

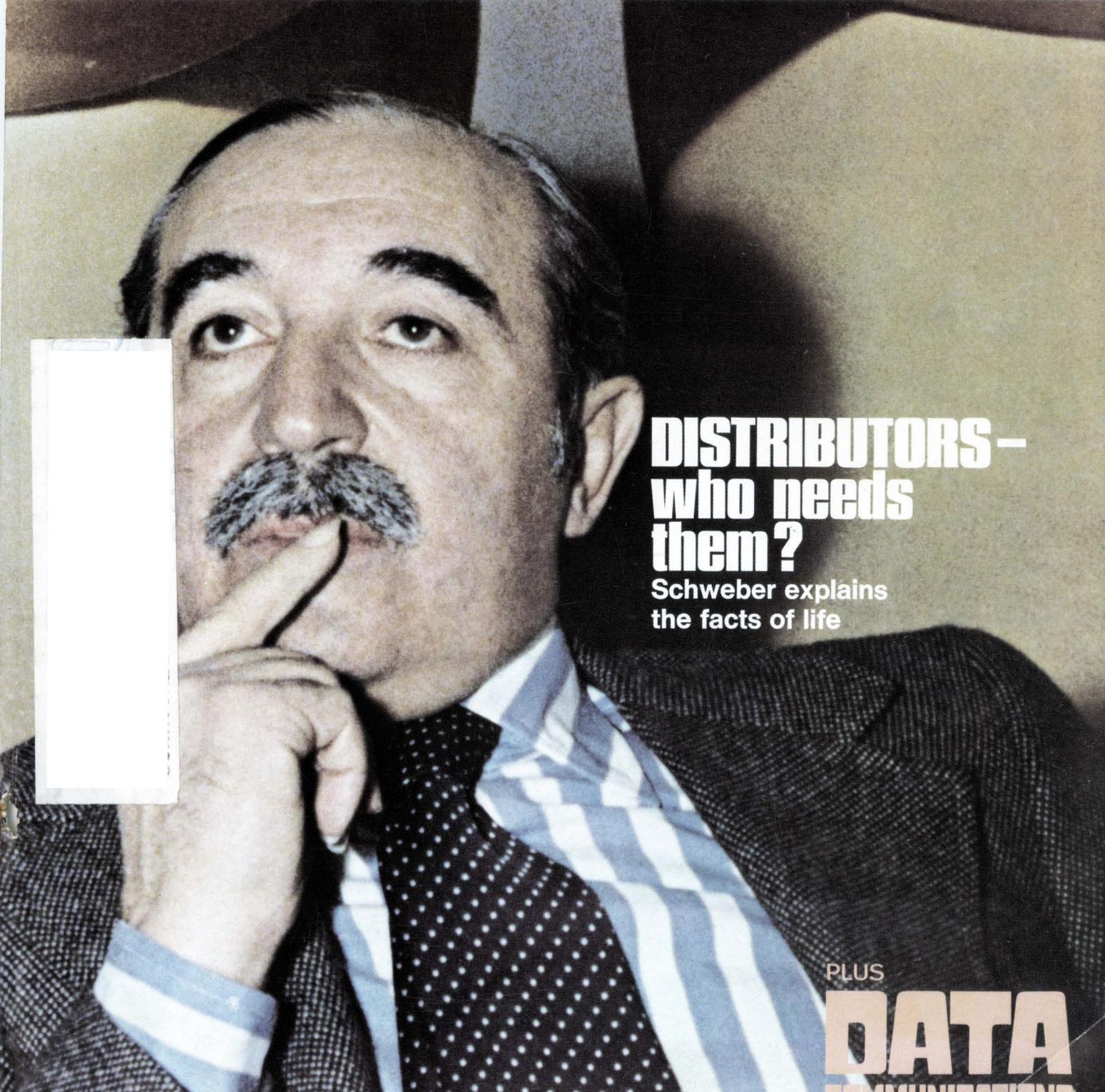
THE ELECTRONIC ENGINEER

a CHILTON publication/June 1972

There's \$100, 3½-digit DVM in your future—
IC advances pull down digital voltmeter prices.

What can a distributor do for you lately?
His special services can save your \$\$\$.

Data Communications feature:
How a digital radio can lengthen your μ wave hops.



**DISTRIBUTORS—
who needs
them?**

Schweber explains
the facts of life

PLUS

**DATA
COMMUNICATIONS**



Crystalonics solid state relays in a TV studio?

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The best doesn't cost any more anymore.

Our TV studio customers formerly used reed relays to switch video signals from various cameras during recording sessions. The reed relays weren't fast enough to operate during the blanking times, so dead spots and image carry-over resulted. *Our* solid state relays switch video signals 1000 times faster than the reed relays, as well as adding solid state reliability at comparable cost.

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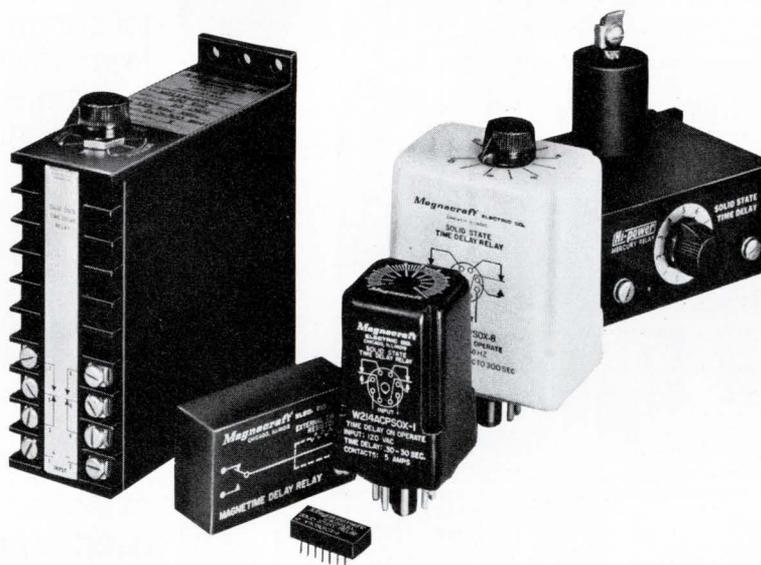
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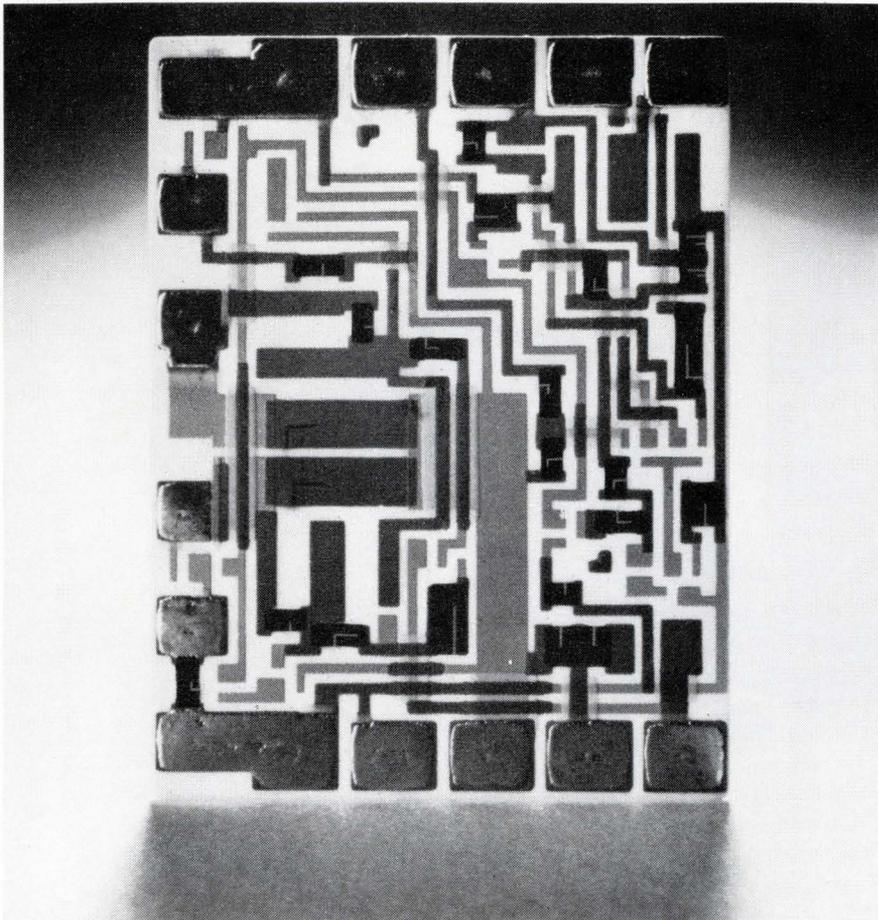
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Do you know how to properly specify a time delay relay? We have a dandy 92-page handbook that can help you. It describes applications you've never thought of. It offers suggestions on how to specify, testing procedures, comparisons of one type to another, principles of operation, and a glossary of terms. This is yours for the asking.

22 trims, 44 cuts, 5 seconds.



The circuit: a linear amplifier produced by RCA's Solid State Division, Mountaintop, Pa. 11 resistors are double-cut, 11 are L-cut. All trims are to 1% of nominal value or ratio. Throughput: better than 700 an hour. System datalogs before and after resistance values and deviations from nominal.

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You also get the ability to make the kinds of cuts you need to produce high-quality resistors... double cuts, scanning cuts, serpentine cuts... in no more time than other systems take for compromise trims.

And that's not all. Industry's fastest laser trimmer is backed up by industry's most complete hardware and software for computer-controlled functional trimming. A trim station can be supplied, for example, as part of Teradyne's new J271 Analog Circuit Test System, for the active trimming of hybrid audio or rf circuits.

Learn more. Write Teradyne, 183 Essex St., Boston, Mass. 02111.

TERADYNE

THE ELECTRONIC ENGINEER

June 1972 Vol. 31 No. 6

Cover. "Why should I deal with a distributor? They may be fine when you're in the prototype stage, but what can they do for you when you're in pre-production and production?" That's not an unusual attitude, we found, with some of the engineers we talked to research this article on what distributors have to offer electronic engineers. Yet according to some major distributors, such as Seymour Schweber, Hamilton/Avnet, Cramer, Kierulff, Jaco, and others, a knowledgeable distributing organization can offer such services as programming ROMs, assembling switches, selecting resistors, and virtually become part of the manufacturing process. For what distributors can do to save you money and time, turn to p. 54. (Photo: A. Socolovsky)

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19 MONOLITHICS SHRINK DVM PRICES Stephen A. Thompson

First, calculators, and soon, digital voltmeters and panel meters—the modularization of instrument design will soon lead to a 3½-digit DVM for a \$100. However, it's not that easy. Here are the design and marketing pitfalls that could hinder this exploding marketplace.

27 PACKAGING WITH INTEGRATED CIRCUITS COURSE—PART 4

After all the hardware, sockets, pins and connectors are in place, and the ICs have been soldered or plugged in, how do you interconnect the ICs or PC modules they're mounted in? Your choice can be either Wire-Wrap®, Termini-Point®, printed wiring, or Infobond®.

- **Think before wiring** Gerald L. Ginsberg, Philco-Ford Corp.
- **Carrying current by bus** Dan LeVantine, Bussco Engineering Inc.
- **Back-panel wiring—interconnection sans solder** Dick Hunter, EECo.
- **Who should wire your back panels?** Chester N. Kowal, Bunker Ramo Corp.
- **Back-panel wiring takes a wrap** Dan. P. Brouwer, William H. Long, and Paul A. Yarbrough, Gardner-Denver Co.
- **Strip, clip, and wire in one operation** Ed Whiteman, AMP Inc.

54 DISTRIBUTORS—WHO NEEDS THEM? Deborah Wilkins

Modern distributors have not made a \$1 billion a year business simply by supplying onesies and twosies for a few prototypes. What's made them grow—service—and what it can mean to you is spelled out in this in-depth look at distributors from the engineer's viewpoint.

60 CHARTING LOGIC ICs FOR SPEED/POWER Arthur J. Boyle

What's the best digital IC for your applications? This guide, which plots average power dissipation against typical propagation delay, makes that an easier question to answer. In addition, we analyze the prospects for the three top technologies: TTL, ECL, and CMOS.

DATA COMMUNICATIONS following page 68

DC-5 DIGITAL MICROWAVE RADIO SHORTENS THE MILES Walter Gill

Spanning the miles like a modern-day version of seven-league boots, digital microwave radio offers an economical method of transmitting PCM voice and digital data hundreds of miles without excessive jitter. Check out this fresh approach to digital modulation and T-carrier.

DC-12 WAVEFORM GENERATOR CREATES FSK AND PSK SIGNALS J. Shales

Here's a simple circuit that allows you to frequency shift and phase shift signals.



KEPCO TALKS POWER SUPPLY TECHNOLOGY:

THE LINEAR REGULATOR Heat Removal vs. Dissipation Limiting vs. Derating

To make a voltage or current oblivious to the effects of various bad influences, like a changing source, or a load that can't make up its mind, you have to either throw away a lot of energy in a continuous or linear regulator or resort to some pretty fancy switching to hold down the dissipation.

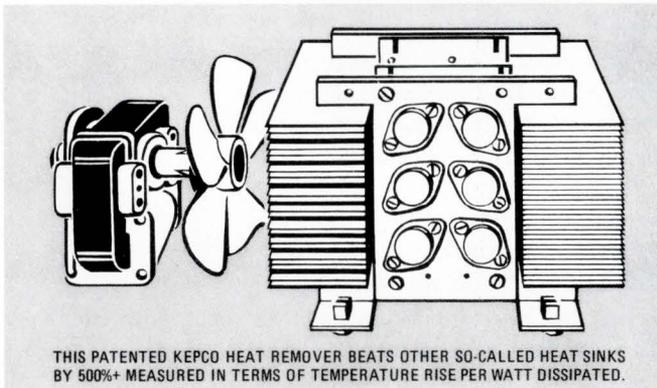
Dissipation-limiting by switching action, whether it be primary or secondary, SCR or transistor, at the source frequency or higher, buffered or not, permits a given size box to regulate more power than it would linearly — but does so at the expense of: 1. Circuit complexity; 2. Slowed transient recovery; 3. Impaired programming speed and an unfortunate tendency to generate unwanted noise.

If the performance of your power supply is more important to you than efficiency, a linear regulator is the best bet. But, a linear regulator has to get rid of an awful lot of unwanted energy to do its job.

Getting this heat out, without baking everything crisply, is a major aspect of power supply design. There are several approaches.

1. Require the use of an external "heat sink."
2. Specify that a certain volume of air be moved past a radiator.
3. Derate the power supply as a function of temperature.

All of these fall into the category of "let the customer worry about it."



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Fortunately, there is a fourth approach: **Provide a built-in heat sink with its OWN SOURCE OF MOVING AIR right inside the box.** This is the Kepco approach. Our object is to exhaust the waste heat of a linear regulator before it can raise the temperature inside the box and cook its guts!

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The Chilton Electronics and Instrumentation Group

The Electronic Engineer
Instruments and Control Systems
Instrument & Apparatus News
Medical Electronics and Equipment News
Electronic Component News

Chilton BPA

God is systems engineering

And systems are just as hard to define.

"Your job is changing."

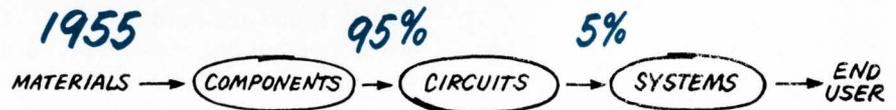
You've heard that before.

"We're moving away from circuits, and into systems."

While that is commonly offered as the reason for the change, it doesn't really explain it. Besides, you've heard it before, too.

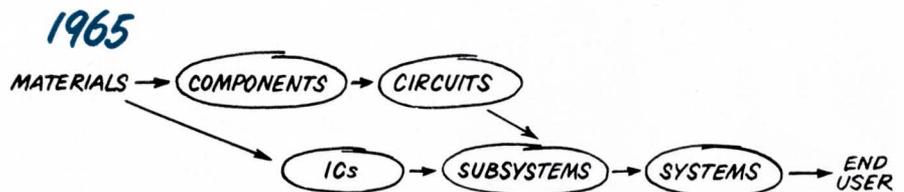
Yet you can't brush the transition off just because there seems to be no satisfactory—all-encompassing, exception-proof—explanation. The change is there, all around you, and it will affect your job, whether you find the reason or not. During the past five years, we've analyzed this evolution several times in this magazine. And we have seen similar, or different analyses with similar conclusions, by many industry leaders. Let's summarize our breakdown here.

In the 1950's, the world of the electronic engineer revolved around the design of circuits. At that time, the electronics field looked like this:



Manufacturers of components (resistors, capacitors, vacuum tubes and, later in the 50's, transistors) bought materials to make them, and sold their components to circuit designers. These were electronic engineers trained in active circuits analysis, network synthesis, equivalent circuits and pole-zero plots. The main activity of these engineers, circuit design with discrete components, was the most important item involved in producing a piece of electronic equipment. Based on the industry sales volume back in, say, 1955, (\$6 billion) and the number of engineers who applied their knowledge to creative assignments in the design and production of electronic equipment (about 60,000), we estimate that 95% of the wages they collected were paid for circuit design. Again, at that time, that amounted to a cool \$6 million, or 1% of the sales volume.

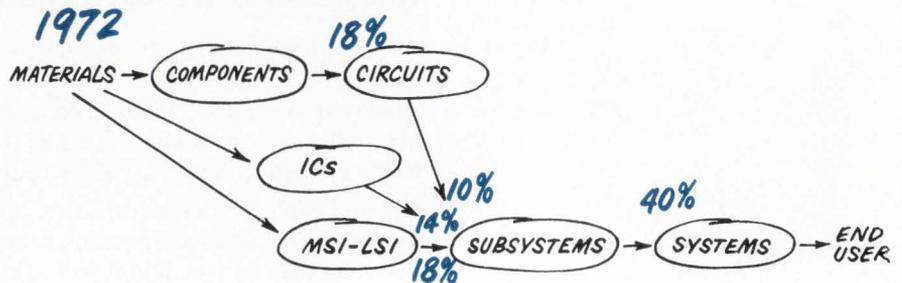
By the mid-60's, although integrated circuits had revolutionized the field in technology, the effect was not yet felt in design functions, nor in allocation of wages. Since ICs are really circuits manufactured as components, the change in structure looked like this:



The cries that the IC manufacturers were going to put all circuit designers and hence, at that time, most designers, out of business, were still premature. In 1965, however, semiconductor manufacturers were already employing many EEs to design their ICs, and the EEs who remained in the design of electronic equipment slowly learned to consider ICs as functional, rather than circuit, components. In other words, they started to design subsystems, moving thereby closer to the end user of their equipment.

How the little chips have changed the big ones.

The trend has continued, in larger proportions and with more evident results, with the semiconductor manufacturers almost continuously introducing increasingly more complex—medium-scale and large-scale—integrated circuits. Based on a study we have recently conducted among our readers, we estimate that, of all the wages paid to EEs for creating electronic equipment, the percentage paid for designing circuits with discrete components has gone down from the 95% of 1955 to about 18%. Where's the rest? Watch this: More than 30% goes for putting together subsystems with ICs, mostly MSI and LSI, while about 40% is paid for systems design, using such "components" as digital instruments and minicomputers. Graphically, it looks like this:



But, what does it mean to your job?

The difficulty, of course, is in defining the word, *system*. As a friend of ours says: "It's so encompassing, that you get the feeling God is systems engineering. While the definition depends on your religious denomination, it's awfully broad and hard to define." To understand systems requires a pretty broad look not just at your specific assignment, but at the requirements of the customer who will use your product, and the capabilities of your suppliers.

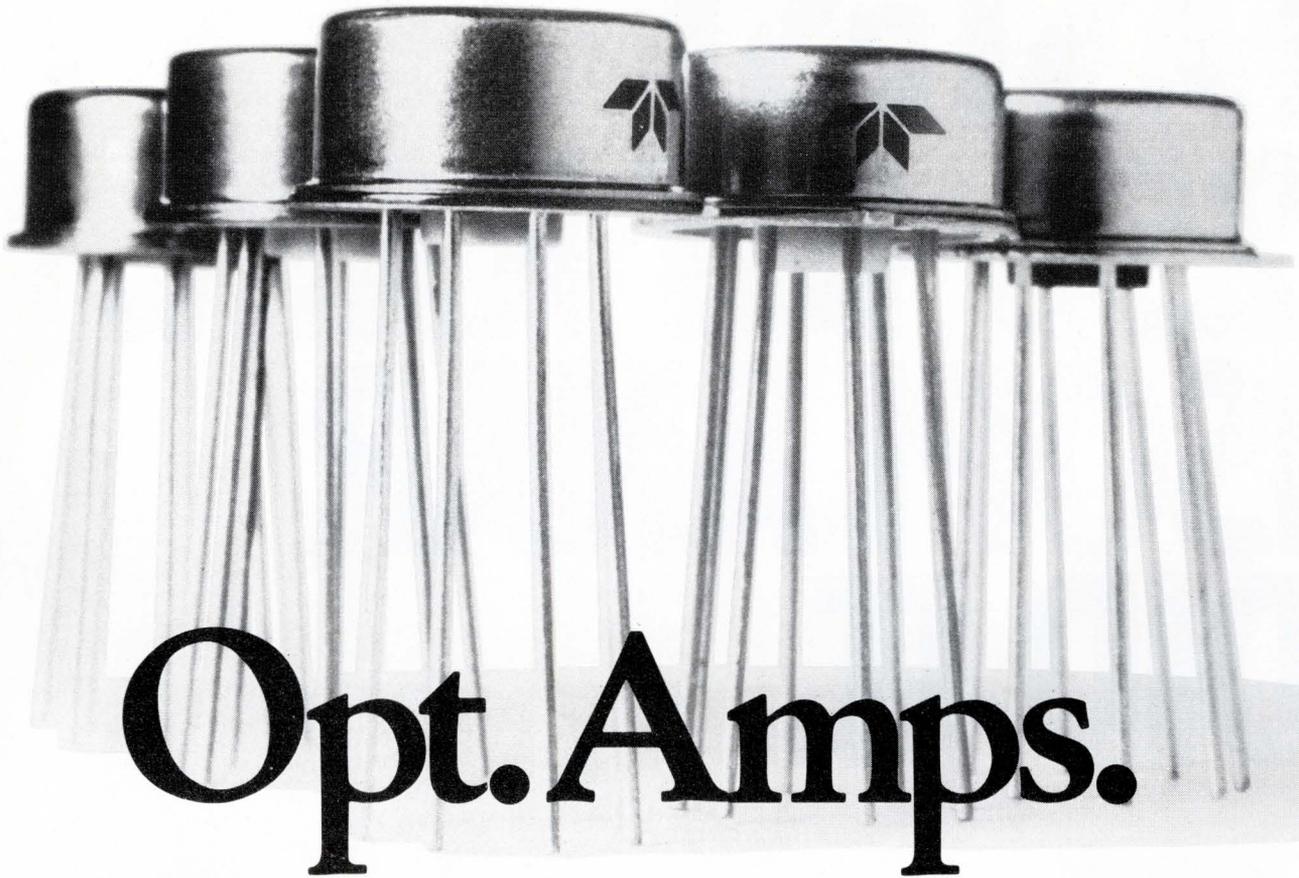
It means that you must constantly look at your customer's products, understand the problems they face in competing in their markets, and smooth them out by designing products that not only interface well with your objectives yet do not tax their expertise. It means that you must take just as hard a look at your suppliers, and use them to free you, and the engineering talent in your company, for what you and they do best.

Think of the implications. This may mean that a power supply manufacturer such as Lambda was smart in offering hybrid supplies which free their customer from the task of designing power sources. It may also mean that Lambda would have been better advised to let a manufacturer of power semiconductors and hybrid circuits, such as Motorola, make those hybrids, instead of manufacturing them themselves. It may mean that minicomputer manufacturers, such as Digital Equipment Corporation and Data General, are looking ahead when they offer computers which interface directly with test equipment or with data communications equipment, but that may be ill-advised in making their own power supplies. And it may mean that instrumentation systems houses such as Foxboro, Hewlett Packard, and Teradyne are right in offering computerized test systems to their customers, but that they should buy—rather than make—the minicomputers which run those systems.

How do you decide what the systems approach means to you and your company? The decisions, as you can guess from the examples, involve both technical and economic factors. For us, it means providing you with information on technical and economic factors which will help you arrive at a sensible decision. That's why you see in these pages not only technical discussions, but also their price tags. That's why you see not only information on your colleagues' problems and how they solved them, but also on the markets of your users and the capabilities of your suppliers. *After all, we too believe in systems engineering.*

Alberto Socolovsky
Editor





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ISOPLANAR
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Here it is: A fully decoded 256 x 1 bit Easy ECL read/write RAM. A high-speed, low-power, low-cost answer to your memory problems. No more compromising your ECL system for lack of speed/cost compatible memory functions.

95410: 256-bit high speed ECL RAM

Here's what you get:

- 25 ns typical read access time.
- 7 ns typical chip select access time.
- 2mW/bit power dissipation.
- Wire-OR able outputs.
- 16-pin hermetic dual in-line package.
- Corner power pins.
- Logic levels fully compatible with 9500, 95100 and other ECL families.

Most important, the 95410 now gives you a 256-bit RAM for any scratchpad, control or buffer memory application in any ECL system - without any interfacing circuitry. And at higher speed than functionally equivalent TTL devices. You save time and money no matter how you figure it: per-bit, per-component, or per-system. As a result you can build ECL systems that are more than twice as fast as TTL. This is of critical importance in new-generation peripheral controllers, mini-computers and large EDP systems.

Isoplanar did it

As we noted last Fall when we announced our 256-bit 93410, fastest TTL RAM, and first isoplanar production IC made, our isoplanar process is here to stay. Fairchild isoplanar technology greatly reduces the cost and improves the reproducibility of high speed bipolar memories. It also improves speed/power performance by reducing parasitic capacitance.

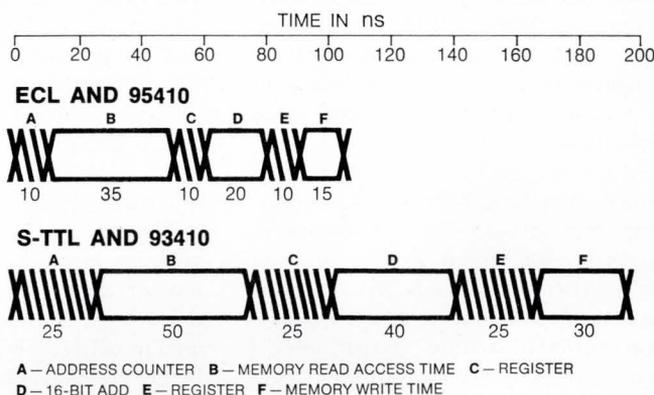
With isoplanar you get: More function for your dollar than with conventional bipolar devices. Near MOS density with bipolar speed. Wide choice of speed/power trade-offs in both ECL and TTL families.

9500-Compatible

The new 95410 is fully compatible with all the other members of the Fairchild series 9500 and 95100 ECL compensated devices, certainly the most comprehensive and easy-to-use ECL family on the market today.

95410 is available now in production quantities from your friendly Fairchild distributor at these prices.

1-24	25-99	100-999
\$46.80	\$43.10	\$37.50



COMPARISON OF ECL AND TTL READ-MODIFY-WRITE SYSTEM PERFORMANCE

These timing diagrams compare the worst case component delays through the critical timing paths of comparable ECL and TTL read-modify-write memory cycles.

Note that the ECL system is twice the speed of the TTL design. In practice ECL will show further improvement due to superior high frequency interconnection characteristics. Generally a more complex multiphase clock scheme will be used to provide further 50% improvement in performance.

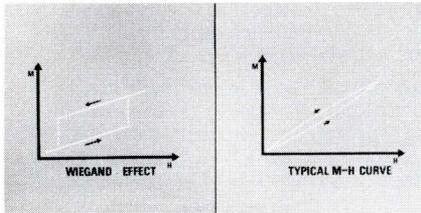
As shown in the ECL system above, 9500 MSI functions are used in association with the 95410 ECL memory. In the TTL system, Schottky TTL/MSI is used together with our 93410 Isoplanar RAM. At 50 ns (max.) the 93410 is the fastest 256-bit TTL/RAM in production today.



The Wiegand Effect

With applications in everything from light switches to automobile ignition systems, the Wiegand Effect is the capability of a ferromagnetic material to recognize an inherent rapid switching of the magnetization when subjected to an applied magnetic field.

At present, the Effect is being demonstrated in a ferromagnetic wire (magnetic field sensor) with the change in magnetization sensed by a read head (pulse generator). This is believed to be the only known magnetic pulse generator unaffected by rate. Output pulse is characterized by a pulse width of about 10^{-4} s, signal ratios in the area of 40 dB, and minimum voltage outputs of 50-250 mV.



Applications of the bi-directional bipolar device in automobile ignition systems are inevitable since, unaffected by rate, the pulse will be generated no matter how slowly the distributor shaft turns. And since the pulse can be generated over a temperature range of -95 to $+300^{\circ}\text{F}$, an engine should provide greater efficiency and performance.

The solid-state device offers a potential solution to the permanent data storage card problem. Made with discrete wires and laminated plastic, essential information would be coded into the wire. Inserting the card in a reading device, the reader would sense the magnetic pulse generated by the passage of the wire, and transfer the information to a viewing screen or a printer.

Still other applications include shift registers, magnetic field sensors, thermostat controls, keyboards, and magnetically operated devices. More details on the Wiegand Effect are available from ComGeneral Corp., 4518 Taylorsville, Rd., Dayton, Ohio 45424.

Circle Reader Service #299

Storing images

In a new type of ceramic imaging device, called Cerampic, images are stored by exposure to light in much the same way as photographic film is exposed. But unlike photographic film, Cerampic pictures need no developing, may be erased and reused at will, and may be reviewed directly or projected onto another surface.

This flexibility implies a potential application in generating images from radio or telephone signals. Facsimiles of documents, photos, or diagrams, generated in only seconds, could be inspected before permanent copies are made. Also anticipated are applications in optical information storage and processing systems, shutters, optical memories, and page composers for holographic memories.

The prototype Cerampic consists of a thin electro-optic ceramic plate coated on one surface with photoconductive film. On the other large surface, as well as on the photoconductive film, transparent electrodes are deposited.

The image is stored by exposing it on the film while applying a voltage to the electrodes. The image may be exposed by illuminating it through a photographic negative, or by scanning it with an intensity-modulated light beam. Exposing a great number of minute areas of the ceramic to varying electrical fields results in a microscopic mosaic of shades of grey, seen by the human eye as a positive image.

Cerampic was developed by Sandia Laboratories, Albuquerque, N.M. 871115.

Circle Reader Service #300

FORTRAN math

If you use an IBM System/370, System/360, an 1130, or an 1800, there's a series of more than 180 mathematical subroutines, in FORTRAN source form, that you can use with your system. The new program series, called SL-MATH (Subroutine Library-Mathematics) will solve the mathematical problems in applications designed for teleprocessing, timesharing, and batch processing.

The SL-MATH routines cover such problems as elementary array operations, solutions to linear equations, optimization, differentiation and integration, and interpolation, to name a few. More complex problems may require the use of a combination of routines.

Whatever the problem, standard Subroutine CALL statements select the required routine. No input/output statements are necessary—in all routines the user specifies the input/output capability and data manipulation required. And advanced numerical analysis techniques can be incorporated into application programs.

Details of the SL-MATH program routines are available from the IBM Data Processing Div., 1133 Westchester Ave., White Plains, N.Y. 10604.

Circle Reader Service #301

Photodiode array

A new addition to systems technology for business machines is a 16-bit MOS/LSI photodiode shift register that averages light intensity levels ranging from 0.1 to 25 mW/cm² and provides a digital output. Applications include credit card and price tag reading, combining electronic cash registers with weighing scales, measuring paper thickness, and monitoring conditions of masters and exposures in copiers.

The array, interfacing digital electronics with optical pattern generators, contains photodiodes, detectors, sample gates, timing circuits, and static shift registers. All are mounted in an 8-lead TO-5 hermetic package with a transparent top.

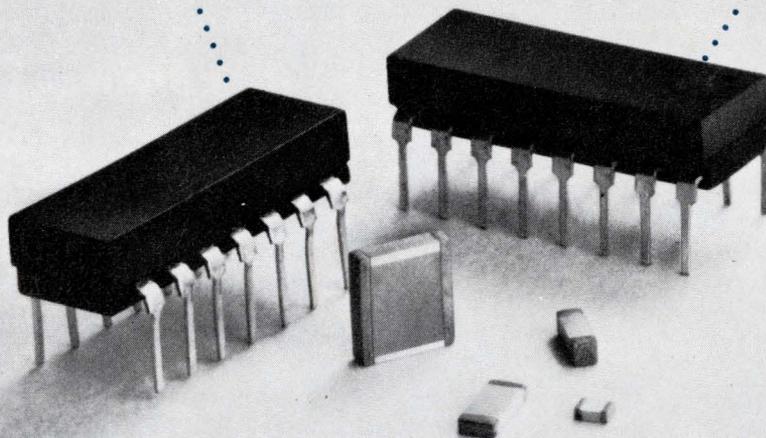
The diodes in the array evaluate the light patterns during an integration period. This is adjusted for each given light level until an equivalent "1" or "0" is parallel-shifted into the register. Output data is then held in the shift register until clocked out onto a single line.

North American Rockwell Microelectronics Co., Box 3669, 3430 Miraloma Ave., Anaheim, Calif. 92803.

Circle Reader Service #302

Give our CHIP capacitor customers something to cheer about.

DIP,
CHIP,
ARRAY



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				NPO	X7F	X7R	Z5U
ULA-11	.085	.060	.050	120	820	5,600	10,000
0805	.065	.040	.020	to 560	to 2,200	to 15,000	to 47,000
ULA-70	.180	.070	.060	330	2,700	18,000	22,000
1805	.160	.050	.020	to 1,800	to 6,800	to 47,000	to .15 μ f
ULA-78	.190	.090	.060	560	4,700	33,000	47,000
1808	.170	.070	.020	to 3,900	to 15,000	to .10 μ f	to .27 μ f
ULA-60	.230	.255	.060	2,700	22,000	.15 μ f	.47 μ f
2225	.210	.235	.020	to 15,000	to 56,000	to .47 μ f	to 1.5 μ f

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Decision day in Dallas . . . The long-awaited decision on a standard ECL line has been made by Texas Instruments. The recognized leader in TTL will attempt to muscle into the ECL market with a line of devices that are not only pin-compatible with Motorola's 10,000 line, but also include on-chip temperature compensation (as Fairchild's 9500 ECL does). Initially, TI will introduce a total of 16 circuits, including some MSI functions. Notable among the MSI list is the 10,181 arithmetic logic unit. Plans call for an additional 13 new product announcements before the end of 1972.

Circle Reader Service #303

Motorola's monolithic modem . . . Motorola Semiconductor is just about finishing up development on a monolithic 103-type modem. Formal introduction of the unit is expected sometime in early August.

Circle Reader Service #304

Plugging credit card leaks . . . During the month of March, Data Source Corp. credit card terminals processed 71,235 transactions, picking up 1,543 bad cards. In a random sample of 40 cards, 15 charges were for \$3 or less, suggesting that credit control can only be achieved with a zero dollar floor limit. This new terminal, combining both automatic credit verification and sales ticket imprinting, makes it possible to enforce a zero limit on each credit card transaction. The Model 2101 is specifically designed for gas stations and high volume retail outlets.

Circle Reader Service #305

Solid state sales top \$1.1 billion in 1971 . . . According to the EIA's Marketing Services Dept., U.S. factory sales of solid-state products totaled more than \$1.1 billion in 1971. Although this marks a decline from the \$1.2 billion total reached in 1970, the IC market showed an increase in sales of almost 20%.

Computers get the bugs out of the beetle . . . More than 60 separate tests can be made on the Volkswagen beetle with the Computerized Self-Analysis System VW dealers will be using later this year. Plugging into a factory-installed socket in every 1972 VW, the electronic check-up system will measure front wheel alignment, ignition performance, engine compression, battery voltage, and many other conditions in a matter of seconds. The computer then prints out an analysis on a high-speed printer, enabling the dealer to compare these readings with standard values for necessary repairs.

Electronics in military contracts . . . In March, contracts for electronic equipment and systems were issued by the Dept. of Defense as follows: Air Force, \$67 million; Army, \$308 million; and Navy, \$102 million. Areas receiving substantial funds were weapons systems (\$296 million), electronic equipment in aircraft (\$33 million), and computers and computer-related equipment (\$28 million). It's estimated that approximately 60% of a \$558 million contract for the SAM-D weapons system awarded to Raytheon Co. by the Army will go for electronics. Also in March, the Navy awarded over \$17 million to Sperry Rand Corp. for computers, computer programs, and peripheral equipment.

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USCC/Centralab has developed highly automated assembly techniques for Mono-Kap and our other ceramic capacitor products— from raw materials to chip capacitors to leaded capacitors with no sacrifice to quality. All this makes possible the fastest delivery in the industry on the wide variety of USCC components. Ask us, we'll give you our best.



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Circle Reader Service #9

Have you been using Ferrite Pot Cores?



SWITCH TO THE NEW FERROXCUBE RM CORE— FOR BIG SAVINGS!

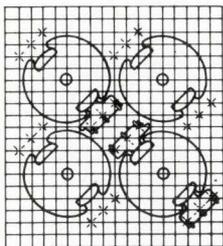
Typical Savings: 40% in Mounting Space 40% in Assembly Labor 30% in Parts Inventory!

FERROXCUBE'S new RM cores are smaller in *everything* except performance.

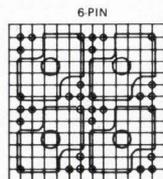
If you're already using pot cores, we don't have to sell you on the merits of the Ferrite Core Experience.*

In fact, if you use 18-mm or 26-mm pot cores, we should have no trouble selling you on our new RM cores, either. You stand to gain a lot, and there's no way you can lose.

TAKE SIZE: our RM6 core is equivalent to an 1811 standard pot core in performance, yet it occupies an area only 0.6" square — including connection terminals and mounting clips — as shown on this standard 0.1" punched PC card you get 18-mm pot-core capability in 14-mm space — up to 400 cores per square foot!



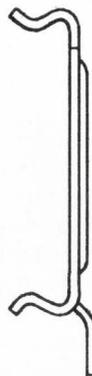
Ø HOLES FOR PINS OF CLIP



Our RM8 core gives you a similar gain: 26-mm core performance in 18-mm core area, or 225 cores per square foot.

TAKE CONSTRUCTION: note the classic simplicity of the RM design — essentially a ferrite cube with two notched-out corners. A reinforced polyester bobbin, single- or double-section already equipped with 4 or 6 P.C. terminal pins, carries the windings. The windings are protected from mechanical damage, and thoroughly shielded, virtually eliminating coupling and interference pickup. Unlike those on pot cores, the bobbin extensions for the terminal pins *lie within the limits of the RM cubical outline*, enabling maximum packing density to be achieved when required. Yet even when mounted side by side in both coordinates, in the densest possible array, crosstalk and interference are negligible.

TAKE ASSEMBLY: this little clip is the only hardware you need to assemble and mount an RM core. The wound bobbin is placed in the bottom core half, the top core half is placed in position, and two of these clips are snapped into place at opposite corners. That's all — you're ready to install. If you're accustomed to the pot-core's assortment of hardware — cans, pressure springs, spacers, terminal plates, etc., you'll see why users report savings of 30% to 55% in assembly time — and fewer rejects, too! The rectangular profile to the RM core really simplifies *automated* assembly, too.



AND DON'T FORGET MATERIAL HANDLING: the simplest pot core assembly includes at least seven separate items. The RM core cuts this to five. Fewer — and simpler — parts to buy, to handle, to stock. From purchase-order processing, through receiving and stocking, all the way to filling production bins, you save more on the RM core.

BUT NO CHANGE IN PERFORMANCE: you get all of the advantages of the ferrite pot core: choice of formulations; choice of ungapped, fixed-gap, or adjustable-gap types; smooth, precise tuning of inductance to $\pm 0.1\%$ in adjustable models; Ferroxcube's justly famous high uniformity and repeatability; and *instant availability, in any quantity, at Ferroxcube Stocking Centers all over the country* (see list below). Get a few samples, today — and start saving.

* If you have somehow managed to escape exposure to the Ferrite Core Experience, don't waste a minute more of your professional existence — use the Reader Service Card to get your personal copy of the 32-page "Linear Ferrite Magnetic Design Manual" . . . everything you need to know for efficient design of all kinds of inductors and transformers in the unfettered ferrite domain.



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Modem operates at gigabit rate . . . Operating at a data rate of 1 Gbit/s, a quadra-phase-shift keying modem system was demonstrated to Lockheed Research Labs representatives by Radiation Systems, a division of Harris Intertype Corp. The modem approaches theoretical performance and is designed to interface with rf equipment at an L-band i-f frequency. Lockheed plans to use the equipment in a laser satellite data link system.

Circle Reader Service #306

TI adds the calculator . . . Continuing their effort to get more value added into the products they sell, Texas Instruments is entering the calculator market. First plans are for a hand-held four function unit, although TI is also looking into more elaborate desk-top models. The first machines will feature MOS chips from the TI operation in Houston, LED readouts from the opto group, and a keyboard from TI in Attleboro, Mass.

Circle Reader Service #307

Already a price war in ECL? . . . Motorola has cut prices an average of 15% on its MECL 10,000 line of emitter-coupled logic ICs, a move anticipated after both Signetics and National Semiconductor decided to second-source the line. At the same time, Motorola is introducing a line of faster (1.5 ns) ECL ICs, called the MECL 10,200, with the same power dissipation as the 10,000 line which has a propagation delay of 2 ns.

For information on MECL 10,000

Circle Reader Service #308

For information on MECL 10,200

Circle Reader Service #309

Schottky diodes shine above 100 kHz . . . According to Alan J. Carlan, Manager of Product Development at International Rectifier, Schottky diodes can be used "to improve efficiency dramatically in low voltage power supply systems, particularly at high frequencies." He indicates that Schottky power diodes exhibit negligible power losses over 100 kHz, unlike conventional p-n junction diodes in which losses increase with frequency. Carlan attributes the improved efficiency in power supplies to the diodes' excellent high frequency characteristics, low forward voltage drop, and reduced switching losses.

Communications technology to improve rural life . . . Dr. Peter C. Goldmark, president of Goldmark Communications Corp., spoke at a National Science Conference, promoting his New Rural Society concept as an answer to the outmigration of people from rural to urban areas. The concept holds that communications systems such as cable TV, facsimile and broadband communications channels will attract people to rural areas by offering the employment and economic opportunities they now find in urban areas. "The imaginative use of existing communications can help to correct the imbalance caused by 90% of our people living on less than 10% of the land," Goldmark claims. The concept is now being implemented in rural Windham County, Conn. (See **The Electronic Engineer**, Jan. 1972, pp. DC-4 to DC-9.)

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Circle Reader Service #11

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New Dual 10A NPN Power Darlingtons give you twice as much in a single package. And double the space efficiency. They're ideal for full wave bridge applications such as stepper motor drivers and converters and desirable as print hammer, servo, relay and lamp drivers, and linear amplifiers. They provide inherently higher reliability through the use of monolithic planar Darlington chips.

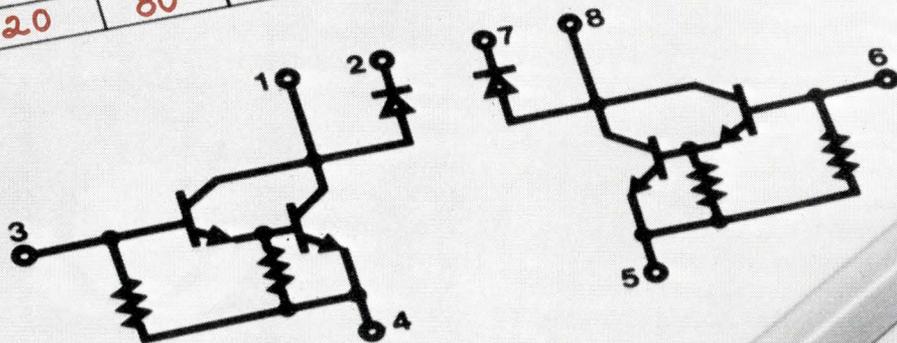
The completely new PNP line beginning with 5A and 10A devices and the 20A NPN additions provide design advantages through unsurpassed performance in saturation voltage, current gain, compact packaging and voltage ratings. It adds up. We'll continue to give you more in Darlingtons because our capabilities are still growing.

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Type	P _D W	V _{CEO} V	h _{FE}	V _{CE(sat)} V	t _{on} μs	t _{off} μs	Package	Price (100- 999)
PIC500	30	100	2000	1.5	0.55	2.0	T0-3 (8-pin)	\$10.00
PIC501	20	100	1000	2.0	0.65	3.6		6.50
PIC502	20	80	750	2.0	0.65	3.6		4.90



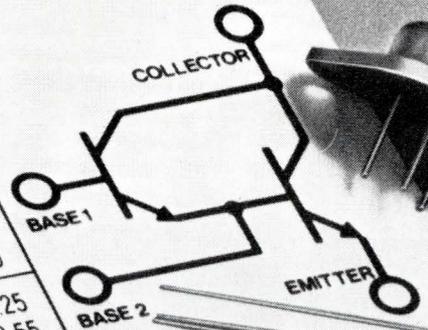
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C-LINE POWER DARLINGTONS

Peak I_c A	Type	Package	V_{CE} V	h_{FE}	V_{CE} (sat) V	t_{on} ns	Price (100- 999)	
NPN	5	U2T301	TO-33	60	1000 @ 2A	1.5 @ 2A	300	\$1.25
		U2T401	TO-66					1.50
		U2T305	TO-33	150	1000 @ 2A	2.5 @ 2A	400	1.80
		U2T405	TO-66					2.10
		U2T101	TO-33	80	2000 @ 5A	1.5 @ 5A	400	2.25
		U2T201	TO-66					2.55
	10	U2T105	TO-33	150	1000 @ 5A	2.5 @ 5A	500	2.85
		U2T205	TO-66					3.15
		U2T501	TO-66	80	2000 @ 10A	1.5 @ 10A	400	4.30
		U2T601	TO-3					4.30
		U2T505	TO-66	150	1000 @ 10A	2.5 @ 10A	500	5.40
		U2T605	TO-3					5.40
20	U2T351	TO-33	60	1000 @ 2A	2.0 @ 2A	250	1.50	
	U2T451	TO-66					1.80	
	U2T355	TO-33	120	1000 @ 2A	2.5 @ 2A	300	2.16	
	U2T455	TO-66					2.52	
	U2T151	TO-33	80	2000 @ 5A	2.5 @ 5A	300	2.70	
	U2T251	TO-66					3.06	
PNP	10	U2T155	TO-33	80	2000 @ 5A	3.0 @ 5A	400	3.44
		U2T255	TO-66					3.78



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First-class appearance will sell your product, so we designed the NEW 4000 series digital panel meters with big, bright, solid displays that are "No. 1" in national user-preference surveys.

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And extra-low input bias current keeps readings accurate and super-stable, even at the highest operating temperatures.

Give your panel the quality look. Your customers will recognize it—*and buy it, too!*

and "Money Savers," too!

We designed the 4000 series to protect you against profit-robbing failures.

The displays are more reliable (and more readable) because there are no "loose" elements inside.

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We're so sure we have the answer, we've extended our WARRANTY for **ONE FULL YEAR!**

It won't take you that long to find out how much money you're saving with the 4000 series on your panel.

Don't be fooled by low price tags! This time, buy quality and reliability *right from the start!*

If you have anything left from your last panel meter purchase, give us a call.

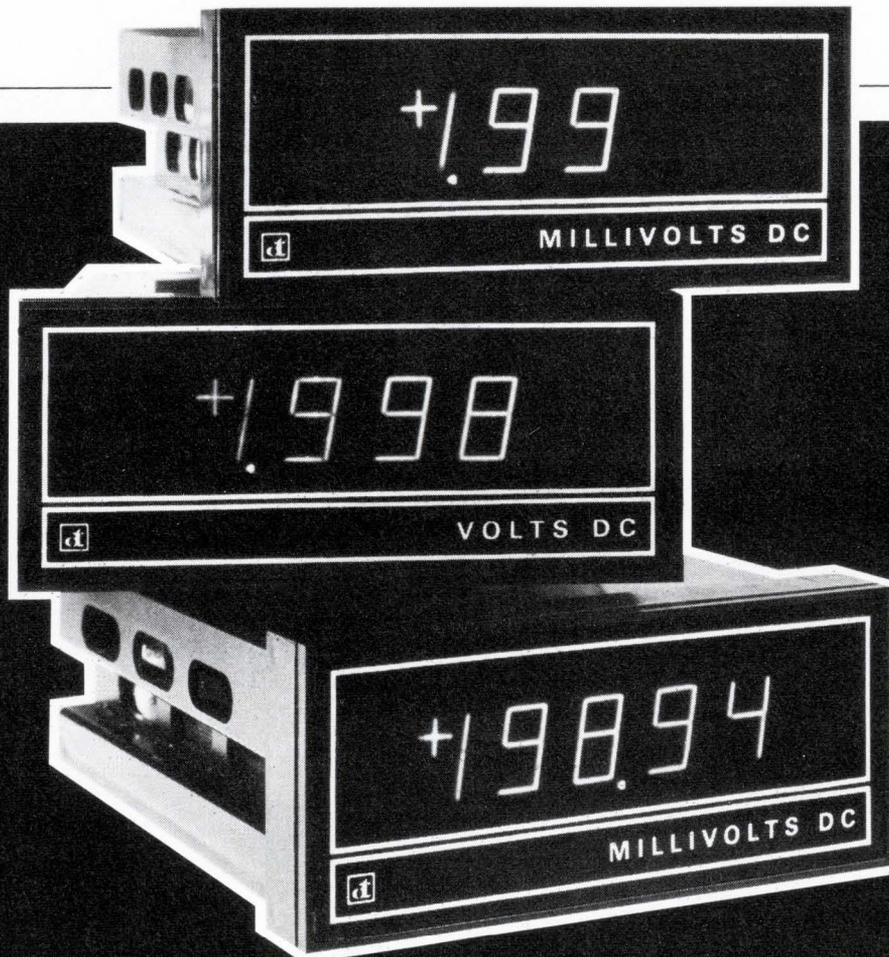
If you don't have anything left, call our sales department collect. (714) 546-7160, ext. 567.

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MONOLITHICS shrink DVM prices

As manufacturers turn to ICs, the \$100 multimeter becomes a question of when, not if.

Stephen A. Thompson, Western Editor—Los Angeles

Ask a DVM manufacturer about the possibility of buying a 3½ digit multimeter for \$100 in two years and the odds are that you will get a 15-second pause. He may become skeptical, alter the time scale, or question the quality, but he won't reject the idea completely.

Why? Because there's a clear trend to modularization of digital voltmeters (DVMs) and digital panel meters (DPMS) into five or six components, just as happened with calculators, with similar effects on price. There are, however, two complicating factors in the DVM case. First, there are significantly lower volume involved with DVMs than with calculators. Second, a DVM also has an analog portion, unlike the purely digital calculator, so it probably will require two chips instead of one.

The differences between system- and bench-oriented DVMs are becoming even more apparent. System types have graduated from event monitoring to controlling a function via BCD outputs. People are still willing to pay for specs and market fragmentation prevails.

On the other hand, bench and panel meters are in a price war where economically accomplishing a measurement is more important than accuracy. To sense the heat of the battle, you must realize that unit sales are expanding at about 20% per year. Unhappily for manufacturers, price erosion may outstrip unit sales and total dollar volume may actually decline.

During the coming fall, the latest free-for-all should be well underway. Dana and HP are making

some moves right now, and there is a lot of noise behind closed doors at Fluke, Systron-Donner, and Data Precision. There are rumors of new 3½ digit multimeters around \$200 and 4½ digit units approaching \$300.

Components make the meter

The cost of ICs strongly influences DVM prices. Looking ahead, Don Kesner, Systems Applications Manager at Motorola, says, "We're in phase 1, where the digital end becomes one chip. Most important houses are funding custom MOS contracts with large semiconductor houses to accomplish exactly that. Phase 2 is about two years away. It will include a monolithic analog front end and a low-cost display in a minimum-labor package. If DVM manufacturers would standardize rather than buy custom chips, every home experimenter could have a 3½ digit DVM from Radio Shack for \$29."

Volume is a key factor according to Don. Although today's digital chip takes only half the area of high-volume calculator chips, it costs the same. To



The digital multimeter/counter concept was pioneered by California Instruments. This 4½ digit, autoranging unit features 17 ranges of dcV, acV, ohms, and frequency and an LED display. Model 8421, \$895.

YOU BUY THE DC

...and
We'll throw in



That's right . . . We designed our Model 4700 DMM with total measurement capability in one box (no options to add) . . . and it sells for only \$985.

When you consider 5-DC, 4-AC, and 6-k Ω ranges; your choice of manual ranging or complete autoranging; 100% overranging; isolated BCD and Programming; and front panel remote override . . . you've got to admit that's a lot. But that is only part of the capability.

Instrument operating specifications are available in the 4700 Data Sheet. Why not get a copy . . . or better still call up for an on-the-spot demonstration.

Behind the front panel you get $\pm 0.01\%$ accuracy when measuring DC and Ohms, and $\pm 0.1\%$ in AC. Outstanding resolution is also built-in to further extend measurement accuracy . . . and to maintain it you need calibrate the 4700 on only a 90-day cycle.

We even went further by putting in a wide operational band for AC measurements (from 40 Hz to 100 kHz), and backed up reliability with plug in IC's and solid state fully isolated digital output and remote programming.

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cover a \$25-50,000 development cost to get digital chips for \$10, you need an order for about 10,000 chips and a total contract price around \$100,000. The trouble is, few independent companies can order more than 10,000 units to get a better price break.

"The basic dc voltage analog section costs another \$10-12 for parts and assembly, not including ranging," continues Kesner. "Motorola has the design for a monolithic analog circuit that should cost below \$3.50 in volume. In two years, the cost of the digital chip should be \$5.50 and the display near \$2.00. If all three break through simultaneously, today's basic large volume component cost should drop from \$25-30 down to \$11-12, exclusive of case and switches. A manufacturer will buy two chips and a display, make two or three adjustments, and ship operating units."

Weston's Product Marketing Manager for Digital Instruments, Jack Stegogna thinks two years is too soon for the complete change to phase 2. "Prices for full digital multimeters (DMMs) are dropping at 15-25% per year, and will continue until they get below \$100. The \$100, 3 1/2 digit DMM is unquestionably on the way, possibly in five years, depending on what the IC people do. Volume is the problem. Once, calculators are behind us, DVM volume will become significant and price breakthrough will start with the best-selling units."

Digitizing is duck soup

The digital portion on a chip is a foregone conclusion for instrument and semiconductor people alike. The three best known commercial approximations are the Fairchild 3814 used in Dana's new 4300, 4 1/2 digit DMM; Mostek's 5002 in Weston's new 4440, 3 1/2 digit DMM; and AMI's S1907 in Digilin's new 4352, 3 1/2 digit DPM.

Tim Trueblood, a Fairchild MOS LSI engineer, admits that calling the 3814 a DVM on a chip is optimistic. "It contains virtually all of the logic, but does not touch the analog problem. It also stops at outputting multiplexed BCD information, which must be decoded. The bipolar compatible output, however, does give the user any display option, up to 4.4 digits." The 3814 costs \$20 in 100 quantity, while the 3815 is a new 5-decade version for the same price.

Mostek developed its 5002 for Weston and the chips delivered to Weston can sense polarity and dual slope threshold crossing, and drive 3 1/2 strobed digits. These special functions are aluminized over in commercial models of the circuit. The 5002 is in a 28-pin package incorporating the basic counter and latch controls, and both 7-segment and BCD outputs. Low voltage decoding is not an advantage to users with high voltage gas discharge displays, so a 5007 version comes in a 16-pin DIP with BCD output only.

The '02s are \$19 in 100 quantity; '07s are \$13.

The AMI S1907 is built to Digilin specs. It counts, decodes, and directly drives AMI's liquid crystal (LC) displays, which Digilin also uses in its new DPMs. In quantities of 100 the S1907 is \$14 each, and 100 3 1/2 digit reflective or transmissive LC displays are \$18 each.

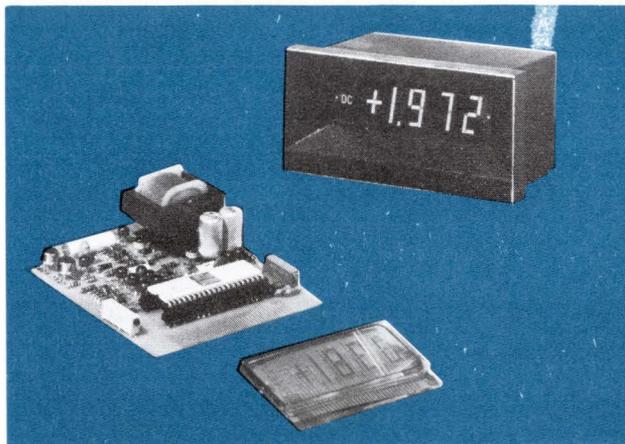
Digital is science; analog is art

Glenn Patterson, Fluke's Product Manager for voltmeters, sums up prevailing opinion. "The analog end is fertile ground to plough." However, opinions differ sharply about if, or when, an analog front end will ever be put onto a chip. Digilin's President, E. B. "Rick" Hibbs, is bullish. "We're working very hard with several people, but have not committed to a circuit yet. A 3 1/2 digit front end is possible in three months. The six-month probability is very high, and I would guess the far limit is about nine."

Tony Schiavo, Dana's Product Line Manager, points out that an analog chip for a very low-performance 3-digit multimeter is one thing, "However," says Schiavo, "a DVM manufacturer prides himself on his analog capability to measure rms ac, low level voltage, and ohms. Not only is the problem itself fairly difficult, the various options make most designs low-volume propositions. The problem will probably be solved with discrettes for some time."

Product Engineer Ken Jessen, of Hewlett-Packard, agrees that discrettes are still cheaper. "You may see an LSI amplifier/attenuator combination, but I do not look for ac, dc, and ohms together on one chip for a while. Even though dc volts is practical, it is not yet economical."

(Continued on next page)



The first DVM with a liquid crystal display is Digilin's 3 1/2 digit 4352 panel meter. It uses AMI's display and S1907 counter/display circuit. The total power drain is less than 1/2W. Cost is \$85 in 100 quantity. Digilin offers a 60-page "DPM Handbook" covering what DVMs are, which specs are important, types of A/D conversion, and many applications. The handbook is free to those who send details of their application, or can be purchased for \$3.

Pick an A/D technique

What's the best, analog-to-digital technique depends on whom you ask. Weston invented dual slope integration (DSI) and thinks it is a basic circuit, as simple as any, and presents no problems. Fairchild, Mostek, HP, and Systron-Donner like it too.

Jerry Hartman, Product Manager for Systron-Donner, likes DSI for technical and cost reasons. Looking at the industrial market with its inherently high noise levels on power lines and radiated through the air, DSI's inherent noise-cancellation looks good, and economical. Another observer indicated that DSI takes care of potential MOS inadequacies. It does not require long-term oscillator stability, and reference voltage can vary from chip to chip.

According to Jack Lieberman, Product Manager for HP's instrument Division, HP has done a good deal of work in integrated analog front ends, and the two bench meters to be announced this month (June) contain thin-film hybrid analog circuits. The 4 1/2 digit model has the "clamshell" configuration, where a mainframe forms the upper portion and snaps onto one of two plug-ons forming the lower part. One plug-on is dc only; the other has full multimeter capability. The 5 1/2 digit model is a dedicated multimeter. Both have LED displays.

Fluke's Glenn Patterson claims, "Admittedly dual slope is widely used, but it is not the only good technique. "Fluke became number two without DSI. Our recirculating remainder techniques has significant advantages for decreasing parts and increasing reliability."

Walt Hanford, Product Applications Engineer for California Instruments, feels that the way to go in this type of instrument is to add frequency, capability to make multimeter/counters such as their new

8421. Calico uses a synchro-count technique that Walt thinks can be easily implemented.

Meanwhile at Motorola, Don Kesner says "DSI is not really suitable for monolithic analog circuits." He feels he has a better solution and though his patent position precludes giving details yet, his method involves reengineering DSI front end methods," because it will make it cheaper in the long run."

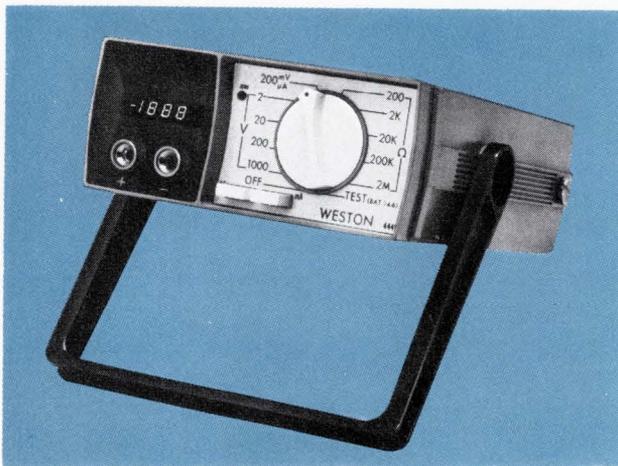
The front end of the meter is also a major concern at Data Precision. Hal Goldberg, Operations Manager, points out the cost savings of the Tri-phasic converter Data Precision uses. "We designed our circuit to replace a \$25 amplifier with a capacitor, three resistors, and three FETs for about \$1.25. Since our units self-servo back to zero between each conversion, we don't worry about drift and offset in buffer amplifiers, integrators, and comparators. We use a monolithic comparator where many others are forced to use discrete comparators. At Data Precision, cost is a spec. If a design does not meet the spec, it does not get produced."

If frogs had wings . . .

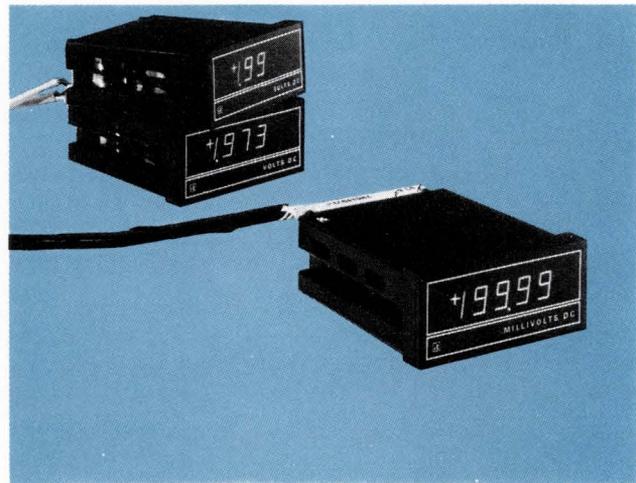
Almost everyone agrees that displays are the high cost item in low cost meters. There is universal agreement that if liquid crystals can deliver the low cost and power that they promise, they will be the one to use.

While HP's Jack Liebman is sure that display breakthroughs will be made, he doesn't know where it will actually happen. He observes, "A couple of years ago, everyone was pretty sure GaAs was the coming thing. A lot of people bet on it. People had that feel about it. Nobody seems to have that feel about any of the things in development now. In fact, some have gone back to incandescents."

(Continued on page 25)



Complete with test leads, Ni-Cd batteries and charger for \$285, the Model 4440 is a 3 1/2 digit, 17 range portable multimeter with a LED display from Weston. It uses a Mostek MOS LSI chip for the digital portion.



New Series 4000 panel meters from Data Technology use Sperry planar gas discharge displays. The 3 1/2 digit model is \$95 in 100 quantity.

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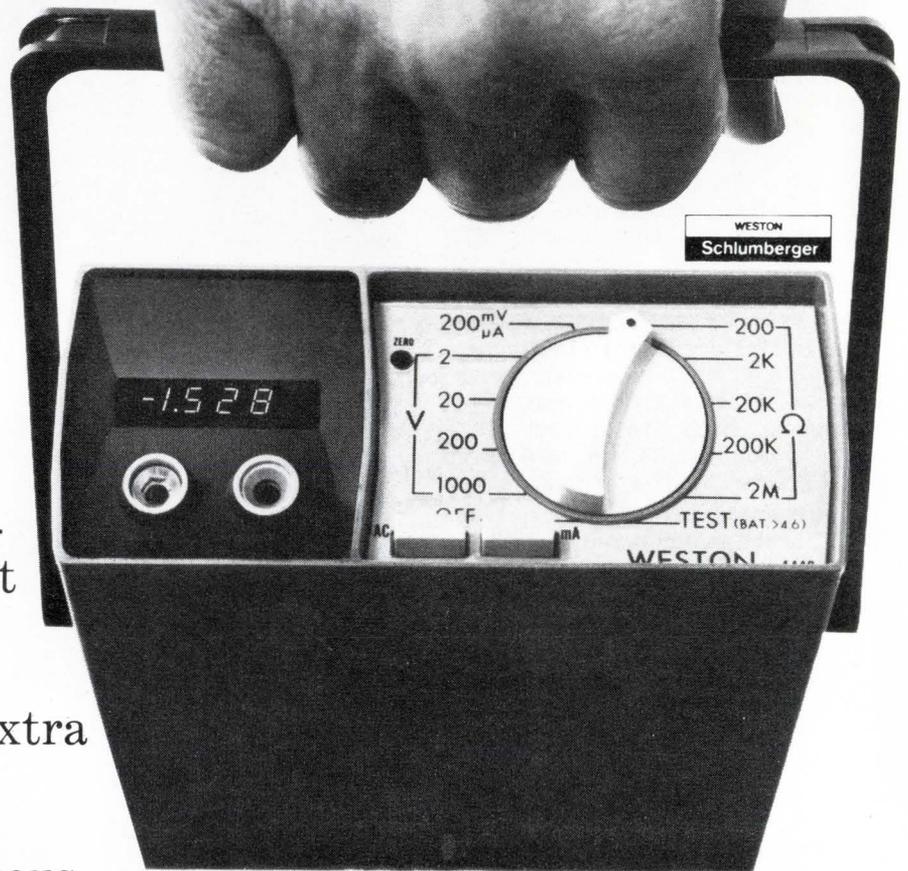
Here's one for the road.

