EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

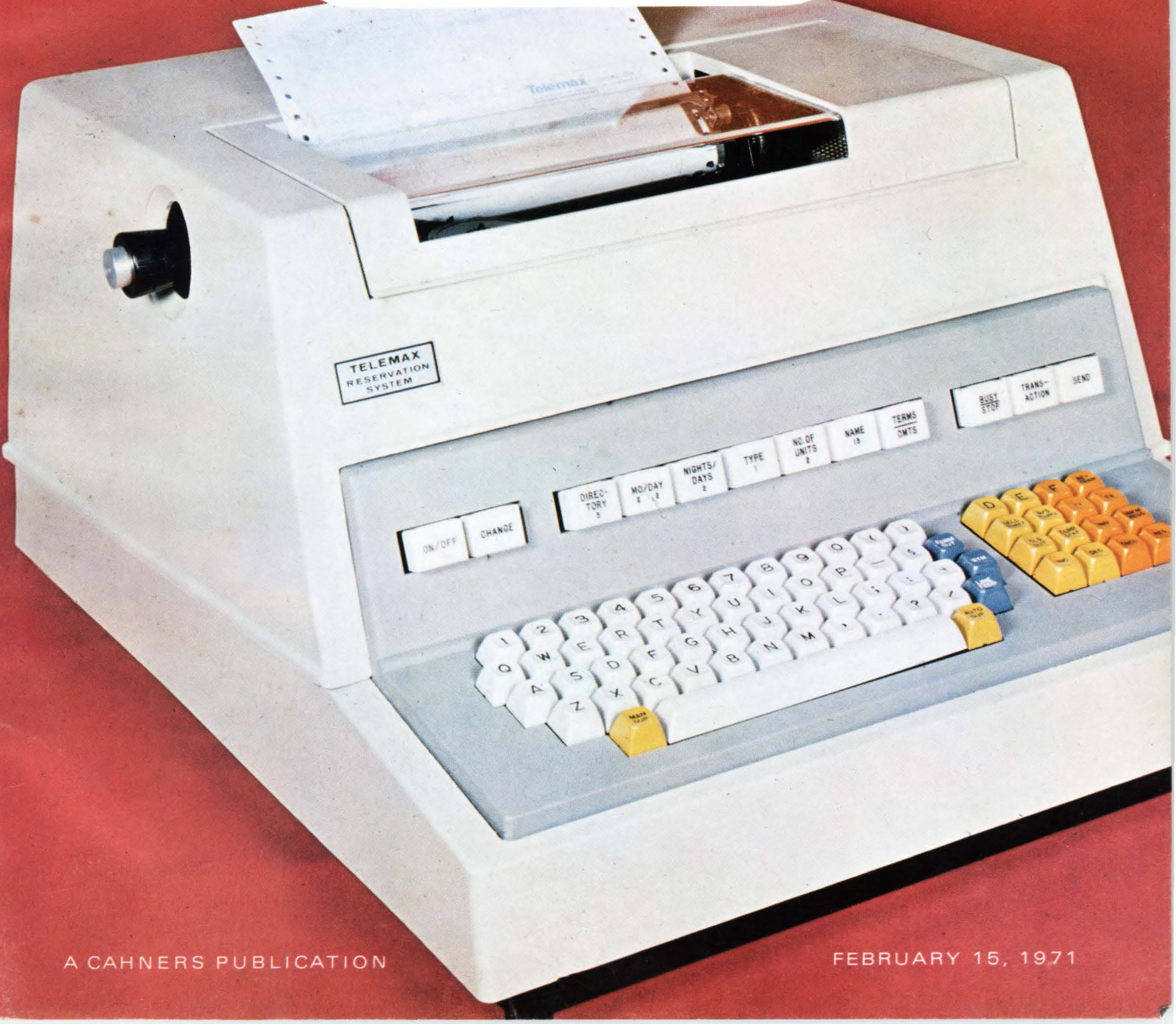
Evolution of a Terminal

Matched Design–Key to LICs

Memories of the Future

New Careers for Engineers

computer hardware In this Issue



A CAHNERS PUBLICATION

FEBRUARY 15, 1971

At Singer's Friden Division Cornell-Dubilier components are involved

Singer's Friden Division specifies quality components from Cornell-Dubilier in their quality performance systems — System Ten Computer, Modular Data Transaction System, and a range of electronic and programmable calculators.

Cornell-Dubilier's track record for quality and reliability can help you set performance records, too. For more information about CDE components—capacitors, relays and filters —write today.

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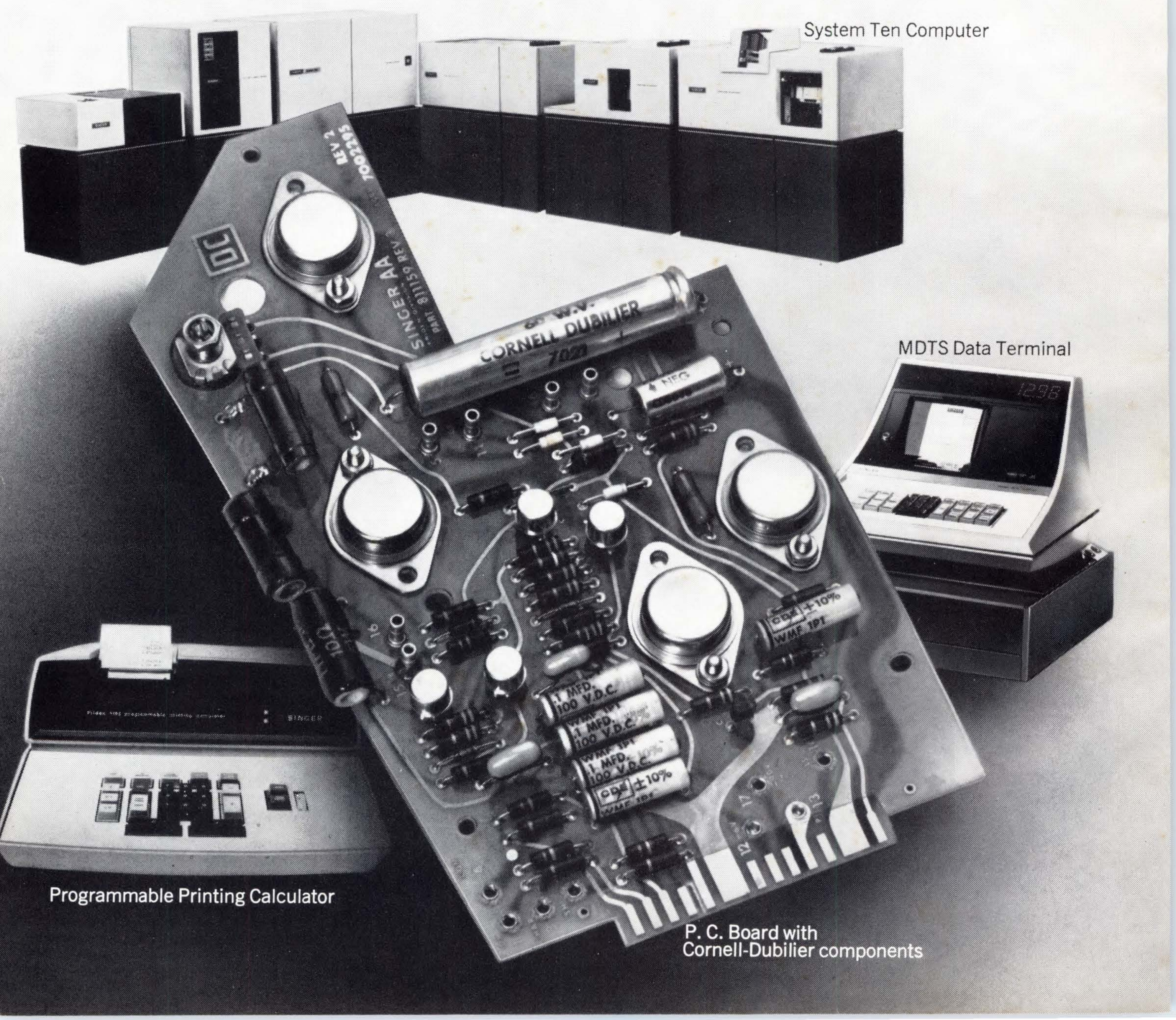
CIRCLE NO. 1



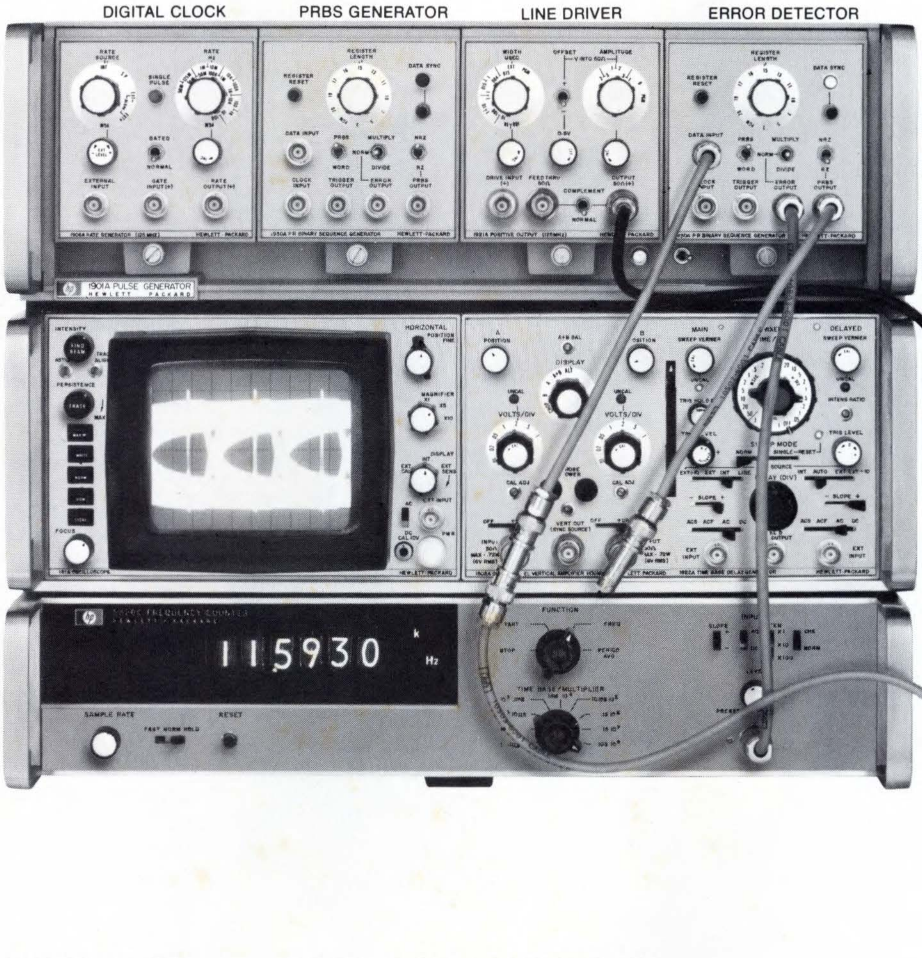
System Ten Computer

MDTS Data Terminal

Programmable Printing Calculator

P. C. Board with Cornell-Dubilier components

The new way to measure bit error rate: HP's pseudo-random binary sequence generator



081/6

How do you test the quality of a digital transmission system? By feeding in data, and comparing what comes out with what you put in... right?

You can do this by hooking up a scope to the output, and looking at the "eye" pattern. The accuracy of your results depends on the randomness of your signal, however ... and even at best, there's still an element of estimation involved.

That's why HP has developed the 1930A—a new plug-in for the 1900 Pulse Generator System. The 1930A is designed specifically to solve digital system testing problems. It enables the 1900 System to generate over 70,000 different apparently-random binary sequences ranging in length from 7 bits up to 1,048,575 bits... at any desired rate up to 40 megabits/second. And this means a better "eye."

The 1930A's capabilities don't stop there, however. By using two synchronized 1930A's, one at each end of your transmission system, you can **directly** compare output with input. Every time there's a discrepancy between the pattern coming in over the transmission line and the pattern being generated by the 1930A at the receiving end, the "receiving" 1930A sends out an error pulse.

Add a counter, and you're measuring bit error rate **digitally**. No more guesses.

Another use for the 1930A's is to scramble and unscramble data where security is important. Data can be coded in over a million different ways and no complex synchronization is required to unscramble.

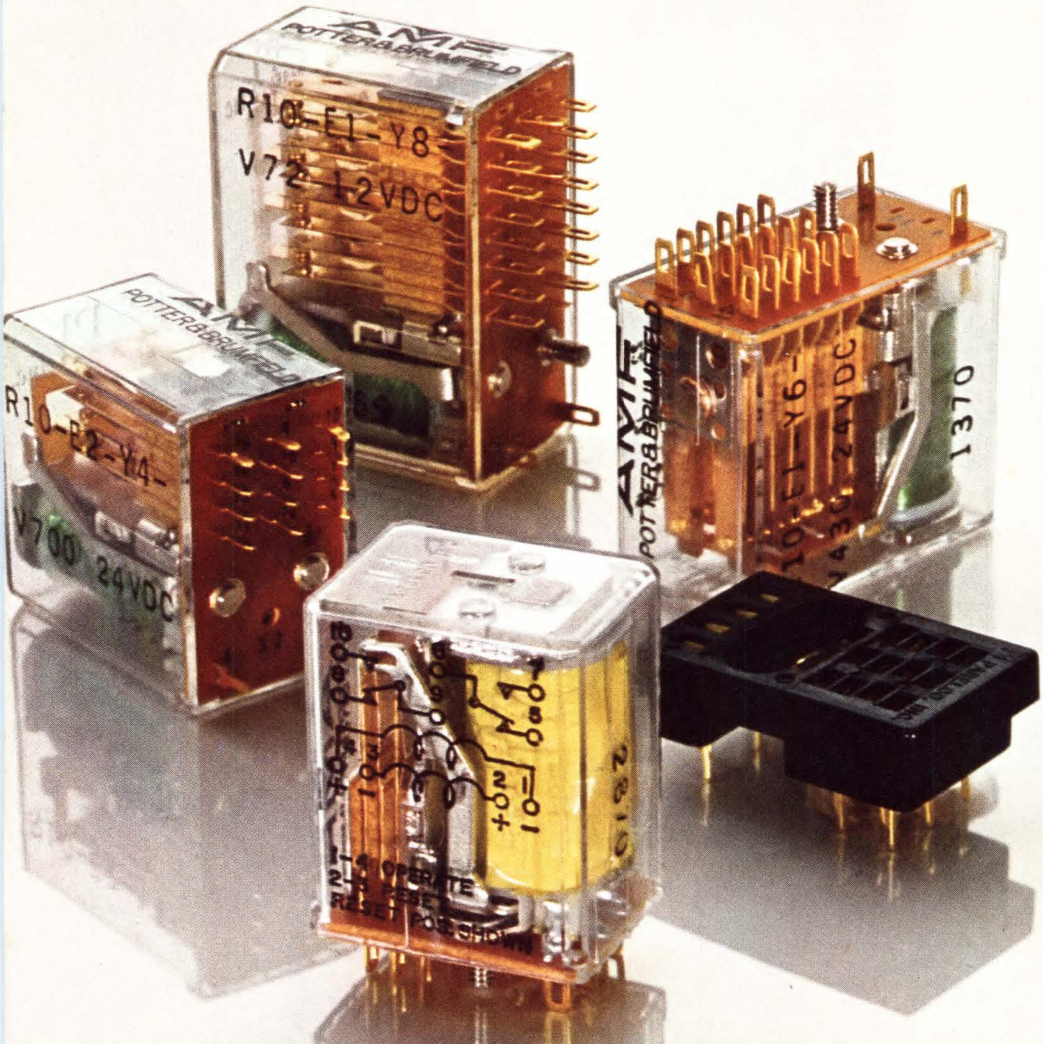
The 1930A is digitally programmable, as is the entire 1900 System. Price of the 1930A is only $1200. For applications where a 16-bit word generator will suffice at the transmitting end, HP's 1925A may be substituted for the 1930A, at a savings of $350.

