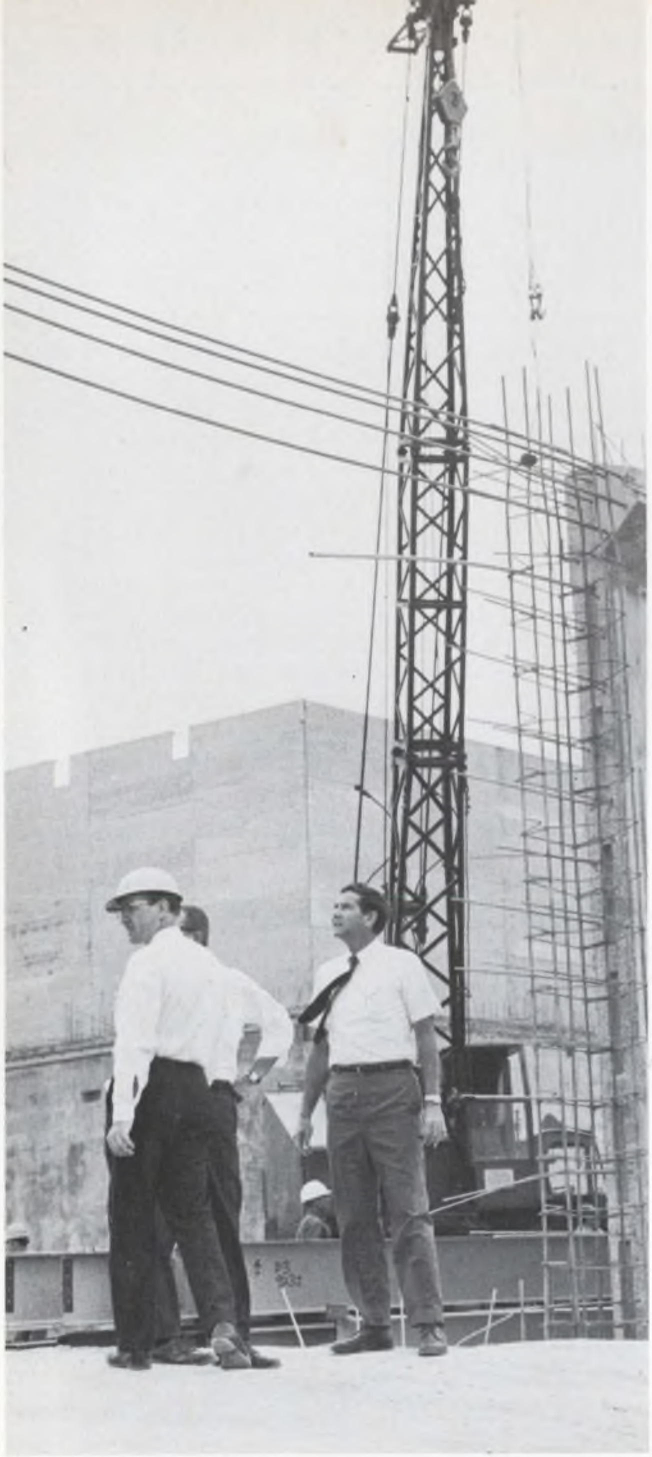
According to Sporck, "An engineer-union has nothing to contribute to the objectives of most effective engineers, a statement which can be applied to all engineers at our company.

"A union," he stresses, "would tend to separate engineering from management, when engineering has to be an integral part of management in order for the company to function properly. An engineering union would destroy a company in the semiconductor business."

Climbing up that stalk

So—how has your company grown?

Sporck says that, before he came on the scene, National was a $5 million transistor-producing company operating out of Danbury, Conn. There was also an extremely small operation in California, producing linear circuits.



President Sporck surveys National's future corporate headquarters, a 115,000 square-foot plant under construction in Santa Clara, Calif.

"We decided," Sporck says, "to become a very large, rapid-growing semiconductor company, because unfortunately, you can't make large profits with a small company. To specialize in semiconductors, we knew we had to excel in marketing; circuit design; product and process engineering; and semiconductor wafer fabrication.

"We eliminated all other operations of the company, such as making packages, designing test equipment, and assembling products. We think it's better to have somebody else do that work, because it's cheaper, and it allows us to concentrate on our own thing.

"After making those decisions," he continued, "we restructured the company to carry them out. Within a month we cut the Danbury work force 60 per cent. Within two months we took the company from a position where it was grossly unprofitable to where it was very profitable. We tripled our output because we had done away with operations not essential to the production of transistors.

"Our transistors carried us for about a year, during this time we invested our profits in ICs. By the start of the second year, our semiconductors were making their own way. Now, transistors are a small but profitable part of our business."

Sporck concluded, "We played to our indispensible strength, and we gambled on the rest. When you're small, you gamble every day; we have no big daddy to take care of us."

Rich market produces poor managers

But the gambling isn't that much of a gamble.

"One of the reasons National does well is because most management is immature in the semiconductor business, and ours isn't," Sporck says. "Poor decisions foster erratic earnings and shorten the time involved in realizing what the mistakes are. Many managers are unprepared because our technical environment is moving so rapidly. An environment that 'fertile' promotes a myriad of sales opportunities, a situation that fails to screen out the immature managers."

Sporck believes that the semiconductor industry allows a random mixture of good and bad management to seep up to the top, whereas in the slower-moving industries, screening is done more thoroughly.

"You don't necessarily find the extremely good managers in the slower industries," he says, "but you don't find the extremely poor ones either. The average in the semiconductor industry is poor because there are some extremely poor managers in it.

"Another reason we do comparatively well is that making a profit forces companies to make agonizing decisions on a competitive basis. Firing people isn't very nice. Measuring people so that you can truly understand their contribution is a lot of work. We do it."

When you ask Charlie Sporck what his greatest contribution has been to the success of the National Semiconductor Corp. in the nearly three years he has headed up the company he says simply: "By being right just a few more times than being wrong."

And he might have added that, where beanstalks are concerned, the emphasis is always on the "jack." ■■

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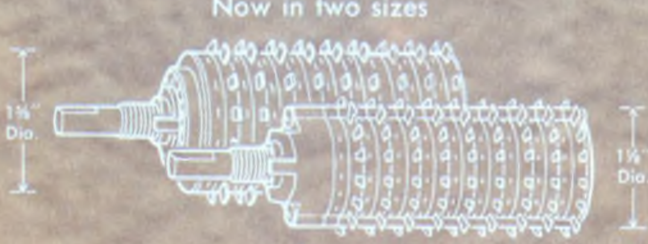

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Epoxy transistor yields 200-watt picosecond pulses

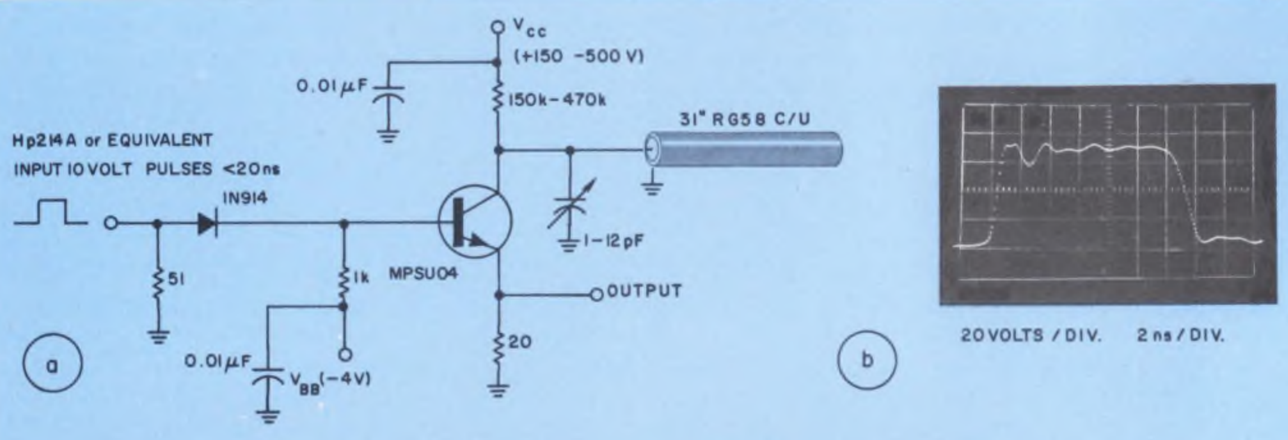
Although avalanche transistor switching has been known for at least a decade, the need for extremely fast, high-power pulses to drive semiconductor lasers has recently created renewed interest in this technique.

The circuit as shown in (a) is extremely simple and, while not unique, yields pulses a full order of magnitude greater than those noted in the literature. It is novel in the use of a single low-cost, epoxy transistor, and maintains full output power to about 8000 pulses per second. No heat sinking is required to 12,000 pps. Over 60 different transistor types were tested, and the MPSU04 (at $1.62) was found superior to all others, regardless of price, including those offered specifically for avalanche purposes by various manufacturers. A good second choice, possibly in stock in many laboratories, is 2N3499.

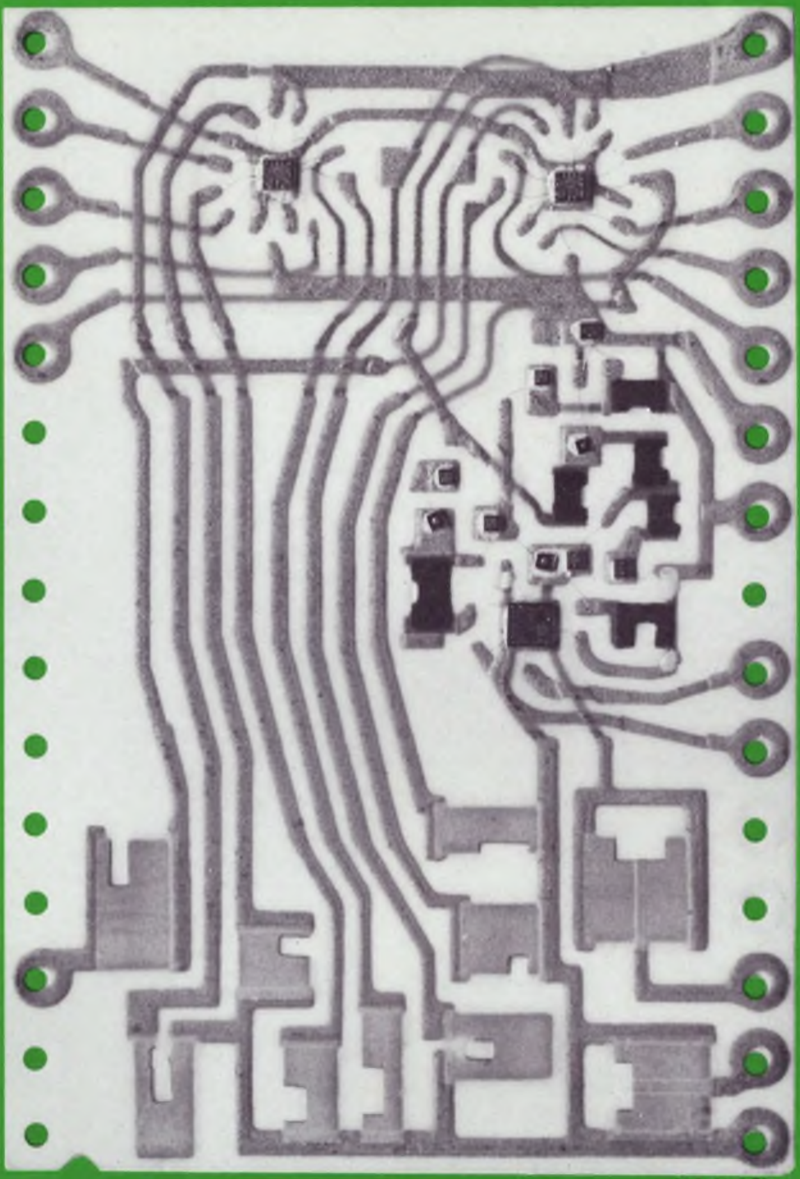
All leads should be kept as short as possible, and the pulse form may be tailored by adjusting the length of the charging cable, the setting of the trimmer capacitor, and the value of the load resistor. When the pulser is initially put into operation, it is advisable to have on hand several transistors, each of which is then tested as follows:

1. Advance voltage until the pulse appears, usually between 165 and 275 volts. Note this as "avalanche voltage."
2. Continue to advance voltage until no further increase in pulse amplitude occurs. Note the output amplitude and input voltage, which may be considered "working voltage."
3. Continue to advance voltage until the pulse becomes erratic or unstable, exhibiting jitter or breakdown, a sudden change in position, or other irregularities. Note this as "maximum usable voltage."

The transistor of choice will deliver optimum pulse amplitude at a relatively modest input voltage, with an excellent safety margin between this point and the onset of erratic behavior. Selected units have performed for hundreds of hours without discernable jitter or other change in parameters. Typically, one might expect avalanche



Epoxy transistor provides high power pulses with picosecond rise times (a). **Sampling scope waveform** shows 250-watt pulse with estimated 800-picosecond rise time (b).



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The new Helipot Model 845 is a thick-film, miniaturized hybrid digital-to-analog converter (DAC) that converts an 8-bit binary word into an analog output. The input gates, switches, resistor network, reference voltage, and output amplifier are all in the hybrid module.

Because of its operating temperature range (−20°C to +85°C), Model 845 can be used for any industrial digital-to-analog conversion, process control being a typical application. Price is $75/unit in 1-9 quantities (less in greater numbers).

The package size is 1.0 inch x 1.5 inches x 0.170 inch. The unit accepts an 8-bit, parallel, binary word that is TTL- and DTL-compatible, and an enable gate is provided. Four different output-voltage ranges are available as standard models: two unipolar (0 to +5 v, 0 to +10 v) and two bipolar (−5 to +5 v, −10 to +10 v). Power-supply requirements are +15 v at 60 ma and −15 v at 10 ma. The output accuracy is ±½ least-significant bit at 25°C ±1 mv per percent of supply-voltage variation. The output-current range is 0 to ±2.5 ma, and the output slew rate is 0.3 v/μsec.

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voltage of 185 volts, full output at 285 volts, and no instability or jitter at 500 or even 700 volts. Approximately 20% of the units tested failed to avalanche, while an additional 20% would not deliver full output power until almost at the point of instability.

John H. Cone, Chief Engineer, Electronic Enterprises, Pasadena, Calif.

VOTE FOR 311

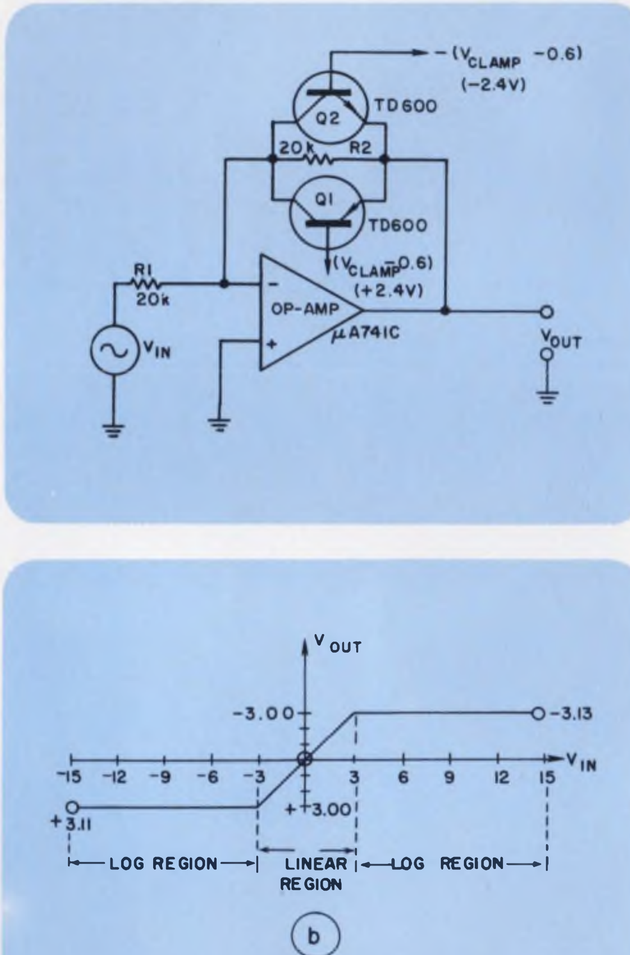
Active clamp circuit uses only two transistors

Back-to-back zener diodes around the feedback resistor are often used when the maximum output voltage of an operational amplifier must be limited. Zener diodes have poor breakdown knees below 6 volts, are quite noisy, and can upset the temperature stability of the amplifier because of increased leakage currents.

A more efficient active clamping circuit (a) can be formed by connecting two transistors in parallel with the feedback loop, and biasing the transistors to conduct at the desired output voltage. *Q1* and *Q2* change the amplifier characteristic from linear to logarithmic. The logarithmic connection ensures that the op-amp inside the feedback loop will remain active during the duration of the output overload. The amplifier will quickly return to linear operation after the overload has been removed.

The recovery time of this circuit was measured by inserting a small-amplitude 500-kHz signal in series with an overdriving 10-volt input pulse. The output response indicated that the amplifier returns to linear amplification of the 500-kHz signal approximately 0.5 μs after the overload condition is removed.

Loop transmission of the op-amp must be compatible with the additional gain contributed by the transistors during the clamped period. Further, the BV_{EBO} rating of the transistors cannot be exceeded.



Active output voltage clamp (a) uses two transistors to achieve desired transfer characteristic (b).

Research sponsored by the U.S. Atomic Energy Commission under contract with the Union Carbide Corp.

E. J. Kennedy, & J. K. Millard, Development Eng., Instrumentation & Control Div, Oak Ridge National Laboratory, Nuclear Div., Oak Ridge, Tenn.

VOTE FOR 312

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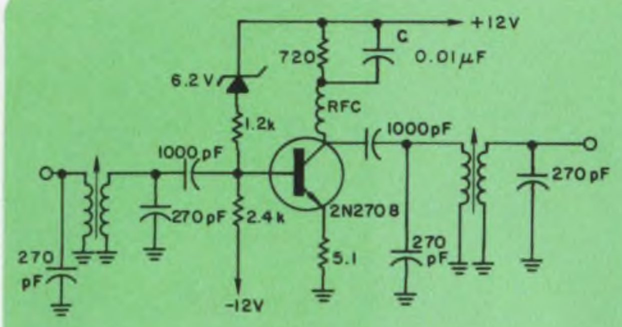
Transposing emitter capacitor speeds amplifier response time

I-f amplifiers are often used to amplify large pulses. Immediately after such a large pulse has passed, the amplifier does not return to its initial sensitivity, due to stored charge on the emitter capacitor. The resulting voltage on the emitter capacitor can reverse bias the base-emitter junction of the transistor for several time constants. This problem exists in radar, nuclear magnetic resonance experiments and other cases where low-level data must be processed immediately after a large pulse is received.

To overcome this problem, the standard common-emitter circuit usually used can be modified, as shown. The emitter capacitor (C) is transposed into the collector circuit. The bias network is then replaced by a modified zener-type network, so that low values of impedance in the base are avoided, with their consequent loss in signal.

The bias is set to provide a constant voltage level at the base consistent with the value of the emitter feedback resistor. The value of decay time for large pulses is 0.08 microsecond for 10-MHz bandwidth amplifier shown.



Common emitter i-f amplifier has faster response time when emitter capacitor (C) is moved to the collector circuit.

William M. Stutz, Engineer, Reeves Instrument Corp., New York, N.Y.

VOTE FOR 313

Full-wave chopper modulator uses only one transformer

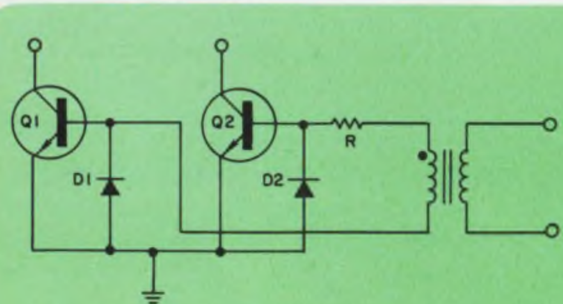
A full-wave chopper for modulation or demodulation usually requires two secondaries or a tapped secondary. Cost and size savings can be realized by using the circuit shown in Fig. 1.

Q1 and *Q2* are forward-biased on opposite half cycles of the transformer drive voltage. On the positive half cycle current flows through the base emitter junction of *Q2* and through *D1*, turning on *Q2*. On negative half cycles current flows through *D2* and the base-emitter junction of *Q1*, turning on *Q1*. When either transistor is in the off state the base emitter junction is also back-biased by the voltage drop across the diode.

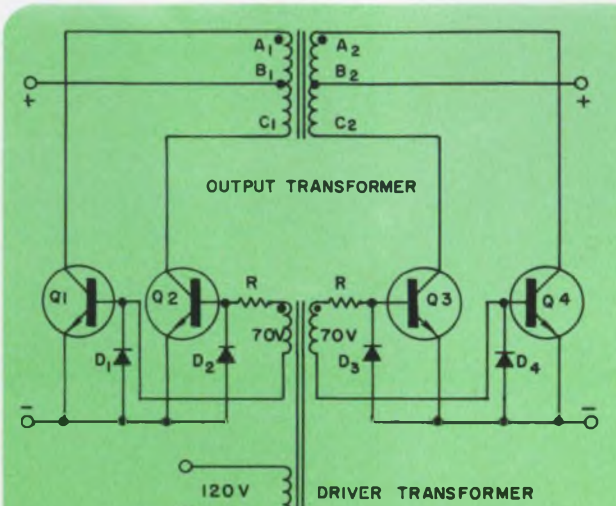
The resistor, *R*, is used to keep the peak base current within the rating of the transistors. The secondary voltage should be reasonably high to minimize the effects of drive voltage variation. Figure 2 shows the circuit used as a modulator and demodulator when dc isolation is required.

L. D. DiNapoli and T. J. Walsh, Design Engineers, Leads & Northrup Co., North Wales, Pa.

VOTE FOR 314



1. **Chopper with single untapped transformer** can be used for either modulation or demodulation.



2. **Chopper circuit used as a modulator and demodulator for dc isolation** is over 95% efficient.

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INFORMATION RETRIEVAL NUMBER 64

Inexpensive circuit generates precision unipolarity output

Many circuit variations exist for generating a precision dc output voltage of one polarity for either polarity of dc input voltages. The circuit described here is simple and uses fewer components than other versions.

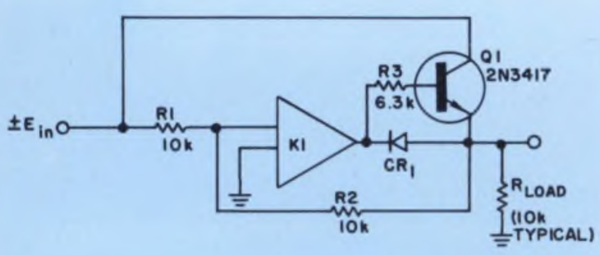
One transistor and one carbon resistor are used in addition to the operational amplifier and its gain determining resistors, R_1 and R_2, to achieve 0.02% performance. For positive input voltages ($+E_{in}$), the output of K_1 is negative, thus causing CR_1 to conduct and biasing Q_1 off through R_3.

Since the feedback is sensed on the output side of CR_1, the offset voltage across CR_1 does not affect the linearity as long as K_1 has a high open-loop gain (> 10,000). When the input signal becomes negative ($-E_{in}$), the output of K_1 becomes positive. This reverse biases CR_1 and causes *Q1* to saturate in the inverted-mode (base current flows through R_3 and the base-collector path of *Q1*).

When *Q1* saturates, E_{out} becomes nearly equal to $-E_{in}$ in both polarity and magnitude. *Q1* becomes heavily saturated for a very small value of E_{in} due to the high open-loop gain of K_1. Typically, for a 2N3417, offset voltages near zero are only 0.3 mV, and only a few mV for several milliamperes of load current. R_1 can be adjusted to match the gain of the + input voltages to the – input.

The switching current that flows through R_3 and *Q1* into the source of $+E_{in}$ must be considered. However, the extra loading on the source can be very small if the application will permit large values for R_1, R_2, R_3 and R_{load}. Normally, the circuit would be driven by a preamplifier, which would satisfy the loading requirements.

Another useful feature of the circuit is that the large step voltage that appears as the output of K_1 may be used to drive a polarity-indicating circuit. This permits a very simple autopolarity analog meter to be constructed. Another feature is that the circuit will rectify an ac signal with great precision. Sinusoidal voltages can be handled by adding a filter to the output.



Precision unipolarity output circuit operates by either saturating or cutting off output transistor.

George R. Latham, Design Engineer, Hewlett Packard Co., Loveland Division, Loveland, Colo.

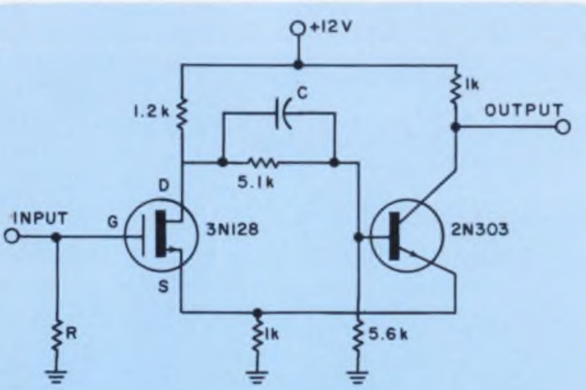
VOTE FOR 315

Schmitt trigger uses MOS to achieve high input impedance

The conventional Schmitt trigger uses two bipolar transistors. When the input transistor conducts, the input impedance is quite low. Typically, an emitter follower precedes the Schmitt trigger to provide a low-enough driving impedance.

By substituting an MOS transistor for the input side, a high-input-impedance Schmitt can be constructed. Such a Schmitt trigger is easily driven directly even by FET or vacuum-tube circuitry. A typical value for the gate charge resistor (*R*) is 1 MΩ. The speed-up capacitor (*C*) should be about 51 pF.

The circuit shown has an upper trip point of +3.5 volts and a lower trip point of +3.0 volts, giving 0.5 volt of hysteresis.



Schmitt-trigger with MOS transistor in input provides a high-input impedance.

Henry D. Olson, Research Engineer, Radio Physics Lab., Stanford Research Institute, Menlo Park, Calif.

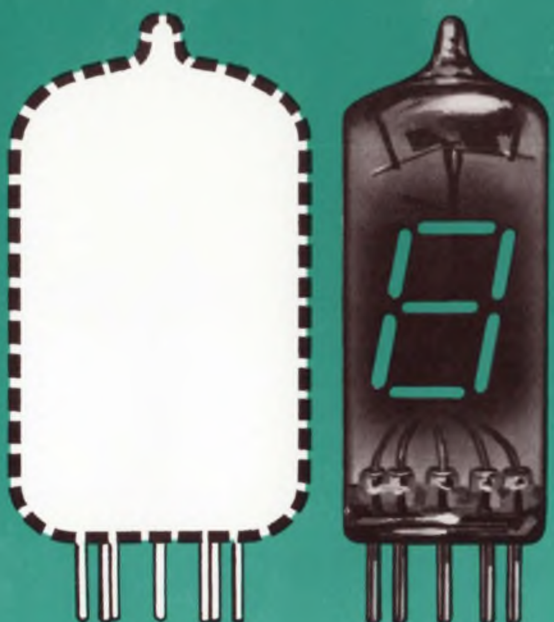
VOTE FOR 316

Electronic Design

PRODUCT SOURCE DIRECTORY

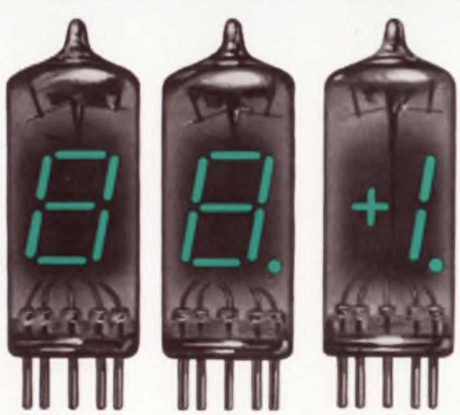
Counters Spectrum analyzers
DVMs Oscilloscopes VTVMs

NOW! A SMALLER* DIGIVAC S/G T.M. READOUT WITH IMPORTANT NEW FEATURES



NEW—Requires less space
NEW—MIL spec construction
NEW—Electrostatically stable
NEW—Solderable leads optional

*ACTUAL SIZE



DT1704B
Numerals 0 to 9, or 14 letters.

DT1705D
With decimal point.

DT1707B
Plus/minus one decimal.

Electrically and optically identical to and interchangeable with the original types . . . but substantially smaller. Same driver and low power requirements. Rugged construction meets MIL specs for shock and vibration. Impervious to electrostatic influences. No reduction in size of the single-plane, high-legibility, 7-segment character. Eye-ease green can be filtered to provide unlimited colors. Regular 9-pin miniature basing, or 10-pins where decimal is required. Solder-in leads reduce seated height of Digivac S/G readouts.

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(T.M.) Wagner Electric Corporation

Product Source Directory

Compiled and edited by **Greg Guercio, Directory Manager**

Here is the first of many comprehensive Product Source Directories covering electronic instrumentation. It covers digital voltmeters, frequency counters, oscilloscopes, spectrum analyzers, vacuum tube and transistor voltmeters.

Use this directory properly and you can make an intelligent, comparative instrument selection from over 1000 instruments currently available. To make the best use of the directory, compare the specs and get a feeling for performance and cost ratios. Then obtain complete manufacturers data by using the reader service numbers in the Master Cross Index on page D6.

How to use the tables

Each table covers a particular type of instrument and lists pertinent technical specifications. A column listing additional features for each instrument is located at the end of the table.

Unless otherwise specified, the power requirements for all the instruments listed are 105-125 Vac, 60 Hz, single phase.

The following abbreviations apply to all instruments listed:

- ina—information not available
- n/a—not applicable

An index of models by manufacturer is included at the end of each table. A location code is included immediately after each model in this index. This permits quick location of the specification for that instrument.

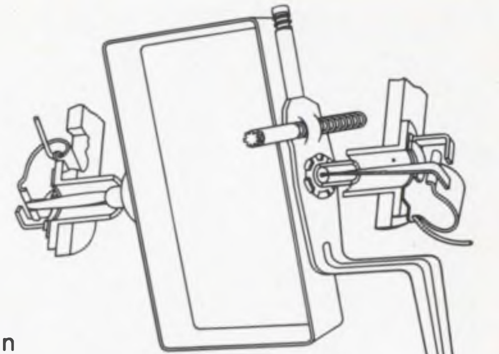
Instrument specifications are given in separate columns. The complete specifications for any one instrument can thus be read across the page.

For each table, the instruments are listed in ascending order of one major parameter. The column containing this parameter is color-coded white for each category. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the index at the end of the section. For manufacturers' addresses and Reader Service literature offerings, see the Master Cross Index.

Each instrument category, for easy use, has been subdivided to bring all similar items together.

Oscilloscopes, for example, have been divided into general-purpose, sampling and main frames. Plug-ins are cross-indexed from both the main frame and the plug-ins available for that main frame.

Westinghouse 20/20 general purpose panel instruments are the best you can buy.



Here's why.

Although all taut-band suspensions are free from friction, free from wear, and capable of low-loss designs, most manufacturers of panel instruments still limit their taut-band designs to high-sensitivity microammeters where minimum friction and loss are design essentials.

Westinghouse, on the other hand, uses taut-band suspension for all its general purpose panel instrument lines.

Back in 1958, Westinghouse pioneered taut-band suspension in heavy-duty switchboard type instruments. These instruments were designed for ruggedness, vibration and shock resistance and high overload capacity.

After several successful years in the switchboard type, Westinghouse adapted taut-band suspension to portable instruments where perfect repeatability, low loss, and high stability are essential. The trademark *tbi*® identifies Westinghouse taut-band instruments.

Then in 1966, drawing from the experience with the top-of-the-line instruments, Westinghouse undertook to design down to a general purpose panel instrument line (USA Specification C 39.1 in the 2% Class) which would approach the ideal in performance. As it turned out, the entire line had to have taut-band suspension to achieve the ideal, so Westinghouse put taut-band into all general purpose panel instruments.

In the Type 20/20 Custom Panel taut-band suspension instrument line, Westinghouse offers these points of superiority:

Perfect Repeatability

Achieved by using a hysteresis-free suspension ribbon made in Westinghouse's own plant by a patented process using secret techniques. This ribbon makes the Westinghouse instrument so free of repeatability errors that differences in successive up-scale and down-scale readings cannot be detected by ordinary means.

High Overload Capacity

The taut-band does not depend on its elasticity for torque. In most dc *tbi* instruments, momentary overloads up to 10,000 percent (even though they will heat the suspension ribbon) will not damage the instrument. In most ac instruments, however, the coils have a thermal limitation at approximately 3,500 percent momentary overload.

High Torque Design

Type 20/20 instruments were designed to be the best 2% Class general purpose panel instruments. No compromise in overall performance was made in order to make these same instruments also serve to make specialized low-current, low-loss measurements. Westinghouse has the Foundation Line of high-sensitivity panel instruments for this purpose. So the 20/20 was designed with high torque mechanisms for fast response and stability in vibration environments.

Rugged Mechanism

The 20/20 panel instrument uses several of the basic suspension features of its big brothers, the *tbi* H1 Shock switchboard instrument, and the Rough Service portable. Because of the high-torque design, it is possible to use an extremely strong suspension ribbon. The 20/20's will be unaffected by shocks which would ruin most other instruments.

Maintained Accuracy

As with all taut-band instruments, there are no wearing parts so the life of the "bearings" is extremely long. Instruments on life tests have exceeded 30,000,000 excursions from zero to full scale—each outlived at least ten pivot and jewel instruments in a parallel test.

Excellent Readability

The standard 20/20 instrument was designed for quick, accurate reading within its accuracy class. The pointer, the numerals and the division marks are bold and clear. The scale arc tracks the end of the pointer for maximum length in each size case. Divisions are always decimals of 1, 2, or 5, just like a slide rule, to minimize reading errors.

Special Purpose Types

On special order the instruments may be furnished with fine-line dials, tubular or knife-edge pointers, mirror scales, multiple arcs, rear-of-panel mounting, with or without illumination, or just about any other desired feature.

Westinghouse will try to discourage certain features which tend to make the instrument appear to be something that it is not. For example, an instrument designed to USA standards for 2% Class panel instruments will not become capable of performance in the ½% Class simply by "calibrating to ½ percent" in the factory. If the customer needs ½ percent, Westinghouse will try to sell him a true ½% Class, or let someone else do the marginal job.

We hope you've found the Westinghouse 20/20 Custom Panel instrument story of interest. Of course, you are not yet convinced, but let us convince you—with a sample. The Westinghouse, or Westinghouse Distributor salesman will be anxious to discuss your particular application and to evaluate it in terms of the advantages to you of using 20/20. Where there may not be such advantages, as does happen now and then, he will be frank to tell you.

Westinghouse Electric Corporation, Relay-Instrument Division, P.O. Box 868, Pittsburgh, Pa. 15230.

J-43018

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

INFORMATION RETRIEVAL NUMBER 602

Master Cross Index

Abbrev.	Company	DVMs	Frequency Counters	Oscilloscopes	Spectrum Analyzers	VTVMs	Reader Service No.
Acton	Action Labs 531 Main St. Action, Mass. 01720 (617) 263-7756	X					423
Adage	Adage Inc. 1079 Commonwealth Ave. Boston, Mass. 02215 (617) 783-1100	X					424
Allied	Allied Radio Corp. 100 N. Western Ave. Chicago, Ill. 60680 (312) HA 1-6800			X		X	425
Anadex	Anadex Inst. Inc. 7833 Haskell Ave. Van Nuys, Calif. 91406 (213) 873-6620		X				426
Atec	Atec Inc. Box 19426 Houston, Texas 77024 (713) 468-7971		X				427
Aul	Aul Inc. 139-30 34th Road Flushing, N.Y. 11354 (212) 886-0600			X	X	X	428
AVO	AVO Gencom Div. 80 Express St. Plainview, N.Y. 11803 (516) 433-5600	X				X	429
Ballantine	Ballantine Operation The Singer Co. Box 97 Boonton, N.J. 07005 (201) 334-1432	X				X	430
Beckman	Beckman Inst. Inc. 2200 Wright Ave. Richmond, Calif. 94804 (415) 526-7730	X	X				431
Binary	Binary Electronics 1429 N. State College Blvd. Anaheim, Calif. 92805 (714) 772-3070			X			432
B&K	B&K Inst. Inc. 5111 W. 164th St. Cleveland, Ohio 44124 (216) 267-4800				X	X	433
Boonton	Boonton Electronics Corp. Route 287 at Smith Rd. Parsippany, N.J. 07054 (201) 887-5110					X	434
Cal-Inst.	California Inst. Corp. 3511 Midway Drive San Diego, Calif. 92110 (714) 224-3241	X	X				435
Cimron	Cimron Div. Lear Siegler Corp. 1152 Morena Blvd San Diego, Calif. 92110 (714) 276-3200	X					436
CMC	CMC 12970 Bradley Ave. San Fernando, Calif. 91342 (213) 367-2161		X				437
Cohu	Cohu Electronics Inc. Box 623 San Diego, Calif. 92112 (714) 277-6700	X					438
Comark	Comark Ltd. Gencom Div. 80 Express St. Plainview, N.Y. 11805 (516) 433-4600					X	439
Dana	Dana Labs Inc. 2401 Campus Drive Irvine, Calif. 92664 (714) 833-1234	X	X				440
Data	Data Inst. Div. 7300 Crescent Blvd. Pensauken, N.J. 08110 (609) 662-3031	X		X		X	441
Data Tech.	Data Technology Inc. 1050 E. Meadow Circle Palo Alto, Calif. 94303 (415) 321-0551	X					442
Digilin	Digilin Inc. 6533 San Fernando Rd. Glendale, Calif. 91291 (213) 246-8161	X					443
Dumont	Dumont Oscilloscope Corp. 40 Fairfield Place W. Caldwell, N.J. 07006 (201) 228-3665			X			444
Dynamics	Dynamics Inst. Co. 583 Monterey Pass Rd. Monterey Park, Calif. 91754 (213) 283-7773					X	445
Dynascience	Dynascience Div. Whittaker Corp. 9601 Canoga Ave. Chatsworth, Calif. 91311 (213) 341-0800	X	X				446
Dytronics	Dytronics Co., Inc. 4800 Evanswood Drive Columbus, Ohio 13229 (614) 885-3303					X	447
E/D	Electro Data Inc. 1621 Jupiter Garland, Texas 75040 (214) 341-2100				X		448
EIP	EIP Inc. 2353 De La Cruz Blvd. Santa Clara, Calif. 95050 (408) 244-7975		X		X		449
Eldorado	Eldorado Electrodata Corp. 601 Chalomar Rd. Concord, Calif. 94520 (415) 686-4200	X	X				450
Fed. Sci.	Federal Scientific Corp. 615 W. 131st Street New York, N.Y. 10027 (212) 286-4400				X		451
Fluke	John Fluke Mfg. Co. Box 7428 Seattle, Wash. 98133 (206) 774-2211	X				X	Contact Local Rep.

Abbrev.	Company	DVMs	Frequency Counters	Oscilloscopes	Spectrum Analyzers	VTVMs	Reader Service No.
Gen Atro	General Atronics Corp. 1200 E. Mermaid Ave. Philadelphia, Pa. (215) 248-3700			X			**452**
FR	General Radio Co. 22 Baker Ave. W. Concord, Mass. 01781 (617) 369-4400		X		X	X	**453**
Greibach	Greibach Inst. Div. Solitron Devices Inc. 37-11 47th Ave. Long Island City, N.Y. 11101 (212) 937-0400	X					**454**
Heath	Heath Co. Benton Harbor, Mich. 49022 (616) 983-3961			X		X	**455**
Hickok	Hickok Elect. Inst. Co. 10555 Dupont Ave. Cleveland, Ohio 44108 (216) 541-8060	X	X	X			**456**
HP	Hewlett-Packard Co. 1501 Page Mill Rd. Palo Alto, Calif. 94304 (415) 326-7000	X	X	X	X	X	Contact Local Sales Office
Honeywell	Honeywell Test Inst. Div. 4800 E. Dry Creek Rd. Denver, Colo. 80217 (303) 771-4700	X					**457**
IB	IB Instruments Inc. 7016 Euclid Ave. Cleveland, Ohio 44103 (216) 431-4790					X	**458**
Ind-Test	Industrial Test Equip. Co. 20 Beechwood Ave. Port Washington, N. Y. 11050 (516) 767-5253					X	**459**
Inst-labs	Instrument Labs Corp. 315 W. Walton Place Chicago, Ill. 60610 (312) 642-0123					X	**460**
Itron	Itron Corp. 11675 Sorrento Valley Rd. San Diego, Calif. 92121 (714) 453-5300		X				**461**
ITT-Jenn	ITT/Jennings 970 McLaughlin Ave. San Jose, Calif. 95108 (408) 292-4025					X	**462**
Iwatsu	Iwatsu E-H Research Labs Box 1289 Oakland, Calif. (415) 834-3030			X			**463**
Jackson	Jackson Elect. Inst. Co. 315 Roslyn Rd. Mineola, N. Y. 11501 (516) 742-5400			X			**464**
J-Omega	J-Omega Co. 2271 Mora Drive Mountain View, Calif. 94040 (415) 961-2000	X					**465**
Julie	Julie Research Labs 211 W. 61 Street New York, N. Y. 10023 (212) 245-2727					X	**466**
Kay	Kay Electric Corp. Maple Ave. Pine Brook, N. J. 07058 (201) 227-2000				X		**467**
Keithley	Keithley Inst. Corp. 28775 Aurora Rd. Cleveland, Ohio 44139 (216) 248-0400					X	**468**
Magtrol	Magtrol Inc. 240 Seneca St. Buffalo, N. Y. 14204 (716) 856-7451		X				**469**
MCD	Measurement Control Devices 2445 Emerald St. Philadelphia, Pa. 19125 (215) 426-8602			X			**470**
Mercury	Mercury Electronics Corp. 315 Roslyn Rd. Mineola, N. Y. 11501 (516) 742-5400			X		X	**471**
Measure	Measurements Box 180 Boonton, N. J. 07005 (201) 334-2131					X	**472**
Medistor	Medistor Inst. Co. 4503 8th Ave. Seattle, Wash. 98107 (206) 784-8141					X	**473**
Micro	Micro Inst. Co. 12901 Crenshaw Blvd. Hawthorne, Calif. 90250 (213) 772-1275	X				X	**474**
Millen	James Millen Mfg. Co. Inc. 150 Exchange St. Malden, Mass. 02148 (617) 324-4108		X				**475**
Millivac	Millivac Inst. Inc. 1100 Altamont Ave. Box 997 Schenectady, N. Y. 12301 (518) 355-8300					X	**476**
Monsanto	Monsanto Electronics 620 Passaic Ave. W. Caldwell, N. J. 07006 (201) 228-3800	X	X				**477**
Muirhead	Muirhead Inst. Inc. 1101 Bristol Rd. Mountainside, N. J. 07092 (201) 233-6010				X		**478**
N. Ross	Polarad/Nelson Ross 5 Delaware Drive Lake Success, N.Y. 11040 (516) 328-1100				X		**479**
NLS	Non-Linear Systems Inc. Box 728 Del Mar, Calif. 92014 (714) 755-1134	X					**480**

Master Cross Index

Abbrev.	Company	DVMs	Frequency Counters	Oscilloscopes	Spectrum Analyzers	VTVMs	Reader Service No.
NA	North Atlantic Industries Terminal Drive Plainview, N. Y. (516) 681-8600					X	481
PAI	Practical Automation Inc. Trap Falls Rd Shelton, Conn. 06484 (203) 929-1495	X					482
Philips	Philips Electronics 750 S. Fulton Ave. Mount Vernon, N. Y. 10550 (914) 664-4500		X	X		X	483
Polarad	Polarad/Nelson Ross 5 Delaware Drive Lake Success, N. Y. 11040 (516) 328-1100				X		484
Preston	Preston Scientific 805 E. Cerritos Ave. Anaheim, Calif. 92805 (714) 776-6400	X					485
Probe-scope	Probescope Co. 211 Robbins Lane Syosset, N. Y. 11790 (516) 433-8120				X		486
Quan-Tech	Quan-Tech Labs 45 S. Jefferson Rd. Whippany, N. J. 07981 (201) 887-5508				X		487
Radiometer	Radiometer The London Co. 811 Sharon Drive Westlake, Ohio 44145 (216) 871-8900					X	488
RCA	Radio Corp. of America Elect. Components & Devices Harrison, N. J. 07029 (201) HU 5-3900			X		X	489
R-S	Rohde & Schwarz 111 Lexington Ave. Passaic, N. J. 07055 (201) 773-8010	X	X			X	490
Sencore	Sencore 426 S. Westgate Drive Addison, Ill. 60101 (312) 543-7740			X			491
Siemens	Siemens America Telcom Div. 350 Fifth Ave. New York, N. Y. 10001 (212) LO 4-7674				X		492
Simpson	Simpson Electric Co. 5220 W. Kinzie St. Chicago, Ill. 60644 (312) 379-1121	X	X	X			493
Singer	The Singer Co. Inst. Div. 915 Pembroke St. Bridgeport, Conn. 06608 (203) 366-3201				X		494
Spectral	Spectral Dynamics Box 671 San Diego, Calif. 92112 (714) 278-2501				X		495
Spectran	Spectran Div. Nortronics Corp. Box 878 Pompano Beach, Fla. 33061 (305) 942-5200				X		496
Spedcor	Spedcor Electronics Route 79 Morganville, N. J. 07751 (201) 591-1000			X	X		497
Systron	Systron-Donner Corp. 888 Galindo St. Concord, Calif. 94520 (415) 682-6161	X	X		X		498
Tektronix	Tektronix Inc. Box 500 Beaverton, Oregon 97005 (503) 644-0161			X	X		499
Tracor	Tracor Inc. 6500 Tracor Lane La Austin, Texas 78721 (512) 926-2800				X		410
Trio	Trio Labs 80 DuPont St. Plainview, N. Y. 11803 (516) 681-0400					X	411
Triplett	Triplett Elect. Inst. Co. 286 Harmon Rd. Bluffton, Ohio 45817 (419) 358-5015					X	412
TSC	Time Systems Corp. 265 Whisman Rd. Mountain View, Calif. 94040 (415) 961-9321		X				413
Tyco	Tyco Instrument Div. Hickory Drive Waltham, Mass. 02154 (617) 891-4700	X					414
Un-Syst	United System Corp. 918 Woodley Rd. Dayton, Ohio 45903 (513) 254-6251	X					415
Vidar	Vidar Corp. 77 Ortega Ave. Mountain View, Calif. 94041 (415) 961-1000	X					416
Waterman	Waterman Inst. Corp. 400 S. Warminster Rd. Hatboro, Pa. 19040			X			417
Waveforms	Waveforms 11922 Valerio St. N. Hollywood, Calif. 91605 (213) 764-1500					X	418
Wavetek	Wavetek 9045 Balboa Ave. San Diego, Calif. 92123 (714) 279-2200					X	419
Weston	Weston Instruments 614 Frelinghuysen Ave. Newark, N. J. 07114 (201) 243-4700	X	X				420
Xetex	Xetex Marconi Inst. 111 Cedar Lane Englewood, N. J. 07631 (201) 567-0607			X			421

- Five full digits plus "1" for 20% overranging
- Basic unit measures 0 to 1100 volts dc in three ranges
- Auto ranging and polarity with active 3-pole switchable filter
- 25 millisecond sampling speed
- Full systems capability with timing signals and ready indicator
- Low cost options include ac voltage, millivolt-ohms, external reference (ratio) and fully isolated remote programming and data output.

The first really new DVM in a decade

Announcing the Fluke 8300A, a 0.005% digital voltmeter with full systems capability for $1295

There are a lot of good DVM's around. All but one share a common set of faults—overwhelming complexity and high cost. And as you might guess, the DVM that beats the others cold is the new Fluke 8300A.

Why?

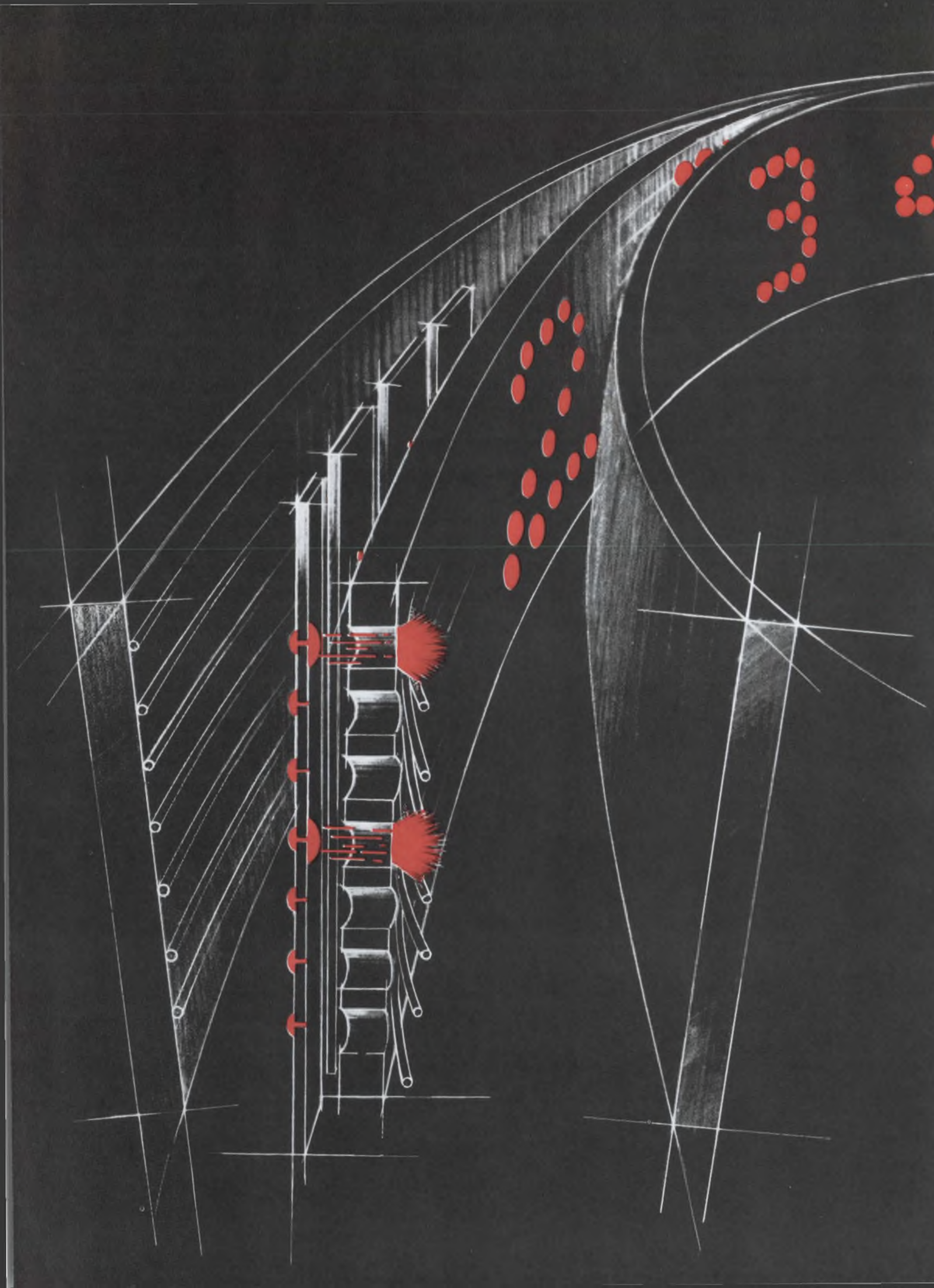
Because Fluke uses a new A to D technique which reduces componentry by up to 500 percent. Obviously, when components are eliminated, good things happen. Power requirements go down, reliability goes up, circuitry is simplified, troubleshooting is speeded and reduced. Most important to the system designer, lowered costs mean we can invest some of the savings in features you need in a DVM.

With all its features and accuracy, the Fluke 5-digit DVM sells for less than many 4-digit units. We price the options low, too. A fully loaded Fluke 8300A sells for $2995. Comparable but not equal competitive instruments cost as much as $5000.

And when the Fluke names goes on the front you know you're getting quality instrumentation . . . in keeping with the Fluke philosophy of bringing you standards lab performance in portable instrumentation.

Fluke, Box 7428, Seattle, Washington 98133. Phone: (206) 774-2211. TWX: 910-449-2850. In Europe, address Fluke Nederland (N.V.), P.O. Box 5053, Tilburg, Holland. Phone: (04250) 70130. Telex: 884-50237. In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.

FLUKE®



SELF-SCAN™ PANEL DISPLAY eliminates up to 90% of drive electronics

SELF-SCAN panel displays represent a Burroughs invention of panel design and circuitry that permits time sharing of the cathode electrode drivers in a flat panel display using gas discharge light emitters. Consequently a savings of up to 90% of the electronics required to drive the dot matrix display is realized.

For informational purposes the SELF-SCAN panel display can be thought of as a dot matrix panel with common cathode strips capable of glowing on both front and back sides. The glow on each side of the cathodes is independently controlled by a set of anodes located on the front and back of the panel. The rear portion of the display consists of 7 glow-priming anodes which work in conjunction with 111 vertical cathode strips (common to both sets of anodes). These cathodes are interconnected in three groups of 37 cathodes each and connected to a three phase clock which sequentially brings each cathode to ground potential. As each cathode is grounded in sequence, the glow is transferred to the adjacent cathode. This transferred glow at the rear of the panel is not discernible from the front. (The illustration shows the first cathode grounded and glow at the 7 rear anode intersections.)

When it is desired to display a dot on the viewing surface, the front glow transfer anodes are utilized. (The glow transfer anodes and common cathodes make up the front matrix.) The appropriate transfer-anode is selected in synchronism with the cathode and the glow transfers forward to the panel front for viewing. (The illustration shows the top and center dots on the first cathode transferred for viewing.) The whole display panel is refreshed and updated to produce a bright flicker-free display.

As a normal dot matrix panel requires a cathode driver for each cathode (80 high-voltage drivers required for a 16 digit display) and the SELF-SCAN panel display requires *only* 3 clock controlled cathode drivers regardless of the number of digits, the significance of this development is immediately apparent.