Our new Model 4440 mini-multimeter is the smallest battery operated digital multimeter on the market.

A true portable in every sense of the word, it's shock-proofed, fully overload-protected, and usable at up to 122°F. Fuses are externally replaceable. (We even throw in an extra set, on the house.)

You get eight to twelve hours of continuous field operation before you have to recharge. In an emergency, you can run it five hours or more on ordinary flashlight batteries!

For all its littleness, this rugged portable features a new 3½-digit LED display with automatic polarity, the latest LSI circuitry for more reliability than ever, and 17 full scale ranges that cover



(A cordless DMM for only \$285.)

200 MV to 1000 volts AC/DC, 200 ohms to 2 megohms, plus AC and DC current.

Your local distributor will set you up with a Weston 4440 for \$285—complete with leads, batteries and recharger. Grab one. Weston Instruments Division, Weston Instruments, Inc., Newark, N.J. 07114. **WESTON**

PRODUCT	PRICE(\$)	QUANTITY	INQUIRY NUMBER
Panel Meters			
Digilin 4532, 3½ digits	85	100	201
Data Technology 4000 Series, 3½ digits	95	100	202
Analogic 2532, 3½ digits	95	100	203
Weston 1295 Series, 3½ digits	<100	100	204
Triplett 4228N, 2¾ digits	105	100	205
Triplett 4235F, 3½ digits	205	100	206
Multimeters			
NRMEC, 3½ digit, 16 range	150-200	OEM	207
Triplett 6028, 2¾ digits, 27 range	275	1	208
Dana 3800A, 3½ digit, 21 range	295	1	209
Weston 4440, 3½ digit, 17 range	285	1	210
Systron-Donner 7050, 3½ digit, 14 range	299	1	211
Triplett 8035, 3½ digit, 23 range	385	1	212
Data Precision 2400 Series, 4½ digit	625-675	1	213
Data Technology 391, 4½ digit, 23 range	649	1	214
Dana 4300, 4½ digit, 6 range	650	1	215
Fluke 8100A, 4½ digit, 17 range	695	1	216
Calif. Inst. 8420, 4½ digit, 17 range multimeter/counter	695	1	217
Calif. Inst. 8421, 4½ digit, 17 range multimeter/counter	875	1	218
Hewlett-Packard, 4½ digit	unannounced		219
Hewlett-Packard, 5½ digit	unannounced		220
Circuits			
Mostek 5007, 4 digit counter/display decoder	13	100	221
AMI S1907, digit counter/display	14	100	222
Mostek 5002, 4 digit counter/display decoder	19	100	223
Fairchild 3814, 4½ digit decade counter	20	100	224
Fairchild 3815, 5 digit decade counter	20	100	225
Displays			
Monsanto MAN-1A, single digit red LED	8.70	100	226
Monsanto MAN-5, single digit green LED	11.25	100	227
AMI 3½ digit liquid crystal	18	100	228
AMI 4½ digit liquid crystal	unannounced		229
Optel, 3½ digit liquid crystal	8-9	10,000	230
Sperry 751, 1½ digit 0.55 in. planar gas discharge	5.04	1,000	231
Sperry 752, 2 digit 0.55 in. planar gas discharge	5.04	1,000	232
Burroughs Nixie, B5800	3.95	1,000	233
RCA Numitron			

At Dana, Tony Schiavo feels that "because manufacturers have almost been forced into using LEDs, they will be in vogue for a while. We had amazing success with good, reliable, inexpensive Nixies. When LEDs came, they were new, different, and solid-state. Publications put them on every other page as state-of-the-art, so customers said that to be state-of-the-art, a new instrument must have LEDs.

"One major reason presented for using LEDs was inherently better solid-state reliability. If I were Burroughs (Nixie®) or RCA (Numitron) I'd debate that point. The other major reason advanced was that portable was popular, and little LEDs would take less power. Nothing could be further from the truth." John Dunn, Data Technology's Product Manager, supports Tony's observations. "Choosing

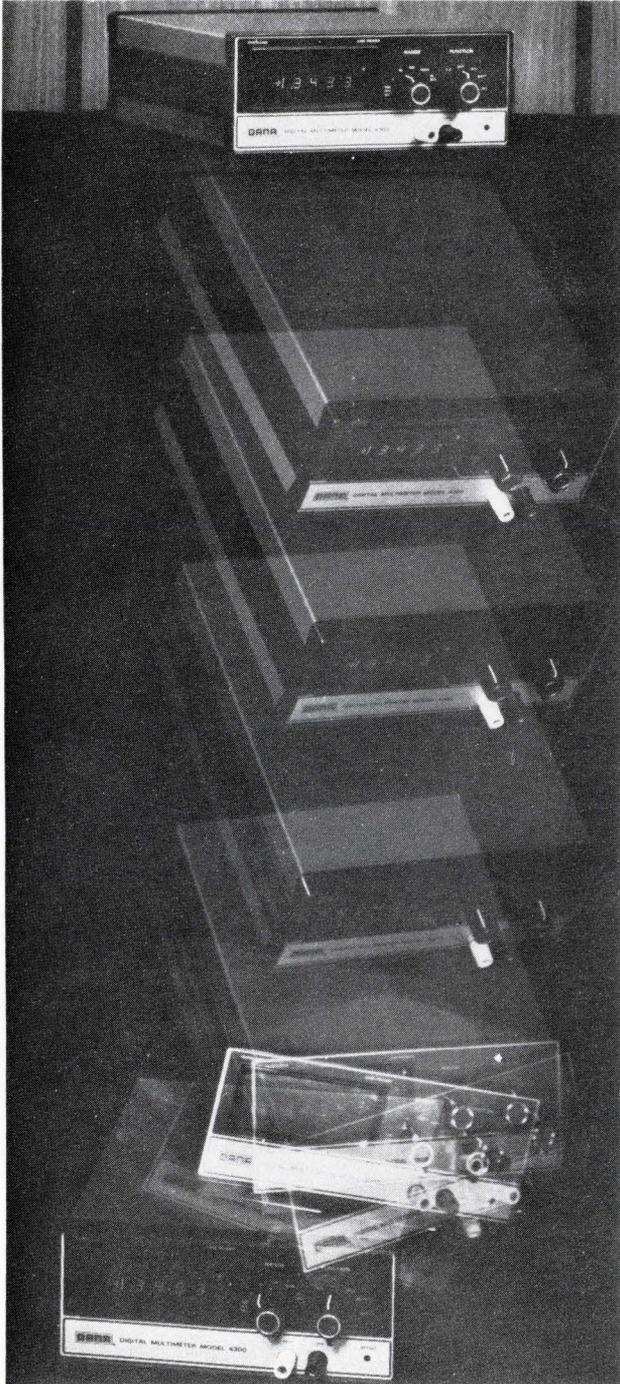
the right display for our new 4000-Series meters was the toughest decision we had to make. When we showed engineers our prototype LED meters, they liked the LED idea, but only from an engineering interface standpoint. When it came to aesthetics, our Sperry display prototypes won hands down. We had a red filter in front of the Sperry units, and the typical response was 'Wow! Whose LED is that!' They were surprised to learn it was a 'flat nixie' tube, as they had been 'pre-conditioned' towards LEDs.

We chose the Sperry because of its overwhelming aesthetic appeal which was confirmed by our national surveys. Also price was reasonable. As for LED pricing, it's really a buyers' market. Just look at the price games being played on quotations and re-quotations, even during the same day."

(Continued on next page)

Digilin displays the way

While other manufacturers dream of 50¢ LC digits and wait for multiplexing, response time, contrast, and temperature specs to improve, Digilin builds them into meters. When asked how he learned to live with liquid crystals so soon, President Rick Hibbs responded, "We introduced the first LED meter when



a 2½ foot drop onto an asphalt tiled floor does not phase Dana's new 4300, which uses Fairchild's 3814, a 4½ digit decade counter. Non-spec features such as ruggedness mean increased business opportunities by opening up such areas as the industrial market. Servicing these markets means just that; *service*, i.e., engineering to customer needs, and distribution via the customer's channels.

they were \$45 a digit. At \$45 they were ridiculous, but we knew they would be 10% of that over the life of the instrument. We made the same type of decision with LCs.

"I think the LC people have been more honest than the LED guys. How can they predict 80 year life after two years, especially in plastic packages? We think we have LC life similar to Nixies and guarantee the whole instrument for one year, which is longer than some Nixie guarantees."

When asked about delivery, Rick admitted, "We had a horrible delivery problem. We had LCs to burn, but: it was God-damned MOS! AMI did a calculator on a chip, but couldn't do a lousy counter. Finally, Howard Bobb (AMI president) wanted a counter to take overseas to demonstrate AMI's entry into LCs. Two weeks after he got onto the project, we got our MOS. Now we put meters together in an hour and a half."

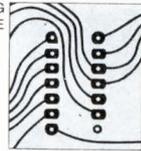
Volume counts in LCs too. Ed Kornstein, Vice President of Marketing for Optel, which makes LCs, does not envision DPMs as a large market. "Compared to calculators or watches, it's small," says Kornstein. A Triplet or Analogic might make 20,000 meters a year, while a watch company makes 100,000 a month. If we can make a simple mask change and sell DPM displays as a fallout of our watch work, fine; if not, that's fine too."

Can manufacturers survive

When DVMs are reduced to a few components, what is left in it for the manufacturers? Glen Patterson thinks that a single multimeter sold into a monolithic market is not in the cards for the future. He, like many, sees more products aimed at narrower, vertical markets, such as communications, industrial, medical, and automotive. Rick Hibbs contends he will be in two businesses: meters and selling applications into vertical markets.

Jerry Hartman asserts that market diversification is more important now than product diversification. While Jack Stegegna feels that the companies that put money into tooling and design for superior design and performance will continue to retain a competitive edge.

Several people have pointed out the need for a top flight distribution system. A major hindrance to a new DVM company would be that the supply of good reps is already committed to existing firms. There is also a lot of soul-searching about how to distribute into the new markets, and what balance of reps and distributors to use. New markets may not be serviceable through traditional channels, so the Allied Catalogs, Radio Shacks, and other nationwide and special product area distributors may become ever more important.



COURSE: Packaging with ICs Part 4

Think before wiring

Gerald L. Ginsberg, Communications & Technical Services Div., Philco-Ford Corp., Willow Grove, Pa.

Amongst all the information and noise disseminated on the various back-panel wiring arrangements (soldered printed wiring, solderless discrete wiring, etc.), the designer shouldn't lose sight of his prime objective—the performance- and cost-effective implementation of an end-product equipment. Both the interconnection wiring and its associated back-panel hardware are only a means toward this end.

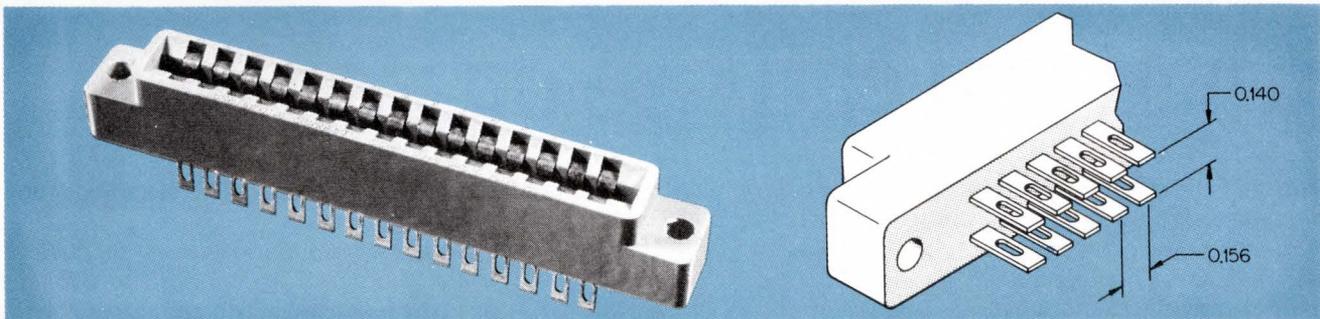
Therefore, before we discuss the methods for back-panel

wiring and the processes and hardware offered by various manufacturers, this installment of the course on Packaging with Integrated Circuits treats the designer's objective, while emphasizing the role of ICs and back-panel configurations. Listed below are some of the major objectives that you must keep in mind for a successful design.

Don't ignore these objectives

- **Flexibility**—to allow future changes in end-product requirements or keep abreast of technological advances.
- **Producibility**—the equipment must satisfy its performance and cost objectives when manufactured in quan-

(Continued on p. 29)



Military and commercial equipment, packaged on single- or double-PW boards, have used Mil-C-21097/1 one-part, card-edge, back-panel connectors. The boards (not usually multilayer) have plated contacts on one tang. Within practical limits, this connector places no restraints on the size and shape of the board or circuit components. It covers various combinations of board thicknesses 1/16-, 3/32-, and 1/4-in. (nominal), number and types of contacts, wiring tails, and mounting methods. The connector illustrated has two rows of contacts, mates with 1/16-in.-(nominal)-thick PW boards, has straight-eyelet slotted hand-soldering posts, as well as provisions for clearance-hole mounting.

Center-to-center spacing between contacts in a row is 0.156-in. (3.97 mm). For double readout connectors, contact rows (two terminals per contact) are usually 0.140-in. (3.57 mm) apart.

This connector comes with either single or dual straight eyelet or straight plug-in (for dip or wave soldering) termination wiring posts, in accordance with the Mil spec. Commercial variations of this connector provide double-vee hand solderless wrap, single-vee solderable and other types of wiring posts. It can be mounted in three ways (clearance hole, threaded insert, and float bushing) directly to the equipment chassis, supporting brackets, or printed wiring back-panel.

Why invest in wire-wrapping facilities,

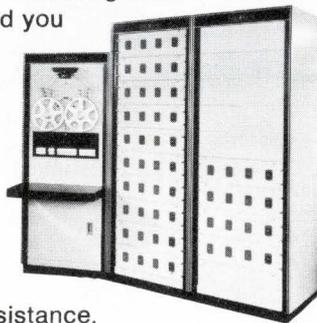


when you can use ours?

We can handle your complete back-panel wire-wrapping including all inventories right up to and including final inspection. You just have to bolt it in. And you can be sure of a completely tested, 100%-error-free back panel.

All your back panels can be tested with an Omnitester 900 Wiring Analyzer. This unit, pictured here in the center, has forward scan capabilities to determine, for example, whether a missing wire went to some other point. It then identifies that point.

The unit further tests for continuity resistance,

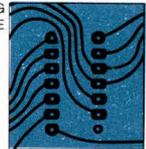


insulation resistance, DC hipot, and features programmable dwell time.

All this at a price less than in-house fabrication. No costly inventories, no capital tied to costly equipment. You can furnish the back panels or we can supply our own.

Delivery? Just 2 to 8 weeks, depending on the job and material availability. And we have two locations: Longmont, Colorado or Endicott, New York. For more details just call your nearest Amphenol sales office or write us direct. Amphenol Cadre Division, Bunker Ramo Corporation, 20 Valley St., Endicott, N.Y. 13760.

BUNKER RAMO AMPHENOL



tity in the factory, rather than in a prototype lab.

- **Reproducibility**—when fabricating nearly identical units keep debugging and “fine tuning” to a minimum. (This is the area where ICs help and the wrong back-panel wiring method hurts.)

- **Implementation**—relates to the duration of the design-through-production cycles, making them compatible with one another. Keep this compatibility in mind when selecting a back-panel wiring technique.

- **Reliability**—of back-panel wiring and packaging hardware has not kept up with that of ICs. It influences, therefore, the equipment’s mean-time-between-failure (MTBF). Many back-panel wiring concepts have failed because their reliability wasn’t considered in the design analysis.

- **Maintainability**—takes into consideration the operating cost to the equipment’s user, as well as costs for maintenance, time, personnel, tools and equipment. This is one of the reasons for using dual-in-line sockets with solderless back-panel wiring. In addition to the factors above, consider how vulnerable your project is to the following significant, though seldom recognized, factors.

- **People**—human involvement during fabrication, assembly, testing, and/or maintenance has a dramatic effect on the ability to produce an equipment within the required time span. Automation reduces their vulnerability to “hand” labor.

- **Machinery**—to use machinery such as fully automatic equipment for back-panel wiring, without manual override or without providing for alternate methods, is to increase vulnerability.

- **Vendors**—who cannot be circumvented in a crisis, or don’t have competition should be avoided. You can tell the more successful back-panel wiring techniques by the number of vendors and their growth.

- **Obsolescence**—makes extremely vulnerable those back-panel techniques that require a large investment in capital equipment and many years to amortize it.

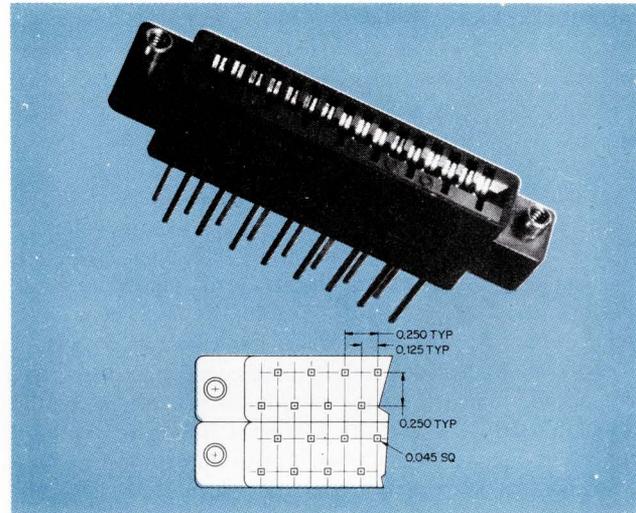
With these general guidelines in mind, refer to the checklist of design details that appears in a box as part of this article. In addition, there are two factors—circuit partitioning and assembly positioning—which can have a significant effect on the success or failure of a design.

Decide early how to partition

When packaging with ICs, the most significant factor conducive to performance- and cost-effectiveness is the initial partitioning of the equipment into subassemblies.

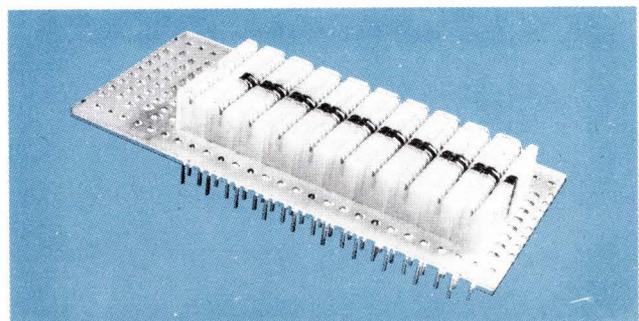
In its most basic form, circuit partitioning can be at the individual IC level—each package plugged into its own receptacle. With dual-in-line packages, this approach is very popular because it affords flexibility and there is plenty of

(Continued on p. 30)

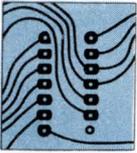


One-part, card-edge connectors for solderless wrap interconnection wiring were born as a modification to Mil-C-21097/1 connectors. They differ from the Mil-type in contact spacing (all posts fall on a grid of 25-mil multiples), type of posts, and mounting. In the picture, the grid spacing is 0.250-in. (6.35 mm) between terminals and between rows, staggered 0.125-in. (3.17 mm). This grid allows the use of computer-aided back-panel wire routing patterns, as well as solderless interconnection wiring equipment.

Solid posts 45-mil square (illustrated), 25-mil square, or rectangular, are accurately located within the connector body so that wiring machines can locate their tips. Wiring is limited to three wires per post, usually #24 or #26 AWG with the 45-mil square post, and #28 or #30 AWG with the 25-mil square post. Ground and voltage distribution buses may be soldered or mechanically secured to the posts. This connector usually includes precision mounting bushings, to insure the true position accuracy of its contacts.



Contact plate assemblies of one-part, card-edge, solderless connectors mate with conventional PW boards, providing wiring posts located accurately enough for fully-automatic solderless back-panel wiring. Their individual contacts are less expensive and easier to tool than those of multiple-contact connectors. However, since the connectors mount on precision punched metal plates, this approach usually requires an outside vendor.



PART 4

support hardware available (sockets with solderless-wrap wiring posts). This low-level partitioning employs two types of back-panel—one which functionally interconnects the components, and the other which interconnects the functional assemblies. Interface connectors usually interconnect these two types of back-panels.

High-level partitioning applies when several ICs (sometimes 100 or more) and discrete components are combined into a function-oriented subassembly. Although high-level partitioning reduces design flexibility, it improves circuit performance, increases packaging density, and, depending on the quantities involved, reduces implementation costs.

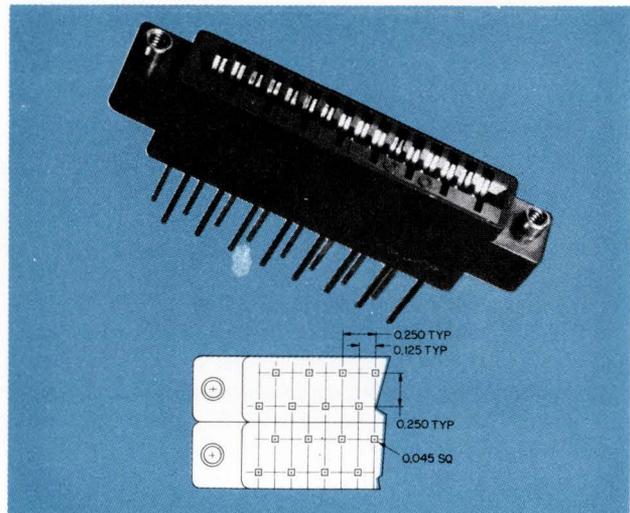
You should consider both the interconnection back-panel wiring problem and the plug-in circuit design jointly when partitioning circuitry, even if it means creating unorthodox circuit assemblies. For example, most assemblies tend to have generic identities, such as transmitter, receiver, etc. Although this may simplify documentation and testing, it may create awkward wiring problems because it requires too many input and output connections.

Keep 'em close

After partitioning, the circuit assemblies must be properly positioned within the equipment. You should place

the output of one assembly as physically close to the input of the other as possible without seriously complicating their design. This closeness not only shortens conductor lengths, but also minimizes blocking of other wires, increasing the wiring efficiency.

It helps to physically group related assemblies such as digital, analog, and so forth. Also, standardization of ground and voltage positions on all circuit assemblies simplifies bused interconnections.



Printed wiring back-panels allow mixing printed and discrete wiring. Single-sided, double-sided, and multilayer back-panels can combine discrete hand-soldered wiring with both automatic and manual solderless wiring. Both one-part (card-edge) and two part (plug and receptacle) connectors have been developed to interconnect between PW boards and back-panel wiring. One-part connector shown is soldered to an assembly of a 4-layer PW back-panel, a PW board with DIPs, and support board hardware. A recent updating of Mil-C-55302 added a two-part connector version of this hardware: plug M55302/43 and receptacle M55302/44.

DESIGNER'S CHECKLIST

These design details must be resolved during the selection of an optimum back-panel design.

Circuit assembly: planar (printed wiring boards), three-dimensional (with modular headers).

Connectors: one-part (printed wiring card-edge), two-part (plug and receptacle), two-part (blade and fork).

Back-panel: metal plate, printed wiring panel, chassis.

Wiring termination: hand soldered discrete wiring, dip/wave soldered printed wiring, manual-semiautomatic-automatic solderless wiring.

Wiring post: eyelet, straight-through pin, vee, solid square, solid rectangle.

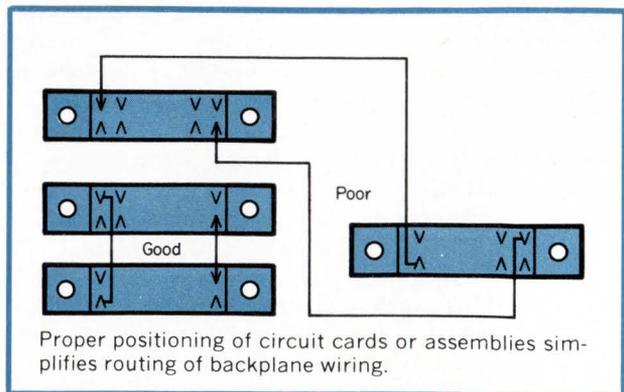
Wiring pattern: grid-oriented rectangular, grid-oriented staggered, irregular.

Wire type: solid conductor, stranded, and/or printed wiring.

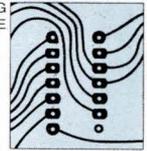
Connector mounting: threaded fasteners, press fit (metal plate), soldered (printed wiring).

Design generation: manual or computer-aided placement of circuit assemblies and routing of wiring.

Support hardware: provisions for board guides, keying, and/or polarization.



Proper positioning of circuit cards or assemblies simplifies routing of backplane wiring.



Carrying current by bus

Dan LeVantine,

Bussco Engineering, Inc., El Segundo, Calif. 90245

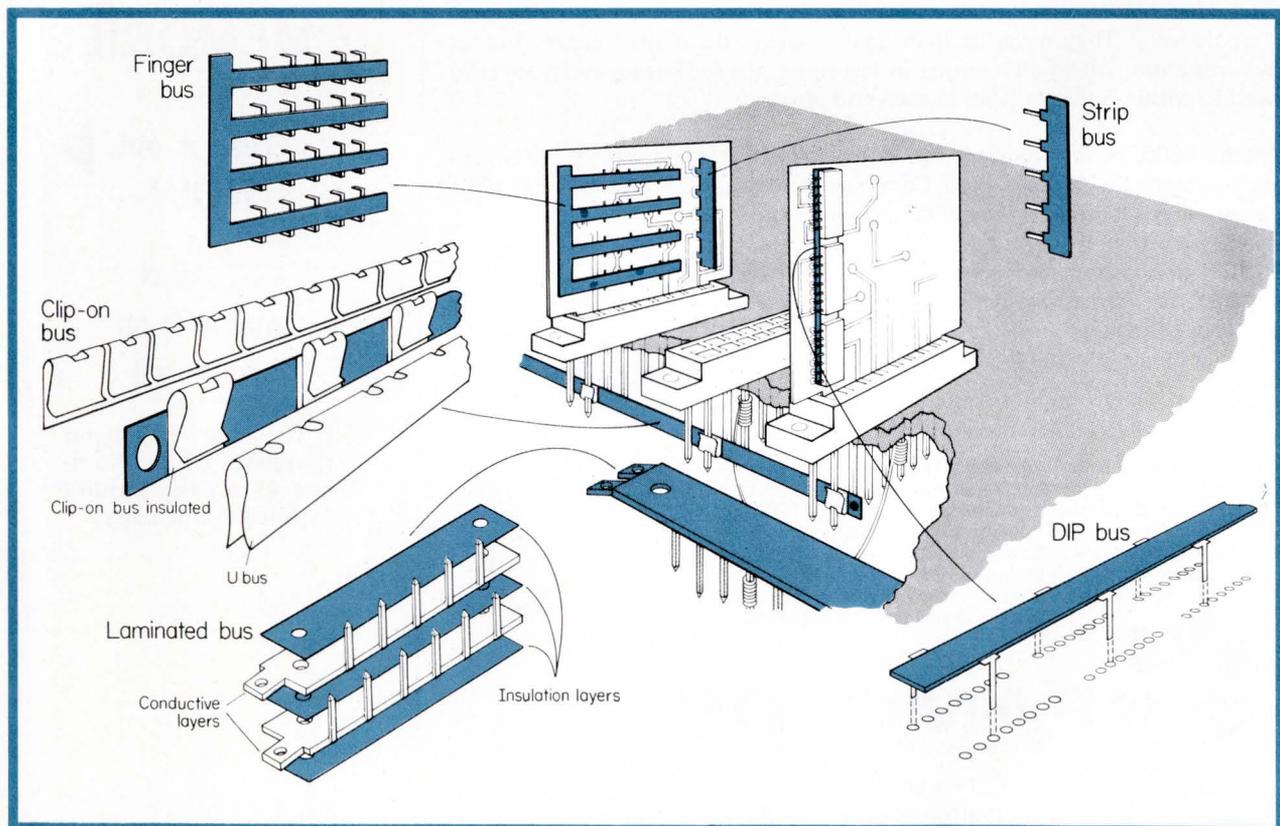
Circuit board busses, combined with two-sided PW boards, do the job of more expensive multilayer boards. The busses, mounted onto PW boards, distribute power and ground levels to ICs, eliminating the need for two circuit paths (voltage and ground) in the board for every IC.

These busses consist of two or more conductive layers sandwiched in, and completely covered with, insulation, except for their soldering tabs. In essence, the bus is really a low-impedance transmission line, ideal for power distribution in high-speed digital systems.

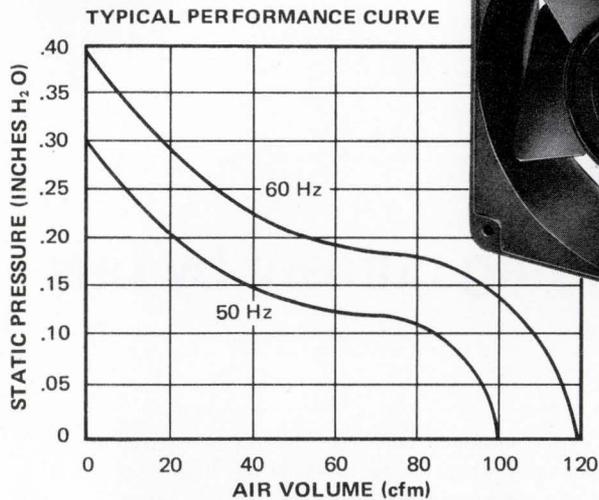
The "finger" and "picture frame" types, applied flat to the board surface, have the highest capacitance. The

"strip" type, mounted perpendicular to the board, offers high packaging density. The DIP-type has high distributed capacitance. Mounted directly under the ICs, its tabs soldered into the same hole as the IC tabs. The multilayer, laminated bus bar (shown with only two layers), can be provided with posts, blades or solder lugs compatible with the rest of the circuit.

For the backplane, there are clip-on busses that interconnect rows of WireWrap® or Termini Point® terminals. Their cross section is equivalent to a #18 AWG wire. When interconnecting an entire row of terminals, one bussing operation is more economical than wrapping two wires to each post. They are simply installed by hand, with finger pressure. *(Course continues on p. 41)*



PAMOTOR MODEL 4600



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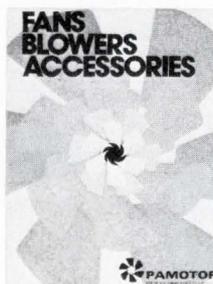
The PAMOTOR Model 4600 is a 4½" shaded-pole axial fan specifically developed for very efficient, high airflow (120 cfm, free air) operation. It is well suited for cooling computers, power supplies, process controls, industrial and medical instrumentation, professional audio recorders, etc.

The Model 4600 has several inherent advantages—its slower rotating speed and computer designed impellers contribute to reducing the acoustic level. The fan's all-metal, steel blades remain stable at any speed, at any back pressure, for more silent air delivery. They never oscillate as do some of the plastic blades. And for reduced vibration, which also results in less noise, the fan's rotor is dynamically balanced to within 5 *microrinches* in each end plane.

The Model 4600, as well as every fan in the PAMOTOR line, carries the Underwriters Laboratories' Yellow Card Component Recognition Number E41168—your assurance of long-term reliability and safety.

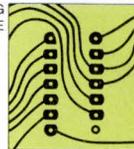
PAMOTOR distributors throughout the U.S. and Canada have the Model 4600 on the shelf for immediate delivery. Give the one nearest you a call now for complete specifications.

Send for Free Technical Literature — New 16-page Short-Form Catalog contains performance data and mechanical specifications for the complete PAMOTOR line. Our six applications monographs, Nos. 7041 — 7046, on "How to Select the Optimum Fan for Your Application," contain comprehensive data on each of the six major factors involved in cooling system design and fan application.



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Back-panel wiring-- Interconnections *sans* solder

Flexibility is the main—and most important—advantage of solderless wiring. You can correct a mistake in a wired panel with a hand tool.

Dick Hunter, Data Products Group
EECO, (Electronic Engineering Co. of Calif.) Santa Ana, Calif.

Previous articles in this course have discussed the advantages and disadvantages of soldering ICs directly to the printed circuit or multilayer boards, or plugging them into sockets. Since an insulating board doesn't need the sockets, which may cost as much as the ICs themselves, for insulation, sockets have to offer some other advantages—the main one being flexibility to design changes.

Actually, sockets have this advantage because their terminals, ending in square posts, can be solderless-wrapped using the Wire-Wrap® production technique pioneered by Gardner-Denver. Indeed, the number of systems employing sockets with solderless wrap terminals has been increasing significantly in the last few years, thanks to the rapid turn-around time. Solderless wrapping requires no artwork, the wiring list is usually generated by computer. In some systems, final changes can be made as late as two weeks before shipping the wired panels, and individual errors can still be corrected after that with a hand tool.

One of the main reasons for the acceptance of solderless wrapping is its reliability. The Bell System has used it for almost 20 years, and Mil-HBK-217 states that solderless wrap is the most reliable interconnect technique available. Since the socket, then, becomes the weak link, manufacturers have done a good deal of work to improve their reliability. Also, the advent of semi-automatic machines has made it feasible to apply the solderless wrap-and-socket approach with a relatively low capital investment. In addition, since these machines do not require the socket pins to be within the same close tolerances demanded by automatic wiring machines, hardware costs are also lower.

Sockets don't live by wrapping alone

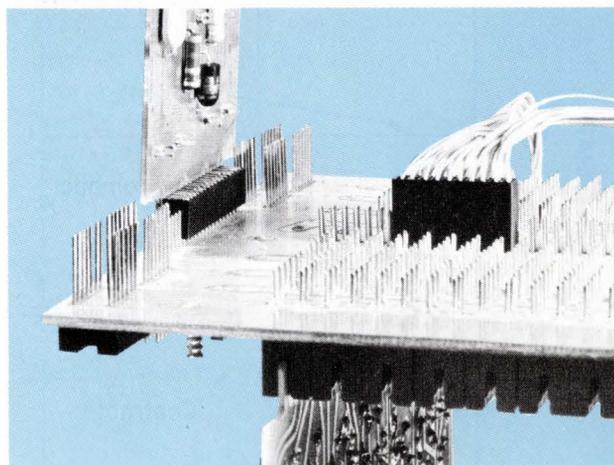
Another wiring approach is to use the socket in conjunction with AMP's Termi-Point® clip connection, described later in this part of the course. Instead of wrapping a solid wire to a square post, Termi-Point clips the wire, either solid or stranded, to a rectangular post (usually 22 x 36 mils). Although this method provides a gas-tight joint, Mil-HBK-217 does not appear to consider its reliability as good as that of Wire-Wrap, nor does it have the acceptance solderless wrap has. Perhaps one reason is that the posts require a special socket available only from AMP. Another is that the availability of Termi-Point service tools in the field is still sparse.

One of the newest interconnecting methods—called Infobond®—consists of stitch-welding a wire to the IC pins.

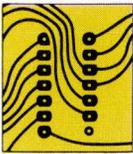
This technique yields higher packaging density than solderless wrapping, because it eliminates the long post. And, since one of the functions of IC sockets was to provide such posts, there is no need for sockets either. However, it is difficult to change a connection after welding, because the stitch is made with a nickel wire. At the present time, the acceptance of the Infobond stitch-wiring method seems to be restricted to aerospace hardware, where density is extremely important and the quantities are small, not warranting the cost of the multilayer boards.

Multiwire®, a technique, developed by Photocircuits to interconnect ICs, bonds wires with an adhesive on one side of a PW board. These wires are interconnected by drilling and plating-through holes in the board. Although this system has a lower set-up cost than multilayer boards and a quicker turn-around, its use is not widespread.

Machine wiring services are aided by a computer entry system that puts the designer's information into a computer language and then into control instructions for wiring. This input system can take several forms, such as a from-to list, and to-to listing; a pin listing (a listing of every pin identifying its connection with a string of wires by a name, or by logic diagram). When comparing these systems, consider all the work that the logic designer must do, and the software support he needs, before his design enters into the computer. This subject will be treated in more detail later on in this course.



Double-sided packaging. Thanks to a connector that mates with 25-mil square posts, the same ones used to wrap wires on, it's possible to connect PW boards, subassemblies, or cables on either side of a double-sided board or back panel. (Elco Corp.)



PART 4

Who should wire your back panels?

For wiring equipment to pay for itself, you must make at least two million wraps a year

Chester N. Kowal, Amphenol Cadre Div.,
Bunker-Ramo Corp.

When choosing between in-house or sub-contract back-plane wiring, consider the production rates of manual, semiautomatic, and fully automated wire-wrapping machines. You may find that some jobs can be profitably handled internally, while others would tax your capacity or become inordinately expensive.

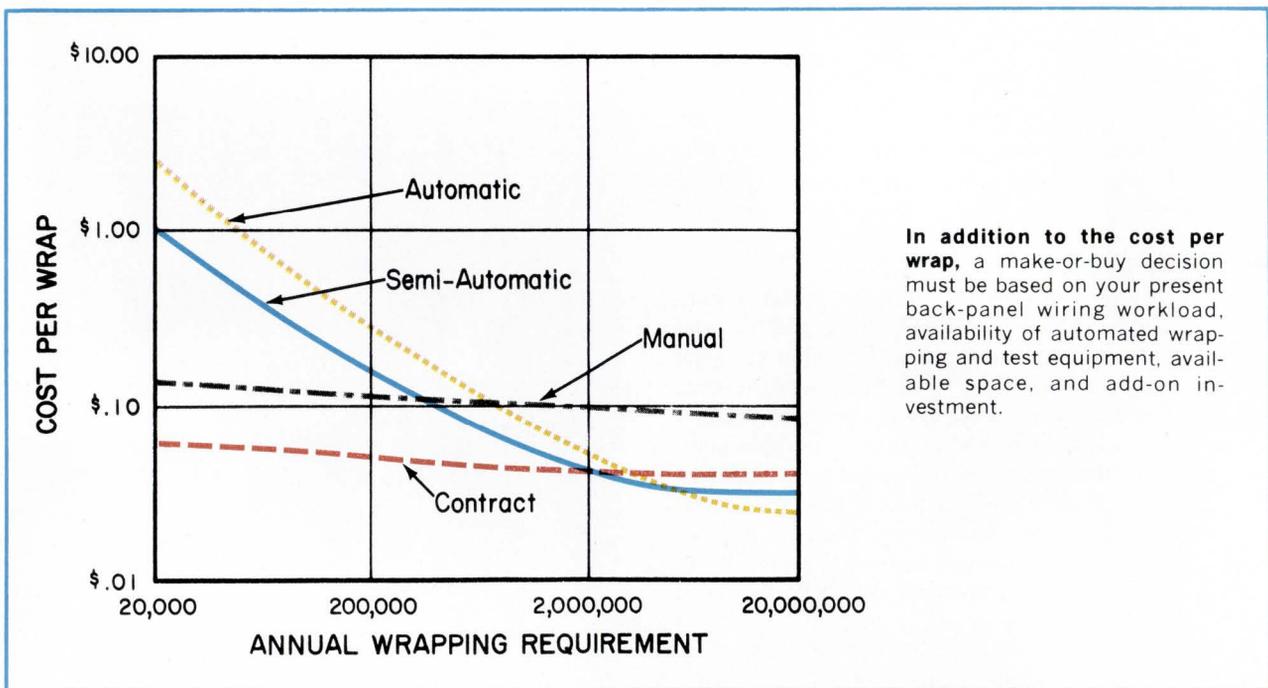
• **Manual**—Competent technicians can produce between 75 and 100 wraps/hr. The number of wraps/panel determines whether the operator can handle five or 50 panels per week. For instance, if you need 100 panels requiring 200 wraps each, it could probably be done by hand. But 50 panels with 2000 wraps should be wired by machine. Besides slow speed, a major disadvantage of manual wire wrapping is poor reliability—about 85%—

which increases the costs of inspection, re-work and repair.

• **Semiautomatic**—In this equipment a computer tells the operator which terminal to wrap, and he just follows the bouncing ball. Depending on board complexity and wire routing, it's possible to average 250 wraps/hour, up to a maximum of 400. Semiautomatic machines yield 99% reliability, and are twice as fast as manual wrappers. Their turnaround time is longer though, because software preparation may take one to two weeks, whereas handwrapping can begin immediately.

• **Automatic**—Many uniform, long production runs are needed to justify equipment that can cost over \$250,000 per machine. This equipment is two to three times faster than semiautomatic, but is limited in ability to handle complex routing problems. You need at least eight million wraps per year to write off the equipment cost.

(Continued on p. 46)

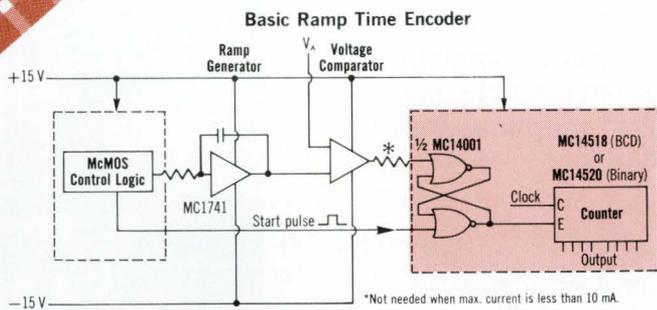


In addition to the cost per wrap, a make-or-buy decision must be based on your present back-panel wiring workload, availability of automated wrapping and test equipment, available space, and add-on investment.

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Motorola Device #	Function	Replaces Pin-for-Pin	Price (100-999)
MC14001AL/CL	Quad 2-input NOR gate	CD4001AD/AE	\$ 4.15/ 1.18
MC14002AL/CL	Dual 4-input NOR gate	CD4002AD/AE	4.30/ 1.22
MC14011AL/CL	Quad 2-input NAND gate	CD4011AD/AE	4.15/ 1.18
MC14012AL/CL	Dual 4-input NAND gate	CD4012AD/AE	4.30/ 1.22
MC14013AL/CL	Dual Type D flip-flop	CD4013AD/AE	5.95/ 2.40
MC14015AL/CL	Dual 4-bit static SR, serial in/parallel out	CD4015AD/AE	12.65/ 5.60
MC14021AL/CL	8-bit static SR, serial or parallel in/serial out	CD4021AD/AE	12.24/ 5.20
MC14027AL/CL	Dual J-K flip-flop	CD4027AD/AE	6.60/ 3.18
MC14501AL/CL	Triple gate	—	4.30/ 1.99
MC14507AL/CL	Quad exclusive OR gate	CD4030AD/AE	4.74/ 1.86
MC14508AL/CL	Dual 4-bit latch	—	24.70/13.75
MC14519AL/CL	4-bit AND/OR select, Quad exclusive NOR gate	—	4.75/ 2.10
MCM14505AL/CL	64-bit RAM	—	31.30/17.50
MC14025AL	Triple 3 NOR gate	CD4025AD/AE	\$ 4.30
MC14025CL			1.22
MC14510AL	BCD Up Down Counter	—	12.60
MC14510CL			7.00
MC14512AL	8-channel Data Select	—	7.20
MC14512CL			4.00
MC14514AL	4-bit latch, high output	—	24.70
MC14514CL			13.75
MC14515AL	4-bit latch, low output	—	24.70
MC14515CL			13.75
MC14518AL	Dual BCD Up Counter	—	12.90
MC14518CL			7.20
MC14520AL	Dual Binary Up Counter	—	12.60
MC14520CL			7.00

recent introductions

Motorola's rapidly expanding McMOS* complementary MOS line is designed to provide a combination of benefits other digital technologies can not.

Put aside for a moment, but don't forget, the facts that complementary MOS in general, and McMOS in particular, has the best noise immunity (45% of V_{DD}) and the lowest system power dissipation of any logic form.

Take note of the rapidly expanding number of available McMOS devices, with seven new MSI functions introduced since March, twelve since the first of the year, and many more coming in the several months ahead. Remember that McMOS combines the most popular second source units with original devices to fill the gaps.

Now, concentrate on less publicized but no less significant aspects of McMOS' system optimized desirability. As indicated in this basic Ramp Time Encoder for simplified A/D conversion, digital-linear systems can be built with reduced power supply requirements. Its wide supply voltage range allows McMOS to operate from the +15 V linear supply. Interfacing is simplified too, because McMOS' ultra low drive current requirements permit nearly direct connection.

McMOS has many advantages for many sorts of systems. Complete information on McMOS is available in a new book, McMOS '72, which is yours simply by circling the reader service number or by writing to Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, AZ 85036. Get it. Then get McMOS.

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MOTOROLA MOS
Directions in digital designs

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There's Gardner-Denver Wire-Wrap* terminating equipment to match any production need! Only Gardner-Denver offers manual, semi-automatic, and fully-automatic equipment for making solderless wrapped connections. Billions of connections have already been made on our equipment without a reported field failure.

Check the models shown at the right. See which is best suited to your production needs. Operating highlights are mentioned below. Complete details are available on our whole family of electronic products including the wire stripping unit, cable binding tool, Grid-Drill™ machine, and N/C tape programmer. Just write for Bulletin AC-35.

PORTABLE!

Portable Wire-Wrap power tools for lab and pilot work and production runs. Air, electric, or battery operated. Also pencil-size wrapping and unwrapping tools for servicemen. Wire-Wrap strapping tools to interconnect terminals with a continuous length of bare wire.

SEMI!

Semi-automatic Wire-Wrap terminal locating machine. Reads punched tape and automatically locates terminals with .001" accuracy. Comes complete with numerically-controlled wire preparation unit which automatically produces the wire needed, cut to length, and stripped both ends. Lighted wire bins also available as an optional feature.

AUTOMATIC!

Fully-automatic Wire-Wrap machine wires back panels at rates of up to 1,600 connections an hour. Eliminates costly rework and troubleshooting due to accuracy and repeatability. Machines are programmed with punched cards for greater flexibility. Contract wiring is available on a production basis at our plant in Grand Haven, Michigan.

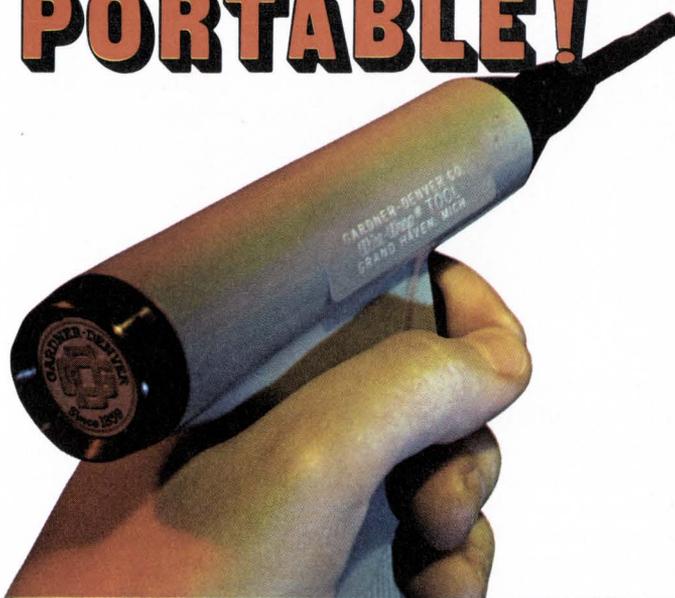
*Wire-Wrap is a registered trademark of Gardner-Denver Company

GARDNER-DENVER

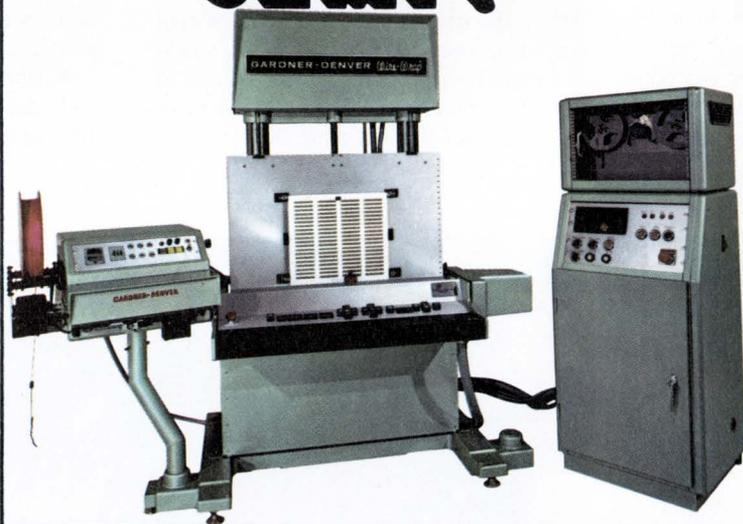
Gardner-Denver Company, Quincy, Illinois 62301
Circle Reader Service #19



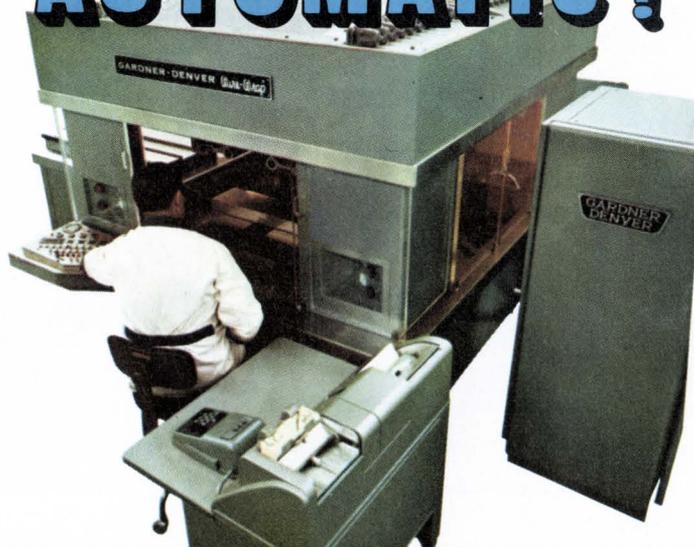
PORTABLE!

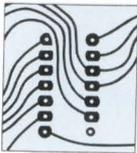


SEMI!



AUTOMATIC!





PART 4

(Continues from p. 42)

Wrapping equipment ties dollars

A back-panel wiring operation involves considerably more than just buying a wire-wrap machine. To be profitable, such an operation demands almost 100% equipment utilization. On the other hand, contracting back-panel wiring with an outside service frees the user from buying materials, assembling the panels, and wiring. It can also cut purchasing, expediting, and warehousing, in addition to capital equipment costs. Before deciding whether to wire your back panels yourself or contract them, consider the following costs.

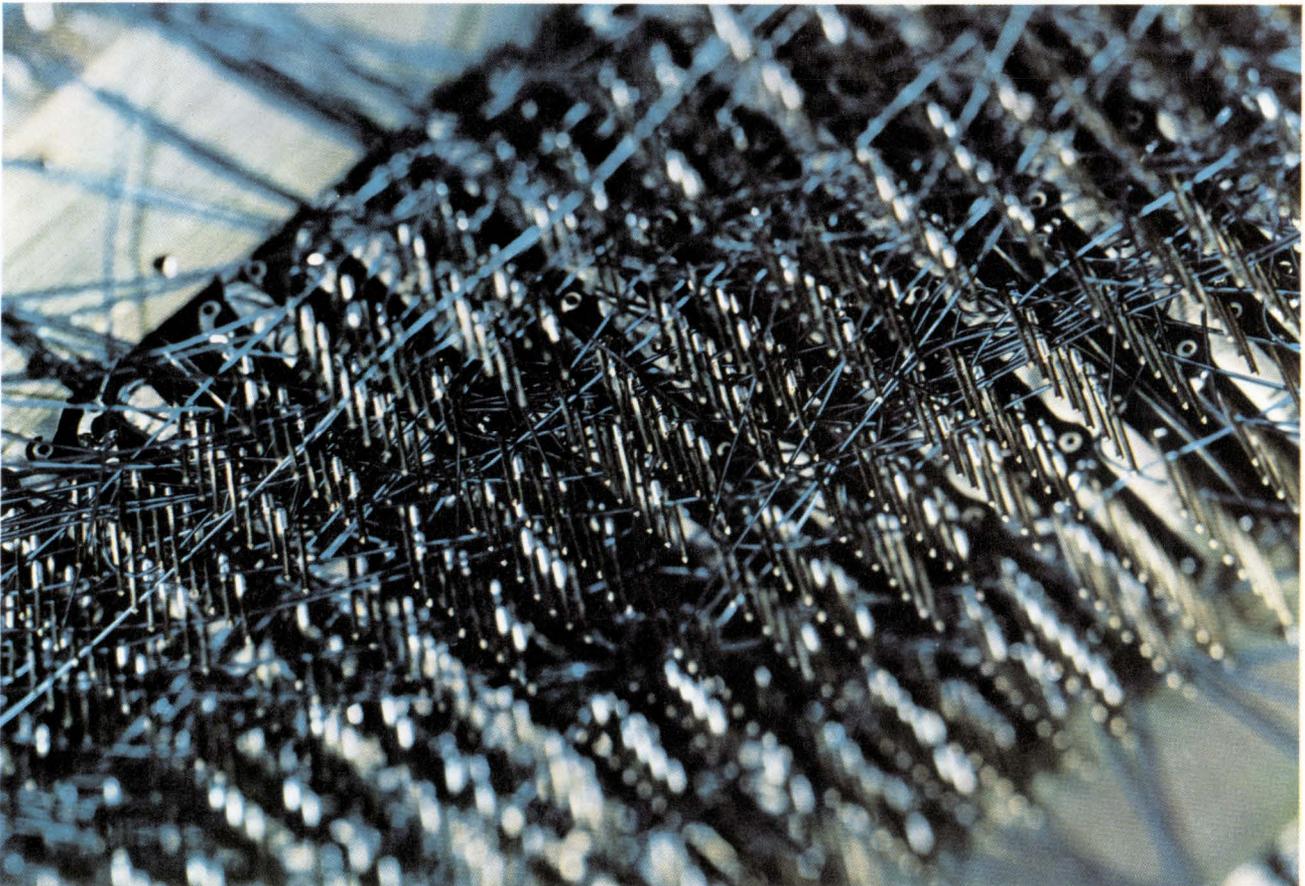
- **Economics**—While the investment for manual wiring is nil, the minimum set-up cost for semiautomatic wrapping equipment can range from \$10,000 to \$30,000, and to more than \$250,000 for automatic machines. The greater the volume of wiring, the larger the investment.

- **Software support**—Both automated wire wrapping and testing equipment require costly programming support—at 15-20¢ wire. Software development is time consuming and can effectively lower production.

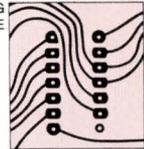
- **Reliable equipment costs** from \$80,000 to \$120,000. While lesser quality machines can be used, their errors and omissions can cost from \$1 to \$2 per error. Any tester can check continuity, but only the more expensive equipment can indicate insulation breakdown and unwanted connections, and do voltage tests up to 1500 V.

- **Wire preparation**—Wire must be cut and stripped prior to wiring, especially when using semiautomatic wrapping machines.

- **Operator training** can take a minimum of six weeks and cost \$1000, plus lost production time. Only six out of 10 operators will reach production expectations.



Wirewrapped backplane. (Photo courtesy of Standard Logic Inc.)



Back-panel wiring takes a wrap

Wrap a taut rubber band around your finger. Feel how tight it is? That's how good a contact a wrapped connection makes.

William H. Long, Electronic Products Div.,
Gardner-Denver Co.

Just like the rubber band, the wire is tensioned, producing an indentation in both the wire and the sharp edges of the terminal. The pressure is so great that it makes a gas-tight contact, impervious to corrosion. After a few turns of wire (14 to 16 indentations) produces a contact area equal to the cross-section of the wire itself, a mechanically stable connection is achieved without noticeable stress concentrations. More turns improve mechanical strength.

Solderless wrapping is not new; Bell Labs investigated the solderless-wrap connection in the mid-1950's. Bell Labs found that the high contact pressure diffuses the wire material to the terminal, and that the bond improved with time. Generally, solderless wrapped connections have a static contact resistance equivalent to $\frac{1}{2}$ in. of the wrapped wire, which is half the resistance allowed by the EIA-RS-280-A specification. Actually, after years of field experience, there are many test reports (such as the NAFI TR-1242) that confirm the reliability of solderless wrapping.* Since there is no known failure rate established for solderless wrapping, the best figure available today is 0.000005 failure per 1000 hours.

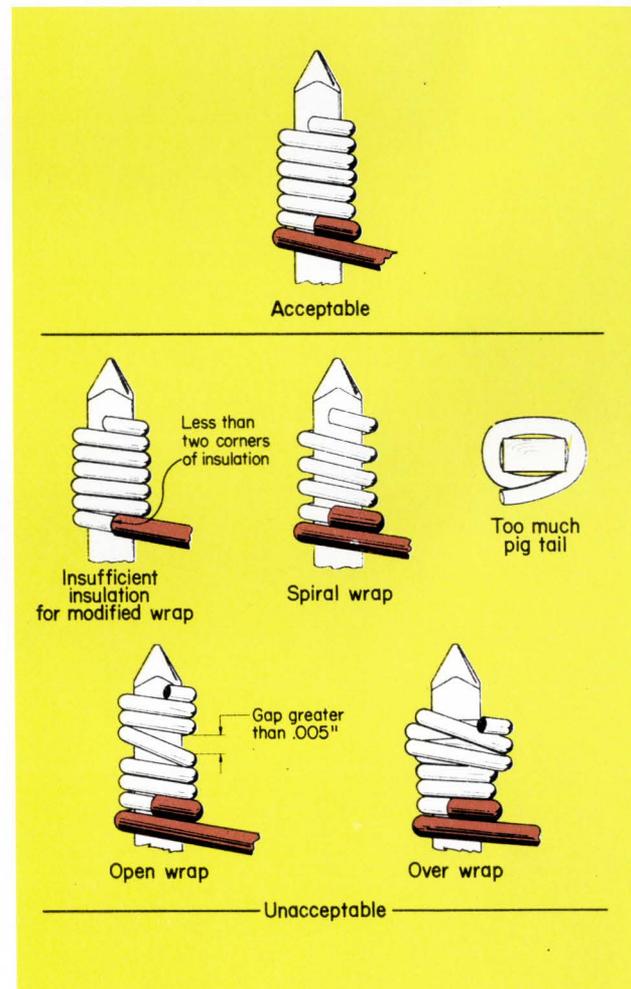
It takes more than wire to wrap

A wire-wrap is only as good as the wrapping equipment, the wire, and the posts you use.

• **Wrapping bits and sleeves**—Wire-wrapping tools tension the wire as it is wrapped around the terminal, without overstressing the wire beyond its elastic limits. There are several types of wrapping bits. The original type, called *Offset countersink*, is still popular for wrapping more than one terminal size at a work station. The *Horseshoe* face, *Counterbore*, and the new *Helical rise* face force the wire down into the corners of the terminal while tensioning the wire at the same time. *Helical rise* is now the most often specified bit face for automatic machine assemblies to wrap IC connectors with 30-gage wire.

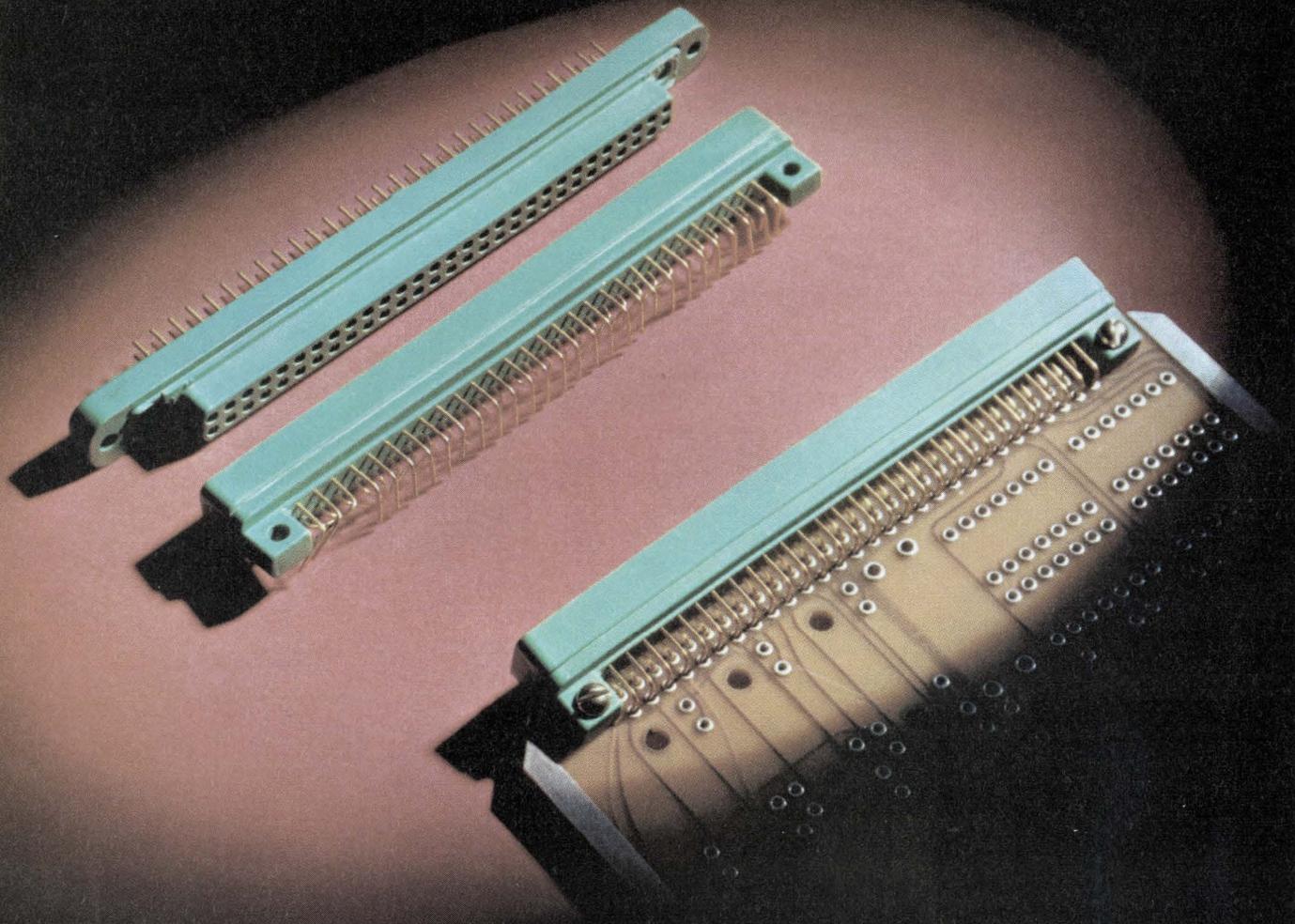
*For a copy of this report (TR-1242) by the U.S. Naval Avionics Facility at Indianapolis (NAFI), write to Defense Document Center for Scientific and Technical Information, Bldg. 5, Cameron Sta., Alexandria, Va. 22314.

(Continued on p. 49)



Visual inspection is the most important production test because it detects faults associated with operator efficiency, practices, and training. Post these sketches in the work area, and look for: **open spirals** (lack of back-force pressure), **burnished tails** (excessive backforce pressure), **pigtails** (stopping the wrapping tool too soon), **shiners** (caused by improper wire insertion), **overwraps** (improper equipment), **improper wire dressing** and **wires too tight** (piercing the insulation).

Bendix printed circuit board connectors put an end to close order drilling.



You know close order drilling. It's what's called for to produce ultraprecise hole locations in printed circuit boards. Eliminate this need and you'll cut costs for sure. Bendix P.C.B. connectors help you do precisely that. Their optional floating pin terminations "give" enough to make it easier to align pins with the printed circuit board holes.

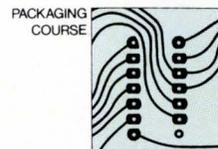
Bendix boasts other features, too. Options like wire wrap or solder termina-

tions. Straight or right angle. Insertable crimp contacts.

Applications? Wherever printed circuit boards are used, such as switching circuits, computers, business machines, process controls, etc.

Chances are, Bendix Printed Circuit Board connectors can help you. Why not find out. The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix



PART 4

(Continues from page 47)

● **Wire wrapping tools**—Power tools, from a finger-operated pencil type to battery, electric, air-powered and squeeze types, are available today for assembly. An air-powered tool can make a 6-turn connection in 0.1 s,—too fast for hand assembly. Wrapping IC assemblies with 30-gage wire requires a sensitive operator touch of approximately 12 oz. of backforce pressure (exerted against wire turns as they wrap around the terminal). The smaller the wire gage, the lighter should the wrapping tool be.

● **Wire (solid conductor)**—Oxygen-free, high conductivity (OFHC) copper wire is the most popular choice for wrapping IC connectors by machine or hand tools. Alloy wire works well with hand wrapping tools because it is stiffer, developing higher strip forces. Actually, both types of wire produce good quality connections, as long as you select the proper wrapping bit for the wire type.

● **The terminal size** is a function of the wire size. Its width should not be greater than three times the wire diameter, and the thickness not less than one diameter.

Even more important is the accuracy of the terminal's diagonal, as this is the critical dimension in selecting a wrapping bit. Square terminals are easier to lay out because the horizontal and vertical separation between them are equal. Also, they produce fewer pigtails because the bit wraps in circular motion, wiping down the wire tail. Although it isn't necessary, terminals are generally tin-soldered or gold plated. Warning: don't use hard gold plating because it lowers the strip force.

A common problem today is to combine older equipment with a new package that uses ICs. The new terminals are smaller—25-mil square for 30-gage wire—than the older, 45-mil square or 31 x 62, which were used with 24-gage wire. There isn't enough space between the terminals of IC sockets to place the 24-gage, wrapping bit-and-sleeve assembly over the terminal, especially when there is a connection on the adjacent terminal. It is possible, however, to wrap 26-gage wire around 25-mil square terminals on 100-mil centers.

Semiautomatic wirewrappers combine man and machine

Paul A. Yarbrough, Electronic Products Div.,
Gardner-Denver Co.

All semiautomatic wirewrapping equipment has the same prime objective—to read wire lists, interpret that data, and search out the point or terminal to be wrapped. Since the operator paces the equipment, production rates decrease with operator fatigue, and increase by optimizing materials handling and machine movement—provided, of course, that the operator likes the equipment.

For positioning, that is, locating the post to wrap, numerical controls utilize either the **absolute** closed-loop system or the **incremental** open-loop system.