For further information on the 1930A, or on any aspect of the 1900 Pulse Generator System, contact your local HP field engineer. Or Write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

SIGNAL SOURCES

CIRCLE NO. 2



R10: Our compact, multi-purpose relay.

You might say P&B designed it to be many things to many people.

Copiers, computer peripherals, business machines, precision instruments—you'll find our R10 in a multitude of applications requiring a compact, reliable, multi-pole relay. That's because it probably gives you more design options than any other single relay.

Consider these choices: Contact arrangements up to 8PDT. Ratings from dry circuit to 10 amperes. Six styles of contacts, including bifurcated. Sockets with solder or printed circuit terminals including one for mounting the relay horizontal to a printed circuit board—all with or without grounding provisions.

Mechanical life up to 100 million operations. Electrical life ranges from 100,000 to 100 million operations depending on load and voltage. Coils for DC operation from 3.0V to 115V can be supplied. AC-operated R10 relays to 2 Form C are also available. R10 relays have Underwriters' Laboratories' Component Recognition, File 42810.

The single lot price for a 4PDT, 2 amperes R10 relay is only $3.60. Quantity discounts apply.

Order R10 relays from leading electronic parts distributors or call your P&B representative. For a complete, 194-page relay catalog, write Potter & Brumfield Division of AMF Incorporated, Princeton, Indiana 47570. Telephone: (812) 385-5251.

AMF
POTTER & BRUMFIELD

P&B performance. Nothing else comes close.

CIRCLE NO. 3

FEBRUARY 15, 1971
VOLUME 16, NUMBER 4

EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Cover

Cover photo depicts the Maxson terminal. This transaction terminal for the commercial world evolved with as much thought given to the behavior of the user as the electronics inside. See story on p. 21.

Design News

Design Predictions

Design Features

Design Ideas

Design Interface

Design Products

Design Departments

EDN's DESIGN ACTIVITY FILING SYSTEM is used to classify all Design Feature and Design Idea articles. The first word indicates the *activity* discussed in the article. The second word denotes the principal product being used in the activity. The third word modifies the second word. Finally, a number is used to specify frequency, where applicable. This number is the $\log_{10}$ of the frequency in hertz.

ABP CP MCRC BPA
ibpa International Business Press Associates
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ELEKTRONIK-ZEITUNG
INTER ELECTRONIQUE

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BROADWAY
W 42 ST

We make components for guys who can't stand failures.

No one likes to be left in the dark. Especially by some "sophisticated" complex of control equipment that failed.

That's why we make our resistors and capacitors for guys who can't stand failures. Guys like your most important customers, guys like you.

We build an extra measure of reliability into all our components to help you build extra reliability into all your systems.

To be specific, we make tin oxide resistors—now including both miniature RLR05's and flame proofs—and glass and Glass-K™ capacitors. They're the best you can get, though they'll cost you no more.

Take our tin oxide resistors—no other resistors can deliver the same stability and reliability over life. They offer guaranteed moisture resistance across all ohmic values, for reliability that can't be matched by metal film, wirewounds, carbon comps or metal glaze resistors.

This kind of extra performance comes in miniature size, too. Our new RLR05 (commercial style C3), developed for dense packaging applications, competes costwise with carbon comps.

And we lead the field with flame proof resistors. Ours will withstand overloads in excess of 100 times rated power without any trace of flame. And because they open rather than short under severe overload, they provide protection for the rest of the system—a vital consideration in critical and expensive EDP, telecommunications, and instrumentation gear.

Or take our glass capacitors. The Air Force has confirmed they have much better stability and much higher insulation resistance than the ceramic, mica, and other capacitor types tested. That's why our glass capacitors have been designed into so many major aerospace and missile projects. And why industry has designed them into the most important EDP and instrument applications.

Or our Glass-K™ capacitors—we developed them to give you the volumetric efficiency and economy of monolithic ceramic capacitors, but with the much improved stability and reliability that only a glass dielectric can add. Our Glass-K™ capacitors are now being used in pacemaker heart units and in several major EDP systems. And these Glass-K™ capacitors can now be used in BX characteristic applications.

As you might expect, both our resistors and capacitors meet Established and High Reliability standards, such as MIL-R-39017, MIL-R-55182, and Minuteman.

At Corning we make components for guys who can't stand failures. Guys like your most important customers. Guys like you.

And even though you might expect to pay a lot more for these features, you don't. Because as the largest manufacturer of these type components, our production volume affords us economies that enable us to be competitive in price.

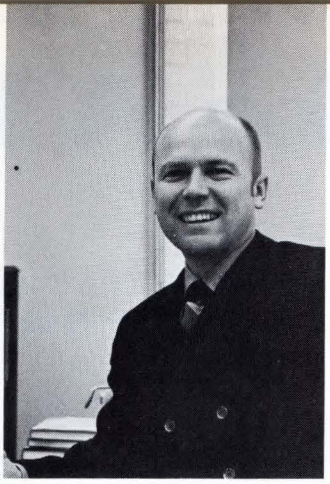
So the next time you're designing a system, design-in an extra measure of performance. Reach for your CORNING® resistor and capacitor catalogs or look us up in EEM. Or for in-depth technical information write us at: Corning Glass Works, Electronic Products Division, Corning, New York 14830.

Then call your local CORNING authorized distributor for fast off-the-shelf delivery. He not only stocks components for guys who are demanding, but he offers service to match, too.

CORNING
ELECTRONICS

CIRCLE NO. 6

Editorial



Some Improvement Despite . . .

A recent report from The Chase Manhattan Bank states that "despite further anticipated reductions in government electronics, the overall industry should show some improvement during 1971." Accompanying the report is a chart, reproduced here, which bears witness to the turbulent history of electronics. There are several characteristics worth noting.

First, it comes as no surprise by now that total U.S. factory sales dipped in 1970—a phenomenon never experienced since the transistor became practical.

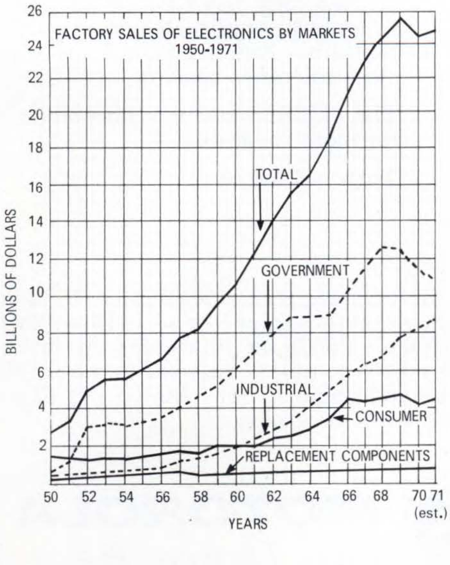
Second, and again not surprising, is that the government's contribution to the total is, historically, by far the most erratic.

Third, the consumer and replacement curves show unmistakably the effects of overseas competition. Had we had the foresight to anticipate and stem dumping and other detrimental one-sided trade handicaps, both the consumer and replacement curves would have risen nicely, probably at about the same rate as the industrial sector.

Fourth, the industrial sector shows by far the most rational and healthy growth. The contrast between industrial and government sectors certainly says a great deal about the ability and willingness of leaders in these sectors to anticipate problems, stimulate orderly growth and provide for the long term.

Recently we have seen several suggestions that the technological needs of this country be placed under the aegis of a group of technologists. The hope would be to convert our present fire-fighting approach to something more suggestive of fire prevention.

It's a heck of a situation when our industry grows *despite* the government.

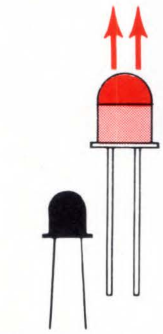


Editor

Take A Bow, Showoffs!

Meet The New REDHEAD* On Your Block For Less'n A Buck

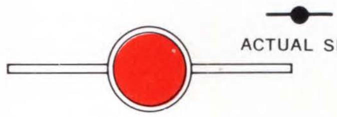
MLED630 69¢



ACTUAL SIZE

It offers 1,100 fL typical brightness at 50 mA input current and a wide, 120° field of view. It's cased in the popular, TO-18-type package with a unique, molded plastic lens for durability and long life, and . . . it's very low cost — only 69¢, 1,000-up!

Use it compatibly with RTL, DTL and T^2L for low-drive-current (200 fL @ 10 mA) applications requiring high visibility, low drive power, fast response . . . and economy!



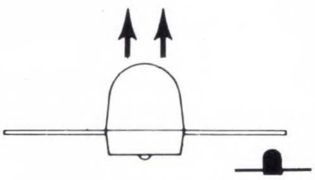
ACTUAL SIZE

Tiny Micro-T* Red LED Shows Big Performance

MLED50 49¢

For space-limited, panel and circuit condition indicators, light modulators, shaft or position encoders, punched card readers, optical switching and logic circuits you can't get a mightier light than this: 750 fL showoff at 20 mils, 330 fL at 10. *Plus* nanoamp leakage. *Plus* molded plastic lens for wider viewing angle. *Plus* easy insertion into PC boards and custom designs.

A 6,600 angstrom Atlas in a pinhead package!



ACTUAL SIZE

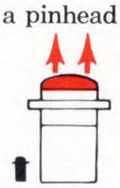
Do Invisible Things With 9,000 Å, Infra-Red LEDs

MLED60/90 99/85¢

Narrow-beam light emission is the keynote of these two new plastic infra-red LEDs, lensed for high, on axis power output (either 550 or 350 μW at 50 mA input) providing a greater signal to coupled silicon detectors.

Low prices make them ideal for card/tape reading as well as industrial processing and control and other designs requiring infrared power output and stable characteristics.

Our Micro-T size = your high density application need.



ACTUAL SIZE

Turn Red Reliably With Tiny LED Pill

MLED610 $2.30

Only 50 mils turns it up to 1,100 fL brightness — enough for most designs requiring metal-package reliability for high density mounting — PC boards, for example, that demand the ultimate in rugged shock, thermal and moisture resistance.

It's the only red LED in the tiny "pill" — use it in space-limited designs that need exacting, IC-compatibility. And in custom arrays where your thing is close-tolerance-spacing.

The Gallium-arsenide-phosphide die is passivated for more reliability.

Turn red today.

7-Unit Detector Team Upstages Plastic Prices

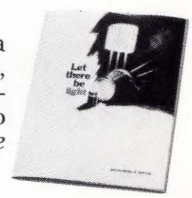
MRD3050-56 55¢ to $1.35

ACTUAL SIZE

Fast and rugged with a wide range of radiation sensitivities available from 0.02 to 0.4 mA/mW/cm² minimum, this hermetic TO-18's performance and reliability contrasts with its low, low price — thousand-ups start small as 55¢! MRD3050-56 is their name and industrial is their game in processing, inspection, counting, sorting, etc. The 3-leaded package also provides external base for added control and Annular† construction ensures proven stability and reliability.

Hermetic devices for plastic prices!

Circle the reader service number for data sheets on these new 5 or write Box 20924, Phoenix 85036 on your company letterhead for complete answers to most opto design aspects in our updated *Let There Be Light* brochure.



MOTOROLA OPTO
Let There Be Light

*Trademark Motorola Inc.
†Patented Process Motorola Inc.
All Prices Are 1,000-up.

CIRCLE NO. 9

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Device Measures Magnetically with

Performing the same function as an electrocardiograph, but without electrical or physical connection to the body, a newly developed instrument measures the heart's magnetic pulses. Like any other magnetic pickup, the magnetocardiograph requires only proximity to the heart cavity to detect its magnetic field.

The instrument, which circumvents many of the current hazards to patients in medical electronics, was developed in the Cryoelectronics Section of National Bureau of Standards Boulder Labs.

Technically, the device is a superconducting gradiometer that measures differences in the field between two superconducting coils connected in series opposition. The opposing connection cancels out fluctuations in the earth's magnetic field.

Within the device, two parallel 3-mm diam holes in a tiny niobium block are joined by a slot which is bridged at one point by a point-contact Josephson junction. This recently discovered device allows magnetic flux to shift between the two holes in discrete units. Within one hole, a small superconducting coil generates flux from two external superconducting coils. In the other hole, a non-superconducting coil is resonant at an RF frequency. The RF impedance of this second coil varies periodically with the flux distribution between the two holes. By placing the device

NBS worker adjusts Josephson junction point contact that bridges slot between two holes in MKG's niobium block (top). **Laboratory version** of ultrasensitive superconducting magnetic gradiometer may lead to other applications (bottom). Among these, developers see detection of magnetic anomalies in earth's magnetic field and submarine detection.