The SELF-SCAN panel display has unlimited applications, as alphanumeric and graphic messages can be presented with simplicity.

Write today for descriptive brochure, Burroughs Corporation, Box 1226, Plainfield, N.J. (201) 757-5000.

Burroughs

INFORMATION RETRIEVAL NUMBER 604

Get the most out of your DVM

The first digital voltmeters had very limited capabilities. They measured only dc voltages, and even then the lowest full-scale range was 10 volts. The measurement accuracy of these early devices was an order of magnitude better than that of the finest analog instruments available today, but this high accuracy uncovered many new sources of errors: loading errors due to high source resistances, superimposed noise from noisy power supplies, and common-mode voltage from ground-loop currents. New developments in test equipment have made digital voltmeters impervious to these and other sources of error.

In addition to making accurate voltage measurements under varying conditions, modern digital voltmeters can also be used to solve a wide variety of other measurement problems. Most digital voltmeters are actually multimeters, measuring resistance with milliohm accuracy; low-level dc voltages to 0.1-μV resolution; and ac voltages, in addition to high-level dc volts. Also, several are classed as ratiometers, capable of displaying scaled MV/volt ratios from transducers and ac transfer functions such as amplifier gain.

Several common measurement problems are presented here together with the various techniques in which digital voltmeters are used to solve them.

Signals from high impedance sources

High performance, regardless of source characteristics, is a very desirable feature to look for in a digital voltmeter, since the exact nature of the voltage source on which measurement is to be made is usually not known when the instrument is purchased. High source resistance and source capacitance can degrade the accuracy of the DVM by several orders of magnitude. To provide this source—independent measurement capability, the digital voltmeter must have a high input resistance, low current error, and no "kick-back" current-parameters.

A digital voltmeter measures the voltage drop across its input terminals; thus any resistance causing a voltage drop at the signal source or in the signal leads will cause a loading error. If the input resistance of a digital voltmeter is 10 MΩ, source resistances up to 1 kΩ will cause less than 0.001% loading error. However, many commonly measured signals have source resistances much greater than 1 kΩ. For instance, the collector voltage on the input transistors in modern, high-performance, operational amplifiers can have up to 500-kΩ source resistance. In this situation, the accuracy of a digital voltmeter with only 10 MΩ input resistance would be limited to 5%, even if the instrument's specification sheet indicates a basic accuracy of 0.0025%.

To reduce loading errors, many digital voltmeters use potentiometric input amplifiers, thereby developing input resistances greater than 10,000 MΩ. The loading error is less than 0.005% when a potentiometric input is used to measure a signal with 500-kΩ source resistance.

High input resistance does not solve all problems associated with source characteristics. The input amplifier in a digital voltmeter, like all amplifiers, has a voltage and current error. For example, a 1-nA current offset will cause a 0.1% (100 μV) measurement error when measuring 10-mV output from a thermistor transducer with a 100-kΩ source resistance. This error is independent of any loading error that might be caused by a low input resistance. In fact, the error caused by current offset is usually more serious, since the loading error will decrease to zero as the input signal is reduced to zero, but the error caused by current offset will remain the same, indpendent of input signal level. Thus, a 100-μV error in the previous example will cause a 0.1% error when a 10-mV signal is measured and a 1% error when the input signal is reduced to 1 mV. The offset current of a digital voltmeter is rarely specified.

Barton A. Weitz, Product Marketing Manager, Dana Laboratories Inc, Irvine, Calif.

Another digital-voltmeter characteristic that is rarely specified is "kickback" current. Some digital voltmeters use zero stabilization techniques that kick back current into the input voltage source. This kickback can cause significant errors in the measurement of capacitive sources such as the output of filtered channels in a data acquisition system. Essentially, the source capacitance stores up the kickback current and introduces a voltage offset.

Dc signals in the presence of noise

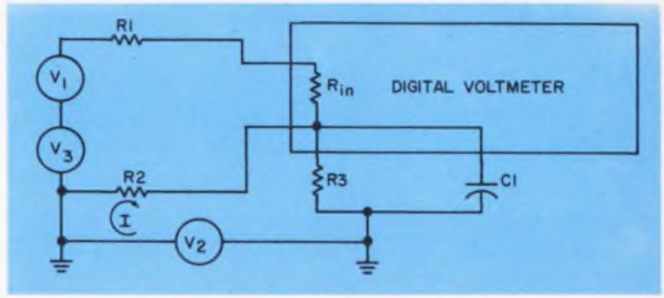
High-accuracy digital measuring instruments have introduced new problems in the area of inaccuracy due to electrical noise on the signal to be measured. Many analog meters are not bothered by noise. Usually, the meter movement essentially filters out superimposed noise, and the battery operation isolates them from ground-loop problems. But the accuracy of any digital voltmeter can be severely degraded by electrical noise. An ideal dc measurement situation would occur when the unknown voltage has no ac component and the low-potential side of the unknown signal corresponds to the low-potential side of the digital voltmeter's power supply. Unfortunately, superimposed noise and ground loops are often encountered in practical measurement situations.

Two types of noise signals affect digital-voltmeter accuracy: normal-mode noise and common-mode noise. Fig. 1 can be considered a typical measurement environment for a floating-input DVM, where R_1 represents the source resistance, R_2 the system unbalance, R_3 the leakage resistance to ground, and C_1 the leakage capacitance to ground. V_1 is the signal source.

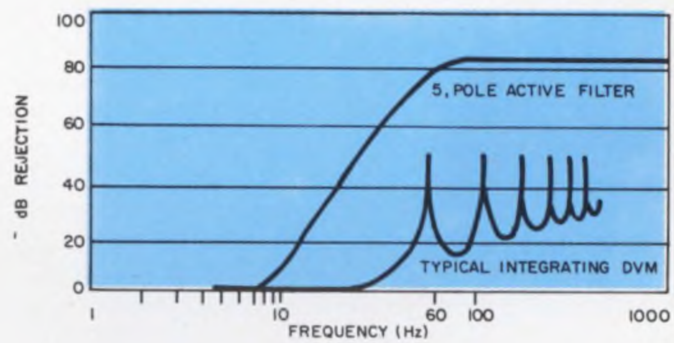
Normal-mode noise consists of those unwanted signals that are in series with the signal source. This is noise that exists between the high and low input leads. This is shown as voltage V_3 in Fig. 1. It is produced by noise in the signal source, electromagnetic effects from power lines or parallel signal lines, and radio frequency interference.

Common-mode noise may be defined as an unwanted signal common to both the high and low input leads. In most cases, it is produced when the signal source and the digital voltmeter are operating at different potentials. A ground loop is developed as a result of current flow in the impedance separating the signal source ground and the digital-voltmeter ground.

The normal-mode noise rejection capability of a digital voltmeter is a function of the noise frequency. Since 60-Hz noise is the most common noise, manufacturers often specify noise rejection at 60 Hz, rather than completely describing the noise rejection characteristic of the digital voltmeter with a chart like that shown in Fig. 2.



1. **A typical DVM measurement environment** is shown for the case of a floating input.



2. **Normal mode noise rejection** of a DVM is a function for signal levels from zero to full scale.

The normal noise rejection characteristics of an integrating digital voltmeter might be adequate for 60-Hz noise but insufficient for other noise frequencies such as 400 Hz, a common power-supply frequency in ground-support equipment. In fact, the noise rejection of an integrator is calculated to be 48 dB for a deviation of ±0.15% from 60 Hz. Since short-term power-line deviation is ±0.15% typically in North America, the actual line frequency noise rejection of an integrating DVM is only 48 dB, and not indefinite as some manufacturers claim.

The normal-mode rejection specification, in Fig. 2, should apply at all signal levels from zero to full scale. Some voltmeters without an input filter reject noise only up to a certain level. Above this level, the input circuit saturates, and the rejection ratio is substantially reduced. For example, the input signal to an integrating DVM is 6 V dc with 8 V of 60-Hz noise, the input amplifier sees the waveform shown in Fig. 3a. Since the input amplifier is generally designed with a ±11-V operating range, the positive portion of the input waveform is clipped, as shown in Fig. 3b. The resultant waveform into the integrating circuitry is no longer symmetrical, and the integrator will not introduce dc error. When this situation occurs, a maximum level of input signal plus noise is often quoted in the specification.

The susceptibility of a digital voltmeter to noise produced by ground potential is specified as common-mode rejection (CMR) ratio. This parameter defines the amount of normal-mode noise produced by a voltage difference between the input circuit and ground with known conditions of source unbalance and frequency. A typical specification would be: 120-dB CMR with 0-100-Ω source unbalance in either input lead, dc or 60 Hz.

The CMR specification indicates that either input lead is isolated from any other ground (ac power line, electrical output, program input, etc.) by an impedance whose magnitude at 60 Hz is equal to the product of CMR ratio and the source unbalance. This would be 100 MΩ. It can also be expressed as "stray" capacitance of 27 pF at 60 Hz.

This degree of intrinsic isolation can be obtained only by using guard-shield techniques. The entire intrument must be enclosed within an electrostatic shield. All power supplies contained must use well-shielded transformers. Any electrical outputs and program leads must not "ground contaminate" the electrostatic environment established. To be a true ground shield, this electrostatic shield must also enclose the input circuit and be referenced to the source of common-mode voltage.

Many digital voltmeters include, within the 60-Hz CMR specification, the effect of an input filter, or the notch filter action obtained by integration. This provides the instrument with an apparently high CMR, although the intrinsic CMR (isolation) of the instrument might be only 60 dB. The addition of 60 dB of input filtering provides an *apparent* CMR of 120 dB (see Fig. 4).

The improvement in CMR gained by this technique is usually at the expense of measurement speed and is useful only for dc measurements. The use of an input filter to provide CMR equivalent to that of a guarded instrument requires that the measurement time be increased to include the filter settling time. The comparison is at an equal noise level resulting from an equivalent common-mode source. This factor becomes particularly important when the instrument is used in an automatic test system that requires input scanning.

The value of the guard-shield technique becomes more important when high-accuracy ac measurements are considered. The input filter used to improve the 60-Hz CMR for dc measurements cannot be used for ac. This reduces the CMR to the intrinsic value. If this value is low, large ac measurement errors can result.

The operator may not be aware of this error, as the displayed reading could appear stable. For example: 60-Hz noise due to ground potentials could be superimposed upon a signal near to 60 Hz. The resulting dc value, after rectification by the ac converter, would contain errors caused by the 60-Hz ground potentials. It is even possible for the noise voltage to exceed the signal, in which case the reading would be in error. This type of noise might exist only during the test, due to poor isolation of the digital voltmeter. This could cause further complications, such as the rejection of another manufacturer's product for failing an acceptance test.

Measuring ac voltages accurately

The growing popularity of dynamic testing is placing more demands on digital voltmeters to make fast, accurate rms measurements of ac waveforms. Digital voltmeters presently on the market display only one parameter on an ac waveform.

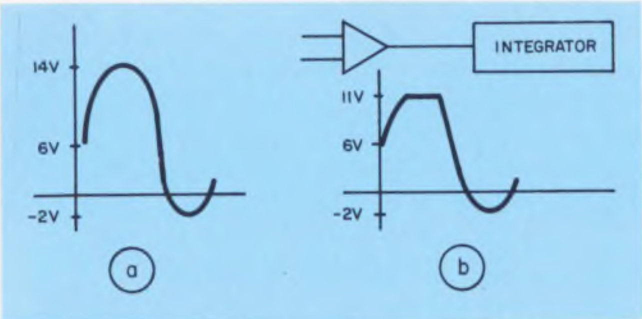
When a single number is used to characterize the magnitude of an ac signal, a question arises as to which property is the most useful one. There are three commonly used values: peak, average, and rms.

When using an oscilloscope to measure an ac signal, the peak or peak-to-peak value is usually measured. This is the critical parameter when determining whether an unknown signal will overdrive an amplifier. In many applications, the peak value would give no information. As an example, random noise has infinite peak value and thus cannot be measured with a peak detecting instrument.

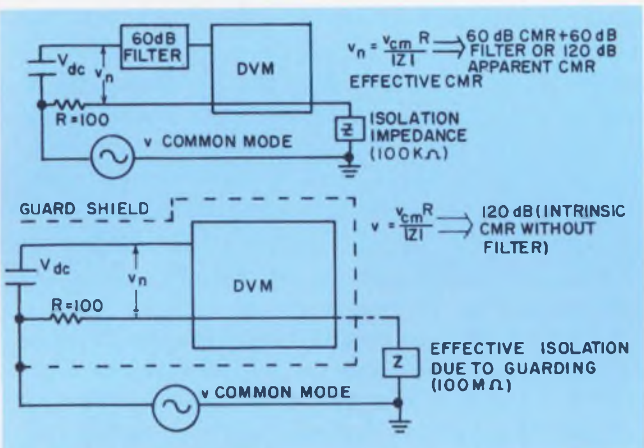
It would seem that the rectified average value of a waveform would be much more useful since the value depends on the whole waveform, not just one point—the peak value. Unfortunately, the average value seldom occurs in the mathematical treatment of waveforms.

In most cases, rms value is the most important signal parameter to know. For example, in linear circuits, the power dissipated is directly proportional to the rms voltage. The rms value is so important that the National Bureau of Standards (NBS) uses the value to define the standard ac volt. This is why virtually all ac voltmeters are calibrated to display the rms value, even though the ac conversion technique used does not measure rms directly. The ac measurement accuracy varies dramatically, depending upon the ac conversion technique used in the digital voltmeter.

These techniques can be grouped into two categories; direct and indirect. Direct measuring techniques, "thermal" and "computing," use circuitry to approximate a square law response, thereby determining the actual rms value of the waveform. Indirect techniques, "average" and "peak," measure a characteristic of the waveform and scale the measured value to indicate



3. **Waveform of an input signal** to an integrating DVM is shown for 6 V dc signal with 8 V of 60 Hz noise (a). If the amplifier has a ±11 V operating range, clipping results, as shown in (b).



4. **Use of an input filter** provides a CMR equivalent to a guarded instrument.

the rms units. The scale factor used is based on the mathematical relationship between the measured characteristic and the rms value of a pure sine wave.

Average responding technique

The average responding technique offers good stability, sensitivity, and fast measurement speed at a relatively low cost. A block diagram of an average responding converter would show a full or half-wave rectifier followed by a filter that performs the "averaging" function. By multipole active filters, settling times of 100 ms for waveforms above 400 Hz, and 300 ms for waveforms about 50 Hz, can be realized. Gain is introduced, permitting the display to be calibrated in rms units.

The average-responding ac conversion technique, like all indirect techniques, has one serious drawback. Small amounts of distortion in the measured signal can cause gross errors. Errors caused by this distortion, when measuring an rms value, are a result of the indirect nature of the technique. The calibration of the average responding converter is based on the precise mathematical relationship between the average value and the rms value of an undistorted sine wave. This relationship is: (E_p = peak value).

The output of the average responding converter is multiplied by 1.11 to display the measurement in rms units. In practical situations, there are no undistorted sine waves. The typical power line has between 1 and 3% distortion. Test oscillators are specified at 0.1% distortion levels. With only 3% distortion the accuracy of a 0.1% average responding converter can be degraded to 1%. In the case of a square wave, a common waveform encountered in circuit testing, the accuracy of an average responding converter, vs the true rms value, is degraded to 11%. The inherent error is a function of the magnitude, harmonic content, and phase of the distortion.

Peak detecting and thermal measurements

The peak-detecting technique has been used longer than any other indirect measurement technique. Like the average responding technique, it is indirect because it measures peak amplitude and indicates rms value. This technique is considered unsuitable for high-accuracy rms ac measurements. This is due to small amounts of distortion that cause far more significant errors in peak-detecting ac converters than in average responding converters. This technique is also inherently more susceptible to noise.

The thermal rms technique is a direct conversion technique capable of yielding excellent accuracies, even when measuring waveforms with very high distortion levels. Essentially, digital voltmeters using thermal rms converters automatically scale and compare the power dissipation in a thermocouple of a known dc voltage and an unknown ac voltage.

When a comparison has been achieved, the dc voltage is displayed. This technique is based on the same principle used in secondary standards; however, the implementation of this technique is rather costly ($1200 to $2500) due to the extensive circuitry being required to overcome the limitations of the thermocouple.

The thermal rms conversion technique has the disadvantages inherent within circuitry using thermo-elements. Measurement speed is slow (2500 ms) due to the response time of the thermocouple. Thermocouples limit the sensitivity of the device, and the thermocouple output will follow a low-frequency wave rather than provide the rms value, thus limiting low frequency response to 45 Hz.

New technique has advantages

A new ac conversion technique[1] has recently been developed using building blocks from high-speed analog computers. The computing rms technique provides measurement speed, dynamic range, frequency response, and economy comparable to average responding techniques. Measurements can be made as accurate as thermal rms converters, in the presence of distortion levels.

The heart of a direct rms converter is the building block with a square response. In a thermal rms converter this function is really used as a thermal element. In the new rms converting technique the thermal element is replaced by a piecewise linear approximation developed with biased operational rectifiers. The problems associated with older curve-fitting techniques are overcome by using operational rectifiers to generate the straight-line segments. By placing the diodes in feedback with operational amplifiers, the dependence on diode characteristics is eliminated. Using precision resistors, the breakpoints can be placed accurately with the assurance of good, long-term stability. The additional use of feedback scales the approximation in proportion to the converter outputs, and thus the over-all accuracy of the approximation is increased even when measuring low-level signals.

In summary, then, all ac converter techniques are capable of measuring undistorted sine waves with high accuracy. In practical situations where 1% to 3% distortion is present or when measuring triangle or square waves, direct conversion, either computing rms or thermal techniques, must be used if accuracies better than 1% are required. When accurate measurments of highly distorted waveforms, such as low-duty cycle pulse trains are required, thermal rms conversion techniqeus must be used. However, measurement speed, sensitivity, and low-frequency response must be sacrificed.

Unstable excitation sources

In an effort to provide high-speed, accurate, low-cost measurement capability, several digital voltmeters have been designed with ratiometer capability. There are now instruments that can directly measure ac/ac, ac/dc, dc/ac, and dc/dc ratios. The ratio capability allows the user to directly display such parameters as amplifier gain, transformer turns ratio, voltage divider ratios, and the gauge factor of transducers with greater accuracies than could be obtained by making two separate measurements and performing the division "on paper." This ratio capability has an obvious benefit in terms of speed and ease of operation. By using the ratio measurement capability, the over-all measurement cost can be reduced. Often, less expensive excitation supplies with poorer stability can be used, since the ratio measurement usually cancels out the effects of excitation supply instability. This is particularly important as ac measurements, since stable ac sources are quite expensive.

There are basically three different ratio measurement techniques commonly employed in digital voltmeters: (1) three-wire, real-time, (2) four-wire, real-time, and (3) quotient. These techniques offer a variety of tradeoffs between accuracy, capability and price.

Three, four wire and quotient techniques

The signal input, E_{in}, and the reference input, E_{ref}, share the same common ground when the three-wire, real-time technique is used in a digital voltmeter. The reference and input signal voltages are compared at the same time; thus errors caused by instabilities in the excitation supply are canceled out. Since the reference voltage is substituted for the internal DVM reference, all errors associated with the internal reference will not affect measurement accuracy. This results in three-wire ratio measurements more accurate than absolute measurements. Since the common ground is shared, this technique permits the measurement of ratios emanating from three-wire devices.

By using the four-wire real-time technique, four-wire ratio measurements can be made. This technique is implemented by using a floating differential amplifier for the input signal.

By using a floating input to achieve four-wire ratio capability, the benefits of real-time ratio measurement, the elimination of errors due to instability and the improvement in accuracy over absolute measurement accuracy are realized.

Four-wire measurement capability can be realized by simply measuring the input signal and storing the result; then measuring the reference signal, dividing the input signal by the reference, and displaying the result. This is accomplished automatically in a digital multimeter using the dual-slope analog-to-digital conversion scheme.

The quotient technique is very economical. Only one signal channel is required, permitting ac/ac ratio measurements to be made with only one ac converter. Two converters are required in real-time techniques.

The quotient technique does not make a real-time comparison between two signals. The input signal and reference signal are measured at different instants of time.

The quotient technique does not produce real-time ratios; therefore errors caused by source instabilities are still present, and the measurement accuracy is generally twice as bad as the absolute measurement accuracy, and measurement speeds two times slower than real-time ratio techniques. ■■

Reference:

1. Ochs, Gene and Richman, Peter, "Curve Fitter Aids the Measure of RMS by Overruling Square-Law Slowdowns," *Electronics*, Sept. 29, 1969, pp. 98-101.

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INFORMATION RETRIEVAL NUMBER 605

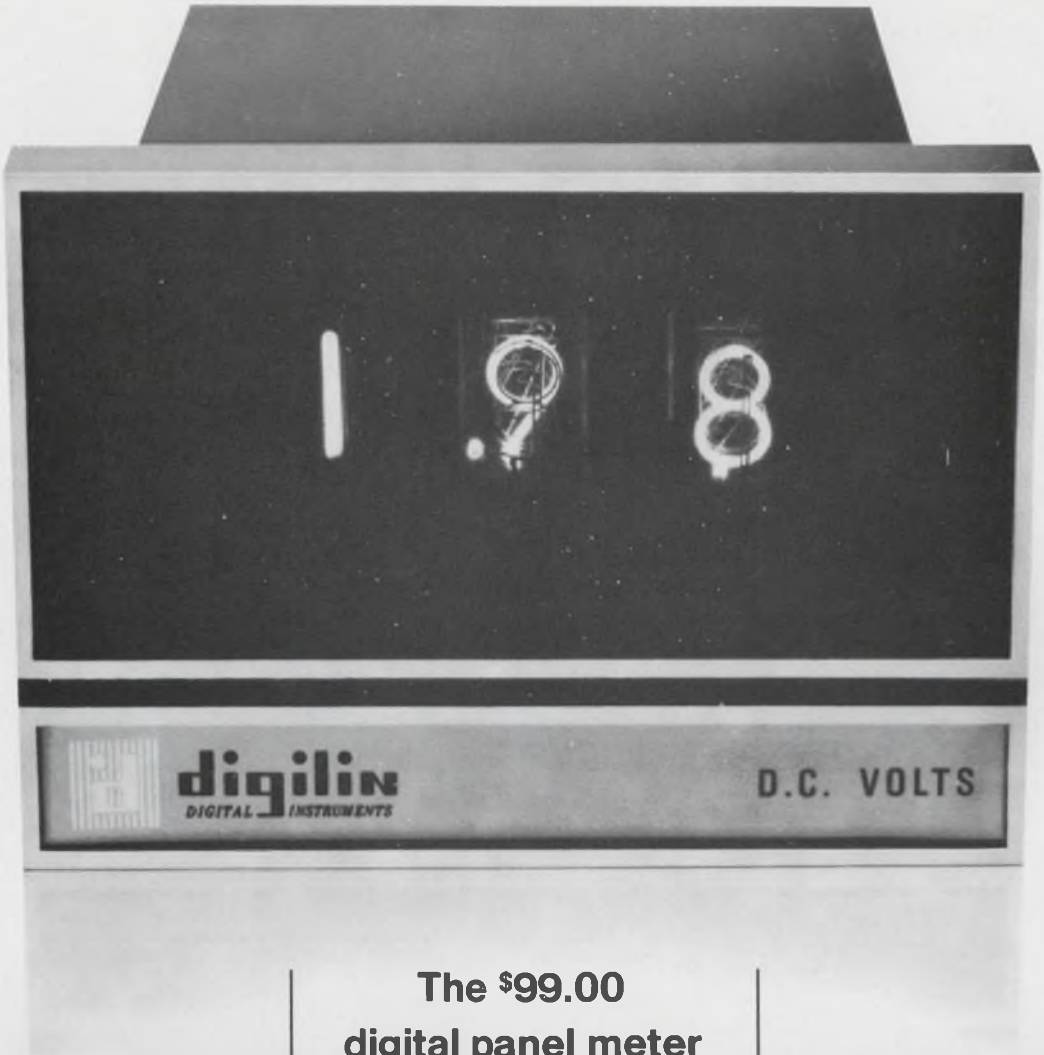
Digital Voltmeters (dc)

	Manufacturer	Model	Voltage Ranges			Accuracy %	Speed readings per sec	Input Impedance MΩ	Output		Mounting	Misc. Features	Price Approx $
			No.	Minimum mV	Maximum V				Signal	Printer			
D1	Un-Syst	251/251-3	2	0.01	1	0.05	2.5	10	n	yes	R	m	740
	Cal Inst	8302	5	0.01	10	0.01	5	10-1000	BCD	yes	C, R		1145
	Dana	5400/015	1	1	10	0.01	500	1000	BCD	ina	C, R		2300
	Adage	VS12-AD	3	1000	100	0.05	ina	100,000	BCD	n/a	R		3500
	Adage	VS16-AD	3	1000	100	0.01	ina	100,000	BCD	n/a	n/a		3700
	Adage	VT14-AB	1	5000	100	0.01	ina	100	yes	n/a	R		6000
	PAI	PDM-611-1	5	199.9	199.9	0.1	3	10-1000	BCD	yes	C, R	u	500
	Dana	4500	4	0.1	500	0.1	55	1	BCD	ina	C, R	ay	1300-1800
	Dana	5400/050	6	0.001	750	0.01	500	1000	BCD	ina	C, R	b	3200
	Greibach	620	3	1	750.0	±0.05	ina	10-1000	BCD	yes	C, R	ab	1175
D2	Greibach	630S	5	100	750.00	0.01	ina	0.11-10	BCD	yes	C, R	g	3595
	Hickok	DP100	5	0.1	999	±0.1	10	10	ina	yes	C	fj	550
	Hickok	DP110	6	0.001	999.9	±0.05	10	10	ina	yes	C	fj	85
	Greibach	85	4	100	999.99	±0.01	100	10-10,000	BCD	yes	C, R	bef	5075
	Dana	5700	6	0.0001	1000	0.0025	75	10,000	BCD	ina	C, R	b	4100-6800
	Dana	5500/135	5	0.001	1000	0.005	65	10,000	BCD	ina	C, R	b	3000-4000
	Dana	5740	6	0.001	1000	0.0025	75	10,000	BCD	ina	C, R	b	4700-9000
	Cal Inst	8101	5	0.01	1000	0.05	5	10	10-line	yes		p	1095
	Dana	5400/035	5	0.01	1000	0.01	500	10,000	BCD	ina	C, R	b	1600-3000
	Dana	4500	5	0.01	1000	0.01	55	10,000	BCD	ina	C, R	b	1300-1800
D3	NLS	X-3A	6	0.01	1000	0.1	20	10-100	yes	n/a	C, R	d	765
	Un-Syst	211	5	0.02	1000	0.05	4	2	yes	n/a	C		239
	Un-Syst	214	5	0.05	1000	0.05	9	2	yes	n/a	C	km	269
	NLS	X-1	3	0.1	1000.0	0.0008	43	10	BCD	yes	C, R	klpq	2785
	Un-Syst	251/251-4	4	0.1	1000	0.01	2	1000	n	yes	R		795
	Monsanto	200A	4	0.1	1000	0.05	4	10	BCD	yes	C, R	dq	895
	AVO	DA 112	5	0.1	1000	0.1	ina	10	BCD	yes	C	ah	495
	Dynascience	DN1440	3	1	1000	±0.01	10	10, 10,000	BCD	yes	C, R	abc	995
	Un-Syst	251/251-1	3	1	1000	0.05	4	10	n	yes	R		595
	R&S	UGZ	3	1	1000	±0.02	1	10	yes	yes	C	b	1875
D4	Dana	5400/060	3	1	1000	0.01	500	1000	BCD	ina	C, R	b	2400-3400
	Cal Inst	8000	3	1	1000	0.05	5	10	10-line	yes	C, R	lp	845
	Data	155	4	1	1000	±0.1	ina	10	n/a	n/a	C		498
	Ballantine	355	5	1	1000	0.25	ina	2	n/a	n/a	C	p	695
	Ballantine	353	5	1	1000	0.02	ina	10	n/a	n/a	C		353
	Data Tech	370	5	1	1000	±0.0025	5	1000	BCD	yes	C	blp	1900
	Eldorado	1820	5	1	1000	0.01	10	1000	BCD	yes	C	adx	675
	Eldorado	1810	5	1	1000	0.1	10	1000	n/a	n/a	C	iv	350
	Vidar	502	6	10	1000	±0.007	35	1000	n/a	yes	R		2500
	Vidar	520	6	10	1000	0.0004	70	1000	n/a	yes	R	g	4500
D5	Vidar	521	6	10	1000	0.0004	70	1000	n/a	yes	R	g	4800
	Cohu	501B	4	100	1000	0.01	0.5	10	yes	yes	R		3600
	Data Tech	350	4	100	1000	±0.01	5	1000	BCD	yes	C	br	695
	Fluke	8300A	4	100	1000	0.005%	40	10	BCD	yes	C, R	di	1695
	Systron	7100A	5	100	1000.0	0.01	5	10-1000	BCD	yes	C, R	blq	2175
	HP	3439A	5	100	1000.0	±0.05	3	10.2	n/a	n/a	R	lpsx	1400
	HP	3440A	5	100	1000.0	±0.05	5	10.2	BCD	yes	R	lpsx	1610
	R&S	UGWD	5	100	1000	±0.3	3	0.1-10	n/a	n/a	C	a	660
	HP	3430A	5	100	1000	±0.1	2	10	n/a	n/a	C	bvw	595
	Preston	723C	5	100	1000	±0.01	10	10	BCD	yes	C, R	lct	895
D6	Preston	723B	5	100	1000	±0.01	10	10	BCD	yes	C, R	lt	645
	HP	3450A	5	100	1000.00	±0.008	15	$10^{10}\Omega$	BCD	yes	R	kpy	3150
	HP	2402A	5	100	1000	0.01	43	1	BCD	yes	C, R	gl	4800
	Honeywell	500	5	100	1000	0.2	1	2-50	n/a	n/a	C	a	250
	Honeywell	333	5	100	1000	0.5	1	1-10	n/a	n/a	C, R	a	345
	HP	2401C	5	100	1000	0.01	10	10	BCD	yes	R	lp	4100
	Beckman	653	5	100	1000	±0.1	ina	10k-1	BCD	yes	C, R	z	600
	Data Tech	361	5	100	1000	±0.1	5	1000	BCD	yes	C		345
	Data Tech	361B	5	100	1000	±0.1	5	1000	BCD	yes	C	h	345
	Cohu	510	5	100	1000	0.01	1.4	10	BCD	yes	C, R	bq	875-1200

Misc. Features, see page D22.

Manufacturers and model numbers, see page D20.

Reader service numbers for literature and application notes, see page D6.



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DIGITAL INSTRUMENTS

INFORMATION RETRIEVAL NUMBER 606

Digital Voltmeters (dc)

	Manufacturer	Model	Voltage Ranges No.	Minimum mV	Maximum V	Accuracy %	Speed readings per sec	Input Impedance MΩ	Output Signal	Output Printer	Mounting	Misc. Features	Price Approx $
D7	Systron	9210	5	120	1000.0	0.01	10	10	BCD	yes	C, R	bq	1325
	Systron	9310	5	120	1000.0	0.01	10	10	BCD	yes	C, R	dq	1445
	Systron	9240	5	120	1000.0	0.01	10	100	BCD	yes	C	aq	1725
	Systron	9340	5	120	1000.0	0.01	10	1000	BCD	yes	C, R	aq	1795
	Systron	9015	5	150	1000	±0.1	3-6	10-1000	n/a	n/a	C	a	495
	Weston	1241	5	200	1000	±0.5	5	10-1000	n/a	n/a	C, R	a	325
	Systron	7000A	3	1000	1000.0	0.01	5	10-1000	BCD	yes	C	r	1175
	HP	3462A	4	1000	1000.000	±0.004	1.1	$10^{10}\Omega$	BCD	yes	R		4900
	Preston	723A	4	1000	1000	±0.01	10	10	BCD	yes	C, R	t	485
	Preston	722C	4	1000	1000	0.1	10	10	BCD	yes	C, R	lpt	395
D8	Preston	722B	4	1000	1000	0.1	10	10	BCD	yes	C, R	i	295
	Simpson	2700	4	1000	1000	±0.05	0.5	10.2	BCD	n/a	C, R	lms	615
	HP	3460B	4	1000	1000.00	±0.004	15	$10^{10}\Omega$	BCD	yes	R	lp	3800
	Systron	7200	4	1000	1000.00	0.005	3	1-10kM	BCD	yes	C, R	dq	3500
	Tyco	404	4	1000	1000	0.02	1.6	10-1000	BCD	yes	C, R		595
	Digilin	340	4	1000	1000	0.1	10	100	n/a	n/a	C	a	345
	Digilin	341	4	1000	1000	0.1	10	100	n/a	n/a	C	ah	395
	Vidar	501	4	1000	1000	±0.007	9	1000	n/a	yes	R		1500
	Systron	9200	4	1200	1000.0	0.01	10	10-1000	BCD	yes	C	bq	1175
	Systron	9300	4	1200	1000.0	0.01	10	10-1000	BCD	yes	C, R	dq	1195
D9	Systron	9220	4	1200	1000.0	0.01	10	1	BCD	yes	C, R	pq	1325
	Systron	9320	4	1200	1000.0	0.01	10	1	BCD	yes	C, R	dpq	1495
	Systron	9230	4	1200	1000.0	0.01	10	1000	BCD	yes	C	ipq	1325
	Systron	9330	4	1200	1000.0	0.01	10	1000	BCD	yes	C	dlq	1445
	Systron	7050	4	1500	1000.0	0.1	5	1000	n/a	n/a	C	i	354
	Systron	9000	4	1500	1000	±0.1	3-6	10-1000	n/a	n/a	C	a	395
	Systron	9025	4	1500	1000	0.1	3-6	10-1000	n/a	n/a	C	a	495
	Acton	332A	3	10,000	1000	±0.01	ina	10	n/a	n/a	C, R	opq	1985
	Ballantine	3572	5	0.1	1100	0.02	20	10-1000	BCD	yes	C, R	d	1675
	Cimron	6853	6	0.0001	1100	0.002	30	10,000	BCD	yes	C, R	bfq	4000
D10	Cimron	6753	6	0.0001	1100	0.005	20	10,000	BCD	yes	C, R	bcfq	3000
	Cimron	6653A	6	0.001	1100	0.01	1000	10,000	BCD	yes	C, R	bfq	2000
	Cal Inst	8300	5	0.01	1200	0.01	5	10-1000	BCD	yes	C, R	abg	1595
	Cimron	6453	5	0.01	1200	0.01	1-4	10,000	BCD	yes	C, R	lq	1000
	NLS	X-2	3	1	1200.0	0.01	10	10	yes	yes	C, R	r	1100
	Fluke	8100A	4	1000	1200	0.02	2	10	n/a	n/a	C	ah	695
	Dynascience	DM330	4	1	1500	±0.1	10	10	n/a	n/a	C	a	349
	J-Omega	413A	5	320	3200	0.1	1	10	n/a	n/a	C, R		685
	J-Omega	415A	6	320	15,000	0.1	1	100	n/a	n/a	C, R		775

a. Digital multimeter
b. Ratiometer available
c. Integrated circuits
d. Remote programming available
e. Price includes dc preamp at $875
f. Also 10 line decimal
g. Integrating digital voltmeter
h. Battery operated
i. Price includes optional mV/Ω plug-in at $350; Ac plug-in at $450
j. Price includes main frame DMS3200A at $375
k. Accuracy full scale
l. Also ohmmeter
m. Speed reading, seconds per reading
n. Serial pulse train output
o. Also phasemeter
p. Ac/dc voltmeter
q. Automatic ranging
r. Plug-ins available for auto-ranging, ac, Ω and 100 mV
s. Plug-in available for current measurements
t. BCD output and print command optional
u. Miniature 6 column printer enclosed in voltmeter case
v. Three digits
w. Dc amplifier output ±16V into 16kΩ minimum
x. Four digits
y. Also true rms voltmeter
z. Plug-in converts 6148, 6155 and 6120-9 frequency counters to digital
Plug-in converts 6148 at $2900, 6155 at $2450 and 6120-9 at $1700 frequency counters to digital voltmeter

Index by Model Number

(continued on page D24)

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MODEL	NUMBER OF FULL-TIME DIGITS	DESCRIPTION	PRICE
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2701	3	Complete digital VOM. Has AC-DC voltage, AC-DC current, and resistance ranges. Automatic decimal point switching over 3 decade ranges.	835.00
2724	4	30 MHz frequency counter. Six switch-selected time bases. Also measures period, frequency ratio, and time interval. Totalizes to 1.9999×10^4.	450.00
2725	5	Same features as model 2724, but with 5-digit resolution. BCD output optional on both models. Accuracy: ±0.01%, ±1 digit.	525.00
2800	3	Compact digital panel meter with ±0.1% accuracy and 100% overrange. Non-blinking storage display. Optional BCD output.	295.00 Under 175.00 in production quantities.

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AGM DIVISION

INFORMATION RETRIEVAL NUMBER 607

Digital Voltmeters (ac)

	Manufacturer	Model	Frequency Min. Hz	Frequency Max. kHz	Voltage Ranges Min. mV	Voltage Ranges Max. V	Voltage Ranges Acc. %	No.	Readout Type	Speed readings per sec	Input Impedance mΩ	Output Type	Output Printer	Mounting	Misc. Features	Price Approx $
D11	Micro	5203	dc	0.02	1000	1000	1	4	nixie	1000	1	BCD	yes	C, R		1550
	NLS	X-3A	20	0.1	400	300	2	3	nixie	20	10	analog	n/a	C, R	a	765
	Micro	5212	0	3	100	1000	0.1	5	nixie	1000	10	BCD	yes	C, R		995
	Acton	332A	30	10	10,000	300	±0.1	3	ina	ina	0.5	n/a	n/a	C, R	glq	ina
	Weston	1240	40	10	200	500	0.5	5	nixie	5	1	n/a	n/a	C, R	b	380
	Dynascience	DM330	50	10	1	1500	0.1	4	in-line	10	10	n/a	n/a	C	ab	389
	Cal-Inst	8101	30	10	0.01	1000	1	5	edge-lit	5	10	e	yes	C, R	g	1095
	Cal-Inst	8300	30	10	0.01	1000	0.5	5	nixie	5	10	BCD	yes	C, R	ac	1595
	R-S	UGWD	20	20	100	1000	±0.5	5	nixie	3	0.1-10	n/a	n/a	C	P	660
	Fluke	8100A	30	20	1000	1200	0.2	4	nixie	3s	1	n/a	n/a	C	am	695
	Dana	5740	20	100	0.01	750	0.09	4	nixie	75	1	BCD	n/a	C, R	ct	4700-9000
D12	Dana	5700	20	100	0.01	750	0.09	4	nixie	75	1	BCD	n/a	C, R	c	4100-6800
	Cal-Inst	8000	30	100	1	100	1	3	edge-lit	5	10	e	yes	C, R	gp	845
	Cal-Inst	8001	30	100	1	1000	1	3	edge-lit	5	10	e	yes	C, R	g	795
	Fluke	8300A	30	100	1000	1000	0.1	4	nixie	2	1	BCD	yes	C, R	k	2095
	Dana	5500/135	50	100	0.01	500	0.05	4	nixie	65	1	BCD	n/a	C, R	t	3000-4000
	NLS	X-1	50	100	0.01	500	0.05-0.3	4	nixie	2	1	BCD	yes	C, R	gq	3800
	Cimron	6753/5775	50	100	0.01	1100	0.02	4	nixie	10	1	BCD	yes	C, R	pt	3000
	Cimron	6853/5875	50	100	0.01	1100	0.02	4	nixie	10	1	BCD	yes	C, R	cpt	4000
	NLS	X-2	50	100	0.1	500	0.02-0.1	4	nixie	2	1	BCD	yes	C, R	g	1700
D13	Dana	5400/060	50	100	0.1	500	0.09	4	nixie	500	1	BCD	n/a	C, R	c	3000-4000
	Dana	5400/035	50	100	0.1	500	0.05	4	nixie	500	1	BCD	n/a	C, R	t	2000-3000
	Cimron	6653A/5676	50	100	0.1	1100	0.05	4	nixie	20	1	BCD	yes	C, R	pz	2000
	Cimron	6453/2	50	100	0.1	1200	0.1	4	nixie	1-4	1	BCD	yes	C, R	t	ina
	Data Tech	370	50	100	10	750	±0.05	4	x	5	1	BCD	yes	C, R		2400
	Data Tech	360B	50	100	100	1000	±0.5	5	nixie	5	10	BCD	yes	R	m	385
	Data Tech	360	50	100	100	1000	±0.5	5	nixie	5	10	BCD	yes	R		385
	Data Tech	350/A2	50	100	100	1000	±0.1	4	x	5	1	BCD	yes	C, R		875
	Greibach	85	50	100	100	1000	0.02-0.1	4	nixie	100	1	BCD	yes	C, R	cdfg	5400
	Greibach	623	50	100	1000	530.00	±0.05	3	in-line	ina	1	BCD	yes	C, R	ac	1525
D14	HP	3460B/3461A	50	100	1000	1000.00	±0.07	4	s	1.2s	5	BCD	yes	R	jpsr	5650
	HP	2402A	50	100	1000	1000	0.1	4	s	1.9	1	BCD	yes	R	gpw	4800
	Preston	723C	50	100	1000	1000	±0.1	4	neon	10	1	BCD	yes	C, R	aghi	895
	Preston	722C	50	100	1000	1000	±0.1	4	neon	10	1	BCD	yes	C, R	agh	395
	HP	3440A	50	100	10,000	1000.0	±0.1	3	s	3s	10.2	BCD	yes	R	gjpu	1685
	HP	3439A	50	100	10,000	1000.0	±0.1	3	s	3s	10.2	n/a	n/a	R	gjpu	1475
	Ballantine	355	30	250	0.1	1000	0.25	6	in-line	ina	2	e	yes	C	go	695
	Fluke	9500A	20	700	100	1000	0.15	5	nixie	3s	1	BCD	yes	C, R	dj	2485
	Hickok	DP130	22	1000	0.01	999	±0.2	6	nixie	5	1000	e	yes	C, R	n	770
	HP	3450A	45	1000	1000	1000.00	±0.04	4	s	2.7s	2	BCD	yes	R	cjprt	4400
D15	Ballantine	3571	30	10,000	0.01	300	0.2	6	nixie	20	10	BCD	yes	C, R	d	2000

a. Digital multimeter.
b. Also measures current.
c. Also ratiometer.
d. Remote programming.
e. Output: 10-line decimal.
f. Optional dc 100mV preamp at $875, ohms plug-in at $775.
g. Ac/dc voltmeter.
h. Optional - Output.
i. Dc, 5 ranges; ohms, 8 ranges.
j. Speed readings, seconds per sample.
k. Price includes mV/Ω at $350.
l. Also phasemeter.
m. Battery operated.
n. Price includes DMS-3200A at $375.
o. In-line mechanical wheel readout.
p. Also measures ohms.
q. Automatic ranging.
r. 5 digits.
s. In-line digital display tubes.
t. True rms meter.
u. 4 digits.
v. Integrating DVM.
w. 6 digits.
x. Gas discharge tubes.
z. Integrated circuits.

Manufacturers and model numbers, see page D20.
Reader service numbers for literature and application notes, see page D6.

Weston does its own thing: an AC/DC, Volts/Amps/Ohms, bench/panel/portable DMM...

Nobody does it like Weston, because nobody else has as much metering and digital experience.

That's why our new Model 1240 multimeter is not just an assemblage of stock components fitted to a package, but a custom-designed instrument embodying the very latest in technology by the leader in precision measurement.

From its rugged, glass-filled thermoplastic case down to its feather-touch pushbuttons, this is proprietary engineering at its finest.

Versatility? The Weston 1240 goes anywhere. It will fit your attache case, weighs only four pounds when carried by its self-contained handle (which doubles as a tilt stand for bench use), and comes completely equipped for mounting in a standard 3½" panel. No extras to buy.

An external switch provides for 115V or 230V operation, and if you're in the boondocks you can plug in an optional battery pack.

Other user exclusives . . . complete circuit overload protection, fuses replaceable from outside the case, recessed controls, in-house designed positive-detent range switch, pluggable Nixie* tubes, automatic polarity and outrange indication.

Performance-wise, the Model 1240 is a 3½-digit, high-impedance unit with ten DC, ten AC and six Ohms ranges, plus full voltage and current measuring capability. Accuracy is 0.1% of reading ±.05% F.S. on DC volts.

Weston engineered features include patented dual slope** integration and shunt circuitry, ultra-reliable gold-on-gold switch contacts, and non-blinking display with automatic decimal positioning.

Also available at less cost is our Model 1241 DC volt/ohm meter. Both models are in stock now for immediate delivery. See them at your Weston Distributor, or ask us about the "going thing" in measurement . . . the Model 1240 DMM by Weston.

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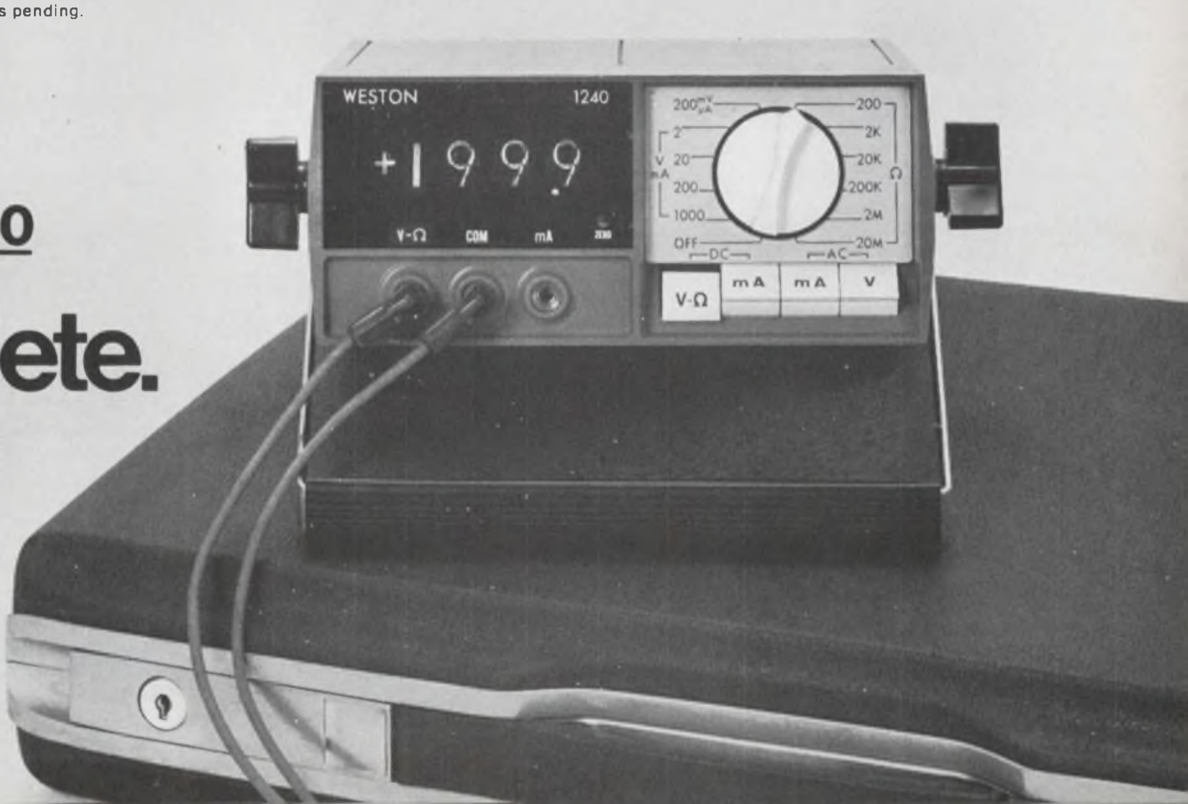
**U.S. Pat. #3,051,939 and patents pending.

for $379.50 complete.



need 1μv repeatability with auto zero?

- Highly stable ratiometric technique
- AUTO ZERO computer eliminates zero drift
- 1μv to 1KV, automatic, manual or remote
- 20 readings per second with true noise integration
- 120 db common mode rejection . . . any conditions
- Excellent time and temperature stability
- Modern, medium scale integrated circuits

Tried and proven in 1000 customer installations, this instrument is the first to be optimized for stable, **low level** DC measurements in harsh noise environments. It easily leads the field in competition with machines costing $3500-$5000 . . . and at a third the investment. Obsoletes lab pots, manual differential VM's, and every DC DVM on the market.

The DS-100 Microvoltmeter delivers an honest .01% repeatability for low level DC and ratios. Its high impedance, guarded, differential front end gets the job done right for general purpose work from microvolt levels to hundreds of volts. Isolated remote ranging, and both digital and analog outputs make the unit ideal for data acquisition. And, there are digital signal conditioning plug-ins for direct thermocouple and PRT temperatures and strain gage transducer engineering units display.

Prices from $790 to $1500. Call collect for immediate demo, sales rep and detailed catalog.

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INFORMATION RETRIEVAL NUMBER 609

(continued from page D20)

Name	Model	Code
Cimron	6453	D10
Cimron Div.	6453/2	D13
Lear Siegler	6653A	D10
Corp.	6653A/5676	D13
	6753	D10
	6753/5775	D12
	6853	D9
	6853/5875	D12
Cohu	501B	D5
Cohu Electronics Inc.	510	D6
Dana	4500(dc)	D1
Dana Labs Inc.	4500(dc)	D2
	5400/015	D1
	5400/035(dc)	D2
	5400/035(ac)	D13
	5400/050	D1
	5400/060(dc)	D4
	5400/060(ac)	D13
	5500/135(dc)	D2
	5500/135(ac)	D12
	5700(dc)	D2
	5700(ac)	D12
	5740(ac)	D11
	5740(dc)	D2
Data - Data Inst. Div.	155	D4
Data Tech	350	D5
Data Technology Inc.	350/A2	D13
	360	D13
	360B	D13
	361	D6
	361B	D6
	370(ac)	D13
	370(dc)	D4
Digilin	340	D8
Digilin Inc.	341	D8
Dynascience	DM330(dc)	D10
Dynascience Div.	DM330(ac)	D11
Whittaker Corp.	DN1440	D3
Eldorado	1810	D4
Eldorado Electrodata Corp.	1820	D4
Fluke	8100A(dc)	D10
John Fluke Mfg. Co.	8100A(ac)	D11
	8300A(dc)	D5
	8300A(ac)	D12
	9500A	D14
Greibach	85(dc)	D2
Greibach Inst. Div.	85(ac)	D13
	620	D1
Solitron Devices Inc.	623	D13
	630S	D2
Hickok	DP100	D2
Hickok Elect. Inst. Co.	DP110	D2
	DP130	D14
HP	2401C	D6
Hewlett-Packard Co.	2402A(dc)	D6
	2402A(ac)	D14
	3430A	D5
	3439A(ac)	D14
	3439A(dc)	D5
	3440A(dc)	D5
	3440A(ac)	D14
	3450A(dc)	D6
	3450A(ac)	D14
	3460B	D8
	3460B/3461A	D14
	3462A	D7
Honeywell	333	D6
Honeywell Test Instrument Div.	500	D6
J-Omega	413A	D10
J-Omega Co.	415A	D10
Micro	5203	D11
Micro Inst. Co.	5212	D11
Monsanto - Monsanto Electronics	200A	D3
NLS	X-1(ac)	D12
Non-Linear	X-1(dc)	D3
Systems Inc.	X-2(ac)	D12
	X-2(dc)	D10
	X-3A(ac)	D11
	X-3A(dc)	D3
PAI - Practical Automation Inc.	PDM-611-1	D1
Preston	722B	D8
Preston Scientific	722C(dc)	D7
	722C(ac)	D14
	723A	D7
	723B	D6
	723C(ac)	D14
	723C(dc)	D5
R-S	UGWD(dc)	D5
Rohde &	UGWD(ac)	D11
Schwarz	UGZ	D3
Systron	7000A	D7
Systron-Donner	7050	D9
Corp.	7100A	D5
	7200	D8
	9000	D9
	9015	D7
	9025	D9
	9200	D8
	9210	D7
	9220	D9
	9230	D9
	9240	D7
	9300	D8
	9310	D7
	9320	D9
	9330	D9
	9340	D7
Tyco - Tyco Instrument Div.	404	D8
Un-Syst	211	D3
United Systems	214	D3
Corp.	251/251-1	D3
	251/251-3	D1
	251/251-4	D3
Vidar	501	D8
Vidar Corp.	502	D4
	520	D4
	521	D5
Weston	1240	D11
Weston Instruments	1241	D7

INFORMATION RETRIEVAL NUMBER 610 ▶

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®

Match your counter to your requirements

Electronic counters are available today in a wide variety of types—each with its own advantages and disadvantages for given applications. The smart buyer, therefore, decides first on a basic counter type, before considering detailed specifications. One breakdown of basic types follows:

- Fixed-function or universal counters.
- Plug-in counters (of fixed-function or universal type).
- Preset time-base counters.
- Preset controllers.
- Reversing counters.
- Reciprocal reading, or computing, counters.

Fixed-function counters are versatile

The fixed-function, or universal, counter can measure frequency, time interval, ratio, or a combination of these functions. Other peripheral functions, such as scaling, scanning, totalizing, frequency generation, or a combination of time-interval and ratio measurements can be added to the basic counter. The upper frequency limit of this group of counters can be anywhere from 100 kHz to 200 MHz on a direct count basis.

The frequency counter is the most widely used type of fixed-function counter. They are capable of functioning over a range of 200 MHz and are fairly simple to operate. Generally, the more expensive units have a selectable time base from 0.1 microsecond to 100 seconds.