Most systems are **absolute**—they receive feedback to compare the data to the actual position of the wrapping head. This assures that the position called for is actually attained, because all data refers back to a floating zero point that is set at the start of a panel and remains the same throughout wrapping. On the other hand, the reference point floats in **incremental** systems. Each point is programmed from the previous one, and there is no monitoring of the driven wrapper to assure that the previous point attained was the correct one. To prevent the accumulation of tolerances, this system includes manual "rezeroing," which automatically returns the wrapper to the floating zero originally set, allowing the operator to reset it if there is a difference.

Mechanical features of wrapping tools

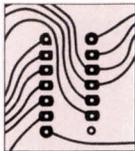
● **Fixed head or tool**—In this design, the N/C tape guides

the operator in aligning the wrap tool over the terminal. Therefore, the operator will not place a wire on a terminal other than one programmed, but neither will it pick up pins out of position.

There are two types of fixed heads or tools: those incorporating a side-loading bit, and those adapting a rigidly-mounted manual tool that loads at the bottom. Although side-loading is faster, since the tool has a rotating bit and sleeve, it can cut and nick previously routed wires. The solution, then, for multilevel wiring, is to set the vertical levels precisely, and to neatly route the wires. Otherwise, the time gained in bit loading could be completely lost in wiring a dense panel.

● **Carriage movement**—When the wrapping head is fixed and the panel mounting plate moves, the most common position for this plate is horizontal. To minimize operator fatigue, the point to be wrapped should always be at the same distance from his eye and well within his reach. With a hand-held tool, the panel mounting plate is vertical to give the operator a "bird's eye view" of the panel and locate the point to be wrapped within his reach.

In many applications, the operator must follow a pre-selected route for the wires to minimize noise coupling among them. A vertical table is less tiring in such cases, because it gives him a top view of the terminals. A horizontal table, on the other hand, rarely provides him with a

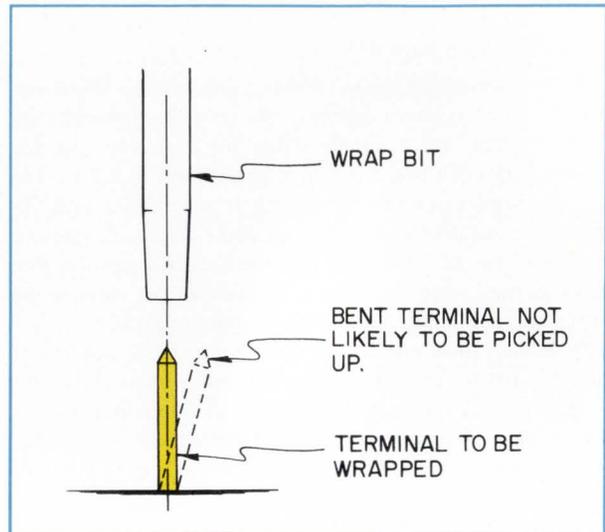


PART 4

clean look at the channel he must route the wire through. This is especially true, considering how fatiguing it is to look at rows of terminals on 100-mil spacings, which is typical of packages using ICs.

- **Dual station**—Most of the equipment mentioned here can incorporate two wiring stations on one machine, both tape-controlled from one unit. Dual station equipment requires two operators—one for each wiring head. Their work must be identical, since there is only one tape input. The advantage is that the additional cost for the second station is low, although the production rate goes down to that of the lowest operator.

- **Wire preparation and storage**—The latest innovation in semiautomatic wiring equipment is the integration of a numerically-controlled, cut-and-strip unit in the wiring station, in place of a wire storage bin. This unit feeds the next wire when the machine is in position for the last end of the previous wire. The time used to feed the bit, which slows down a hand-held tool, is now shared with the time spent in moving the machine.



In semiautomatic systems, a fixed wrapping head will not pick up bent pins.

Automatic wiring for solderless wrapping

Dan P. Brouwer, Electronic Products Div.
Gardner-Denver Company

For an automatic wire wrapping program to be successful, you must consider your package design requirements and their implementation carefully—and as a system, not individually. Automatic wirewrap machines represent a big investment but, when amortized, your wiring costs can go below two cents per wire—including operating expenses, machine maintenance, and manpower. In addition, the quality you can attain with automatic wirewrap is extremely hard to beat.

These machines provide better quality because they not only wire, but also monitor the wrapping operation to insure that wire is put on the terminals. They check the following:

- **Splices**—Insulated wire manufacturers usually butt-weld several pieces together to make a 5,000, 10,000, or 20,000 ft spool of wire. To guarantee that the spliced section does not get into the machine, the wire spec requires it to be bare for at least 8 in. When the splice detector finds this section, it stops the machine.

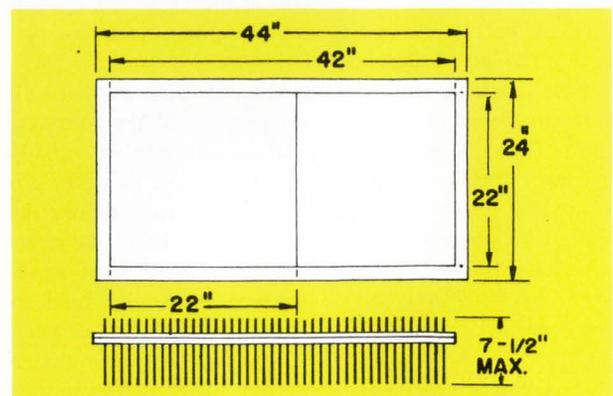
- **Wire feed**—When the machine goes to the next lowest X-Y position to start the next pattern, and grips the wire to draw it through the pattern, it also checks to see that the wire is in position and signals if it isn't, indicating that the wire was not fed across.

- **Z-motion**—If either of the two wrapping tools doesn't reach its programmed Z-level (perpendicular to the panel), the machine stops. This will occur if the machine touches

the top of a terminal, or if one of the wrapping bits runs into any interference.

- **Wrap**—Both wrapping tools measure how far the tool goes back up to the terminal as it wraps, and shut off the machine if either doesn't go far enough. This check not only determines whether a wrap was completed, but also whether there was a terminal at that point. If there is no terminal, the tools don't go up.

- **Card sequence**—Each punched card contains the wiring information for one wire on the panel (two connec-

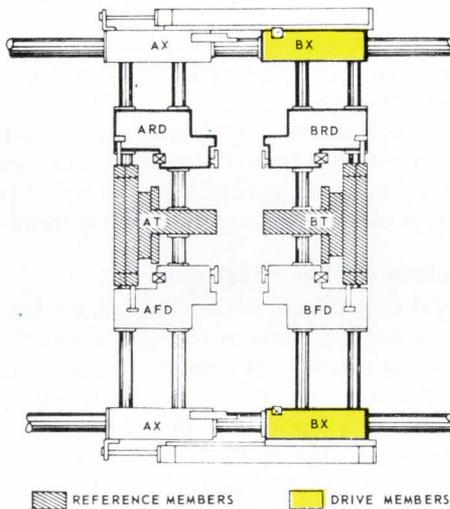


Maximum panel size, including terminals is 44 x 24 x 7 1/2 in. While maximum wrap area of the machine is 22 x 22 in., it can extend the length to 42 in. by using a pallet longitudinal positioning system that shifts the panel under the wrap area in eleven 2-in. increments.

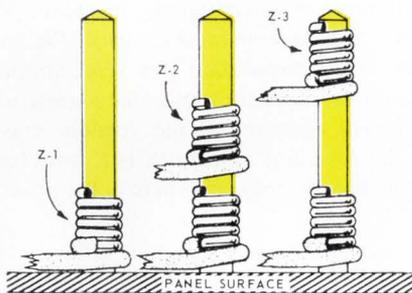
tions). To guarantee that no cards are missing and that they are in the right order, the trailing end of each card has a code number which the next card must agree with.

• **Data**—The machine checks each column of the punched card for odd parity.

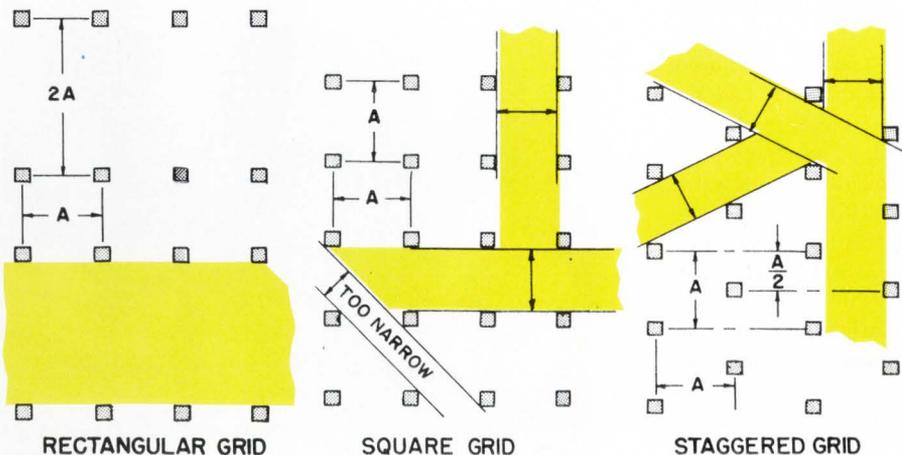
For more detailed information on terminals, back panels, and wire, obtain a copy of "Design Parameters for Wire-Wrap," S.M. 516282, Third Edition, from the Gardner-Denver Co., 1333 Fulton St., Grand Haven, Mich. 49417.



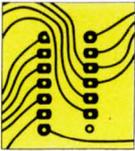
Automatic wirewrap machine has one X drive and two Y drives, plus a co-ordinated Z-motion for both the A and B sides. The machine collapses both carriages to the lowest X and Y position of the next wire to be wrapped to pick up wire. Both carriages move like a train, B pulling A in the X direction to initial BX, and dropping it off at its proper position. The B tool pulls the wire and wraps it. We need now two Y drives, one for A and one for B. There are three carriages on both the A and B sides of the machine. The center carriage is the wrapping tool and two outside carriages are the dressing fingers. The A rear dressing finger (ARD) is locomotive for the A side of the machine, while the B rear dressing finger (BRD) is locomotive for the B side. The machine always progresses in the +X and +Y directions, drawing the wire along its pattern over the top of the terminals. It then strips the trailing end of the wire to be wrapped and the leading end of the next one, descends over the terminals and wraps the wire.



Two terminations per terminal satisfies most panel wiring requirements. Three wires per terminal may indicate redundant wires, or star-network wiring. The panel must be flat enough for the automatic wiring machine to put both levels within its $\frac{1}{8}$ -in. Z-motion. If some terminals are put at a much lower level, they must be wired by hand later. Both ends of the wire are always wrapped at the same level—from Z-1 to Z-1, and from Z-2 to Z-2. The third or upper level is rarely wrapped by machine. This level is reserved for repair and engineering changes. Many people prefer not to unwrap Z-1 wires for repair, as it may be easier to cut off the Z-1 wire next to the connection and repair by wrapping on the Z-3 level.



Wiring channels must be wide enough to accommodate the wires, drawn over the top of the panel, without interfering with terminals. A staggered grid has lower pin density than a square grid, but it provides more channels. This keeps wires apart, reducing crosstalk.



Back panel wiring with clips

Termi-Point® clips a wire—solid or stranded—to a rectangular post

Ed Whiteman, TERMI-POINT Div.
AMP Incorporated

Basically, the Termi-Point* system connects a wire (solid or stranded) to a rectangular post with a metal clip. Clips and wire are applied simultaneously with a tool which can be hand-held, or they're mounted on a numerically-controlled machine head for automatic, or semiautomatic, operation.

Whether the posts you are clipping wires to form part of the sockets or the connectors, or were inserted individually into PW boards, the major points to consider when selecting them are: size, length, spacing, grid pattern, and post tip tolerance.

- **Post size (rectangular)**—Termi-Point® clips work only with rectangular posts, 22 x 36 mils and 31 x 62 mils, which are also suitable for wrap-type wiring.

- **Post length**—95% of all panel designs use only two terminations per post. To allow for changes or additions, use a 3-high termination post, fully exposed, for automatic machine wiring. No obstruction in the panel wiring area should be higher than the posts, or it will reduce the efficiency of wiring machine.

- **Post spacing**—Use the widest spacing possible between posts, to avoid cutting or nicking wires, and to allow room for wire channels.

- **Post retention**—Termi-Point subjects the post to up to 30 lbs. axial thrust, but not to torsional forces. Wire-Wrap** subjects it to only 8 lbs. axial thrust, but with considerable torsional forces.

- **Grid pattern**—The Termi-Point machine moves in increments of 1 mil. (Wire-Wrap® machines in increments of 25 mils.)

- **Post tip tolerance**—Wiring machine manufacturers are aware that not every post remains in relatively true position after handling. Therefore, they build in a forgiveness factor in the terminating head, called "post pick-up capability." This represents the maximum allowable post tip tolerance on a panel. For Termi-Point, this is ± 20 mils for a 22 x 36-mil post, and ± 30 mils for 31 x 62-mil. For Wire-Wrap, it's ± 10 mils for a 25-mil square post, and ± 15 mils for a 45-mil post.

While this information may seem insignificant now, it will play an important role in determining the overall cost of any automatic wiring program. Any cost savings realized in connector and technique selection may be wiped out if you have to straighten the posts later on.

To minimize problems:

- Select connectors that have a post tip tolerance com-

patible with the automatic wiring technique used.

- Check how your vendor packages and ships the panels, to prevent damage.

- Impose receiving inspection to verify and maintain connector quality. If the connectors do not meet machine requirements, use a fixture to align post tips after panel assembly, or use a comparator to reposition them.

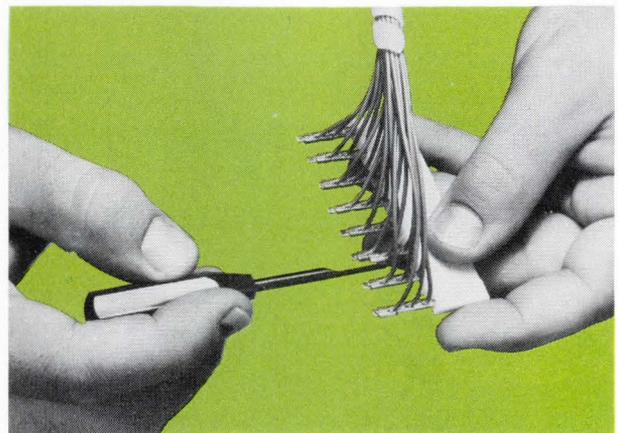
Machines wire at a fast clip

Preparing panel assemblies for semiautomatic machine wiring is much the same as for fully automatic machines, and the considerations for machine wiring with Termi-Point are very similar to the ones described in previous articles for solderless wrap. The main difference is that there is no need to precut and strip the wire, because this step is intrinsic in the Termi-Point system.

Companies which cannot establish their own wiring facilities can contract wiring services with many vendors who have automatic or semiautomatic machines. Regardless of the wiring technique or machine used, the cost items are the same: *Tape preparation* (for semiautomatic) or *programming* (for automatic), *machine wiring*, *wire*, *fixtures*, and *electrical checkout*. Some vendors may change or modify the costs and categories but, however it is done, these costs are covered somewhere in the price.

*Trademark of AMP Incorporated

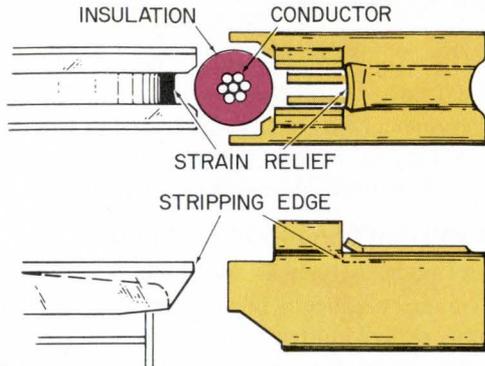
**Trademark of Gardner-Denver Company



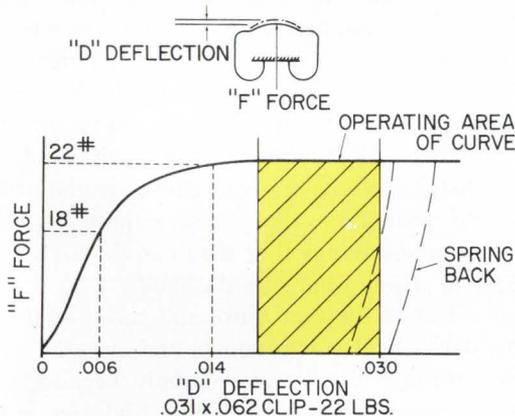
Clips are easily removed without disturbing adjacent posts, or adjacent connections on the same post.

How the wire clip works

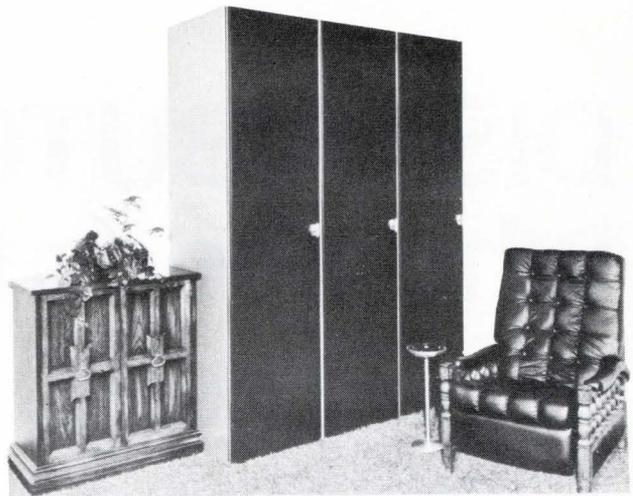
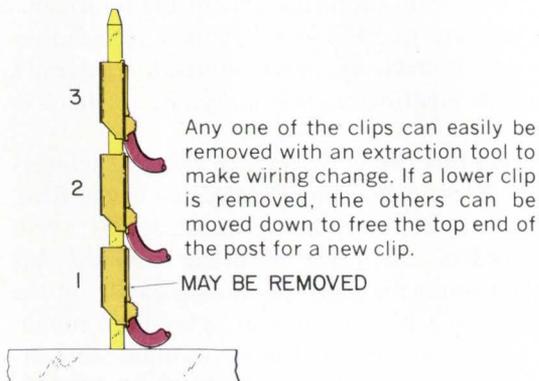
In one cycle, the tool strips the insulation from the wire, preforms the wire, and applies it to the post under a clip. High insertion forces mechanically clean both wire and post surfaces, establishing large contact areas.



Stripping grooves of the Termi-Point tool and clip. Only the leading edges are sharp to avoid nicking the wires during stripping. The highly-polished mandrel groove preforms the wire without damaging its conductor plating. This groove automatically locates the wire in an optimum position for stripping and preforming.



A 6-mil deflection of a Termi-Point clip produces 20 lbs. of contact force. Additional deflection of 0.030 in. changes the force very little. In normal application, the clip operates within the shaded area of the curve, making its force relatively independent of wide tolerances on post, clip, and wire dimensions. The clip performs the same with other solid or stranded wire.



Honeywell Modu-Mount Cabinetry

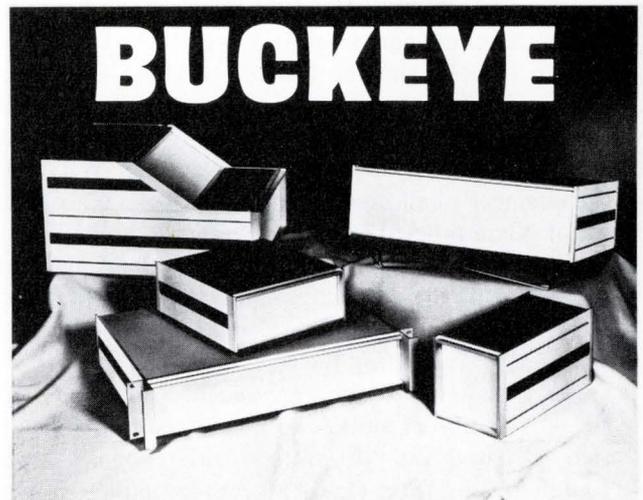
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DISTRIBUTORS - who needs them?

Distributors now dominate a large chunk of the electronic components industry. To find out why, see how distributors have tailored their operation to your needs.

Deborah Wilkins, Assistant Editor

"Lessee . . . for this prototype we need a couple of counters, TI SN7490, some SN7475 latches, and TI's decoder drivers, SN74141. Let's call Schweber and ask for four of each . . . make it five, one spare. We'll also get five 'Nixies', the low-cost job, 0.6 in. high, and ask them what it would cost to get a sample of the new Panaplex."

The action takes place at a lab in Long Island, where an engineer is deciding on the components he'll use in a prototype for a digital clock. Or, if we move the action to Boston or Los Angeles, substitute Cramer or Hamilton-Avnet for Schweber.

Let's see how our friend in Long Island fared. He had no trouble with the Nixies®. Because Schweber Electronics is the authorized distributor for their manufacturer, the Electronic Components Div. of Burroughs Corp., the distributor salesman who took the engineer's call mentioned that there are 12 models of Nixie tubes that have a 0.6 in.-high character, correctly identified the readout tube he had in mind as Burroughs' B-5440, and made sure that he wanted right-side-up mounting (since upside-down mounting would have called for the B-5445). Schweber, however, is not a TI distributor, and the salesman said so. After some prodding, he mentioned that he carried Fairchild and Motorola, suggested the correct Fairchild substitutes for the IC counter and latch, but couldn't find one for the MSI decoder driver.

With the Panaplex®, it was a different story. That's not a distributor item—Burroughs is still selling it directly to users, mostly on large custom orders. The salesman however, realizing that his caller was interested in readouts, insisted that his caller look into Monsanto's solid-state readouts. "Look, if you're using Litronix readouts, I'll give you the same thing from Monsanto, cheap and from stock."

Even though our engineer didn't get all, nor the exact, parts he wanted, he'll be able to build his prototype. However, had he known a little more about both distributors and distribution, he would have

called a TI distributor for the ICs (Arrow in Long Island, Cramer in Boston, Weatherford in Los Angeles or TI Supply in all three areas), and referred his request for Panaplex samples directly to Burroughs.

What you don't know will hurt you

How much do you know about distributors? We asked many engineers that same question, and got responses which confirm the example above. "I'd always thought of distributors as stock clerks."

"I don't depend on them for any technical assistance at all. As long as they have the part I want when I want it, that's all I need them for."

"A distributor's just some nontechnical guy who takes an order, then sees if it's on the shelf."

So who needs distributors? Well, our research shows that you do, and if you don't know why, then you're not doing your job at top efficiency. We talked to engineers who did as much as 90% of their procurement through distributors, yet never talked to them about anything more than a sale. And, while many distributors have given cause to and still deserve the reputation that those comments reflect, there are many things that they can do for you that go beyond selling what's on the shelf.

It's a fact of life that more and more of the electronic components for products and systems will get to you through distributors, simply because manufacturers won't be able to identify and service every possible user. Seymour Schweber, owner and president of the over \$25 million a year company that carries his name, says that the number of identifiable buyers of electronic components will increase from the 20,000 it was in 1970, to 35,000 by 1975, and 50,000 by 1980. "Distributors are already doing \$1 billion a year in electronic component sales. We're going to move from capturing 25% of the total components business to 50%, and 50% is a tremendous amount of business. If the manufacturer doesn't work with the distributor, he's not going to share in our growth."

Triggering this rise is the fact that manufacturers just can't afford to put enough salesmen in the field. Whereas distributors originally handled only small quantity orders, the price of doing business has forced the manufacturer to rely more heavily on the distributor. Since it's not unusual today for a manufacturer to turn to a distributor to accommodate or-

(Cont'd. on page 56)

The distribution game—on the way up

By Alberto Socolovsky and Deborah Wilkins

In 1972, distributors will sell 25% of all electronic components. Since the total volume of component sales will be around \$3 billion, distributor sales will be \$750 million—some say that means that sales by distributors will reach close to \$1 billion this year. Looking at the future there's no doubt about it—distributors are growing.

Fueling this growth is the changing—and expanding—nature of the electronics industry. As the "product life cycle" curves* on this page show, distributors perform their function best with products that have reached maturity. Some forward-looking distributors will always tend to lead the pack and incorporate growing products, while others will hang on to obsolete items.

During the booming 60's, government money helped pay for many new products, and shifted the center of the dollar distribution curve to the left. During the present, leaner years, when most of the new product activity will have to be privately funded by industry, the procurement curve will drift to the right, into the mature product area which depends more on distribution. Today's complex components, then, will become tomorrow's systems components that you will purchase through distributors. Since the markets for these components will continue to grow, the distributors will claim a larger share of a bigger market.

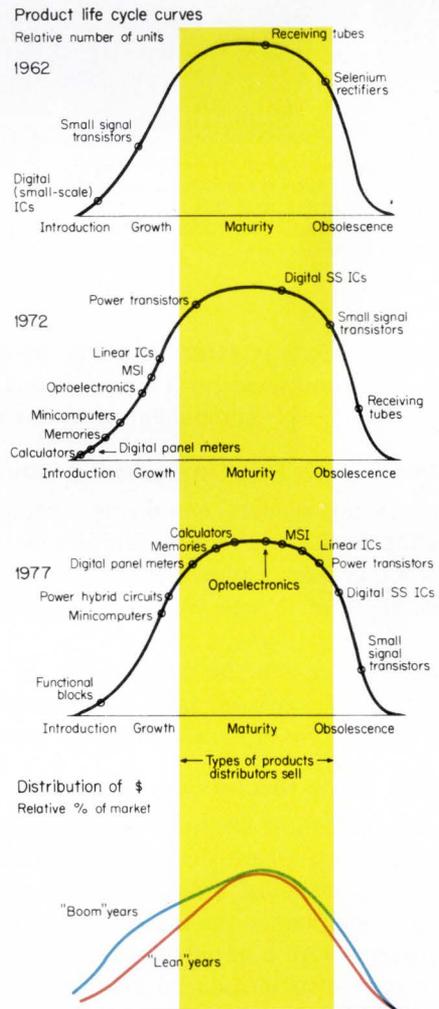
Most distributors began as sales outlets representing an assortment of manufacturers' products. Their business has always revolved around quick delivery of the small quantity order the manufacturer can no longer afford to service. But that's changing. With distributor inventories reaching as high as \$20 million, manufacturers today will often call on a distributor to fill a one million piece order, especially when he's located close to an important customer. In effect, the distributor serves as a storehouse of electronic components made readily available to the buyer.

A variety of distributor types have emerged from this common beginning. The largest, Cramer, Hamilton/Avnet, and Kierulff are general line distributors who serve their customers nationwide. Each stocks more than 20 (Cramer, close to 40) outlets from coast to coast, and each expects sales to climb over \$70 million this year. They're categorized as general line distributors because on their shelves they stock just about every kind of electronic component, and their product lines represent a large number of component manufacturers. Jaco, Schweber, and Powell fall into a similar category, though on a smaller scale and with fewer outlets—the limited line distributor.

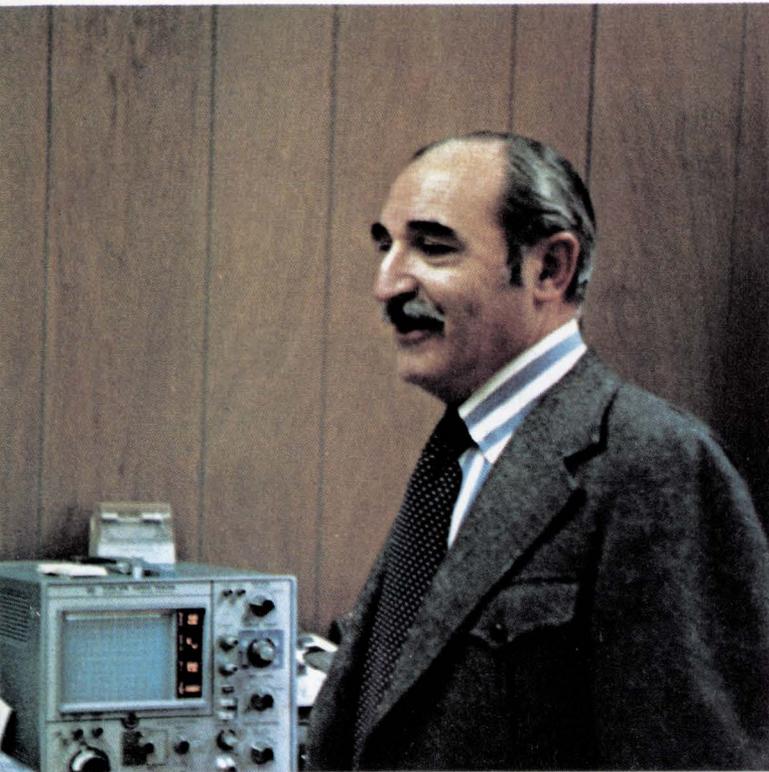
Concentrating only on the semiconductor market, Semiconductor Specialists represents another phase of the industry—the specialist. Although representing a variety of manufacturers, his stock is limited to one or a few product lines. Allied and Newark represent still another facet—the mail order group of distributors.

Value-added services seem to be the key to the modern day distributor. And a wise engineer will take advantage of

the quick delivery time the distributor can offer him on specialized products as opposed to the factory, in which case delivery might take months. The distributor's business is service and it's this specialized service that makes him vital to the electronics industry. He can program your ROMs; assemble your switches, readouts, connectors, and PC boards; assemble and calibrate your meters; strip and label wire; and more. He can also sell you one piece for a prototype or a million for production runs; provide you with detailed applications information or engineering assistance; and help you lower your leadtime with a large inventory of off-the-shelf items.



*When plotted for a single product, the life cycle curve represents the number of units produced as a function of its years of existence. (The inverse of this curve is an approximate plot of the product's unit price.) Plotted, as it is here, for several products, it simply shows where each product is in its life cycle at one point in time.



Modern distribution is much more than parts bins and order takers. A Tektronix storage scope, plus ROM programmers by Spectrum Dynamics and Intersil are part of the lab instrumentation Schweber has added to sell PROMs and other modern components.

ders, in some cases as large as a million pieces a year, it makes good sense for a manufacturer to let a distributor manage his component requirements.

Availability is their most important product

Judging by our readers' comments, availability is probably the service you're most familiar with.

"If it's a quick-react type job and I need an item fast," one engineer tells us, "I'll go to the local distributor."

"If we're buying something for the lab, or for prototyping, we'd probably go to a distributor because the chances of getting it there quickly are good."

Computers to the rescue

Since it's their most important commodity, availability is the area where distributors invest in the most sophisticated tools. Many today are alleviating your biggest complaint—the lack of follow-up to expedite orders—with computerized systems. Semiconductor specialists introduced the first one—called project FUSS—which records the promised delivery date for each item you order. If it's in stock, one week before the delivery date the computer tells Semiconductor Specialists to pull it out. If the parts have not yet arrived from the manufacturer, it ex-

pedites the factory orders and notifies you by letter.

The chances of your order being in stock are getting better, though. Because most manufacturers can't afford inventories of more than two or three months, large inventories are moving to the distributor. The result is that they are stocking more and more standard parts, which means less waiting time for the buyer.

Several manufacturers have begun communications via computers with their distributors to keep inventories well-stocked and up to date. Allen-Bradley, for instance, has an on-line communications system, called IRIS (Instant Response Information System), for this purpose. The distributor dials into Allen-Bradley's central computer in Milwaukee, enters the code numbers and quantities via teletypewriter of the products he needs, and receives an immediate confirmation of his order. Today it's not unusual for distributor inventories to reach over \$20 million and to turn over three or four times a year.

Apparently these systems are working. One engineer tells us, "Semiconductor Specialists has had a computer stocking system for a while. They're one of the best sources. They know what they've got in stock; they know what they're selling; and they order directly. This indicates the system works well."

A good distributor can help with applications . . .

Providing fast delivery on your order is, of course, the distributor's first concern. Next should come information on applications. Unfortunately, according to our readers, that's where the exceptions confirm the rule.

"I rarely go to distributors for information because my own experience has been that they don't have any. They don't know anything about what they're selling."

"Schweber might have applications information, but I've talked with people at Allied and Newark who know nothing about what you're buying. They don't even know *what it is* you're buying. They just look for the part number and put it in your hand."

There are many distributors who are working hard to improve on this point. Semiconductor Specialists, for example, has an applications engineering department staffed with engineers, specifically for the purpose of providing buyers with technical and applications information. R. V. Weatherford, owner of the distribution company of the same name, tells us they have a product marketing department with product specialists to provide technical support to their customers. "Each man has a rather narrow responsibility—one deals with capacitors, one with connectors, and so on, and they become pretty knowledgeable in their specialty because providing detailed technical information is their job."

... all you have to do is call

Think of the time you'd save going to your local distributor for technical information instead of going all the way back to the manufacturer. Take the happy engineer from Raytheon, for example, who called a distributor to find Monsanto's nearest rep so he'd know where to go for applications data. "One time I called Schweber and asked where Monsanto's local rep was so I could get some information on their LEDs. I didn't have to go any further. Schweber sent me evaluation samples and told me everything I wanted to know about them then and there."

There's one undeniable reason why a good distributor is more qualified to give you applications information than even the manufacturer. Schweber considers this to be just about the most important part of distribution. "The manufacturer who made the product is always less aware of the use of the product than the user. The manufacturer will get his ideas from his 10 best customers or from those selected customers he feels will give him volume. But the distributor comes in contact with people, with the actual users, while the manufacturer never even knows their names. So we are a tremendous reservoir of information for both customer and supplier."

Distributors can provide technical data ...

With many distributors handling just one or a few product lines, it's a safe bet you'll find technical information on these products in the offices of the limited-line distributors. Semiconductor Specialists, for example, can probably tell you more than you want or need to know about semiconductors. Paul Carroll, president, points out that his company "has been doing this for 13 years. We even hold seminars, on ICs for example, for this purpose." The same holds true for Jaco and capacitors. Joel Girsky of Jaco tells us "This year we'll sell over \$8 million worth of capacitors. That makes us the largest capacitor distributor in the world. And we'll buy more than \$5 million. Would you believe we buy more capacitors than Westinghouse? And we probably buy 10 times what Airborne buys and they're a \$100 million firm. When it gets down to talking capability, we're not afraid to match up against anyone. Cramer, the largest distributor in the country, may do \$100 million total business, but we do many times the capacitor business they do, and we've got the EEs on our staff to give us the technical information to back it up."

... and final assembly of custom components

Not only are engineers unaware of the technical information they can get from distributors but, we were surprised to find, they're unaware of the value-added services their distributors have to offer. Distributors can program ROMs; assemble connectors; sleeve capacitors; strip and label wire; assemble pots

with the required tapers, bushings, resistance values, and shaft diameters; calibrate meters; and more—yet few seem to know about it.

"Usually when they have something like that I only hear about it second-hand. It's the sort of thing that's not advertised."

"I just never hear about them. I've read about the ROM but nothing much else."

These services are there and they're becoming more and more important to the customer and the supplier as well as the distributor. This is one of the trends Schweber believes will take hold by the end of the 70's. As he puts it, "This is sneaking up on all of us right now. The distributor will slowly become the final assembler of electronic products. It all started when distributors began assembling connectors from component piece-parts after World War II, with Amphenol the originator of the idea. Then Bendix broke the ice selling even more piece-parts and equipment to the distributors, enabling two distributors to grow tremendously—Avnet and Powell. The next time around we found ourselves marking and testing capacitors, then calibrating meters, then putting pushbutton switches together. And so it goes, on and on, until someday we'll be doing the final assembly on all products."

Schweber's an innovator who always seems to be ahead of the game. Although he wasn't the first to program ROMs or assemble connectors or provide any of the other value-added services offered through distributors today, he's probably the most enthusiastic about the idea. Schweber claims that manufacturers have embarked on a "shift-the-labor-to-the-distributor" program. "When quality-minded companies like Allen-Bradley, Amphenol, Cannon, Harris, and Intersil trust the distributor to complete the final assembly on their products, my God, that's like Golda Meir playing golf in Egypt!"

Nobody really knows how the distributors' capabilities have bypassed so many engineers. Joel Girsky of Jaco blames it on the distributors. "There are only two or three distributors who advertise on a national basis. The distributor industry may be a billion dollar industry, but no one really knows what a distributor is, what his capabilities are, and so on. And frankly, I attribute it very heavily to a lack of communications on the distributor's part. We never as an industry exactly tell the electronics industry what we can do, and what they should look to us for. The distributors are not marketing their total corporate capabilities as accurately as they could."

Other distributors agree. Whatever the reason, distributors are becoming an increasingly more important part of the electronics industry. They're growing in dollars, volume, and capability and it's time you found out about it.

Schweber on distribution

The Museum of Modern Art? Not quite, but definitely not your usual industry plant. The building, set in Westbury, N.Y., combines Seymour Schweber's two great interests—distribution of electronic components and modern art.

In his spacious office, where the softspoken, slow-talking Schweber holds forth equally well on the history of civilization, history of electronics and philosophy, the prizes of his collection are kept. In addition to a modern portrayal of a vise, and directly behind the distributor's desk, is an acrylic *piece de resistance*. For as his visitors listen intently to Schweber's acerbic views on the business, their eyes are constantly distracted by a handsome rendition of the rear view of a young woman, unencumbered by clothes.

To gain an insight into the distributor's business which has directly affected the electronic engineer's purchasing habits, it's interesting to listen to Schweber's analysis of the business. Recognized as a leader in the distribution industry, Schweber's acknowledged individuality has paved the way to success for his over \$25 million a year firm. His attitude towards handling competitive lines reflects this individuality. "We didn't have to give up any competitive lines when we took on Intersil. When Intersil entered the market, our two main semiconductor lines were Fairchild and Motorola. I think that both of them must have taken sleeping pills for a couple of years because neither had very much new product development as far as memories were concerned. Either they were playing the waiting game to see which technology would be the winner—MOS, bipolar, or what have you—or they were simply satisfied with what they were doing. So we wound up with nothing in the marketplace for memories, while the new companies were the ones that were advancing in the technology."

If a distributor's business depends on the suppliers' products, it should follow that the distributor would look to them for direction. But looking to the suppliers just doesn't seem to help, according to Schweber. "When we question our suppliers, practically all of them are reluctant to tell us their future plans, future products, and future directions. Suppliers not confiding in us seems unreasonable when you consider that, in many cases, we're not only their biggest customers, but by their own admission, their most profitable ones as well. Something's got to give."

And it's starting to give. Because with every semiconductor and electronic component that's sold, distributors are coming more and more into their own, becoming more independent of the manufacturers, yet a more integral part of the electronics industry. They're gaining more voice in the industry as well as a larger share of the business and profits. But if a distributor can't look to his suppliers for direction he'll have to discern himself in which direction his suppliers are moving.

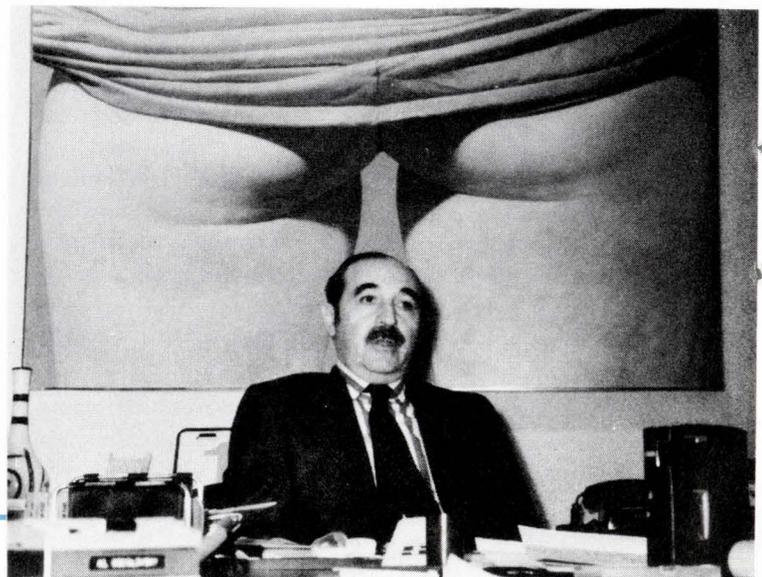
Before the end of the 70's, Schweber predicts, the distributor will become the final assembler of many electronic products. Manufacturers, as he puts it, have embarked on a "shift-the-labor-to-the-distributor" program because they can't afford to do it themselves. "As the industry becomes more complex, there are an increasing number of special-

ized products so orders often get smaller. Manufacturers have realized that it costs them \$100 to process an order, that they're losing money on small orders, so they've passed the labor to the distributor. Now we're assembling more switching, marking more capacitors, selecting more resistors, programming more memories and so on."

Sometimes, however, taking on these value-added services is not a money-making endeavor. "One of our biggest gripes in this business is that we're assembling connectors at a loss. The supplier didn't leave room in his price for us to afford it. And the distributor is cutting the price for the customer—if the guy buys one connector, we'll give him the 100-piece price. Who can afford to assemble just one connector? We always felt that if we were selling at the factory price and the guy gets it in a day without having to pay the freight from California, what more does he want? But it's not the customer who's asking for more; it's the distributor who's offering more. Distributors will have to factor in their time costs and demand the kind of pricing from their suppliers that makes sense in the hard reality of the marketplace."

To give you an idea of the growing importance of these services to the manufacturer, Schweber tells us that "the shift to distributor assembly has so taken over the minds of the suppliers that Amphenol, for example, redesigned and retooled their new Merlin line in order to enable the distributor to do the final assembly work, otherwise the item would never get off the ground."

Schweber and other distributors see distribution as a changing industry, as one that's growing and, in adding value-added services, becoming a stronger part of the electronics industry. It's the first time, he says, that manufacturers are looking at distributors as vital and equal parts of the industry. It's not that these services are something new, but they're constantly becoming more important to everyone involved—the manufacturer, customer, and distributor.



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Especially on our new, automatic pantograph machine where they can stake 12,000 post or receptacle connectors an hour into your PC boards.

The new multihead pantograph is playing an important part in the continuing success of AMPMODU, the electrical connector system that's speeding up production of modular subassemblies for manufacturers of industrial and consumer electronic equipment.

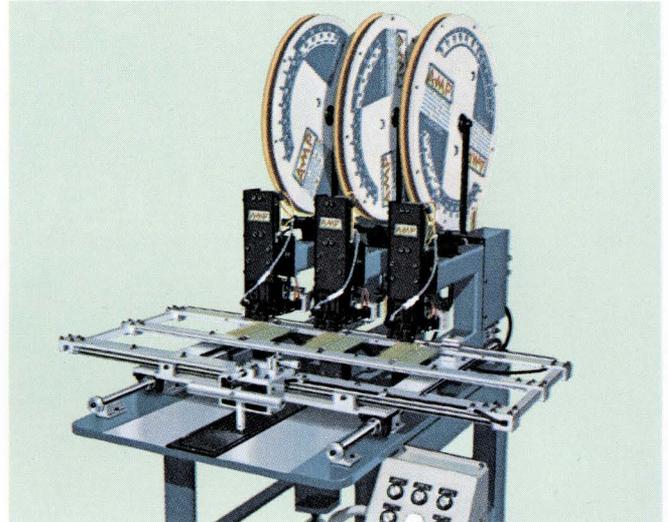
With AMPMODU products, reliable electrical contact is assured by the uniform force applied to mating posts by cantilever spring beams in the receptacles. Receptacles can be machine-staked into the face of a PC board or onto its edge. And mating posts can be wired automatically by TERMI-POINT clip, or by crimp-, solder-, or wrap-type techniques.

A complete family of single- or double-row connector housings to accommodate our crimp-in, snap-in receptacles is also available.

Find out how the AMPMODU electrical connector system and application machines can add even greater volume to your high-volume production operation.

Write for catalog to:

**AMP Incorporated, Industrial Division,
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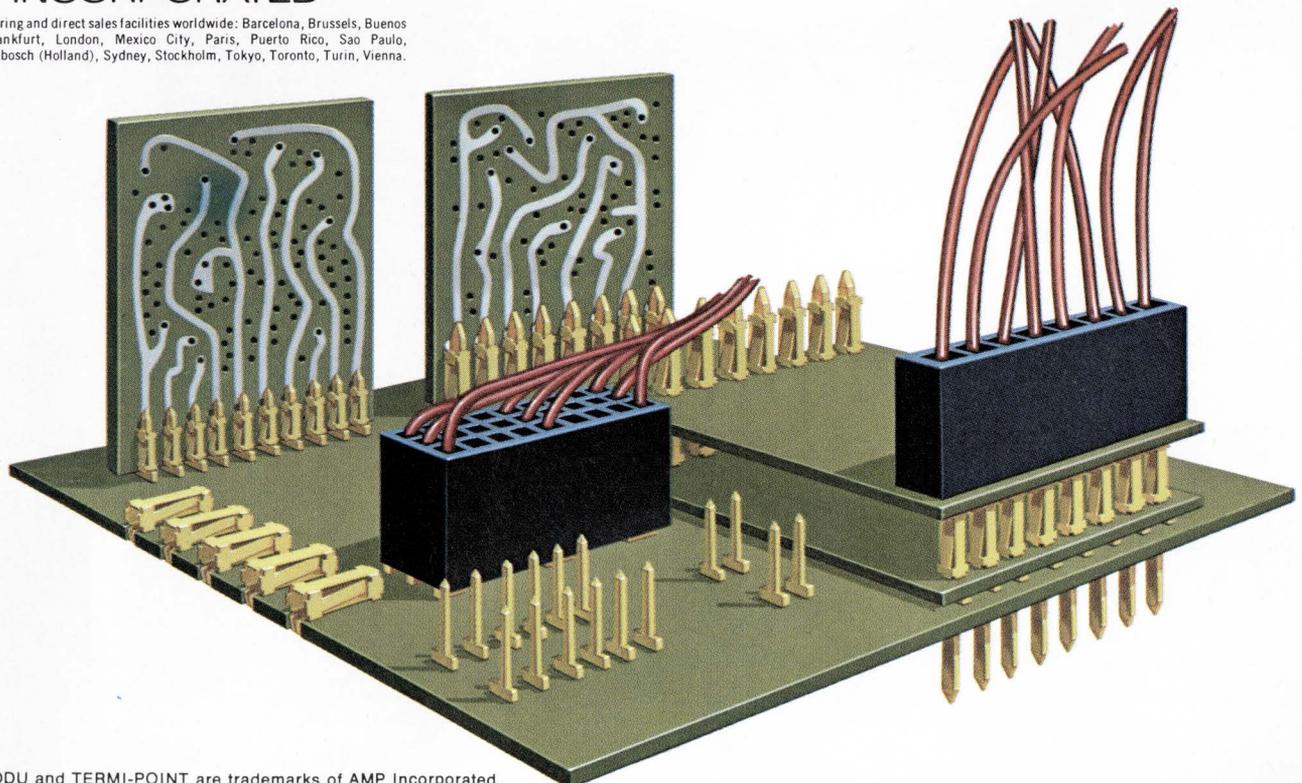


New, strip-fed pantograph stakes posts and receptacles into 3 PC boards at a time, with great accuracy. And can handle boards .062 to .125-inch thick, in 5 x 13-inch to 16 x 13-inch sizes.

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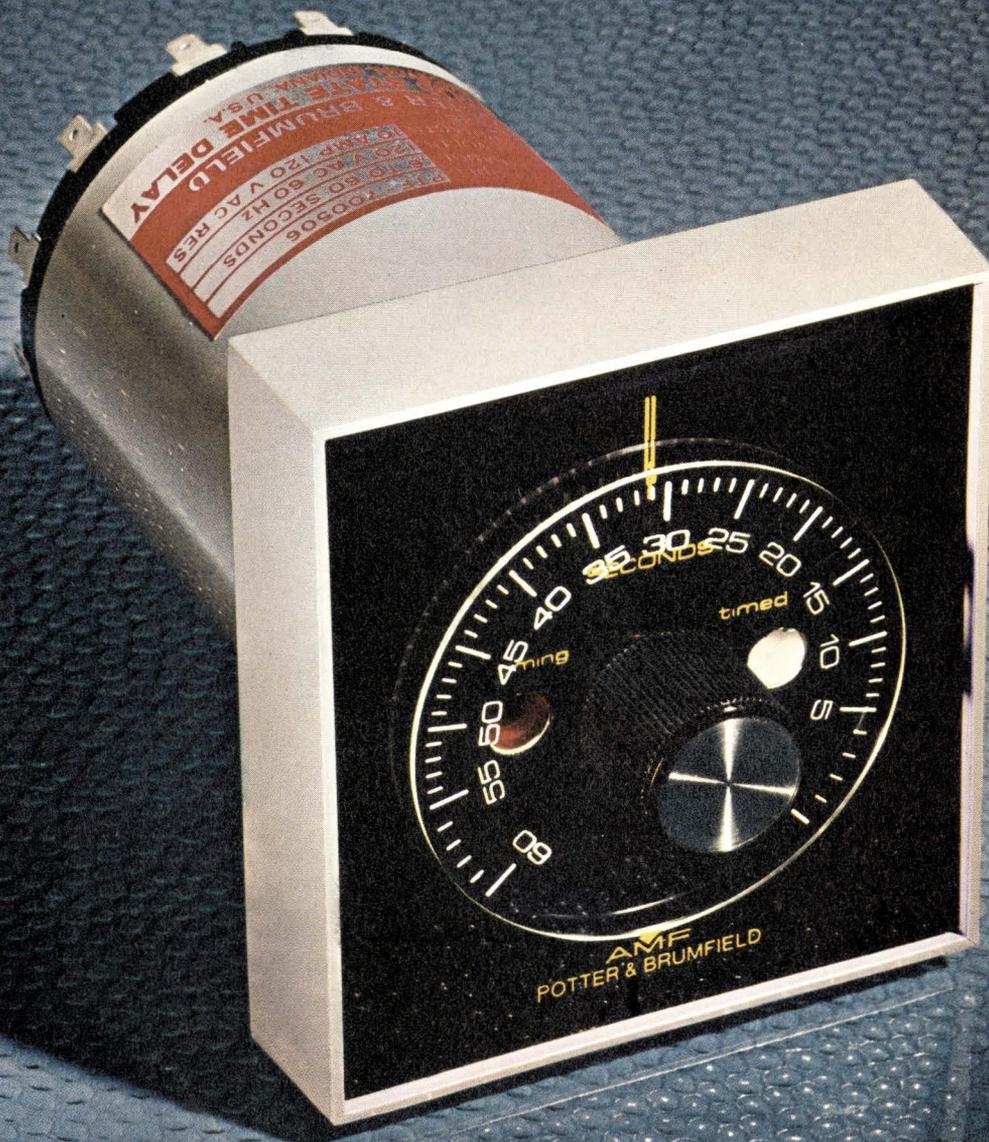
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The new P&B
solid state time delay
is more than
just a pretty face.



Our PT times with accurate solid state circuitry...switches with rugged relays. It's the best of both worlds. And it's available now from authorized P&B distributors.

A pretty face? Yes, indeed. But you get more, much more in our new PT Series panel mount time delay. For example:

- Solid state precision plus hard-contact electrical isolation.
- 10-ampere switching capacity.
- Eight dial-adjustable timing ranges...from 0.1 to 300 seconds.
- Choice of three timing modes: delay on operate, delay on release, delay on operate with both timed and instantaneous contacts.

- The accuracy, dependability and longevity associated only with solid state circuitry.

Standard models, stocked by leading electronic parts distributors, are available for 24 and 120 volts AC or 12, 24, 48, and 110 volts DC operation. They have a 3-inch diameter Lexan housing designed to be interchangeable with most mechanical timers.

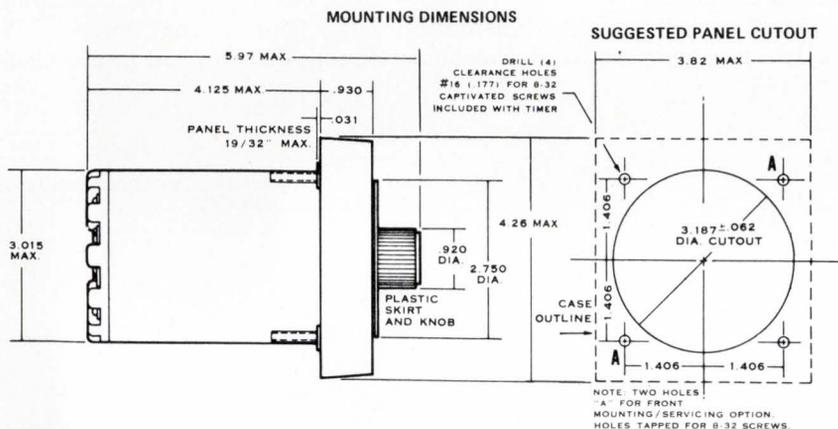
Timing function lights on the face of the PT are available options. A red light indicates timing is being performed and a white light shows tim-

ing has been completed. These lights are available on 110 VDC and 120 VAC models.

The dial is calibrated in seconds and is accurate to within 10% of the full scale. Repeatability is $\pm 1\%$. Typical release time is 45 milliseconds. DC models have polarity protection and AC models withstand transients up to 1000 volts.

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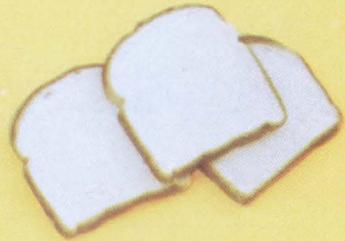


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The new Cimron DMM 50 is a five digit digital multimeter and is first in a family of multimeters to be introduced by Cimron this year. The Cimron DMM 50 offers high quality, high accuracy, high noise rejection and high speed at the same time.

In order to provide such a meter Cimron has employed a logic we call "SAINT." We've taken two logics and combined them resulting in one very powerful instrument. We use Successive Approximation (SA) logic for speed and integrating (INT) logic for its inherent noise rejection.

Each reading on the Cimron DMM 50 starts with an "Automatic Set Zero," then we examine the most significant of the five decades. Any part of a digit from zero through eleven is subtracted. This is called

our "subtractive digit" operation. The most significant decade can be zero through eleven. Next we integrate the four least significant decades.

The four operations of the "SAINT" technique are (1) automatic zero set; (2) subtractive digit; (3) integrate compare "one"; (4) integrate compare "two." This means the DMM 50 can operate at greater than 20 readings per second with a rejection of 60 dB at 60 Hz. An additional 60 dB of noise rejection may be switch selected.

Multimeter capabilities include: 5 ranges of DC and DC/DC ratio; 4 ranges of AC; 5 ranges of resistance; optical coupled data output and remote programming. Priced from \$1200.

Other Cimron products include AC Power Sources and Line Conditioners; Data Acquisition Systems; Pulse Generators; and a complete line of high performance DVMs.

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Charting logic ICs for speed/power

After years of leading the pack, TTL prepares to battle challengers on two fronts

Arthur J. Boyle, Managing Editor

Trying to thread your way through the maze of digital ICs can be time-consuming and frustrating experience. Here's a guide to simplify your task. The chart on the facing page plots average power dissipation vs typical propagation delay for the most popular families of digital logic. The primary purpose of the graph is to put the speed/power tradeoff in perspective when you are choosing a logic family for a new design. For this reason we have dropped both DTL and RTL, which appeared in past versions of the chart, since there is relatively little new design activity with either logic form. While DTL does at the moment represent a significant market for IC manufacturers, the majority of devices appear in equipment that is well into its production stage. As for the future, forecasters concede that DTL sales will decrease dramatically over the next five years as this equipment is phased out. This leaves us looking forward to a battle royal between the present king-of-the-hill and two serious contenders, and these are the three entries on our chart—TTL, ECL and CMOS.

TTL under siege

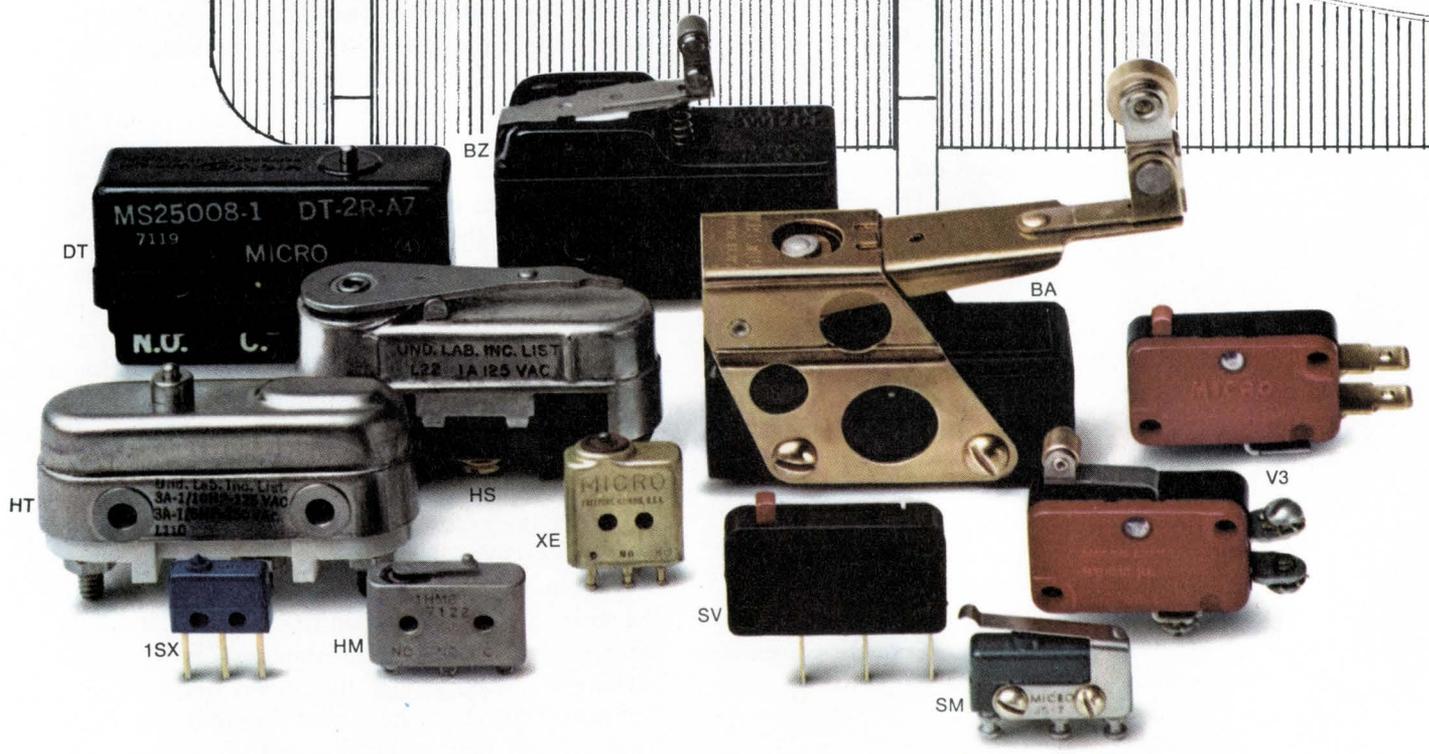
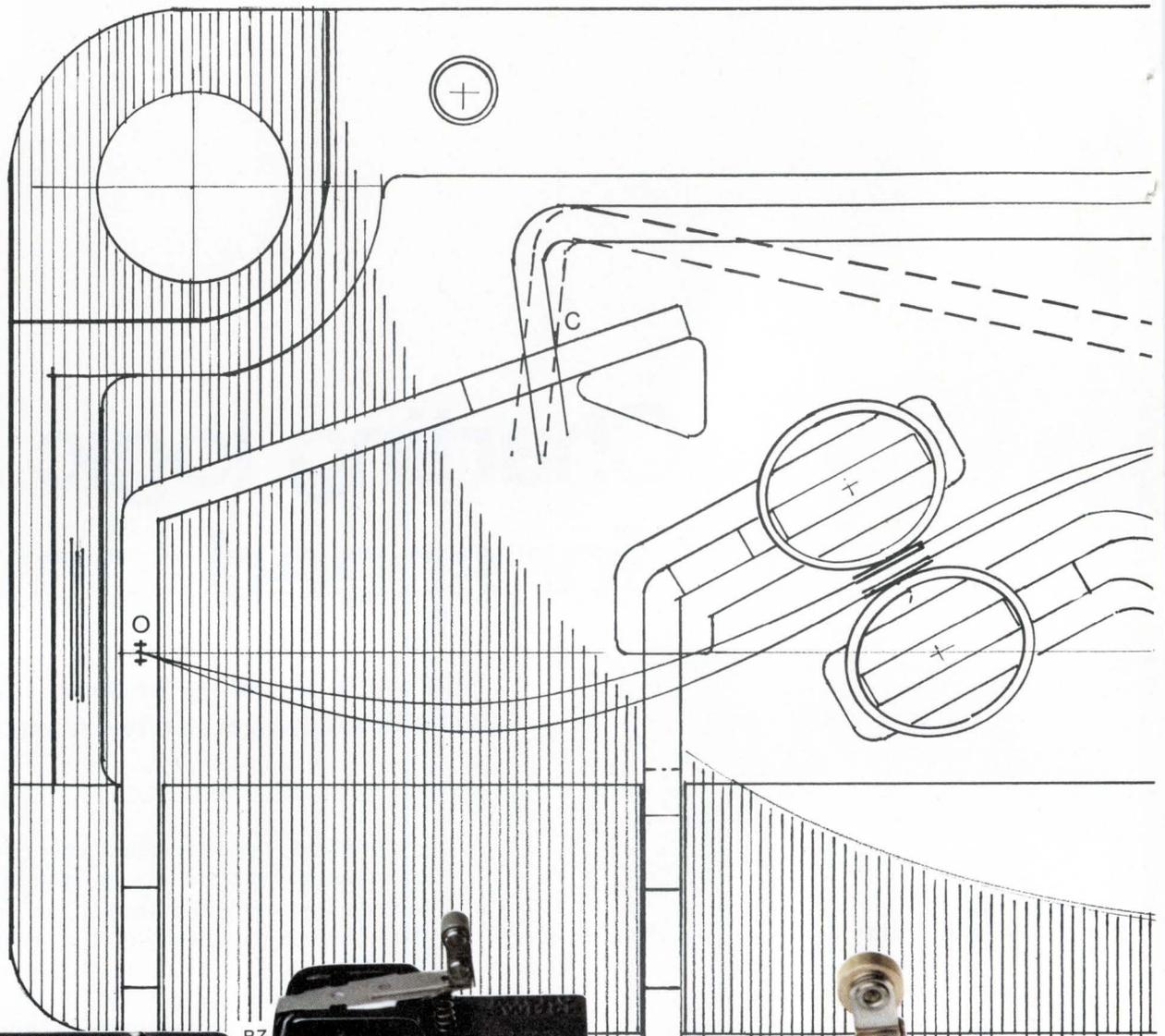
The industry's standard logic form, TTL, faces serious competition from two sides. In the very high

performance areas, standard emitter-coupled logic has been very successful in establishing a beachhead, although we are still a year or two away from the large volume production buys. At the other end of the spectrum, CMOS is starting to put pressure on TTL in both new applications and also for sockets that would have gone uncontested to TTL two years ago.

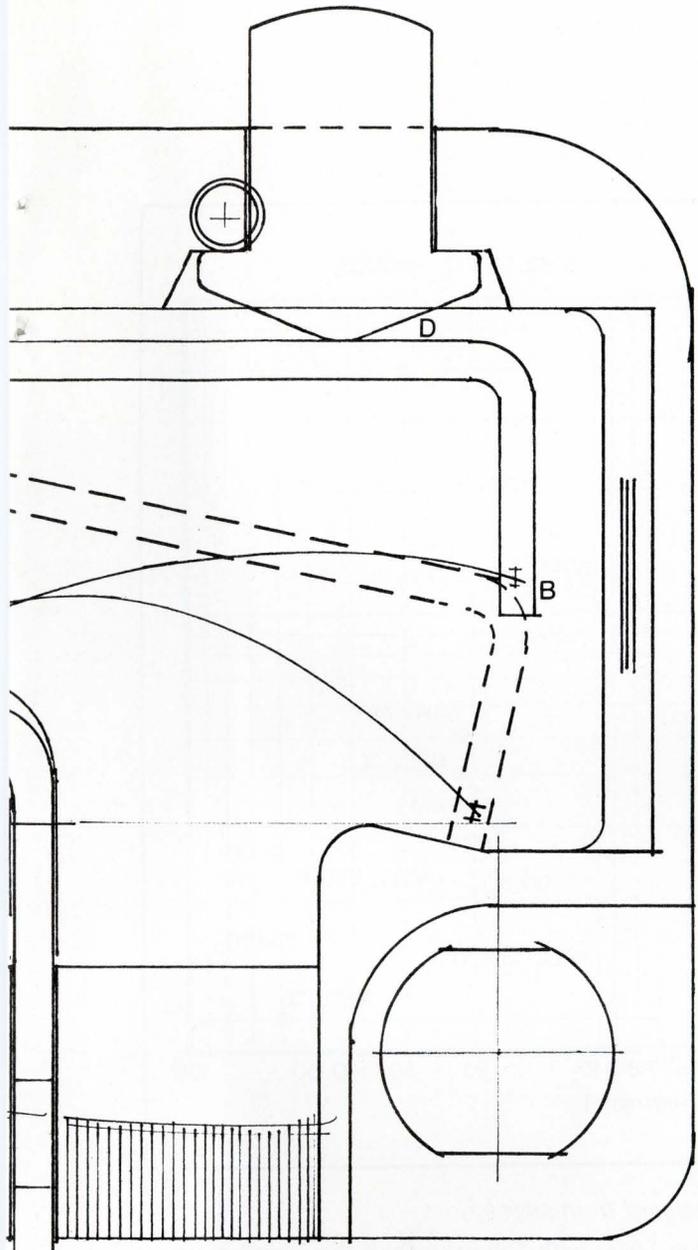
In the near future, the under-4 ns logic market will probably be the most hotly contested. Standard ECL appears to be the first choice for many of the next generation of large machines. (See "ECL—who's leading the band!" *The Electronic Engineer*, April 1972, p. 14). While up to now, the contest has been primarily between Motorola and Fairchild (with most of the second-sources lining up behind Motorola), Texas Instruments has recently joined the game. The newly announced TI line will be pin-compatible with Motorola's 10,000 series, but will incorporate the on-chip temperature compensation of Fairchild's 9500 line.