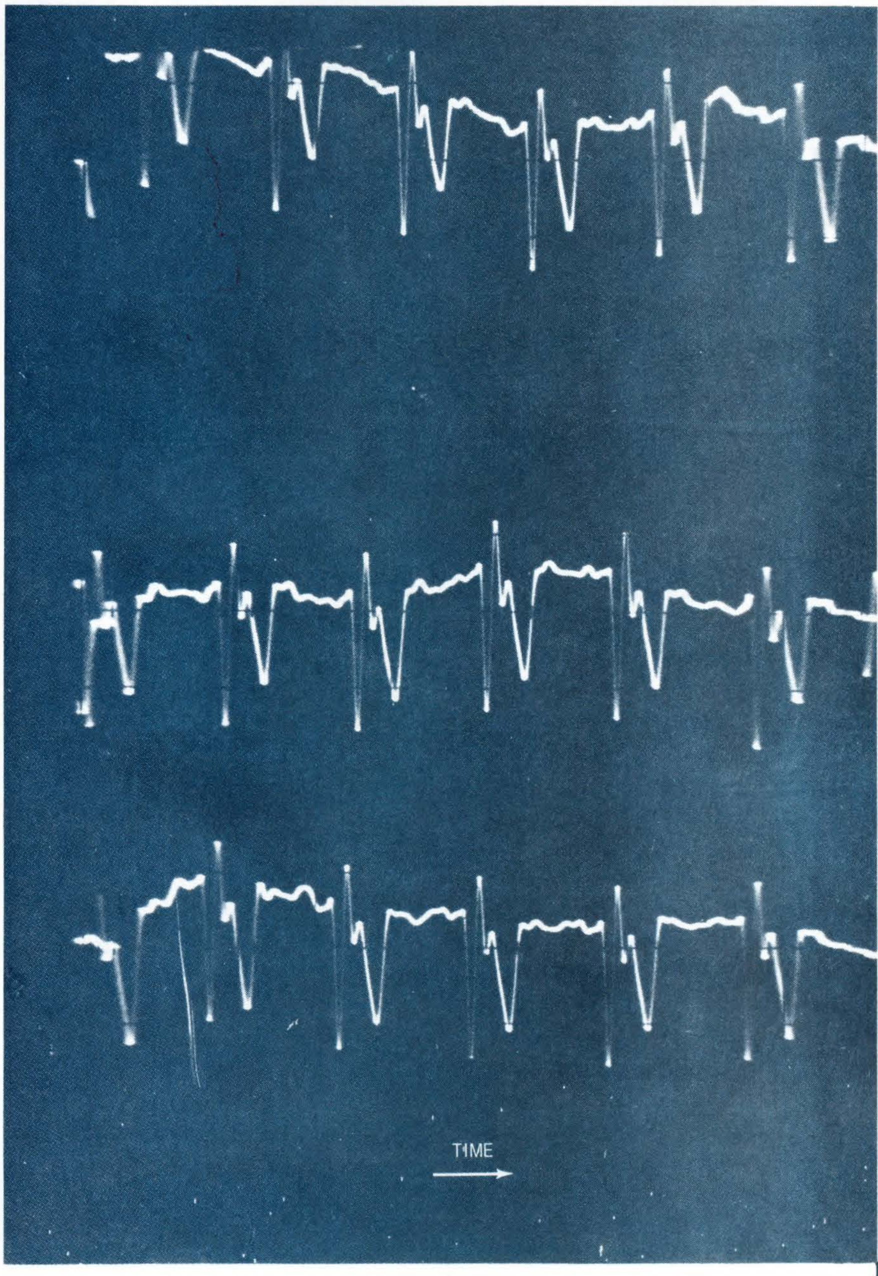
Heartbeat No Contact

so that one of the coils is close to the patient's heart, magnetic heart beat pulses can be detected. The difference between the magnetic field sensed by the two external coils is measured by the change in this RF impedance.

This measurement can be used to drive an oscilloscope or strip-chart recorder, providing a magneto-cardiogram (MKG) similar to an electrocardiogram (EKG).

Along with its advantages of no electrical connection to the patient and consequent safety & conveniences, the MKG has its own set of drawbacks. Some compensation must be provided for the earth's magnetic field, and measurements must be made in a magnetically "quiet" environment, away from fields generated by sources such as motors, power lines and laboratory equipment. Presently, measurements are made in a shielded or magnetically quiet environment. Its developers, J. E. Zimmerman and N. V. Frederick, hope to find a method of cancelling such noise, however, so that the instrument can be used in a doctor's office or hospital without elaborate provisions.

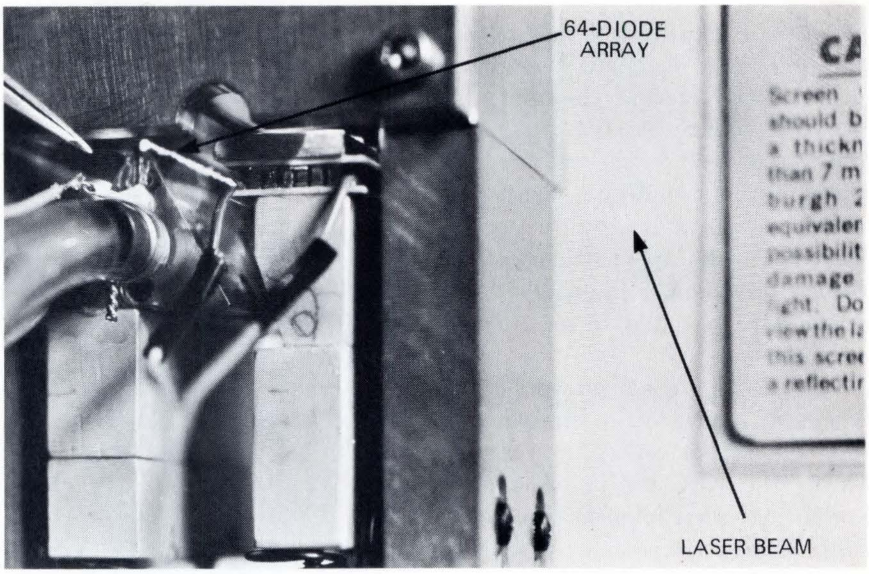
In addition to biomedical applications, the sensor can detect anomalies in the earth's magnetic field distribution. Possible applications that stem from this capability are submarine detection, geophysical exploration and paleomagnetism.



NBS engineer Nolan Frederick demonstrates position of battery-powered MKG detector over reclining patient (top). Only slight modification is needed for measurements in sitting position.

Magnetocardiogram trace is quite similar to familiar EKG trace. This one was made in relatively "quiet" environment, is reasonably free of magnetic "noise".

Diode-Pumped YAG Laser Operates CW At Room Temperature



A neodymium-doped yttrium aluminum garnet (YAG) laser pumped by an array of gallium arsenide phosphide (GaAsP) diodes has achieved continuous wave operation at room temperature (27°C). Its developers, Texas Instruments Incorporated, say this makes feasible satellite laser transmitters smaller than a pack of cigarettes for world-wide communication and data transmission links.

Very high packing density and highly efficient diodes with accurately controlled wave lengths were the key to the achievement, an industry first. Sixty-four GaAsP diodes with 18-mil domes, spaced on 28-mil centers, emitted at 8000Å, right in the pump band of the YAG laser. Each diode in the array is about 0.02 inch in diam, and the entire array consumes only 13W of electrical power to activate the laser.

This isn't the first time TI workers have pushed the state of the art in diode-pumped lasers. In 1968, they gained recognition for the first diode-pumped YAG laser operating CW at −196°C, cooled by liquid nitrogen.

Metal-Core PC Boards Shape Up

Western Electric Co. has reported success in making printed circuit boards with a metal core base material at NEREM '70. The core metal is mechanically shaped as required and then all holes are punched in it. A dielectric of thermosetting epoxy resin is applied over the core by means of a fluidized bed process to a thickness of 12 to 15 mils, which compares electrically to G-10 epoxy glass laminates. The last series of operations involves screening the circuit and plating copper (including through holes) autocatalytically (no external plating currents). Other subsequent operations such as plating gold contact finger and protective coatings over the copper are optional.

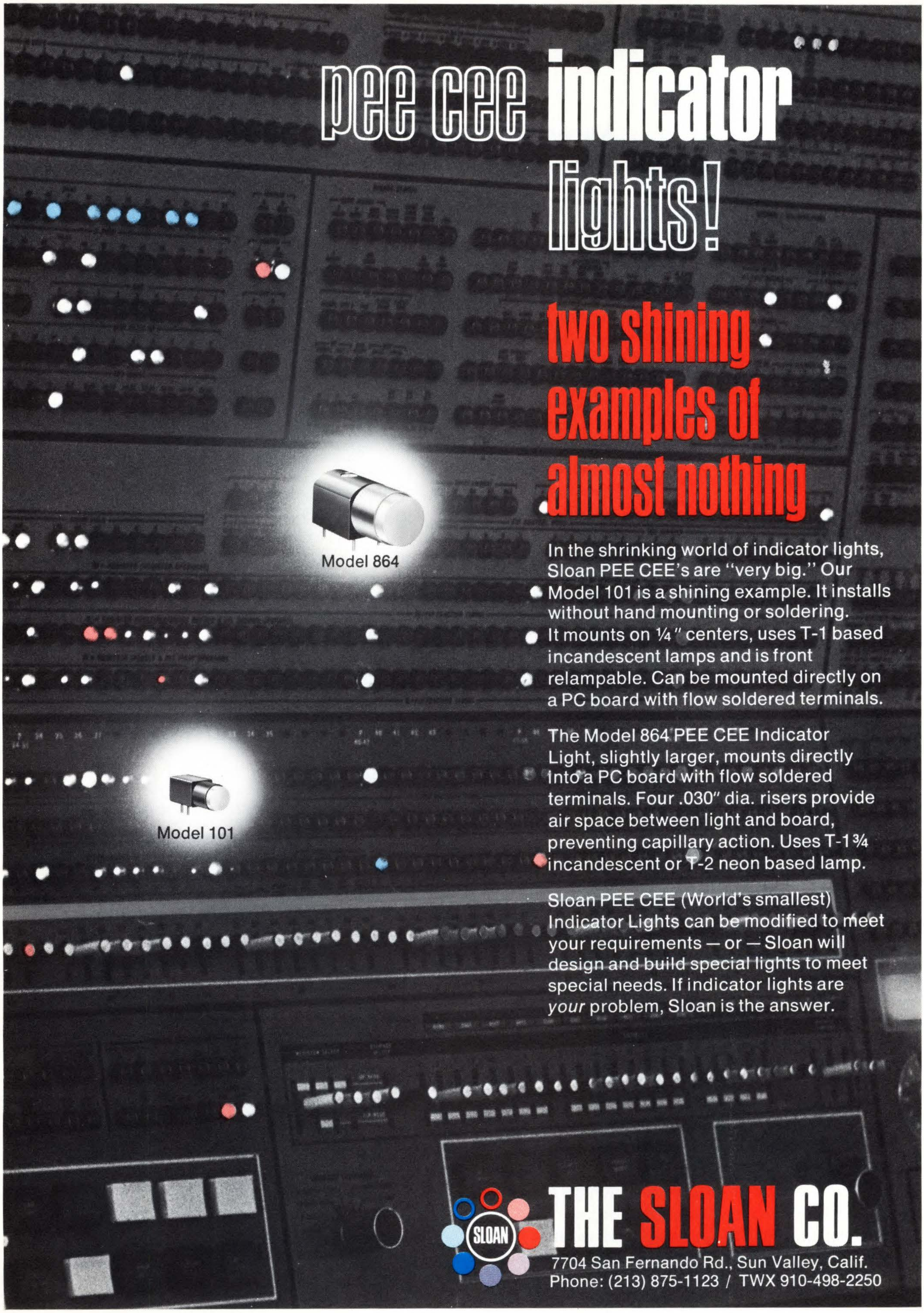
Western Electric reported no electrical breakdowns through the epoxy dielectric, even at edges of holes or sides of the board. They also reported that no special operations were performed to break any sharp edges. This contrasts with past experience with coating metals in fluid bed processes where sharp edges had a high incidence of very thin coatings, and thus possible breakdowns.

Steel has been the most-used core material, but aluminum has proved useful in reducing self inductance. Grounding the base metal can accomplish a number of purposes like shielding all circuits from extraneous fields and reducing coupling and cross-talk between parallel paths.

Heat dissipation should be superior to standard laminates, and copper losses are virtually non-existent since copper is plated only where needed, not etched away.

An important advantage of this type process is that the base metal can be formed into almost any shape and configuration before coating. This allows handle assemblies to be formed as part of the PC board and the board can even serve as a structural support member.

Disadvantages of such an approach lie with the aforementioned edge-coating problems and the fact that only two-sided boards are currently possible.


pee cee indicator lights!
two shining examples of almost nothing
Model 864
Model 101
In the shrinking world of indicator lights, Sloan PEE CEE's are "very big." Our Model 101 is a shining example. It installs without hand mounting or soldering. It mounts on ¼" centers, uses T-1 based incandescent lamps and is front relampable. Can be mounted directly on a PC board with flow soldered terminals.
The Model 864 PEE CEE Indicator Light, slightly larger, mounts directly into a PC board with flow soldered terminals. Four .030" dia. risers provide air space between light and board, preventing capillary action. Uses T-1¾ incandescent or T-2 neon based lamp.
Sloan PEE CEE (World's smallest) Indicator Lights can be modified to meet your requirements — or — Sloan will design and build special lights to meet special needs. If indicator lights are *your* problem, Sloan is the answer.
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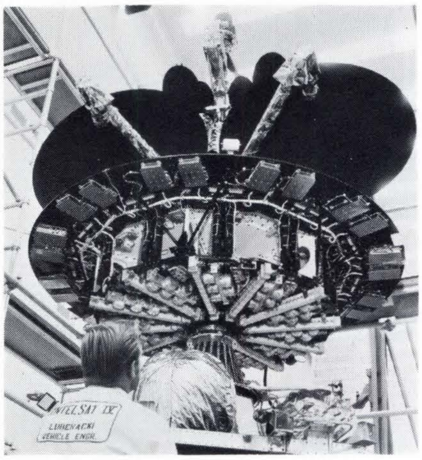
CIRCLE NO. 11

Inside the Bird



Intelsat IV, launched late in January, carried a new wrinkle—upper platform supporting antennas is stationary, pointing precisely at Earth to provide 9000 phone channels or 12 color TV channels. Meanwhile, lower portion, directly in front of inspecting engineer and containing solar panels and associated electronic gear, rotates at 60 rpm to provide spin-stabilization.

IEEE, NSPE Link

In significant action, IEEE got off the hook with its "social action" members and NSPE strengthened its position with an alliance that gives IEEE members access to many NSPE services. Now available to IEEE members is NSPE's employment referral service, as well as its retirement program, legislative programs, many of its publications and participation in some of NSPE's state and local services. As a result of a single joint action of both boards of directors in January, IEEE can maintain its technical orientation, while NSPE should be able to wield considerably more political clout, since it will be able to represent a substantially larger number of engineers. Members should benefit all around, too, with the closest approach yet to a nationwide portable pension plan and the services of an organization which isn't afraid to use a little "muscle" to protect member's rights.

More NASA Fallout

A research team from Jet Propulsion Lab., California Institute of Technology, has found a way to cut the time needed to analyze pictures of the chromosomes in human blood cells. They use the same computer enhancement techniques that so dramatically improved photographs radioed back from the moon and Mars. Chromosome analysis (karyotyping) which formerly took 30 minutes of careful work can now be performed in about 3 minutes. With labor (and consequent cost) reduced, karyotyping could be more widely used to spot hereditary disorders in infants and couples applying for marriage licenses.

Hike Sealing Yield

Flatpack sealing yields of 95% are consistently achieved from new micropackaging design and manufacturing techniques developed by Bendix Electrical Components Div. The division has been working intensively for more than a year to achieve improved packaging characteristics and Donald Michel, chief engineer on the project, says rework is prohibited.

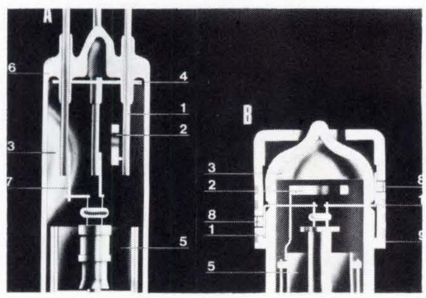
Computerized Crime

The state of Iowa has started work on a computer-based traffic records and criminal justice information system to replace bulky manual records. Among the several benefits that state officials expect is accurate prediction of needs of correctional institutions, such as space, food and supplies. This would lead to maximum efficiency in use of state facilities.