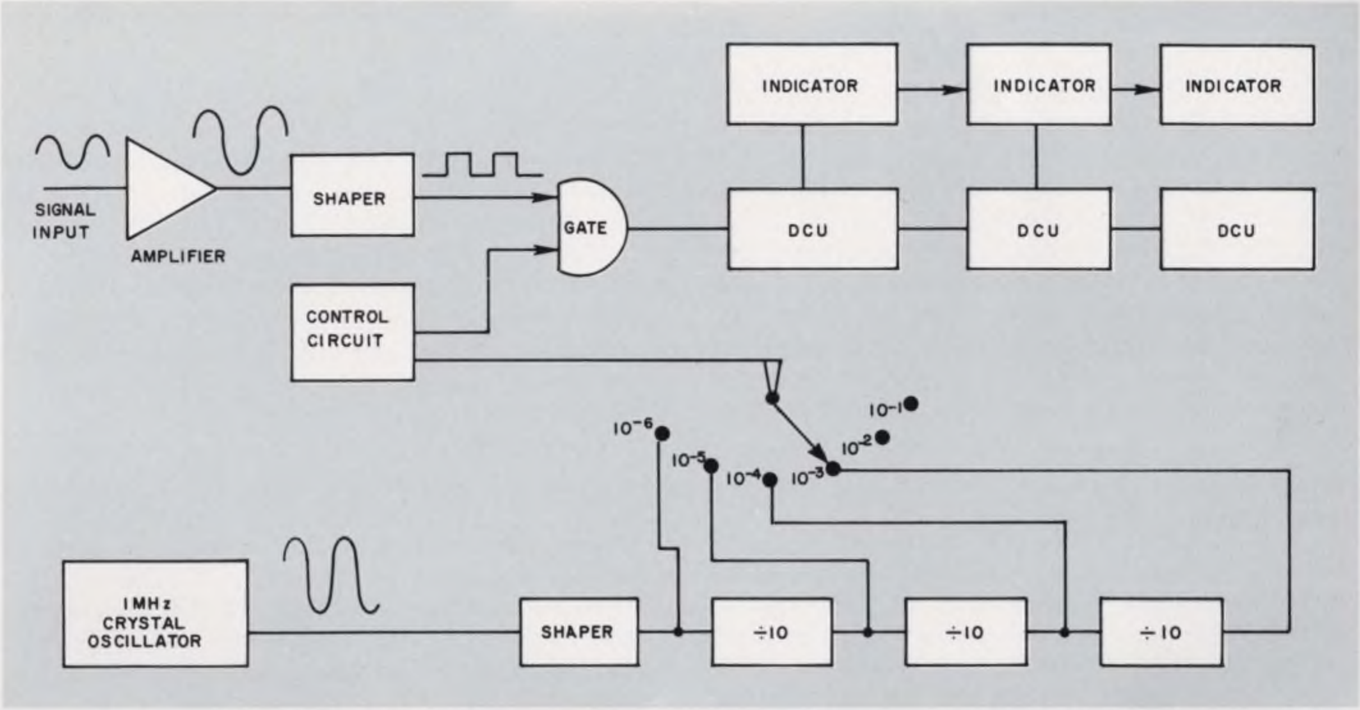
The simplest, and newest, of these fixed-function counters is the $300 to $400 integrated-circuit counter, with a power-line-frequency time base and measurement capabilities to 12 MHz. These inexpensive, usually four-digit, instruments are fine for measuring frequencies up to 10 kHz. Recognizing that the line time base approaches 0.1% stability, it is clear that counting with only four digits will result in 10 counts of jitter when measuring 10 kHz. Since 0.1% stability is rather poor, most manufacturers have provided a crystal time base option to provide the stability necessary to fully realize the capability of the instrument. They also provide up to six digits of information as an option, so that the full frequency range of 12 MHz can be realized when using the 0.1-second time base.

These little counters make an excellent laboratory companion, if they are used properly, and within their limitations. More sophisticated counters that offer high-stability oscillators, BCD output and programmable features begin generally at 30 or 50 MHz.

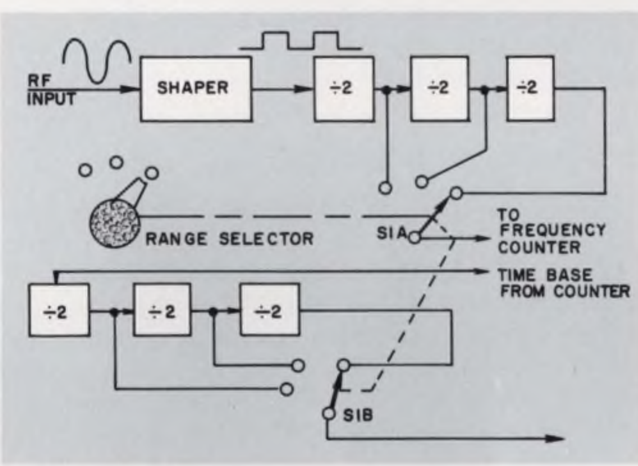
Today, indirect digital frequency measurements as high as 40 GHz are possible. Unique, wide-range extending techniques enable basic counters to read out directly frequency from dc to 18 GHz. Six common methods of making high-frequency measurements are these:

- *Direct counting,* which is available today from dc to in excess of 200 MHz (Fig. 1).
- *Prescaling,* which is used for frequencies from dc to 500 MHz (Fig. 2). The internal time base is expanded by the same factor as the prescaled input, to provide for direct reading.
- *Heterodyning,* which has a range from 50 MHz to 18 GHz (Fig. 3). By generating a combination of frequencies harmonically related to the internal standard, mixing these with the signal measured in a cavity or filter, a difference in frequencies can be obtained that comes within the direct counting range of the basic counter.
- *Transfer oscillator,* which is useful from 50 MHz to 18 GHz (Fig. 4). This is generally conceded to be the best method for measuring pulsed microwave signals. The unknown input frequency is determined by measuring the frequency of a low-frequency oscillator whose output is harmonically related to the unknown input frequency. This harmonic number is then computed and used to modify the instrument's time base to produce a direct reading system.
- *Automatic computing transfer oscillator,* which has a range from 300 MHz to 12.4 GHz

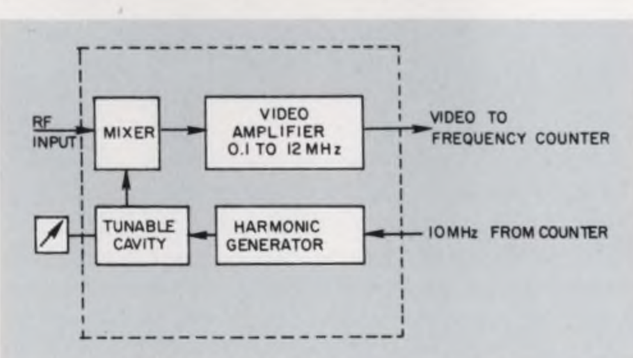
Richard Hall, Chief Engineer, Frequency and Time Group, Systron-Donner Corp., Concord, Calif.



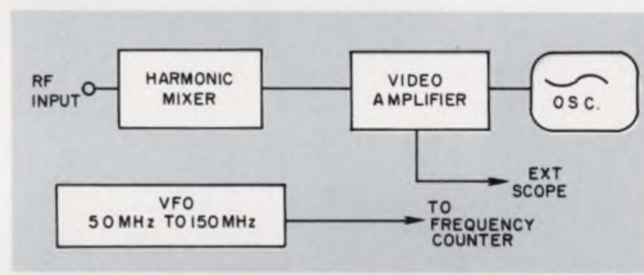
1. **In direct counting,** all of the frequency measuring circuitry is contained within the basic counter. Counting capability with this technique is from dc to greater than 200 MHz.



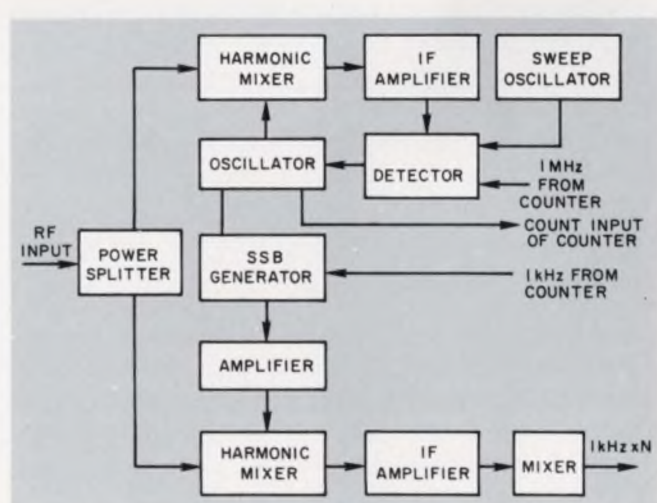
2. **The prescaling technique** uses a prescaler circuit that divides both the rf input and the counter time base by the same factor. This allows direct readout of the measured frequency.



3. **The heterodyning technique** uses a heterodyne converter to generate a difference frequency that can be directly counted by the counter.



4. **The transfer oscillator technique** uses a low-frequency oscillator that is tuned to some harmonic of the frequency being measured. This harmonic is computed, and then the oscillator frequency and the harmonic number are used by the counter to directly read out the measured frequency.



5. **The automatic computing transfer oscillator technique** is similar to the transfer oscillator technique, except that the harmonic number is automatically computed.

(Fig. 5). This is similar in operation to the transfer oscillator technique, except that the harmonic number is automatically computed to produce a direct readout. A low-frequency oscillator is phase-locked to the input frequency of the signal, and this low frequency is directly counted.

- *Automatic divider*, which is another phase-locked transfer oscillator (Fig. 6). With this technique the oscillator is locked to a frequency that is 1% or 0.1% of the unknown frequency. The method is useful over a range of 300 MHz to 12.4 GHz.

Other fixed-function instruments

Another class of fixed-function instruments incorporates not only the ability to measure frequency but to measure period and multiple periods as well. In measuring frequency, it is fairly obvious that the stability of the internal time base and the plus or minus one count gating error, which is prevalent in all gated counters, must be taken into account. Not so well known, however, is the specification that says that the period measurement is, say, 0.3% of the reading.

This means that the counter manufacturer is claiming he has a good input amplifier, which is reasonably clean noise-wise, and that it's now up to the customer to provide to the counter a signal with at least a 40-dB signal-to-noise ratio.

Appreciate that the manufacturer is asking the user not to have more than 1 mV rms of noise on the signal that is being applied to his counter when asking for 100 mV rms of input signal. This has an averaging effect that increases accuracy for each 10 periods measured. Therefore, at a single period, although the error may be 0.3% of reading, the measurement error at period times 10 is now 0.03%; on times 100, it becomes 0.003%.

What this means is that the inaccuracy created by noise signal as it passes through the triggering point of the shaper (Fig. 1) remains relatively constant at a given frequency-amplitude-noise relationship; and that no matter how many periods are sampled, the percentage of error for a given crossing does not change.

Universals also perform TIM

In addition to the frequency-measurement function, electronic counters can also time the interval between two independent signals. This class of counter is normally designated as universal, meaning that the counter can also perform TIM (time interval measurements).

In the TIM mode, counters will accept a contact closure-to-ground to start the counter, and another closure-to-ground to stop. What is being counted is the internal frequency standard of the instrument.

The next level up from these inexpensive counters are the universal counters that contain two identical amplifiers: one for starting and one for stopping when in the TIM mode.

The difference between a time-interval and period measurement is sometimes confusing. A period is nothing but a time interval for one complete event, and time interval is that period of time between two independent events.

The difference can be understood by the degree of accuracy that can be obtained if one has a universal counter and wants to make a pulse-width measurement, at a particular dc level, of the pulse. If the requirement is to measure the pulse width at the 50% point, then by setting the start amplifier to that dc level, which provides start information for the counter, and setting the stop amplifier at the reverse slope at the same amplitude, one can then measure the pulse width within the resolution capability of the instrument. This is not possible in making a straight period measurement, because of the measurement inaccuracies produced by the hysteresis of the trigger circuit. It is this hysteresis that produces the errors in making pulse-width measurements with a single amplifier.

Plug-in counters provide flexibility

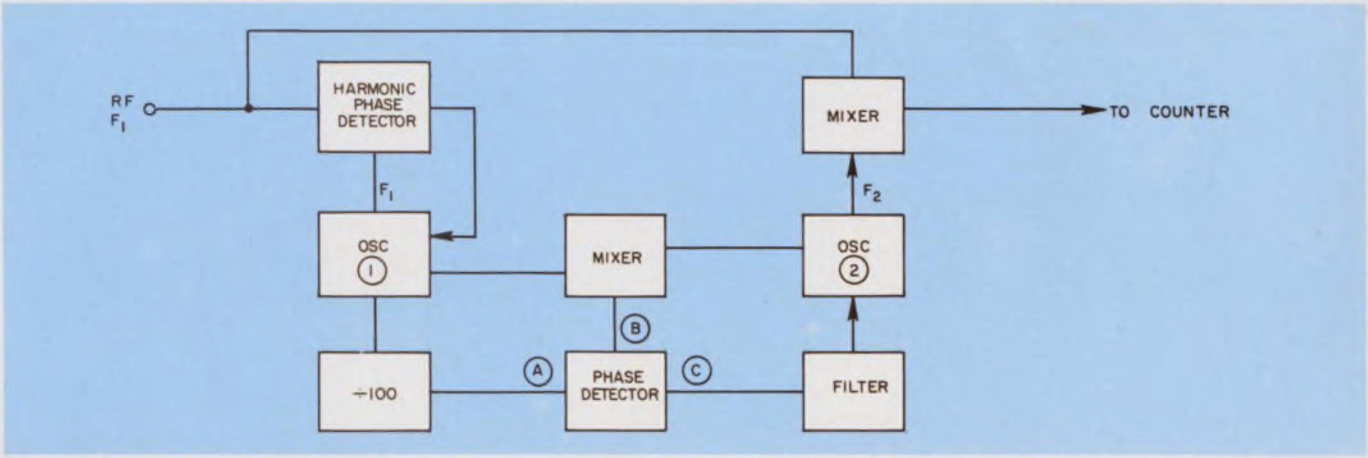
The second group of counters that provides optimum flexibility for the user, is plug-in counters. From the manufacturers' standpoint, there are two schools of thought on the plug-in.

One viewpoint is to modularize the instrument into three sections: one—a plug-in unit—contains the input circuitry and all of the peripheral controls that are identified with the input; the second —another plug-in unit—contains the time base and function section; and the third section is the main frame, or readout portion, containing the power supply to power the other two.

The other school of thought is to use a single plug-in unit, which provides primarily a function change; the time-base circuitry in this case is within the counter main frame.

The plug-in portion of a counter modifies one or more of three inputs to the counter: frequency, number of events to be counted in the count chain, start and stop information to control the counter while it counts its own internal time base. With these three inputs, the counter can make frequency measurements, or it can create from a dc level a frequency that is proportional to the input dc level—which means it functions as a digital voltmeter.

Furthermore, frequency-extending units can be packaged in plug-ins to provide additional fre-



6. **The automatic divider technique** uses an oscillator locked to 1% or 0.1% of the input frequency.

quency-measurement capability. Both heterodyne and transfer oscillator techniques are possible.

Normalized with preset time base

The preset time-base group of counters measures normalized frequency and frequency ratio, and is capable of measuring the time for n events to occur. It also can accumulate, or totalize, n events. Frequency measurements can be made in incremental steps of the internal frequency standard, rather than decade steps, as is typical. This allows the user to normalize the readings and convert frequency information into practical units.

For example, the counter gate can be set to 600 ms in order to measure rpm directly with a tachometer that produces 100 pulses per revolution. Normalized ratio measurements and period measurements can be made in the same manner.

Typical outputs include pulse information at the start and stop of the count gate, and pulse information at T_0, so that time delays may be generated using the counter's internal frequency standard.

Preset controllers measure events

Preset, or numerical, controllers are used for machine-tool control, cut-to-length applications and manufacturing tabulation.

Typical of their operation are cut-to-length applications, where the linear travel is converted to an electrical event in appropriate incremental units; then, at the selected number, an electrical output or relay contact closure is produced to control some other mechanism. Thus, any physical event that can be converted to an electrical event can be counted and controlled to some incremental value.

Within this group are the limit counters—with high, low and on indication. These are useful in any continually monitored process, where either high or low limits are critical, and where an alarm signal is needed if either limit is reached. This alarm signal may be a dc level suitable for firing an SCR, or a contact closure suitable for activating a large solenoid. Event counting to 2 MHz is available in these counters, with input sensitivities from 10 to 100 mV.

Reversing counters are sophisticated

Reversing counters are useful in control applications where the object is to control or accumulate the information from either two variables or a single two-directional signal. Such instruments can be used to indicate status information of machine tools or algebraic summation of two variables or a manufacturing process. Other suitable applications include monitoring a continuous flow process, such as liquid flow rates, controlling position, measuring the velocity of physical events, and comparing two frequencies.

These sophisticated counters employ an anticoincidence circuit in some units, so that if two signals arrive simultaneously, the information is sorted and later transferred in the appropriate direction. Frequencies to 2 MHz are obtainable with reversing taking place at 1 MHz.

Reciprocal counters measure period

The last counter group, and the newest, is the reciprocal, or computing, counters. These instruments measure period, and then automatically compute and display the corresponding frequency. They can provide five or six digits of information in one or two periods of the input. If counting a one-second period, it would require only one second, or two at most, to obtain five or six digits of accuracy. To obtain this accuracy with a frequency measurement would require 50,000 to 500,000 seconds, which is not practical. ■■

Frequency Counters

	Manufacturer	Model	FREQUENCY Minimum Hz	FREQUENCY Maximum MHz	Stability ppm	Digits No.	INPUT Sens. mV	INPUT Imp. MΩ (pF)	Gate Time s	DISPLAY Time s	DISPLAY Type	Conn. Type	Solid State	Misc. Features	Type C-Cab. R-Rack	Price Approx $
F1	Eldorado	224	0	0.1	$1/10^6$	4	0.1-150V	1(30)	1, 10	ina	ina	UG-1094	yes	a	C	325
	Beckman	6246	0	0.2	0.001%	4	100	0.1(50)	10µs-10	0.1-10	p	BNC	yes	f	C	1295
	Beckman	6230	0	0.2	±0.01%	4	100	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	495
	Beckman	6220A	0	0.2	±10Hz	4	100	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	895
	Beckman	6215A	0	0.2	±10Hz	4	100	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	795
	Beckman	6210A	0	0.2	±10Hz	4	100	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	595
	Weston	301	0.5	0.2	ina	5	100	ina	n/a	n/a	ina	BNC	yes	j	C, R	1085
	Weston	301C	0.5	0.2	ina	5	100	ina	n/a	n/a	ina	BNC	yes	hj	C, R	1350
	TSC	410-4	2	0.2	$2/10^6$	5	100	1(30)	0.1, 1, 10	0.1	neon	BNC	yes	ade	C	395
	TSC	410-3	2	0.2	$2/10^6$	4	100	1(30)	0.1, 1, 10	0.1	neon	BNC	yes	ade	C	370
F2	TSC	410-1	2	0.2	ina	4	100	1(30)	0.1, 1, 10	0.1	neon	BNC	yes	de	C	335
	Weston	300	5	0.2	ina	5	1000	ina	n/a	n/a	ina	BNC	yes	j	C, R	995
	Atec	5A35	0	0.35	2	5	100	1(50)	0.01-10	ina	column	BNC	yes	l	C	975
	Hickok	DP150A	0	0.999	5	3	10	1(24)	0.001-10	0.1-10	nixie	BNC	yes	i	C, R	255
	Eldorado	1950-3	0	1	$3/10^8$	8	100	1(80)	1	ina	ina	UG-1094	yes	b	C, R	3250
	Cal-Inst	8300	0.1	1	10	4	100	1	0.01-10	0.01-11	ina	ina	yes	w	C, R	1595
	Magtrol	4602	0	1.5	ina	4	200	ina	ina	0.1,1	nixie	bp	yes		C	req.
	R-S	FET 1	0	2	$1/10^8$	6	3000	10k	ina	ina	nixie	BNC	yes	c	C, R	2680
	Weston	302	0.5	2	ina	5	100	ina	0.01-0.1	n/a	ina	BNC	yes		C, R	1245
	TSC	410-2	2	2	ina	5	100	1(30)	0.1, 1, 10	0.1	neon	BNC	yes	de	C	360
F3	Systron	8040	10	2	m	4	100	1(35)	0.001-10	0.2-5	nixie	BNC	yes		C	354
	Dynascience	361A-R-M2	0	2.5	$1/10^7$	6	10-25	100k	1µs-10	0.2-6	in-line	BNC	yes	cd	C, R	ina
	Dynascience	TS1361A-R	0	2.5	$\pm 1/10^7$	6	10-25	100k	1µs-10	0.2-6	in-line	BNC	yes	c	C, R	ina
	CMC	614	2	2.5	$\pm 2/10^6$	5	100	1	10µs-0.01	0.1	nixie	BNC	yes	b	C, R	1300
	Atec	1130A	10	3	m	4	500	0.01	0.1, 1	1	nixie	BNC	yes	f	C	190
	Atec	1131A	10	3	1	4	500	0.01	0.1, 1, 10	1	nixie	BNC	yes	f	C	325
	Beckman	6235B	0	5	±0.01%	5	50	0.1(50)	1ms-1	0.1-10	p	BNC	yes	f	C	1095
	Monsanto	106A	5	5	n/a	5	50	1(25)	ext	0.2-10	nixie	BNC	yes	df	C	895
	CMC	687	10	5	$\pm 2/10^6$	6	100	1	1µs, 10	0.1	nixie	BNC	yes	b	C	1875
	Eldorado	365	0	10	$1/10^6$	5	100-250	1(40)	1ms-10	ina	ina	UG-1094	yes	a	C, R	550
F4	Beckman	6240B	0	10	0.01%	5	20	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	895
	Beckman	6230B	0	10	±0.01%	5	50	0.1(50)	1ms-10	0.1-10	p	BNC	yes	f	C	695
	Systron	6014	0	10	$\pm 2/10^8$	6	100	1(15)	1µs-10	0.2-5	nixie	BNC	yes	c	C, R	1450
	Systron	6034	0	10	$\pm 2/10^6$	6	100	1(15)	1µs-10	0.2-5	nixie	BNC	yes	ag	C, R	1650
	Systron	1034A	0	10	$\pm 2/10^6$	6	100	1(50)	1µs-10	0.2-5	nixie	BNC	yes	ag	C, R	1500
	TSC	272	1	10	$2/10^6$	5	100	1(30)	ina	1.3	in-line	BNC	yes	afh	C, R	1500
	Dynascience	TS1460	5	10	$2/10^6$	4	100	1(30)	1ms-10	0.2-5	nixie	BNC	yes	a	C, R	ina
	HP	5221B, 5321B	5	10	$1/10^6$	5	100	1(30)	0.01-10	0.05-5	nixie	BNC	yes	a	C, R	700
	HP	5221A, 5321A	5	10	n/a	4	100	1(30)	0.1, 1	n/a	nixie	BNC	yes		C, R	425
	Atec	2200	0	12.5	0.01	5	50	1(30)	1µs-10	ina	nixie	BNC	yes	ft	R	735

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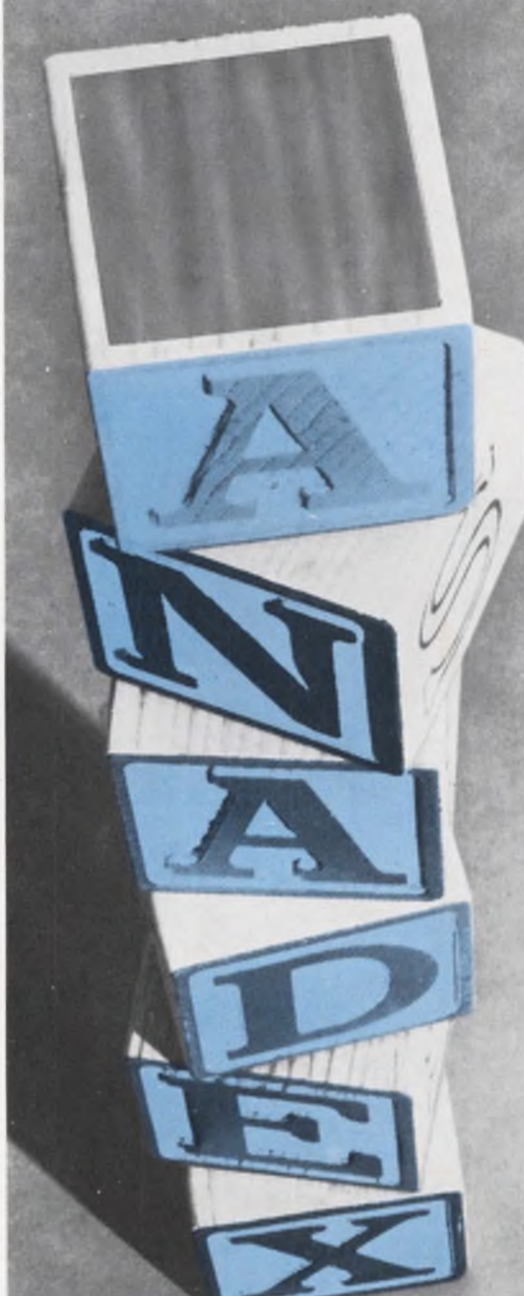

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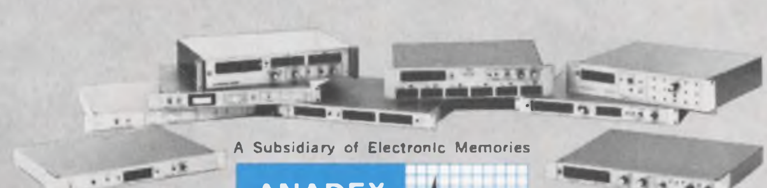

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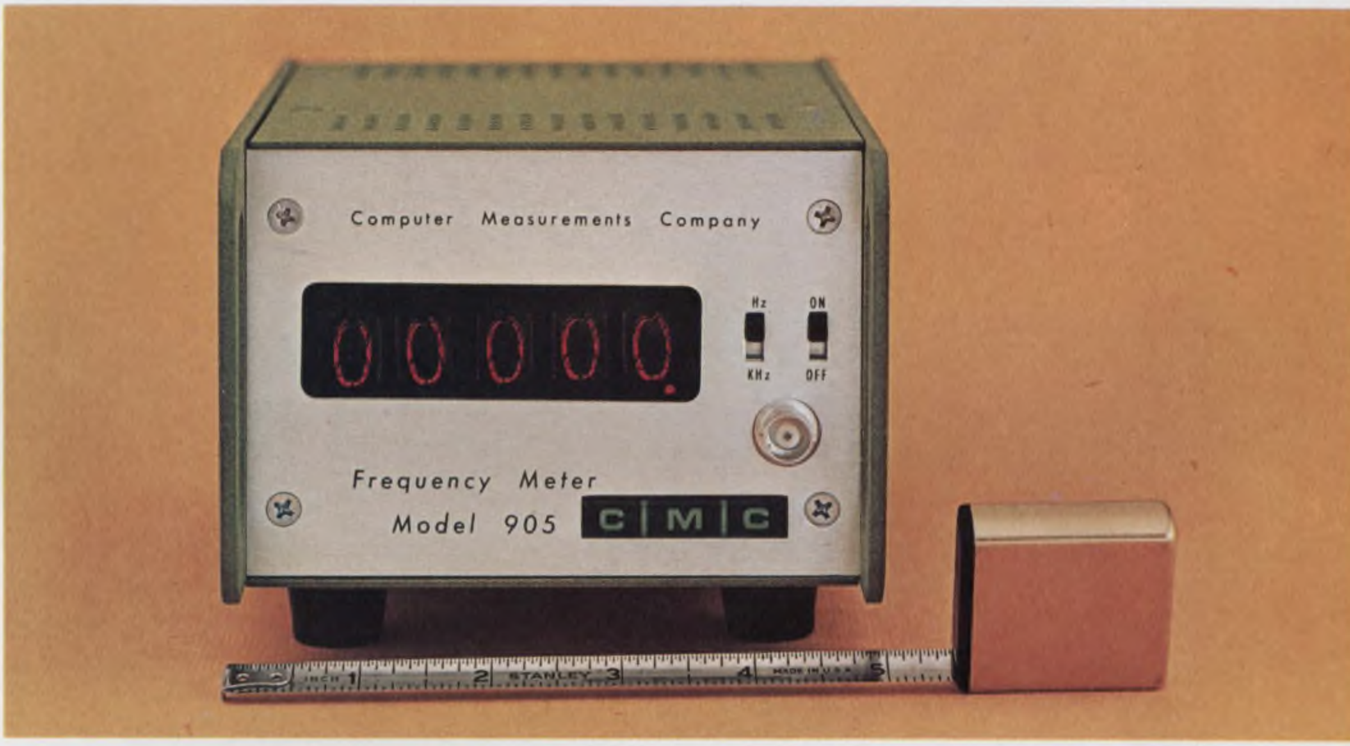
INFORMATION RETRIEVAL NUMBER 611

			FREQUENCY				INPUT			DISPLAY					Type	
	Manufacturer	Model	Minimum Hz	Maximum MHz	Stability ppm	Digits No.	Sens. mV	Imp. MΩ (pF)	Gate Time s	Time s	Type	Conn. Type	Solid State	Misc. Features	C-Cab. R-Rack	Price Approx $
F5	Atec	2304	0	12.5	0.01	4	10	1(30)	1μs	ina	nixie	BNC	yes	ft	R	1100
	Atec	2300	0	12.5	1	4	10	1(30)	1μs	ina	nixie	BNC	yes	ft	R	940
	Atec	2000	0	12.5	0.01	5	10	1(30)	1μs-10	ina	nixie	BNC	yes	ft	R	850
	Atec	2802	0	12.5	1	4	10	1(30)	0.01-10	ina	nixie	BNC	yes	ft	R	455
	Atec	6H86	0	12.5	0.01	6	100	1(30)	1μs-10	ina	nixie	BNC	yes	f	R	1195
	Systron	8200	0	12.5	$3/10^7$	7	100	1(50)	1μs-10	0.2-5	nixie	BNC	yes	bg	C, R	1395
	Systron	114	1	12.5	m	4	100	1(30)	0.1, 1	0.2-5	nixie	BNC	yes	f	C	395
	HP	5216A	3	12.5	$1/10^6$	7	10	1(50)	0.01-10	0.05-5	nixie	BNC	yes	a	C, R	985
	Monsanto	103A	5	12.5	0.1%	4	50	1(20)	0.1, 1	0.2-10	nixie	BNC	yes	f	C	375
	Monsanto	101A	5	12.5	$5/10^7$	5	50	1(20)	1μs-10	0.2-10	nixie	BNC	yes	cdf	C	675
F6	Monsanto	100A	5	12.5	$5/10^7$	5	50	1(20)	0.001-10	0.2-10	nixie	BNC	yes	cf	C	575
	Atec	4B14	10	12.5	m	4	100	1(50)	0.6, 1	ina	nixie	BNC	yes	f	C	395
	CMC	905	0	15	$\pm 2/10^6$	5	100	1	1, 10	0.1	nixie	BNC	yes	c	C, R	395
	Eldorado	1411	0	15	$1/10^6$	5	100	1(50)	1μs-1ms	0.1-10	ina	UG-1094	yes	a	C, R	1050
	Eldorado	1410	0	15	$1/10^6$	8	100	1(50)	1μs-100	0.1-10	ina	UG-1094	yes	a	C, R	975
	Eldorado	325A	0	15	$1/10^6$	5	100	1(40)	1ms, 0.1, 1, 10	ina	ina	UG-1094	yes	a	C, R	450
	Eldorado	225	0	15	$1/10^6$	5	100-250	1(30)	1ms, 1	ina	ina	UG-1094	yes	a	C	395
	CMC	608	2	15	$\pm 2/10^6$	5	100	1	10μs, 10	0.1	nixie	BNC	yes	b	C, R	740
	Anadex	CF-604R	3	15	1	4-7	10	1(50)	10μs-100	ina	nixie	BNC	yes	bf	R	995
	Anadex	CF-635R	3	15	1	4-7	10	1(50)	0.01, 0.1, 1, 10	1μs	nixie	BNC	yes	bf	R	720
F7	Anadex	CF-600R	3	15	1	4-7	10	1(50)	0.01, 0.1, 10	1μs	nixie	BNC	Plug-in IC's	bf	R	595
	Anadex	CF-603R	3	15	1	4-7	10	1(50)	0.1-10	ina	nixie	BNC	yes	bf	R	495
	Anadex	CF-601R	3	15	1	4-7	10	1(50)	10μs-100	ina	nixie	BNC	yes	bf	R	895
	Dynascience	TS1385-R	0	20	$\pm 3/10^7$	7	100	100k(30)	ina	0.2-10	nixie	BNC	yes	b	C, R	ina
	Dynascience	461	0	20	$1/10^8$	7	100	1(30)	0.1μs-100	0.1-5	in-line	BNC	yes	cdefg	C, R	1195
	TSC	300	0	20	$\pm 1/10^8$	7	10	1(30)	1μs-10	100μs-5	in-line	BNC	yes	ceg	C, R	995
	Systron	7034	0	20	$\pm 2/10^6$	7	10-60	1(50)	1μs-100	0.2-5	nixie	BNC	yes	ag	C	1075
	Systron	7014	0	20	$\pm 2/10^6$	7	10-60	1(50)	0.01-10	0.2-5	nixie	BNC	yes	a	C	825
	HP	5325B	0	20	$3/10^7$	7	100	1(30)	0.1μs-10	0.1-5	nixie	BNC	yes	a	C, R	1300
	CMC	609	0	20	$\pm 2/10^7$	6	100	1	1μs, 10	0.1	nixie	BNC	yes	a	C, R	1195
F8	TSC	211	0.1	20	$\pm 1/10^8$	8	10	1(30)	ina	1-10	in-line	BNC	yes	ce	C, R	2100
	TSC	273	0.1	20	$2/10^6$	5	100	1(50)	ina	0.1-10	in-line	BNC	yes	afh	C, R	1800
	TSC	210	0.1	20	$\pm 1/10^8$	7	10	1(30)	ina	1-10	in-line	BNC	yes	ce	C, R	1995
	HP	5323A	0.125	20	$3/10^7$	7	100	1(35)	0.01-4	s	nixie	BNC	yes	a	C, R	2150
	Simpson	2725	5	20	100	5	100	1(30)	100μs	0.5	p	BNC	yes		C, R	525
	Simpson	2724	5	20	100	4	100	1(30)	100μs	0.5	in-line	BNC	yes		C	450
	Beckman	6360	5	20	0.3	6	20	1(30)	0.1μs-10	0.1-10	p	BNC	yes	fz	C	1750
	Beckman	6360	5	20	0.3	6	20	1(30)	0.1μs-1	0.1-10	p	BNC	yes	fx	C	1650
	Beckman	6380	5	20	0.3	8	20	1(30)	0.1μs-1	0.1-10	p	BNC	yes	fz	C	1950
	Beckman	6380	5	20	0.3	8	20	1(30)	0.1μs-1	0.1-10	p	BNC	yes	fx	C	1850
	Itron	650	0	20	ina	5	50	1(50)	0.01-10	0.2-10	in-line	BNC	yes	g	C	595

Why pay $595 when you can have this 15-MHz counter for only $395?



WHAT!

For less than $80 per digit?

The CMC Model 905 is by far your biggest buy in a little counter. You get 15-MHz IC performance, 5-digit readout, a 1-MHz crystal oscillator, an automatic trigger level, simplified controls, and a convenient tilt-up stand—all in a tiny package only 5-inches wide and 3½-inches high.

This mighty little counter weighs only 3½ pounds, and yet it's a reliable workhorse for production line or laboratory. Its IC design results in increased reliability, improved heat dissipation, and reduced power requirements of only 8 watts typically.

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INFORMATION RETRIEVAL NUMBER 612

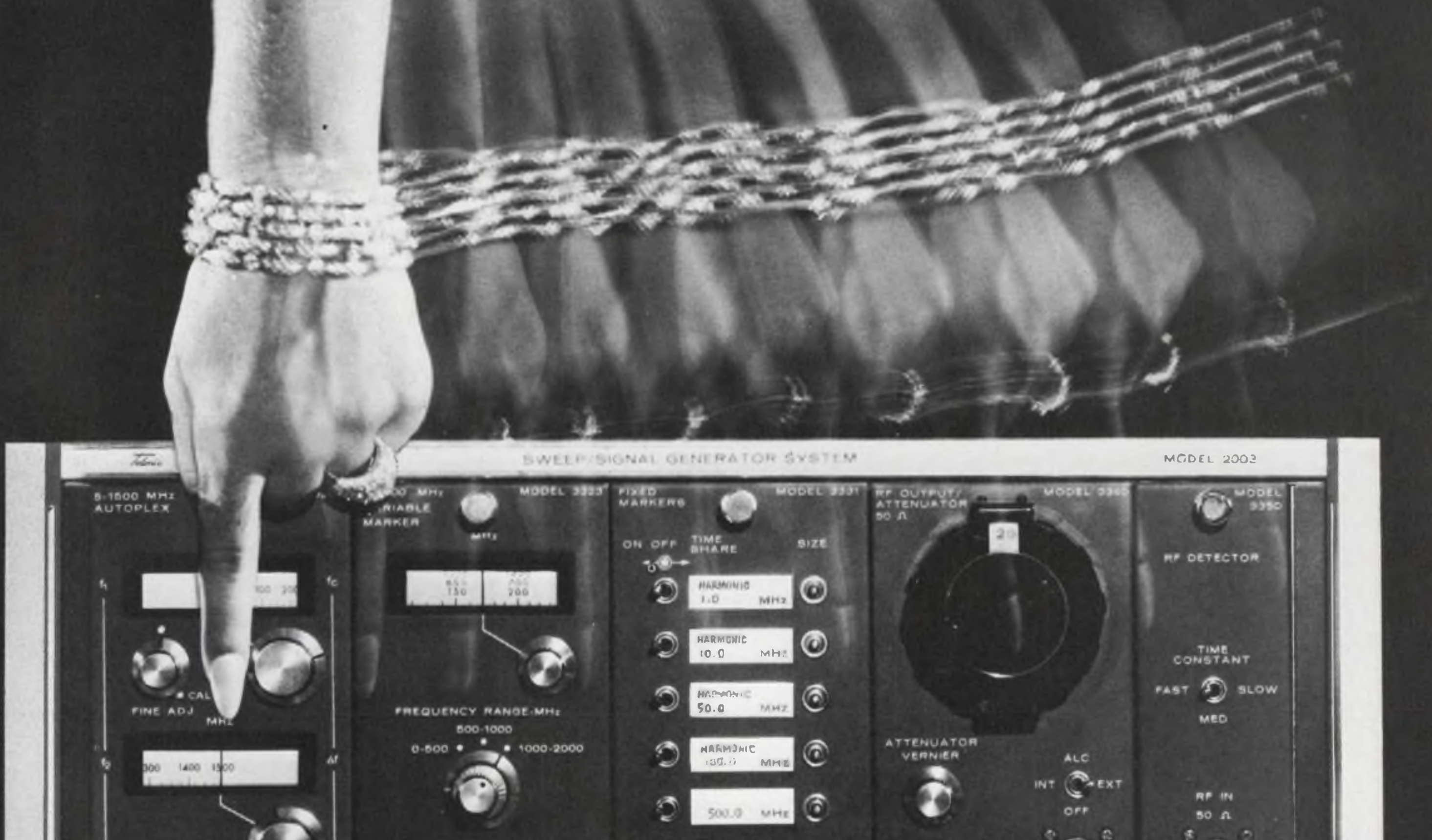
	Manufacturer	Model	FREQUENCY Minimum Hz	FREQUENCY Maximum MHz	Stability ppm	Digits No.	INPUT Sens. mV	INPUT Imp. MΩ (pF)	Gate Time s	DISPLAY Time s	DISPLAY Type	Conn. Type	Solid State	Misc. Features	Type C-Cab. R-Rack	Price Approx $
F9	Eldorado	1605	0	25	$1/10^6$	5	100	1(30)	0.01-10	0.1-10	ina	UG-1094	yes	a	C, R	550
	Eldorado	1607	0	25	$1/10^6$	7	100	1(30)	0.1,1, 10,100	0.1-10	ina	UG-1094	yes	a	C, R	650
	Beckman	6120-9	0	25	0.3	6	150	0.02(40)	10µs-1	0.1-10	in-line	BNC	yes		C	1700
	Systron	8050	0	30	$\pm 2/10^6$	5	100	1(25)	0.001-10	0.2-5	nixie	BNC	yes	a	C	650
	GR	1159	0.6	30	$3/10^{-3}$	6	ina	ina	0.1,1	0.02-10	neon	GR874	yes	c	C, R	2100
	GR	1192	0	32	2	5	ina	ina	100µs-10	0.01-10	neon	BNC	yes	at	C, R	575
	GR	1191-B	0	35	0.001	8	10	1(35)	1µs-10	1µs-10	neon	BNC	yes	c	C, R	1395
	Systron	1017	0	50	$\pm 2/10^7$	6	100	10k(40)	1µs-10	0.2-5	nixie	BNC	yes	a	C, R	1750
	Systron	1037	0	50	$\pm 2/10^7$	8	100	10k(40)	1µs-10	0.2-5	nixie	BNC	yes	ag	C, R	2240
	Monsanto	110A	0	50	$1/10^8$	7	100	1(30)	0.001-100	0.2-5	nixie	BNC	yes	cef	C	1285
F10	HP	5245L	0	50	$3/10^9$	8	100	1(25)	1µs-10	0.2-5	nixie	BNC	yes	c	C, R	2480
	HP	5245M	0	50	$5/10^{10}$	8	100	1(25)	1µs-10	0.2-5	nixie	BNC	yes	c	C, R	3100
	HP	5246L	0	50	$2/10^7$	6	100	1(25)	1µs-1	0.2-5	nixie	BNC	yes	a	C, R	1800
	HP	5244L	0	50	$2/10^7$	7	100	100kV(40	1µs-10	0.1-5	nixie	BNC	yes	a	C, R	1900
	CMC	727D	0	50	$5/10^7$	7	100	1	1µs, 10	0.1	nixie	BNC	yes	a	C, R	1725
	Dana	8100	0.05	50	$3/10^9$	8	10	1(25)	0.001-10	ina	ina	BNC	yes	cef	C, R	1495
	Dana	8120	0.05	50	$3/10^9$	8	10	1(25)	0.001-10	ina	ina	BNC	yes	cefj	C, R	2395
	Monsanto	1505A	0	70	$1/10^7$	6	100	1(22)	0.001-10	0.2-5	nixie	BNC	yes	cf	C	2250
	Monsanto	1515A	0	70	$1/10^7$	6	100	1(22)	0.001-10	0.2-5	nixie	BNC	yes	cf	C	1800
	Hickok	DP160	0	80	0.5	3	20	1(25)	ina	0.1-10	nixie	BNC	yes	i	C, R	395
F11	Beckman	6155	0	100	0.003	8	100	1(25)	1µs-10	0.1-10	p	BNC	yes	cf	C, R	2450
	Beckman	6155ACN	0	100	0.0005	8	100	1(25)	1µs-10	0.1-10	p	BNC	yes	cf	C, R	2850
	Beckman	6148	0	100	0.003	8	100	0.02(25)	10µs-10	0.1-10	p	BNC	yes	cf	C, R	2900
	CMC	880	0	100	$\pm 1/10^9$	8	100	1	1µs, 10	0.1	nixie	BNC	yes	c	C, R	3750
	Systron	6018	0	100	$\pm 2/10^8$	7	100	1(15)	1µs-10	0.2-5	nixie	BNC	yes	c	C, R	2475
	Systron	6038	0	100	$\pm 3/10^9$	7	100	1(15)	1µs-10	0.2-5	nixie	BNC	yes	cg	C, R	2975
	Systron	1018	0	100	$\pm 3/10^9$	7	100	10(40)	1µs-10	0.2-5	nixie	BNC	yes	c	C, R	2525
	Systron	1038	0	100	$\pm 3/10^9$	8	100	10k(40)	1µs-10	0.2-5	nixie	BNC	yes	cg	C, R	2950
	R-S	FET 2	0	100	$1/10^9$	9	1000	50Ω	ina	ina	nixie	BNC	yes	c	C, R	4290
	Dynascience	TS1600	0	100	$2/10^9$	8	100	10k	1µs-10	0.2-6	nixie	BNC	yes	c	C, R	ina
F12	Dynascience	TS1602	0	100	$2/10^7$	6	100	10k	0.1µs-1	0.2-6	nixie	BNC	yes	a	C, R	ina
	CMC	738	10	100	$\pm 3/10^7$	7	100	1	1, 10	0.1	nixie	BNC	yes	a	C, R	1650
	Monsanto	1500A	0	125	$1/10^9$	8	100	1(22)	0.001-10	0.2-5	nixie	BNC	yes	cef	C	2850
	Monsanto	1510A	0	125	$1/10^9$	8	100	1(22)	1µs-10	0.2-5	nixie	BNC	yes	cdf	C	2495
	HP	5248M	0	135	$5/10^{10}$	8	100	1(25)	1µs-10	0.05-2	nixie	BNC	yes	c	C, R	3300
	HP	5248L	0	135	$3/10^9$	8	100	1(25)	1µs-10	0.05-2	nixie	BNC	yes	c	C, R	2900
	HP	5247M	10	135	$5/10^{10}$	8	100	1(25)	1µs-10	0.05-2	nixie	BNC	yes	c	C, R	3150
	Beckman	6401	0	136	0.003	8	100	1(25)	10µs-10	0.01-10	p	BNC	yes	cf	C	1375
	Beckman	6401ACN	0	136	0.0005	8	100	1(25)	1µs-10	0.1-10	p	BNC	yes	cf	C	2175
	Philips	PM6630A	0	160	0.003	8	50	1(15)	1µs-10	0.2-5	nixie	BNC	yes		C, R	2795

To sweep 5 to 1500 MHz
• you don't switch ranges
• or change plug-ins
• or use a second instrument

YOU JUST SWEEP

The 3305 plug-in oscillator lets you operate over this entire range, using either end point or center frequency calibration, at widths as narrow as 200 kHz, as wide as 1495 MHz.

The 3305, in fact, makes the Telonic 2003 Sweep Generator "every man's" instrument while still permitting total flexibility if your requirements change. All functions of the instrument are on plug-in units — there are 7 oscillators including a new one covering audio frequencies, 6 different attenuators, fixed and variable markers, detectors, and other plug-ins regulating sweep rate and display processing. Complete 2003 Sweep/Signal Generator Systems start as low as $1396.00. Price will depend on plug-ins selected.



Catalog 80A contains a comprehensive description of the 2003 and specs on all plug-ins. Send for a copy.

TELONIC INSTRUMENTS
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Beech Grove, Indiana 46107
Tel: 317 787-3231 · TWX 810 341-3202

INFORMATION RETRIEVAL NUMBER 613

Frequency Counters

	Manufacturer	Model	FREQUENCY Minimum Hz	FREQUENCY Maximum MHz	Stability ppm	Digits No.	INPUT Sens. mV	INPUT Imp. MΩ (pF)	Gate Time s	DISPLAY Time s	DISPLAY Type	Conn. Type	Solid State	Misc. Features	Type C-Cab. R-Rack	Price Approx $
F13	Philips	PM6630B	0	160	0.1	6	50	1(15)	1μs-10	0.2-5	ina	BNC	yes		C, R	2220
	Systron	7038	0	200	$\pm 2/10^8$	7	100	1(50)	0.1μs-100	0.2-5	nixie	BNC	yes	cgn	C	2150
	Systron	7018	0	200	$\pm 2/10^8$	7	100	1(50)	0.01-10	0.2-5	nixie	BNC	yes	cn	C	1350
	CMC	901	0	200	$\pm 3/10^9$	9	10-100	1(40)	1μs-100	0.1	nixie	BNC	yes	cf	C, R	2475.
	Beckman	6380	5	200	0.3	8	20	1(30)	0.1μs-1	0.1-10	p	BNC	yes	fy	C	2450
	Beckman	6360	5	200	0.3	6	20	1(30)	0.1μs-1	0.1-10	p	BNC	yes	fy	C	2250
	Eldorado	1615	20	200	$1/10^6$	6	100	1(20)	1ms-100	0.1-10	ina	UG-1094	yes	a	C, R	1050
	EIP	360A	20	200	$7/10^9$	11	100	1(30)	0.1, 1	0.1	nixie	N	yes		C, R	1925
	Beckman	6397	0	220	0.3	6	100	50	0.01-1	0.1-10	p	BNC	yes	f	C	1900
	CMC	616	10	225	$\pm 2/10^7$	7	100	1	0.1, 1, 10	0.1	nixie	BNC	yes	a	C, R	1975
F14	Atec	2806	10	250	0.01	8	50	50Ω (30)	0.1-10	ina	nixie	BNC	yes	f	C	1395
	HP	5360A	0.01	320	$5/10^{10}$	12	100 (ch. A) 20 (ch. B)	1(20)	1μs-10	0.02-6	nixie	BNC	yes	c	C, R	6500
	R-S	FET 3	10,000	350	$3/10^9$	6	10	10k, 50Ω	ina	6	nixie	BNC	yes	c	C	5300
	Eldorado	1450	0	500	$1/10^6$	8	50-200	1(50)	1μs-100	0.1-10	ina	UG-1094	yes	ao	C, R	1875
	Systron	7015	0	500	$\pm 2/10^8$	7	100	1(50)	0.01-10	0.2-5	nixie	BNC	yes	cho	C	1975
	Systron	7035	0	500	$\pm 2/10^8$	7	100	1(50)	0.1μs-100	0.2-5	nixie	BNC	yes	cgo	C	2450
	Monsanto	105A	5	500	$1/10^8$	9	100	1(25)	0.001-1	0.2-10	nixie	BNC	yes	cdf	C	1550
	Systron	8220/FM01	10	500	$\pm 3/10^7$	7	100	100k(40)	0.1-10	0.2-5	nixie	BNC	yes	b	C	1795
	Eldorado	1650	20	500	$1/10^6$	8	100	1(20)	1ms-100	0.1-10	ina	UG-1094	yes	ao	C, R	1650
	Eldorado	970	20	3000	$1/10^6$	9	100	50Ω	0.01-1kHz	0.1-10	ina	TNC	yes	a	C, R	2250
F15	Systron	153	300	3000	$\pm 2/10^6$	5	-7 dBm	50Ω	1μs-10ms	ina	nixie	N	yes	a	C, R	1350
	Systron	6316A	0	12,400	$\pm 2/10^8$	7	100	1(15)	1μs-10	0.2-5	nixie	BNC, N	yes	chk	C	4750
	HP	5240A	5	12,400	$2/10^7$	8	100	1(25)	0.1, 1	n/a	nixie	BNC	yes	a	C, R	4750
	Eldorado	985	20	12,400	$3/10^8$	11	100	50Ω	0.1	0.1-10	ina	UG-1094	yes		C, R	4250
	EIP	350A	20	12,400	$7/10^9$	11	100	1(30)	0.1, 1	0.1	nixie	BNC, N	yes	cu	C, R	4250
	Eldorado	986	20	18,000	$3/10^8$	11	100	50Ω	0.1	0.1-10	ina	UG-1094	yes	b	C, R	5450
	EIP	351A	20	18,000	$7/10^9$	11	100-160	1(30)	0.1, 1	0.1	nixie	BNC, N	yes	cv	C, R	5450

a. Stability per month.
b. Stability per week.
c. Stability per day.
d. BCD outputs.
e. Remote programming.
f. Incorporates integrated circuits.
g. Universal counter.
h. Fully automatic.
i. Main frame DMS 3200A at $375.
j. Also 500 MHz, 1/2 mV sensitivity, 50Ω impedance.
k. Input impedance 50Ω, 100 MHz-12.4 GHz.
l. Battery operated.
m. Power line frequency (stability).
n. Input impedance 0-125 MHz, 50Ω, 100 kHz-200 MHz.
o. Input impedance 0-125 MHz, 50Ω, 10-500 MHz.
p. Glow transfer tube display.
q. Sensitivity channel A, 100 mV, B, 20 mV; Impedance 50Ω nominal.

Manufacturers and model numbers, see page D37

Reader service numbers for literature and application notes, see page D6.

Index by Model Number

(continued on page D39)

The first plug-in curve tracer costs ⅓ less!

With U-Tech's plug-in and console units, any X-Y oscilloscope becomes a curve tracer displaying the dynamic characteristics of both NPN and PNP transistors, N Channel and P Channel junctions, FET's, MOS-FET's, bipolars, unijunctions, diodes, tunnel diodes and SCR's. You have curve tracer capabilities, without buying a complete curve tracer unit. In so doing you pay up to:

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INFORMATION RETRIEVAL NUMBER 614

Frequency Counter Extenders

	Manufacturer	Model	Counter Used With Model	FREQUENCY Minimum MHz	FREQUENCY Maximum MHz	INPUT Sensitivity mV	INPUT Impedance Ω	Type C-Cab. R-Rack	Price Approx $
F16	Monsanto	1107A	1500A series	0	10	30	1M(30 pf)	Plug-in	285
	Dynascience	84	TS1385-R	0	20	100	10k	Plug-in	ina
	Monsanto	1108A	1500A, 1510A	0	50	100	1M(30 pf)	Plug-in	795
	Dynascience	83	TS1385-R	0	125	50-100	50	Plug-in	ina
	Monsanto	1106A	1500A series	10 Hz	175	1	1M(10 pf)	Plug-in	395
	Systron	8051	8050	30	300	100	50	Plug-in	450
	Systron	1979H	1017, 1018, 1037, 1038	0	350	100 rms	50	Plug-in	600
	Beckman	605B	6148, 6155, 6120-9	5	400	150	50	Plug-in	875
	GR	1157-B	1911-B, 1192	1	500	100	50	C, R	850
	Monsanto	1101A	1500A series	10	500	100	50	C	675
F17	Systron	1215	1017, 1018, 1037, 1038	10	500	100	50	Plug-in	750
	Monsanto	1103A	1500A series	50	500	50	50	C	685
	Dynascience	520B	TS1600, 602	100	500	50	ina	Plug-in	ina
	Systron	1291A	1034AH, 1017, 1018, 1037, 1038	50	512	-3 dBm	50	Plug-in	550
	Beckman	606	6148, 6155	1	525	50	50	Plug-in	525
	Beckman	607-4	6148, 6155	50	525	100	50	Plug-in	525
	CMC	884	880	100	555	10	50	C	530
	Beckman	607	6148, 6155, 6120-9	25	1000	100	50	Plug-in	825
	CMC	631	616	100	1300	50	50	C	775
	CMC	931	901	100	1300	50	50	C	825
F18	Dynascience	522	TS1600, 602	200	2600	ina	ina	Plug-in	ina
	Systron	1295H	1017, 1018, 1037, 1038	50	3000	-3 dBm	50	Plug-in	1400
	Systron	1253H	1017, 1018, 1037, 1038	50	3000	-7 dBm	50	Plug-in	1150
	Monsanto	1104B	1500A, 1510A	110	3000	50	50	C	875
	Systron	1295	1017, 1018, 1037, 1038	200	3000	-3 dBm	50	Plug-in	825
	Systron	1253	1017, 1018, 1037, 1038	300	3000	-7 dBm	50	Plug-in	975
	Beckman	609	6148, 6155, 6120-9	950	3000	100	50	Plug-in	825
	Dynascience	525	TS1600, 602	300	3100	ina	ina	Plug-in	ina
	CMC	635	616	200	3300	50	50	C	825
	EIP	361A	360A	200	12, 400	100	50	C, R	975
F19	EIP	362A	360A	1000	12, 400	100	50	C, R	1840
	Beckman	613	6148, 6155, 6120-9	3000	12, 400	100	50	Plug-in	1850
	Beckman	613A	6148, 6155, 6120-9	3000	12, 400	70	50	Plug-in	2000
	Systron	1255A	1017, 1018, 1037, 1038	3000	12, 400	-7 dBm	50	Plug-in	1975
	Monsanto	1111A	1500A series	2000	12, 500	100	50	C	1995
	Systron	1292	1017, 1018, 1037, 1038	50	15, 000	-7 dBm	50	Plug-in	1500
	EIP	363A	360A	1000	18, 000	100-160	50	C, R	2990
	Systron	1257	1017, 1018, 1037, 1038	12, 400	18, 000	0 dBm	50	Plug-in	2175
	Systron	1298	1017, 1018, 1037, 1038	15, 000	40, 000	-15 to -3 dBm	50	Plug-in	3500

r. Input impedance 5 Hz-12.5 MHz; 50Ω, 0.3-12.4 GHz.
s. Varies from 5μs at 20 MHz to 8 sec at 0.125 Hz plus 1 ms compute time.
t. Six and seven digits available.
u. Input impedance 20 Hz-200 MHz; 50Ω, 200 MHz-12.4 GHz.
v. Input impedance 20 Hz-200 MHz; 50Ω, 200 MHz-18 GHz.
w. Frequency counter one function of digital multimeter, also measures ac/dc volts, ac/dc current, dc ratio and ohms.
x. Includes 682 frequency module at $200 and 673 function meter at $450. For dual channel specify 633 module at $300.
y. Includes 685 frequency module at $800 and 673 function meter at $450.
z. Includes 682 frequency module at $200 and 675 universal EPUT and timer at $550.