It is obvious, however, that ECL is not going to win the entire high-speed market hands down. Many designers, particularly in minicomputer and high-speed peripheral areas, report that their first choice is Schottky-TTL when they want improved performance. Almost universally they tell of "feeling comfortable" with TTL and believe that they can get on

(Continued on page 66)



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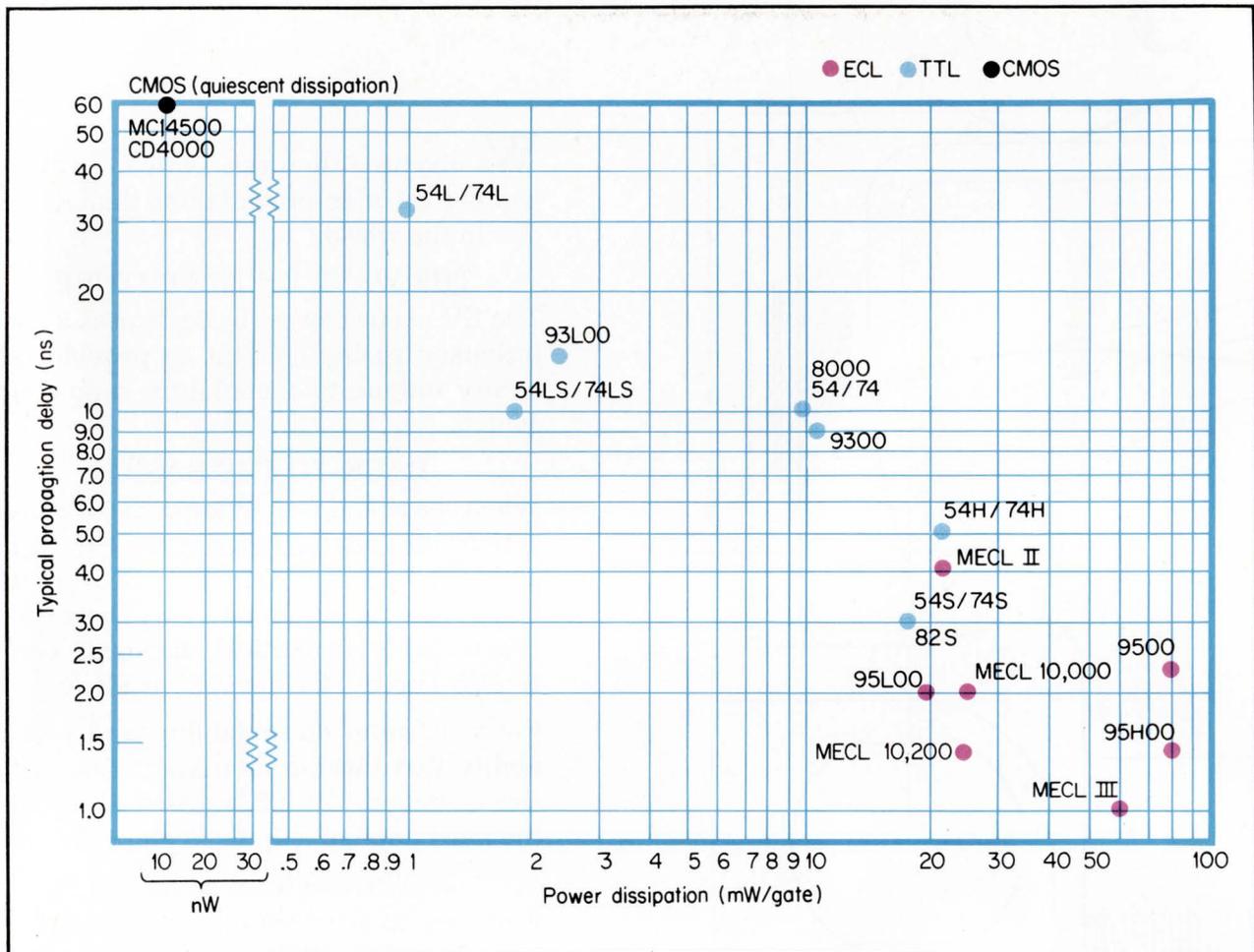
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(Continued from page 63)

stream faster with Schottky than they can by starting from scratch with ECL.

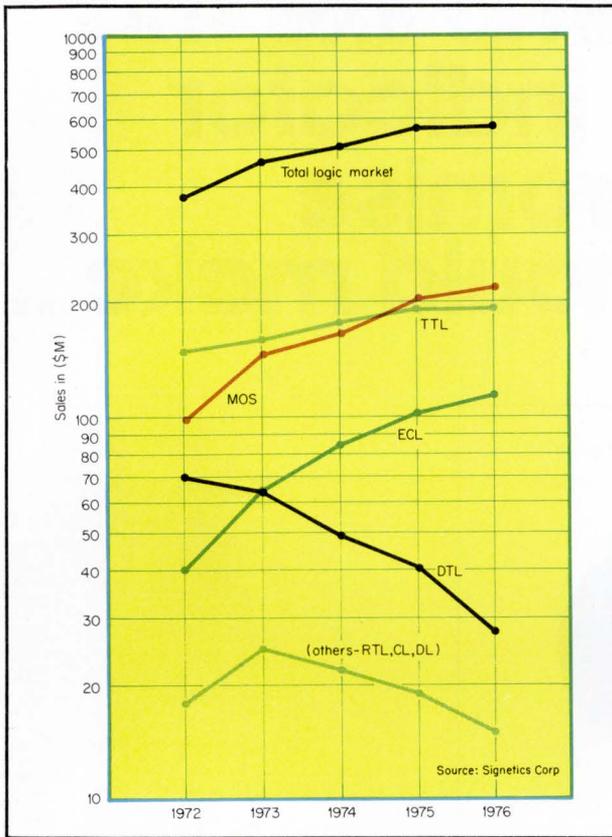
... And in low power

There is also plenty of competition for TTL in non-speed critical applications. In this case the pressure comes from an ever broadening line of CMOS circuits and an increasing number of suppliers. The low power advantage of CMOS appears to be the prime factor in this area, although a number of engineers find noise immunity and insensitivity to power supply variations very desirable features also.

Long the leader with their COS/MOS series, RCA is finding a lot of company in CMOS these days. Probably the biggest challenge is Motorola with their mCMOS line. Both Andrew Bosso, manager of market planning for RCA and Ron Komatz, Motorola's manager of MOS product development & planning believe that CMOS stands to benefit from two separate areas. The first, and the one which has gotten the most attention, is in brand new applications, such as the electronic watch. It is in these new areas

For more information, use these Reader Service numbers

Company	TTL	ECL	CMOS
Advanced Micro Devices	250		
Amperex	251	252	
Fairchild	253	254	
Harris	255	256	
Hughes			257
ITT	258		
Motorola	259	260	261
National	262	263	264
RCA		265	266
Raytheon	267	268	
Siemens	269		
Signetics	270	271	
Solid State Scientific			272
Solitron			273
Sprague	274		
Stewart-Warner	275	276	
Texas Instruments	277	278	
Transitron	279		

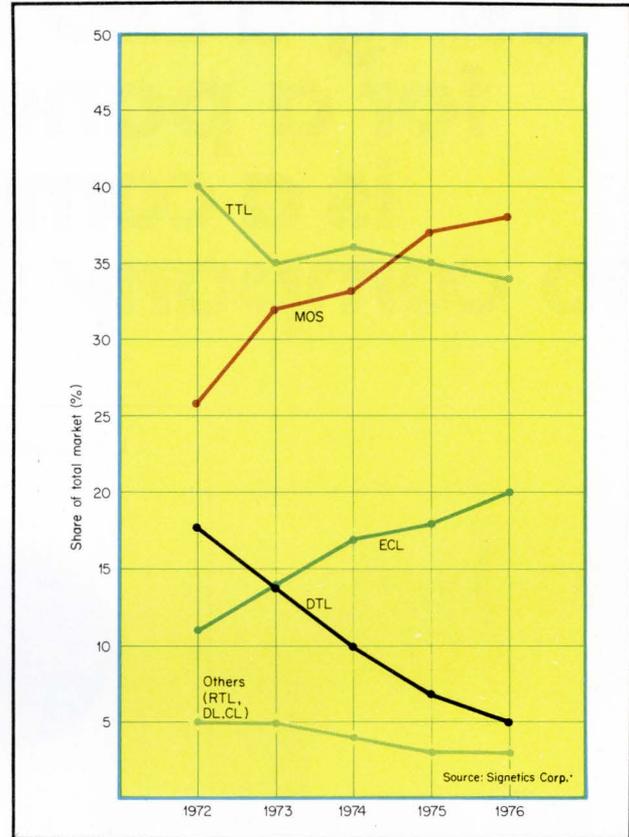


This plot of dollar sales for the various logic forms shows the shape of the market most experts are predicting for the next five years. We have defined the total logic market as being those applications which use any form of IC logic, with the exception of RAMs and ROMs. This particular forecast, supplied to us by Signetics Corp., shows the total market growing by 54% over the next five years. This growth comes from increases in the dollar volume of 31% for TTL, 125% for MOS and a whopping 190% for ECL.

that the low power of CMOS has a twofold effect. First, it opens up possibilities for battery-powered portable equipment in any number of different areas. Second, you can make many more complex chips with CMOS than is possible with bipolar without power dissipation problems. Either one or both features hold a promise of opening up some very lucrative markets which were untapped by electronic manufacturers up to now.

The other area where CMOS holds promise is to bump TTL out of some existing sockets. The advantages of CMOS here are power dissipation coupled with an insensitivity to changes in power supply levels. The net result is a lower system cost due to cheaper power supplies and reduced cooling equipment.

As is the case with the Schottky devices for the high speed application, TTL is not ready to give up this market without a fight. Recently, TI announced that they will supply custom circuits to Ebauche SA of Switzerland (the largest watch manufacturer in

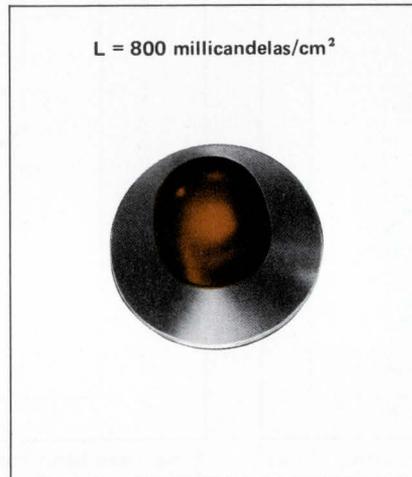


Sales have been converted into dollars into percentages of the total market in this chart. The figures for MOS include both single-channel and complementary circuits. Despite the apparent crossover in 1975, it is predicted that TTL will remain the dominant technology for general purpose logic applications. A great deal of the growth in MOS will come from those areas where the technology already has a lead, for instance, low power circuits (such as, watches) and special purpose arrays (such as, calculators and instruments).

the world) for electronic watches. The circuits are micropower bipolar custom arrays which have a power dissipation of less than 30 nW/kHz. Sources at TI say that by using geometries now in high volume production with their Schottky line, this figure can be brought down to less than 15 nW/kHz. As Gene McFarland, marketing manager for Semiconductor Circuits at TI, puts it, "there is a great deal of promise in low power bipolar circuits which has been pretty much ignored up to now. We are by no means ready to concede the low power market to CMOS."

So, as the market shapes up now there appears to be three dominant technologies for the next five years. Schottky and ECL will battle for the high-speed applications while CMOS will continue to challenge TTL at the low speed end. Meanwhile improvements in the TTL technology will be made to try and repel both challenges. All in all, it looks like a very interesting half decade for both the manufacturers and users of logic ICs.

Using a LED lamp like this for a panel indicator is a compromise no company should make...



...but you might if you only look at the specs!

Specs can mislead you into choosing the lamp above when you really want the lamp at right, a lamp whose diffused beam fills the entire lens with a bright glow, providing an easy-on-the-eyes indicator, viewable from a wide angle.

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A QUICK LOOK – March 1, 1972 (we're adding new types all the time)

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Narrow Beam Lamps Projects a light beam up to 9 feet. Available with visible light or infrared. Eliminates need for concave or convex lenses for distance.	*25 KV coupler *Fiber optic source; counters, readers, traffic monitors, data link, pollution monitor, shaft angle encoder

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JUNE 1972

DATA COMMUNICATIONS

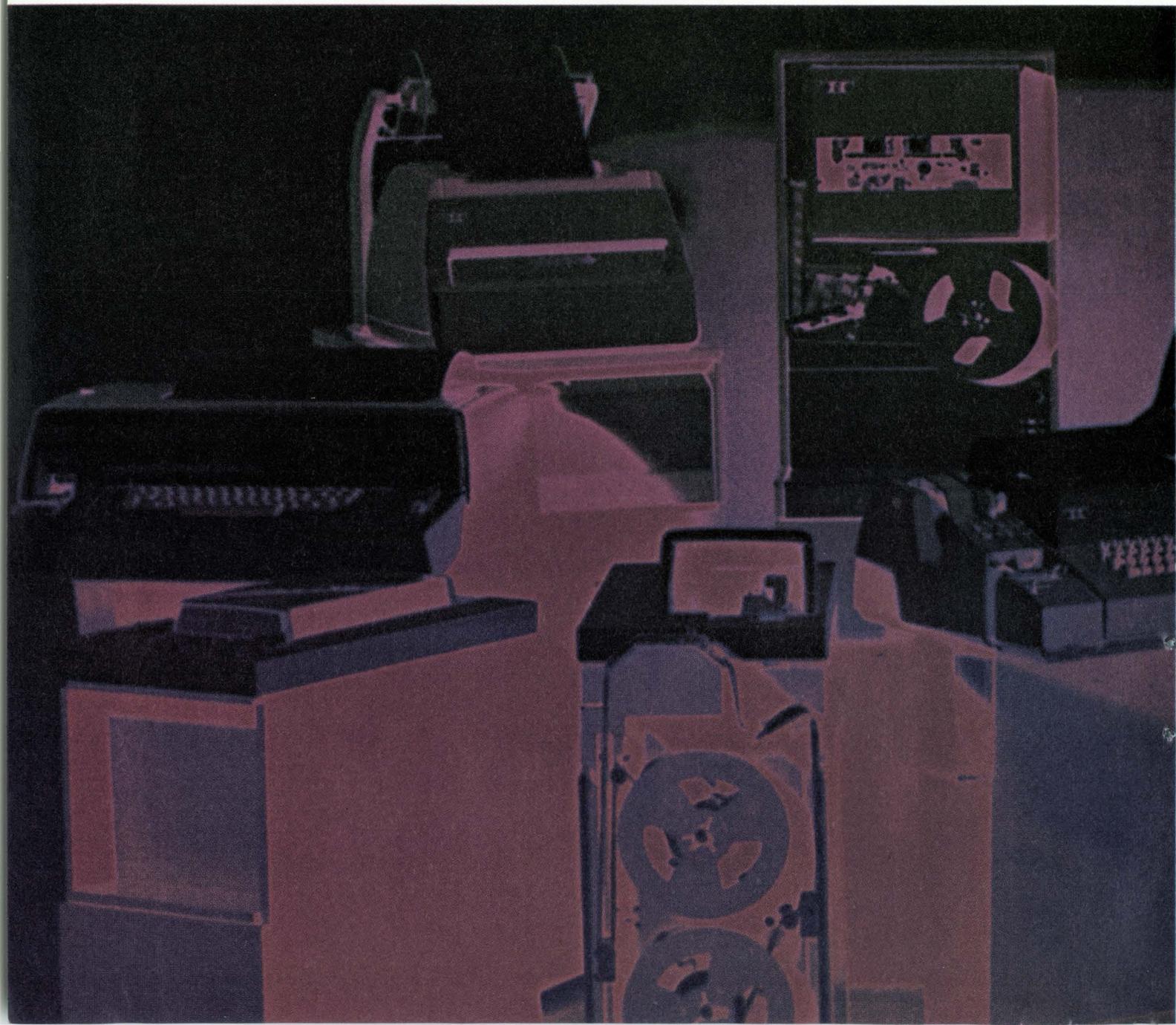


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with a waveform generator.

Feature: A PCM-compatible
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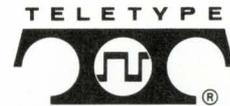
And our machines never have to stand alone. Our applications engineers will work with you to make sure the terminal you buy from us is exactly what you need. And our maintenance

people are ready to make sure things keep running smoothly.

So whatever data terminal problems you're up against, come to us for help. Because when it comes to flexibility, reliability and economy, you can't beat the machines that carry our name.

It takes more than manufacturing facilities to build the machines Teletype Corporation offers. It also takes commitment. From people who think service is as important as sales. In terminals for computers and point-to-point communications.

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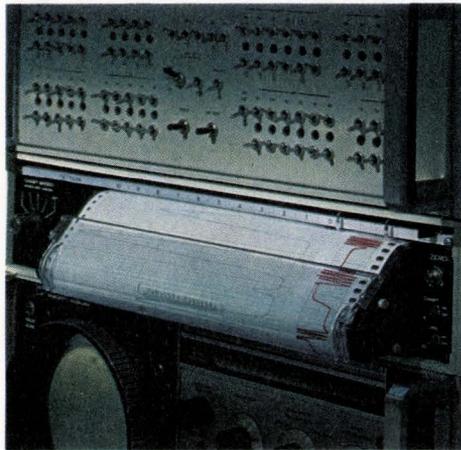


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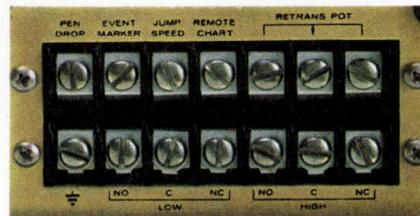


No more 2 a.m. bottles.
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OEM from the ground up.
HP's new 7123 strip chart recorder is built for dedicated OEM applications. You select from nearly 50 options to customize this 3½-inch-high recorder for any end-user system.



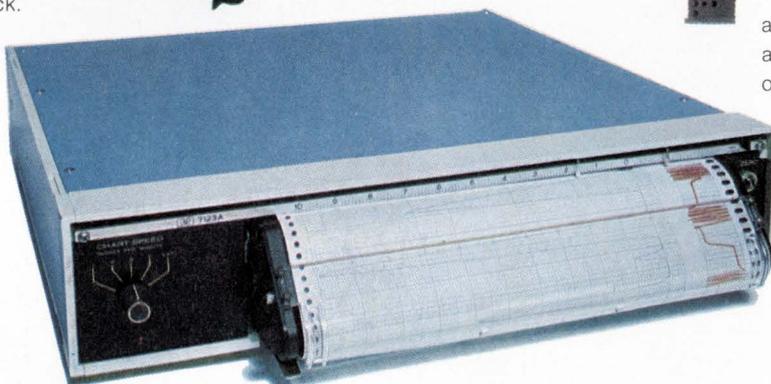
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111-05

Digital microwave radio shortens the miles

PCM-compatible digital radio systems put T-carrier signals directly on microwave.

Walter Gill,

Avantek, Inc., Santa Clara, Calif.

Application of digital modulation to microwave point-to-point radio transmission? It's a hot topic right now. In fact, about 30 organizations responded to the FCC's notice of inquiry (docket number 19311) concerning digital modulation on microwave. So, let's examine some of the features of digital modulation and T-carrier on microwave.

Incorporation of digital microwave radios into the T-carrier plant permits the economic transmission of PCM voice and digital data over links extending several-hundred miles and over rough terrain. Regenerative repeaters eliminate noise and distortion build-up. And the PCM microwave links can be mixed with cable to provide a span line that optimizes the transmission medium for each segment of the line.

First of all, let's make clear the distinction between digital traffic and digital modulation. Digital traffic usually takes the form of computer-oriented data, but it also includes forms of analog information such as voice or video that have been converted to digital (PCM) format. Digital traffic can be transmitted over an analog microwave system in which data sets or modems convert the digital traffic to analog voltages compatible with the analog transmission medium. The majority of digital traffic on microwave is presently carried in this way.

Digital modulation, on the other hand, is a method for placing digital traffic on microwave without intervening data sets. The microwave carrier transmits the information in the form of discrete phases or frequency states determined by the digital signal.

Digital modulation on microwave is, therefore, an economic and natural method for the transmission of digital traffic.

Some T-carrier background

In 1962 the Bell System introduced T-carrier equipment for the cable transmission of digitized voice traffic. The initial equipment was the D1 terminal and T1 line equipment.

The D1 terminal equipment—also called a channel bank—converts up to 24 analog voice-channels to digital PCM, and time-division multiplexes (TDM) them into a single 1.544-Mb/s bit stream. A single pair of wires—typically 22-gauge—carries the 24 multiplexed PCM voice channels; two pairs of wires are used for duplex operation.

The T1 line equipment—also called a span line—consists of the wire pairs, regenerative repeaters, and line termination equipment. Regenerative repeaters—placed about every 6000 ft along the line—reshape the digital pulses. These repeaters provide one of the great performance advantages of T-carrier transmission: they eliminate the buildup of noise and distortion that occurs on analog-repeated lines.

Improved terminal equipment in the form of the D2 channel band is now in use over T1 repeated lines. The D2 uses 8-bit quantization of the voice signal, rather than the 7-bit quantization used in the D1, and so has lower quantization noise.

In addition to voice traffic, the T-carrier equipment also handles digital data traffic. Channel bank equipment can accommodate a wide range and mix of data rates.

The principal applications for T-carrier have involved transmission over wire pairs. And in such applications, the D1/T1 equipment has proved to be a more economical multiplex technique than FDM carrier gear for low-density, short-haul (less than 50 miles), trunks. With more than a million T-carrier circuits installed, their usage has become widespread.

However, confining T-carrier signals to cables inhibits their flexibility in applications where cable is uneconomical or not technically feasible. Such situations arise wherever terrain makes new cable installation too costly or whenever longer-range T-carrier trunks are desirable. Here, microwave transmission of T-carrier signals can offer significant system and cost advantages.

T-carrier on microwave

Up to the present, microwave transmission has been used primarily for analog traffic, either FDM voice or video. T-carrier has not been applied to microwave because of the greater spectrum occupancy of PCM voice compared with analog voice.

However, three factors now make microwave a bonafide transmission medium for PCM:

- the extensive use of T-carrier and the need for microwave as an alternative to cable in some portions of the communications plant (without reverting to analog format);
- the increasing level of data traffic that can be transmitted with greater spectrum efficiency and equipment economy over a PCM medium than over the existing analog FDM medium;
- improved modulation techniques and cross-polarized transmissions that permit more efficient spectrum occupancy for PCM voice.

Either fm radio or digital-modulation radio can transmit T-carrier by microwave. In the case of fm radio, the T1 signal is applied directly to the fm baseband after suitable filtering. Digital-modulation radios, on the other hand, have greater bandwidth and power efficiency than fm radios since their modulation and demodulation characteristics are specifically related to digital signals. For example, phase-shift keying using four phase-states is a very efficient and reliable technique for digital-modulation radios. This method of modulation is also known as *quadrature*, QPSK, and PCM/QPSK.

Characteristics of digital microwave

Most of the system design considerations for digital microwave are similar to those for more conventional FDM/FM microwave. Such factors as path clearance, antenna mounting, primary and standby

power, path reliability (fading), equipment reliability, and station licensing are common to both digital and FDM/FM microwave route planning. The characteristics of digital microwave that distinguish it from FDM/FM microwave are the performance criterion, regenerative repeaters, low interference susceptibility, and cross-polarized operation.

Bit error rate

The performance criterion for a digital system is the bit error rate (BER) at the digital receiver output. Bit error rate is defined as the ratio of erroneous bits to total received bits in a specified measurement interval; or, equivalently, the bit errors per second divided by the data rate in bits per second. Received rf-signal level and BER are related by a curve on which the expected average BER is plotted as a function of the signal-to-noise ratio in a noise bandwidth (in Hz) equal to the digital transmission rate R (in bits per second).

A typical BER vs $S/N_o R$ curve differs from the ideal QPSK curve by 2 dB. Spectrum-limiting filters in the transmitter, imperfect receiver timing, and bit error multiplication in the receiver descramblers cause this difference. These sources of error are predictable and typical of a QPSK transmission system. Other types of digital systems exhibit similar degradation factors that you must consider in system planning.

At a BER of 10^{-6} or better the performance of T1 line is excellent. Actually, useful traffic quality is maintained at a BER much worse than 10^{-6} . However, a BER objective of 10^{-6} between terminals is common practice in T1 line engineering, with an objective of 3×10^{-7} allocated to each span line. Similarly, for T-carrier radio the terminal-to-terminal BER objective is 10^{-6} .

A typical microwave radio link will consist of several repeaters. Under normal propagation conditions each hop will be virtually error free. Signal fading due to propagation anomalies will occur infrequently and independently on each hop. However, the terminal-to-terminal BER performance objective should still be met, even under conditions of deep fading. Accordingly—in our table showing a typical path calculation—an objective of 3×10^{-7} on each hop is specified under the assumption that no more than three hops will simultaneously experience deep fades.

The path reliability as determined by propagation effects is computed from the Rayleigh fading law. Actually, a 2-GHz link will be about four times more reliable than that predicted by Rayleigh fading. Thus, the path reliability of our sample link can be

expected to be 99.999%. This means about five minutes per year of deep fade at which the BER reaches 3×10^{-7} . For the remainder of the time the transmission should be essentially error free.

Note that a digital microwave transmission system introduces channel degradation only during infrequent deep signal fades. Most of the time it is an ideal transmission medium for the digitally-formatted information. An FDM/FM microwave link, on the other hand, continually introduces noise due to intermodulation (independent of signal strength) as well as receiver noise (when the signal fades).

Typical Digital Microwave Path Calculation

1. Transmitter Power (1 w)	30.0 dBm
2. Transmit antenna gain (8 ft diameter)	32.0 dB
3. Coax cable loss (100 ft)	- 2.0 dB
4. Path Loss (40 mi, 2120 MHz)	-135.1 dB
5. Polarization error loss	- 0.5 dB
6. Receiver antenna gain (8 ft diameter)	32.0 dB
7. Coax cable loss (100 ft)	- 2.0 dB
8. Duplexer two-way loss	- 0.4 dB
9. Unfaded received signal power, S	- 46.0 dBm
10. Receiver noise figure	6.0 dB
11. Receiver noise density, N_o	-168.0 dBm/Hz
12. Unfaded S/N_o	122.0 dB/Hz
13. Required S/N_o for BER = 3×10^{-7} at 3.088 Mb/s	78.0 dB/Hz
14. Required signal power	- 90.0 dBm
15. Fade margin	44.0 dB
16. Path reliability (Rayleigh fading)	99.996%

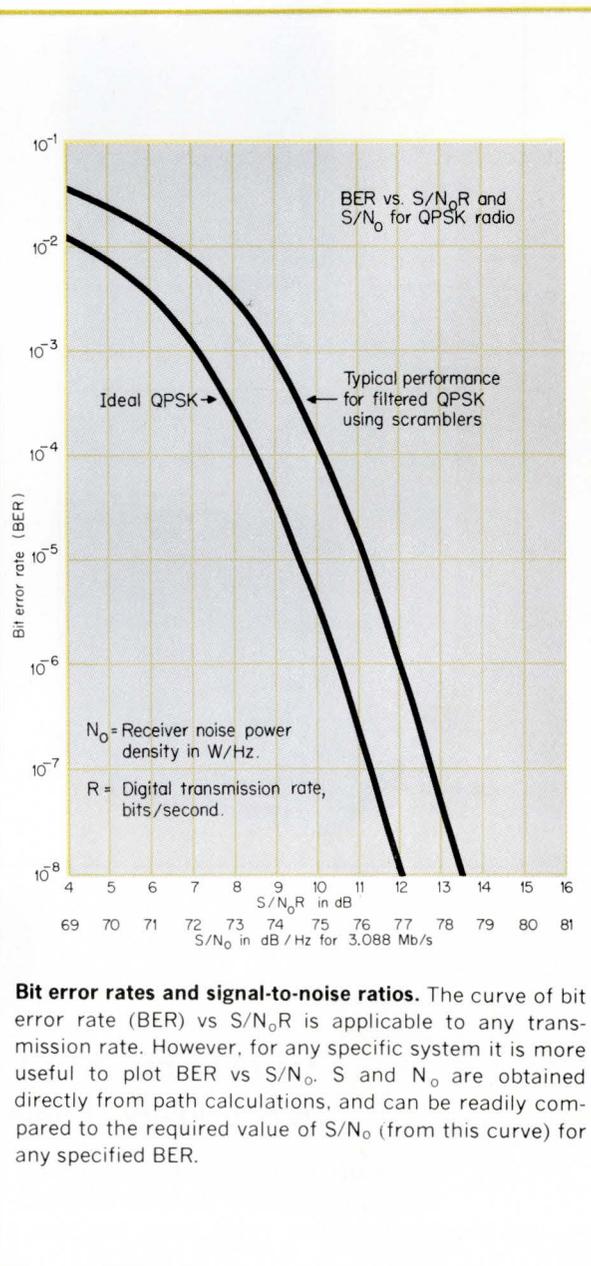
Sample digital-microwave path calculation. The performance criterion for a digital microwave system is best explained by a path calculation. In this sample link, the carrier is at 2120 MHz (common-carrier band), a 1-W transmitter and a 40-mile link are assumed, and the link operates at a 3.088-Mb/s PCM rate (two 1.544-Mb/s T1 lines). Lines 1 through 12 might also be used for an FDM/FM system. But starting at line 13, the distinguishing features of the digital system are apparent. The performance criterion itself is the bit error-rate (BER) at the digital receiver output. In practice, the path reliability (line 16) is actually about four times better than the theoretical Rayleigh prediction shown, resulting in a 99.999% reliability, or about five minutes per year of deep fade when the BER reaches 3×10^{-7} . This is the BER objective specified here. The figure for line 13 comes from the curve of BER vs S/N_o . And with a 6-dB receiver noise figure, the noise power density, N_o , is -168 dBm/Hz (line 11). So the required signal power (line 14) is -90 dBm (algebraic sum of lines 11 and 13). The fade margin is the difference between lines 9 and 14, or the difference between lines 12 and 13; either way, the results are the same.

Regenerative repeaters

Another significant difference between digital and FDM/FM microwave is the use of regenerative repeaters on multiple-hop digital systems.

In conventional FDM/FM microwave relay systems the repeater stations retransmit the signal after linear amplification to increase the power level. This amplification is accomplished either with the modulated signal (heterodyne repeater) or on the multiplexed baseband signal (remodulating repeater). Either method not only raises the signal power level

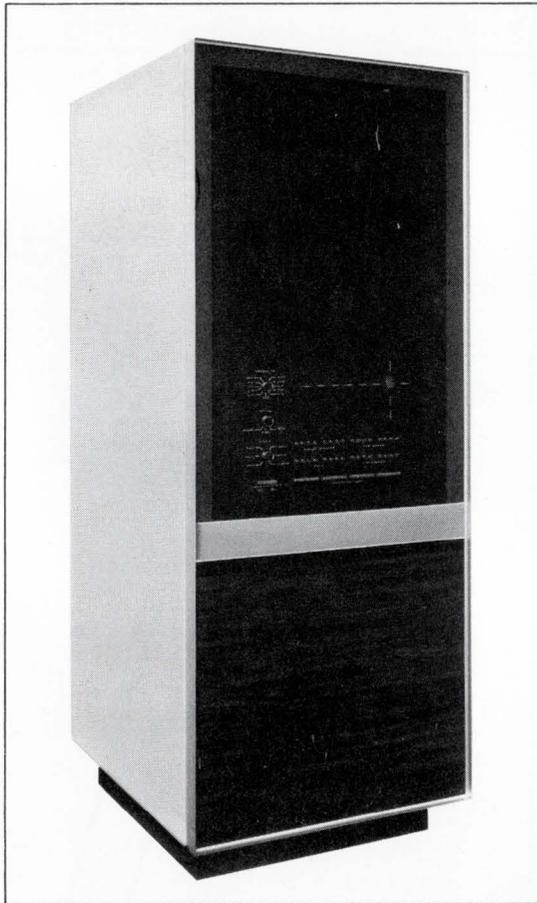
(continued on p. DC-9)



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but also retransmits the amplified receiver noise and any intermodulation components generated in the repeater. This operation is repeated at each repeater and the noise and distortion build-up is cumulative and passed on to the eventual message user.

On the other hand, digital transmission permits the regeneration of the digital bit stream at each repeater. Noise and distortion on each hop are eliminated at the repeater and not allowed to accumulate. Receiver noise will, of course, cause bit errors at each repeater, and the bit errors will be additive over a multi-hop system. However, the build-up of bit errors is far less than the corresponding build-up of noise and distortion in analog systems.

Interference susceptibility

Most digital modulation schemes—such as phase-shift keying—use suppressed-carrier transmission and place almost all of the signal power in the information-bearing sidebands. There is no discrete carrier component. Randomizing the bit stream eliminates the strong, discrete, line components caused by periodicities in the data stream. Digital scramblers do the randomizing (or, more precisely, pseudo-randomizing).

The scrambler modifies the bit pattern in a complex but systematic fashion using a pseudo-random or nearly-random code, breaking down periodicities in the input data streams. Because of the systematic nature of the scrambler, an inverse descrambler operation in the receiver readily restores the original data bit stream.

The uniform power spectrum and the absence of carrier and strong, discrete, spectral components significantly reduce the interference effects of digital modulation on FDM/FM systems. The interference resembles broadband noise similar to a receiver's front-end thermal noise, not single-frequency interference. Noise-like interference is much less objectionable in FDM/FM systems than single-frequency interference.

Single-frequency interference results in the generation of intermodulation products and direct interference in the FDM baseband voice channels. FDM/FM systems are more likely to cause single-frequency interference to other FDM/FM systems than are digitally modulated systems.

Interfering signals can cause bit errors in a digital transmission system by perturbing the normal received waveform and forcing an incorrect decision in the receiver. However, most digital modulation systems, particularly those using phase-shift modu-

lation, have only slight susceptibility to co-channel interference when the signal-to-interference ratio (SIR) exceeds 15 dB*.

For example, a quadriphase system with a BER of 10^{-7} without interference will have a BER of 10^{-5} with a SIR of 15 dB. Equivalently, the fade margin is reduced by only 2 dB to maintain a 10^{-7} -BER goal. A SIR of 20 dB results in less than a 1-dB system degradation.

Cross-polarized operation

The high interference-immunity of digital modulation systems permits the operation of two independent transmitters operating on the same carrier frequency and the same antenna using cross-polarized feeds.

Cross-polarization discrimination of 25 dB or more is typical of well-designed antenna installations. So it is quite possible to operate two independent quadriphase channels on the same carrier frequency using cross-polarized antenna feeds, thereby doubling the amount of traffic through an assigned rf channel.

Note that microwave route coordination among several users takes into account the polarization discrimination available from vertical- and horizontally-polarized antennas. You must exercise care in planning digital microwave systems using cross-polarized operation since the use of both polarizations must be included in route coordination with other systems.

Digital radio applications

The transmission of T-carrier signals on digital microwave can provide a wide range of channel capacity depending upon the choice of frequency band. Examples of PCM voice channel loading in various microwave bands are shown in an accompanying table. But note that the channel loading is less than the capacity of conventional FDM/FM microwave routes. For this reason it is not expected that digital microwave will supplant FDM/FM on those routes requiring high voice-channel capacity. Instead, digital microwave will be used initially:

□ where interfacing with T-carrier plant provides microwave transmission without the added expense, complexity, and message degradation resulting from PCM-to-analog conversion for FDM/FM transmission;

*V. K. Prabhu. "Error rate considerations for coherent phase-shift-keyed system with co-channel interference." *The Bell System Technical Journal*, March 1969.

(continued on p. DC-11)



RT-01. The data entry terminal you didn't think there was the remotest chance you could afford.

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Circle Reader Service #30

□ where low density routes can take advantage of the lower cost of PCM terminal equipment compared with FDM equipment;

□ and where there is substantial data traffic including high-speed lines, many low-speed lines, or a mix thereof. Digital microwave readily handles a mixture of voice and data.

Higher-density digital microwave routes will depend upon the development of more efficient techniques for transmitting digitized voice. The allocation of frequency bands above 15 GHz to digital microwave will spur the development of digital microwave equipment with capacity in excess of 2000 voice channels.

FDM/FM vs digital microwave

In comparing digital microwave and FDM/FM microwave applications the key factors are spectrum utilization, voice channel density, data traffic, existing voice multiplex, and route coordination.

Implied in all of the above factors is economics. Spectrum utilization is always a key factor in microwave planning since the radio spectrum is a limited

resource. In heavily-developed areas, for example, the 4- and 6-GHz bands are almost saturated and spectrum use is essentially the sole factor in determining system planning.

In less congested environments and in more sparsely used frequency bands, economics can have a strong influence on choice of the type of microwave. Digital microwave can economically handle a high percentage of data traffic. In fact, the spectrum efficiency will be greater for digital microwave for data transmission.

When the existing plant already uses PCM T-carrier for voice multiplex, digital microwave is the logical choice. On the other hand, if FDM is extensively used then FDM/FM microwave should be used. When a choice of multiplex exists, the lower cost of T-carrier multiplex relative to FDM dictates the combination of T-carrier and digital microwave.

With regard to route coordination, a digital route can be installed in an environment of existing FDM/FM routes using the same interference criteria as for a new FDM/FM route. A significant difference arises, however, when several digital routes are planned. Because of their lower susceptibility to interference, many more digital microwave routes can operate in the same radio environment. This aspect of digital microwave is particularly important in the design of complex networks of interlaced microwave links in metropolitan areas. Local distribution of long-haul trunk traffic is an example of the capability of digital microwave.

Cable vs digital microwave

At present, most T-carrier is carried on cable. However, the availability of digital microwave now provides an economical alternative to cable where terrain, right-of-way, and distance make cable installation expensive or unfeasible.

Prove-in distances for cable vs microwave are difficult to generalize because of the many factors involved in any particular case. However, studies of typical situations indicate that microwave will prove-in at 3 to 6 miles compared with new, buried cable in average terrain, and will prove-in at 10 to 15 miles compared with adding T-carrier to existing cable.

Microwave greatly extends the distance for T-carrier transmission. T1 signals on cable are normally not used beyond 50 to 100 miles. And on cable, repeaters are used every mile. But with radio, repeaters are located 20 to 50 miles apart. Thus, T1 signals can be transmitted a thousand miles or more before jitter build-up becomes excessive.

**Examples of PCM
Channel Loading**

PCM voice channels*	RF bandwidth	Applicable bands
48	3 MHz	2-GHz common carrier
96	6 MHz	2-GHz PSIT**
288	20 MHz	6-GHz common carrier 11-GHz common carrier
144	10 MHz	6-GHz PSIT
576	40 MHz	11-GHz common carrier
288	20 MHz	12-GHz business 12-GHz PSIT

*PCM Voice Channel Capacity for single polarization; doubled with cross-polarized operation.

**PSIT: Public Safety, Industrial and Land Transportation Bands.

Waveform generator creates FSK and PSK signals

Jim Shales,

Exar Integrated Systems, Sunnyvale, Calif.

With this simple technique you can generate FSK and PSK signals with a waveform generator. Of course, frequency-shift keying (FSK) and phase-shift keying (PSK), the common modulation methods used in data communications, shift either the frequency or phase of the carrier signal to correspond to a data bit.

For efficient use of the frequency spectrum the carrier should be sinusoidal, and the phase- or frequency-shifts should produce a minimum amount of switching transients. Frequency shift keying require also that the phase of the carrier be continuous during the frequency shift.

In this simple method, the circuit provides a sinusoidal output; its phase can be reversed by reversing the polarity of the control voltage across one of the control terminals. And the phase reversal doesn't introduce any distortion or transients on the sinusoidal output.

You can frequency-shift key in a similar way by applying a step input to a different terminal. And in addition to FSK and PSK capability, the oscillator can also be keyed ON or OFF with a third control signal (ON/OFF keying input at pin 13).

The figure shows external circuit connections for operating Exar's XR-205 to produce either an FSK or a PSK signal depending on the selection of the control terminal to which you apply the binary input data.

A timing capacitor, C_o , sets the carrier frequency, $f_o \approx 400/C_o$, where C_o is in μF . The circuit provides a 3-V pk-pk output with a 50- Ω output impedance at pin 11, and an unmodulated square wave sync output at pin 12. Set the trimmer resistor between pins 7 and 8 to minimize the harmonic content of the sinu-

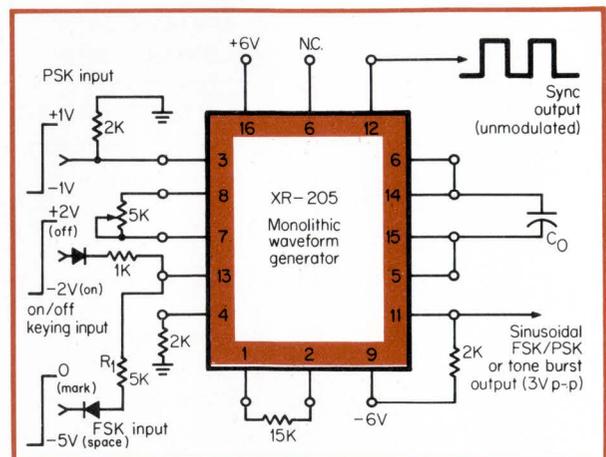
soidal output. Typically, the total harmonic content of the output is $> 2.5\%$.

Reversing the bias polarity at pin 3 produces phase-shift keying; a $\pm 1\text{ V}$ modulation pulse is sufficient. A voltage pulse to the frequency-control terminal (pin 13) produces frequency-shift keying. The frequency shift for a given input-step size is inversely proportional to the value of resistor R_1 in series with the control input. With $R_1 = 5\text{ k}\Omega$ and 0- to 5-V keying pulse, the circuit produces a 2.5:1 frequency shift. And the sinusoidal output maintains phase continuity during the keying operation.

The circuit shown here is suitable for FSK or PSK modulation from 1 Hz to 4 MHz, and operates over the entire military temperature range. It will run with supply voltages from ± 4 to $\pm 12\text{ V}$.

For more information on the XR-205

Circle Reader Service #287



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A New Concept-- Digital Interactive Monitoring

VIMAC, the new VIDAR 690 Monitor Alarm Controller terminal now makes it economically feasible for up to *seven* users to share *one* data acquisition system. Not only can one to 1000 channels be continuously monitored at up to seven operator-controlled VIDAR 690s, but each VIMAC terminal can: initiate system scans; call up data from any desired channel; continuously update for trend data. Used in conjunction with a VIDAR Digital Data Acquisition System (D-DAS), VIMAC will provide read-out in engineering units for temperature (C & F), millivolts, volts and optionally, ohms, vac, psi, ft/lb, and many other parameters. In addition, VIMAC displays pre-data, digital clock, or any five BCD devices.



The VIDAR Monitor Alarm Controller has special application in temperature measurement. If a thermocouple should open, VIMAC will alarm; this feature is relevant to other types of transducers. Operating in an "Open T/C Search" mode, the VIDAR 690 can command the D-DAS to stop scanning when an open T/C channel is reached; the data point is then displayed.

VIMAC application is universal and is a significant addition to an already comprehensive VIDAR systems capability. Find out how this new concept—digital interactive monitoring—can provide you with an *honorable solution* to *your* data acquisition problems. Circle the reader service number for a free brochure on VIMAC or write for details to Dick Kennedy, product manager, VIDAR, 77 Ortega Ave., Mountain View, Calif., 94040.

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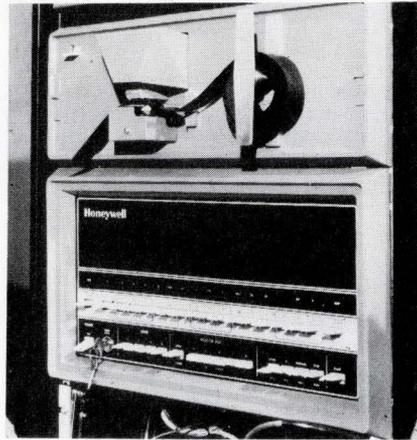
A mini for a maxi growth situation

Reacting to what Honeywell vice president and general manager Edward C. Lund described as a market with an annual growth rate exceeding 18%, Honeywell has introduced a new family of functional minicomputer systems. The eight-member System 700 family is supposed to expand a user's data-processing system into a communications-oriented information processing network.

The System 700 family includes a new central processor, a new operating system, a wide range of communications controllers, and a real-time interface.

The type 716 central processor has a main memory cycle of 775 ns/16-bit word. This general-purpose computer is organized as a single address, two's complement, parallel 16-bit binary machine. Memory size can range from 8,192 words to 32,768 words, each word being 16 bits, or two 8-bit bytes.

The Honeywell Terminal System, one of eight models, is designed for applications requiring data collection via terminals, interactive terminal/computer communications, and data pre-process-



The Terminal System of the Honeywell 700 minicomputer family can handle eight compatible terminals and communicate data to a large host computer.

ing. Applications areas include industrial data acquisition and control, material movement and labor reporting, data entry from medical laboratory terminals, and data entry from banking terminals.

Up to 16 EIA compatible terminals can be connected to this system via the medium-speed line controller, which handles a mix of synchronous and asynchronous lines. In addition, up to

eight local teletypewriters can be used for data entry and/or reporting.

The system is designed for interactive decentralized control of these terminals with communications to a host computer by paper tape, mag tape, or a direct communications line.

The communications link to the host computer is via synchronous, 20,000-baud lines with hardware support for cyclic redundancy checking, full transparency, and binary synchronous operation.

Unattended operation is possible through the use of a read-only memory-resident down-line load program and watchdog timer alarm system. Further system integrity features include byte parity and a power failure interrupt-and-restart system that meets "brown-out" specifications.

A typical Terminal System for controlling eight terminals, including a host computer link and a main memory of 12,288 words, can be leased for about \$1,270 per month on a five-year contract, or can be purchased for about \$40,300.

Circle Reader Service #291

Station-to-station communication

Joining the tried and true war horse of the Teletype® line, the Teletype 33 terminal, is a new stablemate—the Teletype 38 wide platen ASR (automatic send-receive) terminal. The wide platen terminal (15 in. wide) accepts the standard 14 $\frac{7}{8}$ in. fanfold stock and prints a full 132 character line at 10 char/in. Accompanying the 38 is a 4210 magnetic tape data terminal that can handle data distribution and collection at speeds up to 2400 words/min.

Aimed at users who want to minimize their on-line costs and don't require an immediate hard copy printout, the combination functions as a remote-computing terminal arrangement. Among the areas of application are centralized order processing from many outline locations, multi-location inventory control, price and delivery quotations on sales



Station arrangement includes Teletype 38 wide platen ASR terminal and Model 4210 magnetic tape data terminal.

orders, traffic control, routing information for transportation or carrier industries, and other data processing systems requiring a remote or even local batching environment.

With the automatic rewind feature on the 4210, the user can place the unit in an unattended answer mode and receive data at high speeds during low line-rate hours. Once the data batch has been re-

ceived, the 4210 will automatically rewind the magnetic tapes to the beginning of the transmission, turn on the printer and reproduce the data via hard copy at 100 words/min. When all data has been printed, the printer is again automatically turned off and the 4210 switches itself back to the unattended answer mode and is ready to receive additional data.

This station arrangement includes a punched paper tape system and a built-in low-speed modem (comparable to Bell System's 101, 103, and 113 data sets). The modem, about \$200, is scheduled for delivery in the fall. The 38 ASR ranges from \$1,400 to \$1,450 while the 4210 mag tape data terminal is from \$2,200 to \$2,475.

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If you think a cassette's place is in the home, you haven't seen our data recorders at work.

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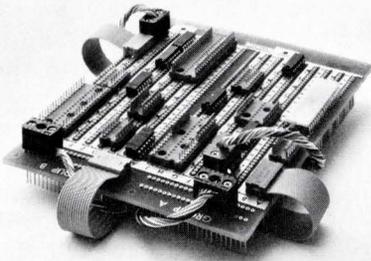
For more on them and our R-70, write or call Ken Williamson, Director of Marketing, Technical Products, TEAC Corporation of America, 7733 Telegraph Rd., Montebello, CA 90640. Phone (213) 726-0303.

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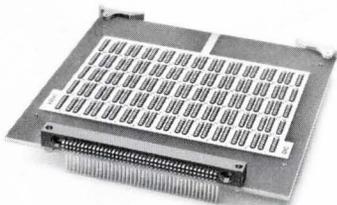


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Circle Reader Service #32

DC-16

DATA COMMUNICATIONS PRODUCTS

DATA MODEMS

The DM1800 L provides Bell 202D compatible operation on four wire, type 3002 private lines up to 1800 baud. The DM1800 S functions at 1800 baud on two or four wire private lines and up to 1200 baud on the switched network when connected to a CDT data access arrangement. Standard features include soft carrier turn-off, clear-to-send delay, carrier detect, and MARK hold on received data when carrier is lost. DM1800 L, \$210. (quan. 100); DM1800 S, \$264. (quan. 100); 45-day del. RFL Industries, Inc., Boonton, N.J. 07005.

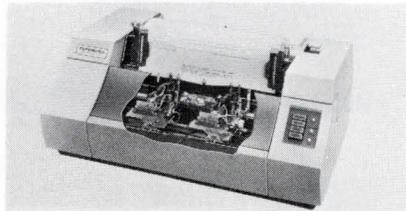
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BIT ERROR TEST SET

This test set consists of a pseudo-run-down noise pattern generator and independent receiver. The Model 7090 used to measure and display bit errors produced by magnetic-tape recorder/reproducers of comm. equipment, PCM/bit synchronizers, etc. It generates a 2047-bit pseudo-random pattern compatible with IRIG document 118-71 and provides PCM codes compatible with IRIG Document 106-71. Price <\$2,600. 60 day delivery. Coded Communications Corp., Box 767, 553 Stevens Ave., Solana Beach, Calif. 92075.

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MATRIX PRINTER



This line printer uses 9 x 7 dot matrix to form characters at speeds of 125 lines/min. for 132 character lines. Standard features include paper run-away control, manual line spacing, hardware code selector, 64 character input, and transmission of up to 75,000 char/s in the parallel mode. \$5390 (single). Centronics Data Computer Corp., One Wall St., Hudson, N.H. 03051.

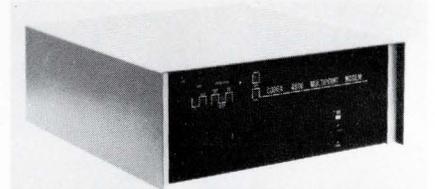
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INTERFACE DATA MONITOR

An EIA compatible data communication interface monitor reduces downtime. Functioning at the interface between the data terminal equipment and the modem, the DM 108 operates as a sensing element, without interfering with system operation. It includes its own internal power supply and remote indicator panel. Although optional panels can monitor up to 14 EIA interface signals, the std unit monitors data transmit, data receive, request to send, clear to send, data terminal ready, data set ready, carrier detect, on or off. \$300 (in small quan.). ESL Inc., Electromagnetic Systems Labs, 495 Java Dr., Sunnyvale, Calif. 94086.

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Claimed as the fastest automatic equalizing 4800 bit/s modem available, this unit was designed specifically for multipoint polled applications. The auto-equalization time is 50 ms. The Codex 4800-MP's speed approaches the synchronizing setup time of manually equalized modems without manual adjustments. \$5,575. Stock delivery. Codex Corp., 15 Riverdale Ave., Newton, Mass. 02195.

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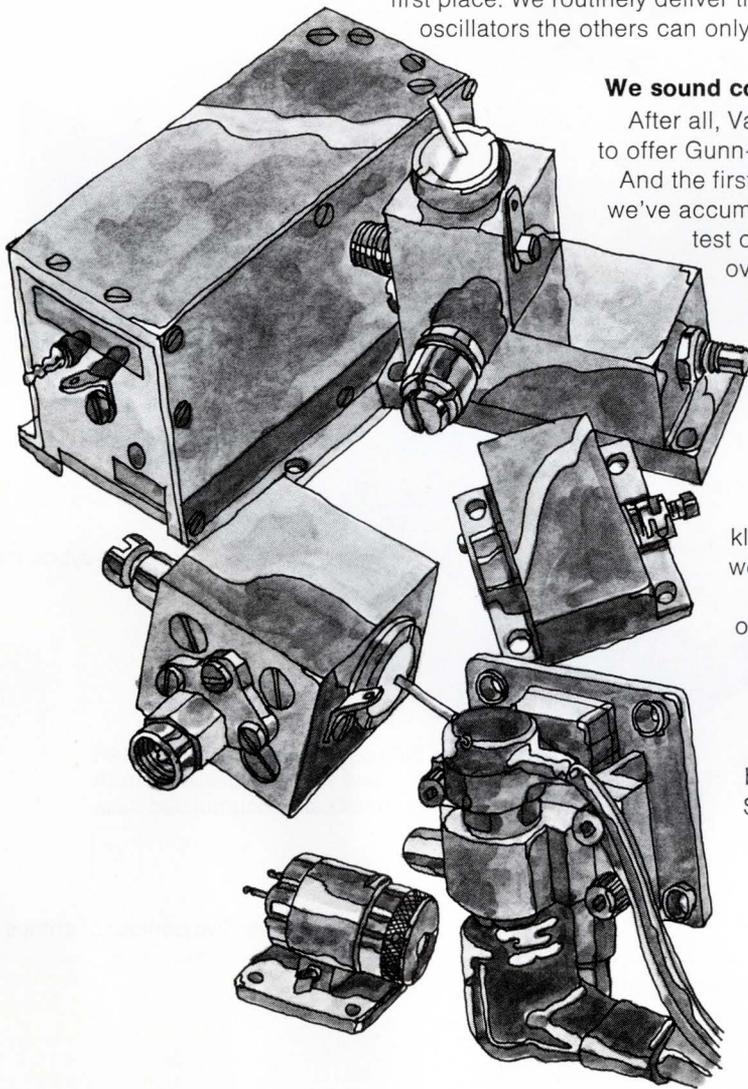
AUTOMATIC DIALER

This automatic dialer performs automatic dialing, control and answering functions for devices attached to the switched telephone network. The Omni-Dialer (either dial pulse or touch tone®) is a solid-state design contained on a single PC card providing OEM plug-in building block flexibility. It recognizes on/off hook, ring and busy states to assist in network control. Applied Technology Systems, Box 90121, Los Angeles, Calif. 90009.

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Single key summation of x , x^2 and n .



Two-key automatic summation of grouped data.



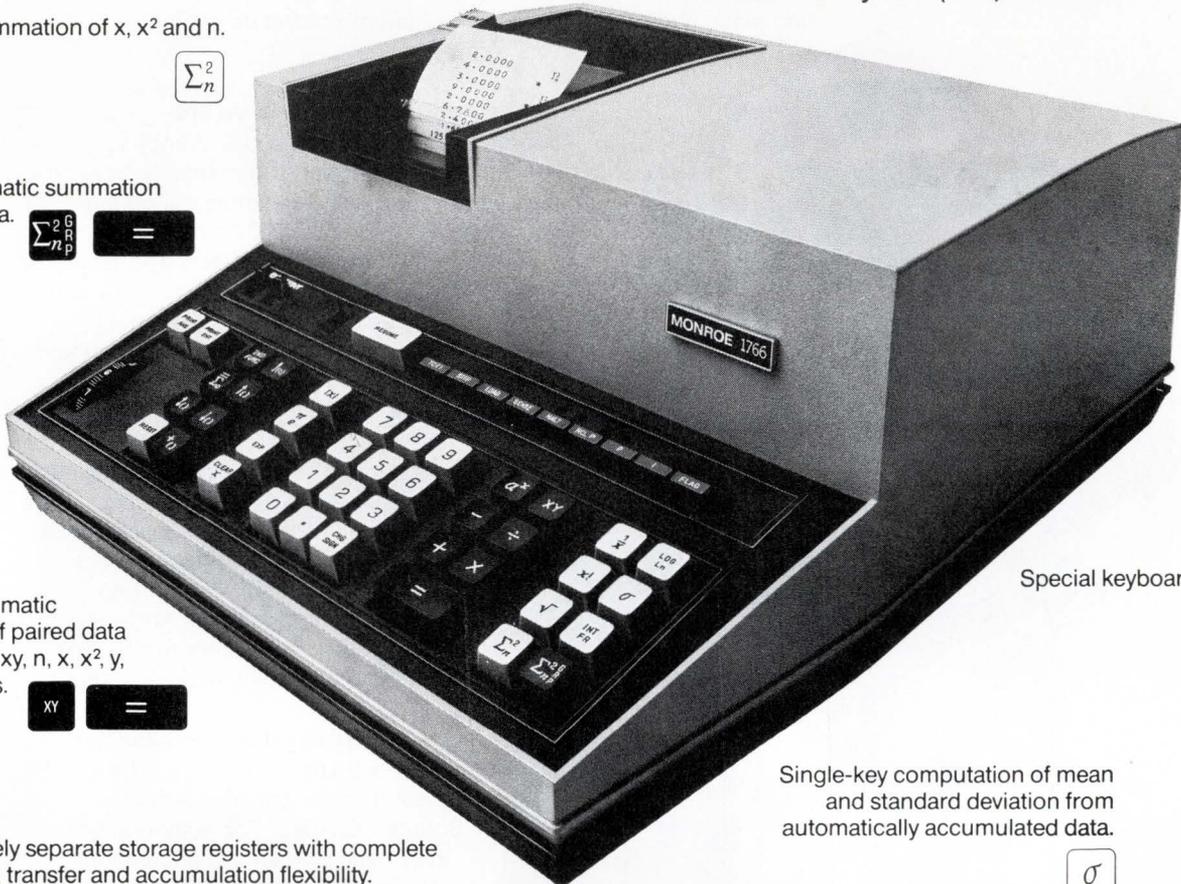
Two-key automatic summation of paired data accumulates xy , n , x , x^2 , y , and y^2 factors.



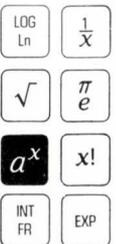
10 completely separate storage registers with complete entry, recall, transfer and accumulation flexibility.



Up to 256 steps of decision-making learn-mode programming. Accessory card reader available for automatic entry of programs.



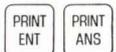
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DATA COMMUNICATIONS NEWS

Gigabit modem system . . . The practicality of a gigabit data rate system was demonstrated with a QPSK modem system, capable of operating at 1 Gb/s. Developed by Harris-Intertype Corp.'s Radiation Systems Div., the system will interface with rf equipment at an L-band i-f frequency. Lockheed Research Labs., Palo Alto, plans to use the equipment in a laser satellite data link system.

Circle Reader Service #280

Nationwide teleprocessing network selected . . . A \$43 million contract has been awarded to Computer Sciences by the General Services Administration to provide an advanced teleprocessing network for Federal agencies. Volume usage could result in a 40% cost reduction in applications and systems requiring access to a common data base by multiple government users through high- and low-speed terminals, in both interactive and remote batch operation. DoT, HUD, NASA, and NBS were among the agencies participating in the GSA studies, prior to selecting the CS INFONET system.

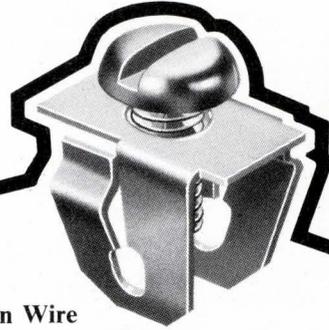
Communications week . . . Symbolizing the growth of communications, the Communications Systems Management Association (CSMA) is sponsoring the first National Communications Week on Sept. 25 through Sept. 29. In addition to nation-wide activities, CSMA plans a series of seminars and exhibits spotlighting equipment, communications trends, and the communications professional.

Circle Reader Service #281

Things are happening at GRI . . . Right on the heels of the award of a patent on its Universal Bus System architecture, GRI, the Newton, Mass. minicomputer manufacturer, signed an agreement to cover U.S. and Canadian maintenance. The initial agreement with Reliance Electric's Service Div. covers 18 major cities; it will be eventually extended to 50 cities. According to a GRI spokesman, the patent award allows the firm to consider possible legal action against some mini makers, including DEC and Lockheed, who GRI claims, use a similar bus system on some models, without benefit of patent protection.

This will really send you . . . The EIMAC Div. of Varian claims that their new 2-MW output super power tetrode is five times more powerful than any previous single amplifier ever built. It was developed for use in high-power transmitters, medium- and high-frequency broadcast service, and for industrial and scientific uses as a 1,000 A, 60-kV switch. In VLF service, two X-2159 tubes can produce 4 MW cw. The stage gain is 17 dB and maximum anode dissipation rating is 1.25 MW steady state. The \$20,000 tubes permit single stage amplification to an output power level of 2.5 MW, 100% modulated.

Circle Reader Service #282



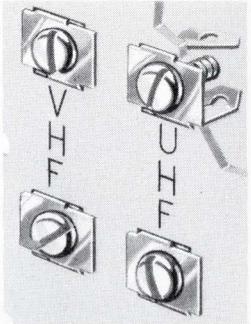
Snap-in!

Fastex® Snap-in Wire Terminal Clips

Speed wire hookups, save on labor and cut production costs. All you do is snap-in this Fastex terminal and attach the inside and outside leads. Simple, easy, fast.

Fastex has a wide variety of styles and sizes to fit your application. The terminal comes pre-assembled with a captive screw. Also available preassembled in terminal boards. Circle that bingo card now for . . .

Free Samples and Literature

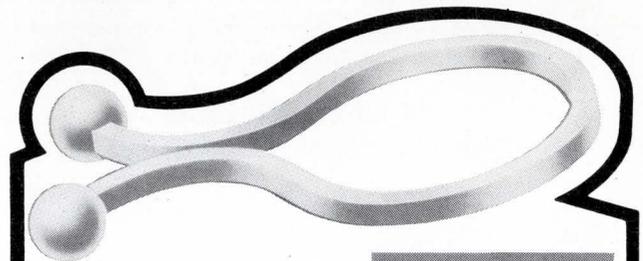


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Circle Reader Service #37

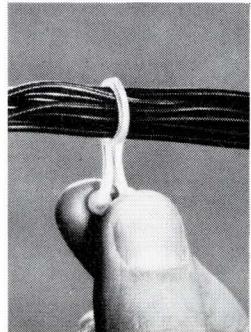


Quick Twist!

Fastex® Purse Lock™ Wire Tie

A quick finger twist securely wraps and fastens bundles of wires—or just about anything. And, they can be removed just as fast as they bundle. Variety of sizes to fit your application. Circle that bingo card now for . . .

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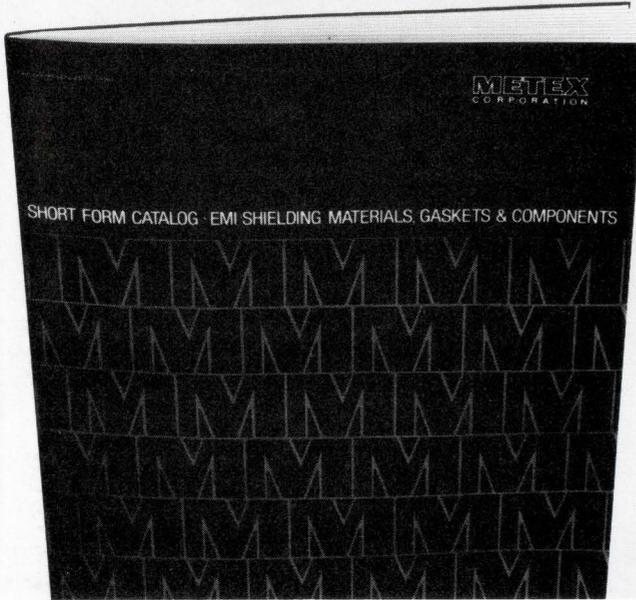
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Circle Reader Service #38

Now you can skip the EMI threat to the performance of your electronic packaging and products. Metex has all the answers—gasket materials that cover the entire product spectrum from commercial to ultrasophisticated. Thousands of Metex sizes and shapes on the shelf, including the versatile and effective Xecon® line. Write for free Design Guide. Metex Corporation, Edison, N.J. 08817. West Coast: Cal-Metex Corporation, Inglewood, California 90301.



Help your designs lead a shielded life.



Circle Reader Service #39

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How to shield your designs from EMI.

Reliable EMI strip-gasket protection

Designers and manufacturers of electronic packaging and products now have a new source for the most advanced elastomer gasketing material—Metex Corporation. Our newly added Xecon Polastrip delivers the best EMI shielding performance available in a solid homogeneous mass of extruded elastomer with consistent conductive cover pattern. To provide the best shielding characteristics, these gaskets are specially manufactured and supported in the electronic marketplace.

Another basic advantage: These gaskets give the basic material used provide the best physical change characteristics available in a homogeneous mass of extruded elastomer. Its recovery and compression characteristics are fully predictable. If you order on our low stock levels, our 72-hour delivery service will get you the low quantity quantities needed. Our CE-16 material performs best at higher temperatures for high frequency signals.

Xecon Polastrip is regularly available in stock in 2, 4, 6 and rectangular cross-sections described on the pages on this page, also in the inside flap of this guide.

In addition, any alternate cross-sections can be produced on special order.

Performance you can count on.

Typical shielding effectiveness.

Compression-deflection characteristics.

Compression set characteristics.

Metex Polastrip from Metex offers these advantages:

- homogeneous EMI and environmental protection.
- Many cross-sections readily available from stock.
- Excellent shielding effectiveness in a thin compression deflection and recovery.
- They are priced minimal with no practical limit on strip length.
- Ease of installation.
- Ease of design.

Material	CE-16	CE-14	CE-12
Thickness (inches)	0.030	0.030	0.030
Width (inches)	0.500	0.500	0.500
Length (feet)	100	100	100
Weight (pounds)	0.001	0.001	0.001
Part No.	CE-16-030-050-100	CE-14-030-050-100	CE-12-030-050-100

Circle Reader Service #39

DATA COMMUNICATIONS NEWS

New Associations . . . To meet the challenge of data communications, new groups are forming. One, the National Interconnect Association (NIA) will offer marketing and sales expertise to the so-called "little guy," according to NIA director Jason S. Schloss. In addition, the group offers an industry-wide purchasing service for discount buying. Future plans call for an information bureau to promote interconnect in approximately 50 markets, distribution of advertising materials, and national conferences and exhibits.

According to Jack Gerber, VP for Marketing at Milgo's International Communications Corp., ICC may spearhead the formation of a user's group within the next two months. The group might supplement the activities of the Independent Data Communications Manufacturers Association, founded by Paradyne, ICC, and others.

For NIA, **Circle Reader Service #283**

For ICC, **Circle Reader Service #284**

Power to the people . . . Two three-day conferences, sponsored by North Electric, will cover the in's and out's of telephone power engineering. The seminars, Aug. 1 and Aug. 22, will investigate modern telephone power plant equipment, the optimum design of power plants, and service and maintenance.