Electronic Demosthenes

An electronic instrument that rhythmically coordinates senses of vision, touch, hearing and motion is dramatically improving the speech of severely handicapped children at the Thomas W. Hughen School for Crippled Children in Port Arthur, Tex. Developed by the medical electronics group of LaBarge Electronics Div., St. Louis electronic systems manufacturer, the unit was originally intended for vision therapy, but has been expanded to help stutterers become more fluent.

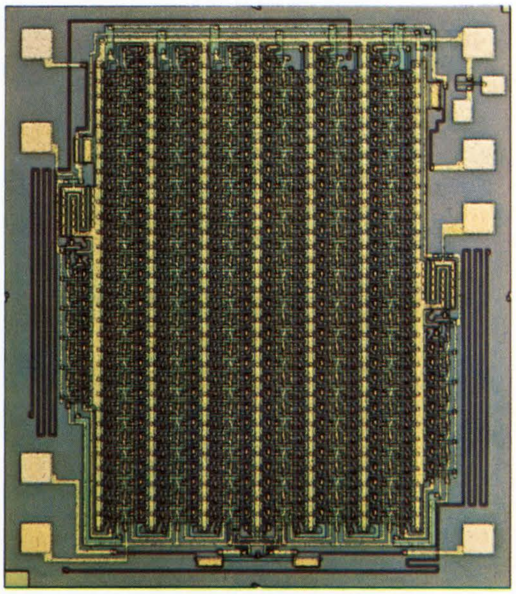
TV Camera Tube Shrinks



Feeding the electrode leads of a TV camera tube radially instead of axially has led Philips Eindhoven Labs. scientists to develop a shorter configuration for such camera tubes (see illustration). They found they could also design with foil strips instead of electrode pins, resulting in drastic reduction of leakage current, flashover and short circuits. More than 10% length reduction has been reported for experimental tubes made this way.

MOS

BY



MOTOROLA

Move Ahead with Motorola

MOS MEMORIES

Beat core and plated wire size and costs

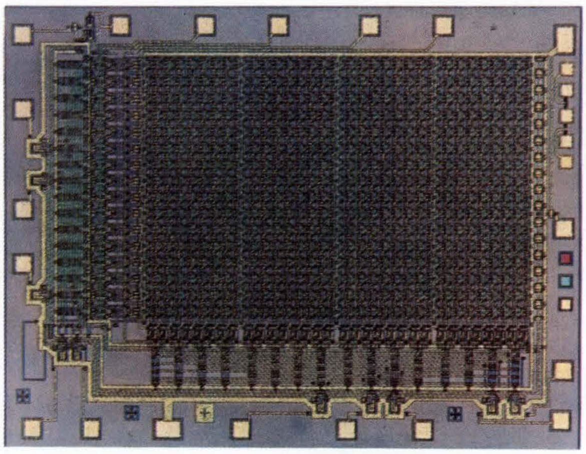
Systems designers' needs for good, fast, low-cost mini-computer and main-frame sequential bulk storage led directly to MOS memories.

The versatile MCM1173L heads Motorola's list of MOS types covering the broad range of memory applications. Highlights are:

- Low address-line capacitance of 2.5 pF (typ) improves system speeds
- Eliminates need for separate chip select clock signal to refresh stored information
- Low capacitance and high "on"-to-"off" current ratio of the output circuit for simplified bipolar interfacing
- Wired-OR capability for memory expansion
- Only 400 ns access time
- Low drive power required compared to other high-threshold MOS
- Monolithic fabrication with the proven P-MOS process
- Low Power Dissipation — 50 μW/bit

Motorola MOS memories available now

2240-bit read only memory — MCM1130
64-bit read/write memory — MC1170
1024-bit read/write memory — MCM1173L



*1024 word by 1-bit dynamic **RAM** — MCM1173L*

Available soon

Diversification and capability are the bywords for these scheduled MOS memory products:

2240-bit read only memory — MCM1120
1024-bit (Si Gate) read/write memory — MCM2372L
2048-bit read only memory (256 x 8) or (512 x 4) — MCM1110
4096-bit (Si Gate) read only memory (512 x 8) — MCM2340
2560-bit read only memory (256 x 10) or (512 x 5)—MCM1150

For details, circle 25

Move Ahead with Motorola

MCMOS

Works on next to no power — and ignores noise

Complementary MOS has its roots in the reliability conscious military and aerospace fields, and now spreads its branches and foliage over a widening range of commercial and industrial applications. Its low power requirements make it the mainstay for tiny, delicate, portable electronic watch systems, yet its high noise immunity makes it ideal for use in rugged applications like industrial controls. Complementary MOS offers operation with a wide range of supply voltages, and as the only logic to work directly from a car battery is a natural for automotive applications. MCMOS, Motorola complementary MOS, features:

- P and N-Channel devices in a single monolithic structure
- Real economy of operation with low quiescent power dissipation of only 50 nW/package (typ)
- Thrives in noisy environments — Noise immunity = 45% of V_{DD} (typ)
- Matches power supplies with any of them — 4.5 V to 18 V

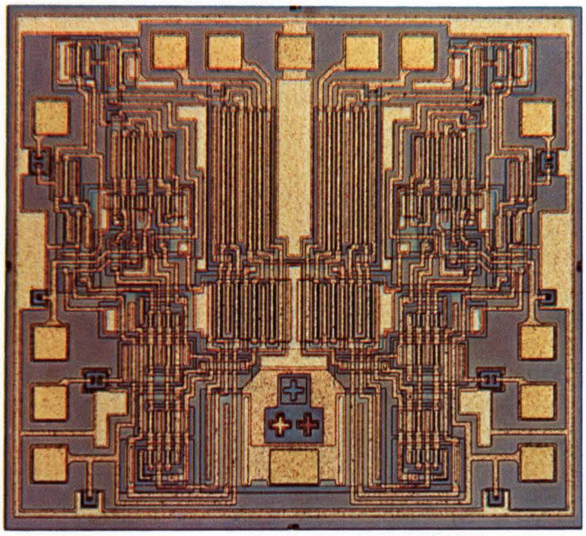
MCMOS available now

Quad 2-input NOR gate – MC14001L (MC2501L)
Dual 4-input NOR gate – MC14002L (MC2502L)
Dual type D flip-flop – MC14013L

Available soon

This short term new product activity plus eighteen new MSI circuits planned from the ground up for system compatibility make MCMOS the premium low power logic family.

64-bit read/write memory – MCM14005L
Quad exclusive OR gate – MC14501L
Quad 2-input NAND gate – MC14011L



Dual type D flip-flop — MC14013L

Dual 4-input NAND gate – MC14012L
Dual 4-bit shift register – serial in/parallel out – MC14015L

For details, circle 25

Move Ahead with Motorola

CUSTOM MOS

Your designs or ours — Original from the ground up, or use our Polycell concept

Let's start by assessing MOS circuitry.

- MOS processing is inexpensive permitting low-cost device manufacture.
- MOS component geometries are small permitting component densities and highly complex circuits on relatively small chips.
- MOS circuits are easy to design encouraging widespread design efforts.

Combined, these three MOS characteristics — inexpensive processing, high component densities, and simple circuit design — clearly point MOS technology in one specific direction; that is, *custom circuitry*.

New ground rules for user and manufacturer

Users will be designing their own proprietary circuits and will implement systems with fewer building blocks. Each of these will be more complex and represent a larger portion of the complete system than is generally prevalent today.

figure 1

For the IC manufacturer, this demands quick-reaction time capabilities and versatile design techniques allowing the customer to interface at any point in the design cycle. We emphasize this. We can and will enter the custom design process at any point in the cycle the customer desires.

This means we will work at either extreme or pick up the job anywhere in between. Give us your masks and we'll give you the product. Give us your system requirements, and we'll develop the design and deliver your product. We'll do it on the drawing board and with the computer.

Polycells and CAD

Combining a library of standard MOS computer building blocks called polycells, an educated computer, and a variety of computer design and drafting aids, Motorola has developed a custom and customer oriented design capability. We're proud of our CAD capability but we recognize that

figure 2

it is only an aid to humans interfacing with humans. Here's how it works.

1. From the polycell library of logic building blocks, the designer selects the polycells to be used in his system.

2. He partitions the system to delineate a number of chips on which the system is finally implemented.

3. Armed with the appropriate preliminary logic diagrams, he transforms these into detailed topological chip layouts, either on a CRT console

(Figure 1), or in the form of a conventional drawing with a computer controlled digitizer (Figure 2).

4. With the exact geometries so displayed, the designer juggles the polycells for the most advantageous layout, and plots the required cell interconnection pattern (on the CRT console or on a coordinate digitizer). A conventional ink plot can be employed for layout verification.

5. Finally, a computer generated program that details the final design is used to control an auto-

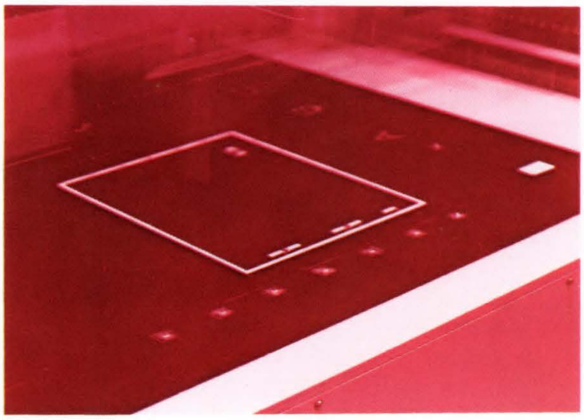


figure 3

matic drafting machine (Figure 3) to prepare a complete set of masks for the MOS array.

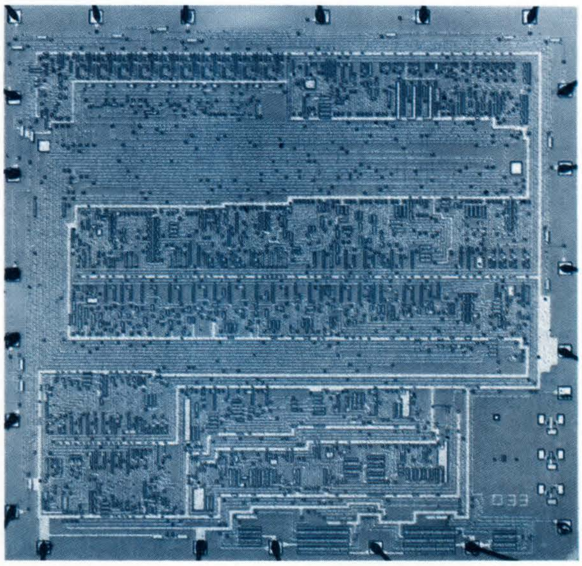
Generic to the Motorola polycell program is a line of completely characterized circuits whose specifications, both electrical and physical, are stored in a computer memory. When a detailed layout is required, it is drawn automatically by the ink plotter in response to information stored in the memory. The amount of time saved through computer-aided design is one of the pivots around which a custom capability revolves. And so are the number and types of basic cells that define an engineer's design freedom. Motorola's initial line consisted of P-channel, high-threshold, static cells (51) with propagation delays of approximately 74 ns per logic level and a power dissipation of 1.7 mW or less per gate. A second series of 28 cells has a power dissipation of less than 0.45 mW per gate and a propagation delay of about 300 ns.

In addition, a series of 12 shift registers and a family of 172 dynamic (2-phase) logic cells have been put into the library. Corresponding sets of low threshold, silicon gate and CMOS cells are being rapidly expanded.

Emphatically, MOS technology is expected to be a dynamic growth area in the years ahead, and custom design capability represents a major challenge to all involved.

Motorola is very much involved.

If you have a custom MOS project, call Motorola Custom MOS, 602-273-3832. A 172-page Polycell MOS/LSI design brochure available for



Custom MOS/LSI in Boeing 747 electronics.

the asking on your company letterhead, covers most of the cells in the library. The balance will be sent automatically as brochure supplements are published. Write to Custom MOS, Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Arizona 85036.

Move Ahead with Motorola

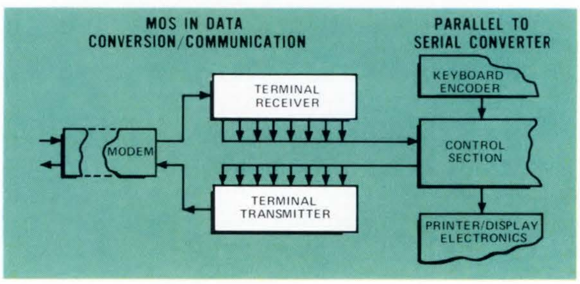
SYSTEMS MOS

The thrust of Motorola's new MOS product activity, in 1971 and beyond, is orientation to the systems needs of the markets we serve. The final criterion for all future standard MOS product is service within the total needs of our customers.

This MOS product philosophy of serving systems is presently hard at work in such diverse fields as electronic timing and time keeping, desk-top calculators, memory systems for processors, CRT display systems and other data handling system requirements.

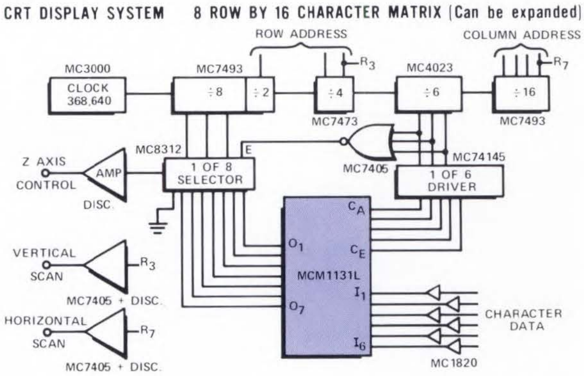
Complementary MOS, MCMOS, is ideally suited to reducing the costs of personal electronics timepieces capable of operating reliably with the extremely small power supplies necessary for this purpose. As a result of Motorola's systems development work, new products with extensive applications will evolve.

MOS subsystems for terminal equipment



A good example of Motorola's systems approach

CRT DISPLAY SYSTEM 8 ROW BY 16 CHARACTER MATRIX (Can be expanded)



to terminal equipment requirements are new developments in products for terminal receivers and transmitters and for CRT display systems.

Systems orientation vital

Another case of orienting new products to the systems needs is the Motorola memory system designed with multiple MCM1173L RAMs for use with a processor. And so it will go, into the future, whether the requirements are for standard or custom designed product, Motorola MOS will be oriented to fulfilling the system needs — all MOS where MOS delivers the best results or interfacing with other logic forms when that is the best solution.

MEMORIES—A LOOK AT TRENDS FOR THE '70s

Semiconductor memories will gradually replace ferrite cores in the '70s and "bubble-DOT type" memories will seriously challenge drums, discs and bulk ferrite core memories, says Joseph F. Kruy, president of Cambridge Memories, Inc.

The dominant role of ferrite core memories will be successfully challenged for the first time since their incorporation in computer and data processing systems. Plated-wire memory was a challenger in the '60s, giving higher speed, potentially lower costs, and nondestructive readout; however, plated wire will be superseded by semiconductor types in the '70s.