Manufacturers and model numbers, see page D39.

Reader service numbers for literature and application notes see page D6.

Freq. Counter Extenders Index by Model

Name	Model	Code
Beckman	605B	F16
Beckman Inst.	606	F17
Inc.	607	F17
	607-4	F17
	609	F18
	613	F19
	613A	F19
CMC	631	F17
	635	F18
	884	F17
	931	F17
Dynascience	83	F16
Dynascience	84	F16
Div.	520B	F17
	522	F18
	525	F18
EIP	361A	F18
EIP Inc.	362A	F19
	363A	F9
GR	1157-B	F16
General Radio Co.		
Monsanto	1101A	F16
Monsanto	1103A	F17
Electronics	1104A	F18
	1106A	F16
	1107A	F16
	1108A	F16
	1111A	F19
Systron	1215	F17
Systron-Donner	1253	F18
Corp.	1253H	F18
	1255A	F19
	1257	F19
	1291	F17
	1292	F19
	1295	F18
	1295H	F18
	1298	F19
	1979H	F16
	8051	F16

Frequency Counters

(continued fom page D37)

Name	Model	Code
Systron	7015	F14
	7018	F13
	7034	F7
	7035	F14
	7038	F13
	8040	F3
	8050	F9
	8200	F5
	8220/FM01	F14
TSC	210	F8
Time Systems	211	F8
Corp.	272	F4
	273	F8
	300	F7
	410-1	F2
	410-2	F2
	410-3	F1
	410-4	F1
Weston	300	F2
Weston Instru-	301	F1
ments	301C	F1
	302	F2

INFORMATION RETRIEVAL NUMBER 615 ▶

digimetrix DX703A

the pint-size portable DMM... costs only $349 and it hustles!!!

this modular-PC package of only 0.1 ft³ and 5¾ pounds boasts, along with much more, *three-digit "Nixie"* readout to 1200 with decimal point, automatic + and −, and an extra digit for accurate readings ±20% overrange, plus built-in galvanometer showing variation, amplitude, and range of measured parameter;

- **Rational Crossbar Pushbutton Selection** of five Functions, with five Ranges in each:
  Voltage from 1 μV to 1000 V AC and DC
  Current from 1 μA to 1200 mA AC and DC
  Resistance from 1 Ω to 1.2 MΩ
- **Accuracy: VDC** .... >1% of reading ±1 digit
  other parameters .... >1.5% of reading ±1 digit
- **Bandwidth** at ±0.25 dB to 9.99 V .... 30 Hz — 60 kHz
  99.9 V .... 30 Hz — 30 kHz
  999.3 V .... 30 Hz — 2 kHz
- **Input Impedance** .... 10 MΩ constant
- **AC Rejection** .... > 60 dB
- **Overload Protection** — on voltage ranges .... to 1000V
  — on other ranges .... to 250V
- **Size** .... 9" x 6¼" x 3⅛"

Beautifully built by (just look inside!) ITT metrix

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Oscilloscopes (general purpose)

	Manufacturer	Model	Channel	FREQUENCY Min. Hz	Max. MHz	Resp. dB	SENSITIVITY Max. mV/cm	Min. V/cm	Input Imp. MΩ(pF)	Signal Delay µs	SWEEP SPEED Max. µs/cm	Min. s/cm	Ext. Trigger V(p-p)	Misc. Features	Type C-Cab. R-Rack	Price Approx $
S1	MCD	349	vert	dc	0.02	1	1000	n/a	1(100)	n/a	0.1s	10	1.0		C	250
	MCD	MK I	vert	dc	0.07	1	6	10	0.5(75)	n/a	5	0.5	n/a		C	99
	MCD	MK II	vert	dc	0.1	2	100	20	1(50)	n/a	5	0.5	n/a	a	C	185
	MCD	300	vert	dc	0.1	1	10	40	0.5(100)	n/a	5	1	n/a		C	188
	Simpson	466	vert	15	0.1	1	12	100	0.5(35)	n/a	12.5	0.065	n/a	d	C	190
	Waterman	OCA-12A	vert	dc	0.2	ina	40	100	1(6)	n/a	6.6	0.066	n/a	a	C	375
	Waterman	OCA-11B	vert	dc	0.2	ina	20	100	1(60)	n/a	200	2	n/a		C	375
	Waterman	OCA-11A	vert	dc	0.2	ina	20	100	1(30)	n/a	6.6	0.066	n/a		C	325
	MCD	S-11A	vert	dc	0.2	2	100	2	0.5(100)	n/a	20	0.5	n/a		C	170
	HP	122A	vert	dc	0.2	3	10	100	1(50)	n/a	5	0.5	2.5	a	C, R	850
S2	Heath	IO-10	vert	dc	0.2	2	100	n/a	3.6(35)	n/a	50kHz	5Hz	n/a	e	C	100
	Heath	IO-21	vert	2	0.2	2	177	n/a	10(20)	n/a	100kHz	20Hz	n/a	e	C	62
	Millen	90923	vert	dc	0.27	3	430	n/a	n/a	0	3.3	0.05	n/a	d	R	322
	Tektronix	503	vert	dc	0.45	3	1	20	1(47)	n/a	1	5	0.5	dgi	C	695
	HP	120B	vert	dc	0.45	3	10	100	1(50)	n/a	5	0.5	1.5		R	560
	Tektronix	504	vert	dc	0.45	3	5	20	1(47)	n/a	1	0.5	0.5	gi	C	595
	HP	130C	vert	dc	0.5	3	0.2	50	1(45)	n/a	1	12.5	0.5	d	C	790
	Spedcor	1120/200	vert	dc	0.5	3	10	50	2(45)	n/a	1	5	0.25	adg	C, R	880
			vert	dc	0.5	3	40	n/a	2(45)							
	Dumont	708A	vert	dc	0.5	3	0.01	10	1(50)	n/a	5	2	0.5	b	R	1495
	Spedcor	1120/300	vert	dc	0.5	3	10	50	2(45)	n/a	1	5	0.25	adg	C, R	855
			vert	dc	0.3	3	1	0.01	2(45)							
S3	HP	132A	vert	dc	0.5	3	0.1	50	1(50)	n/a	1	12.5	0.5	b	C	1475
	Spedcor	1120/100	vert	dc	0.5	3	40	n/a	1(100)	n/a	n/a	n/a	n/a	adg	C, R	
	HP	1200	vert	dc	0.5	3	0.1	50	1(45)	n/a	1	12.5	0.2		C, R	990
	Spedcor	1120/700	vert	dc	0.5	3	0.1	20	2(50)	n/a	1	5	0.25	adg	C, R	1000
	Dumont	704A	vert	dc	0.5	3	0.02	20	1(50)	n/a	1.0	5.0	0.5	d	R	895
	Spedcor	1120/600	vert	dc	0.5	3	0.1	20	2(50)	n/a	1	5	0.25	a	C, R	915
			vert	dc	0.15	3	40	n/a	2(50)							
	HP	1201		dc	0.5	3	0.1	50	1(45)	n/a	1	12.5	0.2	a	C, R	1900
	Dumont	701B	vert	dc	0.5	3	1	10	1(40)	n/a	5	0.2	0.5		R	575
	HP	1202	vert	dc	0.5	3	0.1	50	1(45)	n/a	1	12.5	0.2		C, R	790
	Spedcor	1100/200	vert	dc	0.5	3	10	50	2(45)	n/a	1	5	0.25	dg	C, R	690
			vert	dc	0.5	3	40	n/a								
S4	HP	1205A		dc	0.5	3	5	50	1(45)	n/a	1	12.5	0.2	a	C, R	875
	Dumont	702	vert	dc	0.5	3	10	100	1(44)	n/a	5	0.2	0.5		R	895
	HP	1206	vert	dc	0.5	3	5	50	1(45)	n/a	1	12.5	0.2		C, R	715
	Spedcor	1100/300	vert	dc	0.5	3	10	50	2(45)	n/a	1	5	0.25	dg	C, R	765
			vert	dc	0.3	3	1	0.01	2(45)							
	HP	1207	vert	dc	0.5	3	5	50	1(45)	n/a	1	12.5	0.2		C, R	1550
	Spedcor	1100/100	vert	dc	0.5	3	40	n/a	1(100)	n/a	1	5	n/a	dg	C, R	503
	Spedcor	1100/700	vert	dc	0.5	3	0.1	20	2(50)	n/a	1	5	0.25	dg	C, R	910
	Spedcor	1100/600	vert	dc	0.5	3	0.1	20	2(50)	n/a	1	5	0.25	dg	C, R	825
			vert	dc	0.15	3	40	n/a	2(50)							
	Millen	90925	vert	dc	0.55	3	160	n/a	n/a	n/a	3.3	0.05	n/a	d	R	393
	Data	572	vert	dc	0.6	3	20	n/a	1(30)	n/a	100kHz	10Hz	n/a	d	C	566
S5	Data	539	vert	5	1	3	1000	n/a	1(25)	n/a	100kHz	10Hz	n/a		C	93
			horz	2	0.2		3000									
	Tektronix	R5030	vert	dc	1	3	0.01	10	1(50)	n/a	1	5	0.25, 0.5	bdein	C, R	1850
	Tektronix	502A	vert	dc	1	3	5	20	1(47)	n/a	1	5		bdgm	C	1265
	Millen	90954	vert	dc	1	3	100	1000	n/a	n/a	3.3	0.11	n/a	d	C	655
	Data	536A	vert	dc	1.5	3	20	n/a	1(22)	n/a	100kHz	10Hz	n/a		C	128
			horz	2	0.5											
	Data	556A	vert	dc	1.5	3	20	n/a	1(22)	n/a	100kHz	10Hz	n/a		C	188
			horz	2	0.5		300									
	Xetex	OS15A	vert	dc	3	3	100	50	1(30)	n/a	1	0.1	1		C	200
	Tektronix	323	vert	dc	4	3	10	20	1(47)	n/a	5	1	0.075, 0.19	eh	C	960
	Hickok	770A	vert	dc	4	3	10	50	1(45)	n/a	1	0.5	0.2		C	475
	Tektronix	310A	vert	dc	4	3	100	50	1(40)	n/a	0.5	0.2	0.2	efi	C	795

Misc. Features, see page D42.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see page D6.

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Pick the winner in RF DETECTOR PROBES: The Texscan BN-8511 probe was designed for general applications where swept techniques are used. The detector is usable up to 1000 MHz and incorporates a voltage doubler so both positive and negative half waves of the RF voltage are detected. . . . Pick the winner in RF ATTENUATORS: Our broad line of continuously variable attenuators provide you with a wide variety of attenuation ranges, 50 or 75 ohm impedance levels and are inexpensive. . . . Texscan's LARGE SCREEN X-Y DISPLAY SCOPES are more winners. The DU-17 large screen scope permits the display and resolution of frequency response curves and can be used in conjunction with any sweep generator or signal generator. Three vertical inputs and two reference lines enable the user to display simultaneously the response of the unit under test while also displaying VSWR and insertion loss. Ideal for testing amplifiers, filters, VHF and UHF tuners. . . . The DU-11 FULLY TRANSISTORIZED LARGE SCREEN DISPLAY SCOPE is a big winner: The CRT has a usable area of 6 x 8 inches with a medium P-7 phosphor. A scanning system and three identical directly coupled Y amplifiers permit the simultaneous display of three frequency response curves at three different points in the circuit under test. A unique marker circuit enables the pulse or heterodyne markers from a generator to be displayed as dots, vertical pips or vertical lines.

Texscan CORPORATION
TECHNICAL PRODUCTS DIVISION

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INFORMATION RETRIEVAL NUMBER 616

Oscilloscopes (general purpose)

				FREQUENCY			SENSITIVITY				SWEEP SPEED					
	Manufacturer	Model	Channel	Min. Hz	Max. MHz	Resp. dB	Max. mV/cm	Min. V/cm	Input Imp. MΩ (pF)	Signal Delay μs	Max. μs/cm	Min. s/cm	Ext. Trigger V(p-p)	Misc. Features	Type C-Cab. R-Rack	Price Approx $
S6	Simpson	458	vert	15	4.5	1	16	100	3.3(20)	0.05	4.0	0.065	n/a	d	C	420
	Jackson	CRO-3	vert	20	4.5	1	7	100	1.5(25)	n/a	2.5	0.006	n/a		C	255
	Aul	055	1	dc	5	3	10	20	1	n/a	1	0.3	1		C	400
	Binary	5Mc2P	vert	dc	5	3	100	10	1(30)	n/a	1	1	±0.5	b	C	950
	Xetex	OS25A	vert	dc	5	3	100	50	1(35)	n/a	1	0.1	1	a	C	315
	MCD	1531	vert	dc	5	2	20	10	1(47)	n/a	1	5	0.1	ad	C	995
	Data	557A	vert	dc	5	3	20	n/a	1(30)	n/a	100kHz	10Hz	n/a		C	218
			horz	2	0.5		300									
	Heath	IO-18	vert	3	5	3	28	n/a	27	n/a	500kHz	10Hz	n/a		C	93
	Heath	IO-17	vert	5	5	3	30	n/a	1(25)	n/a	200kHz	20kHz	n/a		C	80
	Mercury	3000	vert	10	5	3	4.6	50	2.7(70)	n/a	0.25	0.025	n/a		C	180
S7	Allied	KG-635	vert	dc	5.2	1.5	0.6	17	7	2	5	3	2		C	120
	RCA	WO-33A	vert	5.5	5.5	3	3	60	1(50)	0.1	13	0.066	n/a		C	139
	Tektronix	321A	vert	dc	6	3	10	20	1(41)	n/a	0.5	0.5		ehi	C	1045
	Sencore	PS148	vert	5	6.2	3	6.8	2000	27(9)	n/a	500kHz	5Hz	n/a		C	250
	Tektronix	317	vert	dc	10	3	100	50	1(40)	n/a	0.2	2	0.5, 4	ei	C, R	1050
	Data	555	vert	dc	10	3	20	10	1(33)	n/a	1	1	1		C	297
			horz	2	0.2		200	n/a		n/a						
	Philips	PM3200	vert	dc	10	3	2	50	1(30)	n/a	0.1	0.5	2	ep	C	480
	Philips	PM3230	vert	dc	10	3	20	20	1(30)	n/a	0.5	0.5	1	b	C	795
	Data	553	vert	dc	10	3	10	20	1(33)	n/a	1	1	1	a	C	487
			horz	2	0.2		200	n/a								
	MCD	100	vert	dc	10	2	50	15	1(50)	n/a	0.5	0.2	n/a		C	359
S8	Tektronix	422	vert	dc	15	3	10	20	1(33)	yes	0.5	0.5	0.125, 0.6	eig	1500	
	Tektronix	422/125B	vert	dc	15	3	10	20	1(33)	yes	0.5	0.5	0.125, 0.6	aeij	C	1850
	Tektronix	515A	vert	dc	15	3	50	20	1(36)	yes	0.2	2	0.5,1.5	gi	C	1050
	Tektronix	516	vert	dc	15	3	50	20	1(20)	yes	0.2	2	0.5,1.5	ai	C	1275
	Philips	PM3231	vert	dc	15	3	10	20	1(30)	0.1	0.2	0.5	1	bdep	C	975
	Xetex	OS2100	vert	dc	25	3	1	20	1(35)	0.2	0.04	0.2	0.3	a	C, R	895
	Hickok	CRO5000	vert	dc	25	3	10	50	1(30)	0.05	0.05	2	0.2		C, R	725
	Philips	PM3250	vert	dc	50	ina	2	20	1(17)	yes	0.05	1	1	ado	C	1995
	Dumont	1050	vert	dc	50	3	1	20	1(25)	n/a	0.1	1	0.02	arst	C	2195
	Tektronix	453	vert	dc	50	3	20	10	1(20)	yes	0.1	5	0.2	adegk	C	2050
S9	Iwatsu	SS-112	vert	dc	100	3	5	12.5	1(13)	0.09	0.002	12.5	0.1	a	C	2340
	Tektronix	454	vert	dc	150	3	20	10	1(20)	yes	0.05	5		adegl	C	2925
	Iwatsu	SS-212	vert	dc	200	3	5	12.5	1(14)	0.08	0.001	12.5	0.04	a	C	3120

a. Dual trace instrument.
b. Dual beam instrument.
c. Multi-channel scope.
d. Identical vertical and horizontal amplifiers.
e. Sensitivity per division.
f. Trigger: 0.2V external dc - 1 kHz or 2V external at 5 MHz.
g. Rackmount at extra cost.
h. Battery operated.
i. Also ac coupled.
j. Battery pack $125.
k. Two channel, channel 1 can be switched for horizontal deflection with channel 2 for vertical deflection. 10 mV/div, dc - 45 MHz, 5 mV/div, dc - 40 MHz. Calibrated sweep delay; xy operation.
l. Two channel, channel 1 can be switched for horizontal deflection with channel 2 for vertical deflection. 10 mV/div dc - 100 MHz, 5 mV/div, dc - 60 MHz. Calibrated sweep delay; xy operation.
m. Sensitivity, dc - 100 kHz, 3 dB down, 100 μV/cm.
n. Current input dc - 5 kHz, 3 dB down, sensitivity 1 mA/cm - 200 mA/cm.
o. Two channels, dc - 50 MHz; xy operation, dc - 5 MHz, 200 μV/cm.
p. Sweep speed per division.
q. Second channel, dc - 2.5 MHz, 2 mV - 2V/div.
r. Dual modulated triggering system.
s. 1 mV/cm sensitivity both channels, dc - 25 MHz; 10 mV/cm dc - 50 MHz at full bandwidth.
t. Low level constant amplitude triggering at full bandwidth.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see, page D6.

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Featuring a remarkable new triggering capability.

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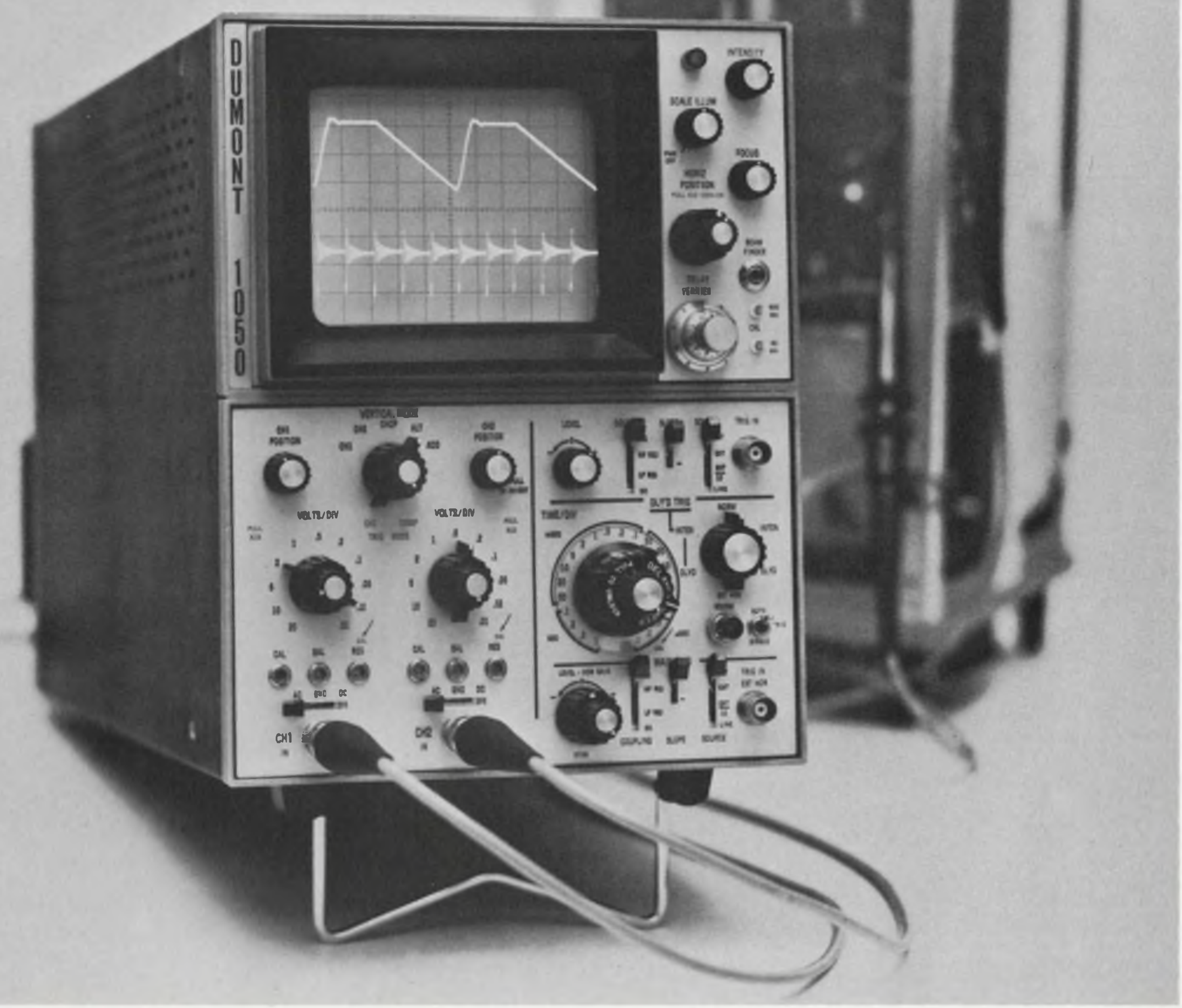


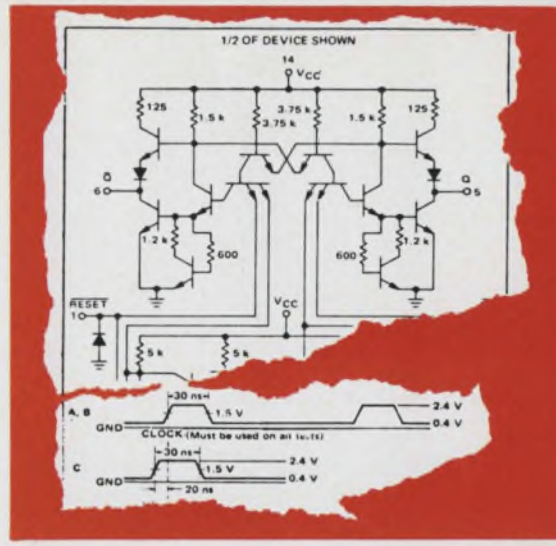
INFORMATION RETRIEVAL NUMBER 617

	Manufacturer	Model	Channel (Misc. Features)	FREQUENCY dc to GHz	Resp. dB	Rise Time ps	SENSITIVITY Max. mV/cm	Min. mV/cm	Imp. Ω (pF)	Noise mV	Delay Line ns	dc Offset V	SWEEP SPEED Max. ns/cm	Min. µs/cm	CRT Details	Price Approx $
S10	Tektronix	564B/3S2/3T2/S5	abc	0.35	3	1000	2	200	1M(15)	0.5	n/a	+1 to -1	0.2	100	8x10cm	3490
	Tektronix	568/3S5/3T5/230/S-5	abcef	0.35	3	1000	2	200	1M(15)	0.5	n/a	+1 to -1	0.1	0.5s	8x10cm	8490
	Tektronix	561B/3S2/3T2/S5	abc	0.35	3	1000	2	200	1M(15)	0.5	n/a	+1 to -1	0.2	100	8x10cm	2935
	Tektronix	568/3S5/3T5/230/S-1	abcdef	1	3	350	2	200	50	2	n/a	+1 to -1	0.1	0.5s	8x10cm	8445
	Tektronix	561B/3S2/3T2/S-1	abcd	1	3	350	2	200	50	2	n/a	+1 to -1	0.2	100	8x10cm	2945
	HP	1410A 1425A	agmn	1	3	350	1	400	100k(2) 50	8	yes	ina	0.004	10	m	3600
	Tektronix	7S11/7T11/S1/7504	single	1	3	350	2	200	50	2	n/a	+1 to -1	0.01	5000	8x10cm	3850
	HP	1410A 1424A	agm	1	3	350	1	400	100k(2) 50	8	yes	ina	0.004	500	m	3100
	Tektronix	564B/3S2/3T2/S-1	abc	1	3	350	2	200	50	2	n/a	+1 to -1	0.2	100	8x10cm	3445
	Tektronix	1S1	gh	1	3	350	2	200	50	1	yes	+1 to -1	0.1	50	h	1400
S11	Tektronix	1S2	ghi	3.9	3	90	5	500	50	2	n/a	n/a	ina	ina	h	1525
	HP	1815A 1816A	single kg	4	3	90	5	500	50	3	ina	ina	0.01	1	k	1950
	HP	1411A 1432A 1424A	agm	4	3	90	0.4	200	50	3	ina	ina	0.004	500	m	3100
	HP	1411A 1432A 1425A	agmn	4	3	90	0.4	200	50	3	ina	ina	0.004	10	m	3500
	Tektronix	564B/3S2/3T2/S-2	abc	7	3	50	2	200	5	6	n/a	+1 to -1	0.2	100	8x10cm	3500
	Tektronix	561B/3S2/3T2/S-2	abc	7	3	50	2	200	50	6	n/a	+1 to -1	0.2	100	8x10cm	3000
	Iwatsu	5009B/V-9B	single	7	3	50	10	200	50	715	ina	ina	10ps	100	7in., 3kV	3255
	Tektronix	568/3S5/3T5/230/S2	abcef	7	3	50	2	200	50	2	n/a	+1 to -1	0.1	0.5s	8x10cm	8500
	Iwatsu	5009B/V-9B/H-9Y	a	7	3	50	10	200	50	15	ina	ina	10ps	100	7in., 3kV	3255
	HP	1815A 1817A	single gk	12.4	3	28	5	500	50	8	ina	ina	0.01	1	k	2600
S12	HP	1430A 1431A 1411A 1425A	agm	12.4	3	28	0.4	200	50	8	ina	ina	0.004	10	see main frame	5500
	HP	1411A 1430A 1424A 1431A	agm	12.4	3	28	0.4	200	50	8	ina	ina	0.004	500	m	5100
	Tektronix	564B/3S2/3T2/S-4	abc	14	3	25	2	200	50	5	n/a	+1 to -1	0.2	100	8x10cm	4020
	Tektronix	568/3S5/3T5/230/S-4	abcef	14	3	25	2	200	50	5	n/a	+1 to -1	0.2	100	8x10cm	9020
	Tektronix	561B/3S2/3T2/S4	abc	14	3	25	2	200	5	5	n/a	+1 to -1	0.2	100	8x10cm	3465
	Iwatsu	5009B/V-9F/H-9W	a	18	3	20	10	200	50	15	ina	ina	10ps	50ms	7in., 3kV	5650

a. Dual trace.
b. Identical vertical and horizontal amplifiers.
c. Storage scope.
d. S-3 sampling head identical as S-1 head, except input impedance 100kΩ, 2.3pF and noise at 3mV, price $435.
e. Digital readout.
f. Programmable.
g. Plug-in.
h. Fits any 530, 540, 550 or 580 (with adapter) see main frame section for price and specifications.
i. Also reflectometer calibrated in ρ (rho) 0.005ρ/div to 0.5ρ/div.
j. Dual channel available using additional 7S11 and sampling head, $4600 minimum.
k. Fits 180 series main frame, see main frame section for price and specifications.
m. Fits 140 series main frame, see main frame section for price and specifications.
n. Type 1425A delayed sweep 0.05µs-0.005s, ±3% accuracy.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see page D6.



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INFORMATION RETRIEVAL NUMBER 618

Oscilloscopes (main frame)

	Manufacturer	Model	Channel (Misc. Features)	FREQUENCY Min. Hz	FREQUENCY Max. MHz	FREQUENCY Resp. dB	SENSITIVITY Max. mV/cm	SENSITIVITY Min. V/cm	SWEEP SPEED Max. ns/cm	SWEEP SPEED Min. s/cm	Int Calib	Mounting	Price Approx $
S13	Tektronix	561B	adij	dc	10	3	a	a	a	a	4mV-40V	C	595
	Tektronix	564B	adijh	dc	10	3	a	a	a	a	4mV-40V	C	1095
	Tektronix	565	bdkg	dc	10	3	b	b	1000	5		C	1675
	Gen-Atro	AN/USM-157	b	dc	10	3	10/div	50/div	100/div	0.1/div	yes	R	ina
	Gen-Atro	K 106	b	dc	10	3	10/div	20/div	100/div	0.1/div	yes	C, R	ina
	Tektronix	536	a	dc	11	3	a	a	a	a	0.2mV-100V	C	1325
	Tektronix	535A	bde	dc	15	3	b	b	100	5	0.2mV-100V	C	1525
	Tektronix	533A	b	dc	15	3	b	b	100	5	0.2mV-100V	C	1275
	Tektronix	531A	b	dc	15	3	b	b	100	5	0.2mV-100V	C	1150
	Gen-Atro	GA 415	b	dc	15	3	10/div	20/div	100/div	0.1/div	yes	C, R	ina
S14	HP	143A	a	dc	15	Flat to 15MHz	a	a	a	a	1V	C, R	1500
	HP	141B	a	dc	20	Flat to 20MHz	a	a	a	a	1V	C, R	1500
	HP	141A	a	dc	20	Flat to 20MHz	a	a	a	a	1V	C, R	1395
	HP	140B	a	dc	20	Flat to 20MHz	a	a	a	a	1V	C, R	695
	HP	140A	a	dc	20	Flat to 20MHz	a	a	a	a	1V	C, R	695
	Xetex	OS-2000	ad	dc	20	3	1	20	40	0.2	yes	R	525
	Tektronix	551	bk	dc	27	3	b	b	100	5	0.2mV-100V	C	2200
	Tektronix	549	befh	dc	30	3	b	b	100	5	0.2mV-100V	C	2625
	Tektronix	543B	bd	dc	33	3	b	b	100	5	0.2mV-100V	C	1450
	Tektronix	545B	bde	dc	33	3	b	b	100	5	0.2mV-100V	C	1700
S15	Tektronix	544	bdf	dc	50	3	b	b	100	5	0.2mV-100V	C	1625
	Data	1700	a	dc	50	3	a	a	a	a	yes	C	885
	Tektronix	546	bdfg	dc	50	3	b	b	100	5	0.2mV-100V	C	1825
	Tektronix	547	bdfg	dc	50	3	b	b	100	5	0.2mV-100V	C	1950
	Tektronix	556	bdgk	dc	50	3	b	b	100	5	0.2mV-100V	C	3700
	Dumont	777	ack	dc	50	3	a	a	a	a	ina	C, R	1895
	Dumont	767H	a	dc	50	3	a	a	a	a	yes	R	895
	Dumont	766H	a	dc	50	3	a	a	a	a	yes	C	795
	Dumont	765MH	ap	dc	50	3	a	a	a	a	yes	C	1075
	Dumont	757	an	dc	50	3	a	a	a	a	yes	R	1095
S16	Tektronix	585A	bde	dc	80	3	b	b	50	2	0.2mV-100V	C	2000
	Tektronix	581A	b	dc	80	3	b	b	50	2	0.2mV-100V	C	1700
	Tektronix	7504	acm	dc	90	3	a	a	a	a	4mV-40V	C	2000
	HP	181A	ad	dc	100	Flat to 100MHz	a	a	a	a	10 p-p	C, R	1850
	Dumont	957	an	dc	100	3	a	a	a	a	yes	R	1140
	Dumont	765MHF	ap	dc	100	3	a	a	a	a	yes	C	1150
	Dumont	766HF	a	dc	100	3	a	a	a	a	yes	C	880
	Dumont	767HF	a	dc	100	3	a	a	a	a	yes	R	980
	Dumont	777/105	ack	dc	100	3	a	a	a	a	yes	C, R	2010
	HP	180A	ad	dc	100	Flat to 100MHz	a	a	a	a	250mV-10V	C, R	895
S17	Tektronix	647A	ad	dc	100	3	a	a	a	a	0.2mV-100V	C	1725
	Tektronix	7704	acm	dc	150	3	a	a	a	a	4mV-40V	C	2500
	HP	183A	ad	dc	500	Flat to 500	a	a	a	a	0.05-0.5V	C, R	1750

Misc. Features, see page D48.

BEGINNING WITH THIS ISSUE

Electronic Design

WILL HAVE A

PRODUCT SOURCE DIRECTORY

IN EVERY ISSUE. LOOK FOR THESE:

DECEMBER 5, 1969
Sweep Generators

DECEMBER 19, 1969
Field Strength Meters

JANUARY 4, 1970
Pulse Generators

JANUARY 18, 1970
Signal Generators

FEBRUARY 1, 1970
Slotted Lines

FEBRUARY 15, 1970
Power Supplies:
High Current, Lab Type,
High Voltage, Constant Current,
Modular AC-DC, Power Supplies

MARCH 1, 1970
Frequency Meters, Coat & WG

MARCH 15, 1970
Noise Generators

APRIL 1, 1970
Multitesters

APRIL 12, 1970
AC Power Supplies, Special Purpose Power Supplies

APRIL 26, 1970
Oscillators

MAY 10, 1970
Squarewave & Function Generators

MAY 24, 1970
Frequency Synthesizers

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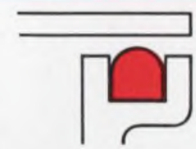

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INFORMATION RETRIEVAL NUMBER 632

"IT'S GOOD BUSINESS
TO HIRE THE HANDICAPPED."

ISN'T THAT A GREAT IDEA, SNOOPY?

THE PRESIDENT'S COMMITTEE ON EMPLOYMENT
OF THE HANDICAPPED, WASHINGTON, D. C.

INFORMATION RETRIEVAL NUMBER 619

Vertical Amplifiers (single trace)

	Manufacturer	Model	FREQUENCY Min. Hz	FREQUENCY Max. MHz	FREQUENCY Resp. dB	SENSITIVITY Max. mV/cm	SENSITIVITY Min. V/cm	Input Impedance MΩ (pF)	Common Mode Rej.	Misc. Features	Main Frames for Plug-In	Price Approx $
S18	Tektronix	2A63	dc	0.3	3	1	20	1(47)	d		561B, 564B, 565	190
	HP	1407A	dc	0.4	3	0.05	50	1(90)	80dB		140, 141, 143 Series	725
	HP	1406A	dc	0.4	3	0.05	50	1(100)	80dB		140, 141, 143 Series	950
	HP	1403A	0.1	0.4	3	0.01	0.125	10(60)	106dB		140, 141, 143 Series	575
	HP	1400B	dc	0.5	3	0.1	50	1(45)	100dB		140, 141, 143 Series	275
	Dumont	74-12	dc	0.85	3	1.0	10	1(37)	40dB		765, 766, 767 Series	295
	Tektronix	1A7A	dc	1	3	0.01	10	1(47)	d		530, 540, 550, 580	525
	Tektronix	2A60	dc	1	3	50	50	1(47)	n/a		561B, 564B, 565	140
	Dumont	74-15	dc	1	3	20	20	1(33)	n/a		765, 766, 767 Series	195
	Tektronix	3A9	dc	1	3	0.01	10	1(47)		de	561B, 564B, 565	525
S19	Tektronix	7A22	dc	1	3	0.01	10	1(47)		dg	7704, 7504	500
	Tektronix	1A6	dc	2	3	1	50	1(33)	d	b	530, 540, 550, 580	295
	Tektronix	3A75	dc	4	3	50	20	1(47)	n/a		561B, 564B, 565	215
	Dumont	74-19	dc	5	3	50	20	1(40)	n/a		765, 766, 767 Series	325
	Gen-Atro	AM-3254/ USM-157	dc	10	3	10/div	50/div	1(42)	n/a		AN/USM-157	ina
	Tektronix	3A7	dc	10	3	1	50	1(20)	d	b	561B, 564B, 565	750
	Gen-Atro	ST 106	dc	10	3	10/div	20/div	1(47)	n/a		K 106	ina
	Data	1Y7	dc	15	3	50	20	1(30)	ina		1700	151
	Tektronix	3A5	dc	15	3	10	50	1(24)	n/a		561B, 564B	950
			dc	5	3	5	n/a					
	Tektronix	G	dc	20	3	50	20	1(47)	d	b	530, 540, 550, 580	235
S20	Xetex	OS2001	dc	20	3	50	20	1(35)	80dB		OS2000	100
	Tektronix	W	dc	23	3	1	50	1(20)	d	b	530, 540, 550, 580	625
	Dumont	76-01A	dc	25	3	5	10	1(40)	n/a		765, 766, 767 Series	425
	HP	1803A	dc	40	3	1	50	1(27)	86dB		180, 181, 183 Series	950
	Data	1Y1	dc	50	3	10	20	1(35)	ina		1700	214
	Tektronix	1A5	dc	50	3	1	20	1(20)	d	b	530, 540, 550, 580	625
	Tektronix	10A1	dc	55	3	20	20	1(20)	d		647A	1025
			dc	35	3	1	0.002					
	Tektronix	86	dc	80	3	100	50	1(15)	n/a		580 Series	425
			dc	75	3	10	5					
	Tektronix	7A13	dc	150	3	1	5	1(20)		d	7704, 7504	1100
			dc	75	3							
	Tektronix	7A11	dc	150	3	5	20	1M	n/a	f	7704, 7504	850
			dc	90	3							
S21	Tektronix	7A16	dc	150	3	5	5	1(15)	n/a		7704, 7504	600
			dc	90								

Misc. Features, see page D50.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see page D6.

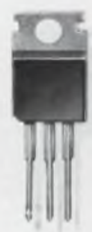
Oscilloscopes (main frame)

Misc. Features for table on page D46

a. Both horizontal and vertical amplifiers are plug-ins, for complete specifications see plug-in tables.
b. Vertical amplifier is a plug-in. Specifications are for main frame and built-in horizontal amplifier. See plug-in tables for vertical amplifier specifications.
c. Multi-channel scope.
d. Rack mount extra.
e. Time base A; Time base B 2µs-1S/cm, delay.
f. Internal calibrator 5mA, dc.
g. Also sweep delay.
h. Split screen storage scope with variable viewing time.
i. Plug-ins available for dual trace, differential, sampling and spectrum analyzers, see appropriate plug-in section.
j. Internal calibrator 10 mA.
k. Dual beam.
m. Internal calibrator 40 mA.
n. High writing scope.
p. Militarized.

IT'S A WINNER!

VERSAWATT



VERSAWATT is RCA's plastic unit on a solid-copper base which displays brute power dissipation capability—up to 50 watts in the transistor line; power handling capability up to 10 kW in thyristors. It is rugged. It has "volumetric" efficiency. It has compactness—a space-saving advantage over larger, equivalent types—that makes VERSAWATT an ideal package for PC board applications where hermetic types previously were employed.

VERSAWATT means versatility in mounting possibilities. RCA offers three basic configurations (you can devise your own option to fit your needs). These configurations are for PC boards and direct plug-in for TO-66 sockets.

VERSAWATT is a plastic package offering different chips for outstanding electrical performance—in transistors, from milliamperes to several amperes. In thyristors, 120- and 240-volt line operation VERSAWATT 8-ampere triacs have low thermal resistance—better than many hermetic types. They offer a high 100 A peak surge current capability.

VERSAWATT has proven reliability, backed by data from more than three years of field testing in commercial and industrial applications. An added plus: VERSAWATT transistor units employ Hometaxial-base consfruction, the industry's best answer yet for freedom from second breakdown.

Check the charts for units packaged as VERSAWATT transistors and thyristors. There are more to come. Right now, see your local RCA Representative or your RCA Distributor for more information. For technical data on specific types, write: RCA Electronic Components, Commercial Engineering, Sec. IG11-2, Harrison, N.J. 07029.

RCA VERSAWATT Transistor Family

TYPE	V_{CER} (sus)**	h_{FE}
2N5293+ 2N5294+	75 V	30-120 @ $I_C = 0.5$ A, $V_{CE} = 4$ V
2N5295+ 2N5296+	50 V	30-120 @ $I_C = 1$ A, $V_{CE} = 4$ V
2N5297+ 2N5298+	70 V	20-80 @ $I_C = 1.5$ A, $V_{CE} = 4$ V
2N5490* 2N5491*	50 V	20-100 @ $I_C = 2.0$ A, $V_{CE} = 4$ V
2N5492* 2N5493*	65 V	20-100 @ $I_C = 2.5$ A, $V_{CE} = 4$ V
2N5494* 2N5495*	50 V	20-100 @ $I_C = 3$ A, $V_{CE} = 4$ V
2N5496* 2N5497*	80 V	20-100 @ $I_C = 3.5$ A, $V_{CE} = 4$ V

+$\theta_{J\text{-}C} = 3.5$°C/W max. *$\theta_{J\text{-}C} = 2.5$°C/W max. **$R_{BE} = 100$ ohms

RCA VERSAWATT Triac Family

		I_{GT}	
	V_{DROM}	I+, III− modes	I−, III+ modes
40668	200 V	25 mA max.	60 mA max.
40669	400 V	25 mA max.	60 mA max.

$\theta_{J\text{-}C} = 2.2$°C/W max.

RCA

INFORMATION RETRIEVAL NUMBER 620

Vertical Amplifiers (dual trace) 14

	Manufacturer	Model	FREQUENCY dc to MHz	Resp. dB	SENSITIVITY Max. mV/cm	Min. V/cm	Input Impedance MΩ (pF)	Common Mode Rej.	Misc. Features	Main Frames for Plug-In	Price Approx $
S22	HP	1401A	0.45	3	1	25	1(45)	40dB		140, 141, 143 Series	450
	Tektronix	3A3	0.5	3	0.1	10	1(47)	c		561B, 564B, 565	950
			0.005	3							
	HP	1408A	0.5	3	0.1	50	1(45)	100		140, 141, 143 Series	575
	Tektronix	3A72	0.65	3	10	20	1(47)	n/a		561B, 564B, 565	310
	HP	1405A	5	3	5	25	1(43)	40dB		140, 141, 143 Series	350
	Tektronix	3A6	10	3	10	10	1(47)	n/a		561B, 564B, 565	550
	Gen-Atro	DT 106	10	3	50/div	20/div	1(30)	n/a		K 106	ina
	Gen-Atro	DT-415	15	3	10/div	20/div	1(30)	n/a		GA 415	ina
	Xetex	OS2002Y	20	3	1	20	1(35)	80dB		OS2000	220
	HP	1402A	20	3	5	25	1(43)	40dB		140, 141, 143 Series	575
S23	Dumont	76-02A	25	3	5	10	1(40)	n/a		765, 766, 767 Series	595
	Data	1Y2	50	3	10	20	1(35)	ina		1700	331
	Tektronix	1A1	50	3	5	20	1(15)	n/a	b	530, 540, 550, 580 Series	650
	HP	1801A	50	3	5	50	1(25)	A-B, 40dB		180, 181, 183 Series	695
	Tektronix	1A2	50	3	50	20	1(15)	20:1	b	530, 540, 550, 580 Series	360
	Dumont	76-08	50	3	5	20	1(23)	n/a		765, 766, 767 Series	790
	Tektronix	7A12	75	3	5	5	1(24)	n/a		7704, 7504	700
			105	3							
	Tektronix	82	80	3	100	50	1(15)	n/a		580 Series	765
			75	3	10	5					
	Tektronix	7A12	105	3	5	5	1(24)	n/a		7704, 7504	700
			75	3							
	Dumont	95-71	100	3	20	40	1(14)	n/a		957 Series, 777/105	1025
S24	HP	1802A	100	3	10	2.5	50Ω	a-b, 40dB	a	180, 181, 183 Series	1200
	Dumont	79-02A	100	3	10	20	1(14)	n/a		765, 766, 767 Series	1015
	Tektronix	10A2A	100	3	10	20	1(20)	n/a		647A/R647A	885
	HP	1830A	250	3	10	2.5	50Ω	n/a	a	183A, 183B	850

Vertical Amplifiers (four trace) 15

	Manufacturer	Model	FREQUENCY dc to MHz	Resp. dB	SENSITIVITY Max. mV/cm	Min. V/cm	Input Impedance MΩ (pF)	Common Mode Rej.	Misc. Features	Main Frames for Plug-In	Price Approx $
S25	Tektronix	3A74	2	3	20	10	1(47)	n/a		561B, 564B, 565	695
	HP	1404A	15	3	10	12.5	1(30)	40dB		140, 141, 143 Series	975
	HP	1804A	50	3	20	25	1(25)	n/a		180, 181, 183 Series	1050
	Tektronix	1A4	50	3	10	20	1(20)	20:1		530, 540, 550, 580	895

a. With 1120H active probe, input impedance 100kΩ, 3pF with 10:1 divider tip shunted by 1pF; passive probes available from -50-5000Ω, 0.7pF.
b. Varies bandwidths and deflection factors available, depends on main frame used.
c. Common-mode rejection, dc-coupled 50,000:1, dc-100kHz, 1000:1 100-500kHz; ac coupled 500:1, 15Hz; 2000:1, 60Hz.
d. Various common mode rejection ratios, depends on bandwidth.
e. Also current, dc-1MHz, sensitivity 1mA-1A/cm.
f. Capacitance (input) 5.8pF, 5-50mV/div, 3.4pF, 0.1-1V/div, 2pF, 2-20V/div.
g. High frequency 3dB point, 100Hz-1MHz; low frequency 3dB point 0.1Hz-10kHz; also dc.
h. Input deflection can be more depending on vertical amplifier.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see page D6.

DOES PROCESSING YOUR TEST DATA TAKE 30 MINUTES OR 30 DAYS?

MARK II RECORDS TEST DATA ON COMPUTER-COMPATIBLE MAG TAPE TO SPEED YOUR MISSION ANALYSIS

Carry it under your arm. Anywhere. The Mark II is a complete data system including a multiplexer, analog to digital converter, programable data formater, digital clock and magnetic tape recorder. The computer-compatible tape enables you to analyze a complete mission — up to 1.2 million readings — in minutes.

Incre-Data Corporation

The Mark II incremental digital data acquisition system is 6¾" high, 7¾" wide, 13⅝" deep and weighs 29 lbs. Cartridge loading simplifies operation; computer-compatible magnetic tape speeds mission analysis. FOR INFORMATION ON MARK II contact Incre-Data Corporation, 6401 Acoma Rd., S.E., Albuquerque, New Mexico 87108. AC 505 265-9575.

INFORMATION RETRIEVAL NUMBER 621

Horizontal Amplifiers (time base) 16

	Manufacturer	Model	SWEEP SPEED Max. µs/cm	Min. s/cm	Acc. %	TRIGGER Input Defl.	Output V	Misc. Features	Main Frames for Plug-In	Price Approx $
S26	HP	1840A	0.01	0.1	±3	1 div	n/a	h	183A, 183B	550
	Tektronix	7B70	0.02	5	2-5	0.3, 1.5 div	n/a	mn	7704	600
	Xetex	OS2003X	0.04	0.2	5	2mm	n/a		OS2000	150
	Xetex	OS2005X	0.04	0.2	5	2mm	n/a	p	OS2000	495
	HP	1822A	0.05	2.5	±3	0.5, 1 div	j	hj	180, 181, 183 Series	900
	Tektronix	7B50	0.05	5	2-5	0.3, 1.5 div	n/a	mn	7504	450
	HP	1820B	0.05	5	±3	0.5, 1 div	n/a	h	180, 181, 183 Series	525
	HP	1820A	0.05	5	±3	0.5, 1 div	n/a	h	180, 181, 183 Series	475
	Dumont	74-03A	0.05	2	3	0.3mm	n/a		765, 766, 767 Series	535
	Tektronix	11B1	0.1	2	-6 to +4	2mm-1cm	n/a	m	647A	765
S27	HP	1821A	0.1	2.5	±3	0.5, 1 div	i	hi	180, 181, 183 Series	800
	HP	1421A	0.2	2.5	±3	0.5 div	j	hj	140, 141, 143 Series	675
	Data	1X2	0.2	0.2	5	0.2	ina		1700	482
	Data	1X1	0.2	2	5	0.2 div	ina		1700	292
	Tektronix	3B4	0.2	2	3	1 div	n/a		561B, 564B	475
			n/a	5	5					
	Tektronix	T	0.2	2	3	0.2-10v	n/a		536	300
	HP	1423A	0.2	12.5	±3	0.5 div	n/a	h	140, 141, 143 Series	490
	Data	1X6	0.5	0.2	5	0.2 div	ina		1700	214
	HP	1420A	0.5	12.5	±3	0.5 div	n/a	h	140, 141, 143 Series	375
	Tektronix	2B67	1	5	3	0.4cm	n/a	k	561B, 564B	235
S28	HP	1422A	1	12.5	±3	0.5 div	n/a	h	140, 141, 143 Series	250
	Dumont	74-14	1	2	3	0.5mm	n/a		765, 766, 767 Series	325

Horizontal Amplifiers (delay) 17

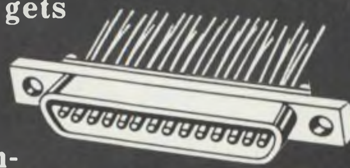
	Manufacturer	Model	DELAY TIME Min. µs	Max. s	Acc. %	SWEEP SPEED Max. µs/cm	Min. s/cm	Acc. %	Jitter parts	Input Defl.	Output V	Misc. Features	Main Frames for Plug-In	Price Approx $
S29	HP	1822A	0.05	10	±1	0.05	0.05	±3	1/ 20,000	r	1	rt	180, 181, 183 Series	900
	Tektronix	3B5	0.1 0.02s	0.1 0.05	3 5	0.01 0.1 2s	0.05µs 1 5	5 3 5	n/a	0.5, 2 div	n/a		561B, 564B	1075
	HP	1821A	0.1	10	±1	0.1	0.125	±3	1/ 20,000	r	1.5	qr	180, 181, 183 Series	800
	Dumont	74-13A	0.25	20	1	0.1	2	3	1/ 20,000	0.5mm	n/a		765, 766, 767 Series	875
	Dumont	74-17A	0.25	20	1	0.05	2	3	1/ 20,000	0.3mm	n/a		765, 766, 767 Series	995
	HP	1421A	0.5	10	±1	0.2	0.125	±3	1/ 20,000	n/a	+4		140, 141, 143 Series	675
	Tektronix	3B3	0.5	10	1	0.5	1	3	1/ 20,000	0.4, 1 div	n/a		561B, 564B	680
	Tektronix	7B51	1 1	5 50	1 2	0.05	5	2-5	1/ 50,000	0.3, 1 div	n/a	mn	7504	510
	Tektronix	7B11	1 1	5 50	1 2	0.02	5	2-5	1/ 50,000	0.3, 1 div	n/a	mn	7704	685
	Tektronix	11B2A	1	50	-6 to +4	0.1	5	-6 to +4	1/ 20,000	3mm-2cm	n/a	m	647A	970
S30	Data	1X2	10	0.5	5	10	0.01	5	ina	0.2 div	ina		1700	482

i. Also delay plug-in, 0.1µs-10s, see delay plug-ins for specs.
j. Also delay plug-in, 0.05µs-10s, see delay plug-ins for specs.
k. Internal, 0.5V at dc increasing to 2V at 2MHz external.
m. Accuracy depends on time base and ambient temperature.
n. Trigger input deflection can be 0.3 or 1.5 div depending on bandwidth.
p. Also variable delay.
q. Also time base plug-in 0.1µs-2.5s/cm, see time base plug-in for specs.
r. After selected delay.
s. Also time base plug-in 0.2µs-2.5s/cm, see time base plug-in for specs.
t. Also time base plug-in 0.05-2.5s/cm, see time base plug-in for specs.

Manufacturers and model numbers, see page D56.

Reader service numbers for literature and application notes, see page D6.

We just got a good idea. We put metal shells on our Micro/Con D series rack-and-panel connectors. They're for when you put a connector in one of those unprotected places and it gets banged around a lot.



One side is stainless steel. One side is die-cast aluminum. And the big thing is, it's the first metal shell connector that will mate with any existing version. Interchangeable. Intermountable. You can use them with old and new equipment alike.

Our new shell comes in all the standard pin sizes (9, 15, 21, 25, 31, 37, 51) and we've even got them on our flat cable connectors. If this excites you at all, maybe you'll enter our contest. Think of a new application for our new metal shell connectors, send it to us, and you'll have a chance at winning a case of scotch. And even if you don't win, we'll send you a genuine certificate recognizing your dumb idea.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California 91030.

MICRODOT INC.