Circle Reader Service #285

Correct billing, electronically . . . A new electronic metering system, developed by Vidar Corp., looks like the answer to precise billing problems, especially in timesharing and remote batch applications. Vidar, which has just landed a more than \$20 million contract with the New York Telephone Co., will directly affect some 3.6 million telephones with their service. The Local Message Metering System relies on electronic scanning to monitor all calls for subscriber numbers, the length of call, and time of day.

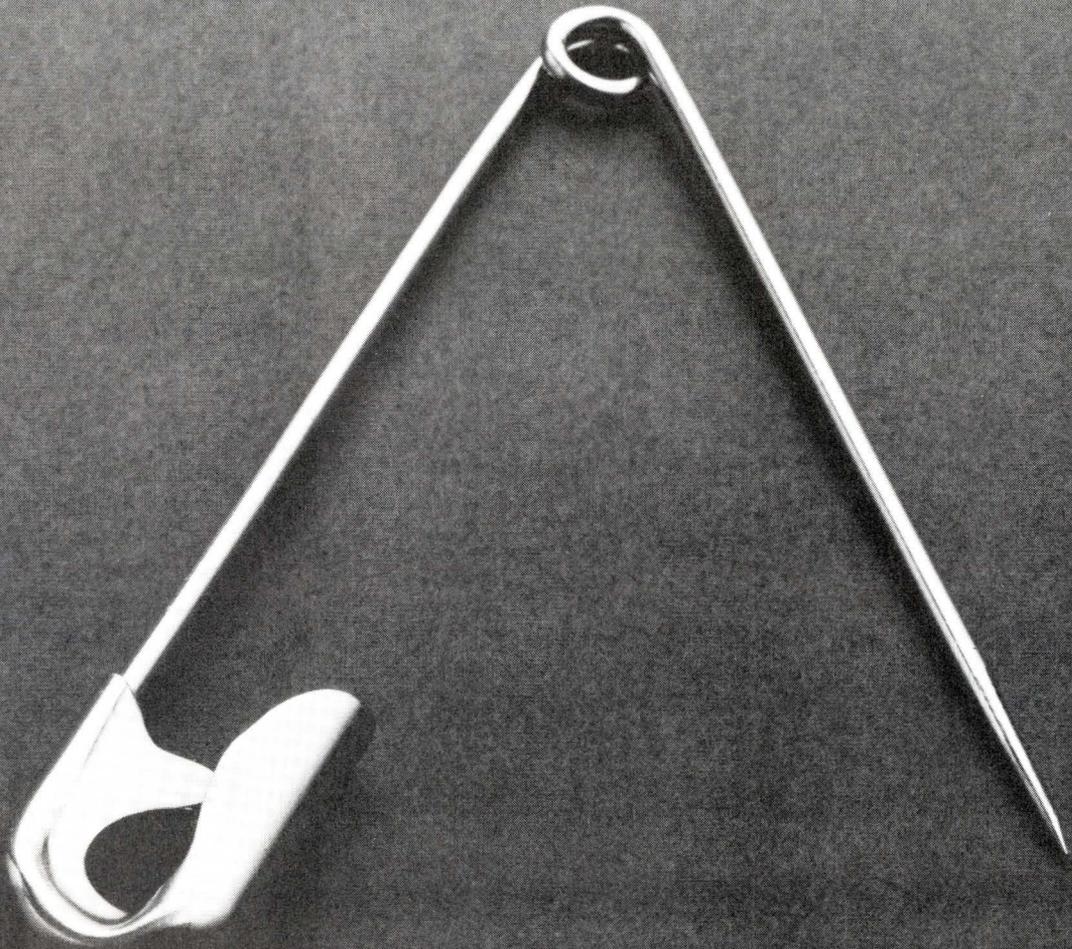
Circle Reader Service #286

Want tariff information . . . For those who are battling the bewildering mass of schedule rates and tariff information, a new service may help. The Center for Communications Management, Inc., offers intrastate tariffs of all states at a price cheaper, they claim, than if the material was acquired from state agencies. In addition, they promise a complete update service.

Circle Reader Service #287

Bits and bytes . . . Digital Equipment Corp. cut prices on the PDP-11 by 13-24%. Also, the DEC 30 char/s data terminal and core disk memory are available at lower prices.

Dr. George F. Mansur joined Martin Marietta's Orlando Div. as Director of Engineering, Communications and Electronic operations. Dr. Mansur was formerly deputy director of the White House's Office of Telecommunications Policy.



It's as simple as a PDP-8.

Anyone can interface a PDP-8. You just plug everything into the OMNIBUS.TM Anywhere. In any order. Any time.

Now if you want to write PDP-8 software you have to know programming. But you don't have to know much. PDP-8 is one of the easiest to program computers ever made. And it has the biggest library

of minicomputer software in the world. So you might not need any new software anyway.

Where you might want some help is in selecting the peripherals. There are over 60 standards to pick and choose from. Plus specials.

But you won't have to waste time figuring out if the PDP-8 can do your job. Every job being done by minicomputers is being done by a

PDP-8. And it'll do your job for a long, long time. PDP-8's have been known to run flat out, 24 hours a day, 7 days a week, for two years straight.

You see, when you get a PDP-8, you won't get stuck.

Digital Equipment Corporation, Maynard, Mass. 01754. (617) 897-5111.

digital

Circle Reader Service #40

SYSTEM PRODUCTS

DIGITAL CASSETTE HEADS

A series of Mini-Digital read/write cassette heads for 0.150 in. to meet the needs of OEM's manufacturing digital cassette recorders and systems for computer peripherals and other data applications. Three styles are available covering three ranges of precision and, accordingly, three price ranges. Nortronics Co., Inc., 8101 Tenth Ave. N., Minneapolis, Minn. 55427. (612) 545-0401.

Circle Reader Service #240

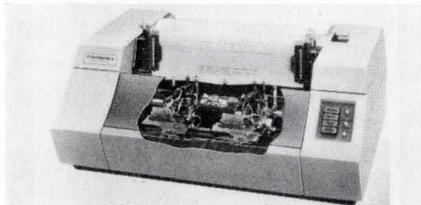
NON-IMPACT PRINTERS



Armed at the mini-computer user's need for low-cost hard copy, these non-impact printers have a 50% lower price than comparable impact printers. The LP-860 (\$3,900) is an 80 column unit that prints 5 x 7 char. up to 600 lines/min. on 8 1/2 in. wide paper. The LP-1150 (\$4,300) is a 132 column printer which prints 7 x 9 char. at 500 lines/min. on 11 in. wide paper. Versatec, Inc., 10100 Bubb Rd., Cupertino, Calif.

Circle Reader Service #241

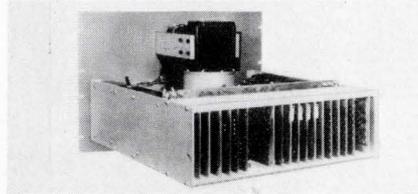
LINE PRINTER



The Model 102B prints 9 x 7 dot matrix characters at speeds of 125 lines/min. for 132 char. lines. Two printing heads which operate in unison and print in both directions account for the high speed. \$5,390 ea., with OEM discounts. Standard features include paper runway control, manual line spacing, hardware code selector, 64 character input, and transmission of up to 75,000 char./s in the parallel mode. Centronics Data Computer Corp., One Wall St., Hudson, N.H. 03051.

Circle Reader Service #242

262K DISC SYSTEM



The DU-1 disc and DC-1 disc controller are compatible with the PDP-8 series and D-112 12-bit computers, plus the RF08 disc system. Each DU-1 disc unit has a max. storage capacity of 4 megabits or 264,144 individually addressable 13-bit words. Average access time for the disc is 8.4 ms with a max. 2 megabit transfer rate. Digital Computer Controls Inc., 12 Industrial Rd., Fairfield, N.J. 07006.

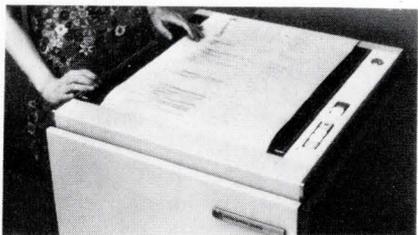
Circle Reader Service #243

WIDEBAND MIXER

The MX12056 has an input freq. range of 4.6 to 10.6 GHz; the i-f range is 1 to 2 GHz. Mixer is for up or down converters, modulators, or phase detectors. It is particularly useful as a broadband first converter in ECM receivers. Over the full range, conversion loss is 9 dB, but it is typically under 7 dB from 5.6 to 10.6 GHz. Isolation is 20 dB min. The 3/4 x 3/4 x 3/8 in. package weighs < 1 oz. Price is \$750.00; del. 30 days. Aertech Industries, 825 Stewart Dr., Sunnysvale, CA. 94086. (408) 732-0880.

Circle Reader Service #244

PRINTER/PLOTTER



This electrostatic printer/plotter features a 14 in. wide format and will operate as an on-line peripheral to all widely used mini-computers. Capabilities of the Status® 31 include plotting a 14 x 11 in. plot of any complexity in 5 s; line printing at 1000 lines/min. in virtual silence and simultaneous plotting and printing of alphanumeric annotations. Varian Data Machines, 2722 Michelson Dr., Irvine, Calif. 92664.

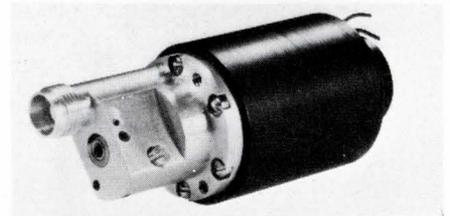
Circle Reader Service #245

NEW SOFTWARE

Microdata now offers simulator SIM16F and cross assembler AP1600 for the Micro 1600 minicomputer. Both are written in a limited subset of FORTRAN IV for operation on large-scale computer systems and are intended as an aid in firmware development. Microdata Corp., 644 E. Young St. Santa Ana, Calif. 92705.

Circle Reader Service #246

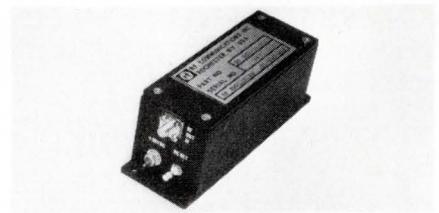
TUNABLE MAGNETRONS



Miniature mechanically-tuned pulsed magnetrons are designed to produce negligible freq. shift and overall reliability under severe environmental conditions. The BLM-167 delivers 1 kW peak power in range of 5.2 to 5.7 GHz; weight, 11 oz. BLM-190 delivers 750 W peak over 5.4 to 5.9 GHz; weight, 7 oz. BLM-149 delivers 450 W peak over 5.4 to 5.9 GHz; weight, 11 oz. BLM-195 delivers 700 W over 9.20 to 9.55 GHz; weight, 7 oz. Cooling is conduction. Varian, Eastern Tube Div., Salem Rd., Beverly, Mass. 91915.

Circle Reader Service #247

WIDEBAND AMPLIFIER



The RF-807-56 covers a range of 10 kHz to 500 MHz with +20 dBm output and flatness of ± 1 dB. The 3 dB points are typically 5 kHz and 600 MHz with usable amplification available over even wider limits. Gain of the unit is 30 dB min. and noise figure is typically 6 dB. RF Communications, Inc., 1680 University Ave., Rochester, N.Y. 14610.

Circle Reader Service #248

For all types of $\frac{1}{4} \times 1\frac{1}{4}$ " fuses and fuseholders:

BUSS YOUR ONE SOURCE

Normal Blowing Fuses

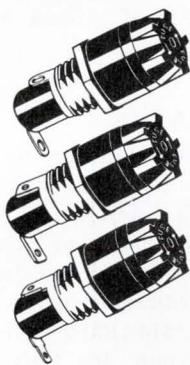
AGC GLH MTH
From $\frac{1}{500}$ to 30
amps, for 32V, 125V,
or 250V

Time Delay Fuses

MDL MDX
From $\frac{1}{100}$ to 30 amps,
for 32V, 125V, or 250V

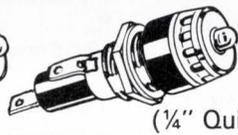
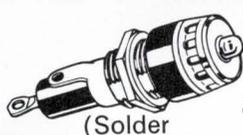
Visual Indicating Fuse

GBA (Red Indicating
Pin)
From $\frac{3}{4}$ to 5 amps,
125V



Space-Saver
—projects only one
inch behind panel

HTA (Solder
Terminals)
HTA-HH ($\frac{1}{4}$ "
Quick-Connect
Terminals)
HTA-DD ($\frac{3}{16}$ "
Quick-Connect
Terminals)



HLD (Solder Terminals) **HLD-HH** ($\frac{1}{4}$ " Quick-Connect Terminals)
Visual Indicating Fuseholder



HKP (Solder Terminals) **HKP-HH** ($\frac{1}{4}$ " Quick-Connect Terminals)
The Fuseholder for All-Purpose Applications



HKL (Octagon Knob) **HKL-X** (Flat-Sided Knob)
Lamp Indicating Fuseholder

FUSEHOLDERS

All Have These Features in Common • Rated for 15 amps at 250 volts • Dielectrically capable of withstanding 1500 volts a.c. between terminals and between terminals and panel • Bayonet-type knob grips fuse so that fuse is withdrawn when knob is removed; strong compression spring assures good contact • Made for installation in D-hole to prevent turning in panel • Terminals are mechanically secured as well as soldered in holder

This is only a sampling — use the coupon below to get a full description of the complete BUSS line of fuses and mounting hardware.

BUSSMANN MFG. DIVISION, McGraw-Edison Co.
St. Louis, Missouri 63107 EE-672

Please send me a copy of BUSS Bulletin SFB

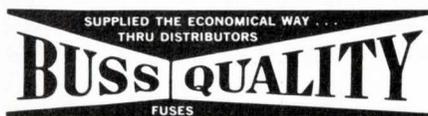
Name _____

Title _____

Company _____

Address _____

City _____ State _____ Zip _____



COMPREHENSIVE FM/IF SYSTEM

The CA3089E gives you all the functions of a comprehensive fm/i-f system including i-f amplifier, quadrature detector, AF preamplifier, and specific circuits for AGC, AFC, muting (squelch), and tuning meter. It's aimed at fm/i-f amplifier applications in high-fidelity, automotive, and communications receivers. RCA Solid State Div., Box 3200, Somerville, N.J. 08876.

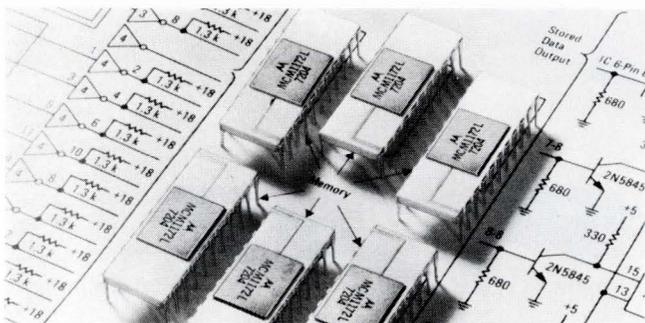
Circle Reader Service #330

NEW ECL DEVICES INCLUDE 200-MHz SR

Here's four new MSI devices in the 9500 family of temperature-compensated ECL products from Fairchild. The 95H00 is a 4-bit universal shift register, with a 200 MHz typical shift rate. Other new devices in the line include the 95H55, high speed 5-bit comparator, 9580 triple 2-input multiplexer and the 95H28, a high-speed version of the 9528 dual-D flip-flop. Fairchild Semiconductor Components Group., 464 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #331

RAMs FOR EXPANDABLE MEMORIES



Both the MCM1172L and the MCM1175L dynamic MOS RAMs are 1024-bit memories. They have a wired-OR capability for memory system expansion in multiples of the 1024 x 1 and a chip select input provides address expansion. Along with the already introduced MCM1173L, these devices provide full second sourcing for the AMS6001 and 6002 memories. The pin-for-pin equivalents are the MCM1172L for the AMS 6001-6C, MCM1173L for the AMS 5001-6D, and MCM1175L for the 6002. Technical Information Center, Motorola Inc., Semiconductor Products Div., Box 20924, Phoenix, Ariz. 85036.

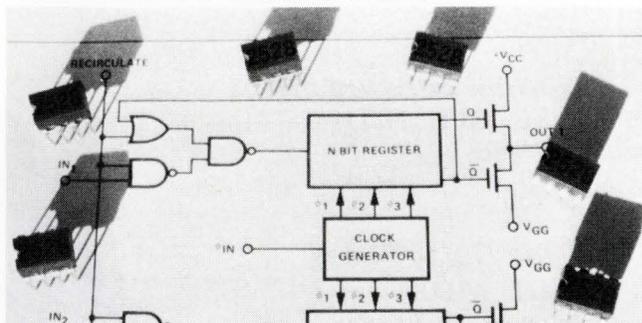
Circle Reader Service #332

RAM FEATURES 150 ns ACCESS

The TMS4062JC, a 1024-bit dynamic RAM, features an access time of 150 ns and a cycle time of 250 ns. The non-critical timing of the device also simplifies the design of a memory system. It uses a three clock configuration with no clock overlap window. Differential current sensing of the output permits a high common-mode noise rejection. The TMS4062JC is a pin-for-pin equivalent to the AMS6002 and is priced at \$10.50 in 1000-pc quan. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, MS/308, Dallas, Tex. 75222.

Circle Reader Service #333

LONG STATIC SHIFT REGISTERS



These three long MOS static shift registers are aimed at digital cassette recorders, delay lines, line storage for CRT refresh memories and low-cost static buffer and sequential access memories. The Model 2527 is a dual 256-bit shift register, the Model 2528 is a dual 250-bit register, and the 2529 is a dual 240-bit version. All three circuits are said to be among the longest static shift registers available on the open market. All three registers are in 8-pin plastic dual-in-line packages. Price \$9.20 ea. (100-999 quan.). Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #334

1103 WITHOUT TIMING CONSTRAINTS

The 3534/1103 serves as a pin-for-pin replacement for the 1103 while eliminating the critical system timing requirements usually associated with that device. This version uses four transistors interconnected to form a latch similar to the flip-flop circuitry used in static memories. Although this design increases cell area, it eliminates the critical precharge and chip enable overlap timing requirement. \$14 (100-999). Fairchild, Semiconductor Components Group, 464 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #335

REGISTER SHIFTS AT 10MHz

Ion implanted 1024-bit multiplexed MOS dynamic shift register is available as a single 1024, dual 512, or quad 256-bit unit. It meets mil-spec temperature range, driven by TTL or DTL, drives MOS and bipolar, and dissipates 150mW at 25°C for 5MHz with 25% duty cycle clocks. Clock capacitance is 100 pf. HDSR 1024, \$20 in 100 qty.; stock. Hughes, 500 Superior, Newport Beach, Ca 92663.

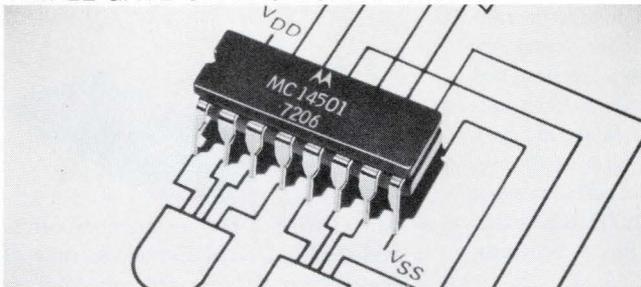
Circle Reader Service #336

CMOS TRIPLE BI-PHASE PAIRS

This triple AND-OR bi-phase pair, designated the CD4037A, can be used for data coding and decoding in split-phase (bi-phase) communication systems; disc, drum, and tape digital recording systems; plated wire and core memory systems; or as a high-to-low logic level converter. It comes in a 14-lead dual-in-line ceramic package (CD4037AD), a 14-lead dual-in-line plastic package (CD4037AE) or a 14-lead flat pack (CD4037AK). Prices at 100-unit level are CD4037AD, \$7.38; CD4037AE, \$3.60; CD4037AK, \$8.16. RCA Solid State Div., Box 3200, Somerville, N.J. 08876.

Circle Reader Service #337

TRIPLE GATE OFFERS DUAL FUNCTIONS



The MC14501AL/CL CMOS logic device has both a 2-input NOR/invert gate and two 4-input NAND gates. You can also derive more complex functions by interconnecting some of the device pins externally. For example by properly biasing the gate with one external pin interconnection, a 2-, 3-, or 4-input AND function is available. Using two external pin interconnections, up to an 8-input AND/NAND function can be implemented. The MC14501AL version operates from a supply voltage of 3 to 18 Vdc, and over -55 to 125°C . The MC14501CL operates from a supply of 3.0 to 16 Vdc and -40 to 85°C . Off-the-shelf prices (1-24) are: \$2.97 and \$6.50 (1-24). Technical Information Center, Motorola Inc., Semiconductor Products Div., Box 20924, Phoenix, Ariz. 85036.

Circle Reader Service #338

16,384-BIT MOS STATIC ROM

The EA4800 uses low-voltage, enhancement-mode, p-channel technology. It operates on $+5\text{-V}$ and -12-V power supplies, and is TTL compatible. The outputs can be wire-OR'd for memory expansion. Organization is either 2048, 8-bit words or 4096, 4-bit words. Address decoding is on-chip. Access time, $1.2 \mu\text{s}$ max.; 0.032-mW/bit max. dissipation. The EA4800SG, in a 24-pin silicone package, costs \$52.50 ea. in 100-pc. lots. Electronic Arrays, 501 Ellis St., Mountain View, Calif. 94040.

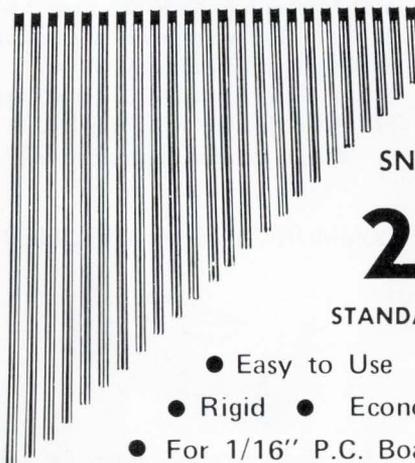
Circle Reader Service #339

CMOS REGISTER

The CD4034A is a static eight-stage parallel- or serial-input, parallel output register. It features bidirectional parallel data input, parallel or serial inputs/parallel outputs, asynchronous or synchronous parallel data loading, parallel data-input enable on "A" data lines, data recirculation for register storage, multi-package register expansion, and fully static operation from dc to 5 MHz. \$15 (100-pcs) in a 24-lead ceramic DIP (CD4034D) or \$18 for 24-lead flat pack (CD4034AK). RCA Solid State Div., Box 3200, Somerville, N.J. 08876.

Circle Reader Service #340





CARD GUIDES

SNAP-IN STYLE

24

STANDARD LENGTHS

- Easy to Use
- Rigid ● Economical
- For 1/16" P.C. Boards
- Molded from reinforced Nylon
- 2 1/2" thru 14" Lengths (1/2" increments)
- Snap into metal plates .047"/.090" thick with .172 dia. holes (11/64 Drill size)



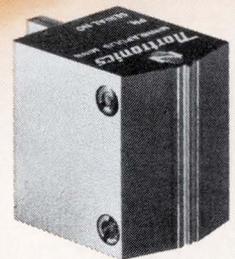
BIVAR, INC.

1500 South Lyon Street
Santa Ana, Calif. 92705
(714) 547-5832

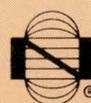
Circle Reader Service #42

Designing high-speed drives?

Consider Long-Life LTC™!



Nortronics' new LTC (Life Time Ceramic) digital heads extend head life ten times, cut replacement costs and eliminate the frequent electronic field adjustments normally required with conventional designs used in modern, high-speed tape drives. The secret? Nortronics tough, new ceramic finish which is permanently applied to the face of digital heads. LTC is another example of Nortronics innovation—a significant breakthrough in magnetic head reliability and long-term survival. Write or call today for detailed information.



'world's leader in magnetic heads'

NORTRONICS
COMPANY, INC.

8101 Tenth Avenue North
Minneapolis, Minnesota 55427 • (612) 545-0401

Circle Reader Service #43

Circuit Savers



AC CROWBARS

Here's low-cost, positive protection from destructive surges for your AC equipment. Model LVC-1L Crowbar switches to short circuit on overvoltage, recovers on polarity reversal, operates on either polarity. Trip voltages to 270V, current to 35A RMS, operating time only 10 usec, temperature range -40 to +100°C. For specs, applications, prices, request Bulletin 12.

Full line of protection modules for every hi-lo voltage/current requirement. Write or call for data.

279 Skidmore Rd., Deer Park, N.Y. 11729
Telephone: 516-586-5125

MCG Electronics

Circle Reader Service #45

SYSTEM PRODUCTS

MEMORY TESTERS

These units test semiconductor random access memories under actual operating conditions. They were designed for the end user who needs an economical method to screen out faulty memory circuits prior to pc board assembly, thus, minimizing the costly rework cycle. Prices \$4000 to \$6000; 6 wks del. Creative Systems, Inc., Box F, Stafford, Tex. 77477.

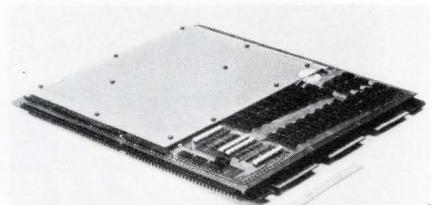
Circle Reader Service #341

4K x 18 CORE MEMORY

Here's a complete magnetic core memory system (4K x 18) on a single pc card. You can get the memory in two configurations, as a complete single board memory system that includes the timing and control function, or with a separate timing and control card that will drive up to eight 4K x 18 digital stack boards. Datacraft Corp., Box 23550, Ft. Lauderdale, Fla. 33307.

Circle Reader Service #342

CORE CONSUMES 0.11mW/BIT



This 3 wire, 3-D core memory offers a cycle time of $1.2\mu\text{s}$ and access time of 550ns. Worst case power consumption is 0.11mW/bit in a 65K x 40 configuration. 16-64K/40 and 32-131K/20 available. MICROMEMORY 600 from Electronic Memories, 12621 Chadron, Hawthorne, Ca. (213) 644-9881.

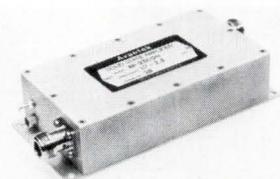
Circle Reader Service #343

OPEN FRAME POWER SUPPLY HAS FERRORESONANT REGULATING TRANSFORMER

The LQ series comes in 19 models with up to 48 V and up to 40 A. The 6000 series has eight single output models, from 5 to 28 V and from 5 to 40 A, and four dual output models from 12 V to 23.5 V and from 6 to 24 A. Prices from \$110 to \$160. They drive the LAS 2000 series or any other regulator like the LM 309 or the μA 723. The LQ series 5000 contains seven single output models from 6 to 48 V and from 2.5 to 25 A. These will power transistors, lights, and relays directly. Prices from \$100 to \$125. Lambda Electronic Corp., 515 Broad Hollow Rd., Melville, N.Y.

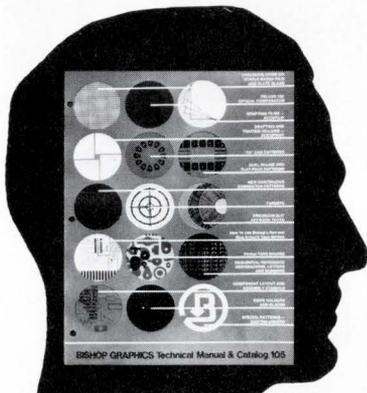
Circle Reader Service #344

COMMUNICATIONS AMPLIFIER



A +30-dBm power output for 1-dB gain compression across any 200-MHz portion of the 1.7-2.3 GHz range is featured in the AP-2300N all-solid-state amplifier. Output is +27-dBm across the full band. Gain flatness from 1.7-2.3 GHz is ± 1 dB, and the amplifier has a 10-dB (max.) noise figure. AvanteK, Inc., 2981 Copper Rd., Santa Clara, Calif. 95051.

Circle Reader Service #345



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Circle Reader Service #44

Scanbe takes the gamble out of the card game.

Our card files provide a sure thing for mounting your P.C. cards. The well known secret to Scanbe's system is the nylon guides with integral mounting feet to insure precise card/connector alignment. The guides are fixed on extruded aluminum bars between end plates or drawer frames. The extruded aluminum mounting bars offer exceptional rigidity, yet the files are rugged and lightweight.

Configurations are virtually unlimited . . . files, kits, drawers, both vertical and horizontal, and fully wired systems. Also, this truly universal system offers any card/connector combination, any card spacing with single and multi row designs.

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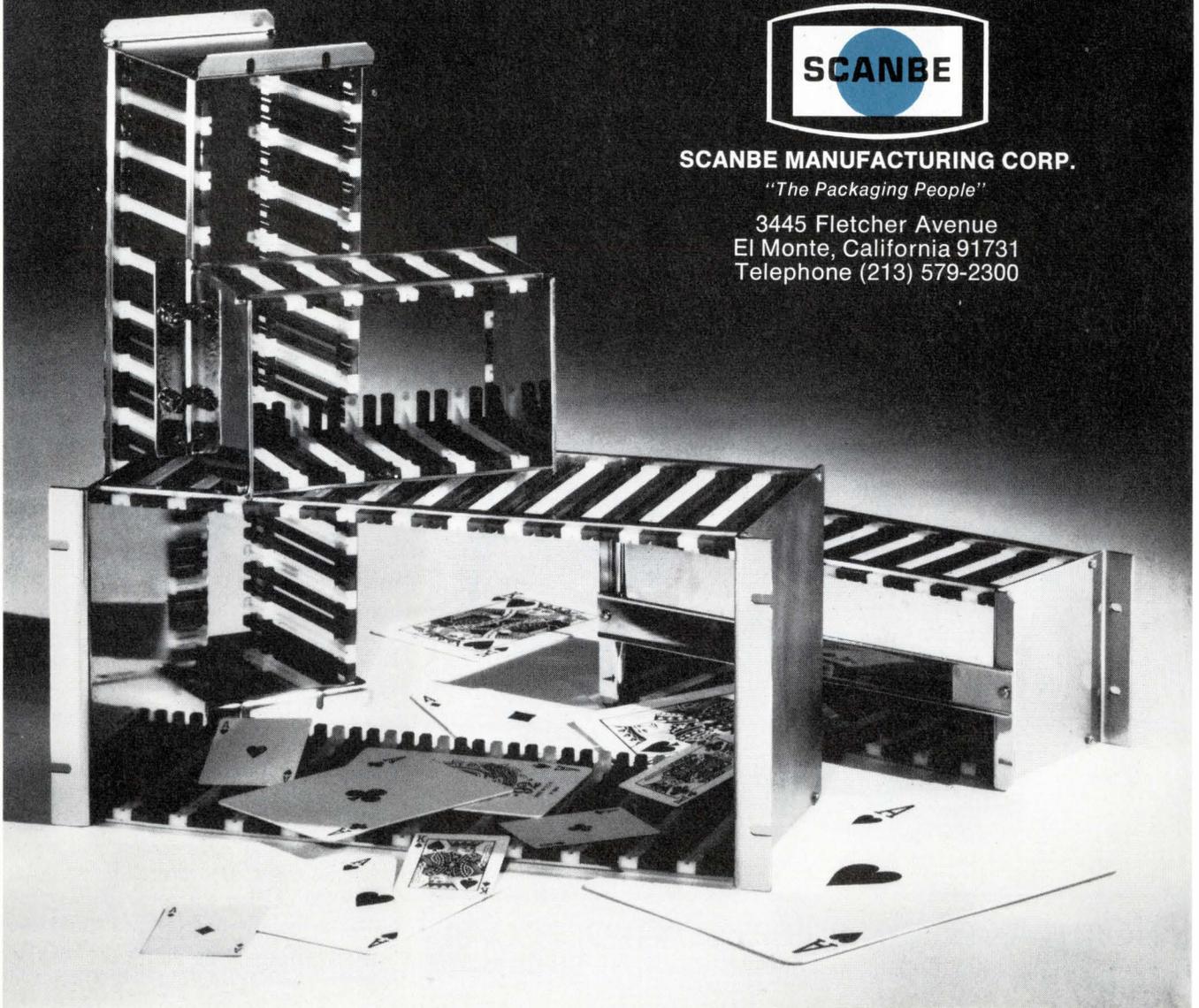
For the solution to your packaging problems, contact "The Packaging People" at Scanbe.



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Telephone (213) 579-2300



Name your stepper motor needs. Chances are we can meet them. Off-the-shelf.

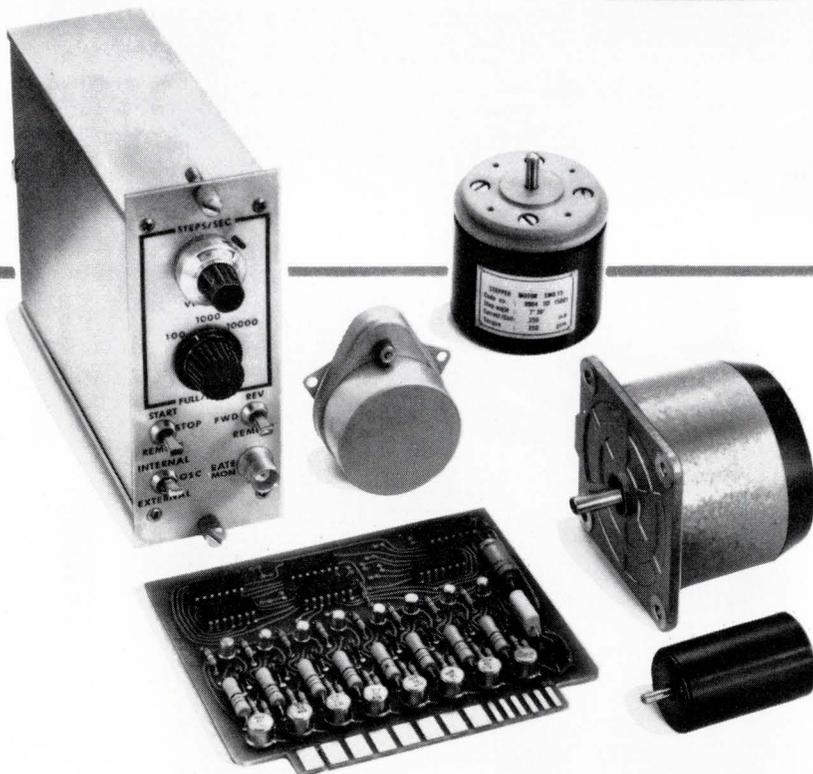
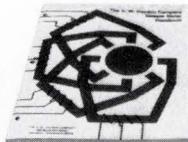
Whatever your design requirements . . . step angle, stepping speed, torque, direction of rotation . . . yes, even price . . . you can save time and money by talking to THE Stepper Motor People first. The A. W. Haydon stepper motor line is one of the most complete, most versatile and most economical available.

We offer you a total capability ranging from the simple to the sophisticated . . . from low-cost 2-phase pulse steppers at \$5.94 to more complex, 8-phase digital models costing up to \$67.75 in quantities of 100. Inexpensive logic cards, variable speed drives

or specially designed systems engineered to your requirements are also available.

Step angles? Name them. With our pulse steppers, you have an unlimited selection. As for our digital models, you can specify angles of $3\frac{3}{4}^\circ$, 7° , 15° , 30° , 45° , or 90° , pull-in rates to 1200 steps/sec and torque to 22 oz-in.

Mind you, this is all off the shelf. So, why shop around? **Write For Stepper Motor Handbook** Here's a clear, concise exposition of the why's and wherefore's of PM stepper motors. It's a MUST for every system designer. Send for it.



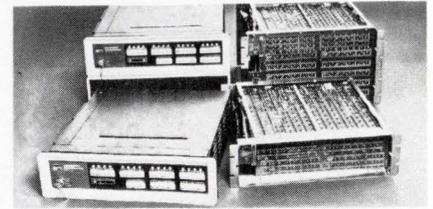
A. W. HAYDON CO. PRODUCTS

NORTH AMERICAN PHILIPS CONTROLS CORP.

A NORTH AMERICAN PHILIPS COMPANY
Cheshire, Conn. 06410 • (203) 272-0301
Circle Reader Service #47

SYSTEM PRODUCTS

NAKED MINI GOES JUMBO



Designed as an OEM system component, this GP computer without power supply or control console has a 32K core memory, 1600ns cycle time, and accommodates up to 12 I/O interface cards. Standard features are hardware multiply/divide, three vectored priority interrupts, two direct memory channels, word and byte mode addressing and processing and 156 instruction set. Options are parity, TTY, powerfail restart, autoload, memory protect, direct memory access and real time clock. The ALPHA model has control panel and power supply. Jumbo ALPHA, \$15,600 each with 32K x 16 memory. Jumbo NAKED MINI, \$2,730 for 10, \$2,195 for 200 with 4K x 16; \$13,000 for 10, \$11,115 for 200 with 32K x 16. Computer Automation, 895 W. 16th, Newport Beach, Ca. 92660. (714) 642-9630.

Circle Reader Service #346

POWER SUPPLY MODULE



A new technique allows conversion of low freq. ac (47 to 440 Hz) to 50 W of regulated power in a package that measures only 4 x 6 x 2 1/4 in. Model Z2.5 delivers 2.5 A output. DC outputs between 24 and 30 Vdc are regulated to well within 0.15% for input changes of 100 to 132 Vrms and load changes of no load to full load. It is protected against short circuits of any duration. Features include remote error sensing and parallel operation. Delivery, 7 days; price, \$219.00 ea. for 1-4 pcs. Contact Roy Baldarrama, Abbott Transistor Lab., Inc., 5200 W. Jefferson Blvd., Los Angeles, Calif. 90016. (213) 936-8185.

Circle Reader Service #347

Variable compression
mica capacitors:

Small, Inexpensive, Wide-range, Go-anywhere Capacitance Packages

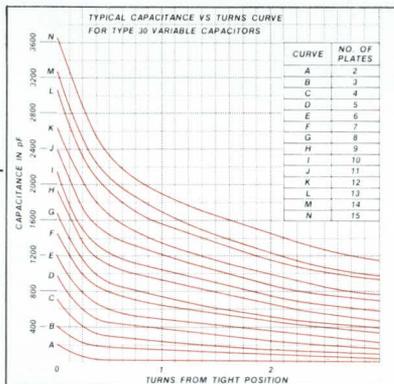
(Try 'em . . . you'll like 'em!)

Do you need a capacitor you can adjust from 1400 to 3055 pF (or almost *any other* range down to 0.9 to 7.0 pF)? As small as $\frac{3}{8}$ " x $\frac{1}{32}$ "? That mounts by *any* method, in *any* location, including PC applications? That has a high Q, smooth adjustment, low inductance, excellent thermal stability and resistance to shock, vibration and humidity?

And that you can buy in quantity, off the shelf, typically for 15¢ each?

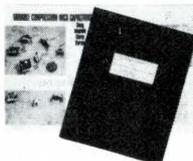
It will pay you to look into EI-Menco variable compression mica trimmers and padders—the “old reliables” whose highly developed characteristics and extremely wide line today make them the capacitors of choice in hundreds of state-of-the-art communications, instrumentation, audio and military electronics equipment. For example: in RF, oscillator and FM antenna circuits . . . HF bias (tape) from 85 to 95 kHz . . . phase control circuits . . . compensation for other components . . .

SSB 2.0 MHz channel strips. And perhaps one of these possibilities gives you an idea: coax cable line termination, pulse transmission, an equalizing/matching network, a low-Q tone generator, or padding in a TV circuit, power supply or home appliance.



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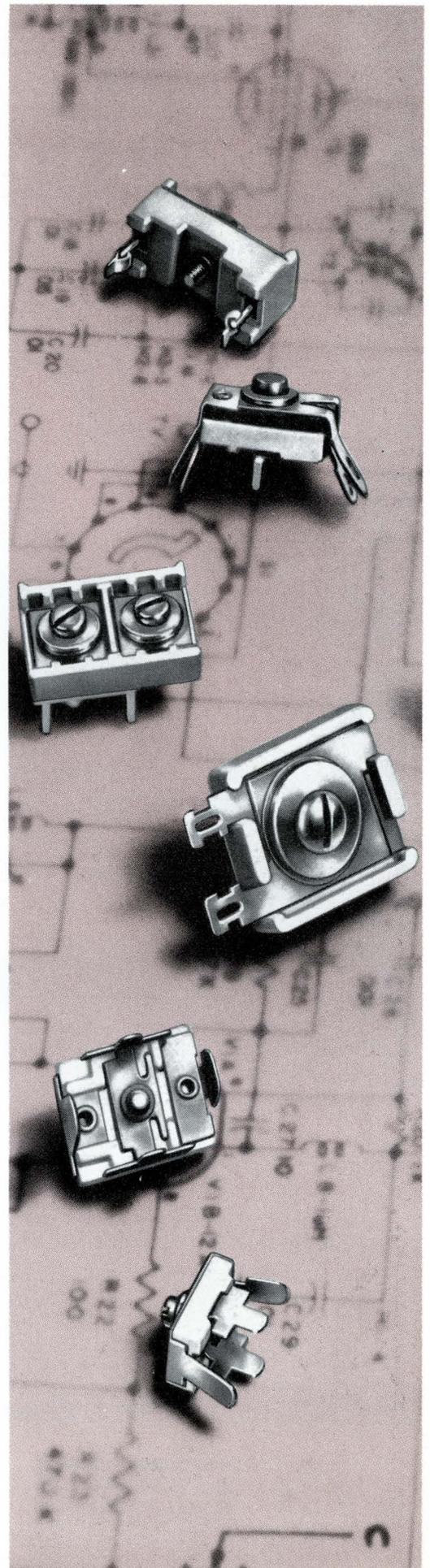
EI-Menco

THE ELECTRO MOTIVE MFG. CO., INC.

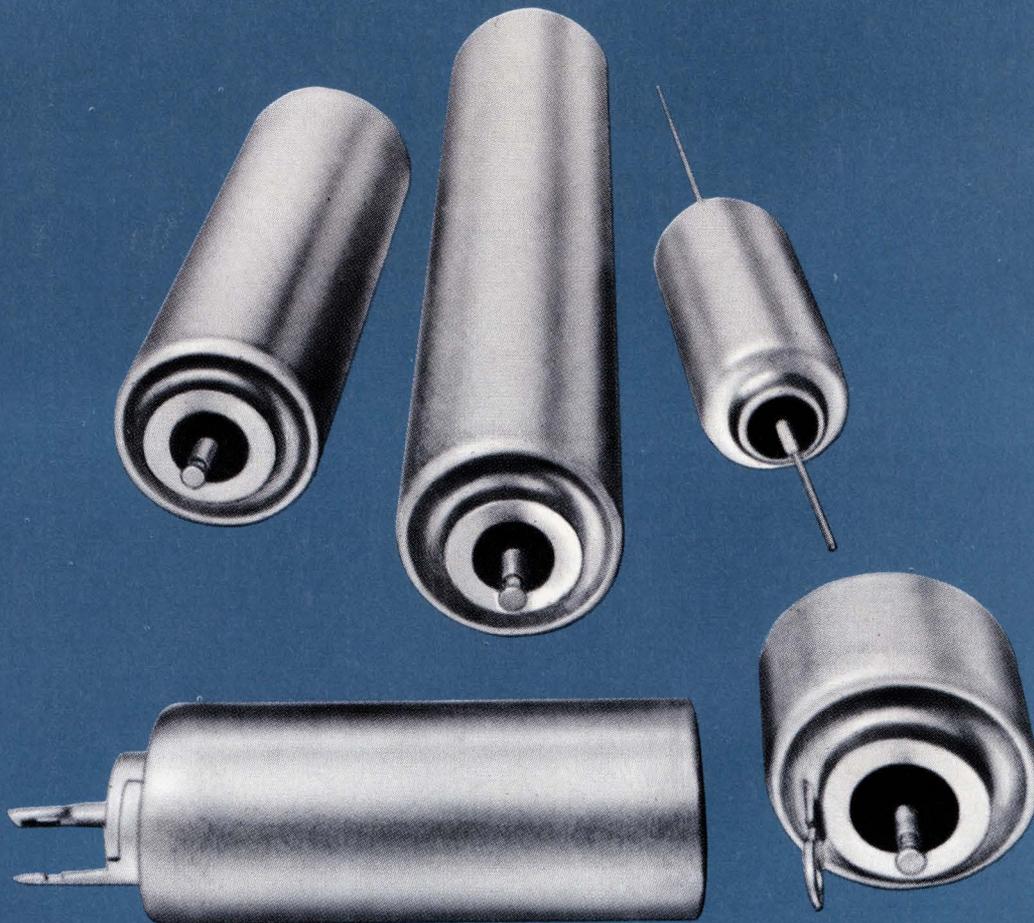
Willimantic, Conn. 06226

West Coast: Collins and Hyde Co.

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Pass the word... our XT wet tantalums are out of this world.



With reliability proven since 1949, our XT series of liquid-electrolyte high-temperature tantalum capacitors is widely used in aerospace, missile, and airborne equipment. Precision industrial components, too.

Rugged construction makes the XT series especially suitable in environmental extremes... from -55°C to $+175^{\circ}\text{C}$. The true hermetic glass-to-metal seal prevents penetration of vapor or liquids in amounts that could damage

internal construction. And double-case construction provides high resistance to corrosion.

Plus... excellent stability, long operating life at high temperatures. Great versatility with a broad line in a wide range of terminal arrangements. Long shelf life. High capacity—up to 2200 mfd in a single small case.

For detailed information and specifications, write for Bulletin 4-84. Or see your authorized Mallory distributor.

MALLORY

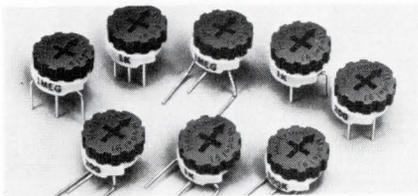
MALLORY CAPACITOR COMPANY

a division of P. R. MALLORY & CO. INC.
Indianapolis, Indiana 46206

Electrical and Electronic Components • Sequence Timers • Metallurgical Products • Batteries

CIRCUIT PRODUCTS

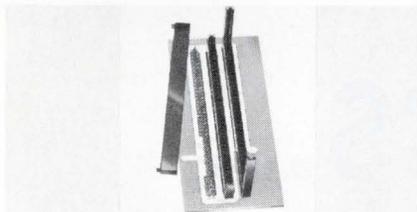
SINGLE-TURN TRIMMERS



Top and side adjust models in 19 resistance values from 10 ohms to 2 Meg., and six pin spacings, feature a dust cover to protect against corrosive atmosphere and dust. Less than 0.5% change during the first 1,000 hrs, with temperature coeff. max of ± 100 ppm/ $^{\circ}$ C over 0-85 $^{\circ}$ C ambient. Series 91, $\frac{3}{8}$ in. trimmers, 35¢ in 50k quantity. Helipot Div., Beckman Inst., 2500 Harbor, Fullerton, Ca 92634.

Circle Reader Service #348

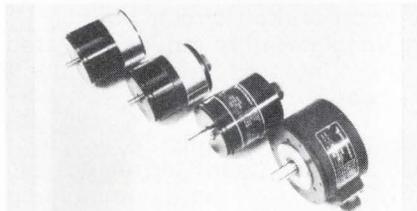
CARD-EDGE CONNECTOR



The series 6317 is a press-fit card edge connector that does not require soldering. This press-fit technique without soldering produces a surprisingly strong mechanical connection as well as a completely reliable gas-tight electrical connection. Elco Corp., Willow Grove, Pa. 19090.

Circle Reader Service #349

OPTICAL ENCODERS

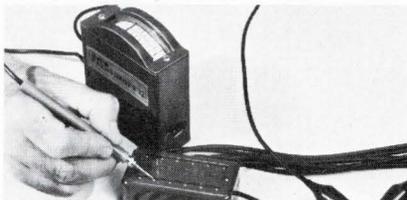


Prices reduced up to 26% for the Optecon encoder line. For example, the heavy-duty industrial model with a resolution of 2500 lines, originally marketed at \$520.00 ea. (in 1-9 quan.), is now \$395.00. Quantity price discount schedule has also been modified. The encoder series is offered in 4 basic physical configurations ranging from the std. OC25 commercial/industrial model to the rugged ON35 heavy-duty sealed unit in std. resolutions from 10 to 3600 lines. Contact D. E. Skenderian, Data Technology, Inc., Watertown, Mass. 02172.

Circle Reader Service #350

THE ELECTRONIC ENGINEER • June 1972

ONE MAN TRACES LEADS



The Pathfinder 12 Wire and Circuit Tracer can trace up to 12 leads, verify continuity, and identify wires in or out of sequence. It is portable, powered by an AA battery, and uses a one-piece resistor block to determine meter displacement which identifies the wire. \$40. Brady, 727 West Glendale, Milwaukee, Wis. 53201. (414) 332-8100.

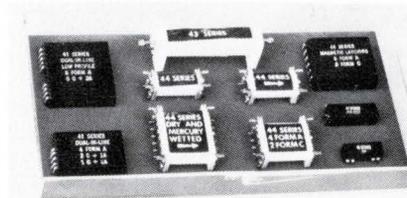
Circle Reader Service #351

HIGH-Q DIODES

Twelve wide area Varactron silicon voltage-variable capacitance diodes have Q as high as 200, and dc (MWV) ratings as high as 100 V. They feature MWV x Q products as high as 20,000 at 25 MHz, capacitances up to 1320 pF, and tuning ratios to 5. Diodes are ideal for VHF-UHF freq. multiplication, harmonic generation, oscillator tuning, electronic tuning, freq. modulation, parametric amplification, automatic freq. control, limiting, and switching. Delivery, from stock. Prices start at \$16.00 and drop to less than \$10.00 in quan. Contact Joel Cohen, Teledyne Crystalonics, 147 Sherman St., Cambridge, Mass. 02140. (617) 491-1670.

Circle Reader Service #352

REED RELAYS



These relays are built around two basic configurations, a molded glass filled nylon bobbin open style construction and relays encapsulated in mineral filled epoxy. The open style relays are available with dry or mercury wetted contacts. The low profile encapsulated relays, 0.275 x 0.375 in. in height, can be equipped with up to eight Form A contacts. Pricing ranges from 72¢ to \$8.50 in quan. of 1000. North American Philips Controls Corp., Frederick, Md.

Circle Reader Service #353

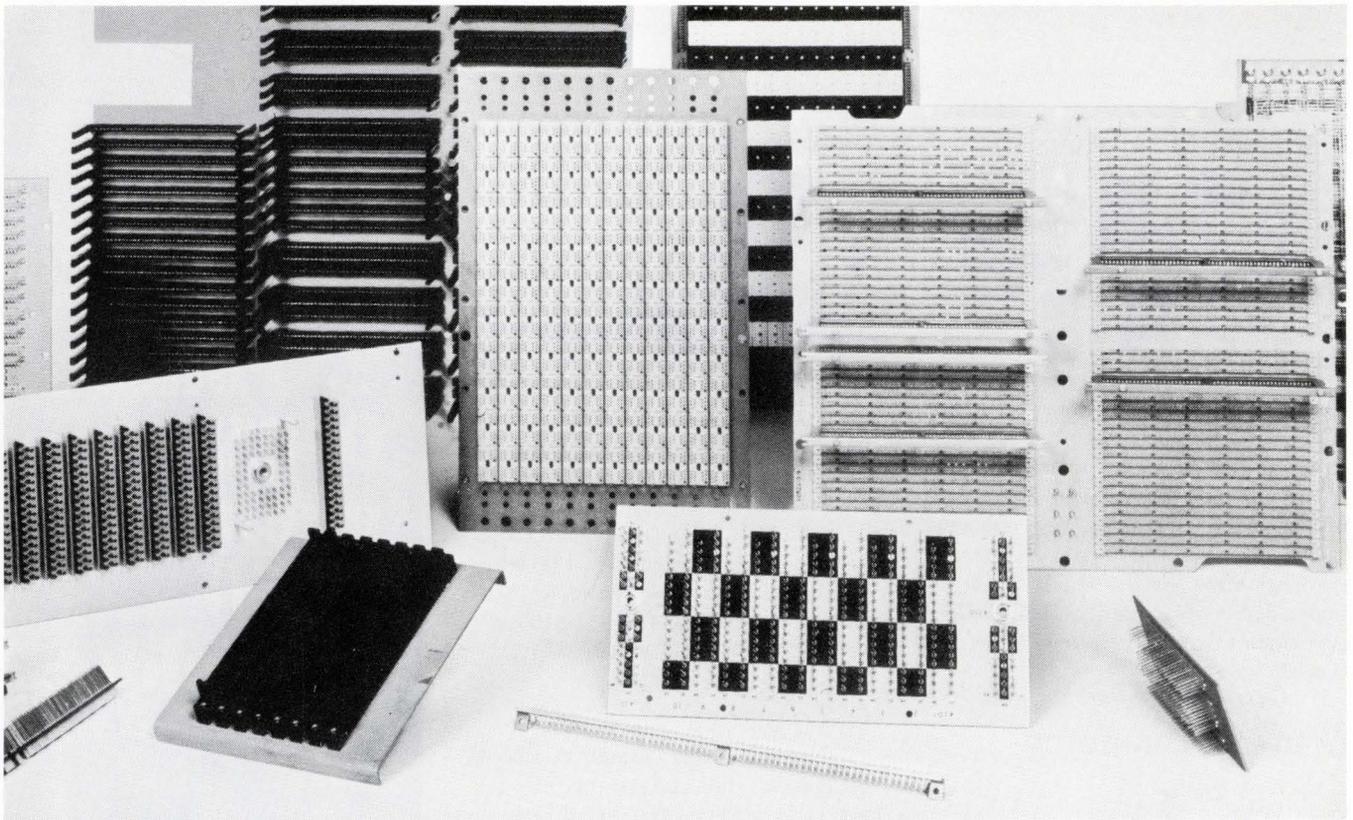
**ac, dc,
volts,
amps,
ohms,
25 ranges,
0.01%
accuracy,
\$650
complete.**



Systron-Donner's new all-function 7004 Digital Multimeter. Measures **everything**—dc and ac voltage, dc and ac current, and resistance. Built-in shunts for current measurements. Fully guarded input for highest common mode isolation. Dual-slope integration design. 1,000 megohm input impedance on three lowest ranges. Optional battery pack with recharger (\$95) **mounts internally**. For lab, field or systems use (with DTL/TTL compatible BCD outputs \$45). Ask your local Scientific Devices offices for technical data or contact: Concord Instruments Division, 888 Galindo Street, Concord, CA 94520. Phone (415) 682-6161.



SYSTRON-DONNER
Circle Reader Service #50



CONNECTRONICS...

a new packaging concept for
solving interconnecting problems

From Elco. It's the Total Packaging Concept that helps you with your interconnecting design, then picks the right components for the job and puts them all together. To give you the best-performing total package back panel assembly at the lowest price.

No longer must you face a bewildering array of card cage, guide, panel, contact and input/output components, and evaluate specs vs. cost on the components that qualify. Nor must you establish quality control standards and inventory control on these parts. Nor make up a step-by-step production timetable. And watch the cost of your finished package mount because of unexpected labor costs. Or miss deadlines because of unforeseen design and manufacturing snags. Not when Elco's CONNECTRONICS specialists and N/C machinery can do the job. From concept to finished package.

All you do is furnish us with a drawing of the daughter card. Tell us how many cards you need. And give us voltage and ground requirements, cage mounting dimensions and a wire list. Then sit back.

We'll pick the right connectors from our hundreds of thousands of standard connector designs. And choose the right back panel. Perhaps it'll be our Variplate™ back panel, the interconnector that provides bussing and voltage and ground planes, accepts individual components in any configuration. And acts as a structural member as well.

Or, if the back panel must be a mounting frame for p.c. board edge connectors or for rack and panel connectors, and must provide the rigidity that phenolic boards cannot, we'll furnish the Elco Variframe™ system. If your interconnecting configuration is standardized and your wiring changes are minimal, we'll use our Variboard™ interconnector. This system lets us do just about anything. Like mounting connectors or components directly on printed circuit boards. Or mounting connectors in plated-through or unplated holes. Mixing wired and printed circuits. And mounting boards on mother boards.

To complete the package, our specialists will select the compatible I/O section, then terminate the package. Automatically . . . N/C . . . or a combination of both. Whichever is the most economical for you. Based on price/performance and delivery, you'll get the best interconnecting total package system available.

For more information on CONNECTRONICS, the Elco Total Packaging Concept, write:

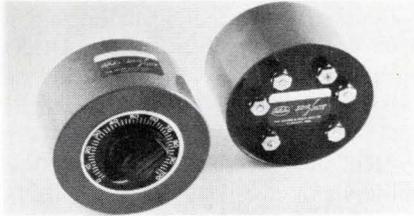


Elco, Willow Grove Division,
Willow Grove, Pa. 19090 (215) 659-7000

Elco, Pacific Division, 2200 Park Place,
El Segundo, Calif. 90245 (213) 675-3311

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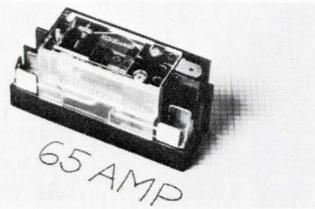
SOLID STATE PANEL TIMER



Panel timer is for ac applications where two timed contacts are required. Time delay is controlled by either a knob or screw-driver shaft. Contacts can be: 2 n.o.; 2 n.c.; 1 open, 1 closed. All time functions are delay to operate 0-120 s. Input is 117 Vac and output contacts (which are 100% solid state), will switch and maintain as high as 220 Vac at 1 A. Inductive overloads in excess of 1000% are tolerable. Contact Richard Lint, The Adams & Westlake Co., 1025 N. Michigan St., Elkhart, Ind. 46514.

Circle Reader Service #354

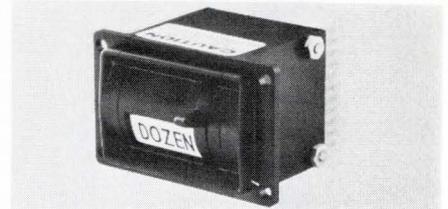
MOTOR OVERLOAD RELAYS



Type PJ overload relays with UL-listed continuous (running) current ratings of 52 through 65 A, including fractional ratings, are for use with specialty motors. Compactly designed, they have plane surfaces to allow stacking of three units for 3 θ motors. The line also includes units with ratings from 1 through 51 A for general-motor applications. Response time can be matched to the specific application. Relays are 3 in. wide, 1 $\frac{5}{8}$ in. deep and 1 in. high, and weighs about 3.5 oz. Heinemann Electric Co., Magnetic Dr., Trenton, N.J.

Circle Reader Service #355

MESSAGE UNIT SWITCH



Message unit is part of the Minilever product line and will offer additional flexibility. A setting lever on the thumb-wheel switch actuates an internal gear to rotate the dial a full revolution by moving the lever only 90°. A quick sweep of the hand across the levers on a control panel resets all switches to zero position before encoding new information. Unit can be imprinted with any message, and offers a selection of four messages. Contact Robert Alexander, The Digitran Co., 855 So. Arroyo Pkwy, Pasadena, CA. 91105.

Circle Reader Service #356



Try our contact...

Discover quick relief from the pains of accessing uneven surfaces for a reliable electrical contact. Our "SNAP-OUT" spring contact probes are commonly applied in production testing of in-lines, wired back panels, printed circuit boards and ceramic substrates. "SNAP-OUT" probes are easily removable from a receptacle which stays in its mounting. Available in four sizes, with nine standard configurations. For more information, contact Walter Frey, Mgr. Customer Service, (714) 593-2541.

EVERETT / CHARLES, INC.

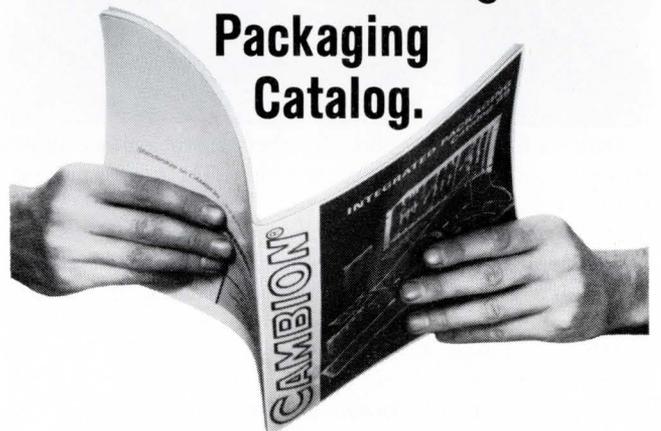
2806 METROPOLITAN PLACE, POMONA, CALIFORNIA 91767

PHONE (714) 593-2541

Circle Reader Service #52

THE ELECTRONIC ENGINEER • June 1972

Catch-up reading. CAMBION'S new Integrated Packaging Catalog.



Its 48 pages cover our whole line of high density IC Sockets, Cambi-Card® circuit boards, bread boards, card files, power planes and Wire-Wrap* products and services. Send for Catalog 99. Cambridge Thermionic Corporation, 445EE Concord Avenue, Cambridge, Massachusetts 02138.

*Registered Mark of Gardner-Denver Co.

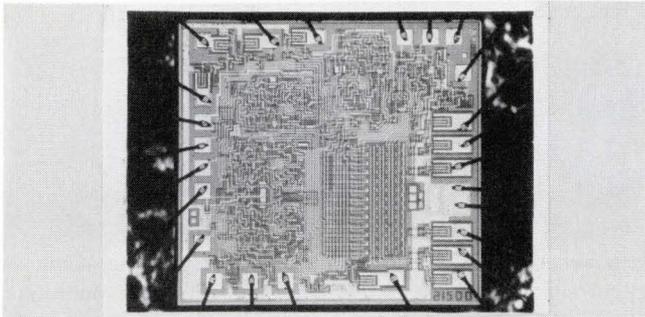
Standardize on

CAMBION®

The Guaranteed Electronic Components

Circle Reader Service #53

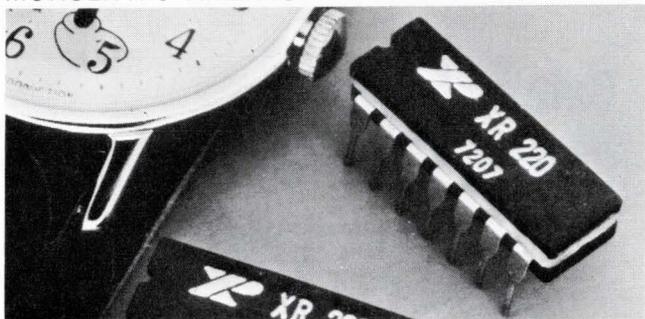
SEVEN-SEGMENT DISPLAY DRIVER



The HD-0140 is a bipolar 4-bit latch/decoder/display driver with BCD data outputs. Using junction-isolated technology, the new device provides a high speed, high current data handling capability for light-emitting diodes (LED) and other types of numerical displays. The circuit provides 40 mA outputs to drive a single 7-segment numeric display. Four additional outputs are included which supply the BCD data stored in the latch. Available off the shelf in 24-pin dual-in-line ceramic packages, the price is \$7.55 (100-999) for the commercial version (0 to 75°C) and \$11.25 for the military version (-55 to 125°C). Harris Semiconductor, Melbourne, Fla.

Circle Reader Service #310

MONOLITHIC TIMER IC



Here's a first: a monolithic chip that generates delay output pulses ranging from one μ s to one hour. The timing pulse itself has a 0.5-% accuracy; temperature stability is 0.002%/°C over the temperature range (military and industrial versions are available). Three external components are needed: two resistors and a capacitor. Output drive capability is 100 mA; supply voltages, 4.5-20 V. The industrial-grade XR-320 costs \$4.00 ea. in 100-pc. lots. Exar Integrated Systems, Inc., 733 North Pastoria Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #311

SECOND-SOURCE FOR HA-2500 OP AMPS

Intersil is producing and delivering the Harris series 2500 high slew rate op amps. These amplifiers are made using dielectric isolation and on-chip precision thin film resistors, resulting in slew rates up to 120 V/ μ s with no positive feedback compensation. In addition to the 2500 series amplifiers, Intersil will soon be introducing 2600 series wideband high impedance op amps and 2700 series low power op amps. Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014.

Circle Reader Service #312

ANALOG DRIVER/SWITCH

A dual, SPST analog driver/switch uses complementary MOS technology on a monolithic structure that includes both n- and p-channel devices on a common substrate. The DG200 analog transmission gate has break-before-make switching, with t_{off} and t_{on} ratings of 500 and 1000 ns at 25°C. Signal range is ± 15 V with ± 15 -V supplies; r is less than 100 Ω . The industrial version—DG200BA—costs \$3.50 ea. in 100-pc. lots. The DG200AA military unit costs \$8.75 ea. Siliconix Incorporated, 2201 Laurelwood Rd., Santa Clara, Calif. 95054.

Circle Reader Service #313

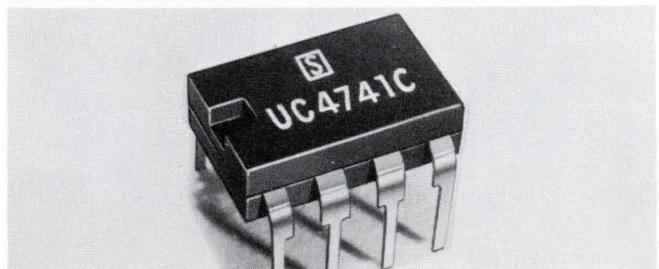
DRIVES 6 LAMPS/PACKAGE



This hybrid "Hex Buffer" drives 6 150mA or 3 300mA incandescent lamps. Inputs TTL/DTL compatible and 5V logic supply. With pull-up resistor, can be used in clock and line driver applications with high fan-out. One-999 20330s, \$5.45; 4-6 weeks ARO. Tom O'Gorman, IEE, 7720-40 Lomona, Van Nuys, Ca. 91405 (213) 787-0311

Circle Reader Service #314

741 IN A MINI-DIP



Solitron Devices is offering their UC4741C operational amplifier in a new package. The 8-lead mini-DIP offers greater package density, since it occupies one-half the space required by the 16-pin DIP and still provides the advantages of automatic insertion. Solitron Devices, Inc., 8808 Balboa Ave., San Diego, Calif. 92123.