Two technologies will challenge the old standbys of ferrite cores, drums and discs. Semiconductor technology, both MOS and bipolar, will be strong in small and medium capacity ranges, while the controlled magnetic domain wall motion memories such as the Bell Telephone Lab's bubble and Cambridge Memory DOT (EDN Nov. 15, 1970) will be potent in large storage capacity ranges. The bubble and DOT both operate on the same principle, with the difference being in the storage medium. These latter memories have very fast access time using the "block" or "page" transfer principle, and their potential cost is at least an order of magnitude less than semiconductor or ferrite-core types, and competitive with discs and drums.

While ferrite core memories are still expected to be dollar leaders in yearly shipments as late as 1974, computers designed after 1971 will use semiconductor and/or "bubble-DOT type" memories in increasing proportions. Most of these memories will be used as part of an internally controlled memory hierarchy.

The main attraction of semiconductor memories vs cores is their higher speed and potentially lower prices in small or medium sizes. Their disadvantages are volatility and unproven reliability, both of which are not insurmountable. Although nonvolatility is an absolute requirement of some computer users for large capacity memories, it may not be essential for small or medium sizes. If essential, the standby power principle can be applied at additional cost. However, the main drawback that will make computer manufacturers think twice before they use a semiconductor memory of any significant size is unproven reliability of the different chip designs. Also, the number of competing technologies within the semiconductor industry poses a difficult problem of selection to the computer manufacturer. As a result, a time lag as long as two to three years is expected between initial R&D use and availability of appreciable production volumes. This will put a financial strain on some smaller semiconductor memory manufacturers.

Nevertheless, the reliability problem will be solved, either by technological improvements or by incorporation of error correction techniques, or both, and those semiconductor manufacturers who survive the shakeout will participate in a huge market since the appetite of the computer user for larger memories appears to be insatiable.

"Many CPUs are in a terrible jam," the Sanders man noted thickly. "Incoming orders are stealing much precious time."

"Let's put MAC 16 on it posthaste," urged his assistant urgently. "With its phenomenal hardware interrupts, Lockheed's mighty mini is the ideal computer for our proposed curative, the Sanders Order Entry System!"

"Interesting," mused the older man, "but what of devices? Can a mini computer control stations enough?"

"An incredible 256 devices!" shrieked the lad. "Plus mass storage and blinding speed!"

"Hmmm. I suppose we could link MAC 16 with our justly renowned Sanders 720 Display Stations..."

"Of course! Two per office—the second one for verification. Why, on-line or off-line, our system will be so foolproof even *girls* can operate it!" the youngster giggled triumphantly.

"My boy, your enthusiasm is contagious. Consider it done!"

"Our fortunes are made!" his assistant exulted, foaming slightly.

Verily, an apt prophecy it was.

Moral: Fame and fortune await. Merely tell Central you want (213) 722-6810, collect, and become the next clever MAC 16 applicator.

Lockheed Electronics
Data Products Division / Los Angeles (213) 722-6810
A Division of Lockheed Aircraft Corporation

CIRCLE NO. 13

Sorensen's new SRL power supply has a great thing going for it.

Built-in overvoltage protection that can be quickly set and instantly checked even under full load.

SRL is a new low voltage, regulated DC power supply for systems and laboratory applications. We designed it by asking power supply users what they liked and didn't like, the features they wanted or needed. Features like exclusive front panel monitoring and adjustment of overvoltage setpoint without removing the load.

SRL comes in 14 models: 4 voltage ranges to 60 VDC, 4 power levels to 2000 watts. It offers higher power density, low ripple and noise, fast response time over full load range, operation to 71°C, IC reliability.

Check out SRL. Or any of the hundreds of other Sorensen power supplies with output voltages from 3 to 150,000 VDC, output currents from 1.5mA to 1000 A. They are all listed, with prices, in the Sorensen catalog. Write for your free copy to Raytheon Company, Sorensen Power Supplies, 676 Island Pond Road, Manchester, New Hampshire 03103. Tel: 603-668-1600.

	Output Power			
	Voltage	Current (ADC)		
Model	(VDC)	55°C	60°C	71°C
SRL 10-25	0-10	25	22	16.7
50		50	44	33.5
100		100	88	67
SRL 20-12	0-20	12	10.5	8
25		25	22	16.7
50		50	44	33.5
SRL 40- 6	0-40	6	5.3	4
12		12	10.5	8
25		25	22	16.7
50		50	44	33.5
SRL 60- 4	0-60	4	3.5	2.68
8		8	7	5.36
17		17	14.9	11.4
35		35	31	23.4

Sorensen
POWER SUPPLIES

EVOLUTION OF A RESERVATION TERMINAL

A transaction terminal for the commercial world is a real Dr. Jekyll and Mr. Hyde. The nice, sophisticated electronics on the inside had better suit the crude, impatient user on the outside.

DAVID C. UIMARI, Corning Glass Works and
ROBERT H. CUSHMAN, New York Regional Editor

The secret of designing products that successfully become working parts of commercial-world data and communication systems seems to start with the designer first becoming a humble student of the behavior of the users of the existing system. The engineer follows up his humble study with a design that uses technology to flatter and aid—but not fundamentally change—that existing user behavior.

A reservation terminal for motels and car rental stations, designed by Maxson Electronics engineers for the Telemax reservation system (Wellington Computer Systems, Inc.), illustrates this philosophy.

Some engineers admonish: "Forget the old; think only of the essential function to be performed." In this project, however, the "old way" was very much the heart of the specifications.

It was not that the customer didn't want progress—the Telemax system has been one of the leaders in applying electronic concepts—it was just that this commercial customer, like any other commercial customer, knows it only takes one experiment that misfires to put him out of business. One of the quickest ways to make a mistake is to try to change the ultimate customer's behavior too radically.

The criterion for properly judging the Maxson terminal is therefore to what degree it enhances the reservation-making process without upsetting the ingrained behavior of the users. Some of the rather plain-looking, commercial-world transaction terminals begin to look slightly remarkable when viewed in this light. The Maxson reservation terminal, at a cost under that of most general-purpose terminals, enables a motel clerk with practically no additional training to go through his standard procedures in making a reservation much faster. We've seen an operator punch in the information as quick as you can make the coffee-cream-sugar selections from a vending machine.

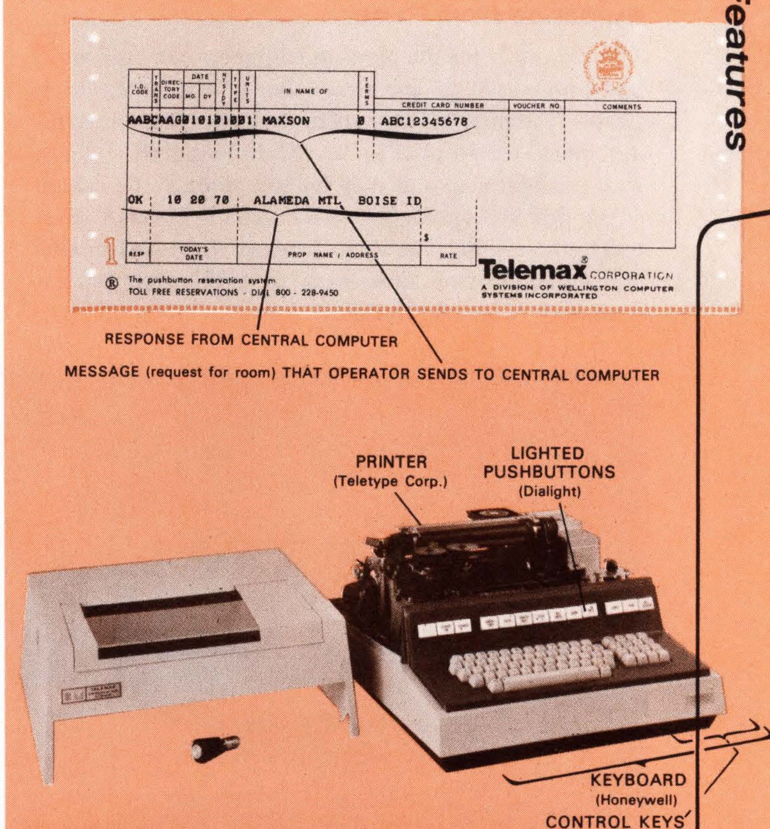


Fig. 1—**Mechanizing the familiar:** The final terminal design has a "self-explanatory" obviousness to operators. The message form (left) has all the familiar items that have been routinely filled in to make a reservation. The machine (right) looks like the familiar typewriter, except that it talks back every once in a while. The row of pushbuttons extending horizontally across the middle of the machine is new, but the buttons are labelled with mostly familiar terms, and besides, individual buttons light up to tell the operator when and where to look.

(Continued)

Reservation Terminal (Cont'd)

At the same time, as is important in all terminals, the Maxson machine minimizes the local teletype line link-time (one of the largest single running costs in the Telemax nation-wide system) and the engagement time to the large central computer facility (Telemax uses two Univac 494s in Fairfield, N. J.).

It takes roughly 220 DIP packs of MSI and gate-level logic and a 512-character glass delay-line memory to do this, or about the same amount of logic that is used in a minicomputer. But this is the new name of the electronics game—using increasingly dependable and increasingly low-cost technology to offset increasingly undependable and increasingly expensive customer help.

Guidance from Past

Fortunately for the Maxson engineers, the "old way" had progressed to the first rung of the automation ladder. Telemax has already developed a simpler, semi-automatic terminal (**Fig. 2**). Eight hundred of these were in field use, and they helped "define" the design of the new system for both Telemax and Maxson. (Systems engineering history is littered with the remains of companies who undertook to develop equipment with only "paper definition.")

The older terminals had been developed by Rixon Electronics. They cost about $1000 apiece. As the photo, **Fig. 2**, shows, these older terminals were an adaptation of the mechanical sliding-bar symbol manipulators that have been used successfully as man-machine interfaces since antiquity. The sliding-bar calculators you can buy for a few dollars are a modern example.

These older terminals showed the Maxson engineers how Telemax wanted the terminal to be a sort of "teaching machine" to guide the operator in rote manner through the steps of filling out a reservation form. The idea is to present the questions implied by the blanks in the form one after the other and give the operator only those limited answers which pertain. This prompts the operator to fill in all the blanks and to do so in the language that the computer will understand. Simple points, but anyone who has ever processed a large number of forms knows full well how many blanks are either inadvertently missed or filled with useless information.

The questions on these earlier terminals are printed in one horizontal row across the top of the sloping panel. The answers are printed as a limited number of specific options vertically underneath each question.

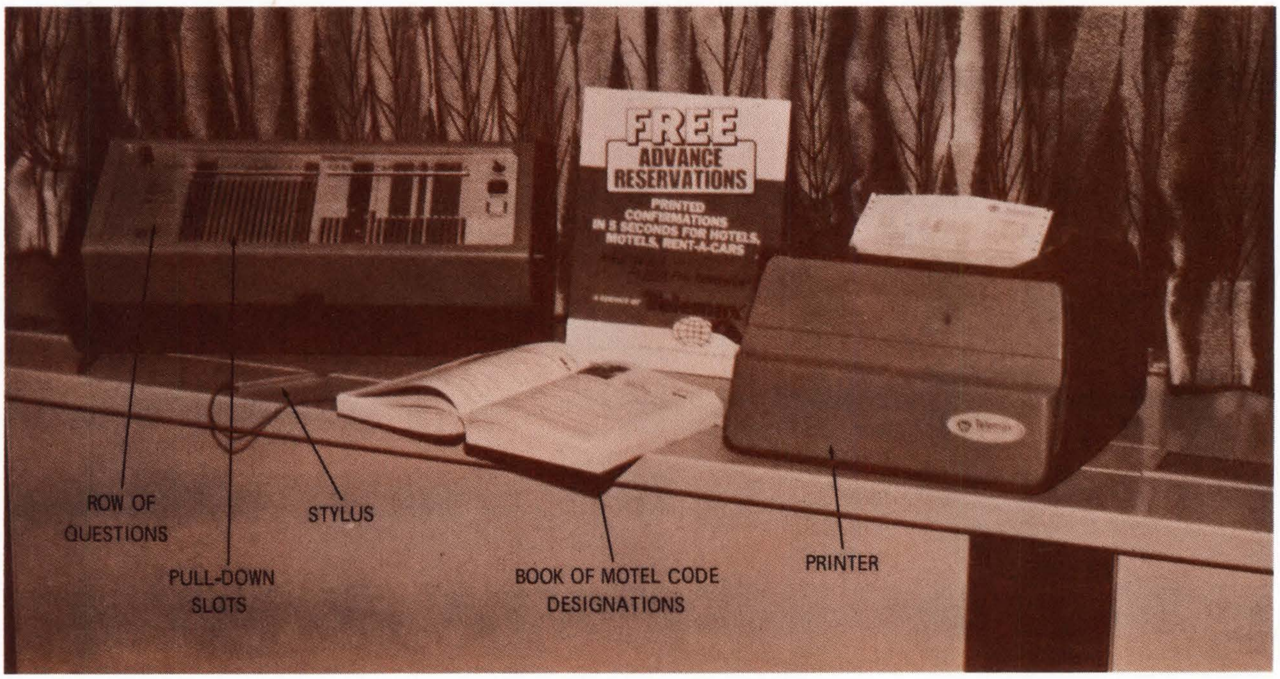


Fig. 2—**Earlier terminal** represented the "electrification" of the classic sliding-bar calculator. User would stick stylus into the slots and pull down bars underneath to desired entry. When all the bars were in place, a horizontal arm carrying optical pickups would read off the bar positions.

The questions correspond to the form blanks: "location," "date," "type room," etc. The answers would be brief code letter or number groups.

Slits alongside the vertical lists of response options expose the sliding bars. These bars have holes adjacent to each response, and the operator communicates his choice to the machine simply by poking a stylus into one of the holes and pulling down until the stylus is stopped by the bottom of the slit.

For example, under "date" there are two vertical slits, one with the numbers 1 to 12 for the month and the other with the numbers 1 to 31 for the day. To enter February 15, the clerk pokes the stylus into the hole adjacent to 02 for the month, pulls the month bar down; then into the hole adjacent to 15 for the day and pulls that bar down. The motion of the bars exposes 02 and 15 in small windows by the question (as with hand calculators) to provide the operator with a check and a memory of his entry.

This earlier terminal was also connected via "Teletype" and leased lines (the long distance cross-country links being multiplexed to save line-leasing costs) to the central computer in Fairfield, N. J. After the clerk has entered all the information, and looked at the feedback windows to check its correctness, he hits the "transmit" button and a long horizontal optical pick-up arm is mechanically moved down behind the bars to read off the coding. The reading arm moves at a speed that automatically puts the allowed 10-characters-per-second on the "Teletype" line.

Then, after a pause, the central computer at Fairfield, N. J. responds, printing out confirmation or rejection of the reservation on a separate standard teletypewriter unit.