	Manufacturer	Model	Frequency Minimum Hz	Frequency Maximum MHz	Frequency Accuracy %	Voltage Sensitivity dBm(µV)	Voltage Sensitivity Minimum V	Voltage Sensitivity Maximum mV	Sweep Accuracy %	Sweep Width kHz	Sweep Rate Hz	Sweep Input Impedance kΩ	Misc. Features	Type C-Cab. R-Rack P-Port.	Price Approx $
	N. Ross	PSA-016	0.5	0.002	5	n/a	n/a	2/cm	1 dB	0.01-0.6	10-120	1000	ab	Plug-in	950
	N. Ross	PSA-026	0.5	0.002	5	n/a	n/a	2/cm	1 dB	0.01-0.6	10-120	1000	ac	Plug-in	1100
	N. Ross	PSA-036	0.5	0.002	5	n/a	n/a	2/cm	1 dB	0.01-0.6	10-120	1000	ad	Plug-in	1100
	N. Ross	PSA-011	10	0.02	10	n/a	n/a	85µV/cm	1 dB	0.1-6	10-50	1000	ab	Plug-in	650
A11	N. Ross	PSA-021	10	0.02	10	(10)	n/a	85µV/cm	1 dB	0.1-6	10-50	1000	ac	Plug-in	800
	N. Ross	PSA-031	10	0.02	10	(10)	n/a	85µV/cm	1 dB	0.1-6	10-50	1000		Plug-in	800
	N. Ross	PSA-032	35	0.1	10	(10)	n/a	85µV/cm	1 dB	0.5-30	10-50	1000	ad	Plug-in	800
	N. Ross	PSA-022	35	0.1	10	(10)	n/a	85µV/cm	1 dB	0.5-30	10-50	1000	ac	Plug-in	800
	N. Ross	PSA-012	35	0.1	10	(10)	n/a	85µV/cm	1 dB	0.5-30	10-50	1000	ab	Plug-in	650
	N. Ross	PSA-013	150	0.5	10	(10)	n/a	85µV/cm	1 dB	2.5-150	5-50	1000	ab	Plug-in	650
	N. Ross	PSA-023	150	0.5	10	(10)	n/a	85µV/cm	1 dB	2.5-150	5-50	1000	ac	Plug-in	800
	N. Ross	PSA-033	150	0.5	10	(10)	n/a	85µV/cm	1 dB	2.5-150	5-50	1000	ad	Plug-in	800
	Tektronix	IL5	10	1	±15	(5)	2/cm	10µV/cm	3	10Hz-1MHz	ina	0.05	klm	Plug-in	1025
	Tektronix	3L5	50	1	±5	(5)	2/cm	0.01/cm	3	0.01-100	ina	ina	lq	Plug-in	1125
A12	N. Ross	PSA-014	1000	2	10	(10)	n/a	85µV/cm	1 dB	10-600	5-50	1000	ab	Plug-in	850
	N. Ross	PSA-024	1000	2	10	(10)	n/a	85µV/cm	1 dB	10-600	5-50	1000	ac	Plug-in	1000
	N. Ross	PSA-034	1000	2	10	(10)	n/a	85µV/cm	1 dB	10-600	5-50	1000	ad	Plug-in	1000
	N. Ross	PSA-205	1000	25	5	-90	n/a	n/a	1 dB	0-25,000	5-20/s	0.05, 0.075	ab	Plug-in	1400
	N. Ross	PSA-235	1000	25	5	-90	n/a	n/a	1 dB	0-25,000	5-20/s	0.05, 0.075		Plug-in	1500
	N. Ross	PSA-225	1000	25	5	-90	n/a	n/a	1 dB	0-25,000	5-20/s	0.05, 0.075	ac	Plug-in	1500
	N. Ross	PSA-235	1000	25	5	-90	n/a	n/a	1 dB	0-25,000	5-20/s	0.05, 0.075	ad	Plug-in	1500
	Tektronix	IL10	1 MHz	36	±100 kHz	-100	n/a	n/a	3	ina	ina	0.05, 0.6	mn	Plug-in	1175
	N. Ross	PSA-201	600,000	108	5	-106	n/a	n/a	1 dB	0-100	10-50/s	0.05	ab	Plug-in	1600
	N. Ross	PSA-221	600,000	108	5	-106	n/a	n/a	1 dB	0-100	10-50/s	0.05	ac	Plug-in	2060
A13	N. Ross	PSA-231	600,000	108	5	-106	n/a	n/a	1 dB	0-100	10-50/s	0.05	ad	Plug-in	1700
	HP	8553L/8552A	1000	110	±1 MHz	-130(10.07)	0.8	0.07µV	±0.5 dB	0-100,000	1ms-100s	0.05	aij	C, R	4725
	N. Ross	PSA-311	1 MHz	300	5	-90	n/a	n/a	±2 dB	0-300 MHz	1-30/s	0.05	ab	Plug-in	1300
	N. Ross	PSA-321	1 MHz	300	5	-90	n/a	n/a	±2 dB	0-300 MHz	1-30/s	0.05	ac	Plug-in	1400
	N. Ross	PSA-331	1 MHz	300	5	-90	n/a	n/a	±2 dB	0-300,000	1-30/s	0.05	ad	Plug-in	1400
	N. Ross	CATV	1 MHz	300	±5	-90	n/a	0.006	2 dB	0-300,000	1-30	0.075		Plug-in	1500
	HP	8554L/8552A	500,000	1250	±10 MHz	-117(0.5)	0.8	0.5µV	±1 dB	0-1250 MHz	1ms-100s	0.05	agh	C, R	6075
	Tektronix	IL20	10 MHz	4200	±2MHz	-110	n/a	n/a	ina	1-10 MHz	ina	0.05	mno	Plug-in	1950
	N. Ross	PSA-511	10 MHz	4500	5	-90	n/a	0.006	3 dB	0-1 GHz	1-60	0.05	bf	Plug-in	1900
	N. Ross	PSA-531	10 MHz	4500	5	-90	n/a	0.006	3 dB	0-1 GHz	1-60	0.05	df	Plug-in	2000
A14	Tektronix	IL30	925 MHz	10,500	±2 MHz	-110	n/a	n/a	ina	1-10 MHz	ina	0.05	mno	Plug-in	1950
	N. Ross	PSA-530A	10 MHz	15,000	±5 MHz	-95	n/a	0.004	±1 dB	0-1 GHz	1-60	0.05	de	Plug-in	1350
	N. Ross	PSA-510A	10 MHz	15,000	±5 MHz	-95	n/a	0.004	±1 dB	0-1 GHz	1-60	0.05	be	Plug-in	1250
	Tektronix	3L10	1 MHz	36,000	±100 kHz	-100	n/a	n/a	ina	ina	ina	0.05, 0.6	nq	Plug-in	1275
	Tektronix	IL40	1500	40,000	±2 MHz	-110	n/a	n/a	ina	1-10 MHz	ina	0.05	mnp	Plug-in	2150

a. Sweeps/second.
b. Plug-in fits Tektronix letter series oscilloscopes.
c. Plug-in fits Tektronix 560 series oscilloscopes.
d. Plug-in fits Hewlett-Packard 140A/141A oscilloscope.
e. On fundamental low range (sensitivity).
f. Sensitivity to 1.5 GHz.
g. 8554L is rf section, 8552A is i-f section. These fit into 140S, 141S and 143S oscilloscopes.
h. Sensitivity at 300 Hz BW.
i. 8553L is rf section, 8552A is i-f section. These fit into 140S, 141S and 143S oscilloscopes.
j. Sensitivity at 100 Hz BW.
k. Accuracy from 10-990 kHz, ±10%, 50-9900 Hz.
l. Voltage accuracy from 1mV/cm-2V/cm, 6%, 10-500µV/cm.
m. Fits 530, 540, 550 or 580 series oscilloscopes.
n. Frequency accuracy +1% of dial reading.
o. Sensitivity, 1 kHz resolution, varies from -110 to -90 dBm depending on frequency; 100 kHz resolution - varies from -90 to -50 dBm depending on frequency.
p. Sensitivity, 1 kHz resolution - varies from -110 to -70 dBm depending on frequency; 100 kHz resolution - varies from -90 to -70 dBm depending on frequency. Waveguide mixer and adapter required beyond 12.4 GHz.
q. Fits 561B and 564B oscilloscopes.

Manufacturers and model numbers, see page D57.

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measure resistance on linear scales from ohms to teraohms

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One easy-to-use Keithley electrometer allows fast, accurate measurements in lab, production and quality control. One like our line-operated 610C that makes more dc measurements over broader ranges than any other multimeter. For only $615. Or one like our 602 model. It's battery-powered and only $695. Both offer stabilities better than 1 millivolt per 24 hours.

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Or, contact us direct. Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139. Europe: 14 Ave. Villardin, 1009 Pully, Suisse. Prices slightly higher outside the U.S.A. and Canada.

KEITHLEY

INFORMATION RETRIEVAL NUMBER 623

Index by Model Number (Oscilloscopes)

Name	Model	Code
Allied	KG-635	S7
Allied Radio Corp.		
Aul	055	S6
Aul Inc.		
Binary	5Mc2P	S6
Binary Electronics		
Data	1X1	S27
Data Inst. Div.	1X2	S30
	1X2	S27
	1X6	S27
	1Y1	S20
	1Y2	S23
	1Y7	S19
	536A	S5
	539	S5
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	76-08	S23
	79-02A	S24
	95-71	S23
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	704A	S3
	708A	S2
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	765MH	S15
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	564B/3S2/3T2/S-2	S11
	564B/3S2/3T2/S-4	S12
	564B/3S2/3T2/S-5	S10
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Waterman Waterman Inst. Corp.	OCA-11A	S1
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	OCA-12A	S1
Xetex Xetex Marconi Inst.	OS15A	S5
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Spectrum Analyzers

plug-in

Name	Model	Code
HP Hewlett-Packard Co.	8553L/8552A	A13
	8554L/8552A	A14
N. Ross Polarad/Nelson Ross	CATV	A13
	PSA-011	A11
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dc voltage standards

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ACCURACY

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Model 351 0.003% Accuracy

BETTER
Model 353 0.002% Accuracy

BEST
Model 355 0.001% Accuracy

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INFORMATION RETRIEVAL NUMBER 625

	Manufacturer	Model	Frequency: Minimum Hz	Frequency: Maximum MHz	Frequency: Accuracy %	Voltage Sensitivity: dBm(µV)	Voltage Sensitivity: Minimum V	Voltage Sensitivity: Maximum mV	Voltage Sensitivity: Accuracy %	Sweep: Width	Sweep: Rate	Input Impedance kΩ	Misc. Features	Type C-Cab. R-Rack P-Port.	Price Approx $
A1	Quan-Tech	304	1	0.005	±0.05	n/a	100	0.03	±5	50Hz-5	r	100	kq	C, R	2700
	Probescope	SS-5	1	0.0053	2	ina	500	0.5	±1 dB	0.02-0.6	1-30	1000		C, R	2750
	Fed-Sci	UA-7/64A	0.032	0.008	±0.2	n/a	100	2	±1 dB	to 8	25ms	50		C, R	40,000
	Spectral	SD301	0.03	0.01	1/2	n/a	10	100	1 dB	10	20	100		R	17,500
	Spectran	100-1.3	3	0.015	ina	(250)	n/a	n/a	n/a	0.1	20	0.05		C, R	12,800
	Spectran	480-3.6	8	0.016	ina	(250)	n/a	n/a	n/a	1.44	40	0.05		C, R	18,700
	Fed-Sci	UA-9	0.01	0.02	0.02	n/a	100	2	±1 dB	20	50ms	100		C, R	30,000
	Spectral	SD301-1	0.03	0.02	1/2	n/a	10	100	1 dB	20	40	100		R	18,750
	B&K	2107-A	20	0.02	±0.3 dB	n/a	1000	0.01	2	6-29%	n/a	0.0022		C, R	1680
	Probescope	SS-20	6	0.023	2	ina	500	0.5	±1 dB	0.04-6	2	250		C, R	1875
A2	Probescope	SS-20L	20	0.023	2	50	500	0.5	±1 dB	0.1-6	2	250	b	C, R	2100
	Singer	SY-1	5	0.025	1	n/a	500	0.5	10	20Hz-5	1 cd	250		C, R	5800
	Singer	SY-3	5	0.025	1	n/a	500	0.5	10	50Hz-5	0.1, 1	ina	b	C, R	3400
	Singer	SY-4	5	0.025	1	n/a	500	0.5	10	0.2,1,5	0.1, 1	ina	e	C, R	4000
	Singer	SY-5	20	0.025	1	n/a	500	0.5	10	0.2,1,5	1	ina	b	C, R	3200
	Singer	LP-1aZM	20	0.025	1	n/a	500	0.5	10%	0.2,1,5	1	250	e	C, R	2500
	Quan-Tech	2156	10	0.03	±5	n/a	100µV fs	300V	±5 fs	n/a	n/a	100, 0.001	q	C	2375
	Muirhead	K-134-A	3	0.0316	±0.5	0-110 dB	300	1	±1 dB	ina	n/a	100		C	1055
	Singer	MF-5/AL-2	20	0.035	1±50Hz	(30 fs)	300	3	10	0.2, 1, 5, 20	1	100		C, R	3000
	Fed-Sci	UA-6A	0.002	0.04	0.2	n/a	30	2	±1 dB	10Hz-40	50ms	100		C, R	19,000
A3	Tracor	814A	0.1	0.04	2	n/a	10	0.3	10	n/a	n/a	100		C, R	2600
	B&K	2112-A	25	0.04	±0.3 dB	n/a	1000	0.01	2	1/3oct	n/a	0.00222		C, R	2495
	Probescope	SS-50S	0	0.05	2	ina	500	0.5	±1 dB	0.5-50	1	55		C, R	3335
	Spectral	SD101B	2	0.05	1/2	n/a	10	31.6	1	0.002-50	s	100	t	R	4000
	Systron	710/800	10	0.05	±1	n/a	3/cm	0.03/cm	ina	10Hz-5	u	0.05-0.001	kv	C	2495
	Systron	710/801	10	0.05	±1	-140	3	0.03	±10	50	3ms/cm	0.05-0.001	bvw	C, R	3250
	Quan-Tech	305	10	0.05	±0.5	ina	300	0.03	±5	500Hz-50	p	1000	kq	C, R	2800
	Probescope	VA-50	60	0.05	2	(50)	500	0.05	±1 dB	0.05-50	1	55	h	C, R	3570
	Spectran	480-5	10	0.06	ina	(250)	n/a	n/a	n/a	2	40	0.05		C, R	17,250
	Spectran	480-10	20	0.075	ina	(250)	n/a	n/a	n/a	4	40	0.05		C, R	16,900
A4	Spectran	480-12	24	0.075	ina	(250)	n/a	n/a	n/a	5	60	0.05		C, R	16,960
	Spectran	480-15	30	0.075	ina	(250)	n/a	n/a	n/a	6	60	0.05		C, R	16,960
	GR	1921	3.15	0.08	±2	n/a	12	5	±0.05 dB	0.00315-80	z	100		C, R	8845-9455
	Fed-Sci	UA-8AH	20	0.1	0.2	n/a	100	2	±1 dB	100	10ms	50		C, R	45,000
	Fed-Sci	UA-8A	20	0.1	0.02	n/a	100	2	±1 dB	100	50ms	50		C, R	35,000
	Quan-Tech	303	30	0.1	±5	n/a	300	0.1	±5	n/a	n/a	100,1000	q	C	1700
	Spectran	480-25	50	0.1	ina	(250)	n/a	n/a	n/a	10	60	0.05		C, R	16,960
	Probescope	SS-100	13.5	0.11	2	(50)	500	0.5	±1	0.2-20	1	55		C, R	1840
	Spectran	240-50	100	0.11	ina	(250)	n/a	n/a	n/a	10	240	0.05		C, R	12,600
	Spectran	100-50	100	0.11	ina	(250)	n/a	n/a	n/a	4	60	0.05		C, R	8510
A5	Spectran	480-50	100	0.11	ina	(250)	n/a	n/a	n/a	20	120	0.05		C, R	17,250
	Spectran	40-50	100	0.11	ina	(250)	n/a	n/a	n/a	1.6	60	0.05		C	6800
	Probescope	TA-100	350	0.12	2	(50)	500	0.5	±1 dB	preset	1	55	b	C, R	2225
	Probescope	LL-120	12	0.13	2	(50)	500	0.5	±1 dB	0.01-120	1	55		C, R	3950
	Probescope	TA-120L	13	0.13	2	ina	500	0.5	±1 dB	0.1-22	1	55		C, R	1900
	Spectran	480-100	200	0.16	ina	(250)	n/a	n/a	n/a	40	120	0.05		C, R	18,900
	Spectran	40-100	200	0.16	ina	(250)	n/a	n/a	n/a	3.2	120	0.05		C	7000
	Spectran	100-100	200	0.16	ina	(250)	n/a	n/a	n/a	8	120	0.05		C, R	8930
	Spectran	240-100	200	0.16	ina	(250)	n/a	n/a	n/a	20	240	0.05		C, R	13,400
	Quan-Tech	2223	10	0.2	±5	n/a	300	0.1	5	n/a	n/a	30	q	C	3525
A6	Spectran	240-125	250	0.2	ina	(250)	n/a	n/a	n/a	25	240	0.05		C, R	13,700
	Spectran	100-125	250	0.2	ina	(250)	n/a	n/a	n/a	10	120	0.05		C, R	9070
	Spectran	480-125	250	0.2	ina	(250)	n/a	n/a	n/a	50	120	0.05		C, R	19,600
	Spectran	40-125	250	0.2	ina	(250)	n/a	n/a	n/a	4	120	0.05		C	7060
	Probescope	TA-165L	350	0.215	2	50	500	0.5	±1 dB	preset	1	55	b	C, R	2325
	Probescope	TA-190L	20	0.24	2	(50)	500	0.5	±1 dB	0.1-50	1	55		C, R	1875
	Probescope	LL-191B	20	0.24	2	(50)	500	0.5	±1 dB	0.01-215	1	55		C, R	3550
	Probescope	UTA-215	20	0.24	2	50	500	0.5	±1 dB	log	ina	ina	i	C	4350
	Probescope	LCA-1	50	0.6	2	ina	200	0.2	±1	1-200	0.3-60	55		C, R	2125
	Singer	MF-5/UR-3	100	0.7	±1 kHz	(30 fs)	300	0.003	ina	1-400	1-60	100		C, R	3250

ACTUAL SIZE

we have quite a thing for systems design, our benrus CRT DISPLAY, for one

spedcor Lavoie Analab Benrus INSTRUMENT DIVISION

Match your systems design installation with a CRT Display custom-ordered to the most narrow specifications ☐ The Benrus concept is simple. You determine the bandwidth and sensitivity required—as far as 1 mv div and up to 25 MHz. Then select a unit to your rack dimensions and choose from a virtually endless range of channel amplifier combinations. Add any number of available options, such as sweeps, heat dissipators, screwdriver controls ☐ The result? A system designer's dream ... the disappearance of Installation Frustration through unequalled versatility. Catalog 802 lists 3110 variations.

... and a few others for that matter.

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The LA-40A Spectrum Analyzer offers systems designers a wide range of unique advantages ... such as dynamic range exceeding 70 db; simplified, single tuning control; 10 cps resolution; sweep rates and resolution automatically optimized for calibrated spectrum widths of 0.5 Kc. to 100 Kc.

spedcor electronics, inc.
Lavoie Analab Benrus Instrument Division
70-31 84TH ST., GLENDALE, NEW YORK 11227 212-894-8100

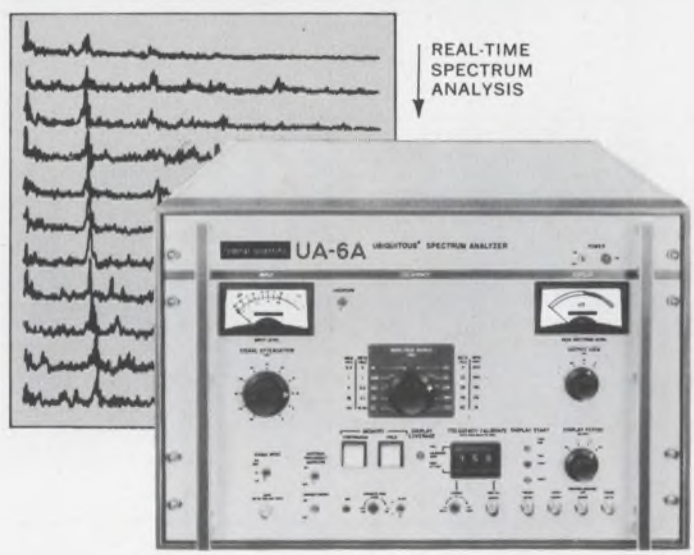
INFORMATION RETRIEVAL NUMBER 626

			Frequency			Voltage Sensitivity				Sweep				Type	
	Manufacturer	Model	Minimum Hz	Maximum MHz	Accuracy %	dBm(μV)	Minimum V	Maximum mV	Accuracy %	Width	Rate	Input Impedance kΩ	Misc. Features	C-Cab. R-Rack P-Port.	Price Approx $
A7	Singer	MF-5/ TI-7	100	1.3	1	(30)	300	3	n/a	0.5-1300	1, 2, 5, 10	0.05		R	4500
	Kay	7030A	1	1.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	.02, .06, 10	a	C, R	4445
	Kay	7029A	5	1.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	.02, .06, 10	a	C, R	3950
	Kay	6061-B	85	1.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	.02, .06, 10	a	C, R	3130
	Quan-Tech	304TD	1	5	.01	ina	300 fs	0.03	±5	50Hz-5	m	1000	kmx	C, R	3575
	Singer	SPA-3000	10MHz	10	1	-105	n/a	n/a	n/a	10k-3GHz	0.1-60	0.05		C, R	10,000
	Siemens	M704	30	25	1 ppm	120	n/a	n/a	±0.1	25Hz-12.5	0.01-25	0.001		C, R	req.
	Siemens	M706	30	25	1 ppm	120	n/a	n/a	±0.1	25Hz-12.5	0.01-25	0.001		C, R	req.
	Siemens	M703	30	25	1 ppm	120	n/a	n/a	±0.1	25Hz-12.5	0.01-25	0.001		C, R	req.
	Siemens	M701	30	25	1 ppm	120	n/a	n/a	±0.1	±25Hz-12.5	0.01-25	0.001		C, R	req.
A8	Siemens	K2021	30	25	1 ppm	120	n/a	n/a	±0.1	25Hz-12.5	.01-25	0.001		C, R	req.
	Singer	MF-5/ VR-4B	1000	27.5	5	(3)	3	.003	n/a	0.5-5MHz	1-60	0.05, 0.075		C, R	4250
	Singer	SSB-50	10	40	1	(20 fs)	3	0.002	n/a	150Hz-100	0.1-30	0.05, 0.6		C, R	6400
	Singer	SSB-50-1	10	40	1	(5 fs)	3	0.5	n/a	150Hz-100	0.1-30	0.05, 0.6		C, R	6900
	Spedcor	LA-40A	2 MHz	135	ina	n/a	.001	2000	ina	0.5-100	45/s	ina		C, R	req.
	E/D	DU-501/ TU-VLA501	100MHz	1000	ina	-63 to -97	n/a	n/a	ina	1200 MHz	20-70	0.05		C	5675
	E/D	PN1010A	100MHz	1000	ina	-63 to -97	n/a	n/a	ina	1GHz	20-70	0.05		R	2895
	E/D	DU-501/ TU-VLB501	100MHz	1800	ina	-45 to -90	n/a	n/a	ina	1700 MHz	20-70	0.05		C	6176
	E/D	PN1012	500MHz	5000	ina	-42 to -56	n/a	n/a	ina	4.5GHz	20-70	0.05		R	2195
	Systron	751	10MHz	6500	ina	-110 to -75	n/a	n/a	n/a	100-0.5	u	ina	k	C	3950
A9	E/D	DU-501/ TU-LX501	1000MHz	12,400	ina	-45 to -58	n/a	n/a	ina	11.4 MHz	20-70	0.05		C	4675
	E/D	PN1011	1000MHz	12,400	ina	-45 to -58	n/a	n/a	ina	11.4 GHz	20-70	0.05		R	1995
	EIP	101B	1000MHz	18,000	0.5	-45	-45dBm	+10dBm	±1 dB	1-18 GHz	1-30	0.05		C	2895
	E/D	DU-501/ TU-LK501	1800MHz	25,000	ina	-40 to -58	n/a	n/a	ina	23 GHz	20-70	0.05		C	5275
	E/D	PN1013	1800MHz	25,000	ina	-40 to -58	n/a	n/a	ina	23 GHz	20-70	0.05		R	2795
	Tektronix	491	10MHz	40,000	±2MHz	-110 to -70	n/a	n/a	n/a	10k-100M	x	0.05	kq	C	4895
	Singer	SPA-100	10MHz	40,000	1	-105	n/a	n/a	n/a	10k-100MHz	01-60	0.05		C	5000
	HP	8551B/ 851B	10.1MHz	40,000	1	-100 to -65	n/a	n/a	n/a	0-2GHz	30ms-10s	0.05	dn	C, R	10,425
	Singer	SPA-100A	940MHz	40,000	1	-105	n/a	n/a	n/a	10k-100MHz	01-60	0.05		C, R	5100
	E/D	DU-501/ TU-XQ501	10GHz	40,000	ina	-30 to -40	n/a	n/a	ina	30,000	10-35	0.05		C	5675
A10	E/D	PN1014	10GHz	40,000	ina	-30 to -40	n/a	n/a	ina	30GHz	10-35	0.05		R	2995
	Aul	84A	10MHz	63,000	1	-110	n/a	n/a	n/a	100k-10M	0.1-33	.050		C, R	6300
	Polarad	SA84WA	10MHz	63,700	1	-115	n/a	n/a	2 dB	0-100 MHz	1-30	0.05		C, R	6500
	Polarad	2400	10MHz	90,000	ina	-105-70	ina	ina	2 dB	0-500 MHz	0.1-33	0.05		C, R	3000
	Polarad	2650	10MHz	90,000	1	-100	n/a	0.002	2 dB	0.2GHz	0.1-33	0.05		C, R	9500

a. Recording spectrum analyzer.
b. Also logarithmic sweep.
c. To one scan/16 minutes.
d. Sweep/second.
e. Also 40 Hz-20 kHz log sweep.
f. Also 20 Hz-25 kHz log sweep.
g. Also 350 Hz-250 kHz log sweep.
h. Internal markers at 60 Hz, 500 Hz, 5 kHz and 50 kHz.
i. Linear sweep 4 and 8 channel 0.1-50 kHz; log sweep 12.5-187.5 kHz.
j. Covers all channels under both constant and proportional bandwidth IRIG standards.
k. Sweep width selectable.
m. Sweep rate 5-5000 seconds.
n. 8551B is rf section, 851B and 852B are alternate display sections.
p. Sweep rate 0.5-500 seconds.
q. Rackmount extra.
r. Sweep rate 18, 180, 1800 seconds.
s. Function of bandwidth in use.
t. Sweep oscillator at extra cost.
u. Sweep rate 3 ms/cm-10 sec/cm.
v. Battery operated.
w. Solid state.
x. 10μs/div-0.5 sec/div.
y. Sensitivity -40 dBm 12.4-18 GHz.
z. Sweep rate: Integration time 1/8, 1/4, 1/2, 1, 2, 4, 8, 16, 32 sec.

Index by Model Number

Son of Ubiquitous®



Precision Real-Time Spectrum Analyzer

The finest most accurate real-time SPECTRUM ANALYZER for every job . . . new wider coverage to 40 kHz . . . built-in expansion capability.

Newest of our analyzers employing digital time-compression to perform 500-point analysis of a signal completely as it occurs. For underwater acoustic signals, radar doppler, speech, noise and vibration data. Much faster than digital computers using fast-Fourier transforms. Is smaller, less expensive, easier to use, with complete input signal conditioning.

Features: 10 ranges from 0-10 Hz to 0-40 kHz with a choice of bandwidths from 0.02 Hz to 80 Hz to match the signal dynamics (optional range translation). Precision frequency calibration with a digital marker, stable and accurate to better than one resolution element (0.2% FS) over every frequency range. Spectrum tracking for signature analysis of rotating machinery. Built-in test signals for complete system calibration, setup and recordings. Flexible power spectral density analysis with the companion dual-memory digital averager. Built-in expansion capability to add correlation, cross-PSD, and system transfer function at any time . . . the UA-6A cannot become obsolete.

Write for detailed specifications . . . also technical papers on correlation and PSD-calibration. Federal Scientific Corporation, Originators of the Ubiquitous® Spectrum Analyzer, subsidiary of ©Elgin National Industries, Inc., 615 W. 131st St., N.Y., N.Y. 10027. Tel: (212) 286-4400.

federal scientific

INFORMATION RETRIEVAL NUMBER 627

Vacuum-Tube Voltmeters (dc)

	Manufacturer	Model	Volts: Minimum mV	Volts: Maximum V	Volts: Ranges No.	Meter: Scale	Meter: Calibration	Amplifier	Ohms: Minimum	Ohms: Maximum	Type C-Cab. R-Rack	Misc. Features	Price Approx $
V1	Keithley	149	100nV	0.1	13	lin	V, 0-ctr	yes	n/a	n/a	C, R	t	925
	Keithley	147	100nV	0.1	16	lin	V, 0-ctr	yes	n/a	n/a	C, R	dt	1395
	Keithley	148	100nV	0.1	18	lin	n/a	yes	n/a	n/a	P, R	dt	1395
	Keithley	150B	25μV	1	14	lin	V, 0-ctr	yes	n/a	n/a	P, R	abcdt	850
	Keithley	604	0.080	1	7	lin	V, 0-ctr	yes	n/a	n/a	C, R	abcdt	895
	HP	425A	0.01	1	11	lin	V, 0-ctr	yes	n/a	n/a	C, R	bt	550
	IB	333	0.3	1	8	lin	V, 0-ctr	yes	n/a	n/a	C, R		245
	Keithley	600B	0.4	10	7	lin	V, 0-ctr	yes	40	10T	C, R	abcdft	425
	Keithley	602	0.050	10	9	lin	V, 0-ctr	yes	100	10T	C, R	abdet	675
	Keithley	640	.002	30	13	n/a	V, 0-left	yes	n/a	n/a	C, R	bet	1875
V2	Comark	1221	.001	30	12	5 in.	100 div	yes	n/a	n/a	C, R	bt	270
	IB	300	1	30	10	lin	V, 0-ctr	yes	n/a	n/a	C	akt	185
	Medistor	A-65C	0.01	100	9	ina	3%	n/a	n/a	n/a	C, R	t	295
	Keithley	610C	0.05	100	11	lin	V, 0-ctr	yes	100	100T	C, R	adcet	585
	Keithley	621	4	100	7	lin	V, 0-ctr	yes	4K	1T	C, R	abct	425
	Comark	1201	.001	300	12	5 in.	100 div	yes	1	100M	C, R	bkt	225
	Comark	1231	1	300	24	5 in.	V, 0-ctr	yes	1	100M	C, R	abjt	280
	IB	301	1	300	12	lin	V, 0-ctr	yes	n/a	n/a	C, R	adt	245
	Trio	110-1	3	300	11	lin	V, 0-ctr	yes	n/a	n/a	R	t	200
	Measure	162	100	300	6	ina	ina	n/a	n/a	n/a	C	t	198
V3	Measure	162R	100	300	6	ina	ina	n/a	0.2	500M	C	t	230
	Trio	107-1	10	300	10	lin	V, 0-ctr	yes	n/a	n/a	R	gt	450
	Trio	305-1	1000	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	gt	225
	Trio	106-4	1000	300	6	lin	V, 0-ctr	yes	n/a	n/a	R	t	150
	Trio	106-3	1000	300	6	lin	V, 0-left	yes	n/a	n/a	R	gt	150
	Trio	106-2	1000	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	gt	140
	Trio	106-1	1000	300	1	lin	V, 0-left	yes	n/a	n/a	R	gt	140
	Trio	305-2	1000	300	1	lin	V, 0-left	yes	n/a	n/a	R	t	225
	Trio	105-1	1000	300	1	lin	V, 0-left	yes	n/a	n/a	R	t	85
	Trio	105-2	1000	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	t	85
V4	Trio	105-3	1000	300	6	lin	V, 0-left	yes	n/a	n/a	R	t	100
	Trio	105-4	1000	300	6	lin	V, 0-ctr	yes	n/a	n/a	R	t	100
	Keithley	662	0.01	500	4	lin	V, 0-ctr	yes	n/a	n/a	C, R	t	1075
	Keithley	630	0.030	500	4	lin	V, 0-ctr	yes	n/a	n/a	C, R	fit	1695
	Trio	310-1	100	500	12	lin	12	yes	n/a	n/a	R	t	250
	Medistor	A-71C	0.0001	1000	5	ina	V	n/a	n/a	n/a	C	t	1995
	Keithley	155	0.00015	1000	19	lin	V, 0-ctr	yes	n/a	n/a	C, R	adt	325
	Keithley	153	.0003	1000	17	lin	V, 0-ctr	yes	n/a	n/a	C, R	bct	575
	Medistor	A-75A	.0005	1000	5	ina	V	n/a	n/a	n/a	C	t	765
	Ballantine	365 S/2	.001	1000	9	log	V, A, dB	yes	n/a	n/a	R	bt	645
V5	Ballantine	365	.001	1000	9	log	V, A, dB	yes	n/a	n/a	C	bt	620
	Wavetek	207	.002	1000	4	lin	V, 0-ctr	n/a	n/a	n/a	C	t	1095
	HP	419A	.003	1000	18	lin	V, 0-ctr	yes	n/a	n/a	C	bt	450
	Millivac	MV-952A	0.01	1000	17	lin	V, 0-ctr	yes	n/a	n/a	C, R	abdot	695
	Millivac	MV-852A	0.01	1000	17	lin	V, 0-ctr	yes	n/a	n/a	C, R	abot	625
	Millivac	MV-07C	0.01	1000	17	lin	V, 0-ctr	yes	n/a	n/a	C, R	bot	575
	Medistor	A-60RB	0.01	1000	18	ina	V	n/a	n/a	n/a	R	t	495
	Philips	PM2436	0.01	1000	17	lin	V	yes	5K	5T	C, R	bt	595
	Boonton	95A	0.01	1000	17	lin	V, A, 0-ctr	yes	n/a	n/a	C, R	bt	600
	Millivac	MV-127B-L	0.1	1000	15	lin	V, 0-left	yes	n/a	n/a	C	at	475
V6	Philips	PM2435	0.1	1000	18	lin	V	yes	n/a	n/a	C	bt	465
	Millivac	MV-964A	0.1	1000	15	lin	V, 0-left	yes	1	100M	C, R	abdot	525
	Millivac	MV-864A	0.1	1000	15	lin	V, 0-left	yes	1	100M	C, R	abot	445
	Dynamics	504	0.1	1000	15	lin	V, 0-ctr	yes	10	100M	C, R	bt	885
	AVO	EA113	0.1	1000	22	5 in.	V, 0-ctr	yes	1	100M	C	bjt	250
	Millivac	MV-27E	0.25	1000	14	lin	V, 0-ctr	yes	n/a	n/a	C	cot	425
	Triplett	601	1	1000	11	lin	V	yes	0.2	1G	C	ajt	150
	R-S	URV	1	1000	7	lin	V, 0-left	yes	n/a	n/a	C	ajt	899
	Medistor	A-50	1	1000	22	ina	.05%	n/a	.001	11	C	t	595
	HP	413A	1	1000	13	lin	V, 0-ctr	yes	n/a	n/a	C, R	t	385

Mini·est mfds for μ spaces

or: our next series may be invisible

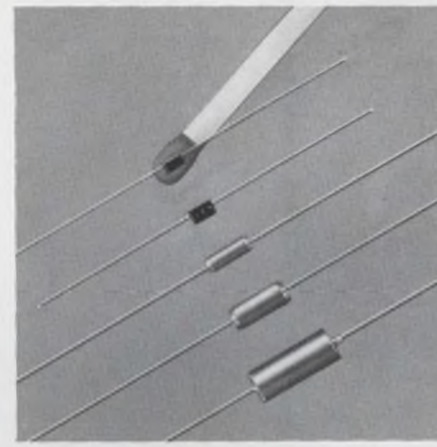
You can still see our new Minitan® W-Series tantalum capacitors . . . but just barely. These extraordinary little solid-electrolyte devices — the industry's smallest — pack up to .47 mfd. into a case about the size of a pin head.

What's more, they do it with a maximum DC leakage (at 25°C) of only 0.5μA, standard tolerances to ±5% and a 130% surge voltage rating. Gold-plated solid nickel leads and an operating temperature range of −55°C to +85°C help make this the finest series of microminiature modular capacitors available for hybrid and thick film circuit use.

Considerably smaller than comparably rated CS13 and epoxy filled devices, Minitan® W's have also out-shrunk monolithic ceramics. For example, a typical .22 mfd. ceramic measures .350 x .095 x .070; the Minitan® W case is only .100 x .050 x .040.

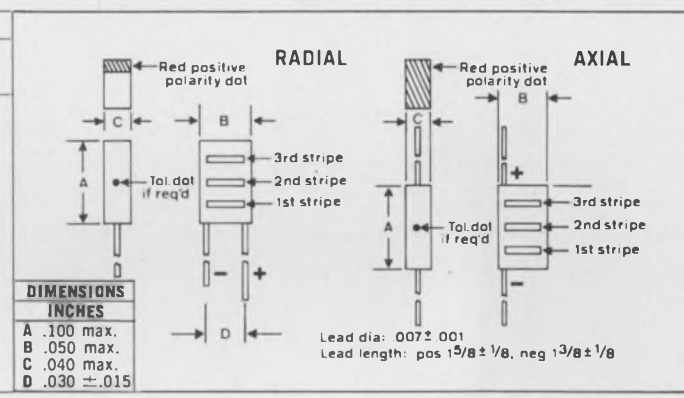
Of course, if you like capacitors you can see with scarcely a second glance, Components also has the broadest line of CS13, CSR13, CSR09, subminiature, and microminiature modular, cordwood, and non-polars around.

Send for our new general catalog and get the small picture.

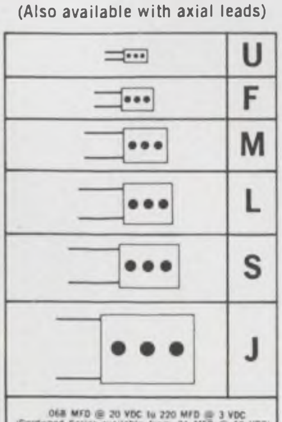


WHAT COMES AFTER MICROMINIATURE? — Looming large in comparison with C.I.'s new "W Series" capacitor (on matchhead) are the following tantalum units: Standard TR Series (CSR13), Miniature TY Series (CSR09), Subminiature Econotan (CT), and Microminiature Minitan® (U case).

W CASE SIZE			
PART NUMBER		CAP. IN MFD @ 25°C. 120 Hz	WVDC @ 85°C
AXIAL	RADIAL		
W472A	W472R	.0047	20
W682A	W682R	.0068	20
W103A	W103R	.010	20
W153A	W153R	.015	20
W223A	W223R	.022	20
W333A	W333R	.033	20
W473A	W473R	.047	20
W683A	W683R	.068	20
W104A	W104R	.10	15
W154A	W154R	.15	10
W224A	W224R	.22	6
W334A	W334R	.33	4
W474A	W474R	.47	2

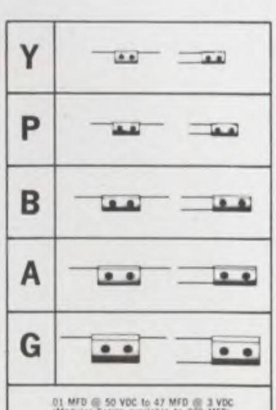


MINITAN® MODULAR
(Also available with axial leads)



(ACTUAL SIZE)

MINITAN® CORDWOOD



(ACTUAL SIZE)

COMPONENTS, INC.
CAPACITOR PRODUCTS
BIDDEFORD, MAINE 04005 - TEL: (207) 284-5956 - TWX: 710-229-1559

INFORMATION RETRIEVAL NUMBER 628

Vacuum-Tube Voltmeters (dc)

			Volts			Meter			Ohms		Type		
	Manufacturer	Model	Minimum mV	Maximum V	Ranges No.	Scale	Calibration	Amplifier	Minimum	Maximum	C-Cab. R-Rack	Misc. Features	Price Approx $
V7	HP	412A	1	1000	13	lin	V, 0-left	yes	1	100M	C	bt	450
	Measure	162	10	1000	7	ina	ina	n/a	n/a	n/a	C	jt	198
	Measure	162R	10	1000	7	ina	ina	n/a	0.2	500	C	jt	230
	HP	427A	100	1000	9	lin	V, 0-left	n/a	10	10M	C	abjt	225
	Mercury	4000	300	1000	8	5 in.	V	yes	10	1M	C	adjt	80
	HP	410B	1000	1000	7	lin	V, A, Ω	n/a	0.2	500M	C	jt	300
	Mercury	1700C	1500	1500	7	lin	V	yes	10	1M	C	jt	50
	Fluke	853A	0	1100	4	lin	V, 0-ctr	n/a	0	100M	C, R	abdjqt	445
	Fluke	895A	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	aqrt	1170
	Fluke	891A-01	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	adqt	795
V8	Fluke	891A	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	aqt	695
	Fluke	885AB	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	adqt	1160
	Fluke	885A	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	aqt	1060
	Fluke	881AB	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	adqt	995
	Fluke	881A	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	aqt	895
	Fluke	871A	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	aqt	695
	Fluke	871AB	0	1100	4	lin	V, 0-ctr	n/a	n/a	n/a	C, R	adqt	795
	Data	107A	0	1500	14	ina	ina	yes	0.1	1000M	C	t	63
	Medistor	A-72	0.0005	1100	5	ina	±0.002%	n/a	n/a	n/a	C, R	t	1125
	Julie	TDV1000	1000	1100	4	lin	V, 0-ctr	yes	n/a	n/a	C, R	jg	1585
V9	HP	414A	5	1500	12	lin	V, 0-left	n/a	5	1.5	C	nt	690
	GR	1806-A	5	1500	4	log	V	n/a	0.2	10G	C	t	645
	RCA	WV-98C	10	1500	7	lin	V, 0-ctr	n/a	0.2	1000M	C	djt	89
	HP	410C	15	1500	11	lin	V, A, Ω	yes	10M	100M	C	bjt	475
	RCA	WV-77E	20	1500	7	lin	V, 0-left	n/a	0.2	1000M	C	djt	52
	RCA	WV-500B	20	1500	8	lin	V, 0-left	n/a	0.2	1000M	C	abjt	75
	Aul	TVOM4	150	1500	8	lin	ina	yes	0.2	50M	C	bjt	55
	Heath	IMW-28	1500	1500	7	lin	V, 0-left	n/a	0.1	1000M	C	jmt	60
	Heath	IMW-18	1500	1500	7	lin	V, 0-left	n/a	0.1	1000M	C	jt	50
	Aul	TVOM3	500	5000	8	lin	ina	yes	0.5	30M	C	bjt	45
V10	Fluke	896A	0	15,000	5	lin	V, 0-ctr	n/a	n/a	n/a	C, R	agt	1995
	R-S	URU	5	30,000	8	lin	V	no	0.5	3000M	C	jt	525
	R-S	URI	20	30,000	6	lin	V, 0-left	n/a	5	1000M	C	bjt	525

Misc. Features, see page D69.
Manufacturers and model numbers, see page D69.
Reader service numbers for literature and application notes, see page D6.

Test yourself:

When you purchase an IC tester, would you rather do business with:

a.) a company that merely makes testers, or

b.) a company that also makes IC's themselves, and thus completely understands their design, their production and–most importantly–their evaluation?

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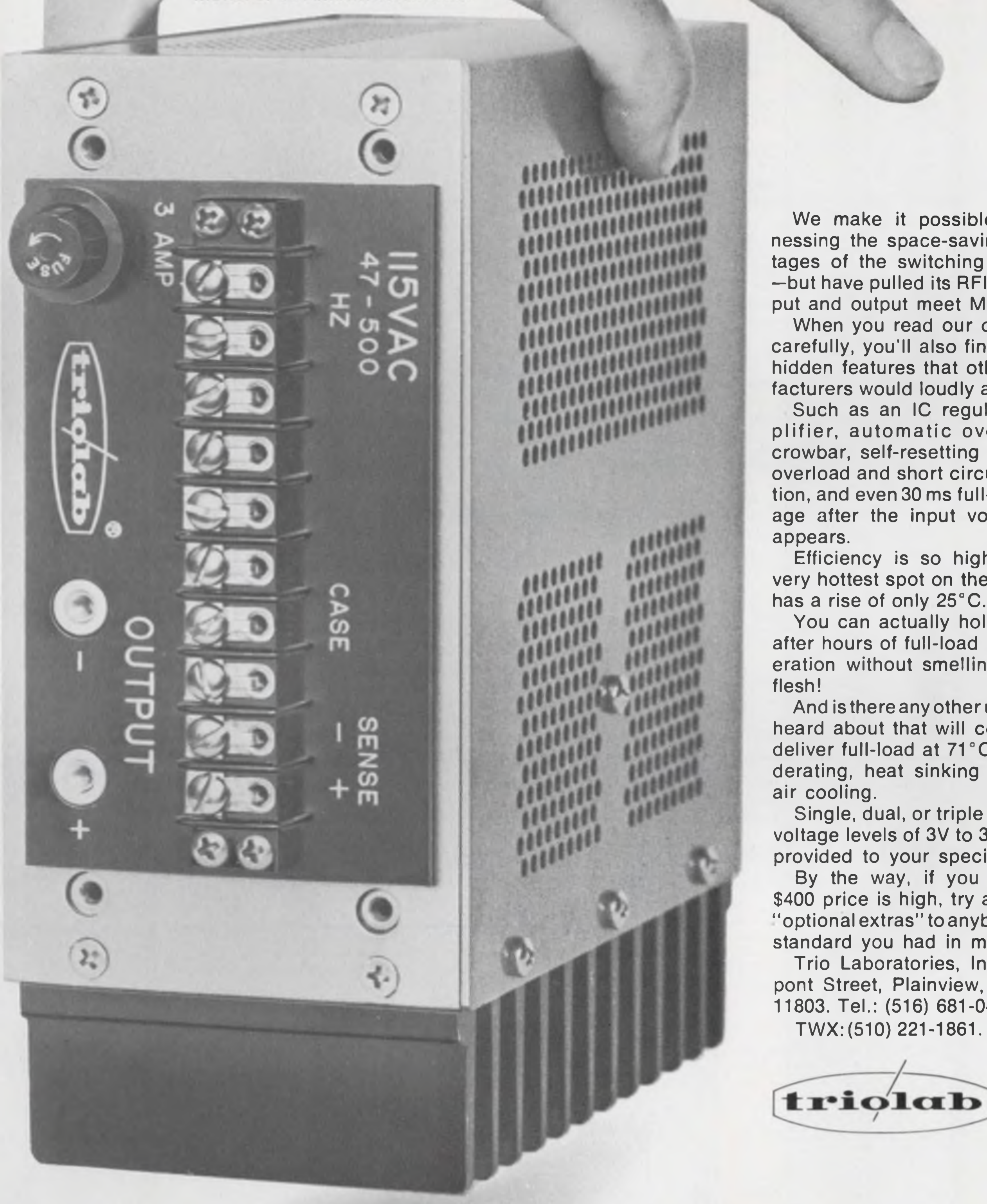
	Manufacturer	Model	Frequency Minimum Hz	Frequency Maximum kHz	Volts Minimum mV	Volts Maximum V	Volts Ranges No.	Meter Scale	Meter Calibration	Amplifier	Ohms Minimum	Ohms Maximum	Type C-Cab. R-Rack	Misc. Features	Price Approx $
V11	Data	165	5	0.1	500	500	12	ina	ina	n/a	n/a	n/a	C		239
	Data	107A	15	0.4	0	1500	7	ina	ina	yes	0.1	1000M	C	ju	63
	Aul	TVM4	3	1	30	1500	7	4	lin	yes	0.2	50M	C	abj	69
	Trio	144-1	5	2	10	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	ly	125
	Trio	141-1	50	2	10	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	gly	185
	Trio	143-1	50	2	10	300	10	lin	V, 0-ctr	yes	n/a	n/a	R	gly	300
	Trio	149-1	50	2	1	300	12	lin	V, 0-ctr	yes	n/a	n/a	R	ly	225
	Trio	302-1	380	2	10	300	1	lin	V, 0-ctr	yes	n/a	n/a	R	gly	275
	Fluke	883A	20	5	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	ajqs	1295
	Fluke	883AB	20	5	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	adjqs	1395
V12	Fluke	887A	20	5	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	ajqs	1495
	Fluke	887AB	20	5	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	adjqs	1595
	Fluke	873AB	20	10	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	adjqs	1095
	Fluke	873A	20	10	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	ajqs	995
	Medistor	A-45	30	10	1	1000	8	lin	V	n/a	n/a	n/a	C		595
	Ind-Test	300PB	60	10	1	300	12	lin	V, 0-ctr	yes	n/a	n/a	C	acdlv	1200
	B&K	2417	2	20	1	1000	11	lin, log	V	yes	n/a	n/a	C, R	u	445
	Comark	1251	3	20	1	30	12	lin	V, 0-left	yes	n/a	n/a	C, R	s	270
	Fluke	893A-01	20	20	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	adjqs	1095
	Fluke	893A	20	20	1	1100	4	lin	ina	n/a	n/a	n/a	C, R	ajqs	995
V13	NA	215C	30	20	0.3	300	13	lin	V, 0-ctr	n/a	n/a	n/a	R	y	ina
	Ballantine	316 S/2	0.01	30	20	200	4	log	V, dB	n/a	n/a	n/a	R	z	505
	Ballantine	316	0.01	30	20	200	4	log	V, dB	n/a	n/a	n/a	C	z	480
	Ind-Test	300B	15	30	1	300	12	n/a	n/a	yes	n/a	n/a	C, R	aclv	1675
	Ind-Test	300A	15	30	1	300	12	lin	V, 0-ctr	yes	n/a	n/a	C, R	aclv	1400
	Fluke	853A	20	30	0	1100	4	lin	ina	n/a	0	100	C, R	adjqs	445
	NA	210C	20	40	3	300	11	lin	V, 0-ctr	n/a	n/a	n/a	C	y	ina
	NA	210B	20	40	3	300	11	lin	V, 0-ctr	n/a	n/a	n/a	C	y	ina
	NA	VM-202	10	50	1	300	12	lin	V, 0-ctr	n/a	n/a	n/a	R	y	ina
	Dytronics	240-SP	10	50	1	300	12	lin	V, 0-ctr	n/a	n/a	n/a	C, R	ls	880
V14	Trio	104-1	20	50	10	300	1	lin	V, 0-left	yes	n/a	n/a	R	s	100
	Trio	103-1	20	50	10	300	10	lin	V, 0-left	yes	n/a	n/a	R	gs	272
	Trio	102-1	20	50	10	300	1	lin	V, 0-left	yes	n/a	n/a	R	gs	160
	Dytronics	242	20	60	100	300	12	lin	V, 0-ctr	yes	n/a	n/a	C, R	ls	600
	Trio	109-1	20	80	1	300	12	lin	V, 0-left	yes	n/a	n/a	R	s	200
	Dynamics	501	5	100	1	300	12	lin	V, 0-left	yes	n/a	n/a	C, R	ajos	500
	NA	214A	10	100	0.3	300	13	lin	V, 0-ctr	n/a	n/a	n/a	R	y	ina
	NA	212A	10	100	0.3	300	13	lin	V, 0-ctr	n/a	n/a	n/a	C	ay	ina
	NA	301A	10	100	1	300	12	lin	V, 0-ctr	n/a	n/a	n/a	R	y	ina
	Dytronics	250	10	100	0.3	300	13	lin	V, 0-ctr	n/a	n/a	n/a	C, R	ls	1380
V15	Millivac	MV-45A	10	100	0.01	1000	17	lin	V	yes	n/a	n/a	C	adu	425
	Dytronics	211	100	100	1	300	12	lin	V, 0-ctr	n/a	n/a	n/a	C, R	ls	1900
	Ballantine	302CS/2	2	150	0.1	1000	7	log	V, dB	yes	n/a	n/a	R	ds	420
	Ballantine	302C	2	150	0.1	1000	7	log	V, dB	yes	n/a	n/a	C	ds	395
	B&K	2409	2	200	1	1000	11	lin, log	V	yes	n/a	n/a	C, R	v	338
	Philips	PM2452	2	200	0.1	300	14	lin	V	yes	n/a	n/a	C, R	s	795
	Comark	1241	3	200	0.01	300	12	lin	V, 0-left	yes	n/a	n/a	C, R	s	225
	Ballantine	300ES/2	30	200	0.3	300	6	log	V, dB	yes	n/a	n/a	R	s	360
	Ballantine	300E	30	200	0.3	300	6	log	V, dB	yes	n/a	n/a	C	s	335
	Ballantine	300G	10	250	1	1000	6	log	V, dB	yes	n/a	n/a	C	s	325
V16	Ballantine	300GS/2	10	250	1	1000	6	log	V, dB	yes	n/a	n/a	R	s	350
	Trio	301-1	20	250	10	300	1	lin	V, 0-left	yes	n/a	n/a	R	gs	250
	Millivac	PM-311A-1	20	250	0-10	0-300	10	lin	V, 0-left	n/a	n/a	n/a	C	u	250
	Ballantine	300M	15	400	0.5	500	6	log	V, dB	n/a	n/a	n/a	C	s	550
	Ballantine	305AS/2	5	500	1	1000	12	log	V, dB	yes	n/a	n/a	R	z	550
	Ballantine	305A	5	500	1	1000	12	log	V, dB	yes	n/a	n/a	C	z	525
	HP	3410A	5	600	0.003	3	13	lin, log	V, dB	yes	n/a	n/a	C	ku	875
	HP	403A	1	1000	1	300	12	lin, log	V, dB	n/a	n/a	n/a	C		320
	Fluke	931B	2	1000	10	1100	5	lin	ina	n/a	n/a	n/a	C, R	aqv	945
	R-S	UVN	10	1000	0.1	300	12	lin	V, dB	yes	n/a	n/a	C, R	s	499

Model SP601 shown actual size.



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Efficiency is so high that the very hottest spot on the heat sink has a rise of only 25°C.

You can actually hold our unit after hours of full-load bench operation without smelling burning flesh!

And is there any other unit you've heard about that will continue to deliver full-load at 71°C.—without derating, heat sinking or forced air cooling.

Single, dual, or triple outputs at voltage levels of 3V to 30V can be provided to your specific needs.

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Trio Laboratories, Inc., 80 Dupont Street, Plainview, L. I., N.Y. 11803. Tel.: (516) 681-0400.

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Now you can squeeze your 5V/20A power supply down to fit your microcircuitry.