Circle Reader Service #315

LOW COST AUDIO AMP

This 2-W audio amplifier is aimed at low-cost applications such as toys. Designated the LM380, the amplifier operates from a single supply from 8 to 22 V. Full power bandwidth is typically 65 kHz at 2W-8 Ω , and total harmonic distortion is typically 0.2%. The amplifier is internally protected against short circuit and thermal overload. Price, in quantities of 100-up, is \$1.50. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051.

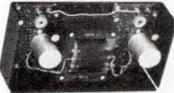
Circle Reader Service #316

16 NEW MULTIPLES

FROM THE POWER HOUSE Dual and Triple Output OEM Power Supplies

The most economical power/cost ratios in the power supply industry are now available in 16 new *multiple* output power supplies. These new units are specifically designed for computer, peripheral and instrument applications.

The same high quality components, low manufacturing costs, proven engineering design, reliability and economy incorporated in our highly successful single output OEM Series are here now in our new multiple output series and that means *multiple* satisfaction! We do it better for less, that's why Powertec is the leader in the OEM business. **EXCLUSIVE FEATURES:** Reliability • Economy • Proven Engineering Design • Low Manufacturing Costs • High Quality Components.

	MODEL NUMBER	OUTPUT POWER			100 PIECE** PRICE
		OUTPUT #1	OUTPUT #2	OUTPUT #3	
2K — DUAL OUTPUT	2K15D-1.3	+12V, 1.5A or +15V, 1.3A	-12V, 1.5A or -15V, 1.3A	NA	\$37.00
	*2K5D-3.0	5V, 3.0A or 6V, 2.5A	5V, 3.0A or 6V, 2.5A	NA	
Depth — 2.50	*2K5, 15D	5V, 3.0A or 6V, 2.5A	12V, 1.5A or 15V, 1.3A	NA	
Width — 7.87	*2K5, 24D	5V, 3.0A or 6V, 2.5A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	NA	
Height — 4.00					
2L — DUAL OUTPUT	2L15D-2.8	+12V, 3.0A or +15V, 2.8A	-12V, 3.0A or -15V, 2.8A	NA	\$65.00
	*2L5D-6.0	5V, 6.0A or 6V, 5.0A	5V, 6.0A or 6V, 5.0A	NA	
Depth — 2.75	*2L5, 15D	5V, 6.0A or 6V, 5.0A	12V, 3.0A or 15V, 2.8A	NA	
Width — 9.38	*2L5, 24D	5V, 6.0A or 6V, 5.0A	18V, 2.0A or 20V, 2.3A or 24V, 2.3A	NA	
Height — 4.88					
2R — TRIPLE OUTPUT	2R-70T	+12V, 1.5A or +15V, 1.3A	-12V, 1.5A or -15V, 1.3A	5V, 6.0A or 6V, 5.0A	\$69.00
	*2R-72T	5V, 3.0A or 6V, 2.5A	12V, 1.5A or 15V, 1.3A	5V, 6.0A or 6V, 5.0A	
Depth — 2.87	*2R-74T	5V, 3.0A or 6V, 2.5A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	5V, 6.0A or 6V, 5.0A	
Width — 11.00	*2R-76T	12V, 1.5A or 15V, 1.3A	18V, 1.0A or 20V, 1.0A or 24V, 1.0A	5V, 6.0A or 6V, 5.0A	
Height — 4.88					
2S — TRIPLE OUTPUT	2S-140T	+12V, 3.0A or +15V, 2.8A	-12V, 3.0A or -15V, 2.8A	5V, 12A or 6V, 8.0A	\$119.00
	*2S-142T	5V, 6.0A or 6V, 5.0A	12V, 3.0A or 15V, 2.8A	5V, 12A or 6V, 8.0A	
Depth 4.00	*2S-144T	5V, 6.0A or 6V, 5.0A	18V, 2.0A or 20V, 2.3A or 24V, 2.3A	5V, 12A or 6V, 8.0A	
Width 15.00	*2S-146T	12V, 3.0A or 15V, 2.8A	18V, 2.0A or 20V, 2.3A or 24V, 2.3A	5V, 12A or 6V, 8.0A	
Height 4.88					

All outputs are floating, can be connected in any common configuration unless otherwise noted. Other voltages and currents available, consult factory for price and delivery.
*NON-STOCKED ** For quantities other than 100, contact factory.

SPECIFICATIONS: INPUT: 115VAC \pm 10V, 47-63 Hz • REGULATION: Line \pm .25%, Load \pm .25% • RIPPLE: 1mv RMS 5 & 15V • RESPONSE: 50 μ sec typical • TEMPERATURE: 0°C to 40°C derated to 71°C • O.L. PROTECTION: Current limit/foldback • Optional OVP available. **DELIVERY:** stocked models within 24 hours, 30 days for others.

Incidentally, if you don't see your exact model on the chart, we'll build an OEM *multiple* from stocked subassemblies in any voltage/current combination. Give us a call and we'll be glad to quote within 24 hours. Stay within the same size and power rating, and the price won't change.

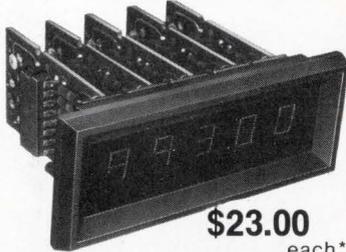
POWERTEC INC. an Airtronics Subsidiary
9168 DeSoto Ave., Chatsworth, California 91311 • (213) 882-0004 • TWX (910) 494-2092

POWERTEC

TEC LED LITE

LED READOUTS

READY TO MOUNT



\$23.00
each*

When you buy a TEC-LITE IC compatible readout, you buy a unit that's ready to mount to your panel with two screws — nothing else! Or you can specify an attractive TEC aluminum bezel and mount up to 10 (or more) readouts** in your panel with just two nuts.

TEC has designed and built more completely packaged LED indicators, switch-indicators and readouts than anyone else — you expect more from the information display leader.

LED PACKAGES

LED/SWITCH PANEL



LED status indicators are combined with TEC-LITE switches in this attractive, easy to mount panel assembly. Your choice of number and type of switches/indicators. Priced from \$2.25* complete, ready to mount.

PANEL MOUNT LED's



Slip bezel assembly in panel hole from the front, secure with Tinnerman clip from the rear. Replaceable LED snaps in place from the front. \$1.50* with clip.

PCB MOUNT LED's



Molded polycarbonate lamp holder is soldered to PCB. LED plugs into unit. Priced from \$1.50*

*100-499 quantity
**80¢ a position

See TEC-LITE for the complete line of readouts, indicators, switches, display panels, keyboards, CRT terminals.

TEC, Incorporated; 9800 North Oracle Road, Tucson, Arizona 85704; or phone (602) 297-1111.



Circle Reader Service #55

CIRCUIT PRODUCTS

OIL-TIGHT SWITCHES

A simple part exchange adds oil-tight capability to "Presslite" lighted push-button switches. The easy addition of this oil-tight part increases the flexibility of an already broad line. Available in 0.5, 3, 5, 10 and 15 A ratings, for alternate and momentary snap and linear action, these spdt and dpdt units are rated for 28, 30 Vdc and 115 Vac operation. A wide range of mounting hardware meets virtually every panel installation requirement. Available from stock. Marco-Oak, 207 So. Helena St., Anaheim, Calif. 92803. (714) 535-6037.

Circle Reader Service #357

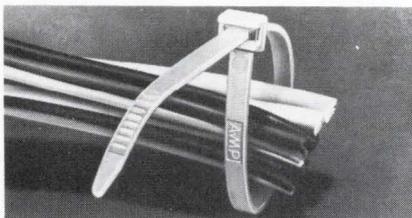
TINY DPDT RELAY



The dpdt relay measures only 0.435 in. high and can switch 2 A at 26 Vdc. High pressure contact enables the unit to switch capacitance or lamp loads with current spikes that would normally weld the contacts of reed relays. AZ 531 Thin-pack comes in std. coil voltages from 6 to 115 Vdc with an operate and release time of < 5 ms. It has PC terminals in 0.10 in. grid spacing. Prices start at \$1.95 ea. for a 6 V coil version in 2500 pcs. Delivery from stock. American Zettler, 697 Randolph Ave., Costa Mesa, Calif. 92626. (714) 540-4190.

Circle Reader Service #358

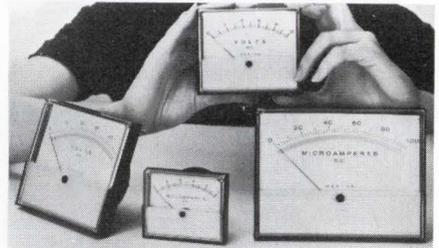
NYLON CABLE TIES



Cable ties have dual stainless steel pawls to provide up to twice the bundling tensile strength of all-plastic cable ties. They come in 4 sizes for bundles from 1/16 to 4 in. in dia., with each size being infinitely adjustable within its range. Ties are self-locking. Supplied in natural color nylon, outdoor weather-resistant black and other colors are available. AMP Incorporated, Harrisburg, Pa. 17105. (717) 564-0101.

Circle Reader Service #359

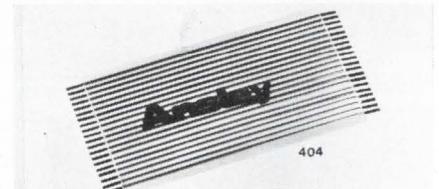
PANEL METER LINE



The 2000 series comes in both pivot and jewel, or taut band. High performance mechanisms provide magnetic excellent shielding. Other features include a flattened scale arc and knife edge pointer for improved readability, wrap-around case for protection against dust and moisture contamination. Quick cover removal combined with easy scale change and installation permits the changing of scale plates quickly. Available from stock in 2.5, 3.5, 4.5 and 5.5 in. sizes, accuracies to 1%. Weston Instruments Inc., 614 Frelinghuysen Ave., Newark, N.J. 07114. (201) 243-4700.

Circle Reader Service #360

PC BOARD JUMPERS



Series 404 jumpers are std. lengths of flame retardant polyester insulated flat cable with about 0.150 in. of insulation completely removed from both sides of the conductors on both ends. The solder coated conductors are easily terminated to PC boards. Standard lengths, 1, 2 and 3 in.; std. conductor centers, 0.025, 0.050, 0.100 and 0.150 in., with 10 to 100 conductors. Price, from 25¢ ea., depending on size and quan. Contact Tom Thomas, Ansley Electronics Corp., Old Easton Rd., Doylestown, Pa. 18901.

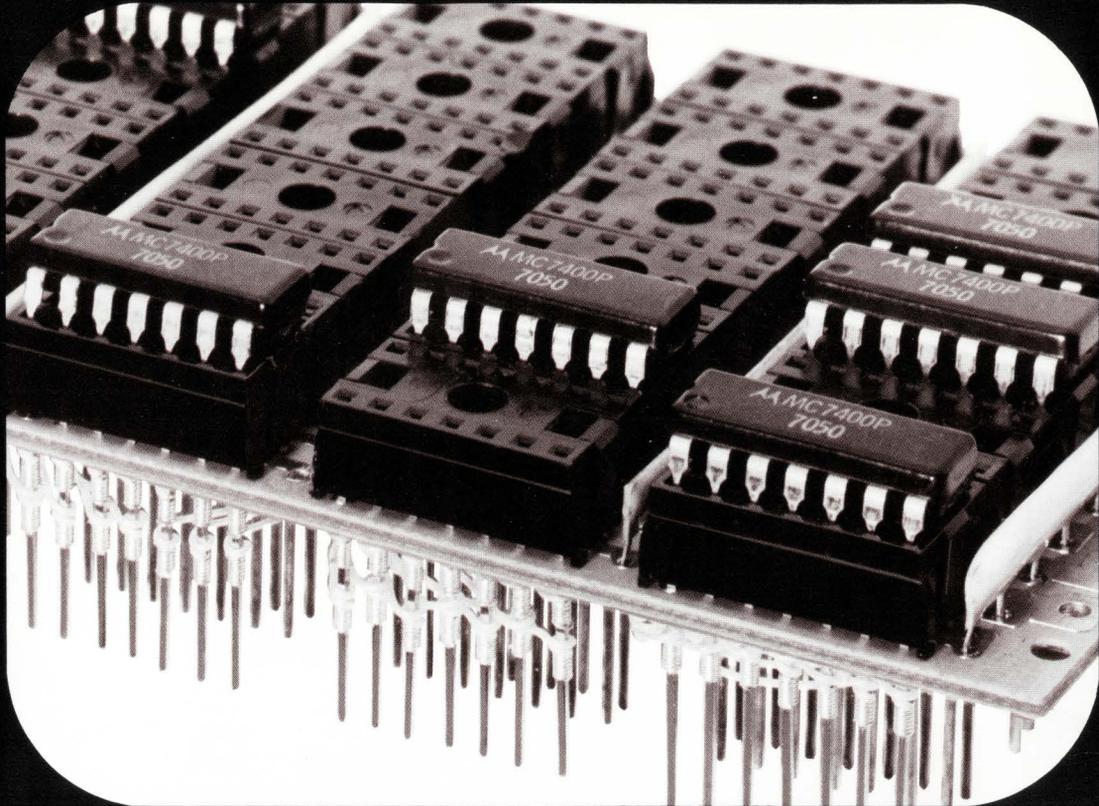
Circle Reader Service #361

MICROMINIATURE INDICATORS

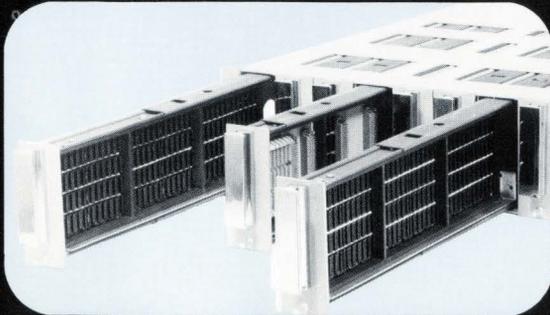
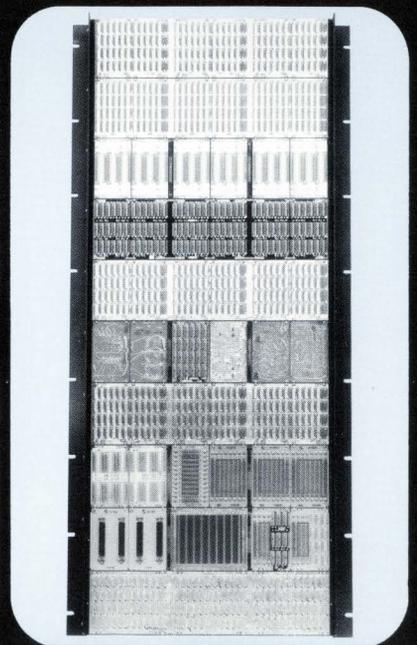
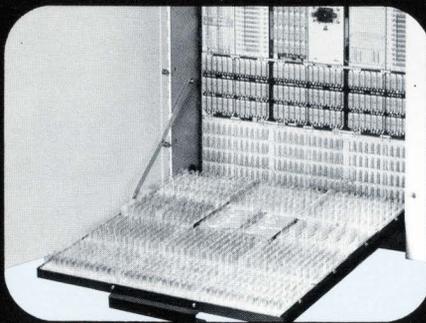
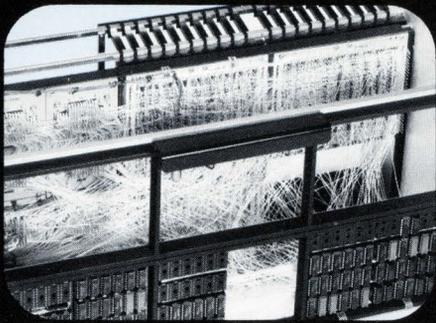
Brite-Eye and Trans-Eye have seven cap styles, 10 colors, and use 15 standard T-1 incandescent lamps. Neon Glo-Eyes use USASI A1K lamps and have resistors in housings for preselecting lifetime. Mounting on panels and pc boards, on 0.225 centers, and front panel lamp replacement. Shelly Assoc., 1562 Reynolds, Santa Ana, Ca. 92711.

Circle Reader Service #362

DUAL-IN-LINE SOCKET BOARDS



and **PACKAGING HARDWARE**



ELECTRONIC ENGINEERING COMPANY of California



EECO IC PACKAGING PANELS and RELATED HARDWARE

Saves you Time — and Money — now you can save up to 6 months and up to 60% of your total packaging costs by using EECO's IC panels, socketboards and related hardware. **No more waiting** for design and fabrication of new logic cards or for expensive new layouts of multi-layer boards.

Now you can have the competitive jump — the EECO Plug-In and wire wrapping approach gets your product to market quickly.

Saving Time is Saving Money — in addition interconnect costs are lower — unnecessary card connectors are eliminated. Also you avoid all the hidden costs of packaging.

Now you can package your design quicker and cheaper with EECO hardware. If that's not enough we'll even take your logic diagram and deliver complete wired hardware back in 4-6 weeks. As a bonus you get all the benefits of our Computer Aid Design programs applied to your systems logic.

VERSATILITY!

It's your choice with regards to dedicated or undedicated power routing...low impedance and noise-free decoupling...expansion or contraction of your system by modular increments. You can specify the exact proportion of 14, 16, 24 and 36-pin sockets and there are wide provisions for inclusion of cards, discrete components, special boards, and specific types of I/O connectors.

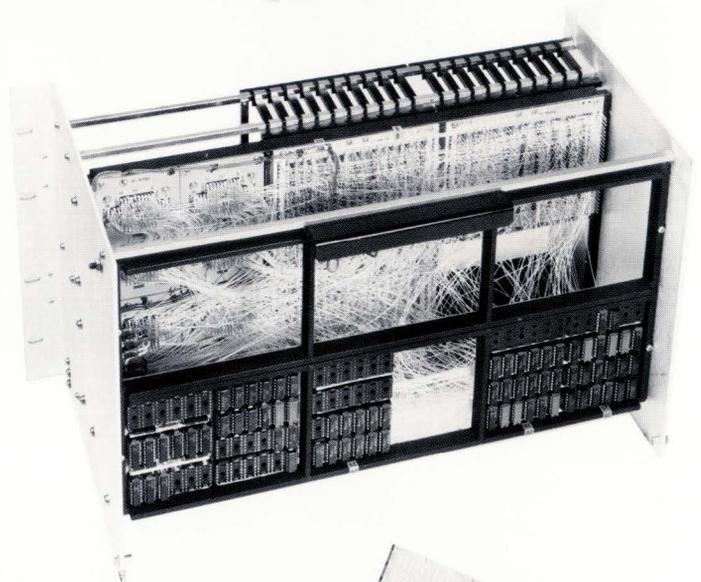
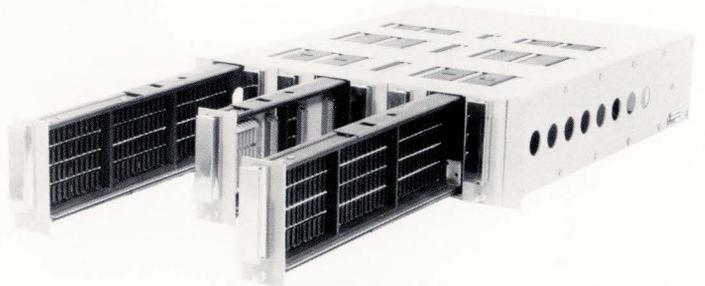
ECONOMY!

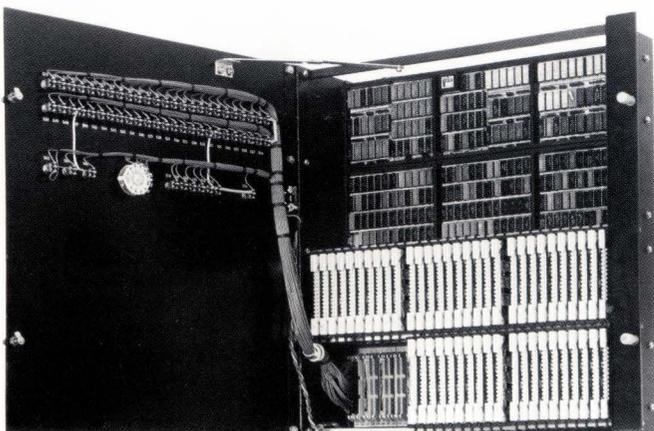
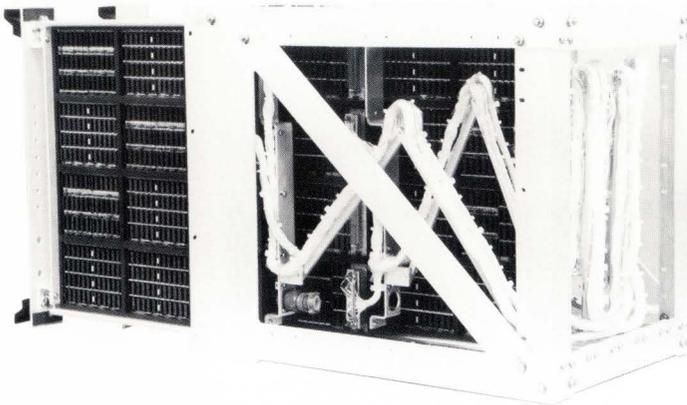
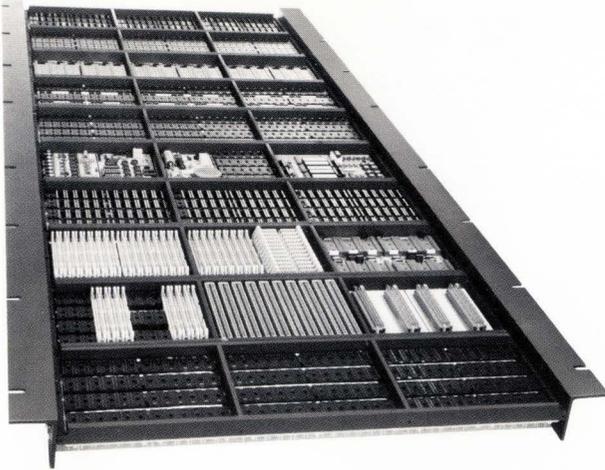
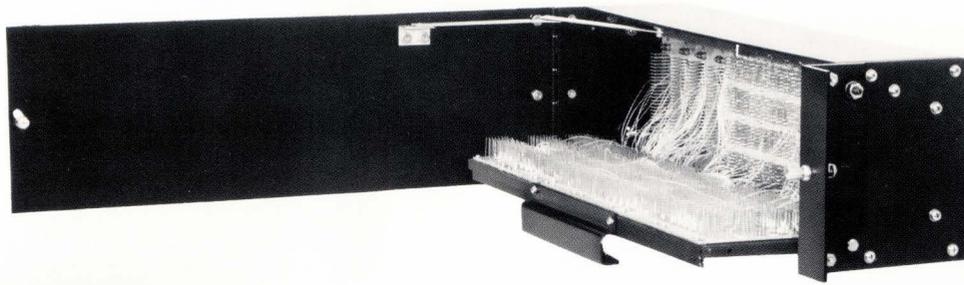
You can save up to 6 months and 60% of your total packaging costs by avoiding the design and fabrication of new logic cards or the delay and cost of multi-layer boards. You also avoid unpredictable production costs. If time is critical, EECO can take your logic diagram and deliver complete wired hardware to you in four to six weeks...with a bonus of helpful computer-prepared documents.

RELIABILITY!

EECO's high test standards are applied to all IC panel boards and hardware from incoming inspection through final shipment to you. All EECO hardware has been tested to applicable portions of MIL-STD-202L i.e. contact resistance, vibration, mechanical shock, thermal shock, salt spray humidity mechanical life test, IC insertion and withdrawal. A complete environmental test report is available upon request. From the basic glass epoxy PC boards, high quality sockets and light high-strength frames to the drawers and, assembly hardware, **you can be sure** of functional reliability with EECO hardware.

MODULAR SOCKET BOARDS CAN FORM THE BEST PACKAGES FOR YOUR PROJECTS





GET THE COMPETITIVE JUMP . . . NOW!

- EECO hardware can save you money and get your product to market faster.
- EECO hardware modularity offers you "custom" results at standard product costs.
- EECO plug-in and wire-wrap techniques avoid delays and costs of custom logic cards or multi-layer boards.
- Interconnection costs are reduced by the elimination of unnecessary card connectors.
- If you prefer, EECO will start with your logic diagram and deliver wired hardware in 4 to 6 weeks. EECO's computer even assigns the pin numbers for standard ICs!

Package your design at less cost and deliver your product faster with the EECO hardware described in this catalog . . .

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EECO SOCKET BOARDS

GENERAL SPECIFICATIONS

BOARD

Material

Thickness..... .062 inches
 Type..... Glass epoxy, flame retardant, NEMA-FR4, MIL-P-13949, Type GF (exceeds requirements of Type GE)
 Color..... Tan
 Plating..... Plated thru holes & tin lead deposition per MIL-P-55110

Etched Conductors

Material..... 2 ounce copper
 Conductor width & clearance are typically held to .025 inches minimum.

POWER BUSING

Material

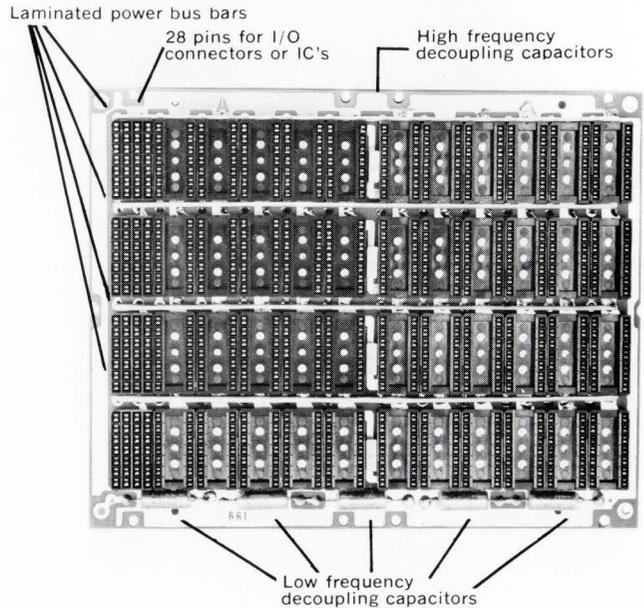
Conductors..... Half-hard brass, .007 inch thick (2 levels)
 Insulator..... Kapton, .001 inch thick
 Capacitance..... Typically 50 pf per inch of length

DECOUPLING CAPACITORS

Low Frequency..... 10 or 20 μ fd, tantalum, 15 VDC (higher voltage may be specified)
 High Frequency..... 0.01 μ fd, ceramic, 200 VDC

SOCKETS

Insulator..... Glass filled nylon
 Contacts..... Phosphor bronze (spring temper) per QQ-B-750, gold plated per MIL-G-45204, Type II., .000020" min. over .000050" nickel.

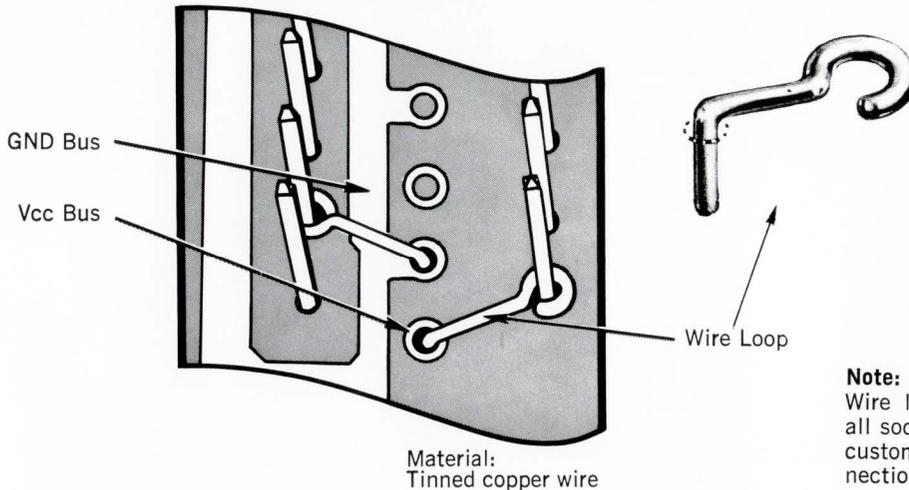


Each bus bar provides 40 to 60 pf of distributed capacitance per inch. Low impedance minimizes generation of noise currents on the power and ground busses.

The DC resistance of the conductor paths is typically less than 2 milliohms per inch of length.

WIRE LOOP POWER CONNECTION

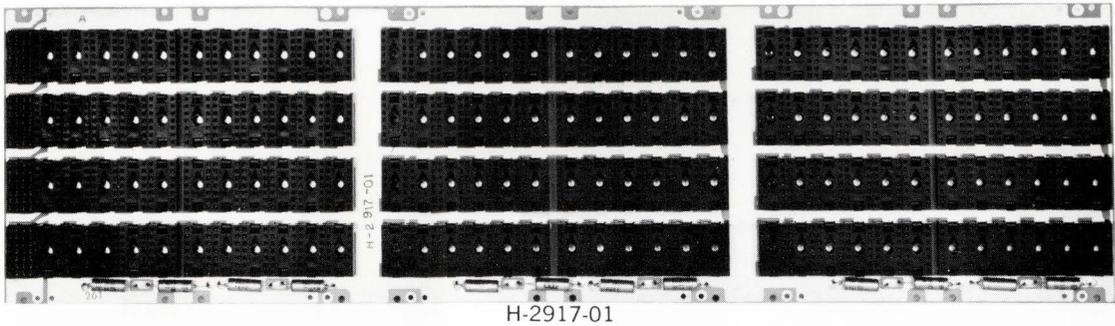
Power is not pre-connected to the sockets on some EECO socket boards. These boards are custom powered by convenient Wire-Loops. Wire Loops are inserted, and soldered, to the wire wrap side of the board and can bring power to any pin. Besides the custom powered boards shown on the opposite page, there are more shown on page 8.



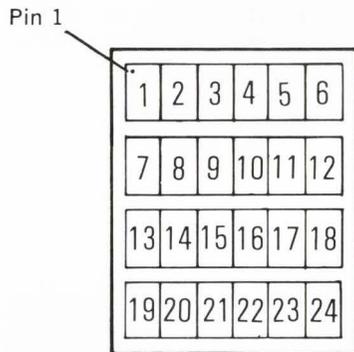
Note:

Wire loops are included with all socket boards designed for custom wire-loop power connections.

LOW COST 14-pin SOCKET BOARDS



These are high quality boards (see Board Specifications), yet economical in application. Power is pre-wired to the sockets ... ground to pin 7 and Vcc to pin 14, both 14 pin and 28 pin sockets.

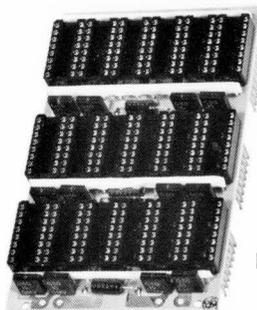


Socket Locations (IC side)

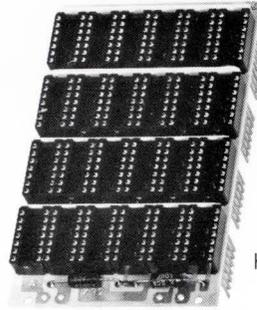
Table 1 14-PIN SOCKET BOARDS

Part No.	14-Pin Sockets	28-Pin Sockets		No. of Blocks	Tantalum Capacitors
		Quantity	Block Location		
H-2915-00	48	—	—	2	4
H-2915-01	44	4	1	2	4
H-2917-00	144	—	—	6	12
H-2917-01	140	4	1	6	12
H-2917-02	140	4	3	6	12
H-2917-03	140	4	5	6	12
H-2917-04	136	8	1, 3	6	12
H-2917-05	136	8	1, 5	6	12
H-2917-06	136	8	3, 5	6	12
H-2917-07	132	12	1, 3, 5	6	12

SOCKET BOARDS for CUSTOM POWER PIN CONNECTIONS

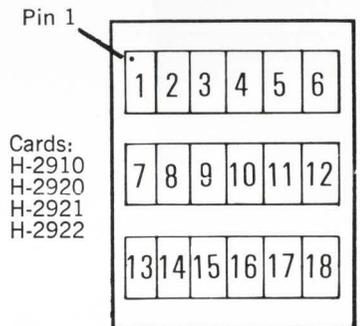


H-2910



H-2919

Power can be brought to any pin on these boards with convenient Wire-Loops except 28-pin sockets. These socket boards have excellent low-noise power distribution.

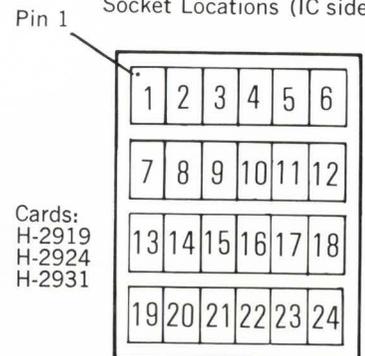


Cards:
H-2910
H-2920
H-2921
H-2922

Socket Locations (IC side)

Table 2 CUSTOM POWER SOCKET BOARDS

Part No.	14-Pin Sockets	16-Pin Sockets	28-Pin Sockets	No. of Blocks	Bus Bars	Tantalum Capacitors	Ceramic Capacitors
H-2910	—	18	—	1	4	3	12
H-2919	24	—	—	1	3	2	6
H-2920	—	36	—	2	4	6	24
H-2921	—	72	—	4	8	12	48
H-2922	—	108	—	6	12	18	72
H-2924	20	—	4	1	3	2	6
H-2931	—	24	—	1	1	2	—

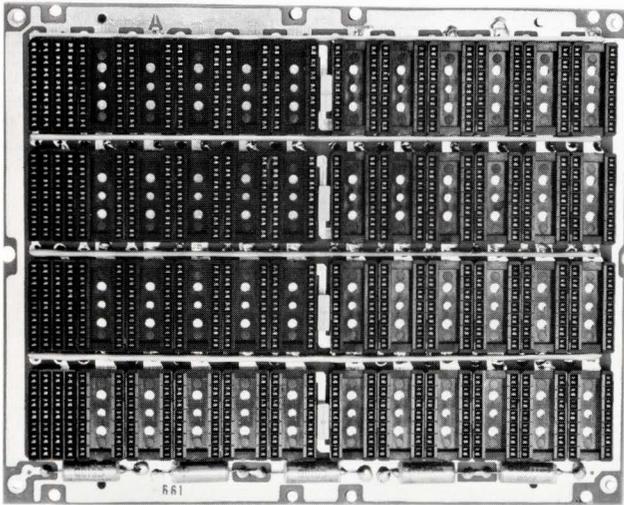


Cards:
H-2919
H-2924
H-2931

There are additional boards using wire loop connection shown on page 8.

Note: No power is connected to the 28-pin sockets on board H-2924.

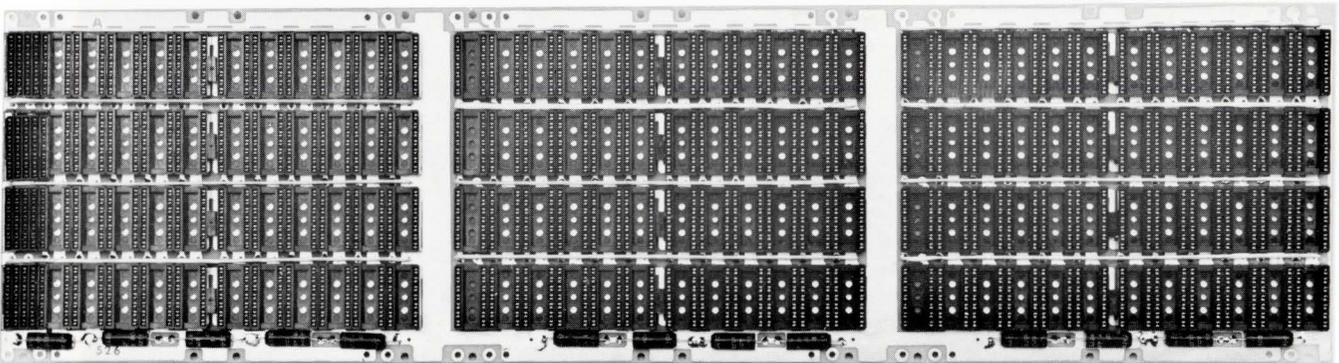
14-pin SOCKET BOARDS with LOW-NOISE POWER DISTRIBUTION SYSTEM



H-2905-01 (2 block)

You can reduce problems and engineering costs by using socket boards which have low impedance power distribution rather than using a "fix-it-up" approach to the power distribution **after** your system is wired. The boards shown on these two pages have been carefully engineered to keep power line noise to a minimum with ceramic and tantalum capacitors and laminated bus-bars.

Power is pre-wired to the sockets...ground to pin 7 and Vcc to pin 14, both 14 pin and 28 pin sockets.



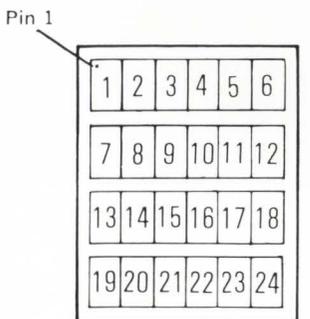
H-2907-01 (6 block)

Table 3 14-PIN SOCKET BOARDS

Pin 7: Ground Pin 14: Vcc

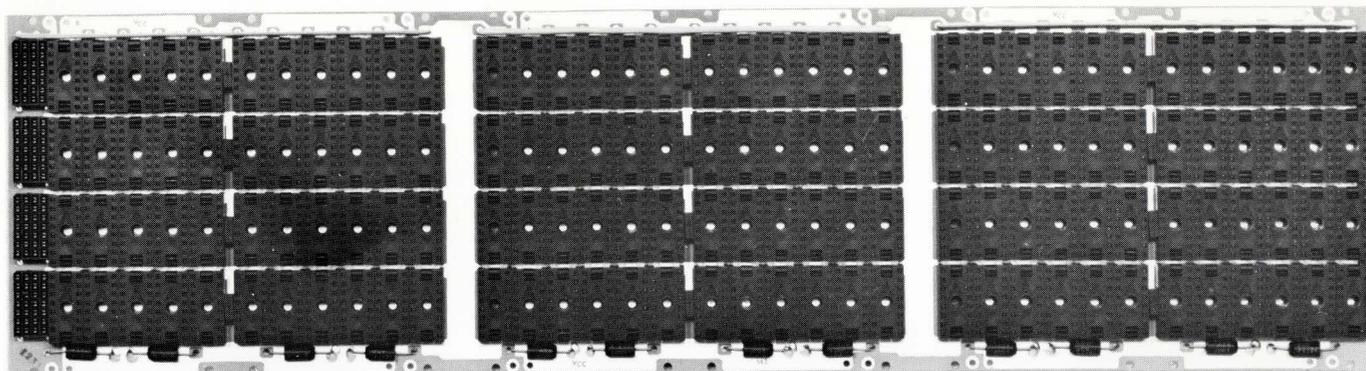
Part No.	No. of 14-Pin Sockets	28-Pin Sockets		No. of Blocks	Bus—Bars	Capacitors	
		Quantity	Block Locations			Tantalum	Ceramic
H-2904-00	24	—	—	1	4	2	6
H-2904-01	20	4	1	1	4	2	6
H-2905-00	48	—	—	2	4	4	4
H-2905-01	44	4	1	2	4	4	4
H-2906-00	96	—	—	4	8	8	8
H-2906-01	92	4	1	4	8	8	8
H-2906-02	92	4	3	4	8	8	8
H-2906-03	88	8	1,3	4	8	8	8
H-2907-00	144	—	—	6	12	12	12
H-2907-01	140	4	1	6	12	12	12
H-2907-02	140	4	3	6	12	12	12
H-2907-03	140	4	5	6	12	12	12
H-2907-04	136	8	1,3	6	12	12	12
H-2907-05	136	8	1,5	6	12	12	12
H-2907-06	136	8	3,5	6	12	12	12
H-2907-07	132	12	1,3,5	6	12	12	12

See page 5 for additional 14-pin socket boards.

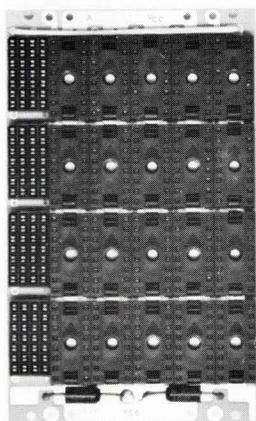


Socket Locations (IC side)

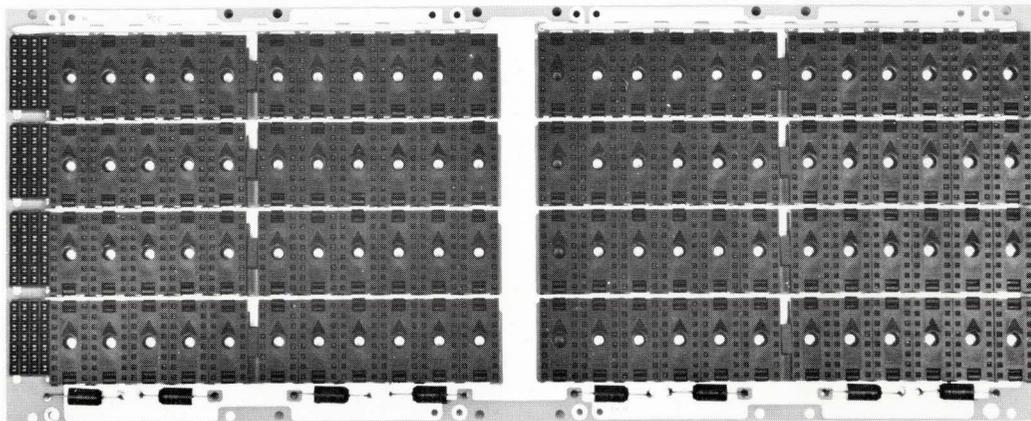
16-pin SOCKET BOARDS with LOW-NOISE POWER DISTRIBUTION SYSTEM



H-2928-01 (6 block)



H-2925-01 (1 block)



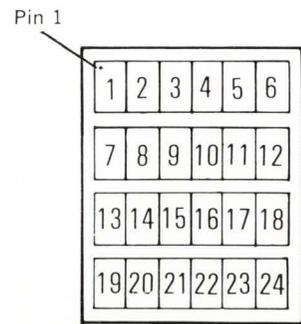
H-2927-01 (4 block)

On the H-2925 series, the 28 pin sockets have pin 14 connected to Vcc.

Table 4 16-PIN SOCKET BOARDS

Pin 8: Ground Pin 16: Vcc

Part No.	No. of 16-Pin Sockets	28-Pin Sockets		No. of Blocks	Bus—Bars	Capacitors	
		Quantity	Block Location			Tantalum	Ceramic
H-2925-00	24	—	—	1	1	2	—
H-2925-01	20	4	1	1	1	2	—
H-2926-00	48	—	—	2	1	4	4
H-2926-01	44	4	1	2	1	4	4
H-2927-00	96	—	—	4	2	8	8
H-2927-01	92	4	1	4	2	8	8
H-2927-02	92	4	3	4	2	8	8
H-2927-03	88	8	1, 3	4	2	8	8
H-2928-00	144	—	—	6	3	12	12
H-2928-01	140	4	1	6	3	12	12
H-2928-02	140	4	3	6	3	12	12
H-2928-03	140	4	5	6	3	12	12
H-2928-04	136	8	1, 3	6	3	12	12
H-2928-05	136	8	1, 5	6	3	12	12
H-2928-06	136	8	3, 5	6	3	12	12
H-2928-07	132	12	1, 3, 5	6	3	12	12



Socket Locations (IC side)

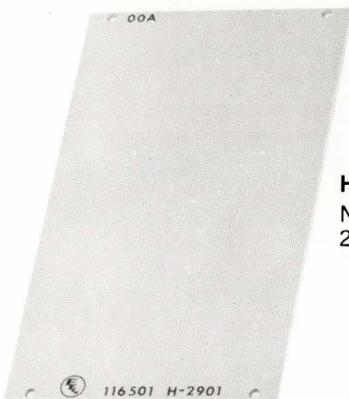
See page 5 for additional 16-pin socket boards.

SOCKET, I/O CONNECTOR and SPECIAL BOARDS

Table 5 Socket, I/O Connector and Special Boards

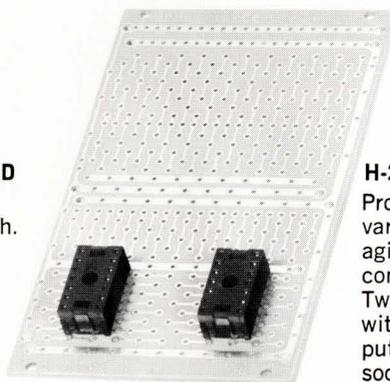
All are 1-block boards except H-2933 (2-block)

PART NO.	SOCKETS	CONNECTORS				NO. OF CONNECTOR PINS	POWER CONNECTION	BUS BARS	CAPACITORS	
		26-PIN	50-PIN	100-PIN	106-PIN				TANTALUM	CERAMIC
H-2901		BLANK BOARD					NONE			
H-2902	2 14-PIN	MATRIX BOARD					NONE			
H-2909	3 36-PIN						CUSTOM	4	6	
H-2911	12 14-PIN			1		100	PRE-WIRED	4	2	
H-2912				1		100	NONE			
H-2913				2		200	NONE			
H-2918	6 24-PIN						CUSTOM	4	6	
H-2923	12 14-PIN			1		100	CUSTOM	4	2	
H-2929					1	106*	NONE			
H-2930					2	212*	NONE			
H-2933		10 EDGE CARD CONNECTORS/ 2-BLOCK BOARD				560	PRE-WIRED			
H-2934	6 16-PIN, 3 24-PIN						CUSTOM	3	2	2
H-2935-01			1			50	NONE			
H-2935-02			2			100	NONE			
H-2935-03			3			150	NONE			
H-2935-04			4			200	NONE			
H-2935-05			5			250	NONE			
H-2935-06			6			300	NONE			
H-2935-07			7			350	NONE			
H-2935-08			8			400	NONE			
H-2936-00	12 14-PIN		1			50	PRE-WIRED	3	2	3
H-2936-01	12 14-PIN		2			100	PRE-WIRED	3	2	3
H-2936-02	12 14-PIN		3			150	PRE-WIRED	3	2	3
H-2936-03	12 14-PIN		4			200	PRE-WIRED	3	2	3
H-2937-01	9 16-PIN		1			50	CUSTOM	4	2	1
H-2937-02	9 16-PIN		2			100	CUSTOM	4	2	1
H-2937-03	9 16-PIN		3			150	CUSTOM	4	2	1
H-2937-04	9 16-PIN		4			200	CUSTOM	4	2	1
H-2938-01		1				26	NONE			
H-2938-02		2				52	NONE			
H-2938-03		3				78	NONE			
H-2938-04		4				104	NONE			
H-2938-05		5				130	NONE			
H-2938-06		6				156	NONE			
H-2938-07		7				182	NONE			
H-2938-08		8				208	NONE			
H-2938-09		9				234	NONE			
H-2938-10		10				260	NONE			
H-2938-11		11				286	NONE			
H-2938-12		12				312	NONE			
H-2939		UNIVERSAL BOARD					NONE			



H-2901 BLANK BOARD

Not copper clad.
2.45" wide x 4.14" high.

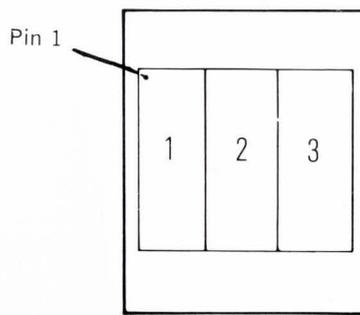
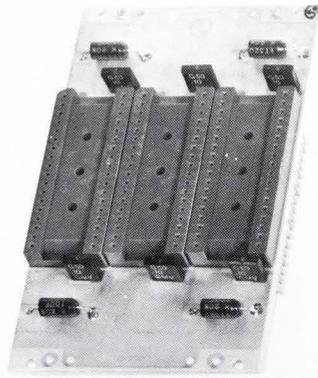


H-2902 MATRIX BOARD

Provides etched circuitry for mounting a variety of discrete components, for packaging special circuits or for adding extra components such as timing capacitors. Two 14-pin IC sockets are mounted with wire-wrap terminals for input/output wiring to components, located in socket position 20 & 23.

SOCKET, I/O CONNECTOR and SPECIAL BOARDS

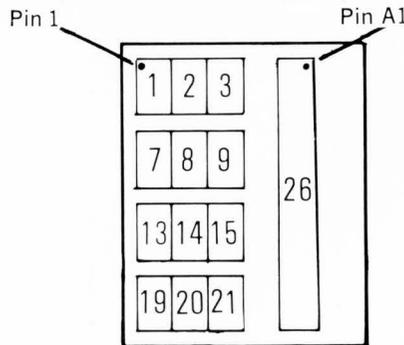
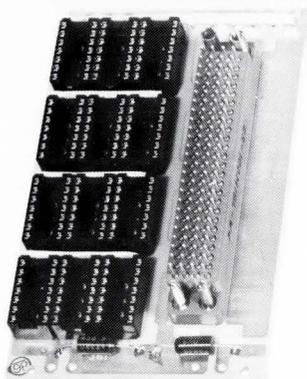
Front (socket) Side



Socket Locations (IC side)

H-2909 36-Pin Socket Board

Requires 1 block space. Contains three 36-pin sockets. Power is connected to any pin desired with wire loops (see Page 4). Tantalum and ceramic power by-pass capacitors mounted.



Socket Locations (IC side)

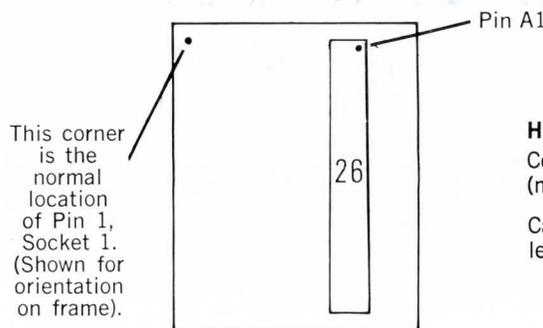
H-2911 100-Pin I/O Connector & 14-Pin Socket Board

Contains one 100-pin I/O connector (mating half not included) and twelve 14-pin sockets, power connected to pins 7 & 14. Laminated power bus and tantalum by-pass capacitors mounted.

H-2923

Same as H-2911 except power on 14 pin sockets is connected to any pin desired with wire loops (See Page 4).

Cannot be used in drawers that have 2 levels of planes.

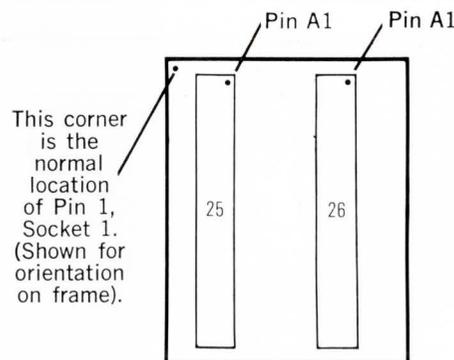
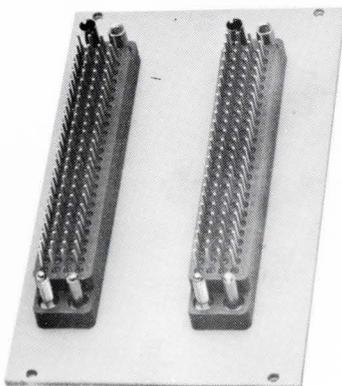


Connector location (I.C. side)

H-2912 100-Pin I/O Connector Board

Contains one 100-pin I/O connector (mating half not included).

Cannot be used in drawers that have 2 levels of planes.



Connector location (I.C. side)

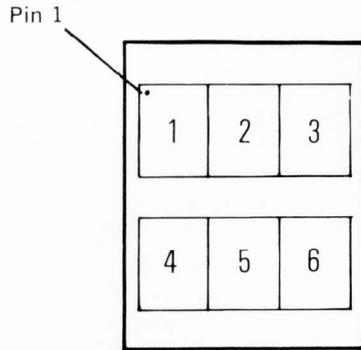
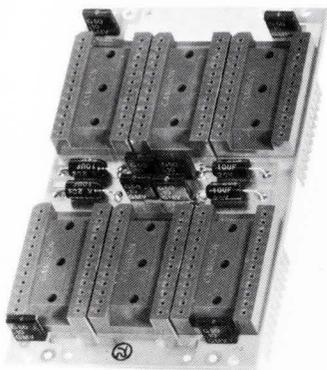
H-2913 I/O Connector Board

Contains two 100-pin I/O connectors (mating half not included).

Cannot be used in drawers that have 2 levels of planes.

SOCKET, I/O CONNECTOR and SPECIAL BOARDS

Front (socket) Side

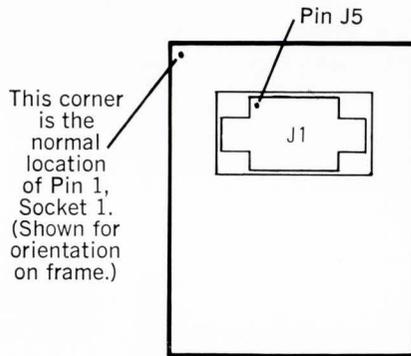
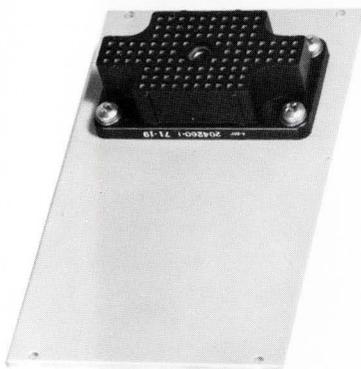


Socket Locations (IC side)

H-2918 24-Pin Socket Board

Contains six 24-pin sockets. Power is connected to any pin desired with wire loops (see Page 4). Has tantalum and ceramic by-pass capacitors.

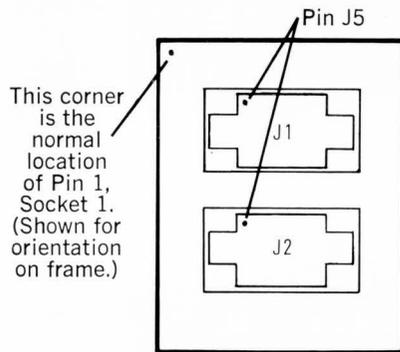
H-2923 — see H-2911.



Connector Location (IC side)

H-2929 106-Pin I/O Connector Board

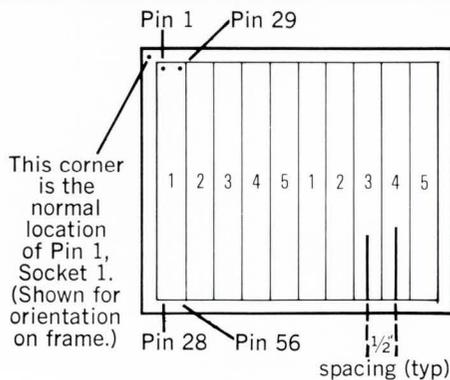
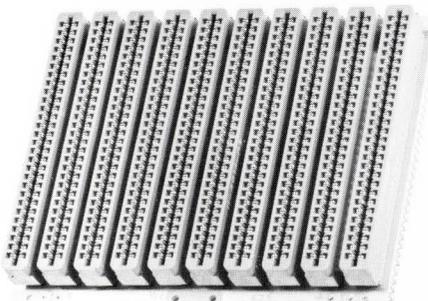
Contains one 106-pin I/O Connector (Mating half not included). Cannot be used in drawers that have 2 levels of planes. For connector details see connector H-4917.



Connector Location (IC side)

H-2930 106-Pin I/O Connector Board

Contains two 106-pin I/O Connector (Mating half not included). Cannot be used in drawers that have 2 levels of planes. For connector details see connector H-4917.



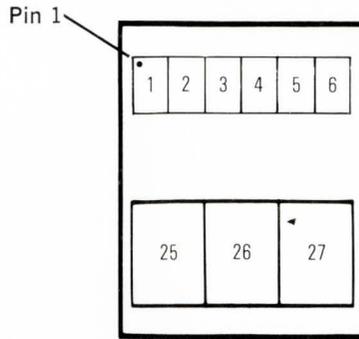
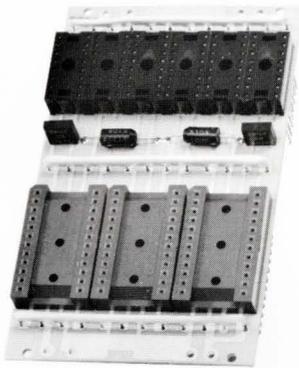
Connector Locations (IC Side)
Occupies 2 block space; must be mounted in single frame opening... see page 26.

H-2933 Edge Card Connector Board (wire-wrap)

Contains ten 56-pin edge card connectors that accommodate EECoLogIC 2 logic cards. Pins 1 and 29 are connected to Vcc and pins 28 and 56 are connected to ground. For card details, see EECoLogIC 2 catalog. For connector details see H-4918-01.

SOCKET, I/O CONNECTOR and SPECIAL BOARDS

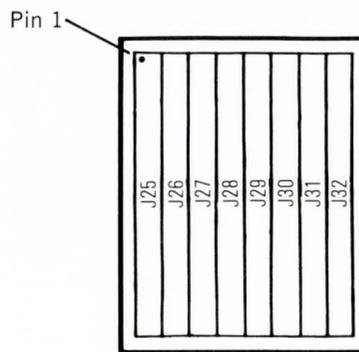
Front (socket) Side



Socket Locations (IC side)

H-2934 Socket Board

Contains six 16-pin sockets and three 24-pin sockets. Laminated bus-bars, tantalum and ceramic capacitors are mounted. Power is connected to any desired pins with wire loops (see page 4).

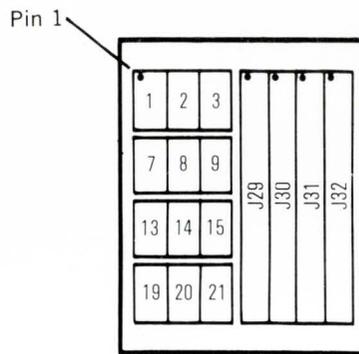
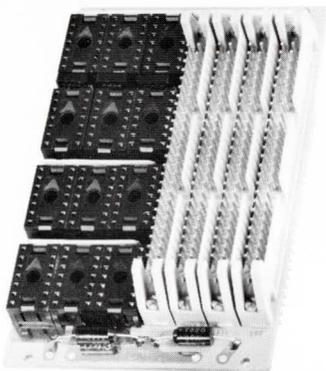


Connector Location (IC side)

H-2935 SERIES 50-PIN I/O Connector Board

PART NO.	CONNECTOR LOCATION								No. of Connectors
	J25	J26	J27	J28	J29	J30	J31	J32	
H-2935-01	•								1
H-2935-02	•	•							2
H-2935-03	•	•	•						3
H-2935-04	•	•	•	•					4
H-2935-05	•	•	•	•	•				5
H-2935-06	•	•	•	•	•	•			6
H-2935-07	•	•	•	•	•	•	•		7
H-2935-08	•	•	•	•	•	•	•	•	8

For connector details and mating connectors, see H-4920 and H-4925

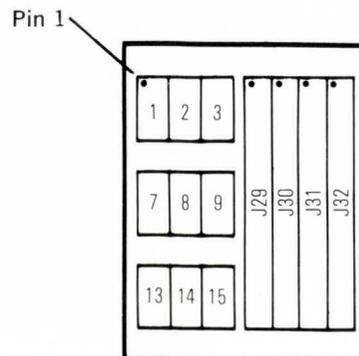


Socket Locations (IC side)

H-2936 50-pin I/O Connector and 14-pin Socket Board

Contains 50-pin connectors in positions shown below (mating half not included) and twelve 14-pin sockets. Power is connected to the 14-pin sockets—ground to pin 7 and Vcc to pin 14. Laminated power bus-bars and by-pass capacitors are mounted to provide low noise power distribution.

PART NO.	LOCATION			
	J29	J30	J31	J32
H-2936-01	•			
H-2936-02	•	•		
H-2936-03	•	•	•	
H-2936-04	•	•	•	•



Socket Locations (IC side)

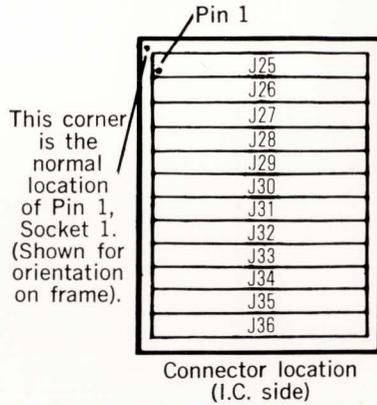
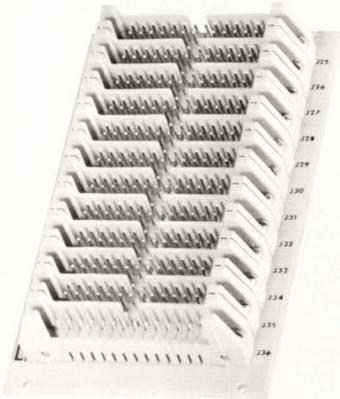
H-2937 50-pin I/O Connector and 16-pin Socket Board.

Contains 50-pin connectors in positions shown below and nine 16-pin sockets. Power can be brought to any pins in the 16-pin sockets by wire loops. (See page 4). Laminated bus-bars and by-pass capacitors are mounted.

PART NO.	LOCATION			
	J29	J30	J31	J32
H-2937-01	•			
H-2937-02	•	•		
H-2937-03	•	•	•	
H-2937-04	•	•	•	•

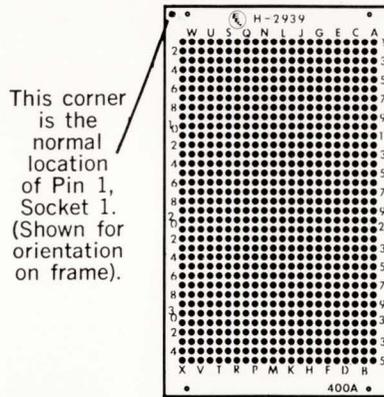
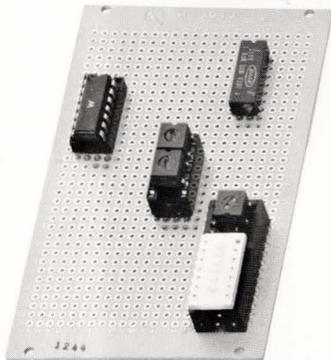
SOCKET, I/O CONNECTOR and SPECIAL BOARDS

Front (socket) Side



H-2938 Series 26-Pin I/O Connector Boards

PART NO.	LOCATION												No. of Connectors
	J25	J26	J27	J28	J29	J30	J31	J32	J33	J34	J35	J36	
H-2938-01	•												1
H-2938-02	•	•											2
H-2938-03	•	•	•										3
H-2938-04	•	•	•	•									4
H-2938-05	•	•	•	•	•								5
H-2938-06	•	•	•	•	•	•							6
H-2938-07	•	•	•	•	•	•	•						7
H-2938-08	•	•	•	•	•	•	•	•					8
H-2938-09	•	•	•	•	•	•	•	•	•				9
H-2938-10	•	•	•	•	•	•	•	•	•	•			10
H-2938-11	•	•	•	•	•	•	•	•	•	•	•		11
H-2938-12	•	•	•	•	•	•	•	•	•	•	•	•	12



H-2939 UNIVERSAL BOARD

770 holes on .100-inch centers... this pattern accepts any type of component, IC socket or IC strip with wire wrap pins. H-2939 has thru-hole plating so sockets and other components can be soldered in position.

I/O CONNECTORS and Mating Plugs

Table 6

	H-2710	H-2711	H-2714-XX	H-2719-XX	H-4914-01	H-4914-04	H-4916-01	H-4916-02	H4917
NUMBER OF PINS	28	28	14	28	100	100	106	106	106
TYPE	CRIMP	CRIMP	CABLE	CABLE	CRIMP	WW	CRIMP	CRIMP	WW
WIRE SIZE AWG	24-26	24-26	24	26	24-26	30	20-24	24-30	30
MATES WITH	H-2708 PINS	H-2708 SOCKET	H-2704	H-2708	H-4914-04	H-4914-01	H-4917	H-4917	H-4916
AVAILABLE ON BOARDS						H-2911 H-2912 H-2913 H-2923			H-2929 H-2930
RECOMMENDED TOOLS:									
CRIMP	H-2715	H-2716*			H-2716 *		H-4926-01	H-4926-02	
CONTACT EXTRACTION	H-2718	H-2717			H-4914-02	H-4914-03	H-4926-03	H-4926-03	H-4926-03
MATE SEPARATION									
PLATING	P5	P5	P3	P3	P6	P6	P1	P1	P1

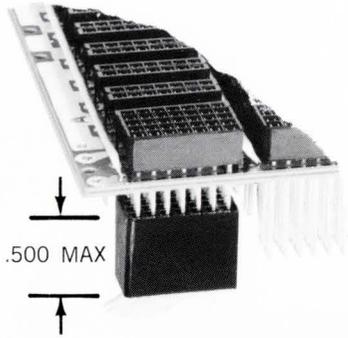
	H-4918-01	H-4919-01	H-4919-02	H-4920-01	H-4920-02	H-4922-01	H-4923-01	H-4925-01	H-4925-02
NUMBER OF PINS	56	26	26	50	50	26	50	26	50
TYPE	WW	CRIMP	CRIMP	CRIMP	CRIMP	FLAT	FLAT	WW	WW
WIRE SIZE AWG	30	22-26	28-32	22-26	28-32	28	28-30	WW30	WW30
MATES WITH	CARD	H-4925-01	H-4925-01	H-4925-02	H-4925-02	H-4925-01	H-4925-02	H-4919 H-4922	H-4920 H-4923
AVAILABLE ON BOARDS #:	H-2933							H-2938	H-2935 H-2936 H-2937
RECOMMENDED TOOLS:									
CRIMP		H-4921-01	H-4921-02	H-4921-01	H-4921-02				
CONTACT EXTRACTION		H-4921-03	H-4921-03	H-4921-03	H-4921-03				
MATE SEPARATION		H-4924	H-4924	H-4924	H-4924	H-4924	H-4924		
PLATING	P2	P3	P3	P3	P3	P4	P4	P4	P4

NOTES: P1 Selective: 30 microinches gold over 30 microinches nickel in contact area
 5 microinches gold over 30 microinches nickel in crimp or WW area
 P2 30 microinches gold over nickel per MIL-G-45204 TYPE II
 P3 40 microinches gold over 50 microinches nickel

P4 gold over nickel
 P5 10 microinches gold per MIL-G-45204 TYPE II
 P6 50 microinches gold over 50 microinches copper
 * See Tool Description on Page 25

I/O CONNECTORS

PIN NUMBERS viewed from Cable Side

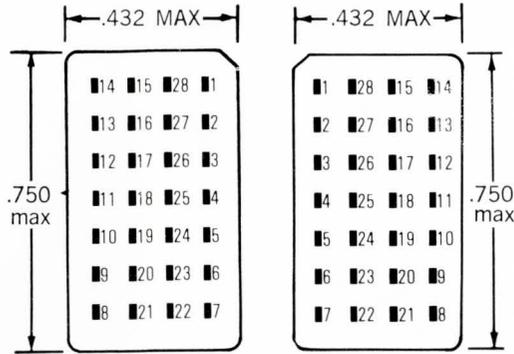


.500 MAX

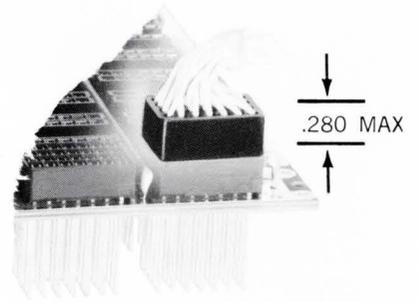
H-2710 28-PIN RECEPTACLE KIT

Contains 28-pin female connector housing and 30 female crimp pins to allow assembly of cable. Plugs directly on wire-wrap pins. Satisfactory connection even with 2 levels of wire-wrap* installed.