"These earlier terminals have proven very reliable," says Theodore Rosenberg, vice president for Wellington Computer Systems. "Their drawback is that they lack flexibility. The mechanical rigidity of the input format limits the clerk's choice to only a 48-character message constrained to the question and answer choices printed on the panel and strips. Thus, if Telemax wanted additional services for its customers (like replenishing motel housekeeping supplies from central warehouse), it would either have to make an ungainly wider terminal or use an awkward system of overlays. And if Telemax wanted to sell its service to an entirely different type of customer (say an airline), there would be an additional delay until Telemax could provide a modified terminal."

The challenge before the Maxson engineers was to maintain all the use-proved features of the older semi-automatic terminal while further augmenting its ease and flexibility of use.

Among the obvious good features of the older terminal, it allows off-line message composition with feedback cuing to remind the operator where he was, followed by automatic, maximum-data-rate transmission. Thus, the total nation-wide system would not be penalized by slow, erratic data entry—such as might occur from drowsy, part-time night clerks or busy, continuously-interrupted owner-managers. The designer of a system such as this must realize that it will be used, not by a dedicated specialist who considers the terminal his prime job responsibility, but by a motel deskman who thinks of the terminal as perhaps just another nuisance, like a phone call.

Maxson's Configuration

The large table shows both the Maxson system configuration (at the top) and the steps in its use (the table itself). This graphical layout emphasizes the part a well-conceived terminal can play as it mediates between the slow, erratic operator and the fast, precise central computer.

The Maxson terminal is built around a central block of logic that is surrounded by I/O and memory subsystems, like a computer. But the function of the Maxson central logic is to control sequences, not compute.

The central logic obtains sequences of questions from the read-only memory (ROM) and poses these questions to the operator by lighting up the engraved push buttons in the row above the keyboard. It receives answers from the operator in the form of button pushes and keyboard strokes. As the answers are received, the central logic places them in their proper slots in the read-write glass memory.

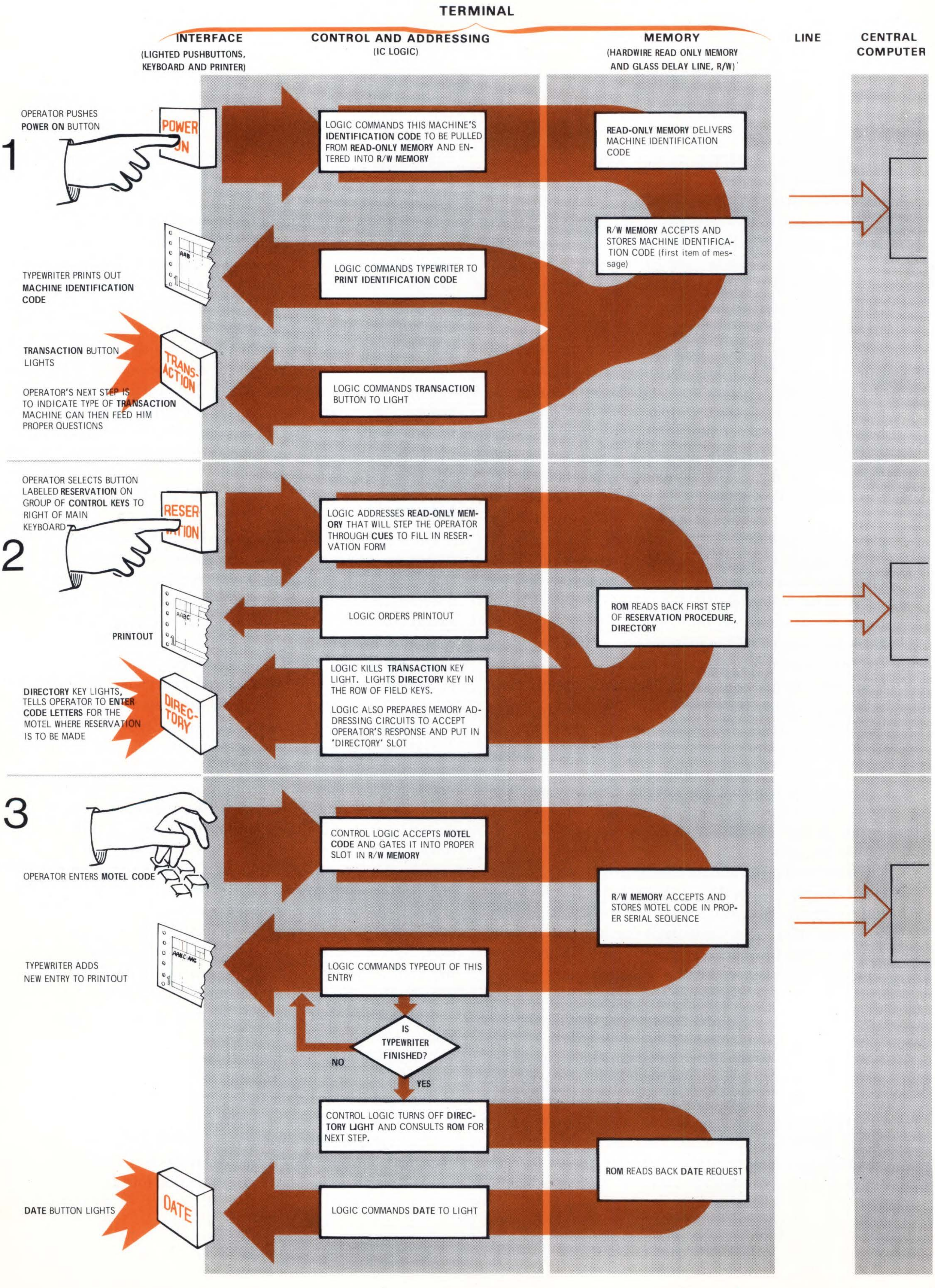
After the message has been composed, the central logic waits for a "transmit" command from the operator, then dumps the contents of the read-write memory onto the communication line leading to the central computer as fast as the line bandwidth will allow.

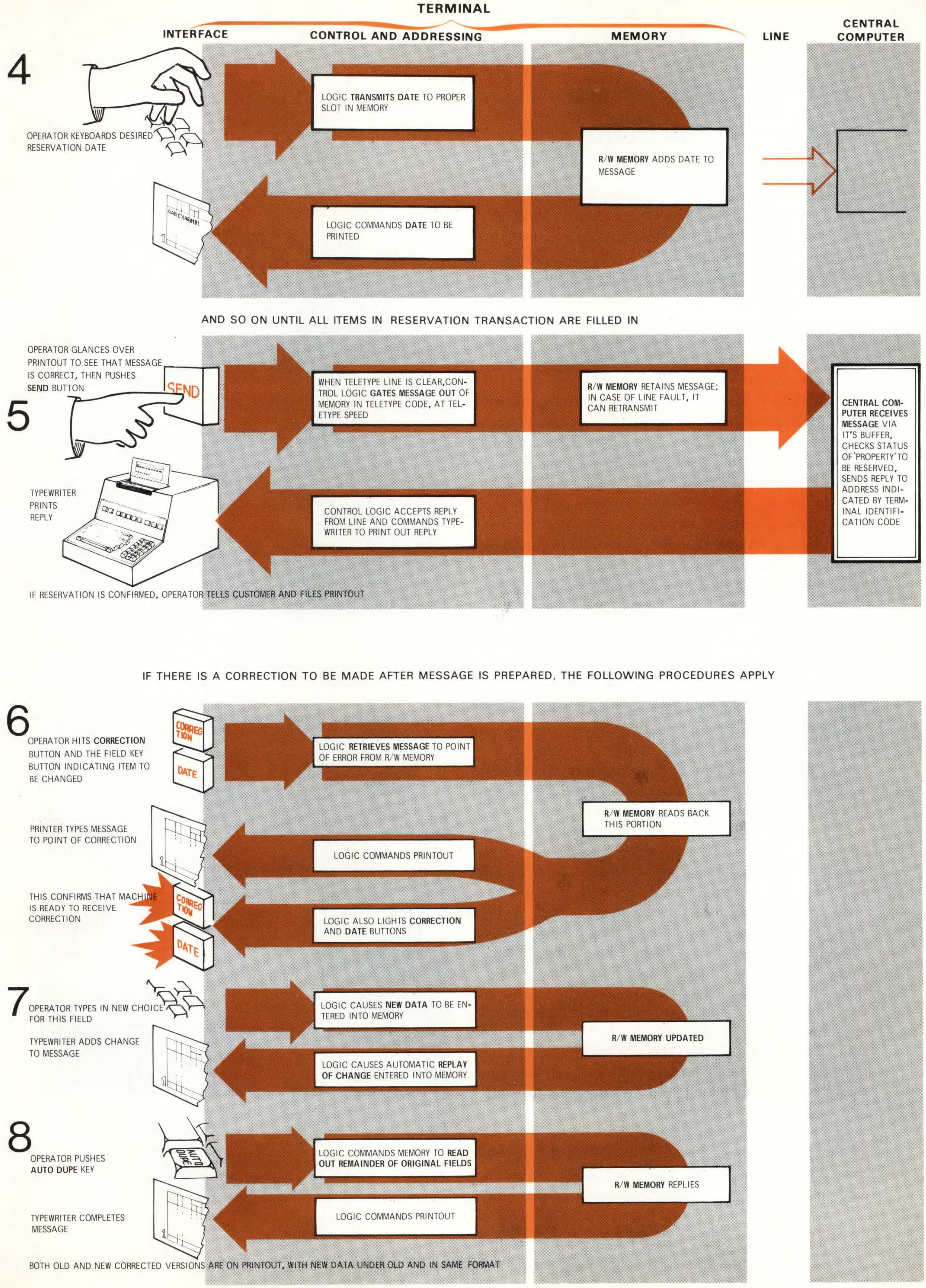
The traveler used to illustrate these steps is a man named "Maxson" who wishes to reserve a single room in Boise, Idaho for the night of January 1. The girl at the desk initiates the first step of the communication by pushing the "POWER ON" button at the left or beginning end of the row of lightable pushbuttons.

This awakes the dormant computer. The central logic looks into its hard-wired ROM memory and pulls out the motel's code "AAB" and puts this into the glass

(Continued)

TABLE SHOWING STEPS IN USING TERMINAL





TERMINAL
INTERFACE
CONTROL AND ADDRESSING
MEMORY
LINE
CENTRAL COMPUTER
4
OPERATOR KEYBOARDS DESIRED RESERVATION DATE
LOGIC TRANSMITS DATE TO PROPER SLOT IN MEMORY
R/W MEMORY ADDS DATE TO MESSAGE
LOGIC COMMANDS DATE TO BE PRINTED
AND SO ON UNTIL ALL ITEMS IN RESERVATION TRANSACTION ARE FILLED IN
OPERATOR GLANCES OVER PRINTOUT TO SEE THAT MESSAGE IS CORRECT, THEN PUSHES SEND BUTTON
SEND
5
WHEN TELETYPE LINE IS CLEAR, CONTROL LOGIC GATES MESSAGE OUT OF MEMORY IN TELETYPE CODE, AT TELETYPE SPEED
R/W MEMORY RETAINS MESSAGE; IN CASE OF LINE FAULT, IT CAN RETRANSMIT
CENTRAL COMPUTER RECEIVES MESSAGE VIA IT'S BUFFER, CHECKS STATUS OF 'PROPERTY' TO BE RESERVED, SENDS REPLY TO ADDRESS INDICATED BY TERMINAL IDENTIFICATION CODE
TYPEWRITER PRINTS REPLY
CONTROL LOGIC ACCEPTS REPLY FROM LINE AND COMMANDS TYPEWRITER TO PRINT OUT REPLY
IF RESERVATION IS CONFIRMED, OPERATOR TELLS CUSTOMER AND FILES PRINTOUT
IF THERE IS A CORRECTION TO BE MADE AFTER MESSAGE IS PREPARED, THE FOLLOWING PROCEDURES APPLY
6
OPERATOR HITS CORRECTION BUTTON AND THE FIELD KEY BUTTON INDICATING ITEM TO BE CHANGED
CORREC TION
DATE
LOGIC RETRIEVES MESSAGE TO POINT OF ERROR FROM R/W MEMORY
R/W MEMORY READS BACK THIS PORTION
PRINTER TYPES MESSAGE TO POINT OF CORRECTION
LOGIC COMMANDS PRINTOUT
THIS CONFIRMS THAT MACHINE IS READY TO RECEIVE CORRECTION
CORREC TION
DATE
LOGIC ALSO LIGHTS CORRECTION AND DATE BUTTONS
7
OPERATOR TYPES IN NEW CHOICE FOR THIS FIELD
LOGIC CAUSES NEW DATA TO BE ENTERED INTO MEMORY
R/W MEMORY UPDATED
TYPEWRITER ADDS CHANGE TO MESSAGE
LOGIC CAUSES AUTOMATIC REPLAY OF CHANGE ENTERED INTO MEMORY
8
OPERATOR PUSHES AUTO DUPE KEY
AUTO DUPE
LOGIC COMMANDS MEMORY TO READ OUT REMAINDER OF ORIGINAL FIELDS
R/W MEMORY REPLIES
TYPEWRITER COMPLETES MESSAGE
LOGIC COMMANDS PRINTOUT
BOTH OLD AND NEW CORRECTED VERSIONS ARE ON PRINTOUT, WITH NEW DATA UNDER OLD AND IN SAME FORMAT

Reservation Terminal (Cont'd)

R/W memory as the first word of the message. And – as it will continue to do so each time it puts something into the R/W memory – the central logic causes this entry to be typed out on the printer in its proper place on the reservation form. Then the central logic looks again into the ROM and pulls out the first question for the operator to answer. It lights up the "TRANSACTION?" push button, which is next button in row.

Now the operator must tell the machine which of the various transactions held in the ROM she wishes to run through. The Maxson machine carries 20 different transaction programs with up to 16 steps each. This is what gives it much greater flexibility than the older Rixon terminal. There are programs for the motel operator to transfer room inventory to and from the central computer's memory. There are transactions used for routine system maintenance and operator training. But typically an operator need only to know codes for one or two transactions.

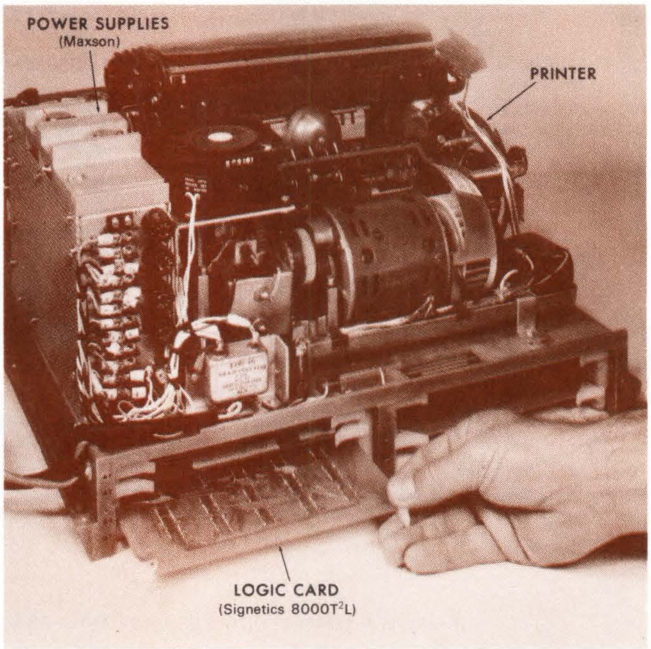
In our example, the girl answers the TRANSACTION? question by looking down to the cluster of control keys to the right of the keyboard and pushing the button engraved "RESERVATION." She has initiated STEP 2 and the central logic immediately sets up to run down the ROM's RESERVATION sequence of questions. And, again, the central logic enters the code for the operator decision into the R/W memory and has the identifying code "A" typed out on the printer to reassure the operator that she's getting somewhere with this machine. (Lesson reinforcement, as they would say in the teaching-machine field.)