INFORMATION RETRIEVAL NUMBER 629

Vacuum-Tube Voltmeters (ac)

			Frequency		Volts			Meter			Ohms		Type		
	Manufacturer	Model	Minimum Hz	Maximum kHz	Minimum mV	Maximum V	Ranges No.	Scale	Calibration	Amplifier	Minimum	Maximum	C-Cab. R-Rack	Misc. Features	Price Approx $
V17	HP	427A	10	1000	10	1000	10	lin, log	V, dB	n/a	10	10M	C	js	225
	Heath	IMW-38	10	1000	0.01	300	10	lin	V	n/a	n/a	n/a	C	s	58
	Ballantine	300H	10	1000	0.03	330	6	log	V, dB	yes	n/a	n/a	C	s	275
	Ballantine	300HS/2	10	1000	0.03	330	6	log	V, dB	yes	n/a	n/a	R	s	300
	RCA	WV-76A	10	1500	0.2	100	9	lin	V, dB	yes	n/a	n/a	C	s	90
	GR	1806-A	20	1500	100	1500	4	log	V	n/a	n/a	n/a	C		645
	HP	403B	5	2000	1	300	12	lin, log	n/a	n/a			C	u	340
	Waveforms	520A	10	2000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C, R	u	300
	Radiometer	RV36	20	2000	1	30	12	lin	V	yes	2MΩ nom	n/a	C, R	ads	req.
	Triplett	850	15	3000	50	1500	8	ina	no	yes	0.2	1000	C	js	93
V18	Allied	KG-625	30	3000	0	1500	15	lin	V, 0-left	n/a	ina	ina	n/a	s	40
	Ballantine	321S/2	5	4000	0.1	330	13	log	V, dB	yes	n/a	n/a	R	svz	645
	Ballantine	320A	5	4000	0.1	330	13	log	V, dB	yes	n/a	n/a	C	v	525
	Ballantine	321	5	4000	0.1	330	13	log	V, dB	yes	n/a	n/a	C	svz	620
	Ballantine	320AS/2	5	4000	0.1	330	13	log	V, dB	yes	n/a	n/a	R	v	550
	HP	400L	10	4000	1	300	12	lin, log	n/a	yes	n/a	n/a	C, R	u	385
	HP	400H	10	4000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C, R	u	375
	HP	400D	10	4000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C, R	u	275
	Inst-Labs	TR	20	4000	3	300	11	lin	V, dB	yes	n/a	n/a	C	ads	req.
	HP	400F	20	4000		300	14	lin, log	V, dB	yes	n/a	n/a	C	u	300
V19	HP	400FL	20	4000	0.1	300	14	lin, log	V, dB	yes	n/a	n/a	C	u	310
	HP	400GL	20	4000	0.1	1000	8	lin, log	V, dB	yes	n/a	n/a	C	u	325
	Ballantine	303-51	2	6000	3	1000	11	log	V, dB	yes	n/a	n/a	C	as	385
	Ballantine	303	2	6000	0.1	350	13	log	V, dB	yes	n/a	n/a	C	ads	395
	Ballantine	303-01	2	6000	0.1	350	13	log	V, dB	yes	n/a	n/a	C	as	335
	Ballantine	303-50	2	6000	3	1000	11	log	V, dB	yes	n/a	n/a	C	ads	445
	Ballantine	314AS/2	10	6000	1	1000	6	log	V, dB	yes	n/a	n/a	R	s	460
	Ballantine	310B	10	6000	0.1	100	6	log	V, dB	yes	n/a	n/a	C	s	385
	Ballantine	314A	10	6000	1	1000	6	log	V, dB	yes	n/a	n/a	C	s	435
	Ballantine	310BS/2	10	6000	0.1	100	6	log	V, dB	yes	n/a	n/a	R	s	410
V20	Philips	PM2454	2	2000	1	300	12	lin	V	yes	n/a	n/a	C, R	s	370
	Philips	PM2451	10	7000	1	30	10	lin	V	yes	n/a	n/a	C	ds	375
	HP	400E	10	10,000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C	u	325
	HP	3400A	10	10,000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C	v	525
	HP	400EL	10	10,000	1	300	12	lin, log	V, dB	yes	n/a	n/a	C	u	335
	Ballantine	317	10	11,000	0.3	350	12	log	V, dB	yes	n/a	n/a	C, R	s	495
	ITT-Jenn	J-1005	10	20,000	0	100,000	5	lin	V	yes	n/a	n/a	C, R		878
	Ballantine	323-06	10	20,000	0.1	330	13	log	V, dBm	n/a	n/a	n/a	C	adv	605
	Ballantine	323-01	10	20,000	0.3	330	12	log	V, dB	n/a	n/a	n/a	C	av	525
	Ballantine	323	10	20,000	0.3	330	12	log	V, dB	n/a	n/a	n/a	C	adv	590
V21	Ballantine	323-07	10	20,000	0.1	330	13	log	V, dBm	n/a	n/a	n/a	C	av	540
	R-S	UVH	30	40,000	0.05	100	9	lin	V, dB	yes	n/a	n/a	C	s	1095
	Micro	5201C	dc	50,000	3000	1000	6	lin	V	yes	n/a	n/a	C		795
	R-S	URI	30	200,000	100	3000	7	lin, log	V, A, Ω	n/a	5	1000	C	bjs	525
	Boonton	91K	0.5MHz	600,000	1	30	8	lin, log	V, dBm	yes	n/a	n/a	C, R	v	705
	HP	410C	20	700,000	500	300	7	lin, log	V, dB	yes	0.2	500M	C	bjs	475
	HP	410B	20	700,000	1000	300	6	lin, log	V, dB	n/a	0.2	500M	C, R	js	300
	Ballantine	340	100,000	1,000,000	0.3	3	8	log	V, dB	n/a	n/a	n/a	C	v	650
	Ballantine	340S/2	100,000	1,000,000	0.3	3	8	log	V, dB	n/a	n/a	n/a	C	v	675
	HP	411A	500,000	1,000,000	10	10	7	lin, log	V, dB	yes	n/a	n/a	C	u	450

Vacuum-Tube Voltmeters (ac)

	Manufacturer	Model	Frequency Minimum Hz	Frequency Maximum kHz	Volts Minimum mV	Volts Maximum V	Volts Ranges No.	Meter Scale	Meter Calibration	Amplifier	Ohms Minimum	Ohms Maximum	Type C-Cab. R-Rack	Misc. Features	Price Approx $
V22	Millivac	MV-38B	10,000	1,200,000	1	3	8	lin	V, 0-left	n/a	n/a	n/a	C, R	aou	675
	Millivac	MV-928A	10,000	1,200,000	1	3	8	lin	V, 0-left	n/a	n/a	n/a	C, R	adou	775
	Millivac	MV-38B	10,000	1,200,000	3	3	7	lin	V	yes	n/a	n/a	C, R	ovw	525
	Millivac	MV-28B	10,000	1,200,000	1	3	8	lin	V	yes	n/a	n/a	C, R	ovw	625
	HP	3406A	10,000	1,200,000	1	3	8	lin, log	V, dB	yes	n/a	n/a	C	sx	750
	Boonton	91DA	20,000	1,200,000	1	3	8	lin, log	V, dB	yes	n/a	n/a	C, R	w	700
	Boonton	91H	20,000	1,200,000	0.1	3	8	lin	V, dBm	yes	n/a	n/a	C, R	v	675
	Boonton	91C	20,000	1,200,000	1	3	7	lin	V, dB	yes	n/a	n/a	C, R	v	575
	R-S	URU	10	1,500,000	100	2500	5	lin	V, dB	n/a	0.5	3000	C	js	525
	R-S	URV	1000	1,600,000	2	10	7	lin	V, dB	n/a	n/a	n/a	C	js	899
V23	Boonton	91L	200,000	2,500,000	1	1	7	lin, log	V, dBm	n/a	n/a	n/a	C, R	w	975

a. Solid state.
b. Also dc ammeter.
c. Also 0-left.
d. Battery operated.
e. Also coulombmeter.
f. Also electrometer.
g. Military type.
h. Null range 0.01-100V, 7 ranges.
i. Null range 0.03-100V, 6 ranges.
j. Ac/dc voltmeter.
k. Local oscillator output 4V squarewave.
l. Also phase sensitive voltmeter.
m. Separate scale for 1.5 and 5V range.
n. Automatic ranging.
o. Rackmount extra.
p. Also frequency meter, 5 Hz-1 MHz.
q. Differential voltmeter.
r. Also ratiometer.
s. Responds to average meter.
t. Responds to dc meter.
u. Responds to rms meter.
v. Responds to true rms meter.
w. True rms up to 30 mV. Sampling voltmeter.
x. Sampling voltmeter.
y. Responds to phase meter.
z. Responds to p-p meter.

Reader service numbers for literature and application notes, see page D6.

Index by Model Number

(continued on page D70)

(continued from page D69)

Name	Model	Code
Fluke	891A	V8
	891A-01	V7
	893A	V12
	893A-01	V12
	895A	V7
	896A	V10
	931B	V16
GR	1806-A(dc)	V9
General Radio Co.	1806-A(ac)	V17
Heath	IMW-18	V9
Heath Co.	IMW-28	V9
	IMW-38	V17
HP	400D	V18
Hewlett-Packard Co.	400E	V20
	400EL	V20
	400F	V18
	400FL	V19
	400GL	V19
	400H	V18
	400L	V18
	403A	V17
	403A	V16
	403B	V17
	410B(dc)	V7
	410B(ac)	V21
	410C(dc)	V9
	410C(ac)	V21
	411A	V21
	412A	V7
	413A	V6
	414A	V9
	419A	V5
	425A	V1
	427A(dc)	V7
	427A(ac)	V17
	3400A	V20
	3406A	V22
	3410A	V16
IB	300	V2
IB Instruments Inc.	301	V2
	333	V1
Ind-Test	300A	V13
Industrial Test Equip. Co.	300B	V13
	300PB	V12
Inst-labs Instrument Labs Corp.	TR	V18
ITT-Jenn ITT/Jennings	J-1005	V20
Julie Julie Research Labs	TDV1000	V8
Keithley	147	V1
Keithley Inst. Corp.	148	V1
	149	V1
	150B	V1
	153	V4
	155	V4
	600B	V1
	602	V1
	604	V1
	610C	V2
	621	V2
	630	V4
	640	V1
	662	V4
Mercury	1700C	V7
Mercury Electronics Corp.	4000	V7
Measure	162	V2, V7
Measurements	162R	V3, V7
Medistor	A-45	V12
Medistor Inst. Co.	A-50	V6
	A-60RB	V5
	A-65C	V2
	A-71C	V4
	A-72	V8
	A-75A	V4
Micro Micro Inst. Co.	5201C	V21
Millivac	MV-07C	V5
Millivac Inst. Inc.	MV-27E	V6
	MV-28B	V22
	MV-38B	V22
	MV-38B	V22
	MV-45A	V15
	MV-127B-L	V5
	MV-852A	V5
	MV-864A	V6
	MV-928A	V22
	MV-952A	V5
	MV-964A	V6
	PM-311A-1	V16
NA	210B	V13
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Philips Electronics	PM2436	V5
	PM2451	V20
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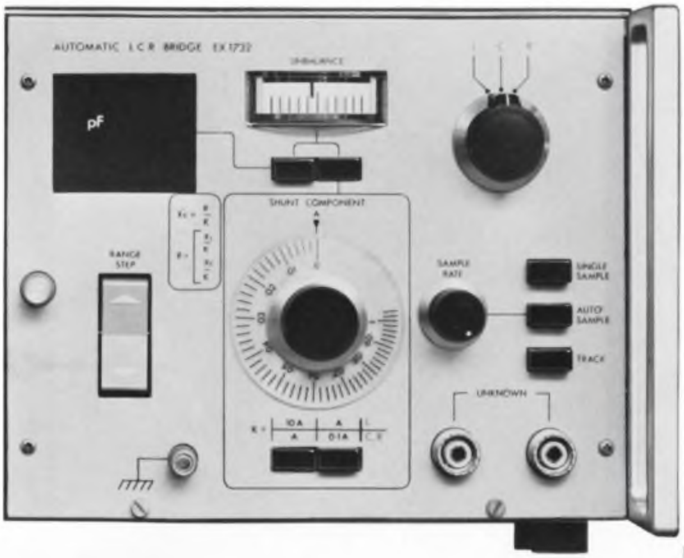
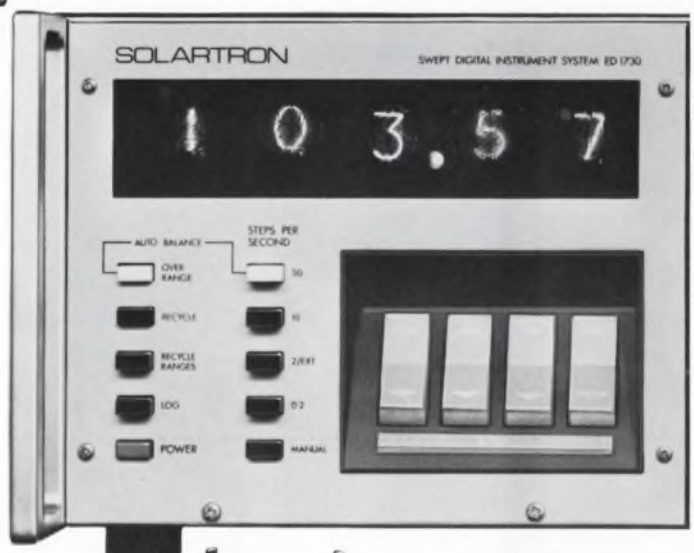
	PM2454	V20
Radiometer Radiometer The London Co.	RV36	V17
RCA	WV-76A	V17
Radio Corp. of America	WV-77E	V9
	WV-98C	V9
	WV-500B	V9
R-S	URI	V10, V21
Rohde & Schwarz	URU	V10, V22
	URV	V6, V22
	UVH	V21
	UVN	V16
Trio	102-1	V14
Trio Labs	103-1	V14
	104-1	V14
	105-1	V3
	105-2	V3
	105-3	V4
	105-4	V4
	106-1	V3
	106-2	V3
	106-3	V3
	106-4	V3
	107-1	V3
	109-1	V14
	110-1	V2
	141-1	V11
	143-1	V11
	144-1	V11
	149-1	V11
	301-1	V16
	302-1	V11
	305-1	V3
	305-2	V3
	310-1	V4
Triplett	601	V6
Triplett Elect. Inst. Co.	850	V17
Waveforms	52A	V17
Wavetek	207	V5

Advertisers' Index



fully automatic LCR Bridge . . .



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The only fully automatic LCR bridge with direct readout to five figures. No half answers — no knob twiddling or button pressing to get the other half. Three terminal "in-situ" measurements. Manual override for component matching to 0.01%. High speed tracking mode for drift monitoring. For print-out — BCD information of measured value and range.
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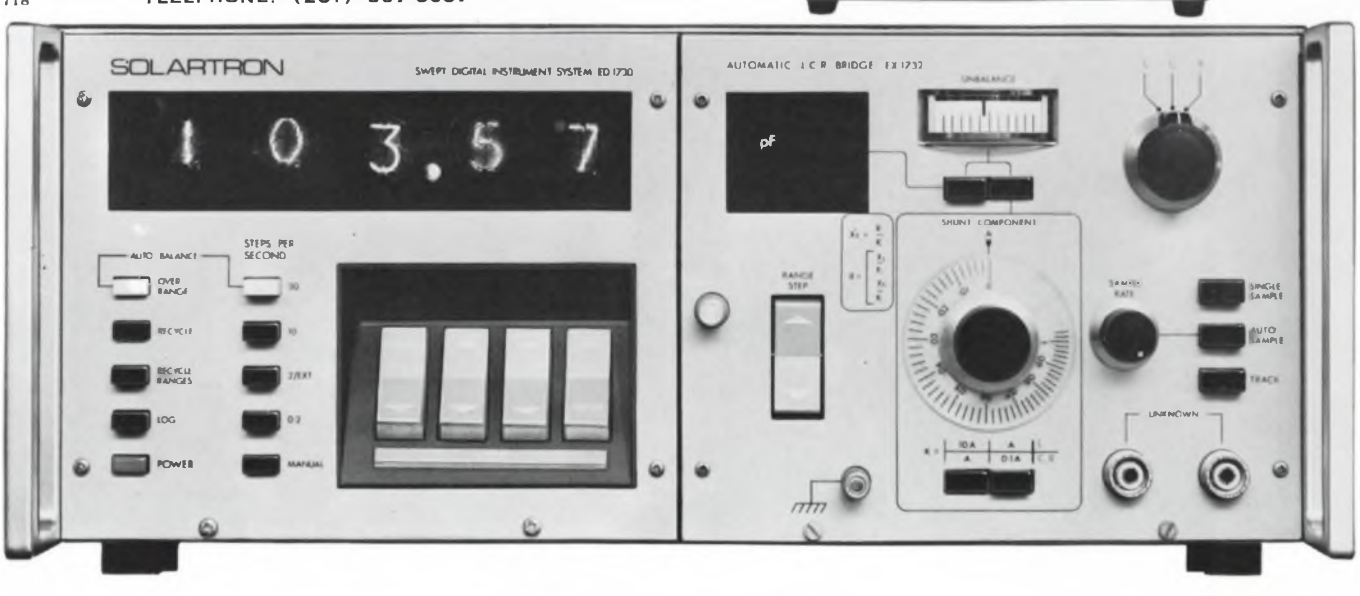

INFORMATION RETRIEVAL NUMBER 630

smooth

RCA WP-700A, 702A, 703A and 704A constant voltage dc power supplies are all solid-state. A negative feedback circuit maintains constant output voltage with low ripple – regardless of varying line. In fact, at rated load, these supplies are so smooth that "they hardly cause a ripple."

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Output voltage of the WP-700A and WP-702A is continuously adjustable from 0 to 20 volts at current levels up to 200 mA.

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Output voltage of the WP-704A is continuously adjustable from 0 to 40 volts at current levels up to 250 mA.

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WP-703A: $49.00* (five or more) $58.00* (less than five)
WP-704A: $49.00* (five or more) $58.00* (less than five)

*Optional Distributor Resale Price.

WP-702A: Siamese Twins of WP-700A, but electrically isolated $73.00* (five or more) $87.00* (less than five)

For further information write: RCA Electronic Components, Commercial Engineering, Department K18W-2, Harrison, N. J. 07029.

Look to RCA for instruments to test/measure/view/monitor/generate

RCA

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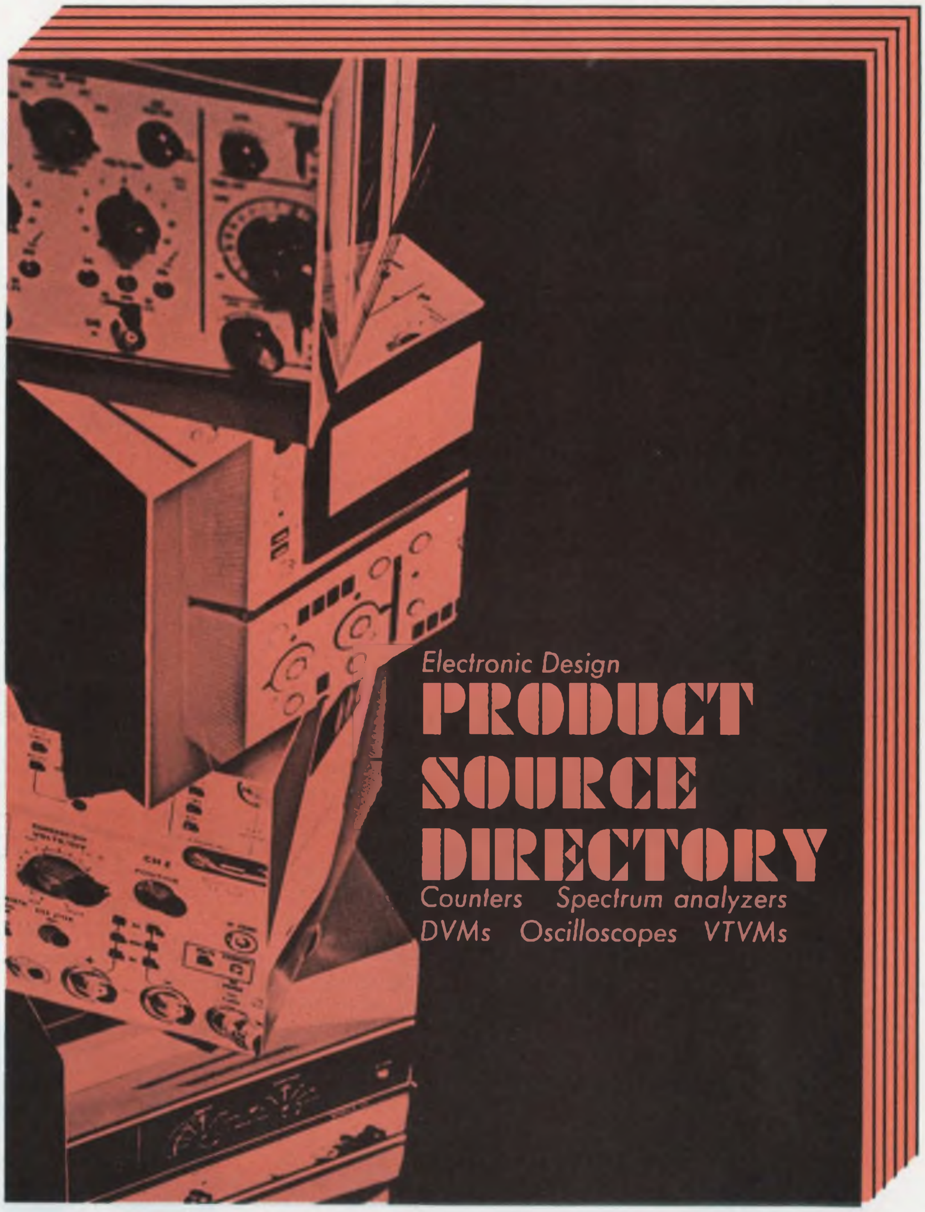

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Dramatic new whiteprinter—high speed—low cost.

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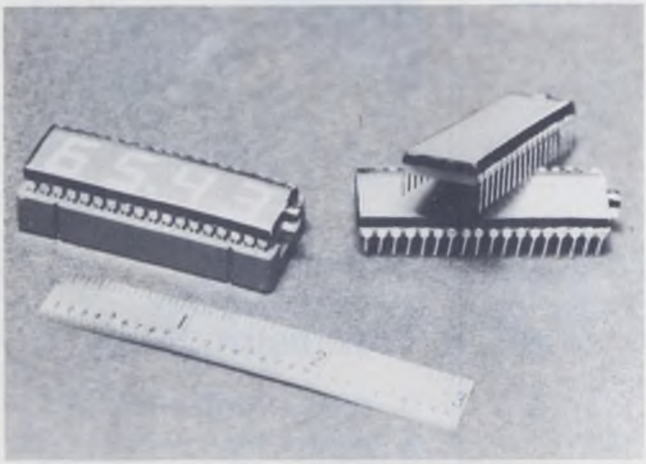
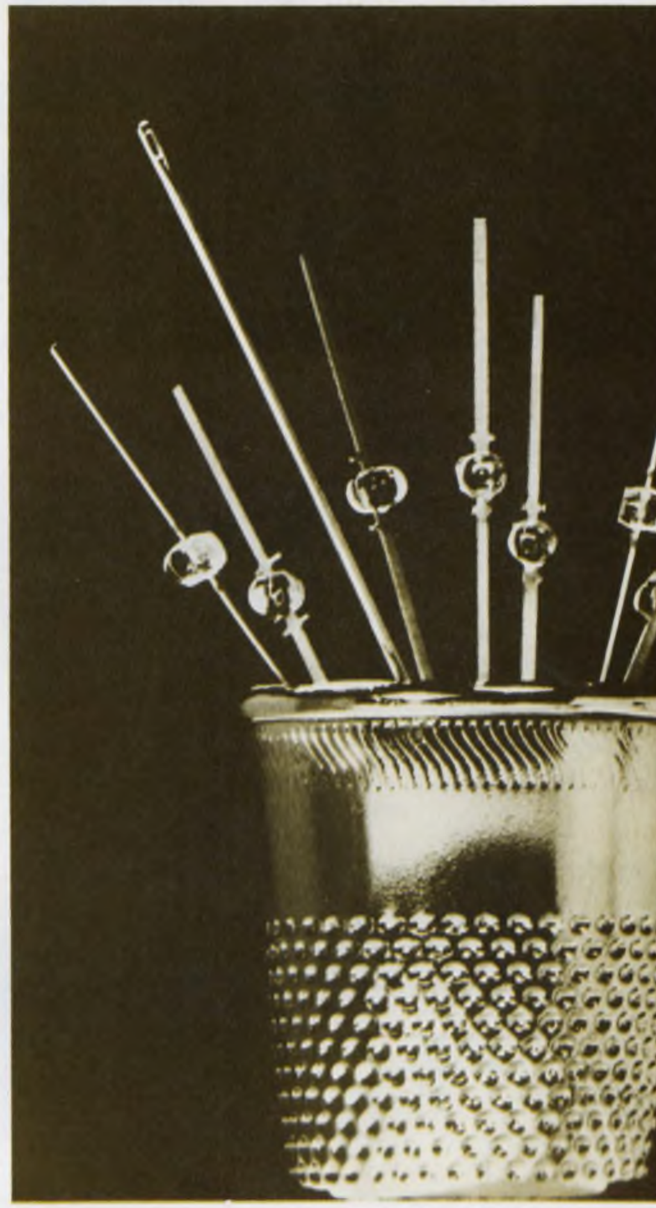
INFORMATION RETRIEVAL NUMBER 71

Products



Electroluminescent readouts fit four digits plus decimal on single DIP panel, p. 100.

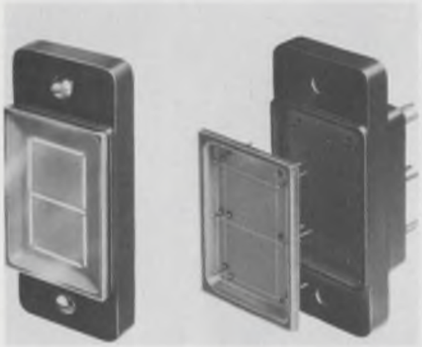
Desktop calculator for $1695 uses nine memories for 111 program steps, p. 119.



Bright red LED with $2.30 price tag glows at 750 foot-lamberts with 20 mA, p. 104.

Also in this section:

Seven-segment readout shows 3/4-in. figures



Pinlites Inc., 1275 Bloomfield Ave., Fairfield, N.J. Phone: (201) 226-7724. Availability: stock.

Maxi-Lite 12-50 is a seven-segment 3/4-in. digital readout whose individual segments are directly viewed incandescent tungsten filaments. All displayed numbers or letters are equally distinct with a viewing angle of 150°. The unit, which has a 100,000-hour design life, measures only 1/2 in. from front to back, including its connector.

CIRCLE NO. 250

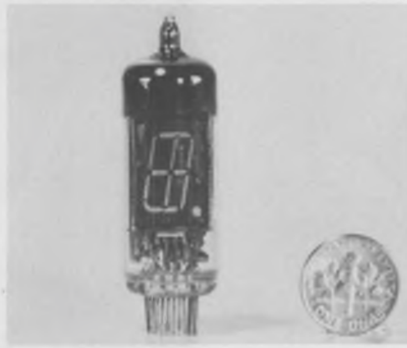
Small 10-W reeds sell for only 80¢

Phipps Precision Products, 7641 Densmore Ave., Van Nuys, Calif. Phone: (213) 785-3109. P&A: 80¢; stock.

A new line of miniature 10-W open-frame reed relays cost only 80¢ each in quantities of 1 to 99. These single-pole form-A relays are available in three choices of coil voltages: 6, 12 and 24 V. Series TA units electrically and physically isolate individual reeds in a rugged nylon bobbin. Magnetic and electrostatic shielding are available as options.

CIRCLE NO. 251

Eight-segment readouts show-up 40 feet away

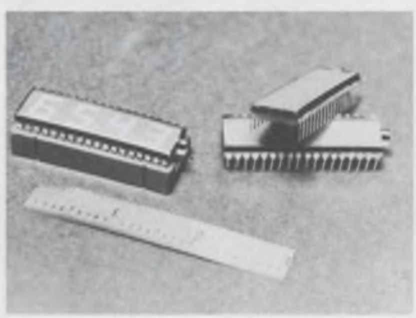


Legitron, 3118 W. Jefferson Blvd., Los Angeles, Calif. P&A: $5.50; stock.

Legi series DG-19 readout tubes, which are composed of eight phosphor-coated segments, can be viewed at distances up to 40 feet away. The new indicators have a wide spectral bandwidth that makes possible different color outputs when the proper filtering is used. Units are available with companion mounting sockets, or with flexible leads for mounting on PC boards.

CIRCLE NO. 252

Four-digit indicators use electroluminescence



Sanders Associates, Inc., Equipment Design Div., Daniel Webster Highway South, Nashua, N.H. Phone: (603) 885-4741.

Easily readable over a 150° viewing angle, new compact electroluminescent numeric indicators fit four digits and a decimal point on readout panels less than 2 by 0.5 in. The devices have standard 36-pin dual-in-line plugs. They consist of electroluminescent contrast enhancement filters and SCRs that permit direct interface with IC logic.

CIRCLE NO. 253

Immediately available from TRW distributors

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The new BP-200 microelectronic active filter is the smallest, most stable and most versatile audio frequency filter in existence. It is a universal filter: a single unit can be connected to function as a bandpass, low pass or high pass element. And modules can be cascaded to provide almost any complex filter function.

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The BP-200 not only eliminates the need for bulky inductors and capacitors, but for magnetic shielding as well. It can also replace vibrating reeds and other mechanical filters, to eliminate shock and vibration interference.

For complete information and applications assistance, contact any TRW distributor. TRW Semiconductors, Inc. is a subsidiary of TRW Inc.

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INFORMATION RETRIEVAL NUMBER 73

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from our Tachometer Generators. They're temperature-compensated, miniaturized, and perfect for precision indicators and velocity servos requiring a highly linear speed/voltage relationship with minimum ripple. Linearity from 0 to 12,000 rpm is better than 1/10 of 1% of voltage output at 3600 rpm. The ripple value will not exceed 3% rms of the D-C value at any speed in excess of 100 rpm. The low-driving torque makes them excellent as damping or rate signals in all types of servos. Brushes and commutators are guaranteed for 100,000 hours of operation — more than ten years — at 3600 rpm. Various models are available with outputs as high as 45v/1000 rpm and can be supplied with an indicator as a complete Speed Indicating System.

SERVO-TEK PRODUCTS COMPANY 1086 Goffle Road, Hawthorne, New Jersey 07506.

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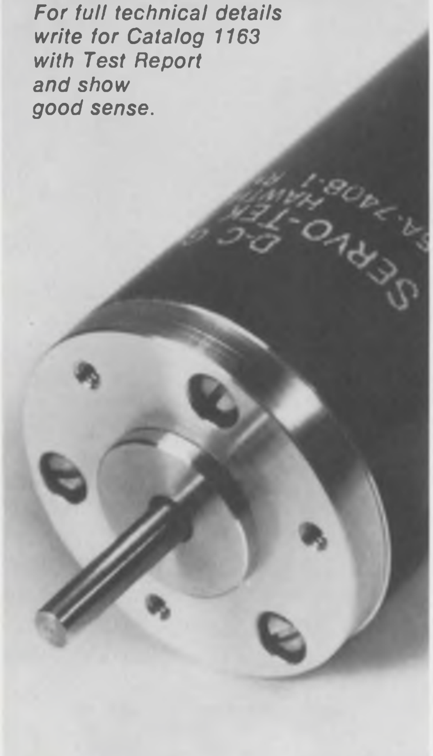


INFORMATION RETRIEVAL NUMBER 74

Shift register is fluidic module

Corning Glass Works, Fluidic Products Dept., Corning, N.Y. Phone: (607) 962-4444. P&A: $30; stock.

A fluidic shift register that transfers information in fixed sequence and that can be easily interconnected for staging is now available in standard module form. The device serves as a memory in fluidic control systems, shifting information from one station to control action later at another. It operates from an air supply of 3 to 10 psig, and has a 100-Hz frequency response.

CIRCLE NO. 254

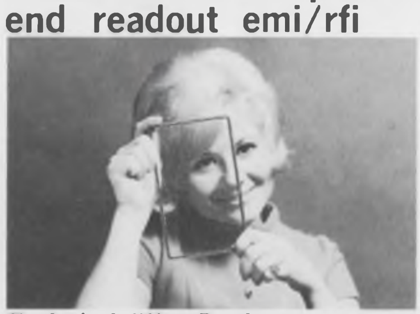
Dc 45-W motors have rfi filter

American Electronics, Inc., 1600 E. Valencia Drive, Fullerton, Calif. Phone: (714) 871-3020.

Ideal for actuator applications, two new series of permanent-magnet dc motors with an integral rfi filter can deliver a 42-W output in intermittent-duty applications. Series 13DA and 13DV have rated speeds of 14,000 rpm and a torque of 4 oz.-in. after magnetic stabilization. Dimensions, including the integral filter, are 1-1/4 in. in diameter by 2-7/8 in. in length; weight is 7 oz.

CIRCLE NO. 256

Shielded window panels end readout emi/rfi



Technical Wire Products, Inc., 129 Dermody St., Cranford, N.J. Phone: (201) 272-5500.

EMC-GLAS panels are ready-to-install emi/rfi shielded windows that permit the viewing of readout devices placed within a shielded electronic enclosure without disturbing the shielding integrity of the enclosure. These new panels are constructed of specially treated nonpolarized knitted wire mesh, which is laminated in Plexiglas or plate glass. The continuous loop pattern of the wire mesh enables clear visibility.

CIRCLE NO. 255

Snap-in paddle switches have all-plastic bezel

McGill Manufacturing Co., Inc., Electrical Div., 909 N. Lafayette, Valparaiso, Ind. Phone: (219) 462-2161.

Eliminating exposed metallic parts, series 0805 paddle-actuated switches are equipped with a plastic snap-in bezel instead of conventional metal cover plates. The new switches conform to Underwriter's Laboratories specifications for double-insulated applications. Electrical ratings include 12 A at 125 V ac and 6 A at 250 V ac.

CIRCLE NO. 257

Fluidic interface meshes electronics

Lee Co., 2 Pettipaug Rd., Westbrook, Conn. Phone: (203) 399-6281.

Called an interface, a new device allows initiating a sequence or overriding a fluidic control system from an external electric signal source. Designed to handle either liquids or gases, the interface has a three-way function that permits it to be converted into a normally closed valve or normally open two-way valve by simply closing the respective outlet. It is designed for operation at 12 V dc.

CIRCLE NO. 258

Tilting switch works without Hg

Aerodyne Controls Corp., 90 Gazza Blvd., Farmingdale, N.Y. Phone: (516) 694-3500.

Designed for both military and commercial applications, a new tilt switch, which does not use mercury as the electrical medium, eliminates many of the problems associated with conventional tilt switches. These problems include breakage due to high-acceleration loads, contamination, and inadvertent actuation caused by vibrations. The new switch is factory preset.

CIRCLE NO. 259

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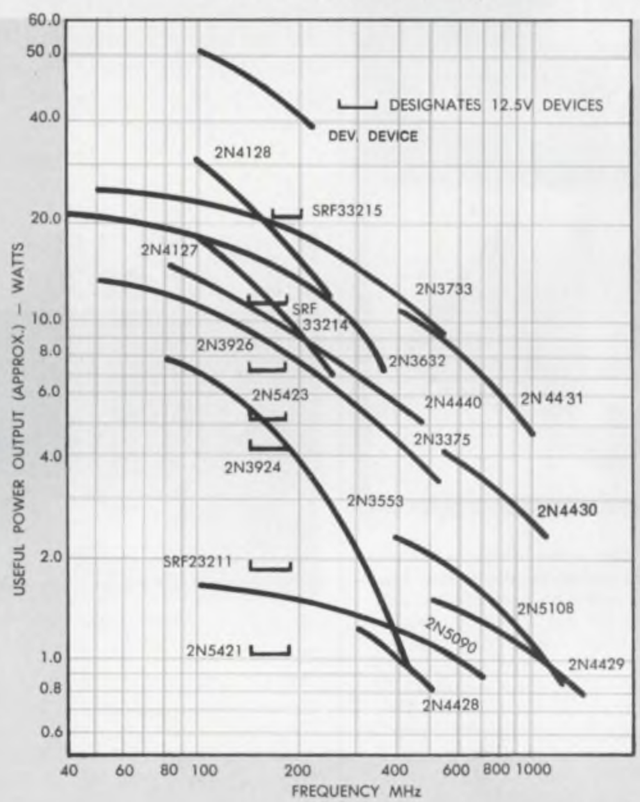
Solitron's wide range of RF power transistors can provide the right devices for your required applications. These transistors cover a useful frequency range from 30 to 1.2 GHz and output power levels of 1 to 60 Watts. All popular package types are available. Take your pick from Solitron's power frequency spectrum and contact us today.



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INFORMATION RETRIEVAL NUMBER 75

CAS series... industrially oriented cassette decks

The Auricord CAS series of two channel, record/playback CASSETTE decks has been designed for a wide range of applications: computer, AV, space and medical, communications... to name a few. Outstanding features include three-motor design and completely electrical actuation, making the system ideal for remote controlability. Also, simplified slot loading and dynamic braking. Add our EP-1 electronics package for a complete system.

MODEL CAS-3 is similar to CAS-1, but adds the advantage of read-out in fast forward and fast reverse modes and has random access capability.

For complete details on the CAS series and other Auricord products for tape mechanism requirements, contact:

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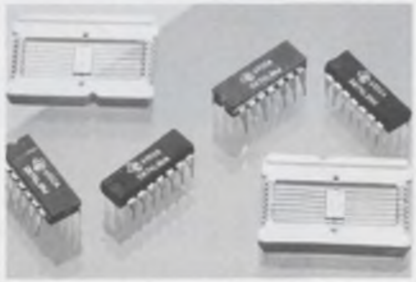
(212) 361-7400

INFORMATION RETRIEVAL NUMBER 76

Multi-function ICs dissipate 1 mW/gate



Texas Instruments Inc., Components Group, P.O. Box 5013, Dallas, Tex. Phone: (214) 238-2011. P&A: $5.44 to $11.83; 2 to 4 wks.

Compatible with all TTL and DTL circuits, two new low-power ICs provide a power dissipation of 1 mW per gate (the SN54L04/74L04 hex inverter) or 3.75 mW per gate (the SN54L86/74L86 quad exclusive-OR). The hex inverter has six inverters that can each drive ten loads. The exclusive-OR unit has four two-input exclusive-OR gates.

CIRCLE NO. 260

Bright red LED sells for $2.30

Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. Phone: (408) 257-2140. P&A: $2.30; stock.

Costing only $2.30 each in quantities from 1 to 99, a new solid-state light source produces a red output of 750 foot-lamberts with a forward current of only 20 mA. The MV50 is a diffused planar gallium-arsenide-phosphide light-emitting diode that peaks at 6500 Å. It can respond at speeds of 1 ns for flashing and pulsing applications. Its expected lifetime approaches 100 years.

CIRCLE NO. 261

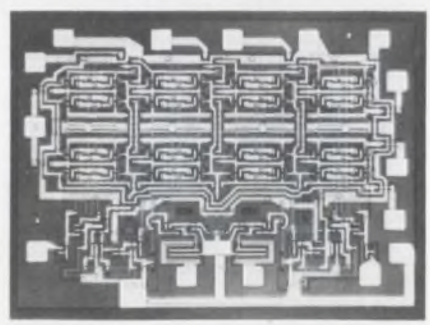
Three-lead 5-V IC regulates by itself

National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: $20 or $25; stock.

Packaged in a three-lead transistor can, a new 5-V regulator chip eliminates the need for external components—its only leads are for input, output and ground connections. The LM109 is protected against overloads by thermal as well as current limiting. It uses the emitter-base voltage of its transistors as the reference, instead of zener diodes.

CIRCLE NO. 262

MSI memory chip consumes 175 mW



Transitron Electronic Corp., 168 Albion St., Wakefield, Mass. Phone: (617) 245-4500. P&A: $13 to $19; stock to 2 wks.

Designed for high-speed computer scratch-pad memory applications, a new low-power 16-bit MSI memory has a power dissipation of 175 mW at an operating voltage of 5 V. In addition, maximum address line select current is only 6.5 mA for the TMC 3262. The new circuit consists of 16 flip-flops, two write amplifiers and two sense amplifiers on one silicon chip.

CIRCLE NO. 263

Npn/pnp pairs for $1 handle 25 W at 4 A

Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. Phone: (415) 962-5011. P&A: $1.20 to $3; stock.

Offering 25-W power capability in a single package, a new line of complementary power transistors cost as little as $1.20 each in single-unit quantities. Packaged in TO-66 metal cans, these pnp and npn devices can handle peak collector currents as high as 4 A.

Type 2N3054 is a npn transistor that costs only $1.20 for one to 99 units and 80¢ for 100 to 999 units. Its maximum collector-base voltage is 90 V, while maximum collector-emitter voltage is 55 V. Base current can be as large as 2 A.

Npn types 2N4910, 2N4911 and 2N4912 have price tags of $1.55, $1.80 and $2.10, respectively. They have maximum collector-base and collector-emitter voltages of 40, 60 or 80 V. Peak collector current is 1 A.

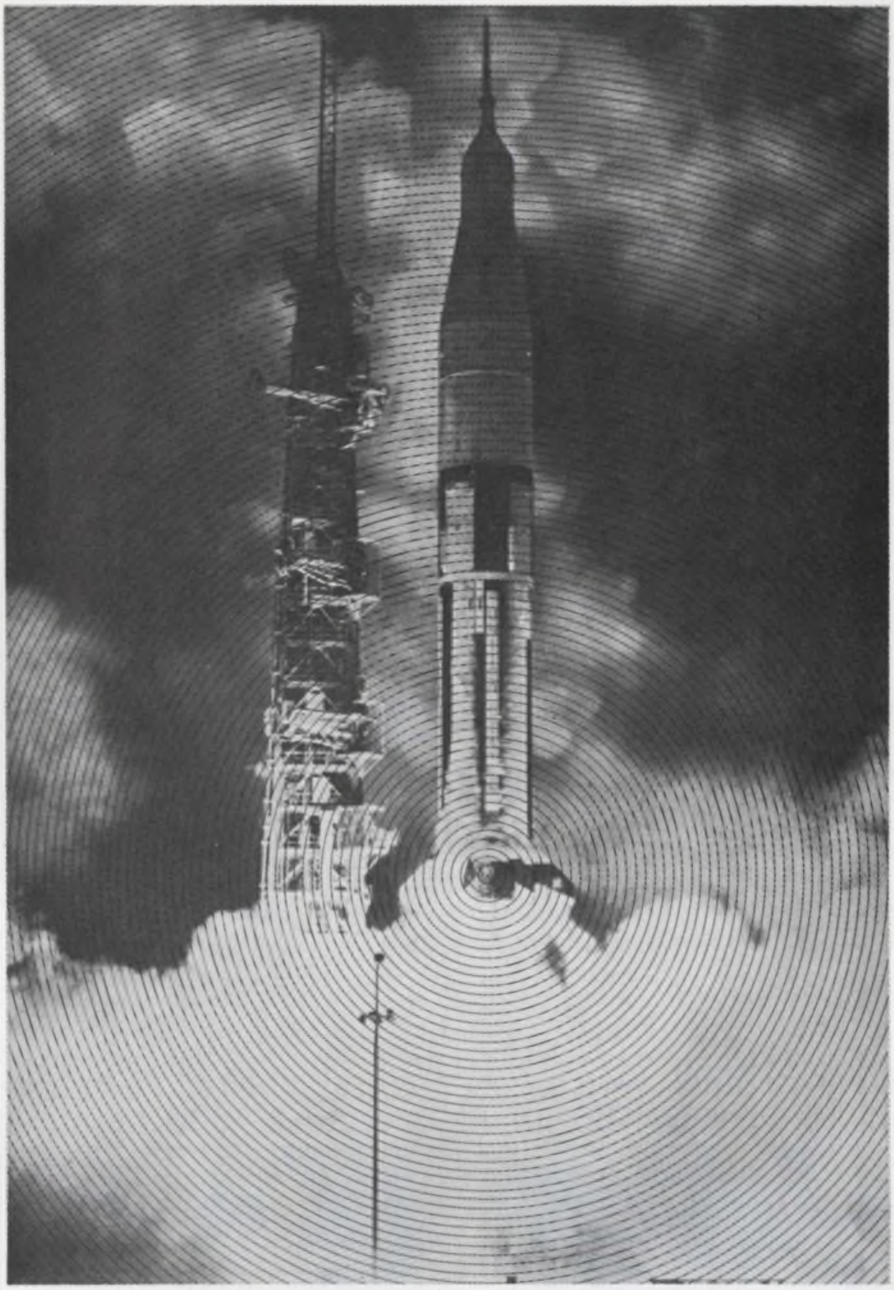
Their pnp complements are types 2N4898, 2N4899 and 2N4900. Prices for these are $195, $2.60 and $2.90, respectively.

Another npn power transistor is type 2N3441. For a cost of $2.70, it offers a maximum collector-base voltage of 160 V and a maximum collector-emitter voltage of 140 V. Collector current can be as high as 3 A.

Types 2N3740 and 2N3741 are 25-W pnp transistors selling for $2.70 and $3, respectively. They can carry a peak collector current of 4 A, with a maximum collector-base voltage of −60 V (2N3740) or −80 V (2N3741). Maximum collector-emitter voltage is also −60 or −80 V.

Operating junction temperature ranges from −65 to +200°C.

CIRLCE NO. 264



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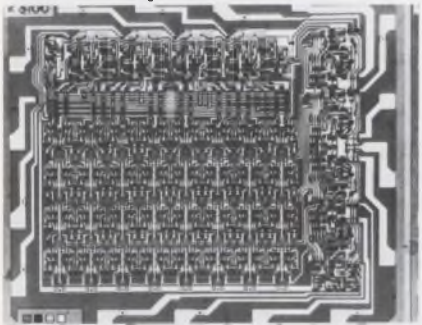
INFORMATION RETRIEVAL NUMBER 77

Random-access memory stores up to 64 bits

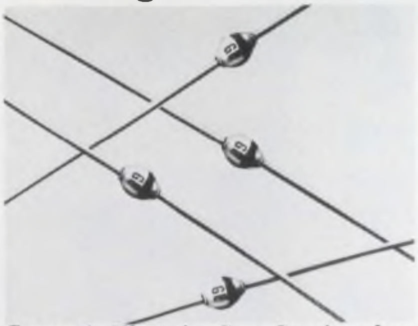


Raytheon Co., Semiconductor Operation, 350 Ellis St., Mountain View, Calif. Phone: (415) 968-9211. P&A: $38 or $51.50; stock.

A new bipolar 64-bit random-access memory, model RR6100, is organized as a 16-word by 4-bit array with a word accessability rate of less than 45 ns. The chip's write recovery time is less than 35 ns, while the minimum write pulse width required is less than 30 ns. The entire chip typically dissipates 350 mW and 420 mW maximum.

CIRCLE NO. 265

Low-current rectifiers are bargains at 30¢



General Electric Co., Semiconductor Products Dept., 1 River Rd., Schenectady, N.Y. Phone: (315) 456-2396. P&A: 30¢ to 57¢; stock.

Priced from 30¢ to 57¢ in 1000-piece quantities, new low-current fast-recovery rectifiers are rated at 1 A, from 50 to 600 V, with a maximum 200-ns reverse recovery time. Series A114 units are axial-lead devices with a dual-heat-sink construction. This provides mechanical support for the pellet and good thermal characteristics.

CIRCLE NO. 267

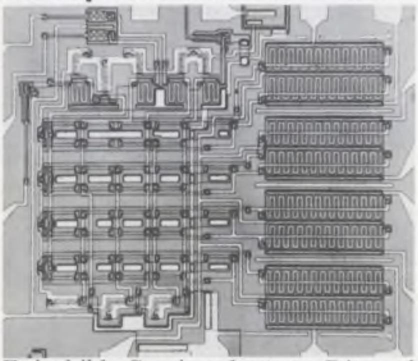
Logic level shifter switches in 200 ns

Mepco, Inc., Columbia Rd., Morristown, N.J. Phone: (201) 539-2000. Availability: stock.

With a typical switching speed of 200 ns, a new thick-film hybrid microcircuit converts logic levels from DTL/TTL levels to MOS levels. Compatible with all RTL, DTL and TTL circuits, the device operates through a temperature range of −55 to +125°C and from a supply voltage of 40 V. It is designed for use in high-speed digital systems and to assure dependable long-life operation.

CIRCLE NO. 269

Eight-channel switch multiplexes in 400 ns

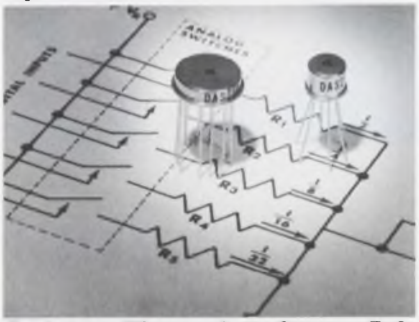


Fairchild Semiconductor, Div. of Fairchild Camera and Instrument Corp., 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $65 to $75.

Achieving a low on-resistance of 125 Ω, a new eight-channel 16-lead DIP multiplexer can switch channels in 400 ns typical. The model 3708, which measures 60 by 74 mils, has low input and output capacitances of 4 and 25 pF respectively, and a 1-nA leakage current.

CIRCLE NO. 266

Hybrid analog gates operate in 300 ns

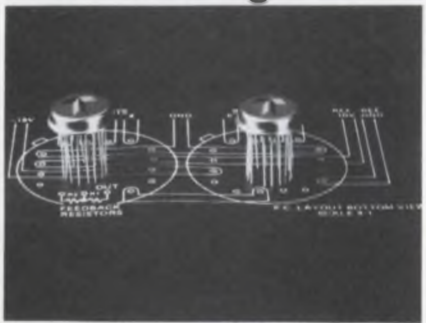


Dickson Electronics Corp., P.O. Box 1390, Scottsdale, Ariz. Phone: (602) 947-2231. P&A: $5.50 to $18; 3 wks.

Series DAS2107 (spst), DAS-2110 (spst) and DAS2126 (spdt) hybrid IC analog gates feature switching speeds as fast as 300 ns and an on-resistance as low as 30 Ω. The units also have zero offset voltage and the ability to handle ac signals through 1 MHz. Input supply voltage can be ±18 V, while operating temperature ranges from −55 to +125°C.

CIRCLE NO. 268

Hybrid IC system works 8-bit logic



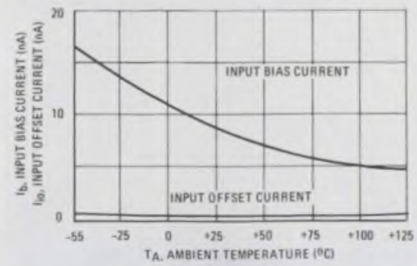
Crystalonics, a Teledyne Co., 147 Sherman St., Cambridge, Mass. Phone: (617) 491-1670. P&A: $450; stock.

Consisting of eight switching circuits and a ladder network in two TO-8 packages, a new hybrid IC system requires only a power supply and an operational amplifier to complete an eight-bit d/a converter. Model CDAS1, which operates from standard logic, has a total accuracy of ±0.1%. Settling time is 0.5 μs typical and 2 μs maximum to full accuracy.

CIRCLE NO. 270

Monolithic op amp slews 2.5 V/μ s

TYPICAL INPUT BIAS CURRENT AND INPUT OFFSET CURRENT versus TEMPERATURE for MC1556G



Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: $28; stock.

Featuring a maximum input bias current of 15 nA and a maximum input offset current of 2 nA, a new monolithic operational amplifier can slew at rates of 2.5 V/μs typical at unity gain. Model MC1556 also offers a power bandwidth of 40 kHz typical, a typical voltage gain of 200,000, a maximum power consumption of 45 mW and offset-voltage zeroing capability.

CIRCLE NO. 271

Monolithic op amp lowers bias to 3 nA

National Semiconductor Corp. 2975 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: $60; stock.

Outperforming FET amplifiers by a factor of 10 over the temperature range of −55 to +125°C is the model LM108 monolithic operational amplifier. It features a maximum input bias current of 3 nA and offset current less than 400 pA, while offset voltage is held to 3 mV and offset voltage drift to 3 uV/°C. The unit has a current gain of 5000.

CIRCLE NO. 272

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INFORMATION RETRIEVAL NUMBER 78

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2255 Old Middlefield Way
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(415) 969-3056

INFORMATION RETRIEVAL NUMBER 79

Stable X-band source phase-locks noise out

Philco-Ford Corp., Micro-Electronics Div., Union Meeting Rd., Blue Bell, Pa. Phone: (215) 948-8400. P&A: $500 to $1000; 75 days.

Claimed to be the world's first phase-lock avalanche oscillator, a new X-band device uses a feedback method to achieve lower noise, size and price in a microwave source.

The standard source, known as AVLOC model P8050, uses a portion of the prime output signal from its avalanche oscillator, feeds this to a phase detector, which compares this to the output of a standard, 0.005%-stable crystal-reference signal. The difference, if any, between the feedback and the crystal-reference signals is fed back into the avalanche oscillator through an IC operational amplifier.

This locks the frequency of the avalanche oscillator source to that of the crystal-reference signal.

The standard unit, at a bandwidth of 1 kHz, shows fm noise figures below the carrier of −50 dB at 1 kHz away from the carrier, −73 dB at 10 kHz away from the carrier, −74 dB at 100 kHz away from the carrier and −100 dB at a point 1 MHz from the carrier.

Noise data from a-m, which is neither enhanced nor degraded by the phase-lock method, is −100 dB at 1 kHz from the carrier at a 100-Hz bandwidth.

Standard output power is 100 mW and is available to 300 mW. Power consumption for the oscillator is 40 mA at −90 to −95 V typical and for the amplifier 100 mA at 28 V.

CIRCLE NO. 273

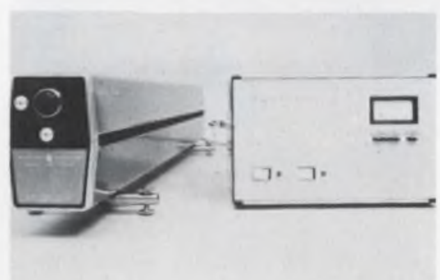
Sweep generator is programmable

Wavetek, P.O. Box 651, San Diego, Calif. Phone: (714) 279-2200. P&A: $995; 30 days.