*Reg. T.M. Gardner-Denver



NOTE: Due to width, two of these connectors should not be located side by side.



.280 MAX

H-2711 28-PIN PLUG KIT

Contains 28-pin male connector housing and 30 male crimp pins to allow assembly of cable. Plugs directly into 28-pin socket.

H-27XX-XX-XX CABLE CONNECTORS

These cable assemblies can be used to extend the flexibility of EECO 2-D.

How to specify part number...

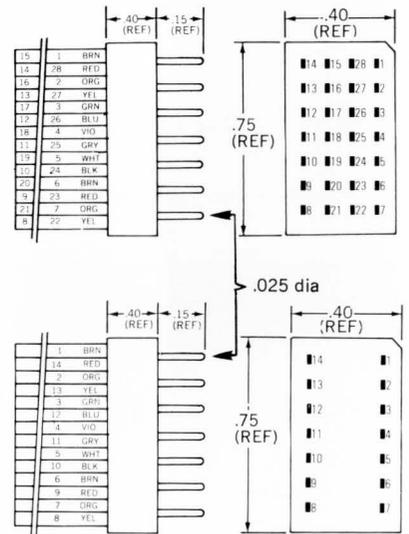
CABLES H-27XX-XX-XX



Cable assemblies, with a connector at one end only, use a color coded flat ribbon cable.

Cable assemblies with connectors at both ends, use #26 wire without color coding.

- Length in inches
- 01 = Connector only on one end
- 02 = Connector at both ends
- 14 = 14 Conductor Cable
- 19 = 28 Conductor Cable



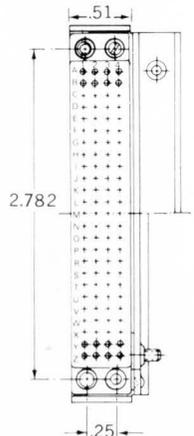
PIN NUMBERS viewed from Wire-Wrap* Side

H-4914-01 INPUT/OUTPUT CONNECTOR (100-PIN)

Mating connector for H-2911, H-2912, and H-2913 connector boards and H-4914-04, rear panel connector. Furnished with 100 contacts. Contacts accept 22-26 AWG size wire. Clamp provided to relieve wire stress, can be mounted left or right. For cable clamp mounted in center position, order H-4914-05.



Dimensions are ± .010



H-4914-04 REAR PANEL CONNECTOR (100-PIN)

Connector used on H-2911, H-2912, H-2913, H-2923 connector boards, and rear panel (11 positions available) of standard drawer (see HAF-1) provides .025 square wire-wrap pins which are machine wrapped in the assembly.

Use Extraction Tool H-4914-03.



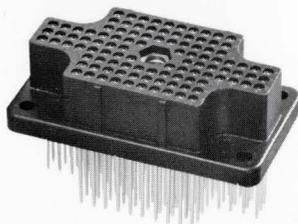
PIN NUMBERS viewed from Wire-Wrap* Side

I/O CONNECTORS



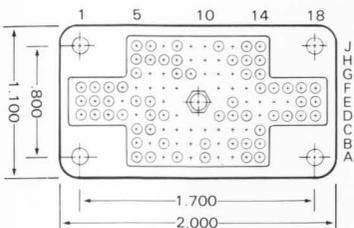
H-4916 106-PIN MATING CONNECTOR

Mating connector for connector boards H-2929 and H-2930. Furnished with 106 crimp contacts and a clamp to relieve stress. Order H-4916-01 for use with 20 to 24 AWG wire and H-4916-02 for use with 24 to 30 AWG wire.

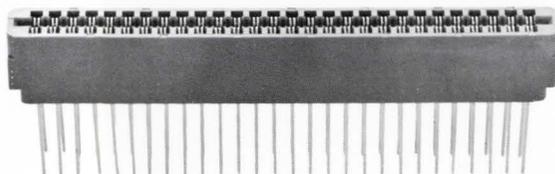


H-4917 106-PIN INPUT/OUTPUT CONNECTOR

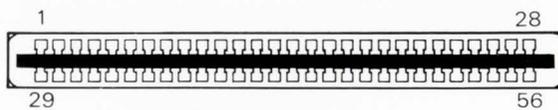
Connector used on connector boards H-2929 and H-2930.



Pin Location (component side, as mounted on board)



*Reg. T.M. Gardner-Denver

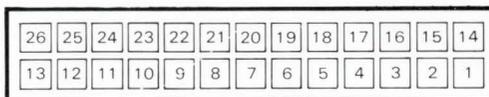


H-4918-01 56-PIN EDGE CARD CONNECTOR

Wire-wrappable edge card connector for EECoLogIC 2 logic cards. Mounted on board H-2933. For more details ask for EECo Drawing No. 311160.



(Top of Mounting Board)



PIN NUMBERS viewed from Wire-Wrap* Side

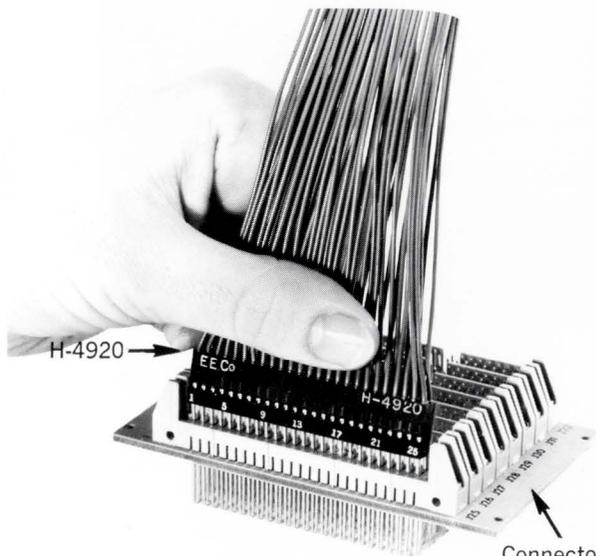


H-4919 26-PIN MATING CONNECTOR

26-pin connector mates with H-2938 series boards. 30 crimp pins are furnished. H-4919-01 connector is for use with 22 to 26 AWG wire (insulation range is .036 to .103) and H-4919-02 for 28 to 32 AWG wire (insulation range is .028 to .054).

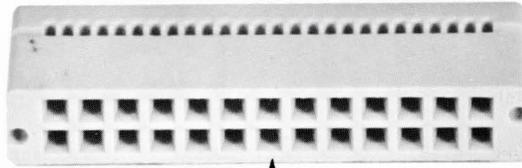
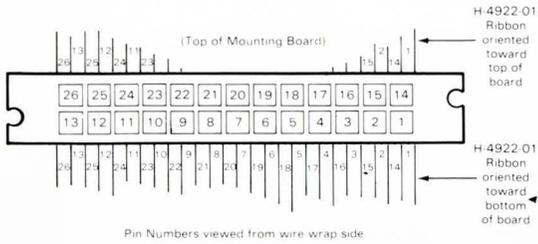
H-4920 50-PIN MATING CONNECTOR

This connector mates with boards H-2935, H-2936 and H-2937. It has crimp-to-wire terminals for use with individual or twisted pair wires. For 22 to 26 AWG, the insulation range is .036 to .103 and the part number specification is H-4920-01. For 28 to 32 AWG, the insulation range is .028 to .054 and the part number specification is H-4920-02.



Connector Board H-2935-08

I/O CONNECTORS



H-4922-01

H-4922-01 26-PIN MATING CONNECTOR

Mating connector for H-2938 series boards. Terminates in flat cable...3M Scotchflex 3365 26 cond. 28 AWG stranded. 3M Scotchflex tool: Model 3440 press is recommended for assembly of cable.

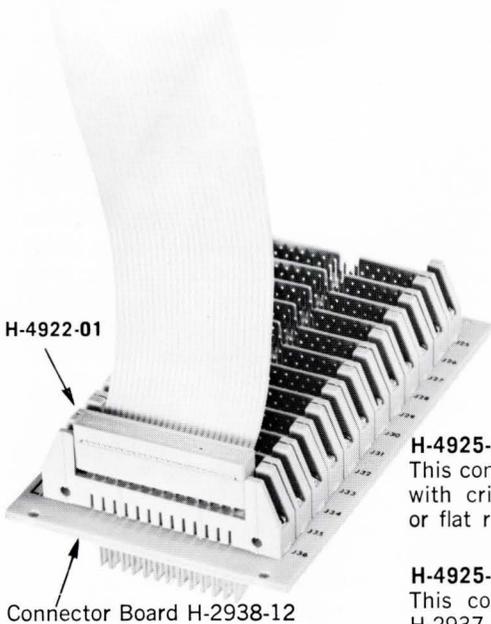
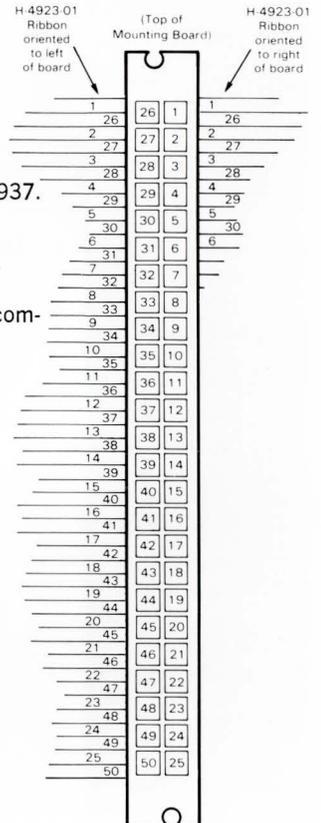
H-4923-01 50-PIN MATING CONNECTOR

Mates with boards H-2935, H-2936 and H-2937.

Terminates in 3M Scotchflex flat cable:

- #3365.....28 AWG stranded
- #3350.....30 AWG solid
- #3380.....30 AWG solid, shielded

3M Scotchflex tool: Model 3440 press is recommended for cable assembly.



H-4925-01 26-PIN INPUT/OUTPUT CONNECTOR

This connector is used on H-2938 boards and mates with crimp connectors H-4919-01 and H-4919-02 or flat ribbon connector H-4922-01.

H-4925-02 50-PIN INPUT/OUTPUT CONNECTOR

This connector is used on H-2935, H-2936 and H-2937 boards and mates with crimp connectors H-4920-01 or H-4920-02 or flat ribbon connector H-4923-01.

NOTE: These connectors can be mated in two different orientations. The wire-wrap pin numbers shown on the wire-wrap side of the connector board are

the correct pin numbers. Pin number identifications on a mating connector, that differ from the board pin numbers, should be completely disregarded.

H-2703 COMPONENT MOUNTING TERMINALS

Discrete components can be connected to two wire-wrap pins with these terminals.

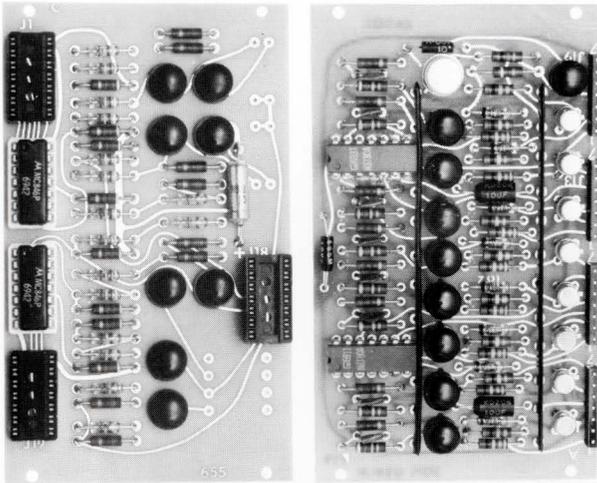
Component Wire Size
 18 to 20 GA
 22 to 26 GA
 28 to 32 GA

EECO Part Number
 H-2703-01
 H-2703-02
 H-2703-03

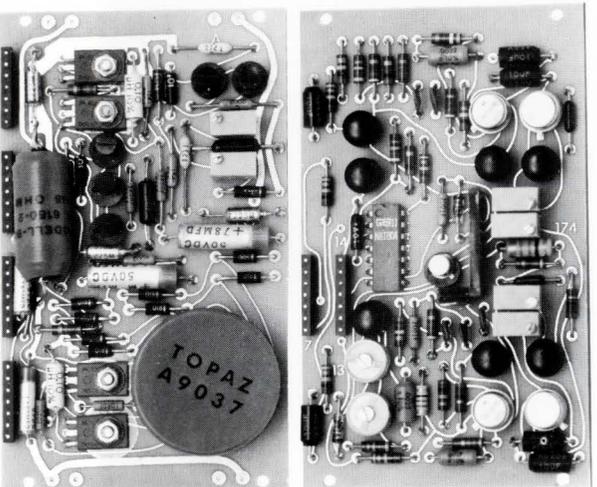


EECO MINIBOARDS

Increased versatility with EECO Miniboards



2D502 2D597
Typical Digital Miniboards



2D592 2D599
Typical Analog Miniboards

EECO provides, with Miniboards, a selection of analog and digital circuits to solve system interface. Even more flexibility is provided with matrix and blank boards which allow the mounting of various components in almost any configuration (see H-2901, H-2902 and H-2939).

Miniboards are versatile and can be mounted in any location of an assembly.

These discrete component assembly boards provide analog and digital functions which are not readily available in IC form. You may specify these on your logic diagram or allow EECO to select the appropriate unit for your application.

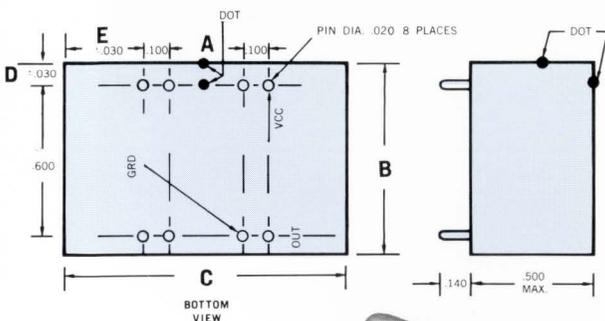
I/O pins are located in standard socket position as H-2904. Complete Data Sheets for Miniboards are available on request.

DIGITAL COMPONENT ASSEMBLIES

- 2D501 Eight input level converters with gated outputs. Input: True level -2.5 to -50V. False level -0.5 to +2V. Output: DTL Logic levels.
- 2D502 Eight output level converters with gated inputs. Input DTL Logic levels. Output: On level 0 to -0.5V. Off level -3.0 to -20.0V.
- 2D504 Six form "A" reed relays with 3 input drivers
- 2D505 Six form "C" reed relays with 3 input drivers
- 2D506 Eight 2-input 250 ma. relay drivers, +35V.
- 2D507 Ten 2-input 100 ma. lamp drivers.

ANALOG COMPONENT ASSEMBLIES

- 2D592 ±15 Volt power supply, converts from +5 volts
- 2D595 3 digit BCD digital-to-analog converter
- 2D596 11-bit binary digital-to-analog converter
- 2D597 8-channel analog multiplexer
- 2D598 Buffer Amplifier
- 2D599 Sample and Hold Amplifier
- 2D600 12-bit analog to digital converter.



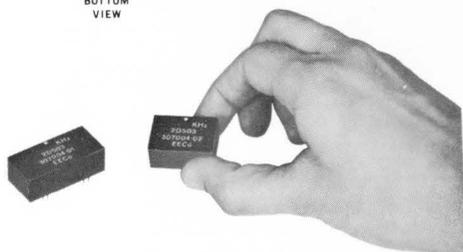
EECO CRYSTAL OSCILLATORS

Crystal Oscillator, stability ±.004%. Various frequencies available
Plug-in Oscillators. Stability ± .004%

Part No.	Frequency Range	Dimensions (inches)				
		A	B	C	D	E
2D-TS-1	12,500 to 199,99 KHz*	.700	.750	1.50	.075	.300
2D-TS-2	200.00 to 16,999 KHz**	.300	.780	1.12	.090	.312
2D-TS-3	17,000 to 30,000 KHz*	.700	.750	1.50	.075	.300

**Occupies 3 sockets. Output is pin 8 of first socket.

*Occupies 4 sockets. Output is pin 8 of second socket.



MICROBOARDS

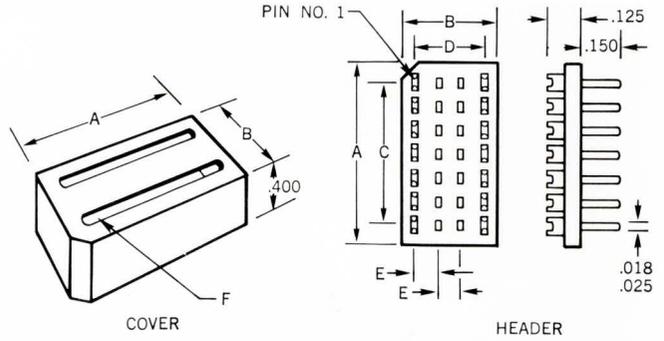
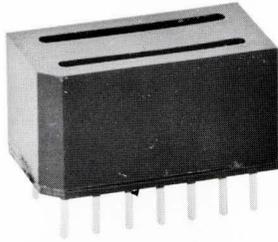
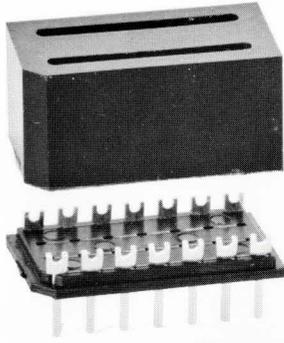


Table 7 MICROBOARDS

H-2723	Single Width			Double Width		Without Cover	With Cover	Dimensions							
	14 Pin	16 Pin	28 Pin	14 Pin	16 Pin			A	B	C	D	E	F		
-01	X					X		.750	.400	.600	.300				
-02	X						X	.750	.400	.600	.300			(2) .050X .590 SLOTS	
-03		X				X		.850	.400	.700	.300				
-04		X					X	.850	.400	.700	.300			(1) .050X .690 SLOTS	
-05				X		X		.750	.800	.600	.700				
-06					X	X		.850	.800	.700	.700				
-07			X			X		.750	.400	.600	.300	.100			
-08			X				X	.750	.400	.600	.300	.100		(2) .050X .590 SLOTS	

H-2723 MICROBOARDS

Microboards plug into IC sockets to provide mounting for discrete components. Microboards can also be used as test points. As microboards are extensions of socket pins, pin numbers will correspond to those of the sockets. See socket layouts below. **CAUTION:** Pre-wired sockets will have Vcc and ground on the corresponding pins as shown in the socket board information.

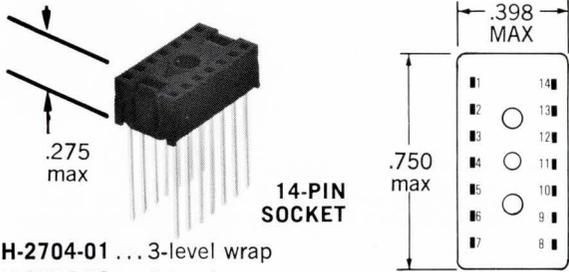
NOTES:

50 microinches gold type II class I over 200 microinches nickel QQN290. Full spring temper-Miller 200+Grade A Phosphor Bronz.

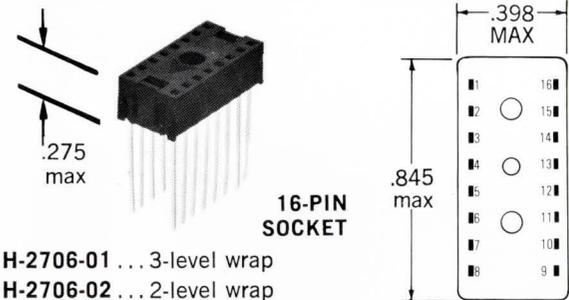
EECO SOCKETS

All pin layouts are top shown from the IC side.

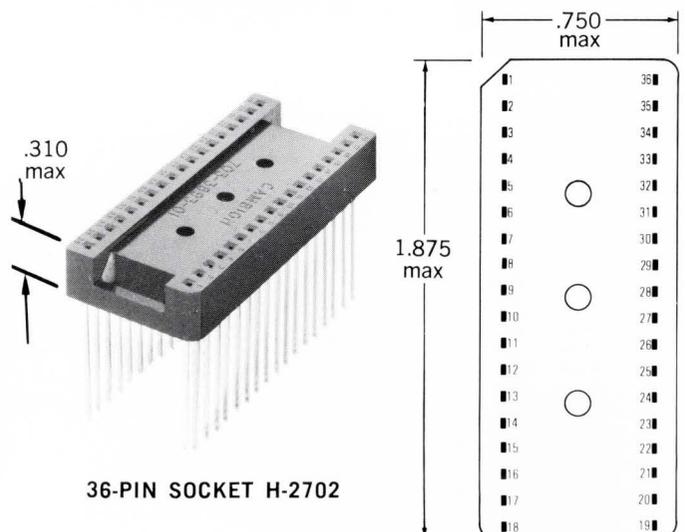
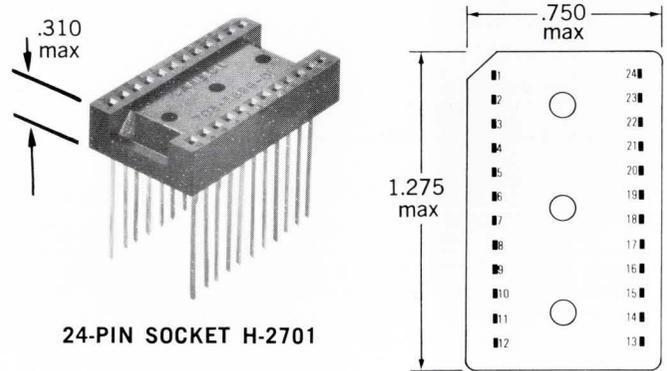
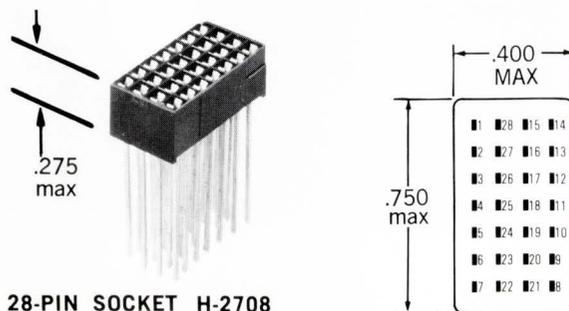
Housing Material: Nylon, black, type 6



H-2704-01 ... 3-level wrap
H-2704-02 ... 2-level wrap



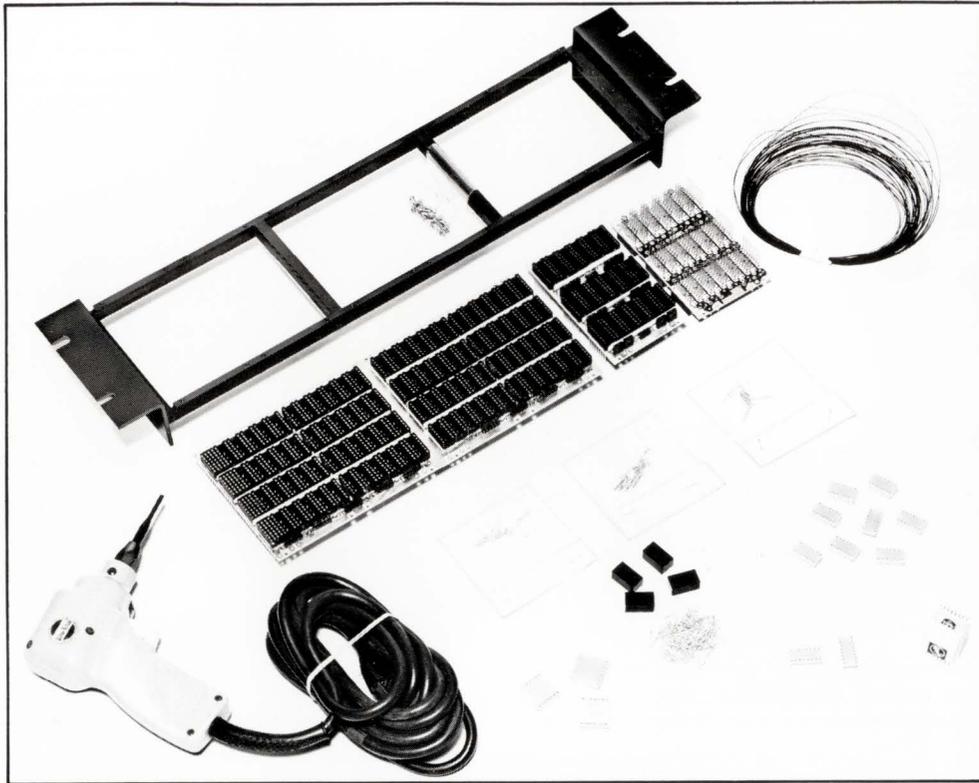
H-2706-01 ... 3-level wrap
H-2706-02 ... 2-level wrap



Contact Materials for H-2704 and H-2706:

Phosphor bronze per QQ-B-750. Gold plater per MIL-G-45204, Type II .000020 minimum over .000050 nickle.

EECO IC BREADBOARD KITS



Kit H-7003

These kits are very useful for prototyping and testing logic ideas. The parts included in the kits are described more fully in this catalog (see product index).

Four optional items should be considered when ordering one of these kits:

- Option A Wire Wrapping Gun, Gardner Driver 14XA2-B
- Option B Unwrap Tool, Gardner Denver 505084-(LH)
- Option C Bit & Sleeve (1 ea), Gardner Denver 507502 & 507100
- Option D Power Supply, P-2699-01 (requires 2-block spaces if mounted in the frame).

Kit **H-7001** forms a 48 IC socket assembly with forty four 14-pin sockets and four 28-pin sockets. The 28-pin sockets can be used as either 14-pin IC sockets or as I/O connectors. Ample frame space is provided to allow up to 96 additional sockets.

Kit **H-7002** forms an 84 IC socket assembly with forty four 14-pin sockets, four 28-pin sockets (the 28-pin sockets can be used as either 14-pin IC sockets or as I/O connectors), and thirty-six 16-pin sockets. Ample frame space is provided to allow up to 48 additional sockets.

Kit **H-7003** forms a 132 IC socket assembly with ninety two 14-pin sockets, four 28-pin sockets (the 28-pin sockets can be used as either 14-pin IC sockets or as I/O connectors), and thirty-six 16-pin sockets.

KIT CONTENTS

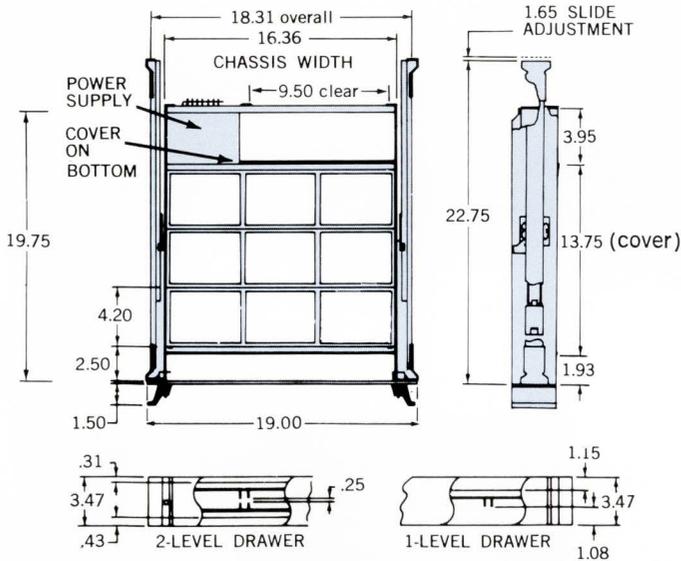
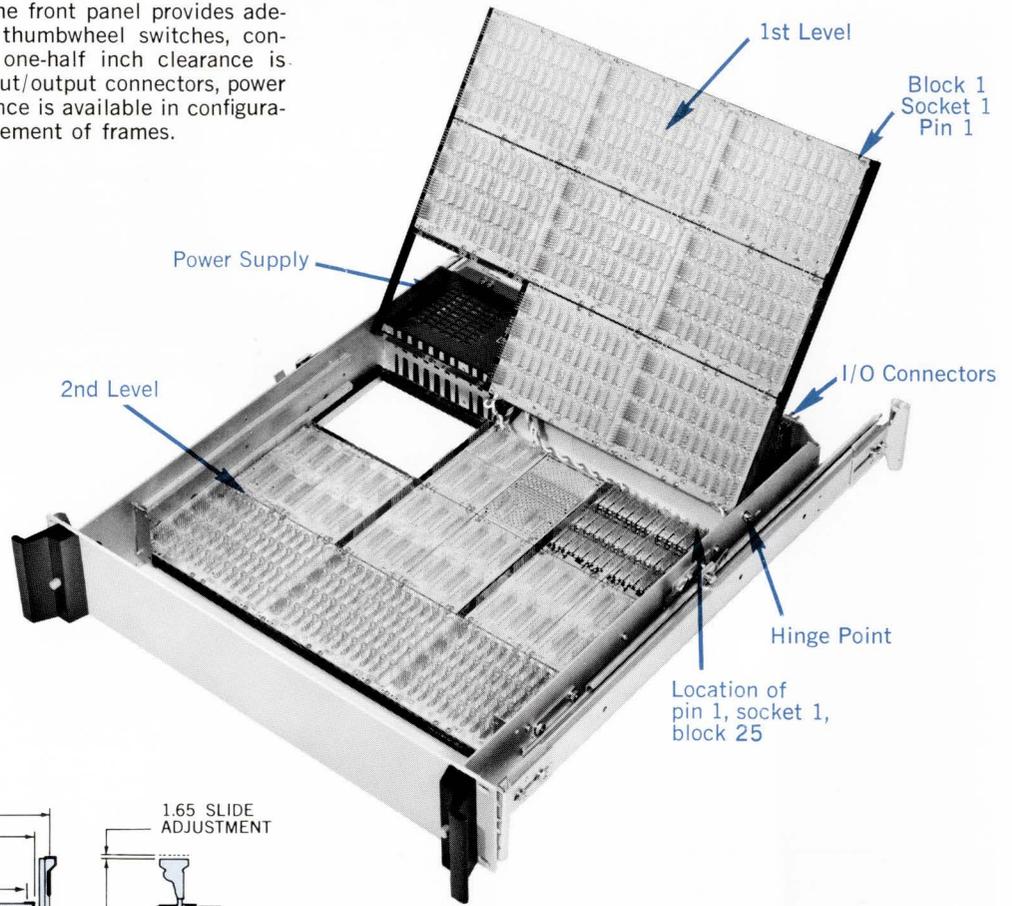
		QUANTITIES		
		H-7001	H-7002	H-7003
H-2905-01	Socket Board Assembly/48 Sockets (44 14-pin and 4-28 pin)	1	1	
H-2906-01	Socket Board Assembly/96 Sockets (92 14-pin and 4-28 pin)			1
H-2910	Socket Board Assembly/18 16-pin Sockets		1	2
H-2300-01	Connector Frame	1	1	1
H-2711	Plug, Male — 28 contacts	4	4	4
H-2712-01	Micro-Board, 14 pin — Single Width	4	4	8
H-2712-02	Micro-Board, 16 pin — Single Width		4	2
H-2712-03	Micro-Board, 14 pin — Double Width	2	1	2
H-2712-04	Micro-Board, 16 pin — Double Width		1	1
H-2705	Test Clip	1	1	1
H-2703-02	Terminal, Single Contact	12	18	24
346002-59	Wire, Solid — Kynar Insulation/30 AWG	250 ft.	500 ft.	750 ft.

You can, of course, list and order a "kit" containing frames, boards and parts other than the three shown above.

EECO 2-D DRAWERS

Drawers are designed to mount in MIL-STD-189 equipment racks. Perforated bottom covers are included, as well as tilt type ball bearing slides.

A 2½" mounting space behind the front panel provides adequate room for panel mounted thumbwheel switches, controls, and indicators. Four and one-half inch clearance is provided at the rear panel for input/output connectors, power supplies, etc. Even greater clearance is available in configurations with less than a full complement of frames.



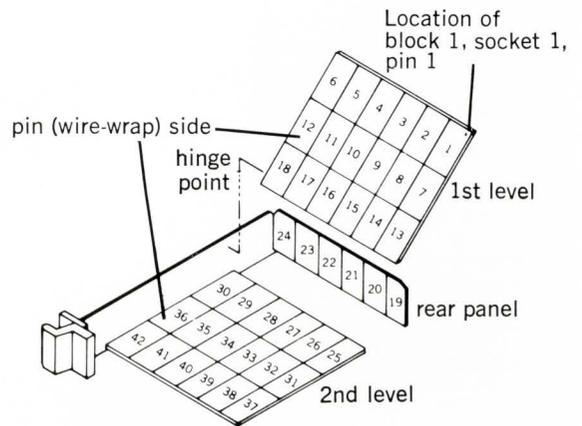
MATERIALS:

- Front Panel:** Aluminum 1/8", gray color Federal Std. 595-26440
- Chassis:** Aluminum
- Finish:** Gold anodized
- Frames:** Diecast aluminum, black anodized
- Slides:** Accuride 335 Series, ball bearing, front disconnect, 360° rotatable and lock-out mechanism
- Handles:** Aluminum, pushbutton latch, black anodized

Table 8 EECO 2-D DRAWERS

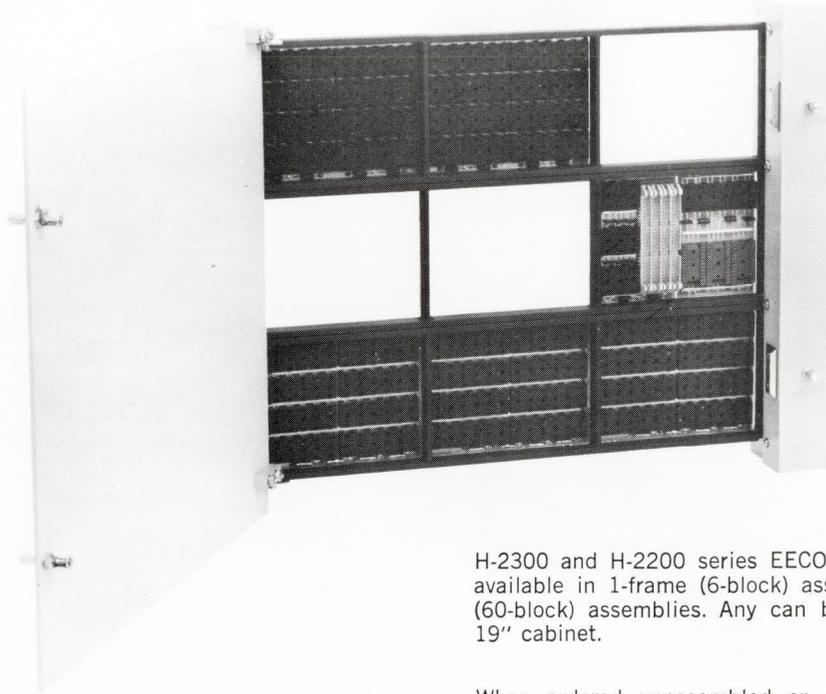
Part Number	Max. IC Capacity	No. of Frames	No. of Blocks	Blocks Included
H-2100-01	144	1	6	1 thru 6
H-2100-02	288	2	12	1 thru 12
H-2100-03	432	3	18	1 thru 18
H-2100-04	576	4	24	7 thru 18 25 thru 36
H-2100-05	864	6	36	1 thru 18 25 thru 42
H-2120 *	1152	8	48	1 thru 24 31 thru 48

*Contact EECO for dimensional information (Drawing #117793)



Connectors H-4917 or H-4914-04 can be mounted on rear panel.

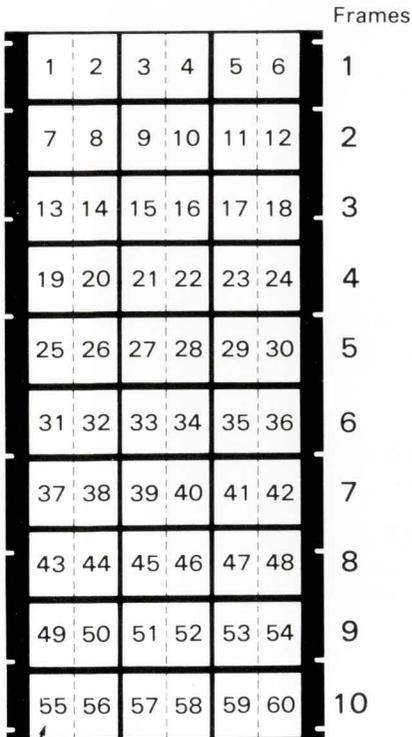
EECO SINGLE LEVEL FRAME ASSEMBLIES



H-2200-13

H-2300 and H-2200 series EECO FRAME ASSEMBLIES are available in 1-frame (6-block) assemblies through 10-frame (60-block) assemblies. Any can be mounted in a standard 19" cabinet.

When ordered unassembled or separately, EECO FRAMES come with insulator strips, 24 No. 2 Nylon washers, and 24 Pan head 2-56 screws, installed.



Block numbers as seen from the IC or component mounting side of the finished assembly.

H-2200-10
H-2300-10

SPECIFICATIONS

Frame:

Material: Die cast aluminum
Finish: Black Anodize

H-2200 Mounting Flange, Hinge and Front Panel:

Material: Aluminum
Finish: Painted, Lt. Gray, No. 26440
per FED-STD-595

H-2300 Mounting Flange:

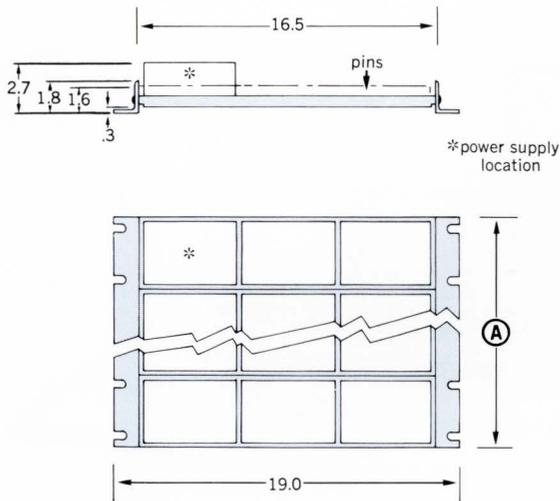
Material: Extruded Aluminum
Finish: Black Anodize

Table 9 EECO FRAME ASSEMBLIES - SINGLE LEVEL

SERIES H-2200 and H-2300

Single Level Fixed	Single Level Swing-Out	Single Level Swing-Out w/Panel	No. of Frames	Block Spaces	Max. IC Socket Capacity	"A" Dim.	"B" Dim.
H-2300-01	H-2200-01	H-2200-11	1	6	144	4.20"	5.22"
H-2300-02	H-2200-02	H-2200-12	2	12	288	8.40"	10.47"
H-2300-03	H-2200-03	H-2200-13	3	18	432	12.60"	13.97"
H-2300-04	H-2200-04	H-2200-14	4	24	576	16.80"	17.47"
H-2300-05	H-2200-05	H-2200-15	5	30	720	21.00"	22.71"
H-2300-06	H-2200-06	H-2200-16	6	36	864	25.20"	26.22"
H-2300-07	H-2200-07	H-2200-17	7	42	1008	29.40"	29.71"
H-2300-08	H-2200-08	H-2200-18	8	48	1152	33.60"	34.97"
H-2300-09	H-2200-09	H-2200-19	9	54	1296	37.80"	38.47"
H-2300-10	H-2200-10	H-2200-20	10	60	1440	42.00"	43.71"

H-2300 series single level fixed frame assemblies



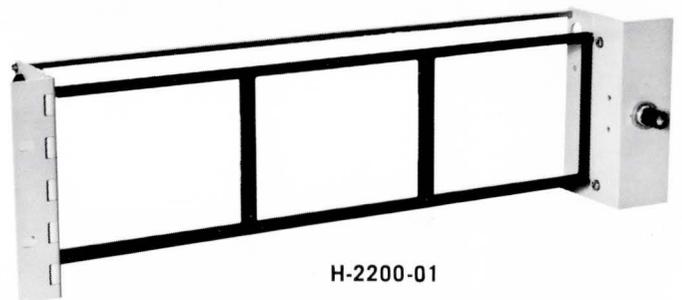
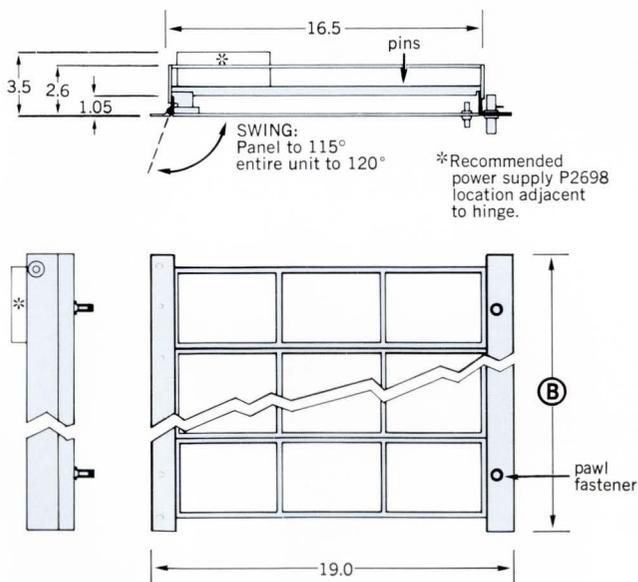
H-2300-03

SINGLE LEVEL FIXED FRAME ASSEMBLIES

Dimensions are rounded to tenths of inches. For more exact dimensions, ask for EECO drawing number 117364

Single level Fixed Frames can be mounted vertically or horizontally permitting a wide range of installation alternatives. Power Supply can be mounted in any open 2-block space.

H-2200 series single level swing-out frame assemblies



H-2200-01

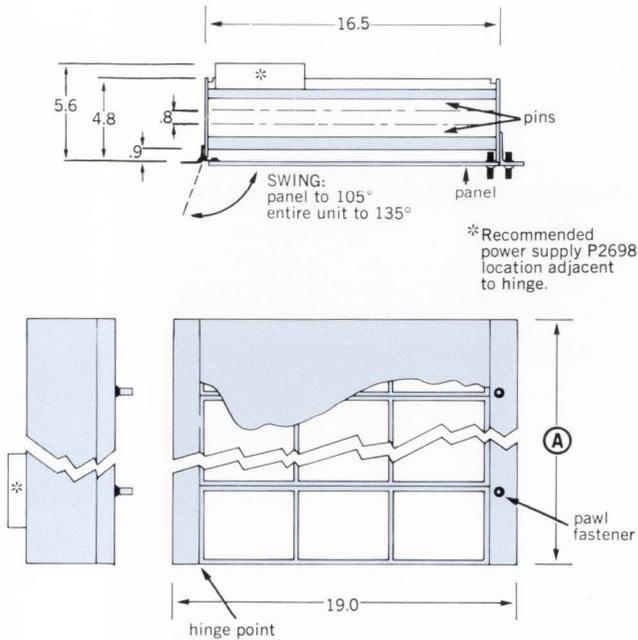
SINGLE LEVEL SWING-OUT FRAME ASSEMBLIES

Dimensions are rounded to tenths of inches. For more exact dimensions, ask for EECO drawing number 110911

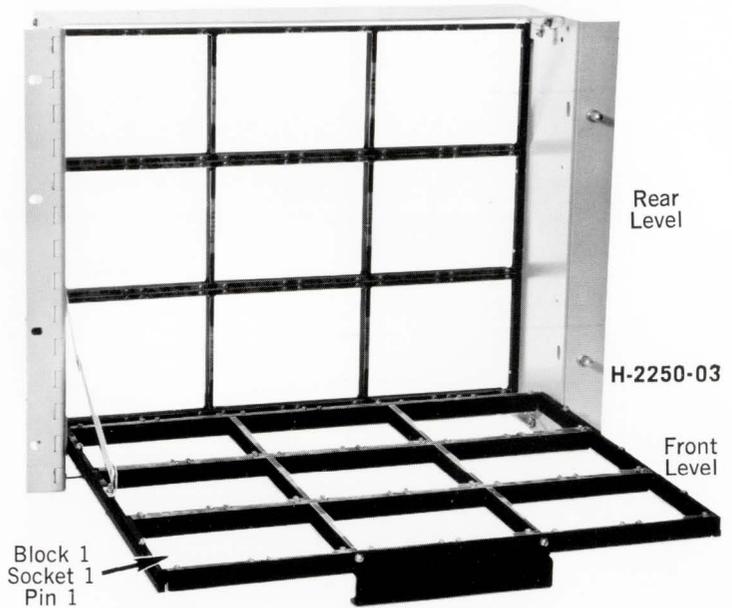
H-2200 series frames swing out 120 degrees from the closed position providing ready access to the wire-wrap pin side. Assembly is locked in the closed position with a one-quarter turn pawl lock.

Front Panel models are available for all H-2200 Series Frames. The front panel fits flush with the mounting flange. One-quarter turn pawl locks provide positive locking of the front panel. Front panel hinge and flange is painted light gray No. 26440 per FED-STD-595.

H-2250 series double level swing-out frame assemblies



DOUBLE LEVEL SWING-OUT FRAME ASSEMBLIES
 Dimensions are rounded to tenths of inches. For more exact dimensions, ask for EECO drawing number 119736



H-2250 Series assemblies can hold double the IC density per front panel size. Frame assemblies are 19" wide for standard rack mounting.

The complete unit swings out 135° from its closed position. The front frame is hinged to open 95° vertically for access between panels. The rear level is fixed. Quarter-turn panel fasteners lock the assembly in the closed position.

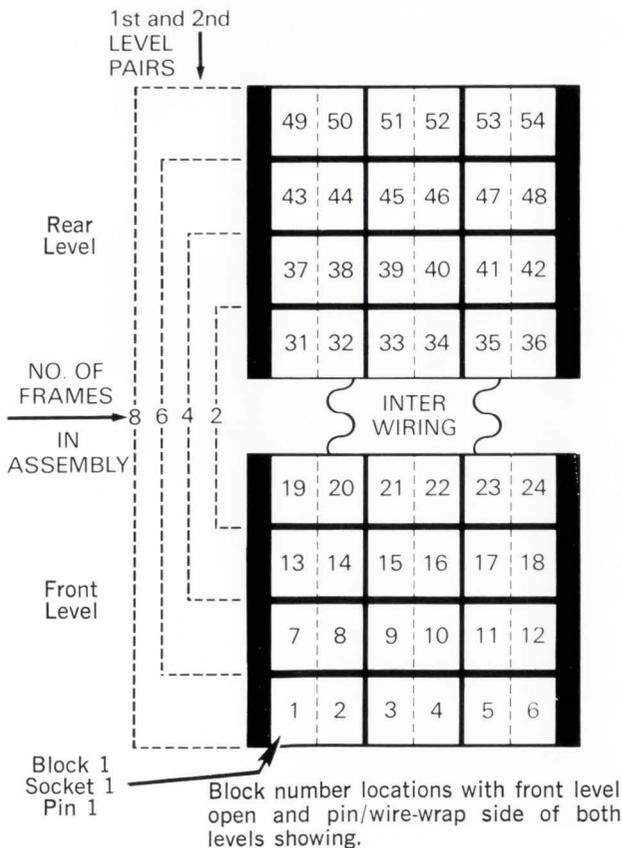
A power supply can be mounted (2-block spaces) in blocks #31 and 32.

A terminal block with six pairs of no. 6 terminals provides for power hook up. If a power supply is used, the terminal block is normally mounted to it.

Front Panel models are available for all H-2250 Series Frames. The front panel is flush fitting with the mounting flange. One-quarter turn pawl fasteners provide positive locking of the front panel. Front panels are painted light gray No. 26440 per FED-STD-595.

Table 10
DOUBLE LEVEL SWING-OUT FRAME ASSEMBLIES
 H-2250 SERIES

No. of Frames	Block Spaces	Max. IC Socket Capacity	Part Number		"A" Dim.
			w/o Front Panel	w/ Front Panel	
2	12	288	H-2250-01	H-2250-05	5.22"
4	24	576	H-2250-02	H-2250-06	10.47"
6	36	864	H-2250-03	H-2250-07	13.97"
8	48	1152	H-2250-04	H-2250-08	19.22"

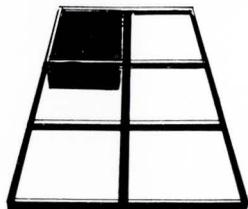
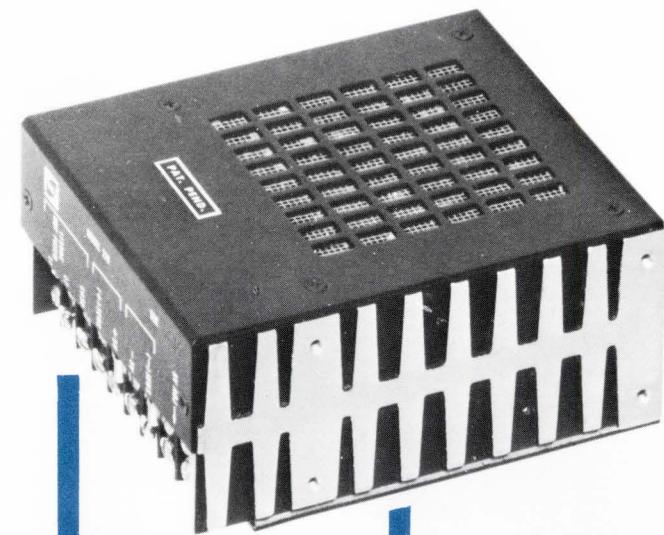


SPECIFICATIONS

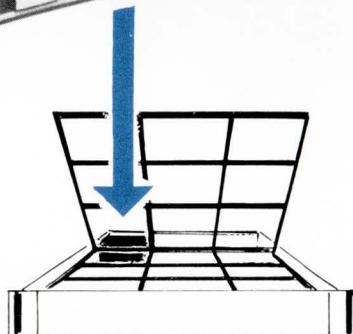
- Frame:**
 Material: Die cast Aluminum
 Finish: Black Anodize
- Mounting Flange, Hinge and Front Panel:**
 Material: Aluminum
 Finish: Painted, Lt. Gray, No. 26440 per FED-STD-595

EECO 2-D POWER SUPPLIES

For Digital and Analog Functions



P-2698 Power Supply mounts in any 2-block section of a frame.



P-2699 Power Supply mounts in the rear left of standard drawer (Does not mount in frame.)

SPECIFICATIONS

Input

105 to 130 VAC, 50 to 1000 Hz. External fuse required.

Output

3.5 to 5.5 VDC @ 10 amps.

Protection

All outputs current limited, continuous overload and short circuit proof. 5 volt outputs have self-recovering over-voltage protection set at 6.8 to 7 volts.

Temperature Stability

Better than 0.01%/°C

Cooling

Maximum mounting base temperature for full output is 85°C. For no cooling (air or conductive), max. ambient temperature of 30°C for full output. Derate linearly to 60% power at 60°C ambient and no cooling. (See derating curve for units mounted in hardware.)

Operating Temperature

-20°C to +85°C

MTBF

Over 100,000 hours calculated in accordance with MIL-HDBK-217A (Life Test Report available on request).

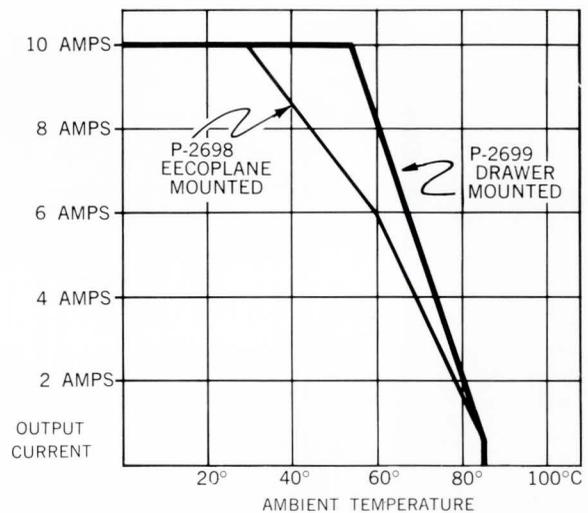
Size

5-1/16" x 4" x 2-1/4", 45 cubic inches

Weight

2 pounds

-50 watts in 45 cubic inches
-5-1/16" x 4" x 2-1/4", weighs 2 lbs.
-70% efficiency
-fully protected
-20 KHz operation, no audible noise
-RFI filtered

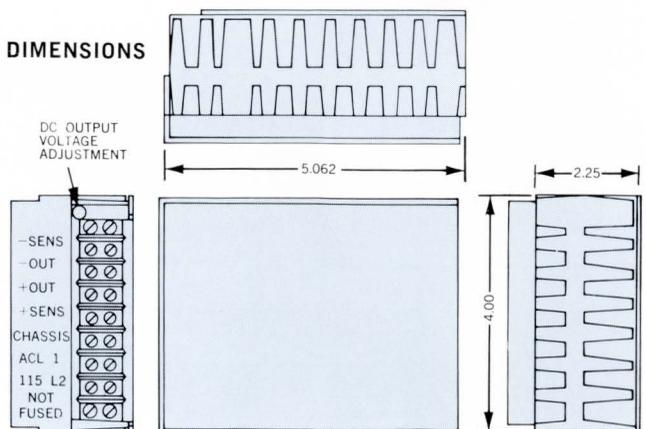


The above curve shows the max. current available from the indicated power supply in its normally installed condition.

Life Test Reports available on request. Test Report Number A-117558 — MTBF 100,000 hrs. per MIL-HDBK-217A.

For availability of power supplies with voltages and currents other than those listed, contact factory.

DIMENSIONS

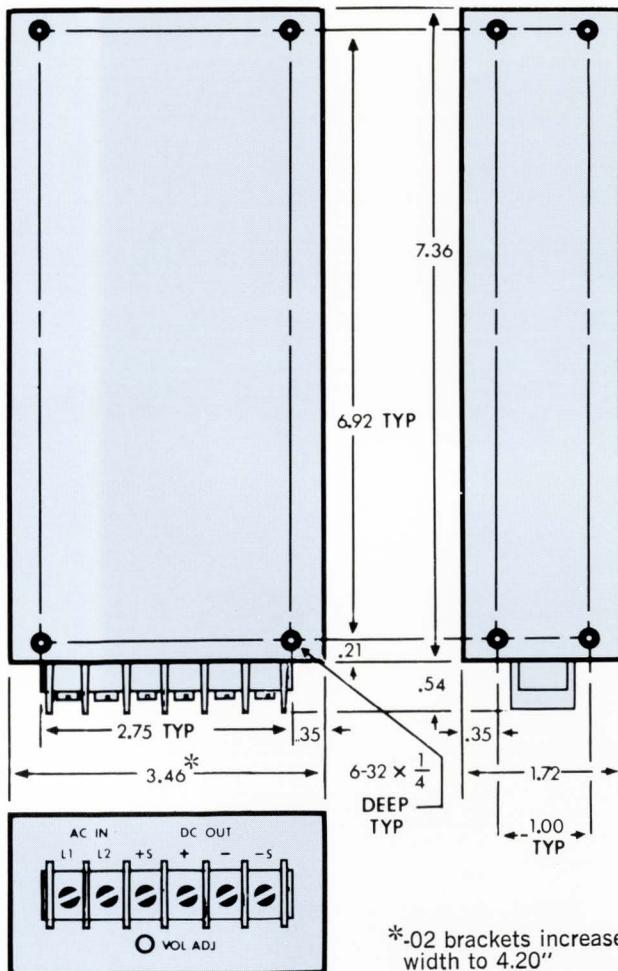


LOW POWER — COMPACT — POWER SUPPLIES

P2693-01 and **P2694-01** . . . standard
P2693-02 and **P2694-02** . . . with mounting bracket

Power Supplies P2693-01 and P2694-01 must be custom mounted directly, without mounting brackets, on the back of the back panels in H-2100 series drawers.

Power Supplies P2693-02 and P2694-02 have a mounting bracket designed to mount on the wire-wrap side of a frame. They require three block spaces and should be mounted at left or right end of a frame (not in middle). Either can be used on H2300 or H2200 series frame assemblies. They cannot be used on H2250 series frames or H-2100 series drawers.



COMMON SPECIFICATIONS

INPUT

105 to 125 VAC, 50 to 70 Hz

Power Supply Protection

Current limit provides continuous short circuit and overload protection

Load Protection

Crowbar: set at $7 \pm 0.2V$ model P2694 only;

Transient Response

No turn on or off overshoot

20 mv max. change for 40% load change in model 105, recovery in 20 microseconds

20 mv max. change for 50% load change in model 106, recovery in 20 microseconds

Temperature Stability

Better than .03%/°C

Remote Sensing

Remote sensing connection standard

Cooling

Max. mounting base temperature for full output is 75°C.

For no (air conduction) cooling, max. ambient temperature is 25°C for full output. Derate linearly to 60% of current @ 60°C and no cooling.

Operating Temperature

-20°C to +75°C (see above cooling spec.)

Weight

4½ lbs.

*-02 brackets increase width to 4.20"

Model	Volts	Current	Ripple P-P	Regulation	
				±10% line	O-F-L.
P-2694-01 & -02*	1.5 to 6 VDC adj.	5A	<5mv	<±1mv	<12mv
P-2693-01 & 02*	6 to 30 VDC adj.	1.5A	<6mv	<±2mv	< 8mv

RECOMMENDED TOOLS



Hand Wrapping Tool — Model 14R2

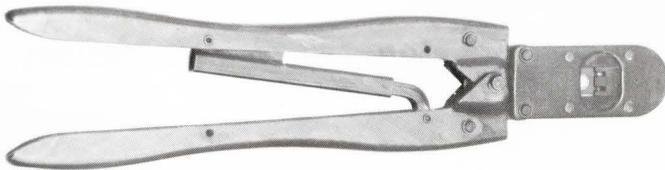
GD No. 14R2....Battery powered, pistol grip wrapper
 GD No. 507502....Wrapping bit for powered wrappers
 GD No. 507100....Sleeve for wrapping bit

Wire — 30 AWG, solid wire, copper with silver coating, KYNAR Insulation.

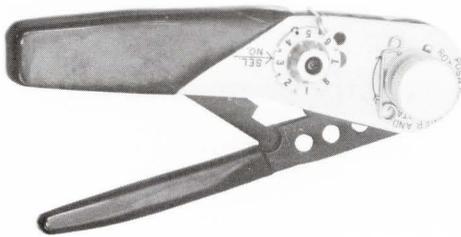
Not normally stocked by EECO, and may be obtained from Gardner Denver.



H-2705 Test Clip and Insertion/Extraction Tool for IC's



H-2715 Crimp Tool for H-2710 28-pin Receptacle Contacts



H-2716 Contact Crimp Tool for H-2711 & H-4914-01 connectors.

- H-2716-01 Common Handle
- H-2716-02 Common Gauge
- H-2716-03 Positioner for H-2711
- H-2716-04 Positioner for H-4914-01



H-2717 Tool, Contact Insertion and Removal for use on H-2711 2-D 28-pin plug



H-2718 Extraction Tool for H-2710 28-pin Receptacle Contacts



H-4914-03 Extraction Tool for H-4914-04 rear panel connector



H-4914-02 Extraction Tool for H-4914-01 100-pin connector

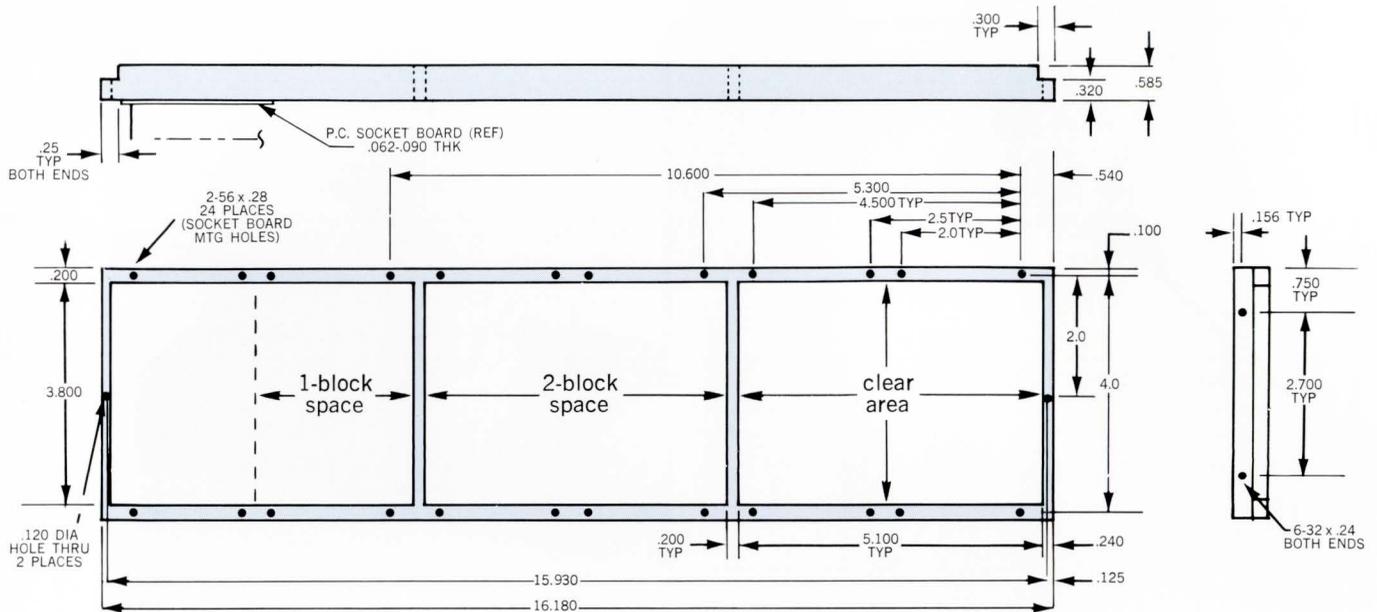
EECO handles these tools as a customer convenience. The manufacturer's part number is shown in case you wish to purchase directly or to check your existing tools.

See Table 6, page 12 for use of tools

Table 11 TOOL PART NUMBER CROSS REFERENCE

EECO PART NO.	MANUFACTURER	MFG. PART NO.
H-2715	SAE Advanced Packaging, Inc.	ME-2500
H-2716-01	Daniel Mfg. Corp.	MH800
H-2716-02	Daniel Mfg. Corp.	G110
H-2716-03	Daniel Mfg. Corp.	K196
H-2716-04	Daniel Mfg. Corp.	K200
H-2717	SAE Advanced Packaging, Inc.	2700
H-2718	SAE Advanced Packaging, Inc.	MC-2500
H-4914-02	U.S. Components, Inc.	RT-2260
H-4914-03	U.S. Components, Inc.	RT-2366
H-4921-01	Berg	HT-66
H-4921-02	Berg	HT-68
H-4921-03	Berg	HT-80
H-4924	3M	3438
H-4926-01	AMP	90260-1
H-4926-02	AMP	90223-5
H-4926-03	AMP	91038-3

GENERAL INFORMATION



Standard Frame Dimensions

HARDWARE MODULARITY

EECO's board/frame modularity offers a very wide variety of "custom" assemblies from the standard parts listed in this catalog. The final configuration may vary from a single IC socketboard with 24 to 144 sockets up to a multi-plane assembly holding up to a 1440 IC sockets per plane.

BLOCK

The basic unit size is a "block" based on one 2.45" x 4.14" PC board.

BOARDS (PC Boards)

Socket boards come in 1-block, 2-block, 4-block and 6-block sizes. Connector boards, Miniboards and special boards are normally 1-block size.

FRAMES

To hold the boards, there are 2-block, 4-block and 6-block frames.

FRAME ASSEMBLIES

Frames are joined to form Frame Assemblies. A single level frame assembly can hold up to ten 6-block frames (60-block total). Double level frame assemblies can hold up to eight 6-block frames (48-block total).

DRAWERS

Drawers can hold up to two levels with four 6-block frames per level (48-block total). The standard drawer (also two levels) holds up to six 6-block frames (36-block total).

LEVELS

Multi-planes within an assembly are designated as levels (i.e. Rear Level and Front Level or First Level and Second Level).

PLANES

A frame or frame assembly with boards mounted is called a "plane."

PANEL

"IC PANEL" is the term used to describe the EECO boards and planes in general.

MIXED BOARD and CARD ASSEMBLIES

EECoLogIC 2 logic cards or your own circuit cards can be used with the IC panel hardware shown in this catalog by using an edge card connector (EECO part no. H-2933) that fits both the EECO frame and wire-wrap plan.

FRAME and BOARD MOUNTING DIMENSIONS

If you are supplying any custom boards to mount in a standard EECO FRAME be sure all components are mounted in the clear area shown above.