In the cycles that follow – STEPS 3, 4 and 5 – it can be seen that the machine is patiently asking the operator to fill in the blanks of the reservation form, not proceeding to the next question until the operator has done so. At no time does the machine ever ask the operator any question that can't be filled out with a few hunts-and-pecks of the keyboard. And always, the machine not only enters the response from the operator into the memory, but also has it typed out in place on the form by the printer so the operator can keep track of the message she's composing.

In STEP 3 for example, the machine has asked the operator for the date of the reservation, and the operator is able to respond with four keystrokes, 01 and 01, for January 1.

The message is not sent out on the line until it's completed. This saves line time charges and helps cut down on errors, both of which are major operating costs in a nationwide system like this (experts say

Fig. 3 – **Back of Maxson terminal.** Maxson mounted the subsystems in and on a custom-designed base of cast aluminum. This had sufficient structural rigidity to lessen the noise of the "Teletype" printer. The logic and memory cards slide into grooves in this casting.



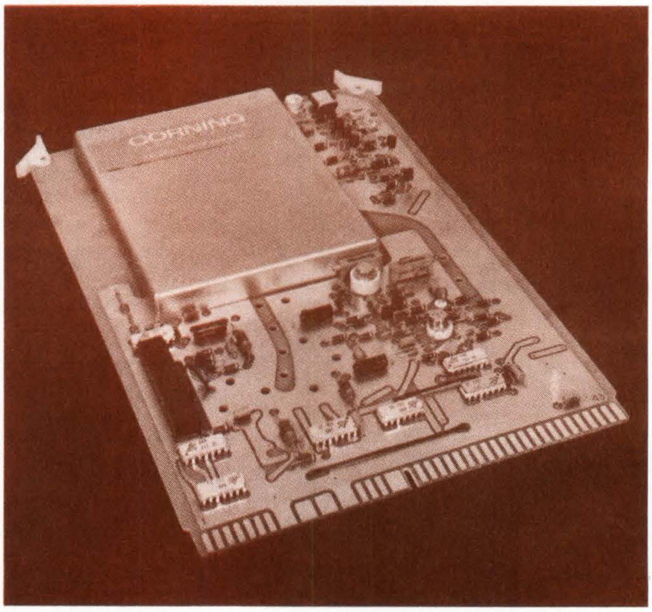


Fig. 4 – **Memory plug-in** exemplifies the Maxson design philosophy: wherever possible, purchase subsystems as complete, self-contained and functional OEM units. This way you get to market first with the most reliable, produceable product. Corning glass delay-line memory was shipped complete with its pre-engineered drivers and compatible interface circuits.

they'll be worldwide before long).

Reservation services charge $1 or more per reservation, and at that rate it would not take too many scratched-out entries or mistakes to take the profit margin out of a $18 room for one night.

The type of reply the girl would get from the central computer after a short delay is shown below the query on the same form. This indicates that the main computer in New Jersey has searched the block of rooms given to it by the Boise motel and has assigned one to Mr. Maxson. The girl can tear a copy of this off for the customer so he has proof that he has a reservation and save another copy in the motel files to prove she made the reservation.

STEPS 6, 7 and 8 show how easy it is for the girl to make a change or correction in the message. The organization of the terminal's logic is such that the operator merely has to push the field key associated with the memory slot she wishes to change, then enter the new answer. The terminal does the rest, retyping the message up to and beyond that point.

Careful Shopping for Components

Because of the financial and engineering man-hour contraints on commercial projects, it is necessary to get all the help possible from suppliers, yet never pay for more than the needed function. To Maxson, this meant diligently seeking out components and preferably whole subsystems that were already designed and proven out and committed to manufacture. This led the Maxson engineers in the direction of MSI rather than gate-level logic and complete ready-to-plug-in OEM packages for keyboard, memory and printer.

Central Logic. The central logic used for control and addressing was made up of Signetics Series-8000 T^2L and made heavy use of multi-function and MSI-level DIPs such as 4-bit adders, 4-bit shift registers and 8-input multiplexers. Series-8000 T^2L was chosen because, at the time the decision was made, this family offered the largest selection of the desired MSI functions. Though T^2L speed is not needed for the present operation, it provides a healthy performance margin for updating the terminal for future use over wider-band communication lines (which conceivably could be local microwave links in some regions).

The task of "cueing" the operator step-by-step through the information-entry procedure, as spelled out in the large table, required an unexpected amount of logic. Though such machine-aid for an operator looks simple enough from the outside, it was what caused the Maxson machine to use the equivalent of 5000 to 6000 logic gates and cost in the neighborhood of $3500 while the older Rixon machine which had less "cueing" used hardly any electronics and cost only $1000.

"It is always surprising to find out how much electronic complexity must be designed in to replace even the simplest, garden variety patterns of human intelligence," says Louis Huber, Maxson Deputy Director of Data Systems.

Read/Write Memory. Maxson would have had to put in even more logic if the R/W memory had not been purchased as a self-contained unit, complete with most of its bookkeeping logic. The fact that Corning offered a working subsystem with the capacity needed for the various transaction messages – 512 characters – was one of the factors that swung the Maxson engineers toward selecting a glass delay-line memory. Corning would deliver it as a complete card, ready to be plugged in and work with Maxson's T^2L logic (see **Fig. 4**). Other benefits that came with this selection were small physical size, low maintenance requirements and no need for expendable peripheral supplies such as magnetic tape or paper tape.

Only MOS shift registers could compete with the glass delay line and, at the time of the decision, none of these looked as low in per-bit cost. Besides, none of the MOS units had the degree of proven design and certainty of availability of the Corning unit.

As with the T^2L logic, the speed capability of the glass delay-line memory – 8 MHz – far exceeded the needs of the application. Yet, since the T^2L had the speed reserve, it was nice to know that the memory, too, had a reserve so that the whole system in the future could be used with the high-speed data links.

Printer. Perhaps the most down-to-earth decision in the design was to use a time-proven "Teletype" Model 32 printer as a combined display and hard copy readout. The customer did not need the glamour of a CRT for this terminal. "Half the time we expect the motel operators will bury these in their back offices," says Rosenberg, "so why have the expense and risk of malfunction inherent with a CRT? Besides, we'd need a printer anyway because it's vital that both the traveler and the motel operator have a record of the transaction." The venerable Model 32 can be purchased from ITT for $450 and, though it is noisy and slow, it has proven reliable and adequate for this application.

Keyboard. Quite the reverse of the printer, Maxson turned to one of the newest components on the market for the keyboard. They chose the new Honeywell key-

(Continued)

board that translates key motion into electronic signals via Hall-effect transducers. Again, what Maxson liked was the fact that it could obtain a complete, functional subsystem from a known supplier and thus, in one stroke, have fair chance of being rid of further problems with the design and manufacture of this major component.

Lighted Push Buttons. For the row of field keys, which by visual animation would provide the operation cueing, the Maxson engineers used Dialight Corp. lighted pushbuttons.

A Maxson designed power supply and a rigid custom base casting completed the basic chassis. The cover ("the cosmetics"), a necessary final flourish in completing a commercial product, was styled by Maxson.

Same Old Rush, But with Less Manpower

It's unrealistic to discuss a commercial design project without mentioning the severe limitations upon engineering manhours as compared with military projects. Maxson engineers said that they had the same old "we wanted it yesterday" pressure for delivery of final units that they had experienced in past military projects. But the difference an outsider notes when comparing military and commercial projects is how the commercial project is done with just a handful of engineers while the military projects always seem to be done with "seas" of engineers.

The time pressure forced the half-dozen engineers of the Maxson project to overlap the stages during the 1-1/2 years of the project. They hadn't really completed their first prototype to see if all the subsystems would "play" together, when they had to start on the 15 field-trial prototypes. They only had these field-trial prototypes out in use a few months (September through December 1969) when they had to start their final design for the 1200 production units to meet the May 1970 production-unit shipment deadline.

Yet the prototypes played a vital part in guiding both Maxson and Telemax to a "not-too-many-regrets" final design. Verbal and paper communication between customer and the engineers have always been fraught with misunderstandings, and there is nothing like the actual field trial of prototypes to resolve constructively the many questions that arise (or, worse, those that don't arise—until later).

The field trials also gave Telemax the opportunity to check the reactions of their customers, the motel and car-rental system owners, and so provided the vital final closing of the designer-customer-customer's customer communication loop.

Epilogue

Maxson's aim now is to use what it has learned from this terminal as the springboard to sales in other markets. It believes the terminal can be the least expensive answer to the needs of users in fields such as mail-order houses, department store chains, brokerages and even education (as a teaching machine).

"But to sell to these wider markets, we need a more 'universal' terminal," says Louis Huber. "We've found you've really got to show something pretty concrete to a businessman. You can't rely on his imagination. You've got to go ahead and invest your own money and tailor the machine to perform the businessman's routines. You've got to be able to put something down on the businessman's desk that he can play with and see that it can 'talk' the language of his business. Otherwise, you won't even come close to a sale.

"The problem of trying to sell other industries on the basis of our reservation machine is that it costs us too much to alter it for speculative demonstrations. Our present hardwiring can be changed only by redesigning whole circuit boards, and this can cost as much as $100,000. Therefore, we are in the process of altering our system so that we can substitute MOS read-only memories (ROMs) for the hardwiring. Then when we want to change our cueing format, we only have to change one or two ROM chips on one of the boards.

"By the end of 1971 we expect to be able to produce custom demonstrators in a few weeks by using programmable ROMs (those with fusible links). We ought to be able to do so for $10,000 to $20,000 which would be reasonable selling prices to a large-volume potential customer. Then, if the demonstrator cinches the sale, we can order custom ROMs and have them within 6 weeks or so. Because of our redesign, we should not have to charge customers large engineering costs for each application, and this will give us an important price edge in the competitive terminal business." ▭

David D. Uimari, with Corning Glass when this article was developed, is presently manager of applications at Harris Semiconductor, where he has specific responsibility for digital and memory products. His prior experience includes the design of hybrid microcircuits and serial delay line memories. He obtained his B.S.E.E. from Illinois Inst. of Technology and his M.E.E. from North Carolina State Univ.

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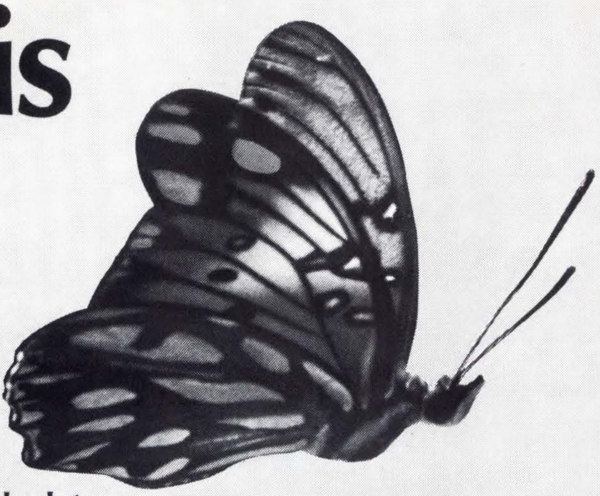

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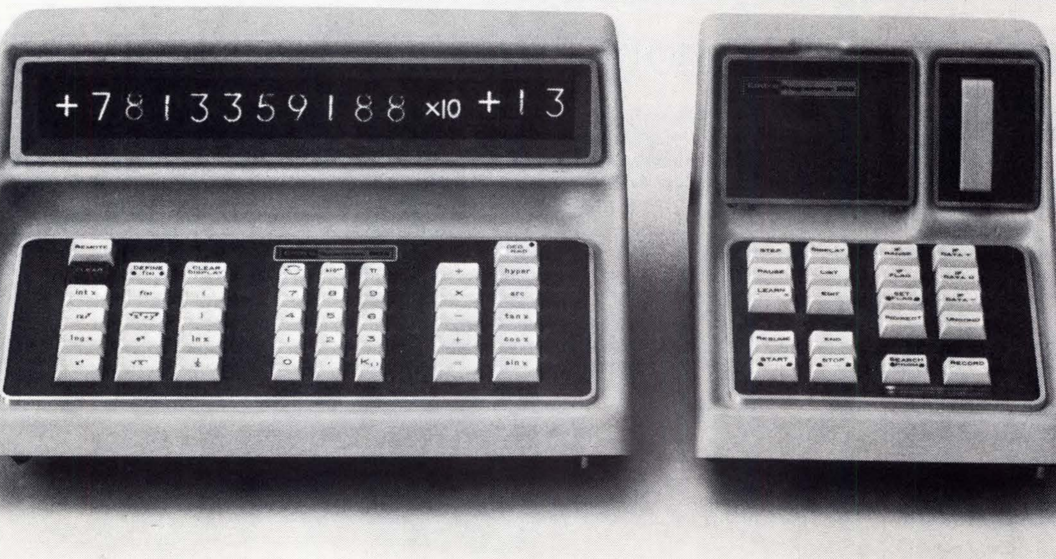

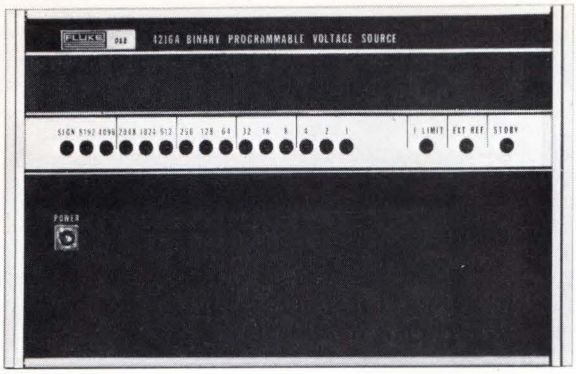

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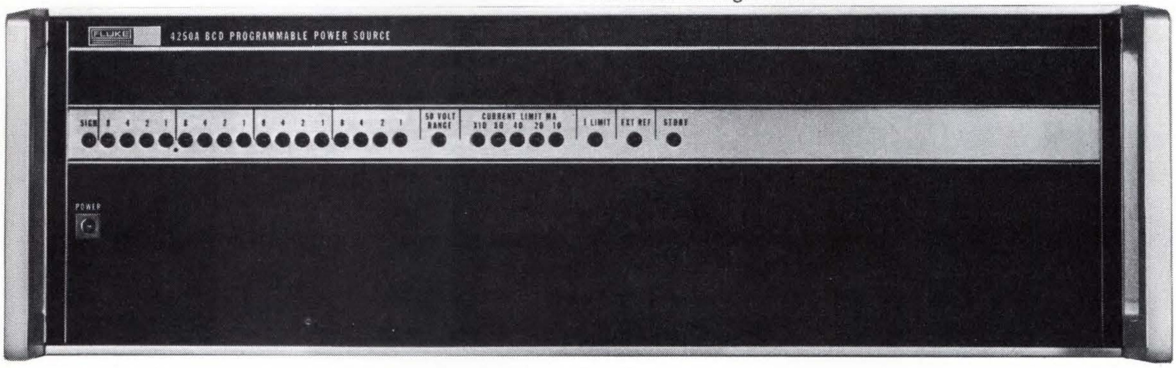

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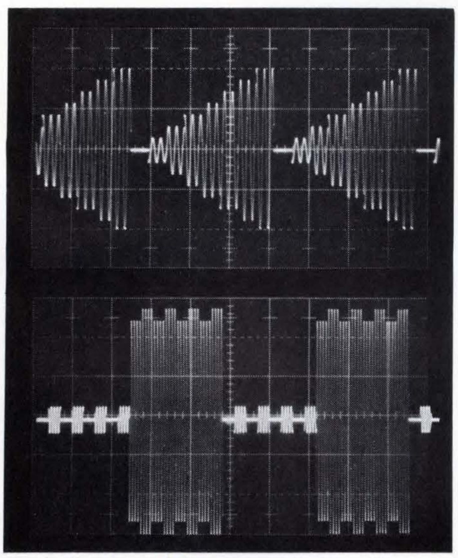

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CIRCLE NO. 18

MATCHED DESIGN— KEY TO LINEAR ICs

Imaginative interconnection of matched monolithic IC components can create many new building blocks. These, along with existing ones, can be used to generate a wide variety of new LICs.