Covering the frequency band of 500 kHz to 300 MHz, a new sweep generator can be externally controlled by any program interface capable of providing analog logic. The model 1001, which has an output of 1 V rms, can have its center-frequency tuning, sweep width, and variable attenuation parameters programmed for operating data or analog readout of operating points.

CIRCLE NO. 274

Air-cooled He-Cd laser emits in blue and UV



Spectra-Physics, 1250 W. Middlefield Road, Mountain View, Calif. Phone: (415) 961-2250. Price: $7500.

Claimed to be the first of its kind, a new air-cooled helium-cadmium laser emits a low-threshold, continuous and coherent light source in the blue and ultraviolet regions. The model 185 provides an output of 50 MW at 4416 A° blue and 5 mW at 3250 A° ultraviolet. The blue and ultraviolet wavelengths are both very short.

CIRCLE NO. 275

Comb generator spans 12 to 18 GHz

Zeta Laboratories, Inc., 616 National Ave., Mountain View, Calif. Phone: (415) 961-9050. Availability: 60 days.

Containing an integral 100-MHz power amplifier and an output ferrite isolator, a new comb generator provides a spectrum of 12 to 18 GHz with spectral lines spaced at 100-MHz intervals. Model 6000 has a spectral line power of −25 dBm and variation in spectrum flatness is held to less than 10 dB over 12 to 18 GHz.

CIRCLE NO. 276

Laser diode pulser socks out 28 A

Washington Technological Associates, Inc., 979 Rollins Ave., Rockville, Md. Phone: (202) 427-7550. P&A: $190; 4 wks.

Designed to pulse most semiconductor diodes efficiently, a new laser diode pulser can deliver 28 amperes in a package measuring only 1.5 cubic inches. The model LP-2 pulser works at a pulse width of 100 ns and can be clocked internally (special order), or triggered externally up to a 10-kHz rate.

CIRCLE NO. 277

Moorlee has the long and short of it in the box and cover business

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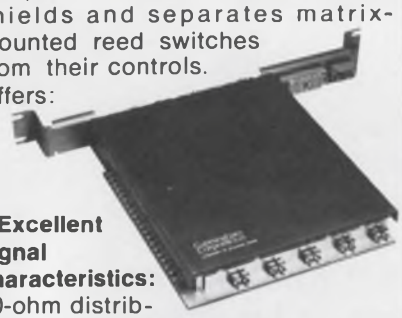
INFORMATION RETRIEVAL NUMBER 80

Isolation was the only thing preventing a high-frequency Reed Switch Matrix

Until now.

The Cunningham Reed Switch Matrix reduces high-frequency crosstalk and interference to a new low. Unique "sandwich" design seals, shields and separates matrix-mounted reed switches from their controls. Offers:



- **Excellent signal characteristics:** 50-ohm distributed. Broadband handling with top isolation. Low thermal noise.
- **100% Random access:** Any number or combination of crosspoints can be set, any place, any direction without affecting other crosspoints.
- **Computer compatibility:** Can be directly addressed by all computers using +5 volt logic. No added interfacing needed.
- **Proven reliability:** Up to 100 million operations.
- **Easy inspection and maintenance:** Control and signal sections can be separated for easy access.
- **Applications:** Interconnecting video channels; broadband data switching; test systems for nanosecond digital pulses; telemetry equipment for multiple data channels; antenna switching; medical data monitoring.

Write or call for Data Sheet No. 603, Cunningham Corporation, 10 Carriage St., Honeoye Falls, New York 14472. Phone: (716) 624-2000.

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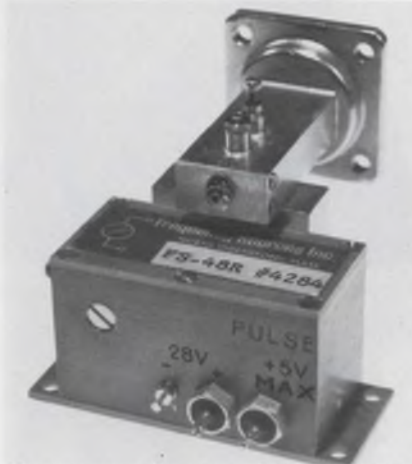
INFORMATION RETRIEVAL NUMBER 81

Ku-band oscillator tunes mechanically

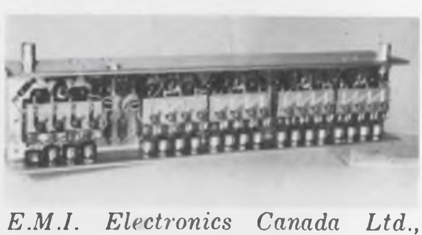


Frequency Sources Inc., Kennedy Drive, P.O. Box 159, N. Chelmsford, Mass. Phone: (617) 251-4921.

Featuring operation over the temperature range of −54 to +71°C, a new frequency source mechanically tunes over the Ku frequency band of 12.4 to 18 GHz. The FS-48R has a stability of ±0.1% over its operating temperature range, −35 dB harmonic suppression and minimum output power of 2 mW when used with a supply of 28 V dc at 125 mA.

CIRCLE NO. 278

Lightweight amplifier yields 100 W at 32 MHz



E.M.I. Electronics Canada Ltd., P.O. Box 1005, Dartmouth, N.S., Canada.

Operating in the 2 to 32 MHz range, a new 2-1/4-lb modular solid state linear amplifier can supply an output of 100 W when used by itself, and up to kilowatts when used in parallel with other units. The unit, which operates from a power source of −24 V dc at 11 A, has interface compatibility with hf Manpack transmitters.

CIRCLE NO. 279

Bandpass filters tune to 4 GHz

Texscan Microwave Products Corp., 4610 N. Franklin Rd., Indianapolis, Ind. Phone: (317) 454-6481. P&A: $320 to $510; 2 to 3 wks.

Series VF tunable bandpass filters span the frequency range of 50 to 4000 MHz, with any single model covering more than an octave. The new units are available with either a three- or five-section response and have a 3-dB bandwidth of 5%. Insertion loss varies from 0.2 to 1.5 dB, while VSWR is less than 1.5:1. The filters are housed in an aluminum case.

CIRCLE NO. 280

Broadband amplifier lowers noise to 6 dB

Electro/Data, Inc., 1621 Jupiter Rd., Garland, Texas. Phone: (214) 341-2100. P&A: $750; stock.

Covering the frequency range of 1 to 2 GHz, a new amplifier has a 15-dB gain within this range and a 10-dB gain from 0.7 to 2.2 GHz with a typical noise figure of 6 dB and a maximum of 8 dB. The model A-12 has input and output impedances of 50 Ω and a shielded dc-bias input. It is compact and lightweight and requires −12 V at 14 mA for biasing.

CIRCLE NO. 281

Pulse-width analyzer uses BCD readouts

Holiday Engineering, 2540 Teresina Dr., Hacienda Heights, Calif. Phone: (213) 336-0821. P&A: $360; 30 days.

Using all IC logic circuitry, a new digital pulse-width analyzer can measure pulse widths from 1 μs to 999 ms by three BCD decade readouts. The model 501 can measure pulses with an amplitude of ±1.5 to 50 V to accuracies of 0.005% ± 1 count over the preset range. Transient pulses 25 ns or greater and overranging are indicated by front-panel lights.

CIRCLE NO. 282

Amplifier/voltmeter is accurate to 3%

Cohu Electronics, Inc., P.O. Box 623, San Diego, Calif. Phone: (714) 277-6700. P&A: $825; stock.

Able to make direct potentiometric and comparative voltage measurements and non-inverting dc amplifications, a new dc microvoltmeter/amplifier has an accuracy of 3% of end scale. Model 207 has a common-mode rejection of 120 dB from dc to 60 Hz, better than 1 V/week of zero stability and amplifier linearity to within 0.05% of full scale.

CIRCLE NO. 283

Low-cost $795-counter measures to 200 MHz

Itron Corp., 11675 Sorrento Valley Rd., San Diego, Calif. P&A: $795; stock.

Measuring frequencies from 20 to 200 MHz, a new counter can also measure period, time interval, frequency and multiple ratio, totalize and count events-per-external time for only $795. Model 680 has a seven-digit display, 100 mV sensitivity, gate times of 1 and 10 s, 20% noise rejection, and an input impedance of 1 MΩ direct and 50 Ω in the prescale mode.

CIRCLE NO. 284

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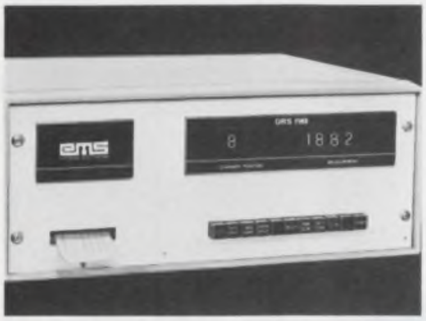
INFORMATION RETRIEVAL NUMBER 82

Low-cost data system scans 1000 channels



Electronic Micro Systems, 1672 Kaiser Ave., Santa Ana, Calif. Phone: (714) 549-2295. P&A: $1995; 4 wks.

Providing a 10-point scanner for programming inputs, visual display of measured input data and scan positioning, and a paper-tape printout, a new low-cost data acquisition system optionally scans up to 1000 input channels. Model DRS-1168 unit has a resolution of 0.1% on three-place readings with optional five-place readings and resolutions of 0.01% or 0.001%.

CIRCLE NO. 285

Five-digit counter has adjustable limits

Monsanto Electronic Instruments, 620 Passaic Ave., W. Caldwell, N.J. Phone: (201) 228-3800. P&A: $975; 12 wks.

A five-digit 0 to 2.5-MHz counter expands its capabilities by its use as a timer, high-speed digital comparator, and a high- and low-limit counter. The model 109A counter has adjustable 0 to 99,999 high- and low-limit switches, is remotely programmable, has a sine-wave sensitivity of 50 mV rms, and is compatible with computers.

CIRCLE NO. 287

Wideband analyzer goes out to 110 MHz

Hewlett-Packard Co. 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $2950; 90 days.

Displaying gain or loss over an 80-dB range and measuring up to 100 dB, a new network analyzer spans the frequency range of 0.1 to 110 MHz. The model 8407A with optional accessories completely characterizes displayed data, acts as a tracking filter during swept measurements and shows amplitude at 0.25 dB/octave and phase at 1°/division.

CIRCLE NO. 289

Digital counter/timer is fully-programmable

Beckman Instruments, Inc., 220 Wright Ave., Richmond, Calif. Phone: (714) 871-4848. P&A: $1375.

Complete programmability, plug-in ICs and frequency measurement to 136 MHz are features of the model 6401 counter/timer. The eight-digit display unit has trigger-point monitor lamps, burst mode and measures half-period. Frequency or period can be measured on either of two channels and the unit can display the frequency of a random burst of pulses.

CIRCLE NO. 286

Remote time display can mount anywhere

Systron Donner Corp., 888 Galindo St., Concord, Calif. Phone: (415) 682-6161. P&A: $1300 to $1550; 30 to 45 days.

With its swivel base, a new single-line remote digital time display unit can be mounted on walls or from ceilings for any application requiring a time readout located far from its time-code generator or timing instrument. Model 8181 converts IRIG B serials BCD inputs into parallel form and presents them in days, hours, minutes and seconds. Display characters are 0.808-in. high and allow a rated viewing distance of 38 ft.

CIRCLE NO. 288

Economy oscilloscopes cover 10-MHz band

Tektronix, Inc., P.O. Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $550, $435, $685; 19 wks, 3 wks, 13 wks.

A new series of three oscilloscopes, the dual-trace D54 and the single-trace S54A and S54U, offers a range of selection: vertical bandwidths of dc to 10 MHz, deflection factors of 10 mV/cm to 50 V/cm in 12 steps, sweep rates from 200 ns/cm to 2 s/cm in 22 steps and 6- by 10-cm CRTs. The model S54U can also be operated from batteries.

CIRCLE NO. 290

Binary-level monitor displays when strobed

Industrial Inventions, Inc., RD2, 463 U.S. Route 1, Monmouth Junction, N.J. Phone: (201) 329-6000. P&A: $225; stock.

Comparing binary data levels of different points, a new strobed latching monitor unit allows simultaneous monitoring of 10 changing binary circuit points, and stores and displays the data when it is strobed by a high, low or manual level. The Logalog model 33 can also monitor 10 slowly changing data points by a 1 or 0-state indication.

CIRCLE NO. 291

Test probe with hooks simplifies gripping

Hunter Associates, 182 Clairmont Terr., Orange, N.J. Phone: (201) 672-0423. P&A: $2.10; stock.

Consisting of three retractable spring clamps which are activated by light pressure on its head, a new probe will grip the finest wire and then retract into an insulated sleeve, eliminating short circuits in high-density wiring. The H-3 probe is a heavy-duty device that will not loosen under vibration or when twisted. Connections to it can be made through a standard banana jack on its head.

CIRCLE NO. 292

Looking for an economical system building block?

REDCOR 720 MUX/A-D CONVERTER

REDCOR's Model 720 Multiplexer/A-D Converter is an economical and versatile system-building block that accepts up to 32 channels of analog data. Time-shared multiplexing and successive approximation analog-to-digital conversion are utilized to process the analog input data into a format suitable for inputting directly into a computer. The basic 720 contains modular multiplexers, high-input impedance buffers, a sample and hold, an ADC, power supplies, and a voltage reference.

The 720 Multiplexer/A-D Converter offers distinct cost-performance advantages for a wide variety of data-acquisition problems where high resolution and attendant accuracy must be compared to system cost and throughput rates. The 720 is available in 8 to 12 bits binary, with system throughput rates ranging from 40 KHz to 20 KHz. Either single-ended or differential inputs are provided, with full-scale input ranges from 5v to 20v in bipolar or unipolar configurations.

The 720 is completely self-contained in a forced-air-cooled 19-inch chassis that requires only 1¾ inches of panel space. Modular concepts are employed throughout the instrument, with all circuitry contained on plug-in circuit modules that are removable from the master interconnect mother PC board. All test points required for system test calibration and maintenance are available from the swing-out front panel. The modular structure of the 720 ensures ease of maintenance and simplifies field expandability of channels.

Simplified operation, low-cost, ease of interfacing, and guaranteed system performance specifications make the Model 720 Multiplexer/A-D Converter attractive for any computer-controlled data-acquisition or process-control application.

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INFORMATION RETRIEVAL NUMBER 84

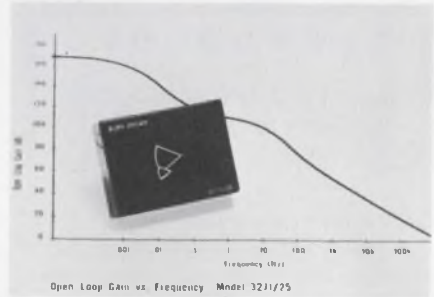
Small 5-W IC supplies power up to 800 gates

Datacube Corp., P.O. Box 676, Salem, N.H. Phone: (603) 898-9400. P&A: $49; stock to 4 wks.

Measuring only 2 by 2 by 0.4 in., a new series of low-cost regulated power supplies deliver a 5-W output of 5 V dc at 1 A. This means that a single series DUP supply can power up to 100 DTL dual quad gates or 25 TTL decade counters. All units feature a line and load regulation of ±0.05%. In addition, they have full short-circuit and overvoltage protection.

CIRCLE NO. 293

Chopper amplifier supplies 50 to 110 V

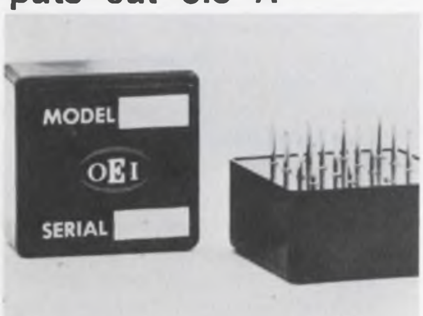


Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: $160; stock to 4 wks.

Designed for operation from power supplies of ±60 to ±120 V dc, a new encapsulated chopper-stabilized operational amplifier provides an output of ±50 to ±110 V. Model 3271/25 ensures a maximum input voltage drift of only 1 μV/°C, while eliminating the noise spikes usually associated with chopper amplifiers.

CIRCLE NO. 295

Compact op amp puts out 0.5 A



Optical Electronics, Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: $77; stock.

Delivering an output current of 0.5 A, the 9684 operational amplifier is a flexible building block capable of driving servo motors, deflection coils and very long cables. No external compensation components are required for unity-gain operation. Minimum open-loop gain is 50,000; maximum input bias current is 100 nA.

CIRCLE NO. 294

Hybrid $9 amplifier boosts power to 5 W

Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif. Phone: (714) 871-4848. Price: $8.95.

Selling for $8.95, a new 5-W miniature unity-voltage-gain power booster can drive low-impedance loads to within 4 V of either the negative or positive supply voltage. Model 823 is a hybrid cermet thick-film amplifier with a total bandwidth of dc to 4 MHz. The unit can boost a preamplifier's power level with no deviation from recommended compensation network values.

CIRCLE NO. 296

Dual op amp supply is a 1.5-in. square

Palomar Engineers, P.O. Box 455, Escondido, Calif. Phone: (714) 745-2051. P&A: $62.50; 2 wks.

Providing a dual 15-V output at 150 mA, a new power supply for operational amplifiers measures only 1-1/2 by 1-1/2 by 1 in. and weighs 2.7 oz. The unit is intended for limited space applications and direct PC-boad mounting. Its line and load regulation is 0.5%, ripple is 2 mV rms, and short-circuit current is 175 mA. The ac source could be 115 V, 50 to 400 Hz.

CIRCLE NO. 297

Economy amplifiers drift but 2.5 μV/°C

Zeltex, Inc., 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $16 to $35; stock.

Suitable for high-gain inverters, comparators, and buffers, three new low-cost operational amplifiers, models ZEL-1/02, 03 and 04, hold maximum input voltage drift to 2.5, 5 or 10 μV/°C, respectively. All three units have a minimum dc gain of 500,000, a 50-nA input bias current, a common-mode rejection ratio of 20,000, 6-V/μs minimum slew rate, and only 2-μV of noise.

CIRCLE NO. 298

Faster, easier set-ups with

advanced "AGREE" chambers

Tenney's "AGREE" Chambers have always offered the utmost in performance to meet and exceed all test levels of MIL-Std-781A. Now you also get the utmost in operator convenience. Tenney's exclusive "Redi-Seal" (patent applied for) provides a soft cushion of foam to seal between the chamber and L.A.B. or comparable vibration testing machines. No more cumbersome diaphragms . . . no removable chamber sections . . . just roll the table in place. Save set-up time. Fully automatic operation of chamber, vibrator, and test item. Make it easy for yourself. For complete information on the latest in "AGREE" testing, write or call

Tenney ENGINEERING, INC.
1090 Springfield Rd., Union, New Jersey 07083 • (201) 686-7870
Western Division: 15721 Texaco St., Paramount, Calif. 90723

488

INFORMATION RETRIEVAL NUMBER 85

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ACHRODYNE

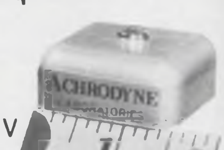
2 NEW POWER PACKED OP AMPS

NEW
PM6100 10A 250W
PM6040 4A 100W

BOTH UNITS FEATURE

- Full electronic protection
- Open loop gain 90dB min.
- Full ± 25V output
- Supply ranges of ± 10 to 30V
- Compact 1" x 3" x 4" and 1" x 2" x 2.5"
- Full output from dc to 50kHz
- Quiescent current 7mA and 25mA max.

Prices start at $135.00
1 to 9 units
Full specs and prices on request



PM603
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Still the best buy in wideband operational power
$49.50 (1 to 9 units)

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LABORATORIES
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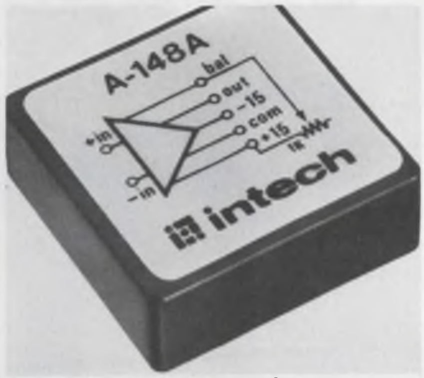
Yorktown, Va. 23490
(703) 898-6152

INFORMATION RETRIEVAL NUMBER 86

FET-input amplifiers settle in 1 μs to 0.01%



Intech Inc., 1220 Coleman Ave., Santa Clara, Calif. Phone: (408) 244-0500. P&A: $40 to $50; stock.

Series A-148 FET-input operational amplifiers offer maximum settling times of 1 μs to reach 0.01% of final value; typical settling times are 0.6 μs to 0.01%, 0.4 μs to 0.1%. Due to their smooth 6-dB/octave roll-off, the units achieve good pulse response with minimum overshoot and ringing. Bias current is 25 pA; input impedance is 10^{11} Ω; minimum bandwidth is 7.5 MHz.

CIRCLE NO. 299

Compact power supply holds ripples to 50 μV

Transidyne General Corp., 462 S. Wagner Rd., Ann Arbor, Mich. Phone: (313) 663-9329.

Ideal for amplifiers that require a low-noise power source, the MPS-15 is a solid-state ±15-V dc power supply that features a maximum ripple of 50 μV at full load. This new product weighs just 1-1/2 pounds and measures only 4-3/4-in. square by 2-in. high. It has four output terminals: +15 V dc, −15 V dc, a floating common, and an earth-to-ground connection.

CIRCLE NO. 317

High-gain op amp drifts 0.6 μV/°C

Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. Phone: (213) 894-2271.

Featuring a differential input, open-loop gain of 20 million, and a single-ended output, a new solid-state dc operational amplifier has a high stability, drifting only 0.6 μV/°C and 5 μV per week. Model 3002 can operate over the temperature range of −55 to +125°C. It has a 300-MΩ input impedance, zero offset voltage and 2-pA/°C offset current drift.

CIRCLE NO. 318

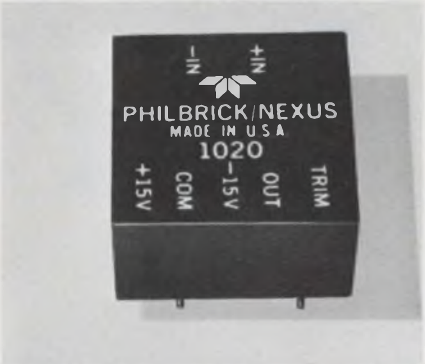
Low-power clock runs on batteries

General Oceanology, Inc., sub. of Bolt Beranek and Neuman Inc., 27 Moulton St., Cambridge, Mass. Phone: (617) 492-6300. Price: $895.

Consuming only 2 mW at a supply voltage of 9 V, a new self-contained crystal-controlled electric clock can operate for one year on only six C-cell batteries. The clock has an over-all accuracy of one second per day over a temperature range of 0 to 30°C. Drift can be as low as 0.05 ppm per week. The unit provides a 14-bit digital clock number with the least and most significant bits at 15 minutes and 2048 hours, respectively.

CIRCLE NO. 319

Differential op amp offsets ±0.5 mV



Philbrick/Nexus Research, a Teledyne Co., Allied Drive at Route 128, Dedham, Mass. Phone: (617) 329-1600. P&A: $33 to $62; stock.

Model 1020 is a new economy chopperless differential operational amplifier that offers maximum initial offset voltages from ±0.5 to ±3 mV. Maximum offset voltage temperature coefficient ranges from ±0.25 to ±5 μV/°C for its four versions. Performance characteristics for the unit entail a gain of 10^6 and a common-mode rejection ratio of 10^5.

CIRCLE NO. 320

Operational supplies slew at 1 μV/s rate

Kepco, Inc., 131-38 Sanford Ave., Flushing, N.Y. Phone: (212) 461-7000. P&A: $468; 30 days.

Featuring output voltages of 0 to 500 Vdc at 0 to 40 mA and 0 to 1000 Vdc at 0 to 20 mA, two new operational power supplies, models OPS 500 and OPS 1000, display an open-loop dc gain of 0.5 × 10^6 V/V and a 1 μV/s slewing rate. They are self-contained high-voltage unipolar operational amplifiers that can suppress ripple down to 0.01%.

CIRCLE NO. 321

Until our new Unipulser II came along,

single decade counters were pretty much alike.

Compare it with any competitor on these eight points:

1. Size. Unipulser II is more compact than any comparable electric counting decade.

2. Durability. Mechanical and electrical transfer lives are longer than those of comparable decades. That's because Neyoro g wiper contacts provide the highest quality electrical contacts available.

3. Power. Three voltages are standard, not just one. 12, 24 and 48 VDC.

4. Readability. Large figures, wide-angle viewing.

5. Unitized metal diecast frame. This makes Unipulser II self-supporting from the front and simplifies installation. Push button preset model has the same frame dimensions.

6. Input. Counts from transistorized circuits, photocell impulses or standard contact closures. Speeds up to 40 cps; count is retained even if power fails.

7. Modular. Each Unipulser II has its own drive input circuit, transfer and reset circuit and an eleven-line output for control or electrical readout. This lets you combine Unipulser II's in series for sequential counting or parallel entry. Control circuitry also lets you use them as recycling or single cycle predetermined counters—or as counters with remote display. Or even as readout devices for *other* counters or recording units.

8. Price. Here's the best part. Our prices begin at $18 and go down just as fast as anyone else's on quantity buys. Push button reset model begins at $19. All in all, you won't find another decade that does so much for so little. For full information and specifications, write for Unipulser II catalog. 622 N. Cass Street, Milwaukee, Wisconsin, 53202.

The modular Unipulser II has hundreds of uses, from metering to data processing to all types of production control.

CONTROL

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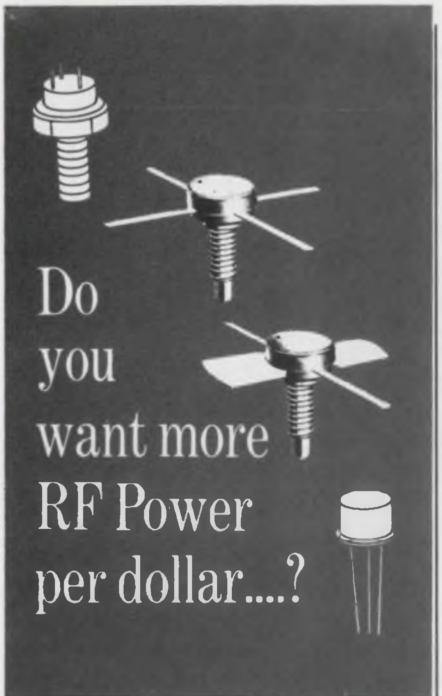
A CUTLER-HAMMER COMPANY

INFORMATION RETRIEVAL NUMBER 87



Investigate Solid State's Cost Optimized RF Power Transistor Families

Solid State Scientific's new SD 1100 and SD 1180 RF power transistor families can be the answer to your CATV-MATV, Mobile Communications, and other RF amplifier and oscillator requirements. Four power packages, including TO-39, TO-60, "satellite" and "butterfly" strip-line configurations, can satisfy the broadest range of applications. Multi-emitter electrode construction with a 60% increase in emitter density results in increased current handling. Other important features include gain to 12 db, extremely high efficiencies, low distortion and noise, and the lowest prices in the industry.

Solid State's other standard low cost UHF power transistors range from a 2N3866 at $1.35 to a 2N4431 at $22.00, available in any quantities.

For further information and technical data write or call

SOLID STATE SCIENTIFIC INC.

A SUBSIDIARY OF TRESCO SCIENTIFIC DEVICES
MONTGOMERYVILLE, PENNA. 18936
215-855-8400 TWX-510-661-7287

INFORMATION RETRIEVAL NUMBER 88

Small modular supplies deliver up to 5 kV

Computer Power Systems, Inc. 722 Evelyn Ave., Sunnyvale, Calif. Phone: (408) 738-0530. Price: from $410.

A new series of interlocking epoxy-block high-voltage power supplies, which are only 4-1/2 by 4-5/8 by 9 in., cover the voltage range of 500 to 5 kV. The CPS 2000 series offer low drifts of 0.005% per hour and 0.01% per 24 hours. Regulation is less than 0.001%; and ripple is 2 mV pk-pk. These short-circuit-protected units operate inaudibly and eliminate shock hazards.

CIRCLE NO. 322

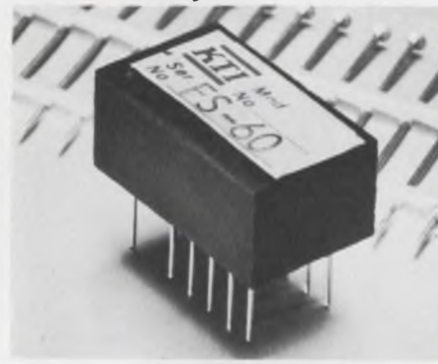
Power sequencers control 8 supplies

Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, N.Y. Phone: (516) 694-4200. Price: from $580.

Designed for precise sequential control and protection of associated equipment, series SPS-90 and SPS-80 power sequencers will sequence up to eight power suppliies "on," independent of polarity in any order, and "off" in the reverse order. An incomplete turn-on sequence causes all output voltages to be crowbarred.

CIRCLE NO. 323

Active 10-kHz filter needs only 0.3 mW



Kinetic Technology, Inc., 3393 De La Cruz Boulevard, Santa Clara, Calif. Price: $10.

Particularly suitable for use in battery-operated equipment, a new hybrid IC active filter requires only 0.3 mW of power at ±2 V. Operating in the frequency range from dc to 10 kHz, the FS-60 features multi-loop negative feedback for high stability and a Q range from 0.1 to 500. Other key specifications include the ability to attain complex zeros anywhere in the s-plane.

CIRCLE NO. 324

Low-cost power supply has 0.2% regulation

Optical Electronics Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-3605. P&A: $28; stock.

Costing only $28 in 10-lot quantities, a new regulated dc power supply provides an output of 15 V dc at 100 mA with a line and load regulation of 0.02%. The model 887 unit is packaged in a five-lead module that measures four cubic inches. Its output voltages can be trimmed and it is completely short-circuit proof.

CIRCLE NO. 325

Low-cost calculator programs 111 steps

Sony Corp. of America, 47-47 Van Dam St., Long Island City, N.Y. Phone: (212) 361-8600. Price: $1695.

Featuring a simple programming format and low cost, a new $1695 desktop programmable calculator with nine memories accepts up to 111 program steps. Model ICC-2500 enters information through a front keyboard and displays it on a 15-digit numeric readout and can display and correct program instructions. Cassette program storage and accessory printer are optional.

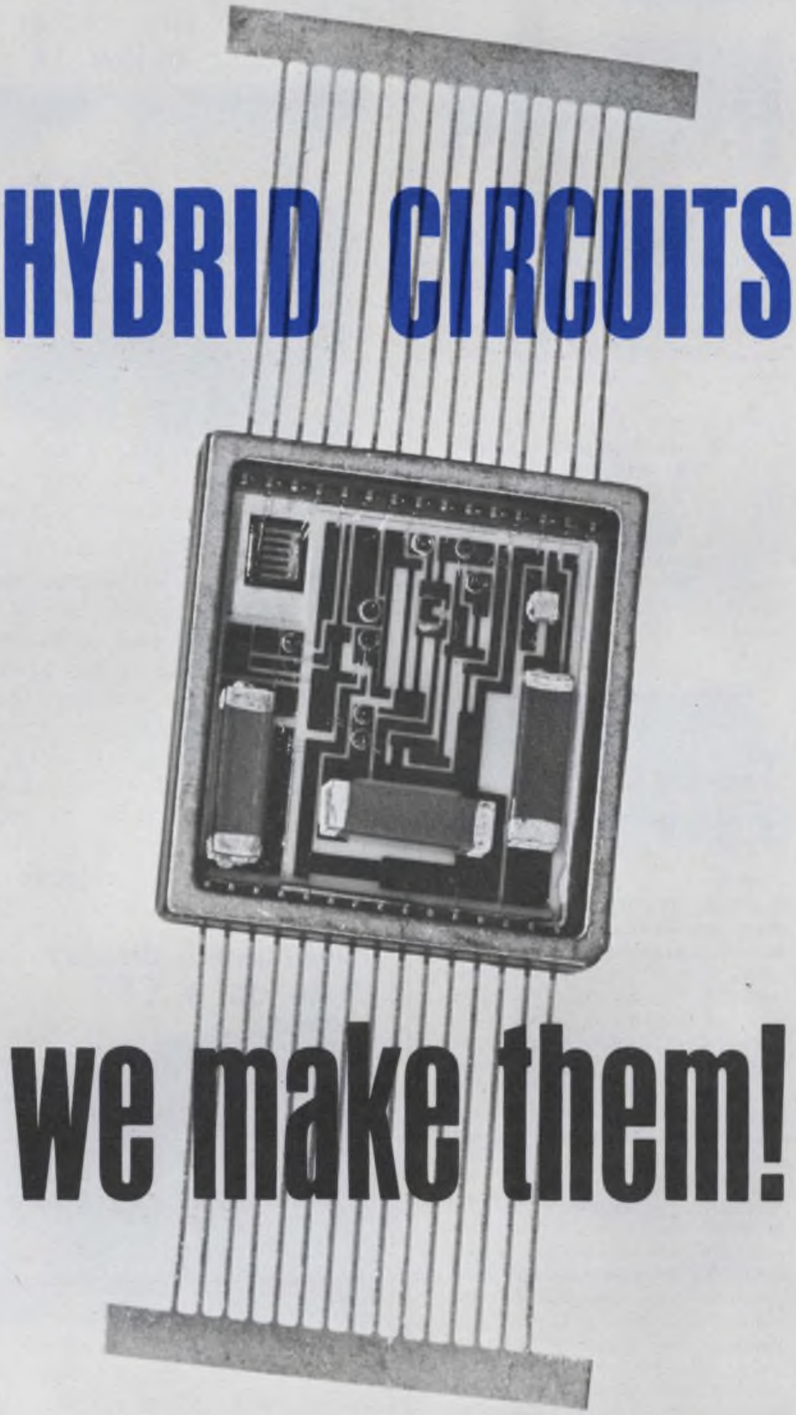
CIRCLE NO. 757

Desktop calculator performs in 10 ms

Busicom U.S.A., Inc., 31 E. 28 St. New York, N.Y. Phone: (212) 689-4925.

With a display capacity of 12 digits, a new easy-to-use MOS IC desktop calculator can add and subtract in 10 ms and multiply and divide in 250 and 300 ms respectively. The model 120DA automatically places the demical point with the user selecting the number of digits to appear to the right of the decimal. The unit consumes 7 W and measures 10 by 11-1/2 by 4 in.

CIRCLE NO. 335



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INFORMATION RETRIEVAL NUMBER 89

NEW PRODUCTS FROM EDC

ELECTRONIC DEVELOPMENT CORP.
BOSTON, MASSACHUSETTS

The DC Voltage ΔVM/TVM/Calibrator Model 2900 is a high accuracy Differential Voltmeter. It is also an active dc Voltage Calibrator and a very high impedance (Z_{in} 100MΩ) Transistorized Voltmeter. *Calibration accuracy:* ±.002%. *Differential measurements in 5 ranges:* ±1000, ±100, ±10, ±1, ±0.1 V (f.s.) w/decade resolution of 1 ppm: 1 mV, 100 V, 10 V, 1 V, 100 nV. *Eight (8) push-button range sensitivities:* ±1000. ±100, ±10, ±1, ±0.1, ±0.01, ±.001V and ±100 V. The Z_{in} is ∞ at null, ALL input voltages, and up to 100 MΩ off null. *Output Mode* (calibrator): 4 ranges: ±100 V, ±10 V, ±1 V, ±100 mV. 1 ppm resolution: 100 μV, 10 μV, 1 μV, 0.1 μV. Current is 100 mA, w/4-terminal remote sensing. *Price:* $1,650.00, F.O.B. Boston.

The Model AC-1000, Series A, a "Work Horse" standard for laboratory, production line or field applications, is a calibrator for meters, VOMs, TVMs, AC Millivolt Meters and DVMs. Used by designers for development and evaluation of amplifiers, converters, filters, rectifiers, regulators, demodulators, transformers and low Z inductors. It is a stable source for servo applications, an input conditioner for gyroscope, microsyn, and spin motor supplies and a stability testing source for components, modules and systems.

Four output ranges: from 10 μV to 1100 Vac. *Resolution:* from 1μV to 1 mV. *Amplitude accuracy:* 0.05% of setting. *Stability:* 0.0075%/8 hours is a major feature. *Power output:* 50 VA or 2A maximum. Z_{out}: from 1 mΩ to 10Ω maximum.

Frequency range: 45 Hz to 5000 Hz with internal and external oscillator capabilities.

Output distortion: less than 0.5%.

Small size: 19" x 7" x 14", bench or rack mountable. *Weight:* 45 lbs. Short-circuit and overload protection with front panel indicator. The price of the Model AC-1000 Series A is $2940, F.O.B. Boston.

Instruments available for no-charge engineering evaluation.

Electronic Development Corporation
423 W. Broadway ● Boston, Mass. 02127
(617) 268-9696

INFORMATION RETRIEVAL NUMBER 90

Table-top dry copier cuts cost below 1¢

Friden Div. of The Singer Co., 2350 Washington Ave., San Leandro, Calif. Phone: (415) 357-6800. P&A: $1795; 1st quarter, 1970.

Utilizing an electrostatic reflex image transfer process, a new dry table-top office copier produces 15 copies per minute of any kind of uncoated paper at less than 1¢ per copy. The model 1070 unit needs no warm-up, produces sharp images of paper sizes up to 8-1/2 by 14 in. and can make 10 copies automatically.

CIRCLE NO. 336

High-speed display plots on a CRT

Datatrol Inc., Kane Industrial Dr., Hudson, Mass. Phone: (617) 562-3422. P&A: $265/month; Nov. 1969.

Interfacing directly to incremental plotters, a new high-speed display offers a speed advantage of 100 to 1 over mechanical plotters. FastPlot 1200 displays information on a large storage tube with versions available for 11 and 30-in. plotters and step sizes of 2.5, 5 and 10 mils. Scissoring and magnification features are also included in the display.

CIRCLE NO. 337

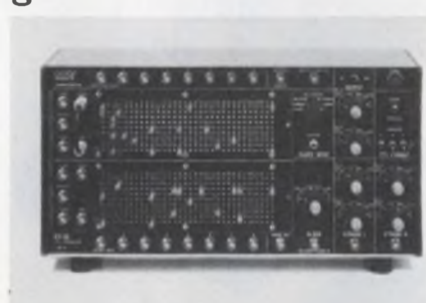
Document expediter communicates rapidly

Graphic Sciences, Inc., Corporate Dr., Commerce Park, Danbury, Conn. Phone: (203) 744-3100. Price: $75/month.

Part of a family of modular acoustically-coupled information expediters, dex 1 is an appliance that transmits and receives documents nationwide over ordinary telephone in 1 to 6 minutes. It has an integrated acoustic coupler box and uses a single sheet of electro-sensitive paper to transmit and receive anywhere handwritten, typed, drawn or pictorial information.

CIRCLE NO. 338

Eight-bit byte source generates to 8 MHz



Adar Associates, Inc., 85 Bolton St., Cambridge, Mass. Phone: (617) 492-7110. P&A: $2500; 30 days.

Operated in master-slave combinations by a patch-panel program control that allows sequences, wide output words and program nesting, a new low-cost pattern generator provides 32 or 64 eight-bit bytes at rates of 10 Hz to 8 MHz in parallel or serial form. Model EC-22 has sync and strobe signals, TTL-compatible outputs and can provide ASCII outputs without reprogramming the board.

CIRCLE NO. 339

Electric typewriter types edited copy

IBM Corp., Office Products Div., 590 Madison Ave., New York, N.Y. Phone: (212) 751-1900. P&A: $7875 or $175/month; 8 wks.

Using inserted magnetic storage cards with a storage capacity of 5000 typed characters to capture typed information, a new typewriter types the information back at a speed of 150 words per minute with the desired corrections or revisions. Model 975 Selectric typewriter is activated for typing back by a pushbutton after a new copy has been inserted in the typewriter.

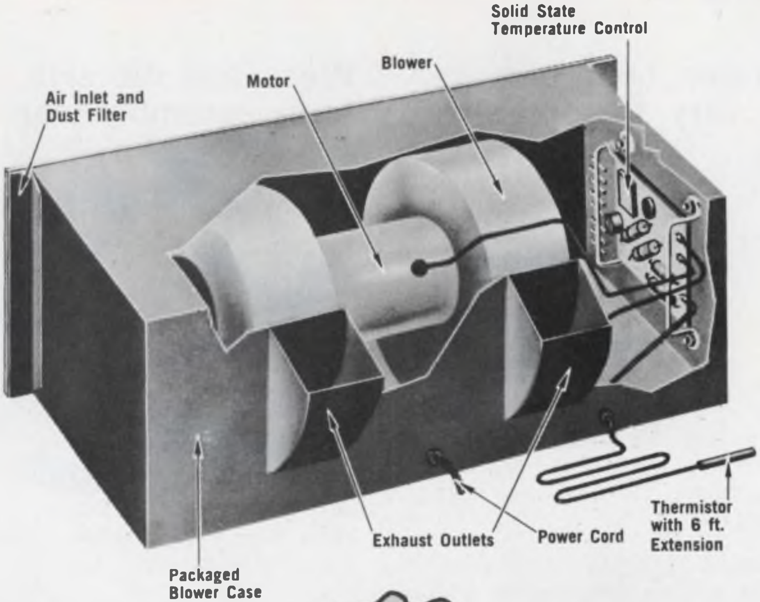
CIRCLE NO. 340

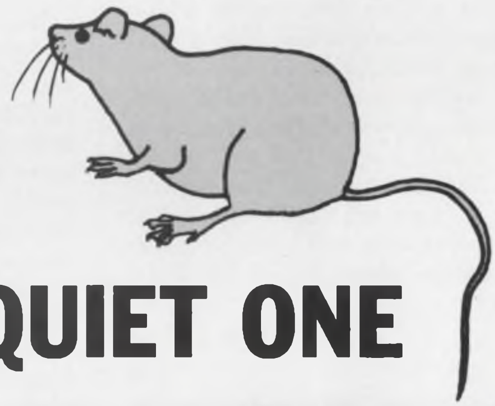
Portable projector shows most drawings

Taylor Merchant Corp., Microfilm Div., 25 W. 45 St., New York, N. Y. Phone: (212) 757-7700. Price: $80.

Accepting drawing sizes from A through E and military D micro aperture cards, a new fan-cooled 3-lb projector can show entire drawings in ambient light with a wall-size image. The portable Aperture-Master 400 loads quickly and easily, has a sharp lens system and can be adapted to show color slides and film strips.

CIRCLE NO. 341





THE QUIET ONE

McLEAN'S SOLID STATE MOTOR CONTROLLER PROVIDES THE ANSWERS TO NOISY COOLING

Now you can cut audible noise level in system cooling to a bare minimum. McLean's transistorized control and modulating thermostatic probe sense component or outlet air temperatures. Together they automatically slow down blower speed to meet the exact requirement for cool air to maintain constant thermal stability. The slower blower speed results in quietest operation, efficient cooling, and longer life for components and blowers. Write for Data Sheet No. SSC700.

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McLEAN ENGINEERING LABORATORIES

Princeton Junction, New Jersey 08550 • Phone: 609-799-0100 • TELEX: 84-3422

INFORMATION RETRIEVAL NUMBER 91

Portable heat blowers can vary temperature

Master Appliance Corp., 1745 Flett Ave., Racine, Wis. Phone: (414) 633-7791.

Able to provide a continuous flow of hot air (250 to 800°F) on a 24-hour basis, a new line of heat blowers features an adjustable intake orifice that varies the temperature. Series AHD units use a heavy-duty motor and a precisely rated heating element. The blowers also have an adjustable handle for easy portability and maneuverability, and an adjustable 6 by 13-in. base.

CIRCLE NO. 342

Wick-type desolderer ends burnt fingers

Easey Electronic Co., P.O. Box M-33, Fremont, Calif. Phone: (415) 792-1030. P&A: $1.80 or $3.50 per spool; stock.

Packaged in two sizes of interlocking hand-sized spools, a new wick-type solder remover prevents finger burning during desoldering and eliminates waste and tangles. Called Solder Blotter, the product works in one second to make connections solder-free and ready for circuit salvage or resoldering. Two sizes are available, for large (Bonus-Wik) and small (micro-Wik) tasks.

CIRCLE NO. 343

Press and die sets form assembly team

Janesville Tool & Mfg., Inc., Janesville, Wis. P&A: $42.50 for press, $23 to $30 for die.

Helping to solve the problems of small parts assembly and intricate die work, a new small in-line (arbor) press and three new miniature die sets offer precision features for electronic/mechanical assembly, or light stamping. The die sets may be used separately from the press or in combination. The two new products provide inexpensive tooling set-ups and allow low-volume manual production runs. In addition, they can eliminate the tying up of larger and more expensive equipment. Die sizes are 2-3/16 by 2-1/2, 2-7/8 by 3-3/8, and 3-3/4 by 5 in.

CIRCLE NO. 344

Hand-held cutter trims burr-free

Henes Manufacturing Co., 4301 E. Madison St., Phoenix, Ariz. Phone: (602) 215-4126. P&A: $35; stock.

A new hand-held tool simultaneously cuts flat burr-free ends on all three leads of TO-92, TO-18, TO-52, and TO-46 transistor packages. Square-Kut model Sk-210 eliminates linear stress on the leads being cut. It also incorporates a single-lead aperture for cutting flat burr-free ends on diode, resistor, and capacitor leads up to 0.032-in. in diameter.

CIRCLE NO. 345

Relay servicing kit adjusts and calibrates

Jonard Industries Corp., Precision Tools Div., 3047 Tibbett Ave., Bronx, N.Y. Phone: (212) 549-7600. Price: $34.

Consisting of 15 pieces, a new relay precision-tool kit (K-55) contains the necessary equipment for adjusting, servicing and calibrating all relay types. All tools are made of high-quality carbon steel with heavy chrome plating. The dielectric tools permit adjustments and repairs to be made on live equipment without stopping operation.

CIRCLE NO. 346

Torque control unit dials handtool speed

Chicago Wheel & Manufacturing Co., 1101 W. Monroe St., Chicago, Ill.

Handling up to 4-A loads, Handee Torq-master is a solid-state torque control circuit that allows you to dial the right speed for virtually any motorized handtool. The unit takes over as soon as the tool touches the work—providing instantaneous feedback signals to maintain motor speed under load. Its dual-range speed selector switch permits selection of the best operating speed, up to the full rated value.

CIRCLE NO. 347

Portable heat gun shrinks Teflon plus

Ideal Industries, Inc., Sycamore, Ill. Phone: (815) 895-5181.

Especially designed for heat-shrinkable-tubing applications, a new portable electric heat gun provides adequate temperatures to handle flexible, semi-rigid, and melt-liner/melt-wall tubing, including Teflon, up to 3/4-in. in diameter. The unit has a maintenance-free brushless self-lubricating motor that runs at 3350 rpm on 12 W of power. The gun can either cool or heat an object.

CIRCLE NO. 348

Beam-lead bonding tools suit all chip needs

Micro-Swiss, Inc., Rock Hill Rd., Cherry Hill, N.J. Phone: (609) 424-2515.

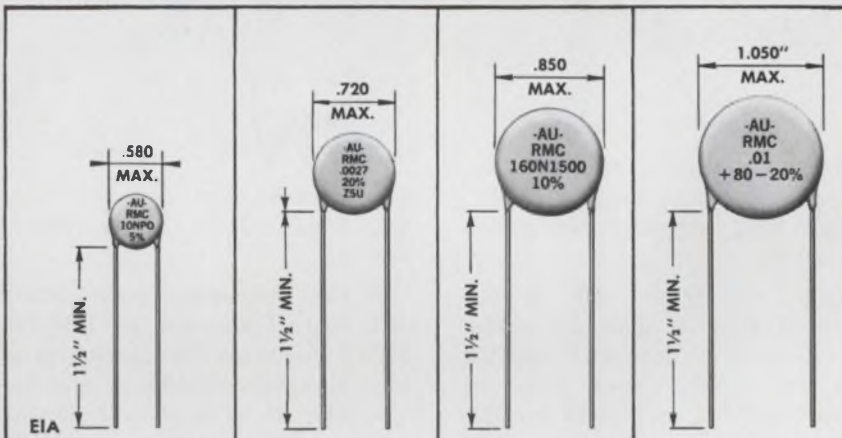
Satisfying custom chip bonding needs, a new line of beam-lead bonding tools is now available in any size or style for any chip application and in any desired quantity. They can be supplied for either wobble or self-aligning tool applications, and can be specified with the heater soldered on or separate and replaceable. Material choices include carbide, tungsten or Inconel alloys. Tip recess dimensions can have tolerances as close as ±0.0001 in.

CIRCLE NO. 349

NOW! from RMC

TYPE -AU-

"ACROSS-THE-LINE" U.L. LISTED DISCAPS



EIA Class					
Class II	330 470 680	820 .001 .0015 .0022 .0027	.0033 .0039 .0047 .005	.0068 .0082 .01
Class I				
NPO	3.9 - 20	21 - 31	32 - 47	
N750	15 - 35	36 - 61	62 - 82	
N1500	15 - 67	68 - 119	120 - 180	

THICKNESS: .225 Max.

RMC now offers a complete line of ceramic disc capacitors fully approved by Underwriters Laboratories for the NEW "Across-The-Line" capacitor requirements. This approval is required of all capacitors utilized directly or indirectly across the power supply line.

This application is significantly different from the "Antenna Coupling and Line By pass" capacitor requirements of Underwriters Laboratories Subject 492, and the original RMC -U- capacitor type continues to be approved for those applications.

SPECIFICATIONS

CAPACITANCE: Within specified tolerance:
Class I @ 1MC and 25°C
Class II @ IKC and 25°C
CAPACITANCE TOLERANCES AVAILABLE:
Class I ±5%, ±10% or ±20%
Class II ±20%, +80−20%
WORKING VOLTAGE: 150 VRMS @ 60 cycles (210 volts peak AC plus DC)
POWER FACTOR:
Class I .1% max. at 1 MC
.2% max. less than 30 pf
Class II 1.5% max. at 1KC
INSULATION RESISTANCE: Greater than 7500 Megohms @ 500 VDC

TEMPERATURE COEFFICIENT:
Class I NPO N750 N1500
Class II Z5U; Z5F 1500 pfd. And Less.
FLASH TEST:
Per U.L. Sub. 492
LIFE TEST:
Per U.L. Sub. 492
INSULATION RESISTANCE AFTER HUMIDITY:
Greater than 1000 Megohms @ 500 VDC
BODY INSULATION: Durez phenolic—vacuum wax impregnated. Standard coating on leads 3/16" max. measured from tangent
LEAD STYLES AVAILABLE: Long lead—#20 AWG tinned copper

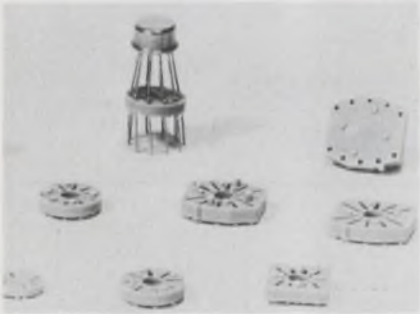
DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago, Ill. 60646
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

INFORMATION RETRIEVAL NUMBER 92

PC-board converters insulate discretes

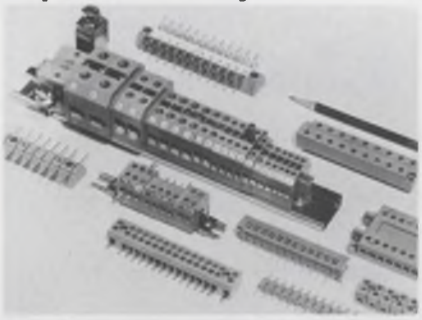


Robison Electronics, Inc., 2134 W. Rosecrans Ave., Gardena, Calif. Phone: (213) 321-0080. Availability: stock.

Made of Acetal and having stand-off feet to allow for solder fillet formation, flush and cleaning and air cooling, a new series of seven insulator/converters for micrologic networks insulate discrete component cases from the PC board and convert adjacent component leads for greater clearance between them. They are available for six-, eight- and ten-lead TO-5 cases.

CIRCLE NO. 700

Terminal blocks expand variety



Component Div., Electrovert, Inc., 86 Hartford Ave., Mount Vernon, N.Y. Phone: (914) 664-6090. Availability: stock.

A complete line of modular terminal blocks known as the Staffel terminal block system, includes high-current blocks, test, micro and plug-in terminals, terminal strips, and pneumatic connectors. These units require no tools to snap on to a standard assembly rail for secure mounting. Terminal bodies are made of melamine.

CIRCLE NO. 701

Low-viscosity compound has high conductivity

Epoxy Technology, Inc., 65 Grove St., Watertown, Mass. Price: $10/kit.

A two-component epoxy potting compound known as Epo-Tek 920FL combines the properties of high thermal conductivity and low viscosity. It is a smooth-flowing paste when mixed, with a viscosity of 14,000 centipoise at 79°C, has an eight-hour pot life, cures in 1 to 2 hours at 60°C and in 30 minutes at 80°C and has a thermal conductivity by the comparative method of 7.55 Btu/in./ft/h/F°.

CIRCLE NO. 702

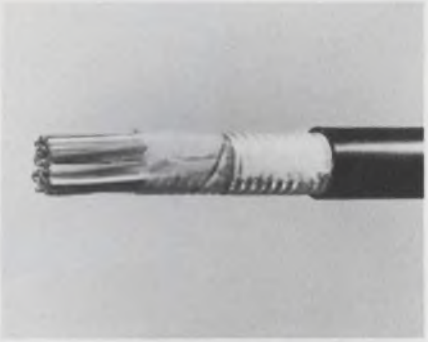
Multi-conductor cable bends like accordion

Electrowave, Inc., 324 Howard St., Rockland, Mass. Phone: (617) 878-7660.

Available in any combination of gauge sizes and colors, and in groups of 4 to 100 conductors, a new flat woven multi-conductor cable can be accordion-folded for minimum space requirements. It offers great flexing and tensile strength, high reliability, standard connectors and terminals, ease of installation, servicing and testing.