MOUNTING NOTE: All EECO FRAMES have 2-block open areas. Boards must be mounted in the same orientation (Horizontally as shown in this catalog). 2-block boards must mount in a 2-block frame opening. 4-block and 6-block boards are designed to fit the 2-block frame opening pattern and must be mounted accordingly and always in one frame, **not** in two adjoining frames.

A QUICK ESTIMATE OF HARDWARE SIZE REQUIREMENTS:

1. Count the number of ICs on your logic diagram and divide by 24. This will give you the **minimum** number of block spaces needed.
2. Estimate other requirements in terms of block spaces. For example —
 - a power supply mounted within a frame requires 2-block spaces
 - special boards, mini boards and I/O connector boards needed will each require one block.
3. Check the hardware pages for the type of configuration you need (drawer, fixed frame assembly or swingout frame assembly). Tables give you a quick cross-reference between the block space capacity and the outside sizes of assembled hardware. The part number you select must match or exceed the block total needed.

Most project requirements are met by drawers, fixed-frame and swing-out frame assemblies, but EECO also offers excellent in-house circuit board and metal working facilities for fast response to special requirements.

PLANNING and ORDERING AIDS

The latest Pricing Guide for EECO IC PANELS and Related Hardware is designed to facilitate pricing of hardware and/or wiring and software. It includes terms and discounts.

Hardware Assembly planning can be expedited with special EECO forms:

HAF-1 ... for Drawers

HAF-2 ... for Frame Assemblies

Table 12 INDEX TO EECO PART NUMBERS

BASIC PART NO.	ITEM	SEE PAGE NO.	BASIC PART NO.	ITEM	SEE PAGE NO.
H-2100	DRAWER	19	H-2934	MIXED SOCKET BOARD	8
H-2110	DRAWER	19	H-2935	CONNECTOR BOARD	8
H-2200	FRAME ASSEMBLY	21	H-2936	MIXED SOCKET BOARD	8
H-2250	FRAME ASSEMBLY	22	H-2937	MIXED SOCKET BOARD	8
H-2300	FRAME ASSEMBLY	21	H-2938	CONNECTOR BOARD	8
H-2703	DISCRETE MOUNTING TERMINAL	15	H-2939	UNIVERSAL BOARD	12
H-2705	TEST CLIP	25	H-4914-01	I/O CONNECTOR	12
H-2710	I/O CONNECTOR	12	H-4914-03	TOOL	25
H-2711	I/O CONNECTOR	12	H-4914-02	TOOL	25
H-2714	I/O CONNECTOR	12	H-4914-04	TOOL	25
H-2715	TOOL	25	H-4916	I/O CONNECTOR	12
H-2716	TOOL	25	H-4917	I/O CONNECTOR	12
H-2717	TOOL	25	H-4918	I/O CONNECTOR	12
H-2718	TOOL	25	H-4919	I/O CONNECTOR	12
H-2719	I/O CONNECTOR	12	H-4920	I/O CONNECTOR	12
H-2723	MICROBOARD	17	H-4921	TOOL	25
H-2901	BLANK BOARD	8	H-4922	I/O CONNECTOR	12
H-2902	MATRIX BOARD	8	H-4923	I/O CONNECTOR	12
H-2904	14-PIN SOCKET BOARD	6	H-4924	TOOL	25
H-2905	14-PIN SOCKET BOARD	6	H-4925	I/O CONNECTOR	12
H-2906	14-PIN SOCKET BOARD	6	H-4926	TOOL	25
H-2907	14-PIN SOCKET BOARD	6	H-7001	BREADBOARD KIT	18
H-2909	36-PIN SOCKET BOARD	8	H-7002	BREADBOARD KIT	18
H-2910	16-PIN SOCKET BOARD	5	H-7003	BREADBOARD KIT	18
H-2911	MIXED SOCKET BOARD	8	P-2693	POWER SUPPLY	24
H-2912	CONNECTOR BOARD	8	P-2694	POWER SUPPLY	24
H-2913	CONNECTOR BOARD	8	P-2698	POWER SUPPLY	23
H-2915	14-PIN SOCKET BOARD	5	P-2699	POWER SUPPLY	23
H-2917	14-PIN SOCKET BOARD	5	2D-TS-1	OSCILLATOR	16
H-2918	24-PIN SOCKET BOARD	8	2D-TS-2	OSCILLATOR	16
H-2919	14-PIN SOCKET BOARD	5	2D-TS-3	OSCILLATOR	16
H-2920	16-PIN SOCKET BOARD	5	2D501	MINIBOARD, DIGITAL	16
H-2921	16-PIN SOCKET BOARD	5	2D502	MINIBOARD, DIGITAL	16
H-2922	16-PIN SOCKET BOARD	5	2D504	MINIBOARD, DIGITAL	16
H-2823	24-PIN SOCKET BOARD	8	2D506	MINIBOARD, DIGITAL	16
H-2924	14-PIN SOCKET BOARD	5	2D507	MINIBOARD, DIGITAL	16
H-2925	16-PIN SOCKET BOARD	7	2D592	MINIBOARD, ANALOG	16
H-2926	16-PIN SOCKET BOARD	7	2D595	MINIBOARD, ANALOG	16
H-2927	16-PIN SOCKET BOARD	7	2D596	MINIBOARD, ANALOG	16
H-2928	16-PIN SOCKET BOARD	7	2D597	MINIBOARD, ANALOG	16
H-2929	CONNECTOR BOARD	8	2D598	MINIBOARD, ANALOG	16
H-2930	CONNECTOR BOARD	8	2D599	MINIBOARD, ANALOG	16
H-2931	16-PIN SOCKET BOARD	5	2D600	MINIBOARD, ANALOG	16
H-2933	EDGE CARD CONNECTOR	8			

EECO WIRING and SOFTWARE SERVICES

EECO WIRING SERVICE

EECO I.C. socket boards may be hand wired or machine wired to your instructions. EECO's service is designed to assist you as much as possible in getting your logic design converted to the N/C tape required for machine wiring. EECO's wiring meets the requirements of NAVORD WS6119 and the intent of MIL-STD-1130.

EECO SOFTWARE SUPPORT

EECO has some of the most advanced computer programs available to assist the logic designer by providing him with diagnostic information, detailed system documentation, and information needed for future expansion as well as preparing the N/C tape for machine wiring. In addition, EECO can assist you by preparing special programs, if you desire.

PLAN A: Your input need only be your hand-drawn logic design. You do not even need to add pin numbers to the logic elements. EECO will process the logic design and provide you with a Design Exception Report for your review and update before the logic elements are assigned to integrated circuit pack-

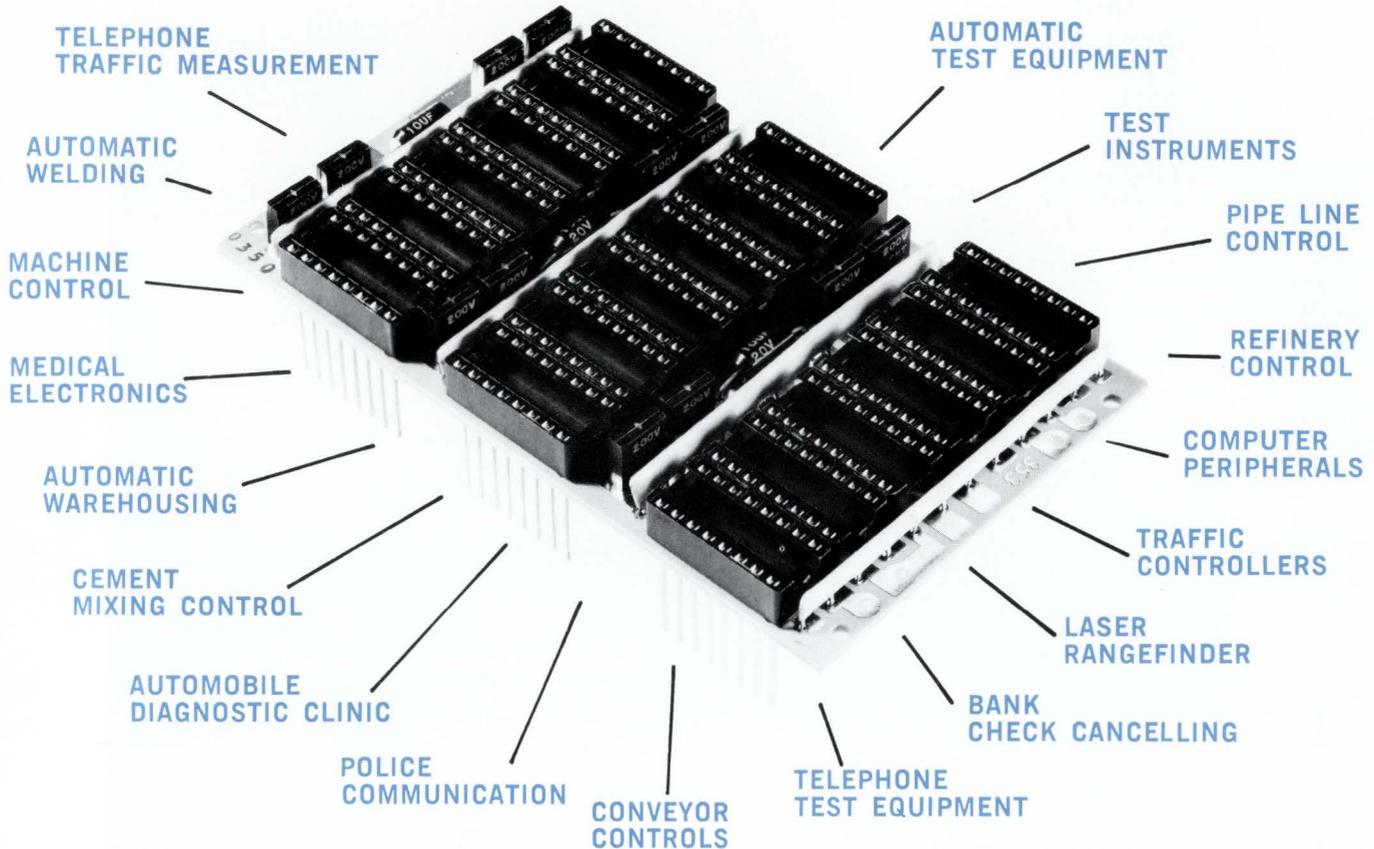
ages. When you are satisfied with the design implementation, EECO will prepare the final circuit documentation consisting of...

Circuit Type Summary	Wire Loop List
Circuit Type Total	IC Location List
Exception Report	IC Type List
Preliminary String List	Socket Size List
String List	Pin-by-Pin List
Pin Assignment List	Unused Circuit List

PLAN B: Your input is a pin list rather than a logic diagram. As in Plan A, the logic elements are not assigned to integrated circuits until after the Design Exception Report has been reviewed. With Plan B, you assign the logic elements to integrated circuit packages. The documentation you receive under Plan B is identical to Plan A documentation. With Plan B you save because of the pin list entry.

PLAN C: Your input is a pin list in the actual integrated circuit hardware configuration. While this plan requires more work by the designer, it also represents significant cost savings.

EECO 2-D PANELS and WIRING SERVICES are already PROVED in hundreds of new IC logic applications



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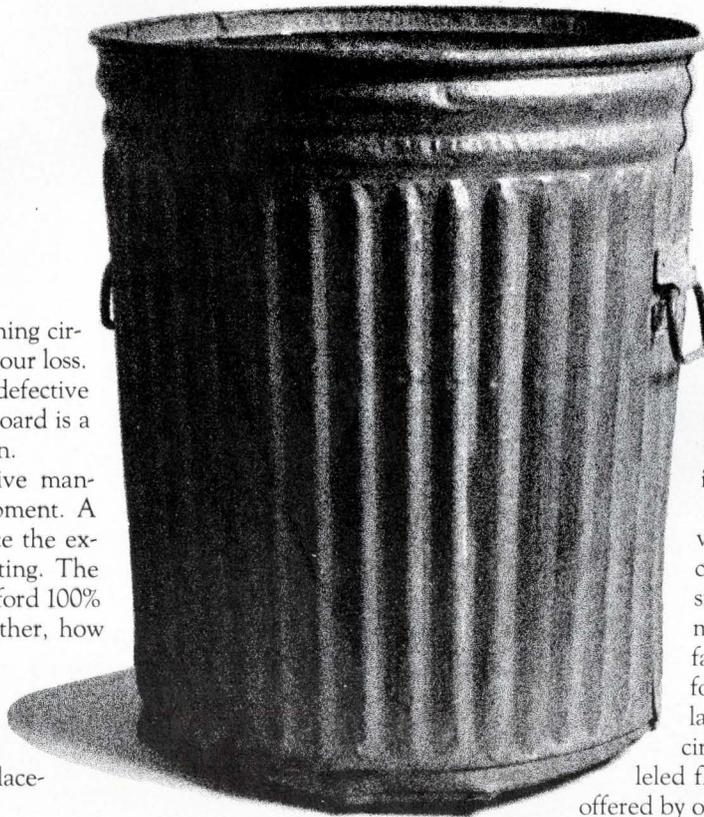


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Circle Reader Service #317

BROADBAND FUNCTION GENERATOR

An a-m/phase lock function generator with a 0.0001 Hz to 11 MHz freq. range and trigger and gate capability for single shot and burst waveforms offers a broad freq. operating capability with full amplitude waveforms at highest freqs. Amplitude modulation is featured with the ability to vary the percent of modulation from 0 through 100% to suppressed carrier. The VCA (voltage controlled amplitude) input allows amplitude control from dc to wideband ac amplitude modulation. The Model 7056 varies output amplitude without changing the percentage of modulation due to the incorporation of separate carrier, modulating signal and output amplitude controls. \$995. f.o.b., Hillsboro, Ore. 2 weeks delivery. Exact Electronics, Inc., Box 170, Hillsboro, Ore. 97123.

Circle Reader Service #318

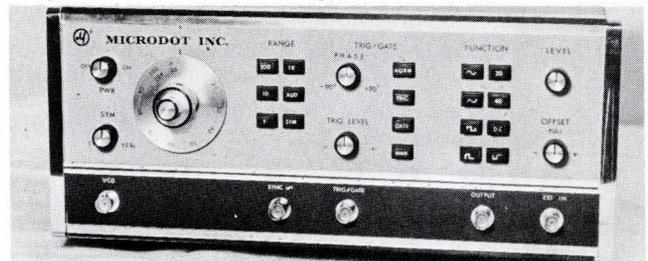
FUNCTION GENERATOR



This function generator offers nine modes of operation and adds an exponential ramp function for logarithmic sweeping, in addition to separate waveforms and ramp outputs, pulse, sweep and burst modes, and external voltage control of main output frequency. The exponential sweep in conjunction with the linear sawtooth output enables semilog plotting. In external and sweep modes, the Model 5300's freq. range extends from 0.00003 Hz to 3 MHz. Maximum main output is 20 V p-p open circuit, or 10 V across 50 Ω . \$695., 30 day delivery. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139.

Circle Reader Service #319

GENERATOR USES ECL QUAD SWITCHING



Microdot's new benchtop function generators feature an exclusive vcf generator circuit designed around an active ECL switching technique. Output waveforms are sine, triangle, pulse, ramp, squarewave, and dc modes. A 2,500V/ μ s bipolar linear output amplifier handles pulse widths of 50ns at 50% duty cycle, and rise and fall times of less than 10ns, 7typ. Model 501 has 5MHz trigger/variable start-stop, \$395; Model 510 has 10MHz vcf generator, \$495; and Model 511 with 10MHz trigger/variable start-stop is \$695. Microdot, 19535 E. Walnut, City of Industry, Ca. 91748 (213) 965-4911.

Circle Reader Service #320

PASSIVE RF MILLIWATTMETER

This milliwattmeter makes non-terminating rf power output measurements below 1 W for signal generators and transceivers. The ThruLine® Model 4330 wattmeter is passive (i.e., without amplifiers), and directional (as opposed to bolometer head or termination wattmeter). This is helpful in the design phases of coaxial components, where insertion loss and reflections (VSWR) are the variable parameters. It samples the signal in an integral section of 50 precision transmission lines with plug-in elements for different freq. bands within the range of 60-2300 MHz. \$125 and plug-in elements from \$60 to \$80; 90 days ARO. Bird Electronic Corp., 30303 Aurora Rd., Cleveland, Ohio 44139.

Circle Reader Service #321

GENERAL PURPOSE X-Y RECORDERS

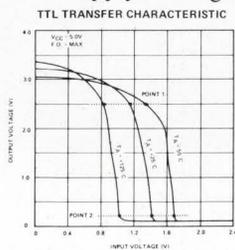
Two new recorders use a rugged aluminum mainframe which eliminates the need for critical mechanical adjustments. A medium speed recorder Model 7044A offers a slewing speed of 20 in./s; the Model 7045A is faster with a slewing speed of 30 in./s. Acceleration of the Model 7045A on the Y axis is 3000 in./s², and on its X axis, 2000 in./s². Input ranges of both instruments are from 0.5 mV/in. to 10 V/in. Input resistance is 1 M Ω on all ranges. Input is floating, 500 Vdc or peak ac. 7044A, \$1350. 7045A, \$1675. 4 weeks delivery. Inquiries Manager, Hewlett Packard Co., 1601 California Ave., Palo Alto, Calif. 94304.

Circle Reader Service #322

LITERATURE

8000 Series MSI catalog

Complete specs for each device plus design data and detailed packaging and pin configurations are provided in this 80-page catalog covering the 8000 Series MSI line Raytheon is second-sourcing from Signetics. There's design data for output structures, decoupling MSI, power supply and ground dis-



tribution systems, isolation diodes, disposition of unused inputs, input clamp diodes, and signal processing. The catalog describes and diagrams applications for each circuit, and includes logic diagrams and truth tables for each device. Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040.

Circle Reader Service #363

Power supplies

An automatic crossover power supply and dc power supply module are detailed in these data sheets. Following schematic diagrams, dimensional drawings, and a complete list of specs and electrical characteristics, you'll find a technical explanation of programming, digital control, sweep control, and speed. Kepco Inc., 131-38 Sanford Ave., Flushing, N.Y. 11352.

Circle Reader Service #364

Counter pair

Here's a high-speed counter pair that's compatible with Texas Instrument and Fairchild Semiconductor devices. Both 4-bit synchronous up/down counters offer separate up and down clocks, asynchronous parallel loading, and operate at a typical speed of 32 MHz. Read about them in this note that offers logic symbols and diagrams, electrical and switching characteristics, loading and MSI interfacing rules, switching waveforms, and applications information. Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086.

Circle Reader Service #365

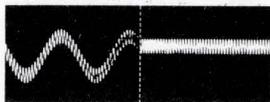
Digital cassette recorder

Described in this 12-page booklet is a new digital cassette recorder from Bell & Howell. Photos and diagrams illustrate the recorder's capabilities, advantages over upgraded audio systems, and applications. Bell & Howell, Electronics & Instruments Group, 360 Sierra Madre Villa Ave., Pasadena, Calif.

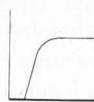
Circle Reader Service #366

Filters, oscillators, and more

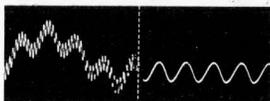
One goes to HP's or DEC's catalogs, for example, not only for product information, but for background on the types of equipment they sell. And it's a great help to find information not only pertinent to the equipment, but that's really a good, simple description of what goes into it. Such is the case with the chapter on filters in Krohn-Hite's 1972 instruments catalog. Having recently



NOISE BELOW THE SIGNAL BAND



high-pass filter



NOISE ABOVE AND BELOW THE SIGNAL BAND



band-pass filter

expanded its line to include low-cost function generators, it is still best known for its line of filters, and the catalog shows why. The explanations are so clear and to the point, on a rather complex subject, that it serves as a testimony to the background this company has in filters. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass.

Circle Reader Service #367

1972 Electronic components catalog

Switchcraft's 1972 short form catalog lists more than 6000 mechanical and electromechanical components in its 40 pages. Phone jacks and plugs; lever, slide, and pushbutton switches; connectors; and audio accessories are illustrated and described with price information included. There's also a numerical-alphabetical index for quick location of the part you're after. Switchcraft Inc., 5555 N. Elston Ave., Chicago, Ill.

Circle Reader Service #368

Plastic semiconductors

Operating characteristics of more than 100 kinds of epoxy-encapsulated field-effect and bipolar transistors are listed in this catalog. There's technical data on general purpose, switching, and rf FETs, and npn/pnp bipolar devices. The catalog is offered to you by Siliconix Inc. in conjunction with Ledel Semiconductors Inc. Copies are available from Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054.

Circle Reader Service #369

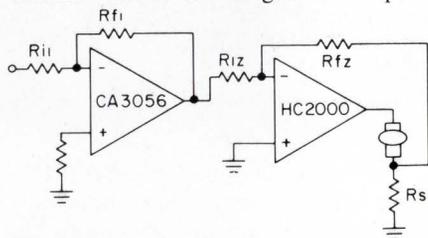
Analog switching magazine

To engineers who are specifically active in analog switching and rf front end design, Teledyne Crystallonics will send the first issue of their company magazine. It contains technical articles and new product information pertinent to the field of analog switching, rf tuning, and low noise amplification. This issue, "Of signals and circuits and things that go glitch in the night," contains articles on a Crystallonics relay vs the reed relay in automatic test equipment, and FET and FOTOFET applications. Teledyne Crystallonics, 147 Sherman St., Cambridge, Mass. 02140.

Circle Reader Service #370

Power hybrid circuits guide

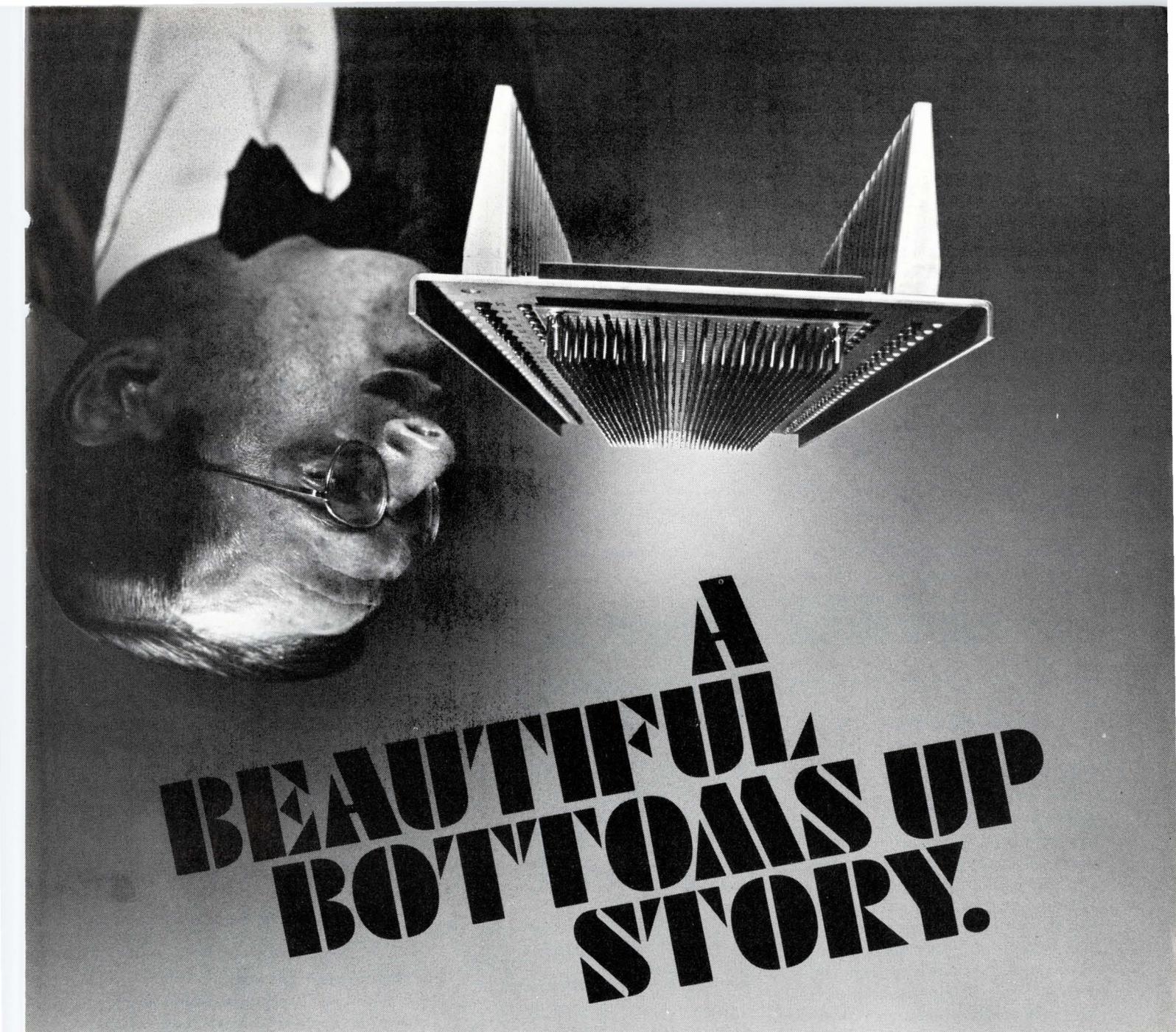
RCA's complete line of power hybrid circuits covered in this product guide includes linear amplifiers, series voltage regulators, Darlington circuits, high-current output arrays, and "building blocks." Schematic diagrams are pro-



Typical connection for the 7-A op amp, HC2000, as a dc servo motor-control.

vided as are functional diagrams, socket data, and electrical characteristics. Applications are listed and there's information on where to get more detailed application notes. RCA Solid State Div., Box 3200, Somerville, N.J. 08876.

Circle Reader Service #371



BEAUTIFUL BOTTOMS UP STORY.

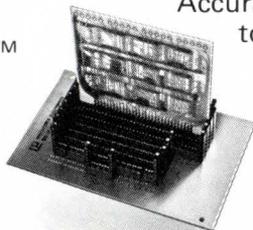
AccurSystem™ back panels from Winchester Electronics offer you the bottom-to-top versatility and reliability you need from one manufacturer. To give you the cost/performance target you're after.

Just consider the three basic AccurSystem offerings . . . bottoms or tops up.

On the bottom, AccurFrame®, AccurPlate™ and AccurPlane™ back panels are available ready for automatic or semi-automatic wire-wrapping with accurate, reliable terminal alignment. Or, they will be shipped already precision-wrapped to your specifications.

AccurFrame and AccurPlane back panels accept Winchester Electronics HW Series edgeboard connectors on grids of .100 x .200 and .125 x .250; and our DW's with .125 x .125 spacing. AccurPlate back panels accept our PW Series connectors for grids of .100 x .200 and .125 x .250; or, PDW's with .125 x .125 spacing. Plus all three types accept our RW Series input/output connectors on either a .100 or .125 grid with wrappable contacts.

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Many AccurSystem back panels feature field replaceable contacts. And, our back panels accept standard .062 printed circuit cards. Custom designs will be quoted to suit your specifications.

AccurSystem is a proven, total interconnect solution to suit your design requirements. Exactly, even if it includes ground/voltage planes or ground bussing. You'll call it a beautiful bottoms up story, too. Because any way you go, the AccurSystem means you can order precisely the back panel you want. AccurSystem.

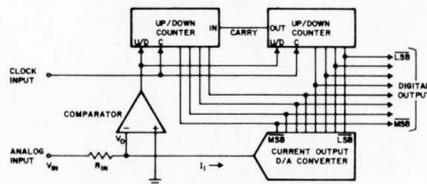
Developed by Winchester Electronics with your total needs in mind. Put our full scope of innovative ideas and practical knowledge to work for you, now. Winchester Electronics Division, Main Street & Hillside Avenue, Oakville, Conn. 06779. (203) 274-8891. Or, for discrete connectors, contact your local authorized distributor.



WINCHESTER ELECTRONICS
Circle Reader Service #58

Tracking A/D converter

An 8-page application note provides details on the design, construction, and performance of an 8-bit tracking A/D converter costing under \$30. With no sample-and-hold amplifier required, it's suggested for applications such as on-the-spot digitizing of remote trans-



Basic tracking A/D block diagram

ducers, audio digitizing for digital communications or echo-generators and digital filters. A complete components list and full size PC board layout are provided for minimum construction time. Precision Monolithic Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050.

Circle Reader Service #372

Photoelectric switch

This application note discusses a new photoelectric switch using LEDs as a light source. It covers applications, the light source, receiver, and amplifier units (construction), operating principles, ratings and characteristics, and provides dimensional diagrams for each model. Diagrams also illustrate the operation of the various types of amplifier units. Omron Tateisi Electronics Co., 10 Tsuchidocho, Hanazono, Ukyo-ku, Kyoto, 616 Japan.

Circle Reader Service #373

Printed wiring board repair manual

Manufacturers and users of printed wiring structures will be interested in a printed wiring board repair manual that demonstrates how to repair various types of damage that might occur during manufacture or assembly. It deals with problems you might encounter with defective or damaged conductors, lifted conductors, terminal areas, plated-through holes, contact tabs, component replacement, eyelets, warped boards, or multi-layer boards. There's also a section on solder joint and conformal coating removal. Copies are available for \$5 from Institute of Printed Circuits, 1717 W. Howard St., Evanston, Ill. 60202.

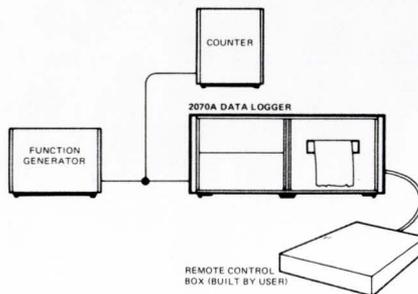
Electromechanical components

This 116-page guidebook contains both specialized and standard electro-mechanical equipment and components from such manufacturers as Keithley, Honeywell, GE, and Bourns. The products are suggested for research and development projects and prototype work, and sell for about half the manufacturer's established price. Included are transducers, pots, relays, counters and timers, power supplies, servo motors, and more. American Design Components, 39 Lispenard St., New York, N.Y. 10013.

Circle Reader Service #374

Data storage guide

The advantages of adding a data storage option to HP's 3480A/B digital voltmeter are described in a 16-page application note. Applications in A/D conversion, high-speed scanning, and DVM



measurement speeds independent of system speeds are covered. Illustrations supplement both application and operation information. Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304.

Circle Reader Service #375

Two-channel recorder

Features of a two-channel high performance recorder are outlined in this bulletin. It tells about double width 80-mm channels with 50 divisions each, built-in preamplifiers for a measurement range from 0.5 mV/div. to 500 V dc full scale, rectilinear trace presentation, and pressurized ink writing. Complete specs and ordering information for standard recorders, accessories, and supplies are included also. Gould Inc., Instrument Systems Div., 3631 Perkins Ave., Cleveland, Ohio. 44114.

Circle Reader Service #376

Handbook reference library

If you use ICs (and who doesn't?) you'll surely be able to use one or all four of these volumes. In 878 pages, they describe 275 different MOS and bipolar ICs, both digital and linear. The handbooks are loaded with applications ideas, and cost \$1 ea. Or you can order all four for \$3. In the library, so far, is the "54/74 TTL Handbook," the "8000-Series TTL/MSI and Memory Handbook," the "MOS Silicon-gate 2500-Series Handbook," and "Linear Integrated Circuits, Vol. 1." We rate it a good buy. Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086.

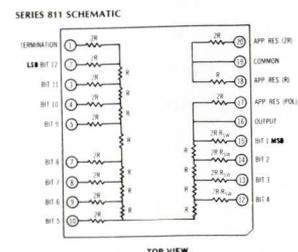
RCA technical papers

Another book (56 pages) of technical papers from RCA contains such titles as "Silicon-on-sapphire devices," "Assessment of queue formation in computer systems," "RUDI: computer-controlled test data acquisition and processing," and "High-speed strip-line digital-clock distribution system." All papers are illustrated and supplemented with background information. RCA Government and Commercial Systems, Moorestown, N.J. 08057.

Circle Reader Service #377

Binary ladder networks

For use in digital-to-analog conversion applications are these 12-bit binary ladder networks. This data sheet discusses construction, operation, circuitry, specs, and illustrates the device in a typical application. You also re-



ceive a capsule listing of data converters providing technical information on A/D, D/A, synchro, resolver, and multiplexed converters, driver amplifiers, sample and hold modules, and angle indicators. ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801.

Circle Reader Service #378

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We can turn your IC designs into products in just weeks instead of months.

And cut your packaging costs 40% or more doing it.

We've got the world's largest selection of plug-in IC hardware, everything from wire-wrap sockets to complete low-cost, high-density packaging systems.

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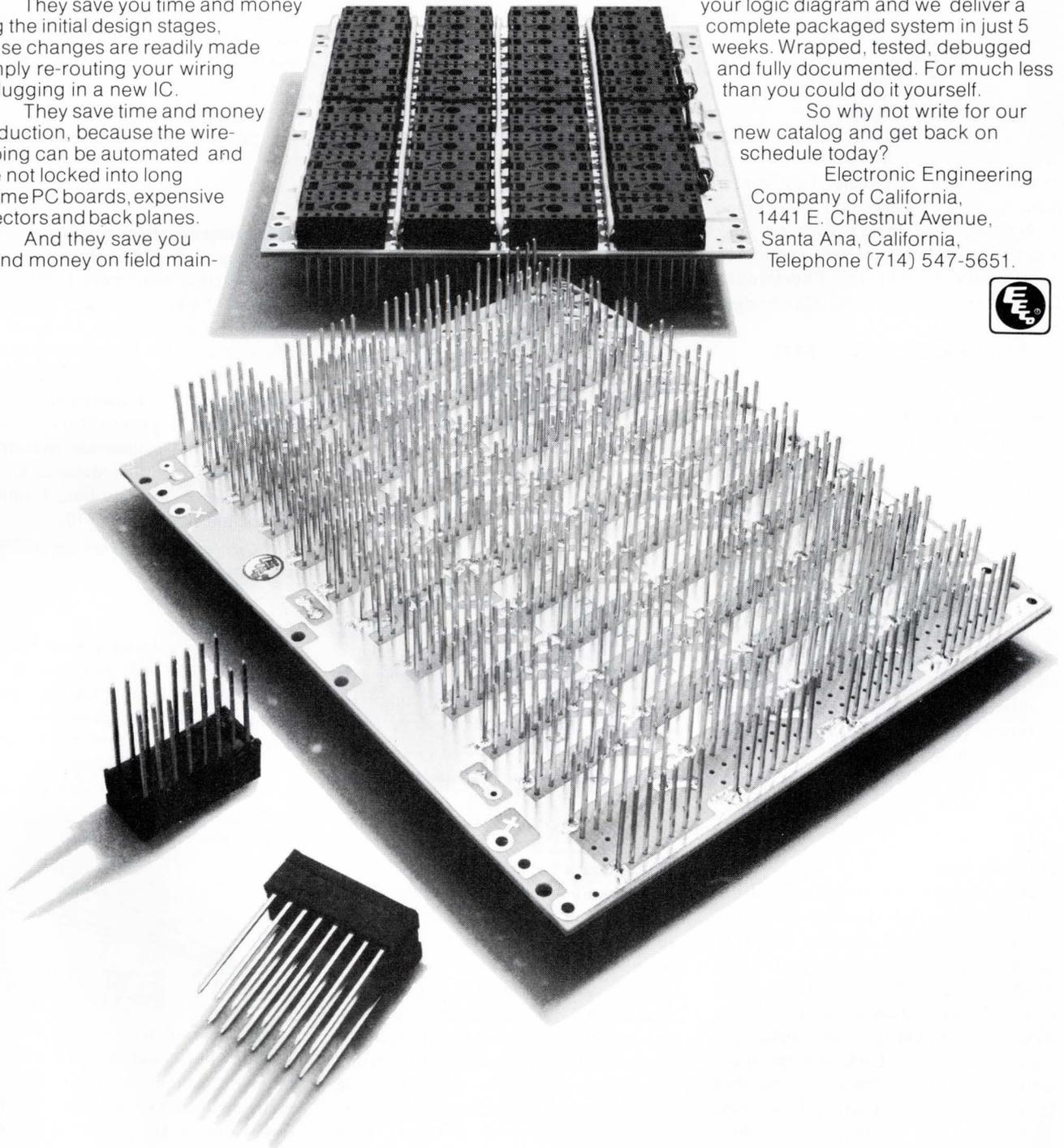
tenance and modification because of their plug-in flexibility and low-cost spares requirements.

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So why not write for our new catalog and get back on schedule today?

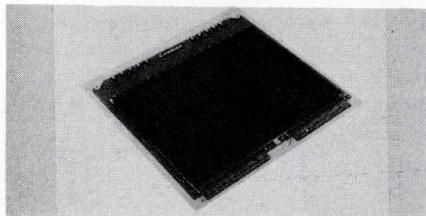
Electronic Engineering
Company of California,
1441 E. Chestnut Avenue,
Santa Ana, California,
Telephone (714) 547-5651.



EECO logic panels: help when you need it most.

Integrated packaging

Just about everything you need for circuit packaging is included in this 48-page catalog. It illustrates and describes several series of PC boards for mounting dual-in-line circuits, discretives, and other electronic components. It also covers



card files, interface circuits, logic cards, memory cards, sockets, and many other accessories. And there's data on custom-designed boards for your special requirements. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138.

Circle Reader Service #379

New EIA standard

"Standard test methods for passive electronic component parts" is the new standard available from the EIA. It establishes uniform methods for testing capacitors, resistors, switches, relays, transformers, and jacks. Tests covered include humidity, dielectric, salt spray, high and low frequency vibration, mechanical robustness of terminals, soldering effects, thermal shock in air, heat, and insulation resistance. The standard is available for \$5.20 from the EIA Engineering Dept., 2001 Eye St., N.W., Washington, D.C. 20006.

IC test system

Here is an IC test system, called the Sentry system, that consists of six compatible modularized units and is equally adaptable to discrete ICs, MSI or LSI, and modular testing. The modular concept of the Sentry system allows you to expand your system as your application requirements grow. Each member of the series, and its capabilities, are described in this brochure. Fairchild Systems Technology, 974 E. Arques Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #380

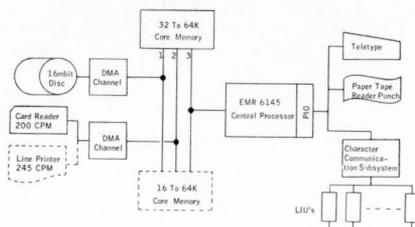
Scan converter unit

Designed as a video data processing element for a variety of information display applications is this miniaturized self-contained electrical signal storage unit. You get a complete picture of the unit in this booklet that details the basic functions, principal modes of operation, special operating features, scan converter tube principles, typical performance, and general specs. Hughes Aircraft Co., Industrial Products Div., 2020 Oceanside Blvd., Oceanside, Calif.

Circle Reader Service #381

Communications systems manual

An introduction to data communications terms and techniques begins this 30-page communications systems general information manual. It then goes on to discuss methods of integrating computer hardware and software into a to-



Basic 6145 computer system

tal communications system, centering around EMR's Series 6100 systems. Block diagrams illustrate available systems and capabilities. EMR Computer, 8001 Bloomington Freeway, Minneapolis, Minn. 55420.

Circle Reader Service #382

Data distribution applications

Applications of Multitran, a modular time-division multiplexer, are discussed in this brochure. It describes Multitran as a basic communications building block for configuring low cost networks with optimum data distribution capability; as an intermixing multiplexer for any combination of terminals operating at any speed; and as reconfigurable hardware with expansion capability. Computer Transmission Corp., 1508 Cotner Ave., Los Angeles, Calif. 90025.

Circle Reader Service #383

Broadband product guide

More than 75 new products are featured in this 148-page broadband products catalog, as well as a large selection of standard and other precision microwave and rf test equipment and devices. You're given electrical specs, mechanical characteristics, photos, circuit and block diagrams, applications information, and prices for all products and a technical data section introduces each major category. The Narda Microwave Corp., Plainview, N.Y. 11803.

Circle Reader Service #384

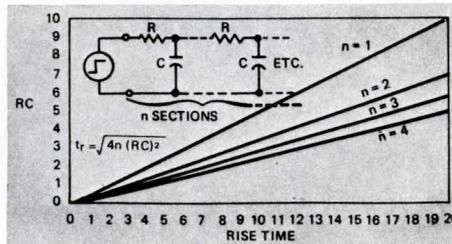
Data communications equipment

Analog and digital data acquisition and reduction equipment is the subject of this 12-page catalog. It provides photos and descriptions for signal conditioning and fm multiplexing and demultiplexing equipment, typical systems, manual and computer programmable PCM decommutation equipment, test and calibration instruments, fm accessories, and modular assemblies. Data-Control Systems Inc., Commerce Dr., Danbury, Conn. 06810.

Circle Reader Service #385

Computer and communications chart

A quick and handy reference for your computer and communications work is this wall chart. It provides tables, charts, curves, nomographs, equations, and formulae in such categories as digital codes and digital/analog conversion



factors, dB/voltage/current/power conversion, pulse parameters and calculations, time-domain and frequency-domain conversions, and more. Ballantine Laboratories Inc., Box 97, Boonton, N.J. 07005.

Circle Reader Service #386



Now, Helipot offers covered cermet trimmers for low-budget projects.

There's not much sense in using cheap wirewound or carbon trimmers anymore. Not when the new Helipot Series 91 Cermet Trimmers are available *off-the-shelf* for a few cents more.

These single-turn, $\frac{3}{8}$ " , covered trimmers come in 10 different mounting styles and 19 standard resistance values from 10 ohms to 2 megohms. Covered construction helps protect against moisture, corrosive atmospheres, dust, oil and other

contamination. Which means, in addition to cermet stability and better resolution, you get long-term dependable performance.

The breakthrough price is just 35¢ each in the 50,000 piece quantity, and they're equally well-priced in other quantities.

Send now for complete data on the Series 91 Trimmers... the finest of their class. We've made them for your projects where the budget may be tight, but you don't want to compromise performance.

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Circle Reader Service #61

Electronic test accessories

In its 60 pages, this annual catalog of electronic test accessories contains more than 500 products. It includes everything from adapters, banana plugs, and connecting leads to shorting bars, test probes, and universal testing harnesses. Illustrations and engineering information are provided for each product. Pomona Electronics Co., Inc., 1500 E. 9th St., Pomona, Calif. 91766.

Circle Reader Service #387

Dana digital multimeters

The 4-digit multimeter described in this brochure measures ac volts, dc volts, and ohms, and functions in system applications without adding accessories or options. The brochure discusses versatility, general features, systems performance, and reliability, and outlines dc and ac voltage, resistance, and general operating requirements. Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 29664.

Circle Reader Service #388

Digital circuit board tester

Using a language called CONTEST, this diagnostic testing system is easily programmed to test a variety of logic elements, devices, assemblies, and complex systems. A 6-page bulletin describes the system as well as programming, operation, and system controls. Digital General Corp., University Circle Research Ctr., 11000 Cedar Ave., Cleveland, Ohio 44106.

Circle Reader Service #389

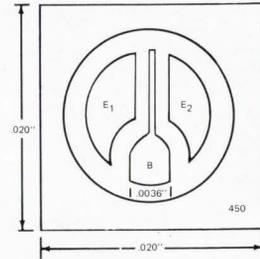
1972 Optical electronic components

Included in this 33-page product catalog are complete specs and prices for 97 operational amplifiers and analog function modules. Wideband and general purpose bipolar and FET op amps, analog building blocks, memories, converters, and logarithmic amplifiers are among the products covered. Prices have been reduced on many products, too. Optical Electronics Inc., Box 11140, Tucson, Ariz. 85706.

Circle Reader Service #390

Transistor chips catalog

Semiconductor chips for use in hybrid circuits are described and diagrammed in this 16-page catalog. It includes FETs, pnp and npn switching transistors, integrated choppers, and monolithic inter-



face circuits. And there's a variety of forms available—probed chips, 100% tested premounted chips, and carrier-mounted chips. Teledyne Crystalonics, 147 Sherman St., Cambridge, Mass.

Circle Reader Service #391

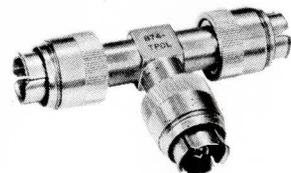
Lacing tape catalogs

Lacing tapes, dial cords, lacing systems, and accessories are described in these two catalogs. You'll read about cable lacing tools, swivel tilt harness boards, harness board pins, cut lengths for spot ties, and proper use of the lacing tools. There's complete information on construction, materials, sizes, finish, color, strength, width, and temperature range for each product. Gudebrod Bros. Silk Co. Inc., 12 S. 12th St., Philadelphia, Pa. 19107.

Circle Reader Service #392

Coaxial components guide

Described in a 36-page guide to coaxial components are hundreds of components and accessories for high-frequency applications to 9 GHz. Detailed specs are provided for connectors, attenuators, adapters, terminations, cou-



774-TPD Power Divider

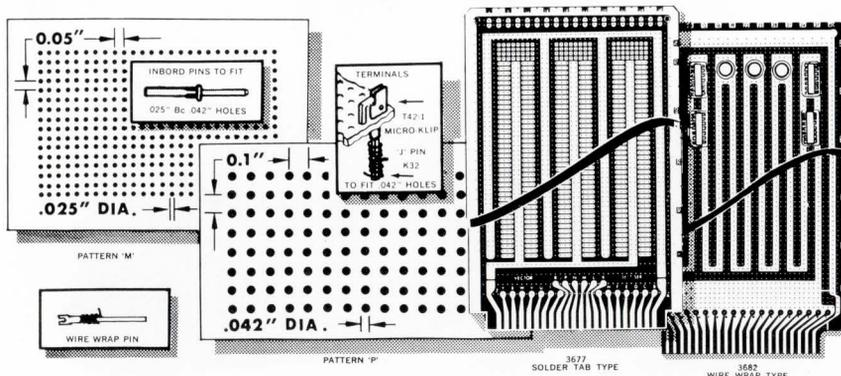
pling elements, and more. Smith charts are included as are technical discussions of microwave coaxial equipment and precision coaxial components and standards. General Radio, 300 Bake Ave., Concord, Mass. 01742.

Circle Reader Service #393

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TERMINALS — Micro-Klips, Mini-Wire-Wraps, Rd. Pins, Patch Cords, etc., available.

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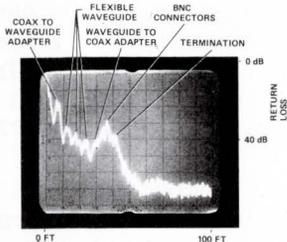
12460 Gladstone Ave., Sylmar, California 91342
Phone (213) 365-9661 • TWX (910) 496-1539



Circle Reader Service #62

Cable and waveguide testing guide

A 16-page guide details testing rf transmission line runs (coax and waveguide). It describes test arrays (0.01 to 18 GHz) for swept measurements of insertion and return loss vs. frequency,



Terminated test section

and outlines the test systems' capability to perform frequency-selective location of faults in the transmission line. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304.

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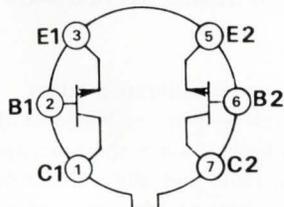
8-A Plastic SCR

This 8-A plastic SCR is believed to be the first of its class with a guaranteed dv/dt rating. Applications include controlling large appliances, heating and lighting controls, automotive controls, power supplies, and more. This technical bulletin provides complete data on the 50V/ μ s dv/dt rating as well as other specs and dimensional drawings. International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245.

Circle Reader Service #395

Monolithic npn transistors

This series of super-beta, monolithic dual npn transistors are designed to provide high dc current gain over wide collector current ranges with attendant high breakdown voltages. This data



TO-71

Pin configuration

sheet discusses absolute maximum ratings, specs, common device parameters, and physical dimensions. Analog Devices, Route One Industrial Park, Box 280, Norwood, Mass. 02062.

Circle Reader Service #396

Data conversion products

A full line of data conversion products and systems and their specs and prices are presented in this booklet. Members of the new line include computer compatible data converter instruments assembled from Xincom's standard modules and modular packaged ADCs, DACs, and a sample-and-hold module. Xincom Corp., 20931 Nordhoff St., Box 648, Chatsworth, Calif. 91311.

Circle Reader Service #397

Business communication systems

All the components necessary for a business communications system are described here—600, 720, and 1200 w/min. systems—transmitters, receivers, data terminals, and input/output options. This booklet discusses the role of each in a total system, describes the flow of a typical business system, and lists a variety of applications within the system's capabilities. Tally Corp., 1310 Mercer St., Seattle, Wash. 98109.

Circle Reader Service #398

Power supply catalog

Mobile power inverters, specialized power supplies for TWTS, ion pumps, CRTs, and custom designed system power supplies are among the typical power supplies covered in this 116-page catalog. While many are available off-the-shelf, there's an inventory of almost 3,000 different designs that can be modified to suit your specs. Captron Div. of AMP Inc., Elizabethtown, Pa. 17022.

Circle Reader Service #399

A/D converter

For use in computer-controlled data acquisition systems or in instruments with digital readouts, this family of dual-slope, integrating-type A/D converters features $\pm 0.01\%$ linearity and conversion times of less than 2 ms. Details on accuracy, conversion time, drift, operation, offset adjustment, and grounding are provided in this technical note. Function Modules Inc., 2441 Campus Dr., Irvine, Calif. 92664.

Circle Reader Service #400

Circle Reader Service #63

1972 Rental catalog

All the information you need for renting electronic equipment is included in this 60-page catalog. It provides rental prices and terms and specs for amplifiers, counters, detectors, oscillators, oscilloscopes, filters, recorders, power supplies, generators, and more. All equipment is shipped fully calibrated according to manufacturers' specs. Rental Electronics Inc., 16600 Oakmont Ave., Gaithersburg, Md. 20760.

Circle Reader Service #401

Solid state replacement guide

Entertainment and industrial replacement types are included in a 96-page guide to RCA's SK series transistors, rectifiers, thyristors, and ICs. Performance and application data are provided as are dimensional drawings, terminal diagrams, and operating considerations. All is summarized on a chart suitable for hanging on your office wall. Optional price is 40¢. RCA, Distributor Products, Harrison, N.J. 07029.

Line driver applications

The application of IC line drivers and receivers to the transmission of incremental encoder pulses over long lines and noisy environments is discussed in this 20-page note. It covers cable and termination selection, the encoder/driver, interfacing, typical shield grounding scheme, transmission cable recommendations, and power supply scheme. Trump-Ross Industrial Controls Inc., 265 Boston Rd., Billerica, Mass. 01862.

Circle Reader Service #402

Electronic amplifiers

Here is a selected collection of items on electronic amplifiers. All are based on well known circuit design concepts, simplified or refined to meet reliability, simplicity, safety, and environmental adaptability requirements. Sections cover high power, buffer and isolation, general purpose, communications systems amplifiers, and more. Copies are available for \$1 from the National Technical Information Service, Springfield, Va.

Portable VOM

A battery-operated portable FET volt-ohm milliammeter is described in this brochure. You'll read about the micro-power circuitry that allows the VOM to be left on indefinitely without impairment to its performance. The brochure also discusses applications, auto polarity, solid-state FETs, and more. Triplett Corp., Dept. 603PR, Bluffton, Ohio

Circle Reader Service #403

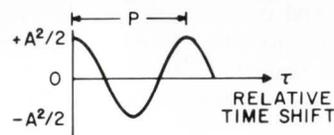
Audio accessories catalog

Prices, illustrations and descriptions are provided for all the audio accessories listed in this 28-page catalog. You'll find phone jacks and plugs, push-button and slide switches, audio and phono connectors, audio accessory kits, microphone mixers and amplifiers, hi-fi switches and controls, audio adapters, special purpose cable assemblies, and molded cable assemblies. Switchcraft Inc., 5555 N. Elston Ave., Chicago, Ill.

Circle Reader Service #404

Waveform wall chart

This handy wall chart illustrates ten different basic waveforms in five different processing domains. There are five examples of repetitive waveshapes, and five random signals. The typical func-



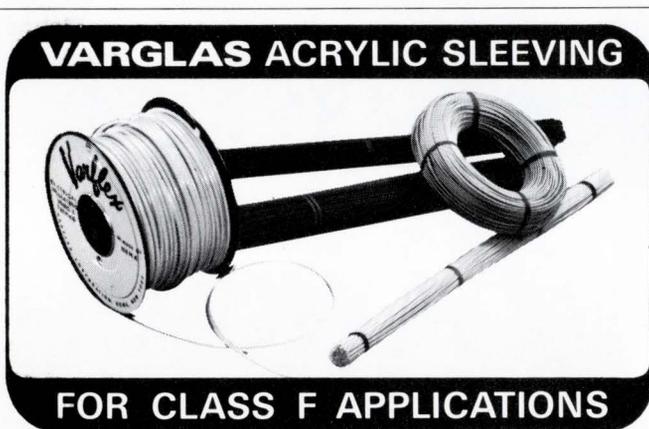
tions shown are time, auto-correlation, averaged frequency spectrum, probability density, and cumulative distribution. Federal Scientific offers you this handy waveform guide at 615 W. 131st St., New York, N.Y. 10027.

Circle Reader Service #405

Thermocouple calibration tables

Just released by the National Bureau of Standards is a new thermocouple calibration table and alloy data reference book. There's no advertising or product information in this catalog covering such topics as useful ranges of thermocouples, sheath materials, thermoelectric fixed points, thermocouple wire size and resistance tables, and more. Copies are available through Omega Engineering Inc., Box 4047, Stamford, Conn.

Circle Reader Service #406



Varglas Acrylic Sleeving by Varflex will not soften, flow or blister — even at 155°C, for as long as 15,000 hours. In fact, it passes the thermal endurance test under MIL-1-3190 (latest revision).

Made of modified acrylic resin on Fiberglas braid, it is compatible with polyester, epoxy, phenolic or formvar coatings and is made to exceed military, IEEE and NEMA standards. Varglas resists acids, solvents, oils, alkalies, fungus and moisture.

Select from a wide range of sizes and coding colors. Immediate off-the-shelf shipment or one week for special production.



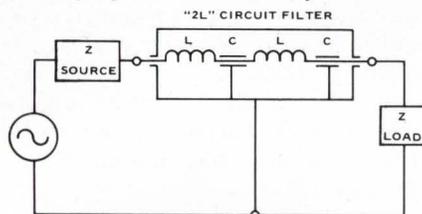
Circle Reader Service #64

Solar cells and photocells handbook

Design equations, theoretical considerations, characteristic curves, and detailed application information for solar cells and photocells are included in this 100-page handbook. You'll find chapters, for example, on photovoltaic cell performance characteristics, light and other radiant energy sources, filters, photographic applications, and more. Get your copy for \$2 from International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245.

EMI/RFI mini-filters

The application guide included in this 12-page EMI/RFI mini-filter booklet insures that your equipment complies with the conducted interference requirements of applicable FCC regulations or military specs. All necessary informa-



tion is here—voltage ranges, current ratings, insertion loss diagrams, dc resistance, environmental qualification test data, and more. Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221.

Circle Reader Service #407

1972 Standard relay catalog

Condensed specs, dimensions, and prices are given for more than 500 relays and motor controls in this 28-page catalog. There's a quick selection guide in front, followed by product data for aerospace, reed, commercial, industrial, and hybrid relays. Struthers-Dunn Inc., Pitman, N.J. 08071

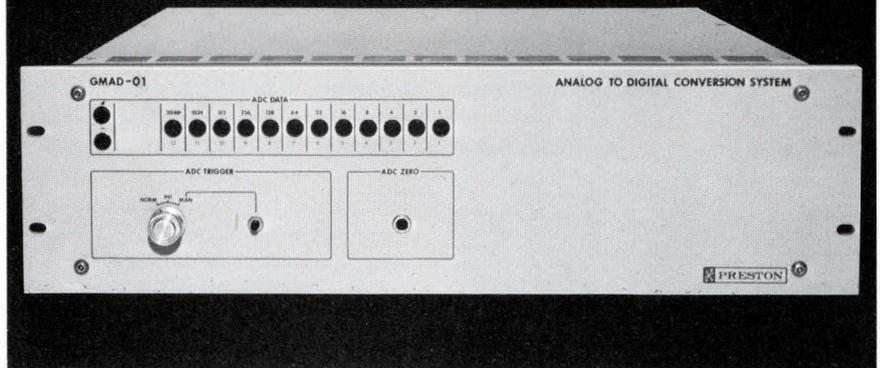
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Tool catalog

This 1972 catalog features 184 pages of information on just about every kind of tool you can think of, including both standard and unusual items. In addition, it covers tool kits for every type of assembly, in standard form, so you can design your own. Techni-Tool Inc., 1216 Arch St., Philadelphia, Pa. 19107.

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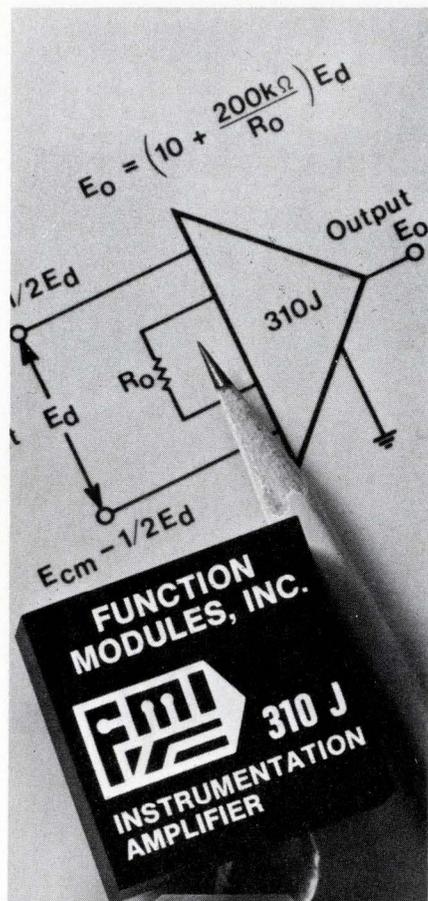


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Reed switches

The samples offered here are exact electrical, mechanical, and dynamic replacements for IBM reed switches. They're for applications in counters, commutators, relays, switching matrices, limit switches, and proximity magnetic switching. They also serve as interfaces between solid-state and relay logic. These reed switches are offered to you by Gordos Corp., 250 Glenwood Ave., Bloomfield, N.J. 07003.

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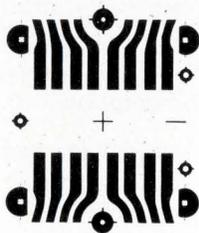
Low cost power wirewounds

Low cost and low resistance values are features of the SAX resistor, a new power wirewound product from Lectroh. Circuit configurations requiring several watts of dissipation in fractions of an ohm have prompted this new design. SAX resistors are available from 0.02 to 1.5 Ω , and 5 and 10-W axial lead packages. Welded lead and ceramic tube construction provide the quality and reliability of the wirewound resistor at film resistor price levels. Lectroh Inc., 5560 Northwest Hwy., Chicago, Ill. 60630.

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PC board relay patterns

Unlike conventional relays adapted for PC board use with terminal pins or sockets for solder mounting, the Printact magnetic latching and non-latching relays plug directly into the PC board. Your free sample of the conductor pat-



terns (on pressure-sensitive mylar) used in PC board preparation and the accompanying technical notes introduce you to the advantages of this unusual relay. Printact Relay Div., Executone Inc., Austell Pl., Long Island City, N.Y.

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Cable ties

In addition to the cable ties offered here, you're also offered a sample of a snap-in adhesive backed mount for securing harnesses to smooth surfaces in light duty applications. The cable ties accommodate harness diameters up to 2 in. and are available as either locking or releasable types. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. 60477.

Circle Reader Service #413

Torsional isolation/coupling calculator

In slide rule format, this device is designed to solve your torsional vibration problems. You'll be able to calculate torsional isolation and select the proper elastomeric coupling to suit your application. You can determine torsional response characteristics of a drive train, convert horsepower to torque for flexible coupling assemblies, and more. Lord Mfg. Co., Div. of Lord Corp., Erie, Pa. 16512.

Circle Reader Service #414

Air filters

Designed for air filtration and EMI/RFI attenuation in electronic equipment requiring ventilation are these E Z Kleen air filters. They're made of slit and expanded aluminum and come in a wide variety of sizes and shapes, allowing for flexibility in electronic equipment design. Custom-made filters are available also for your special requirements. Research Products Corp., 1015 E. Washington Ave., Madison, Wis. 53701.

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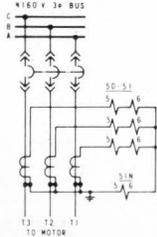
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Whether you clean your electronic parts and equipment by hand or by machine, you'll want this free sample of Liqui-Nox, a phosphate-free liquid detergent, and Alconox, a low-phosphate powder detergent. Completely soluble in hard or soft water at any temperature, both clean metal, glass, plastic, and other hard product surfaces. Alconox Inc., 215 Park Ave., So., New York, N.Y.

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Pre-printed symbols

Any diagram, specifications detail, or symbol that you use in your design work can be duplicated on triacetate sheets for quick transferral to your drawings. You'll save a lot of time using



these pre-printed pressure sensitive sheets made from your own artwork of the symbols and diagrams you use most often. Stanpat Products Inc., Covert & Main Sts., Port Washington, N.Y.

Circle Reader Service #417

Nylon harness ties

These no-twist, no-turn nylon harness ties feature holding capacities to 50 pounds. Precision injection molding insures positive locking in the flexible, translucent nylon ties. And they're available in five bundle size capacities, from 3/4 to 4 inches. Get your free samples from Dek Inc., 1555 Hawthorne La., West Chicago, Ill. 60185.

Circle Reader Service #418

Fastener and holding components

This sample board contains samples of 24 plastic fastener and holding components. Among the devices you'll receive are PC board supports and guides, spacers, clamps, clips, bushings, perforated straps, wire ties, hangers, wire saddles, harness wrapping, grommets, and idler pulleys. Richo Plastic Co., 5825 N. Tripp Ave., Chicago, Ill.

Circle Reader Service #419

Cutting fluids

For aluminum machining operations, use your free sample of AlumTap. Or for breaking down metal-to-metal bonds in tapping, threading, deep drilling, or reaming operations, try Tapfree. Both are chemical cutting fluids (not oils) offered to you by Winfield Brooks Company Inc., Conn at Fowle St., Woburn, Mass. 01801.

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OUR NEWEST THUMBWHEEL



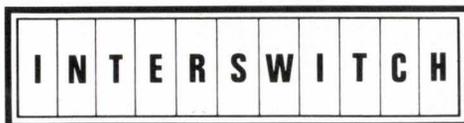
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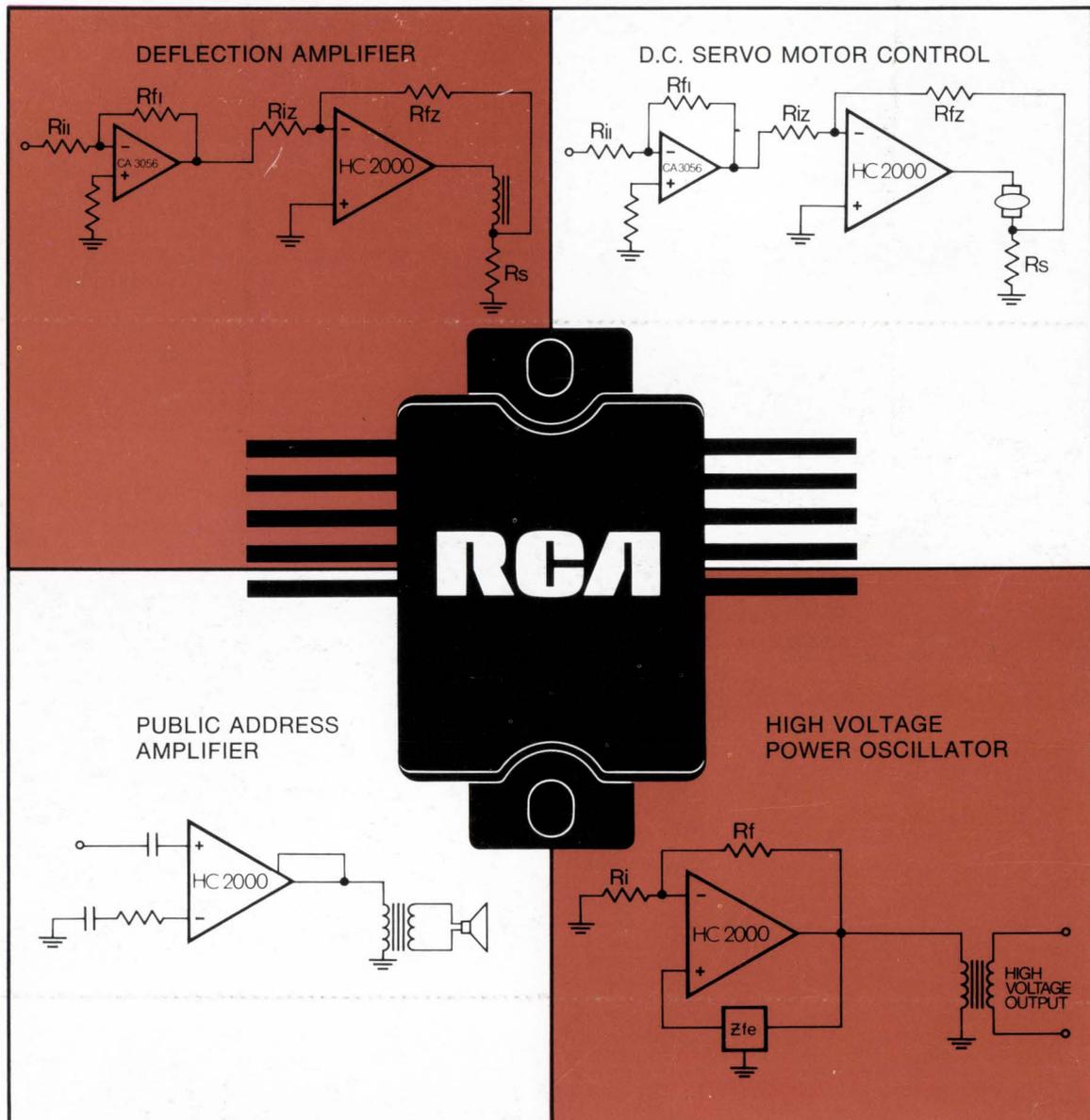
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