CIRCLE NO. 703

Anti-corrosion cable resists moisture too

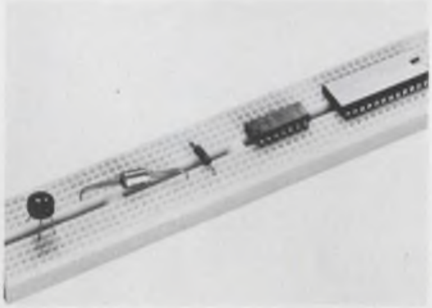


Anaconda Wire and Cable Co., 605 3rd Ave., New York, N.Y. Phone: (212) 867-8000.

Filled with a high-dielectric water-proofing compound of petrolatum and polyethylene, a new communications cable effectively resists moisture ingress and corrosion. Called Alpeth-TF, it displays an attenuation 15 to 20% lower than non-filled cables at frequencies above 150 kHz, and is available in sizes of 22 to 19 gauge (3 to 150 pairs) and 24 gauge (6 to 150 pairs).

CIRCLE NO. 704

DIP-terminal strips accept discretes too



AP Inc., 72 Corwin Dr., Painesville, Ohio. Phone: (216) 357-5597. P&A: $6.30 to $15; stock.

Designed for breadboarding with even the largest dual-in-line packages as well as TO-5 cases, a new series of solderless terminal strips accept all discrete components with lead diameters from 0.01 to 0.032 in. The strips exhibit typical contact resistance of 5×10^{-4} Ω after 1000 insertions at 1 A and 25°C. Interconnection stray capacitance is less than 4 pF maximum.

CIRCLE NO. 705

TRANSTECTOR

CIRCUIT PROTECTOR

prevents transients from causing "unexplainable" circuit failures.

Don't blame circuit failures on bad luck.

Voltage transients can cause circuits to fail or suffer undetected and progressive damage.

Transtector* circuit protector, a new solid state device, senses transients within nanoseconds, absorbs the surge and resets itself. Gives continuous protection for tubes, transistors, diodes and integrated circuits.

Find out about Transtector Systems from M&T Chemicals Inc., 1161 Monterey Pass Road, Monterey Park, Calif. 91754. Tel. (213) 264-0800.

M&T Chemicals Inc.
SUBSIDIARY OF AMERICAN CAN COMPANY

*Trademark of M&T Chemicals Inc.

INFORMATION RETRIEVAL NUMBER 93

Being untouchable is not so bad

for Andersen

the only producer of microwave integrated delay subsystems. (Nobody else comes within touching distance.)

Now you can get delay devices with associated circuitry on a single substrate. Tremendous savings in size, weight, and cost for signal delay applications. UHF through X band. Why buy just the delay when you can get the entire subsystem?

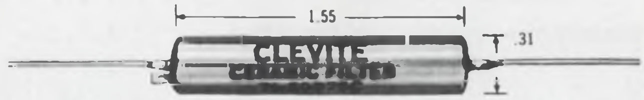
Send for literature discussing microwave integrated delay subsystems.

ANDERSEN LABORATORIES
1280 Blue Hills Ave. Bloomfield, Conn. 06002

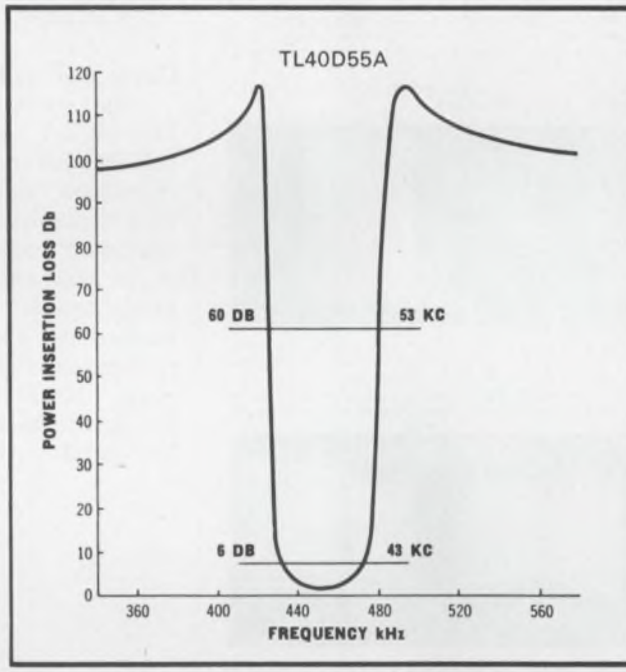
Microwave by Andersen

INFORMATION RETRIEVAL NUMBER 94

Still using LC's? This might change your mind:



Clevite's ceramic ladder filters deliver 80 db rejection in 0.1 cu.in.!



Here's a fixed-tuned filter that offers more selectivity for its size than any conventional i-f filter on the market! Clevite's non-magnetic, non-microphonic, 17-disc ceramic ladder filter is ideal for i-f stages of high quality superheterodyne radio receivers used in airborne or ground AM and FM communications equipment. Stop band rejection: 60 or 80 db. Center frequency tolerance: ± 1 kHz for 20 kHz B/W and below; ± 2 kHz for 30 kHz B/W and above. Stability: within +0.2% for 5 years; within 0.2% from −40°C to +85°C. Impedance (in and out) 2500 ohms for 12 kHz bandwidth and below; 1500 ohms for 13 kHz to 29 kHz B/W; 1200 ohms for 30 kHz bandwidth and above.

Following models standard at 455 kHz (A) or 500 kHz (C) (custom models on special order):

Model Number	B/W Min. @ 6db	B/W Max. @ 60db	Model Number	B/W Min. @ 6db	B/W Max. @ 60db
TL-2D5 (A)	2 kHz	5 kHz	TL-20D32 (A)	20 kHz	32 kHz
TL-4D8 (A)	4 kHz	8 kHz	TL-30D45 (A)	30 kHz	45 kHz
TL-6D11 (A)	6 kHz	11 kHz	TL-40D55 (A)	40 kHz	55 kHz
TL-8D14 (A)	8 kHz	14 kHz	TL-45D65 (A)	45 kHz	65 kHz
TL-10D16 (A)	10 kHz	16 kHz	TL-50D75 (C)	50 kHz	75 kHz
TL-16D25 (A)	16 kHz	25 kHz			

PRICES: 1 — $52.50; 25 — $42.00 ea; 100 — $36.75 ea; 500 — $31.50 ea; 2000 — $26.00 ea.

(Prices subject to change without notice.)

Send order or request for Bulletin 94017 to: Piezoelectric Div., Gould Inc., 232 Forbes Rd., Bedford, Ohio 44146, U.S.A. Or: Brush Clevite Company, Limited, Southampton, England.

GOULD CLEVITE

INFORMATION RETRIEVAL NUMBER 95

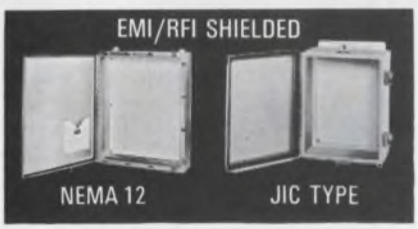
Your best choice in enclosures

- ☐ oil and dust tight
- ☐ EMI/RFI shielded
- ☐ rigid one-piece construction
- ☐ available from stock

Consoles in versatile stock design, 50" x 24" x 23", with gasketed front and rear doors. Options include rack angles, swing-out and stationary subpanels and writing desk. **Consolets** are offered in eleven stock sizes for desktop mounting of remote controls. Floorstand optional.

All units are heavy gauge steel with all-welded seams, easily shielded.

NEMA 12 units in stock sizes up to 90" x 36" x 24". Rigid 12 gauge steel with all-welded seams, gasketed doors front and/or rear. Oil and dust tight. Options include several interior panel arrangements, rack angles and shielding.



Heavy gauge steel boxes with hinged doors, all cadmium plated. Oil and dust tight, fully shielded. Interior mounting panels and terminal block kits optional. Shipment from stock, all sizes.

For mounting controls where oil, dust and water are not a problem. One-piece heavy gauge steel construction, finished in gray prime. Flush latches. Interior panels for mounting components. Wide size range in stock.

Hoffman

HOFFMAN ENGINEERING COMPANY
Division of Federal Cartridge Corporation
Anoka, Minnesota, Dept 431

ELECTRICAL ENCLOSURES

INFORMATION RETRIEVAL NUMBER 96

Evaluation Samples

Cord holders

Four different sizes of new Fast-Mount adhesive-backed cord holders are now offered as free evaluation samples. Designed to keep extension, appliance and equipment cords safely up and out of the way, the new holders mount firmly, without damage to walls or baseboards. They are intended to replace mechanical fastening devices like staples, molding clips and tacks. Mounting can be either horizontal or vertical. 3M Co.

CIRCLE NO. 724

Short-tip biaxial plug

Normally costing $1.75 each, a new short-tip biaxial bannana plug is now available as a free evaluation sample to qualified readers of ELECTRONIC DESIGN. The new connector is dimensioned for use with shorter-depth binding posts. Its spring-loaded pressure-bar knife edge compensates for insertion wear, while its self-wiping action provides uniform contact resistance. The wire is insulated for 5 kV at 10 A continuous. Farmer Electric Products Co., Inc.

CIRCLE NO. 725

Negative artwork

A new negative drafting system for PC-board prototypes eliminates the need for photography through the use of negative drafting symbols, components, and opaque masking. Called the 'B' Neg system, this new technique can also be used to rescue existing negatives when circuit corrections or missing components must be added. Complete kits, available within the system, allow the designer to go from idea to actual prototype in as little as 90 minutes. Free 'B' Neg samples are available. Bishop Graphics, Inc.

CIRCLE NO. 726

Film adhesives

Primarily intended to introduce the reader to the basics of film adhesive technology, a new four-page three-color bulletin contains actual samples of the three film adhesives discussed. Opening with a simple explanation of how a film adhesive functions, the brochure goes on to describe representative film adhesives for bonding metals, plastics, rubber, cellulosics and ceramics. The three free evaluation samples are general-purpose products, just right for diddling. USM Corp., Girder Chemical Div.

CIRCLE NO. 727

Design Aids

Tape selection chart

Containing actual samples of 20 different thermosetting electrical insulating tapes for OEM use, a selection chart gives complete data on both physical and electrical characteristics. The tapes are backed with thermosetting adhesives, and use such insulations as paper, polyester film, glass and acetate cloth, and acetate and vinyl film. Charted data includes insulation class, tensile strength, elongation, thickness, electrical resistance, and type of adhesive and adhesion. Johns-Manville, Dutch Brand Div.

CIRCLE NO. 728

Crystal characteristics

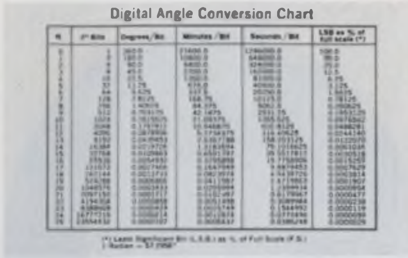
Printed on letter-size heavy-duty cardboard, a new durable chart summarizes the characteristics of quartz crystals. This easy-to-use design aid concisely describes the orientation and flexture modes of principal crystal cuts, as well as the temperature characteristics of various crystal elements. The text is backed up with illustrative diagrams and curves. Another section of the chart deals with crystal properties, and includes a tabulation of quantities like useful frequency range, capacitance ratio, resistance and typical Q. Electronic Service Co.

CIRCLE NO. 729

Connector wallchart

Putting an entire connector catalog on a single 22 by 33-in. wallchart, a time-saving easy-to-read graphic selection guide simplifies finding the right pin-and-socket connector for any circuit application. The wallchart shows contact configurations, specifications, applicable circuit requirements, required assembly tools and accessories for six popular rack-and-panel connector families. Bunker-Ramo Corp., Amphenol Industrial Div.

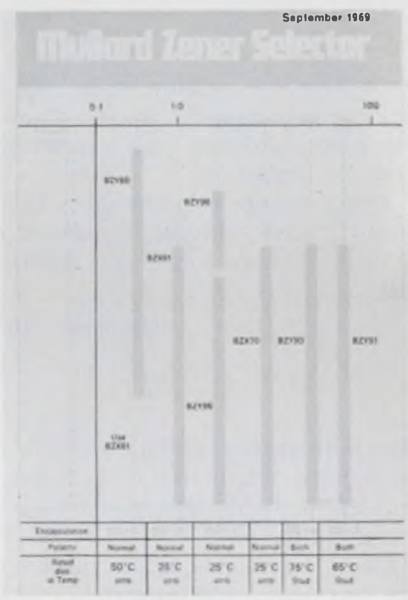
CIRCLE NO. 730



Wallet conversion aid

A new handy plastic wallet-sized card is actually a digital angle conversion chart. It compares n, 2^n bits, degrees per bit, minutes per bit, seconds per bit and the least significant bit as a percentage of full scale, for 0 to 25 bits in increments of one bit. The card, which is printed in two colors, measures 2-1/2 by 3-1/2 in. Astrosystems, Inc.

CIRCLE NO. 731



Zener selector

Showing available reference voltages and power ratings, a new zener diode selector is a handy pocket-sized chart that also details voltage limits, polarity, package type, and ambient operating temperature. Eight series of these voltage regulator diodes are shown. All units have tolerances of ±5%, while voltage ratings vary from 3.3 to 75 V, and power ratings cover 400 mW to 75 W. Mullard, Inc.

CIRCLE NO. 732

C-COR AMPLIFIERS

POWER AMPLIFIERS LINEAR OUTPUT UP TO 63 WATTS

WIDEBAND 1 kHz to 400 Mhz
GAIN FROM 8 dB to 30 dB
PRICED FROM $1250 to $4000

Model 1028 illustrated is but one of many Power Amplifiers made by C-COR . . . each designed for a specific use. The chart below indicates a few of C-COR'S power amplifiers and their characteristics.

Model	Passband 3 dB Nom.	Power Output @ 1 dB Comp. Nom. dBm	Gain Nom. dB
1029	100-300 MHz	+44	8
1029-A	0.1-250 MHz	+44	10
1029-B	1-160 MHz	+48	16
1012	0.001-185 MHz	+41	7.5
1012-A	0.1- 60 MHz	+44	12
1028	30-300 MHz	+35	30
3002	200-400 MHz	+32	17

Driver Amplifiers available to increase gain

In amplifiers, it is well to turn to C-COR . . . where amplifiers are the main business. If we can't supply you off-the-shelf, our engineers will design and produce the amplifier you need — and do it fast!

Write or telephone for catalog and technical data on your amplification requirements . . . or check C-COR Listings in EEM.

"C-COR Amplifiers . . . Rated First Where Performance is Rated First."

C-COR

C-COR
ELECTRONICS, INC.
60 Decibel Road
State College, Pennsylvania 16801
814 238-2461

INFORMATION RETRIEVAL NUMBER 97

Annual Reports

Printed circuits and memory products are mainstays for **Data Technology Corp.**, 1050 E. Meadow Circle, Palo Alto, Calif. Other product lines include computer peripherals, instruments and communications equipment. Fiscal records show net sales of $13,041,504 for 1969 and $7,801,254 for 1968. Net income is $753,893 for 1969 and $464,890 for 1968.

CIRCLE NO. 706

Cognitronics Corp., 333 Bedford Rd., Mount Kisco, N.Y. Machined parts, audio clocks, data processing systems and services.

1968: net sales, $1,672,478; net loss, $66,893.

1967: net sales, $467,264; net loss $270,597.

CIRCLE NO. 707

Coleman Engineering Co., Inc., 3121 W. Central Ave., Santa Ana, Calif. Vote-tallying systems, photographic systems, hydraulics.

1969: net sales, $4,614,008; net income (loss), $108,181.

1968: net sales, $4,801,866; net income (loss), $445,139.

CIRCLE NO. 708

Electronic Wholesalers, Inc., 9390 N. W. 27th Ave., Miami, Fla. Distribution of various electronic components.

1969: net sales, $17,104,671; net loss, $559,087.

1968: net sales, $16,003,376; net loss, $168,902.

CIRCLE NO. 709

Foto-Mem, Inc., 2 Mercer Rd., Natick, Mass. Memory systems, information storage and retrieval systems, monitors.

1969: common stock sale, $1,265,077; cash increase, $1,049,682.

1968: common stock sale, $145,350.

CIRCLE NO. 710

Harris-Intertype Corp., 55 Public Square, Cleveland, Ohio. Communications and information handling equipment.

1969: net sales, $339,346,000; net earnings, $20,125,000.

1968: net sales, $292,904,000; net earnings, $16,468,000.

CIRCLE NO. 711

MPB Corp., Precision Park, Keene, N. H. Bearings, guide assemblies for computer peripheral equipment, film rollers.

1969: net sales, $21,212,695; net income, $746,607.

1968: net sales, $20,013,581; net income, $1,197,897.

CIRCLE NO. 712

National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. Digital, linear, MOS and hybrid IC semiconductors.

1969; net sales, $7,517,900; net net earnings, $1,467,806.

1968: net sales, $11,031,776; net earnings, $890,439.

CIRCLE NO. 713

Roanwell Corp., 180 Varick St., N.Y. Cooling devices, communications.

1969: net sales, $7,517, 900; net earnings, $334,780.

1968: net sales, $7,873,887; net earnings, $696,986.

CIRCLE NO. 714

Solitron Devices, Inc., Tappan, N.Y. Semiconductors, rectifiers, transistors, and microwave and rf components.

1969: net sales, $24,261,108; net income, $5,962,227.

1968: net sales, $18,414,498; net income, $3,735,248.

CIRCLE NO. 715

Sparton Corp., 2400 E. Ganson, Jackson, Mich. Military electronics, transducers, communication products, furniture.

1969: net sales, $36,905,768; net income, $1,771,293.

1968: net sales, $38,346,241; net income, $1,657,630.

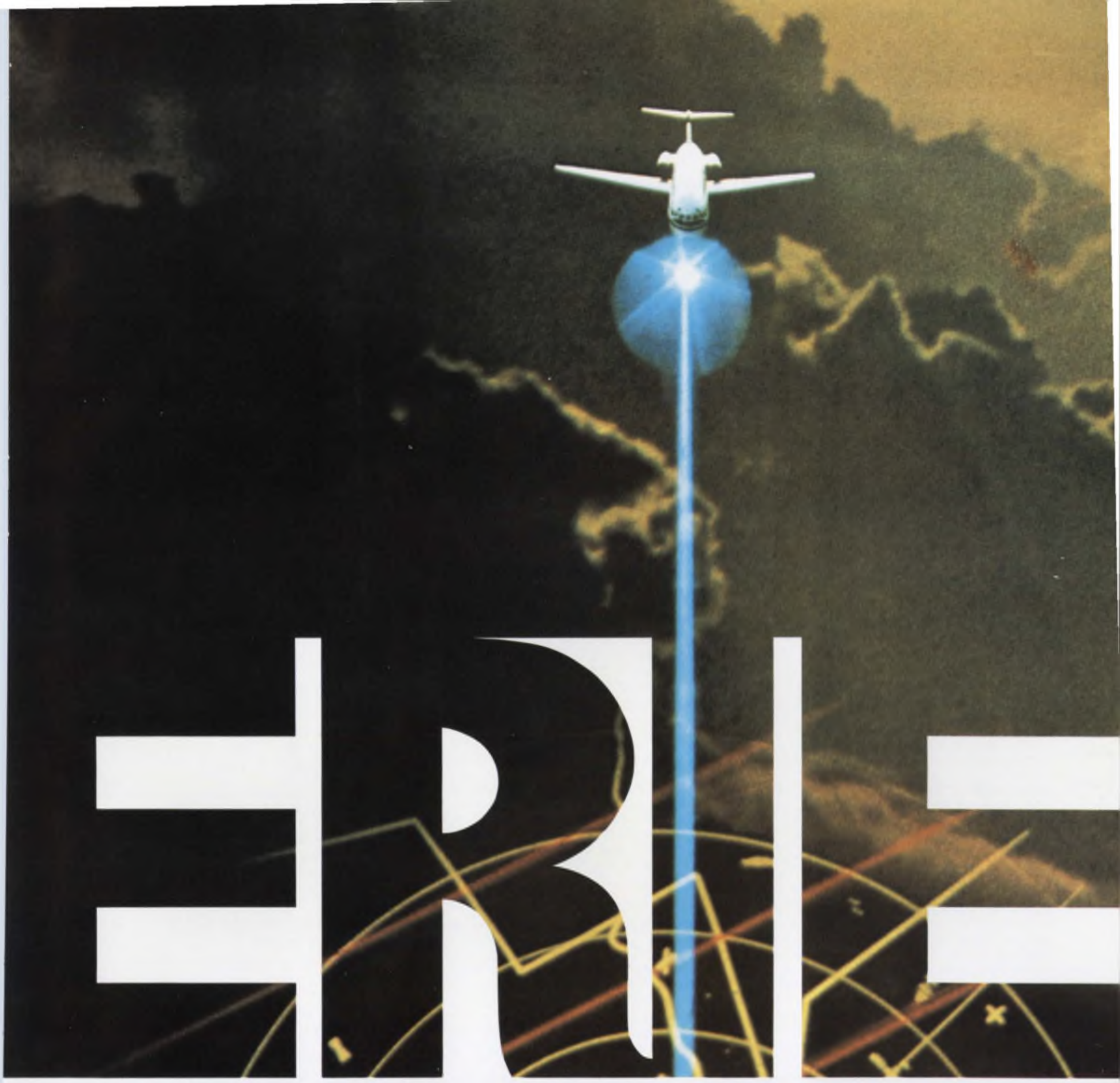
CIRCLE NO. 716

Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. Computer services, calculators, data analysis systems, medical systems.

1969: net sales, $23,263,301; net earnings, $2,801,513.

1968: net sales, $16,646,671; net earnings, $1,973,840.

CIRCLE NO. 717



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Symbolic electronic signal undistorted by EMI — photographed by Howard Sochurek

bring ERIE in early.

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644 West 12th Street, Erie, Pa. 16512
(814) 456-8592

THE PRACTICAL REFERENCE SHELF

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Lothar Stern

A practical guide to integrated circuits — their theory, manufacture and applications. This book offers complete discussion of the various techniques of integrated circuit fabrication and their strong influence on circuit design and performance. From a marketing viewpoint, it compares the relative qualities of the numerous IC's devised to date in terms of economics and logistics.

The book covers basic semiconductor principles, monolithic integrated circuits, thin-film circuits and their characteristics, hybrid and other integrated structures. There is also discussion of packaging, design and layout principles, and LSI. A volume in the *Motorola Series in Solid-State Electronics*. 208 pages, 7 x 10, illustrated, cloth cover.
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Will help the executive to write better letters, faster. In practical, down-to-earth style, this book shows how to find the real reasons for writing; provides a simple plan for organizing ideas logically and psychologically, and points out ways to get affirmative responses from readers. Shows how to avoid cliches, verbiage and how to inject an air of informality into letters. Key feature is the programmed learning section on painless grammer. 134 pages, 6 x 9.
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A practical approach to attaining consistently accurate estimates by summarizing many general practices and introducing specific methods proven valuable in various kinds of work. Five methods of estimating are discussed, the fifth of which combines the two most important developments in the field: standard hours and the learning curve. To insure complete understanding, full coverage is given to construction and use of learning curves. Nearly 100 pages of learning curve tables appear in the appendix. 344 pages, 8½ x 11, illustrated, cloth cover.
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Norman H. Crowhurst

A practical guide covering all aspects of the subject. The book shows how to select and install the appropriate equipment, covers routine operation and maintenance of the finished system. Special attention is given to solving the problems encountered in providing successful service. 136 pp., 6 x 9, illus., paper.
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The dependence of electrical circuit theory on topology (theory of line graphs) is of growing importance because line graphs for networks represent their flow patterns. Applicaton of topological methods has lagged behind the use of matrix methods only because of minor application problems. This volume resolves these problems in a logical and understandable way. 100 pages, 5½ x 8½, paper cover.
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A comprehensive description of the history, development and use of stroboscopy in industry, commerce and research. Stroboscopy for analysis and measurement has spread to many specialized areas of science and engineering, such as high-speed cinematography, photometry, radiometry, torsional vibration and other areas. This book discusses the state of the art today and areas of further usage. 284 pages, 6 x 9, illustrated, cloth cover.
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Complete how-to information on the various techniques of electrical waveform measurement—from troubleshooting to signal synthesis. Book details procedures for the isolation and measurement of a single harmonic from a multisignal mixture, measurement of total distortion, calculation of harmonic values from heights of the wave patterns, etc. 96 pages, 5⅜ x 8¼, illustrated, paper cover.
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Saul Heller

A compact, illustrated guide to the capabilities and operation of the versatile SCR and the triggering circuits associated with these devices. Throughout the book, schematic diagrams illustrate the application of the various SCR's as static switches, phase-control switches, inverters, choppers, etc. Emphasis is placed on choosing the right SCR to do a given job. 134 pages, 5⅜ x 8¼, illustrated, paper cover.
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Harry E. Stockman

Structured on engineering concepts and facts, this new course first provides a groundwork in transistor technology. Two-part theory viewpoints are applied continuously to give the work an engineering slant. The balance of the experiments deal with more intricate transistor networks, such as the theory and operation of multivibrators, and the concept of parametric action. 128 pages, 7¼ x 10, illus.
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Application Notes

D/a converters

Sixteen ways of using miniature digital-to-analog (d/a) modular converters are described in an eight-page application note. Included are specifications, a description of digital-to-analog operating principles, the use of modular converters in non-inverting, inverting and bipolar modes, schemes for bipolar tracking modes using the internal reference for upstream voltage compensation and applications with external reference sources. Analog Devices Inc., Pastoriza Div.

CIRCLE NO. 718

Silicon oxidation

A four-page bulletin describes studies that have been carried out to determine silicon oxidation during photoresist stripping using oxygen plasmas. Included are electron diffraction studies that show negligible oxidation of silicon during the process with any oxide layer formed being substantially less than 100 Å thick. The results are illustrated with four photographs. International Plasma Corp.

CIRCLE NO. 719

Transmitting pentode

An eight-page booklet describes specifications, applications data and design considerations for a 250-W pentode transmitting tube with a shadow grid. The discussion includes equations, characteristic curves, and complete electrical and mechanical ratings. Telefunken Sales Corp.

CIRCLE NO. 720

PC artwork

A new eight-page bulletin describes the use of photographically separated red and blue patterns on a single master artwork for both sides of two-sided printed wiring boards. Outlined is the total process, from the circuit schematic to the finished photographic negatives. A separate section deals with the photographic processes, including specific lighting and film and filter data. Cost-saving hints and potential pitfalls are also pointed out. Bishop Graphics, Inc.

CIRCLE NO. 721

Chopper noise

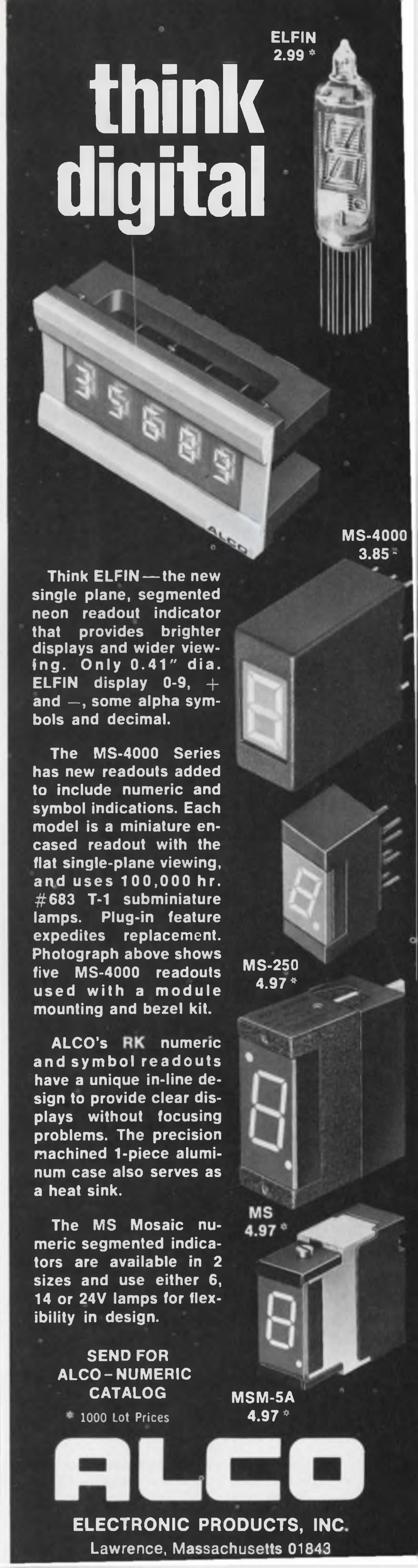
A four-page technical paper covers the subject of chopper noise sources and measurement techniques. Discussed is magnetic noise, thermal noise and drift, as well as electro-mechanical noise measurement. There are illustrative block diagrams, curves, tables and test data. James Electronics Inc.

CIRCLE NO. 722

Magnetic tape

Talking about concepts, techniques and economics, a new booklet discusses some of the common causes of magnetic tape problems and overall corrective programs. Causes of signal loss are reviewed along with possible cures. Criteria for assessing the costs of computer tape failure are provided, plus descriptions of the methods by which failures can be detected and corrected. Kybe Corporation.

CIRCLE NO. 723



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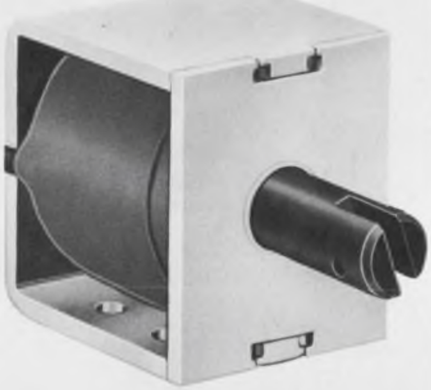

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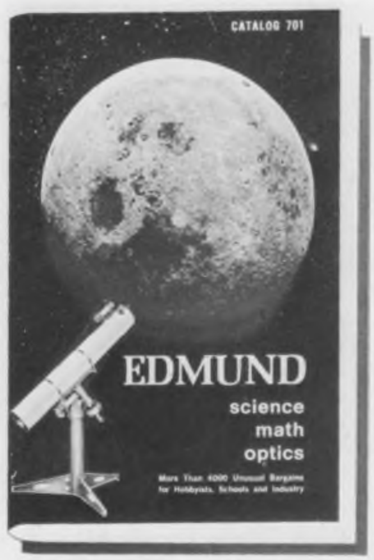
New Literature



Edmund catalog

Covering a range of items in the categories of science, mathematics and optics, a new 148-page catalog contains a list of lenses, prisms, optical instruments, magnets, magnifiers, microscopes, binoculars, photo components, fiber optics, art accessories, lasers and telescopes. These are only a few of the hundreds of items covered. Edmund Scientific Co.

CIRCLE NO. 733

Kilovolt capacitors

Over 300 high-voltage capacitors and nearly 70 capacitor stacks are described in a new 28-page capacitor catalog. Electrical and dimensional data are included for capacitors from 0.0015 to 1 μF with voltage ratings of 2 to 50 kV and above. Capitron Div. of AMP Inc.

CIRCLE NO. 734

MOS/LSI fabrication

Original equipment manufacturers who are interested in designing their own MOS LSI circuits and in having masks and wafers fabricated by an outside source, can obtain information on the feasibility of this approach in a new 12-page catalog. It covers technical aspects of MOS electrical characteristics, process parameters, design guidelines and situations to avoid, input protection, along with information on delivery and specification for customer-furnished masks and masks produced with laser interferometer equipped mask-making facilities. Cartesian, Inc.

CIRCLE NO. 735

Semiconductor fuses

Fuses for rectifier, SCR, thyristor and power transistor protection make up a new 12-page catalog. It incorporates a simple easy-selection method for fuses ranging from 32 to 600 V and 0.1 to 10,000 A in eight package styles, plus typical characteristics in graphs showing peak let-through and melting time. Airpax Electronics, Cambridge Div.

CIRCLE NO. 736

Molded terminals

A complete line of molded insulated terminals, with photos, drawings specifications and detail is in a new 72-page catalog. Included are thousands of variations on standoffs, feed-throughs, test jacks, sockets and binding posts. Featured is the Nurl-Loc method of mounting, providing the highest radial- and axial-pullout resistance of any insulated press-in type terminal. Diallyl phthalate plastic is molded with the component metal inserts to form a strong integral unit, with heat resistance up to 500°F. Electronic Molding Corp.

CIRCLE NO. 737

A/d converters

Basic theory of analog-to-digital converters in general and information on a new series of utility converters in particular are contained in a new eight-page application manual. Included are circuits and definitions of key parameters (accuracy, differential linearity, offsets, gain and resolution) of a/d converters, plus units that provide up to 12-bit resolution and 4-μs conversion time. Analog Devices, Inc.

CIRCLE NO. 738

Servo amplifiers

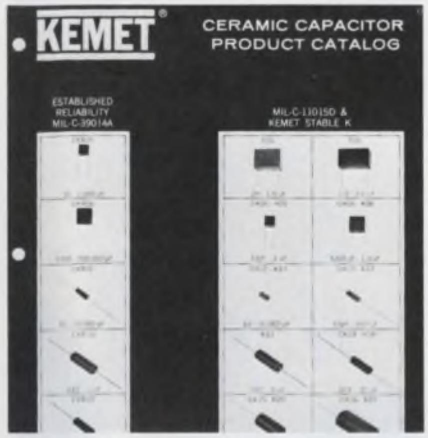
A comprehensive servo amplifier listing is in a pocket-size catalog which describes a list of servo amplifiers and motor controls. Listed are ac amplifiers from 6 W to 10 horsepower and dc amplifiers from 50 W to 400 horsepower. Westamp, Inc.

CIRCLE NO. 739

IC semiconductors

A description of two series of IC gates and flip-flops, with 38 types of devices, is included in a 42-page brochure. These devices are packaged in 14 and 16-lead hermetically sealed ceramic packages and are available in two operating temperature ranges of −55 to +125°C and 0 to 70°C. ITT Semiconductors.

CIRCLE NO. 740



Ceramic capacitors

A complete line of monolithic ceramic capacitors is featured in a new catalog. It features capacitors manufactured to Mil-C-11015D and Mil-C-39014A requirements and a complete cross reference of the part number suffixes (dash numbers) and designations between Mil-C-39014 and Mil-C-39014A. Union Carbide Corp., Electronics Div.

CIRCLE NO. 741

Circuit card guides

A new eight-page brochure describes circuit card guides. Features of a one-piece, molded polycarbonate card guide, as well as complete test information (vibration, shock, temperature, and humidity) are presented with dimensional data and prices on stock sizes from 0.05 to 0.1-in. thick. Unitrack, Div. of Calabro Plastics, Inc.

CIRCLE NO. 742

PC connectors

Twenty-five series of metal-to-metal connectors, 14 and 16-pin dual-in-line and test-probe receptacles are described in a 52-page connector guide. The connectors, which range in size from 2 to 152 contacts, conform to MIL-C05400, MIL-E-8189 and MIL-T021200. Connector applications are indexed on an illustrated three-page foldout chart. Elco Corp.

CIRCLE NO. 743

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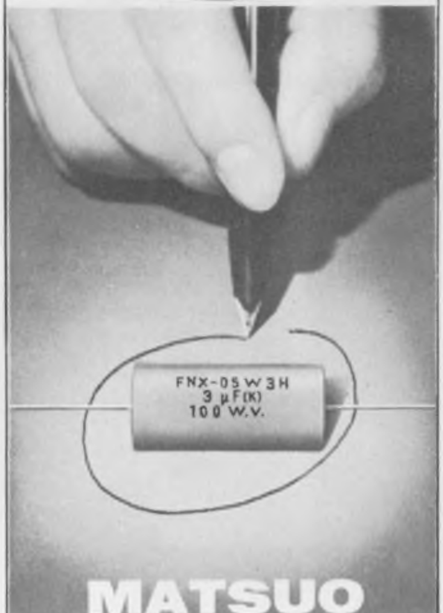

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Tokyo Office: 7, 3-chome, Nishi-Gotanda, Shinagawa-ku, Tokyo

INFORMATION RETRIEVAL NUMBER 114

Switches

Eleven new models of switch lights and indicators are in a new six-page catalog. Shown are switches for applications in aircraft, computers and instruments. Also included are a handy selection chart and dimensioned engineering drawings of the switches. Korry Manufacturing Co.

CIRCLE NO. 744

Decals and labels

More than 186 identification products and personalized items are shown in a new comprehensive 64-page catalog. Shown are new ideas, products, systems and four-color illustrations. Special pages are devoted to advertising posters, truck signs, decals, name plates, warning tags, employee and visitor badges, award plaques, parking control labels, property identification tags, valve tags, pipe markers, roll-form labels and scores of other identification products. Seton Name Plate Corp.

CIRCLE NO. 745

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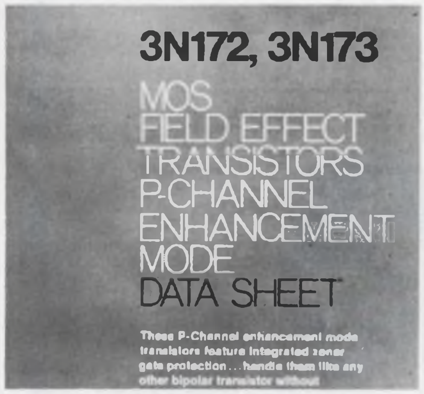

MOS transistors

A six-page brochure provides application information and descriptions of two new MOS p-channel enhancement-mode field-effect transistors. It includes maximum ratings, mechanical data, noise and switching characteristics, a test circuit and chart showing switching time details and switching times versus on-state drain current, static electrical characteristics and supporting charts. Union Carbide Corp.

CIRCLE NO. 746

Ac trigger note

A 32-page applications handbook about the recently introduced model μA742 Trigac acquaints systems designers and circuit engineers with the wide range of uses for this linear integrated circuit. The Trigac is an interface device that permits the design of alternating-current zero-crossing on-off and proportional controls in 110-V household appliances and 220-V plant equipment. Fairchild Semiconductor.

CIRCLE NO. 747

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INFORMATION RETRIEVAL NUMBER 119

Equipment buys

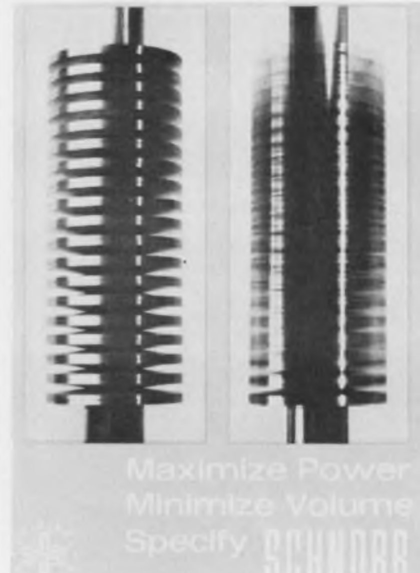
The annual edition of "Equipment Bargains" contains 52 pages of wholesale buys on light and heavy-duty industrial equipment. Included are variable-speed transmissions, generators, speed reducers, motors, solenoids, pumps, and hydraulic equipment. In addition, special sections show how to choose and install a generator, and describe hydraulic principles and applications along with formulas. Roberts Electric Co.

CIRCLE NO. 748

Dc power supplies

Mechanical and electrical specifications and prices for 52 models of three series of regulated dc power supplies are included in a new six-page bulletin. The supplies range in output from 3.6 V at 250 mA to 180 V at 10 mA and include dual- and single-output types of the bench- and PC-mount variety. Computer Products.

CIRCLE NO. 749



Disc springs

A new descriptive 24-page publication with pictures and diagrams shows applications for precision disc springs in such varied areas as press tools, gate valves, engine starters, brake gears, cable pullers, veneering presses, crane jib safety switches, aircraft brake adjusters and nuclear power stations. Karl A. Neise, Inc.

CIRCLE NO. 750

Transistor chips

A comprehensive short-form catalog describes 26 silicon planar epitaxial transistor chips for use in hybrid circuits. The six-page fold-out publication not only lists the probed-parameter electrical characteristics but also presents curves showing device gain with collector current. Physical geometries are clearly illustrated and they include dimensions and illustrated methods of packaging. Sprague Electric Co.

CIRCLE NO. 751

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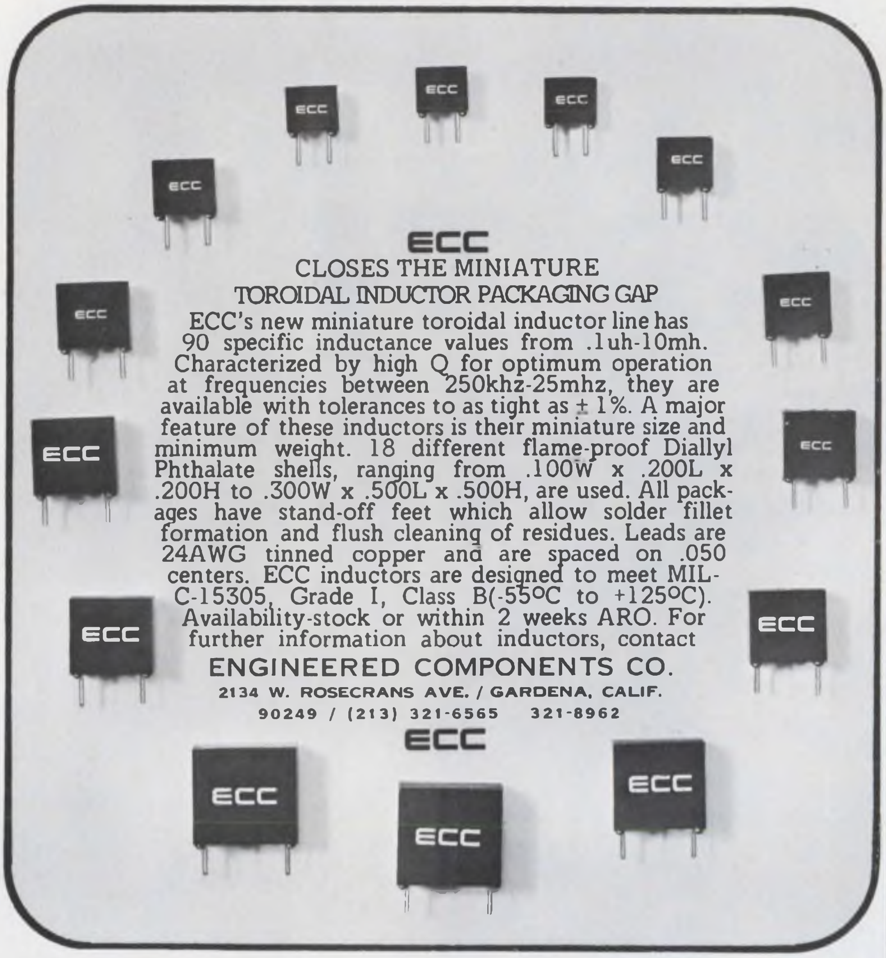

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CIRCLE NO. 752

Drafting products

Presented in a new 28-page catalog is an extensive line of precision die-cut drafting aids for the printed circuit industry, as well as an extensive line of precision slit pressure-sensitive products for charts, graphs, office layout, newspaper borders and many other graphic presentations. Flexigraph Manufacturing Inc.

CIRCLE NO. 753

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Title			
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Capacitors

A new well-organized catalog with application information on pulse-forming networks, dc filtering and blocking, arc suppression and power factor correction contains complete data on dc and pulse capacitors (Mylar-wrap and epoxy-case), flat-disc and flat-line low-inductance energy-discharge capacitors and pulse-forming network design data. Products covered are applicable to military specifications MIL-C-5, MIL-C-25, MIL-C-19978 and MIL-N-23182. Axel Electronics, Inc.

CIRCLE NO. 754

Hybrid computation

A versatile and economical hybrid computing system is the subject of a new 16-page brochure. It describes a system having the capability of handling the total spectrum of scientific computation at a relatively low cost. Electronic Assoc., Inc.

CIRCLE NO. 755

TFE fluorocarbons

Detailing the properties of TFE fluorocarbons is a new pamphlet that lists a total of 44 processing, mechanical, thermal, electrical and resistance properties in convenient chart form. Included are three graphs that plot linear thermal expansion and the coefficients of linear thermal expansion of annealed parts, specific volume versus temperature, and weight loss (percent per hour) versus temperature. The pamphlet is pre-punched for insertion in a standard three-ring looseleaf book. Raybestos-Manhattan, Inc., Plastic Products Div.

CIRCLE NO. 756

Design Data from Manufacturers

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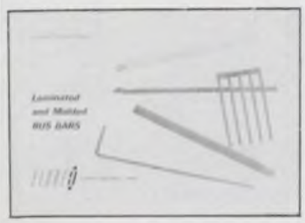

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Free Op-Amp Catalog/Handbook

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Electronic Component Drafting Aids Design Guide

Free Catalog! Free Samples! The industry's largest selection of electronic component drafting aids! All in a new 68-page printed circuit design guide and catalog. Includes the most advanced technical information — with hundreds of illustrations — on printed wiring master artwork. Plus the industry's only tested-and-proved system for absolute registration for two-sided printed wiring boards with the only complete photographically compatible Red and Blue System. Send now for Catalog 10. Free samples included.

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Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard
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Terminal Block Selector

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177

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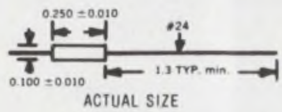
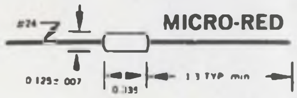
NEW! *smallest axial shielded inductor available the "NANO-RED"*



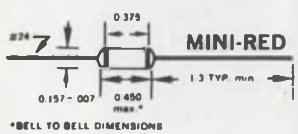
Range: 0.10μh to 1,000μh in 49 stock values
Size: 1/10 dia. by 1/4 lg.
Inductance Tolerance: ±10%

This new "NANO-RED" offers the highest inductance to size ratio available in an axial shielded inductor. Exceptional "Q" and self-resonance characteristics. Max. coupling 2% units side by side. Non-flammable envelope. Designed to MIL-C-15305. Operating temperature −55°C to 125°C.

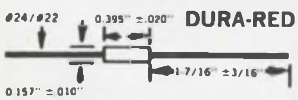
Other Lenox-Fugle Subminiature Shielded Inductors:



MICRO-RED The "Micro-Red" is a shielded inductor that offers the largest inductance range in its size: 0.10μh to 10,000μh. "Q" to "L" ratio unsurpassed, with excellent distributed capacity. Inductance tolerance ±10%. Designed to MIL-C-15305. Stocked in 61 predesigned values.



MINI-RED The "Mini-Red" offers the highest "Q" to "L" ratio available over inductance range 0.10μh to 100,000μh in its size. inductance tolerance ±10% measured per MIL-C-15305. Stocked in 73 predesigned values.



DURA-RED The "Dura-Red" is designed to MS-90537 with inductance range 0.10μh to 100,000μh with tolerance ±10%. Stocked in 73 predesigned values.

Data Sheets: write or phone

LENOX-FUGLE ELECTRONICS, INC.
100 Sylvania Place, South Plainfield, N.J. 07080
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INFORMATION RETRIEVAL NUMBER 121

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This high performance, completely assembled and tested instrument will perform virtually any measurement function you need. It has remarkable versatility and its unique modular design is fully compatible with the famous Heath Digital System. Here are some of the features that make the "805" the industry's best buy in a digital instrument:

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Assembled EU-805A with DVM **$1250**
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INFORMATION RETRIEVAL NUMBER 122

Advertisers' Index

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We solve your budget problems by offering our Model 620 Digital Multimeter for only $985.00.

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INFORMATION RETRIEVAL NUMBER 123

Information Retrieval Service

All products, design aids (DA), application notes (AN), new literature (NL), and reprints (R) in this issue are listed here with Page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

New Literature

Application Notes

Design Aids

Evaluation Samples

Dale expands square trimmer line

New 3/8" & 1/2" models do more for you

Dale's expanded line of square wirewound trimmers has seven new models to meet your needs at prices near rectilinear levels.

NEW 3/8" LINE. Better for packaging because they're thinner—only .145". Stronger PC mounting. Heavier (22 AWG) pin design reduces mechanical problems caused when lighter pins fail under mounting stress.

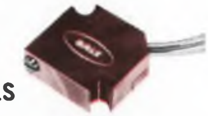
NEW 1/2" LINE. Complete internal redesign for better performance and prices that are equal to or lower than competition.

Both new Dale square trimmer lines are rated at one watt at 70°C. Both are made to MIL-R-27208 specs. Dale has a lot going for you in square trimmers—and more are on the way. For complete technical and price information, phone 402-564-3131.

3/8" MODELS

5850—Insulated leads
5880—PC pins, top adjust
5887—PC pins, side adjust
5891—PC pins, base mount
Size: .375" x .375" x .145"

1/2" MODELS



5050—Insulated leads
5091—PC pins, base mount
5080—PC pins, top adjust
Size: .50" x .50" x .19" (5050)
.50" x .50" x .22" (5091, 5080)

Resistance Range: 10 ohms to 50K ohms
Resistance Tolerance: ±5% standard
Resolution: 1.01% to .09% (3/8") .54% to .10% (1/2")
Power Rating: 1 watt at 70° C
Operating Temperature Range: −65° C to +175° C
Temperature Coefficient: ±50 PPM/° C Max.
Moisture Resistance: 10 Meg. minimum insulation resistance
Mechanical Adjustment: 25 turns (3/8") 25 turns (1/2")

DALE ELECTRONICS, INC., 1328 28th Avenue, Columbus, Nebraska 68601 In Canada, Dale Electronics Canada, Ltd.

INFORMATION RETRIEVAL NUMBER 235

Three lines of RCA computer readout and data display tubes make up the broadest selection in the industry. They are listed below.

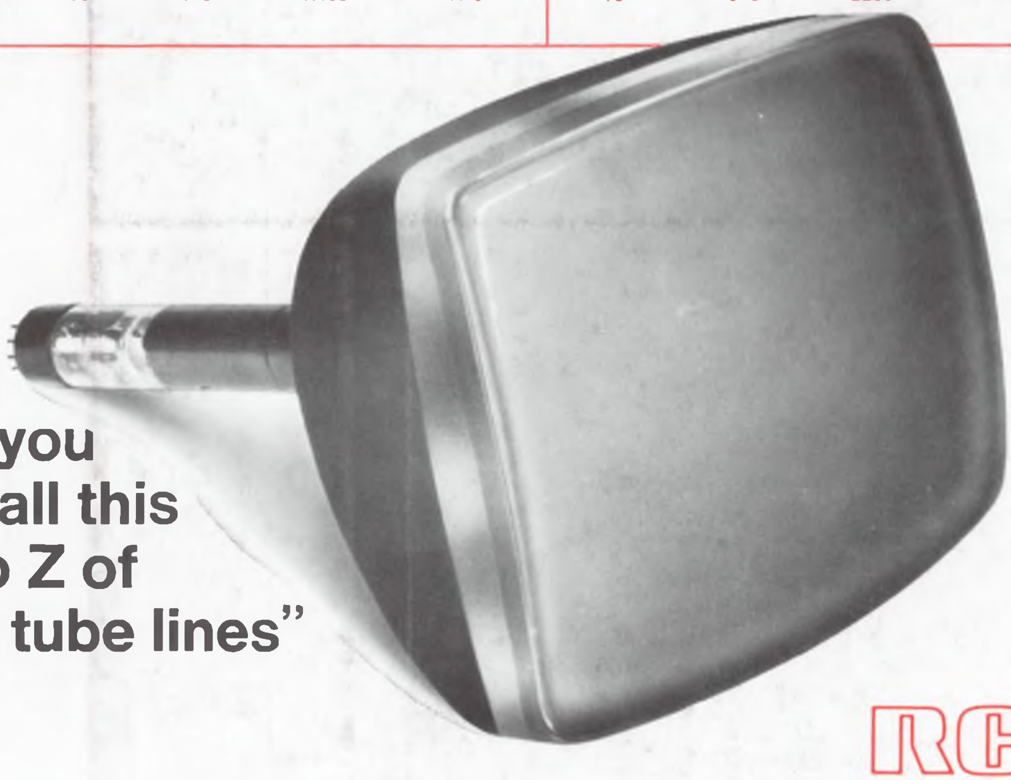
But if you design configurations requiring larger—or smaller—tubes, we can produce them, too.

Or if you want phosphors other than the standard P4 or P31, we can supply them.

And if you need extra implosion protection, we offer a variety of systems.

In short, for further information, see your local RCA Representative, RCA Industrial Tube Distributor, or write: RCA Electronic Components, Commercial Engineering, Section L18Q-1, Harrison, N.J. 07029.

Type Number	Nominal Tube Diagonal Inches	Deflection Angle Degrees	Screen Area Sq. Inches	Neck Diameter Inches	Maximum Overall Length Inches	Typical Operation: Anode Voltage Kilovolts	G2 Voltage Volts	Focus Voltage Range Volts	Heater Volts/ Milliamperes
Low-Cost Computer Readout Tubes									
1861P4	12	110	74	1.125	9.598	12	340	0-400	6.3/450
1862P4	14	90	104	1.438	13.500	12	340	0-400	6.3/600
1863P4	15	70	100	1.438	17.844	16	340	0-400	6.3/450
1864P4	16	114	125	1.125	10.811	16	340	0-400	6.3/450
1865P4	17	70	149	1.438	19.562	16	340	0-400	6.3/600
1866P4	17	90	149	1.438	15.000	16	340	0-400	6.3/600
1867P4	17	114	141	1.125	11.450	16	340	0-400	6.3/450
Medium-High Resolution Computer Readout Tubes									
1880P4	12	70	74	1.438	14.813	12	340	0-400	6.3/450
1881P4	12	90	74	1.125	12.598	12	340	0-400	6.3/450
1881P31	12	90	74	1.125	12.598	12	340	0-400	6.3/450
1882P4	14	90	104	1.438	13.876	12	340	0-400	6.3/450
1883P4	15	70	100	1.438	16.594	16	340	0-400	6.3/450
1884P4	17	70	149	1.438	17.826	16	340	0-400	6.3/450
1885P4	17	90	149	1.438	15.313	16	340	0-400	6.3/450
High-Resolution Computer Readout Tubes									
4557	12	70	74	1.438	16.6	12	340	1650	6.3/600
4573	12	90	74	1.438	14.5	12	340	1560	6.3/600
4575	14	90	104	1.438	15.4	16	340	2150	6.3/600
4576	15	70	100	1.438	18.0	16	340	2220	6.3/600
4577	17	70	149	1.438	19.5	16	340	2250	6.3/600
4578	17	90	149	1.438	17.0	16	340	2200	6.3/600



Maybe you could call this "the A to Z of display tube lines"

RCA