DOUGLAS R. SULLIVAN and MODESTO A. MAIDIQUE, Nova Devices, Inc.

The key to understanding LICs is not a simple 1, 2, 3 process that can be handed to any engineer; however, the **Matched Design** concept is of such vital importance to successful LICs that it might be viewed as the **key** to understanding their design. This concept is based on profiting from the inherent matching of characteristics of components contained on a single monolithic die. While an engineer should be familiar with transistors and transistor circuits to become proficient in the design or evaluation of LICs, he should also be aware that many of the principles considered poor design practices in discrete circuits are commonly used in LICs. This difference in concepts is caused in part by the inherent component matching found in ICs, as opposed to mismatches in component characteristics that plague discrete designers.

To show how matched design provides for improved LICs, let's take a close look at the several matched design techniques in common use today. Once these techniques are understood, the discrete designer can adapt them to his own designs to optimize their performance. While other LIC guiding principles will also be considered, the emphasis is on the matched design concept.

Matched Design— Where Has It Been Hiding?

In simple terms, matched design has been hidden by high costs. The concept was around long before transistors, and it was not invented by LIC designers. It is simply an expression of one of the most powerful concepts in engineering—symmetry. One of the first matched designs in electronics was probably the vacuum-tube differential amplifier. This was a very successful circuit and was the input stage in almost every sensitive dc amplifier. Discrete transistor circuit designers were limited by costs to one or two matched pairs in their designs. To get two well-matched transistors ($\pm$ 2 mV V_{BE} mismatch), they were faced with either a costly selection or a pseudo LIC—two transistors in the same can. Either approach was expensive, cumbersome, and for the most part unsatisfactory.

In LIC design, there is available an abundance of matched transistors on a single die such that new cir-

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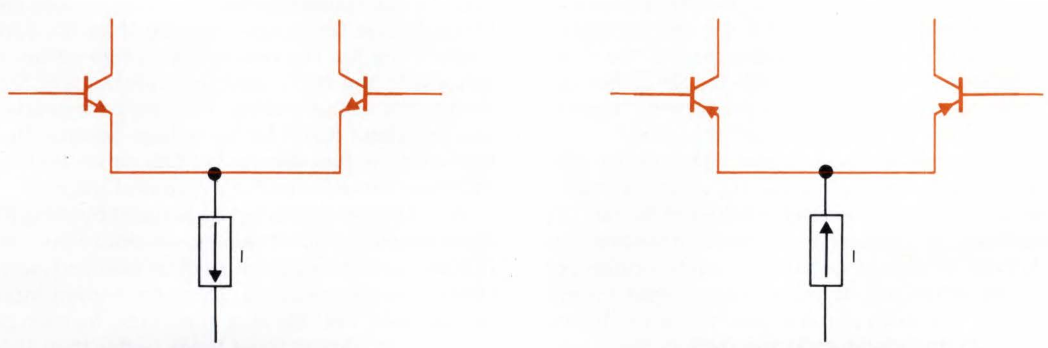

Fig. 1—**Basic differential amplifiers**

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cuit innovations are based on the availability of many matched devices. Additionally, in LIC design, components can be accurately mismatched through relative device geometry changes such as area, thus opening up even greater design possibilities. Through technology improvements there is an almost unlimited supply of matched active devices, thus LICs have turned the tables on the cost game. This has led to the use of more matched active devices and fewer resistors, resulting in more circuitry and performance per unit area of chip.

Differential Amplifiers

The simplest extension of the classic npn differential amplifier is its complement, the pnp (**Fig. 1**). PNP amplifiers have been avoided in past LIC designs because high beta in a pnp was not readily available and excess

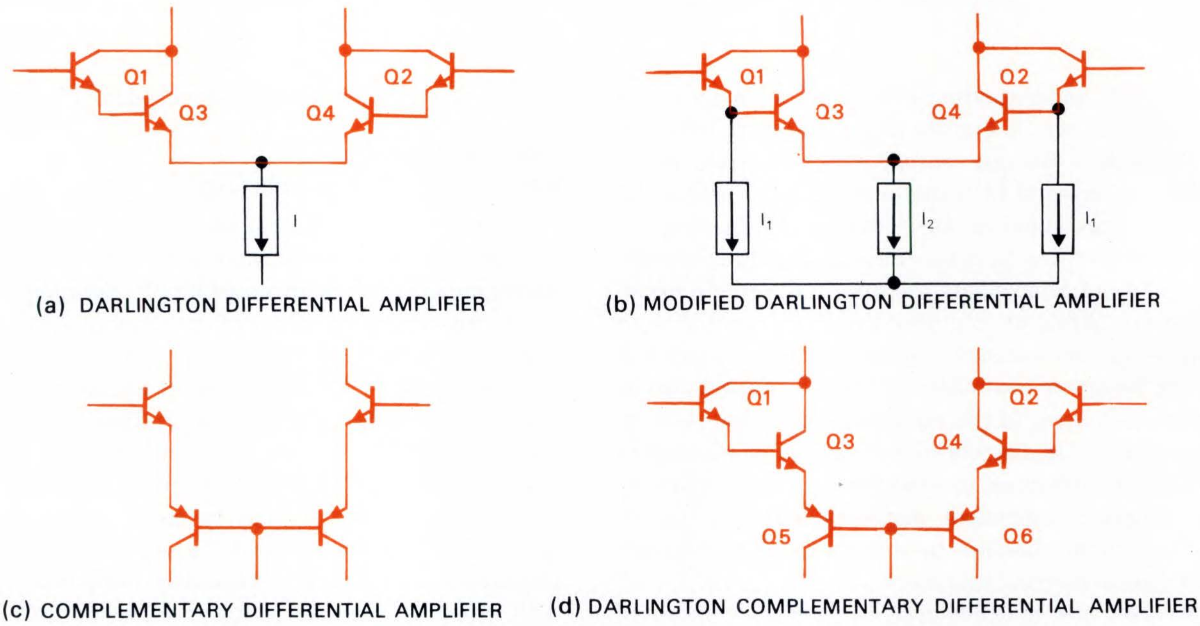


Fig. 2—**Improvements on the basic differential amplifier.** Two Darlington-connected transistors, Q1 and Q2, added to the basic diff amp (**a**) give a factor of beta improvement in bias current, offset current, and input impedance. Maximum differential input voltage rating is doubled, while voltage gain for a given collector loading is halved. Voltage gain reduction can be corrected by doubling emitter current source so that emitter resistance for each transistor is halved. This still yields a $\beta/2$ improvement in bias current. Low input offset voltage in the Darlington configuration is more difficult to attain than for the basic diff amp because offset current in Q3 and Q4 causes operating points of the Darlingtons to be different. Careful matching of transistor pairs minimizes this effect.

Control over offset voltages of the input buffer transistors (Q1, Q2) in (**a**) can be improved by inserting matched current sources in the emitters of Q1 and Q2 (**b**). The current sources are made large compared to the bias currents of Q3 and Q4 so that variations in emitter current of Q1 and Q2 are minimized. By swamping out offset current of Q3 and Q4, the extra current sources help to insure that Q1 and Q2 are operating at the same current, thus reducing their contribution to offset voltage. Other improvements are extended frequency range and a gain comparable to the basic npn diff amp. Input impedance higher than for (**a**) results from increase of beta with current, and while bias current is also higher, it is well below the value for a single differential pair.

Differential input voltage ratings are increased by the complementary arrangement in (**c**). Here, npn input transistors act as buffers for the poor bias current characteristics of the integrated pnp. A common-base configuration optimizes frequency response of such a pnp for differential inputs. The pnp acts as a high-voltage diode in series with the npn's emitters, substantially raising the differential voltage rating. The pnp base-emitter diodes can withstand high reverse voltage because the doping level of these junctions in LIC fabrication is the same as that used for collector-base diodes of the npn.

Input current for (**c**) can be reduced by using a Darlington arrangement (**d**). Attaining low input offset voltages is further complicated because three matched pairs of transistors are now required. Thus, for a given input offset voltage spec, the individual transistors for each pair must be matched almost three times better than the classic case (**Fig. 1**).

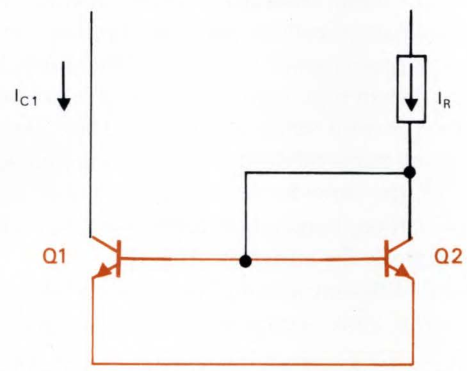


Fig. 3 – **The classic LIC current source.** Here one transistor V_{BE} is used as a reference diode, as its base is shorted to its collector. Since the transistors are matched devices and their V_{BE} potentials are constrained to be equal, emitter currents of each device will be equal. Therefore, collector currents will be matched except for an error current equal to two times base current. For high gain transistors, base current can be neglected, and collector currents will be equal and stable with temperature. It is common practice to fix the reference current with other circuitry so that the current source output is predetermined.

The close relationship between the classic differential amplifier and the classic current source becomes clear when it is noted that the classic current source is simply a differential amplifier with both base inputs connected to one of the collectors. Here V_{BE1} is forced to be equal to V_{BE2}. Collector currents can be expressed, using the Ebers Moll relation,

$$I_C = \alpha_F I_{ES}\,(e^{qV_{BE}/kT} - 1) - \alpha_R I_{CS}\,(e^{qV_{BC}/kT} - 1)$$

For a forward biased transistor, the second term can be neglected and since $V_{BE} >> kT/q$ and $\alpha_F \simeq 1$ (high gain transistors), the final relationship reduces to:

$$I_C \simeq I_{ES1} e^{qV_{BE}/kT}$$

Thus for $V_{BE1} = V_{BE2} = V_{BE}$ the equation for each of the collector currents becomes:

$$I_{C1} \simeq I_{ES1} e^{qV_{BE}/kT}$$

$$I_{C2} \simeq I_{ES2} e^{qV_{BE}/kT}$$

These two relationships can be combined to produce the equation:

$$\frac{I_{C1}}{I_{C2}} \simeq \frac{I_{ES1}}{I_{ES2}}$$

Saturation currents I_{ES1} and I_{ES2} are proportional to device areas and inversely proportional to doping. In LIC fabrication, matched doping profiles are inherent to the process, while the area of each device can be accurately controlled through careful layout. For matched devices $I_{ES1} = I_{ES2}$. Therefore:

$$I_{C1} \simeq I_{C2}$$

Since in this analysis the beta of the transistors is considered to be essentially infinite, I_{C2} is equal to the reference current, I_R. Thus:

$$I_{C1} \simeq I_R$$

If non-equal currents are required, a simple solution is to make areas of the two transistors different through differences in geometry (or layout). In this case, the equation for the two transistor current sources becomes:

$$I_{C1} \simeq \frac{A_1 I_R}{A_2}$$

where A_1 and A_2 are the emitter areas of Q1 and Q2 respectively. *This freedom to manipulate device geometry as well as geometry ratios exhibits another side of current source design and of LIC design in general.*

phase shift was experienced above 1 MHz. Therefore, their use was limited to "internal" circuitry such as level shifting and active loads (current sources) for npn stages. However, recent improvements in geometry and process techniques should extend these limits. The shortcomings of integrated pnp transistors do not apply to discretes, thus discrete pnp diff amps are common items. Various levels of improvement over the classic differential amplifier are shown in **Fig. 2**.

Current Control

Despite their crucial importance in front end design, differential amplifiers account for only a part of the matched design building blocks in a typical LIC. Current sources represent another equally important segment in the overall LIC picture. Here, current source applies to single sources, multiple tracking sources and proportional sources, as well as temperature varying current sources used to offset or complement other temperature effects in the overall circuit.

LIC current source designs are basically variations of the familiar discrete emitter follower except that a matched transistor base-emitter diode potential is used as a reference voltage, and the emitter resistor is either eliminated or reduced, depending on the magnitude and temperature dependence of the desired current. Availability of matched transistors for LIC devices has enhanced importance of this technique.

The classic LIC current source shown in **Fig. 3** is the simplest of all sources, using only two matched transistors. However, only moderately small currents can be realized here because the current source output is equal to the reference current (except when geometries are purposely made different). In order to realize an extremely low-value current source, the designer must provide for a very low reference current, thus requiring very large value, stable resistors which are not possible in LIC design. However, there are ways

(Continued)

of getting around this problem and improving current source performance by using matched design techniques shown in **Fig. 4**.

Multiple Tracking Current Sources

While the single current source-reference combination enjoys the widest usage, it is often necessary to have a relatively large number of equal current sources in the same circuit. In such cases, it is desirable to use a single diode-connected reference unit for all of the other common current sources. However, in this circuit configuration, the base current loading on the diode-connected transistor and the resultant error in matching output current to reference current is significant, even when high gain transistors are used (about 5% for four current sources with $\beta = 100$). The effect could become more intolerable for pnp current sources (for $\beta = 10$, the error for four current sources $\cong 50\%$). Once again, though, matched design techniques can be used to improve the situation (**Fig. 5**).

Although differential amplifiers and current sources make up the lion's share of matched designs, many

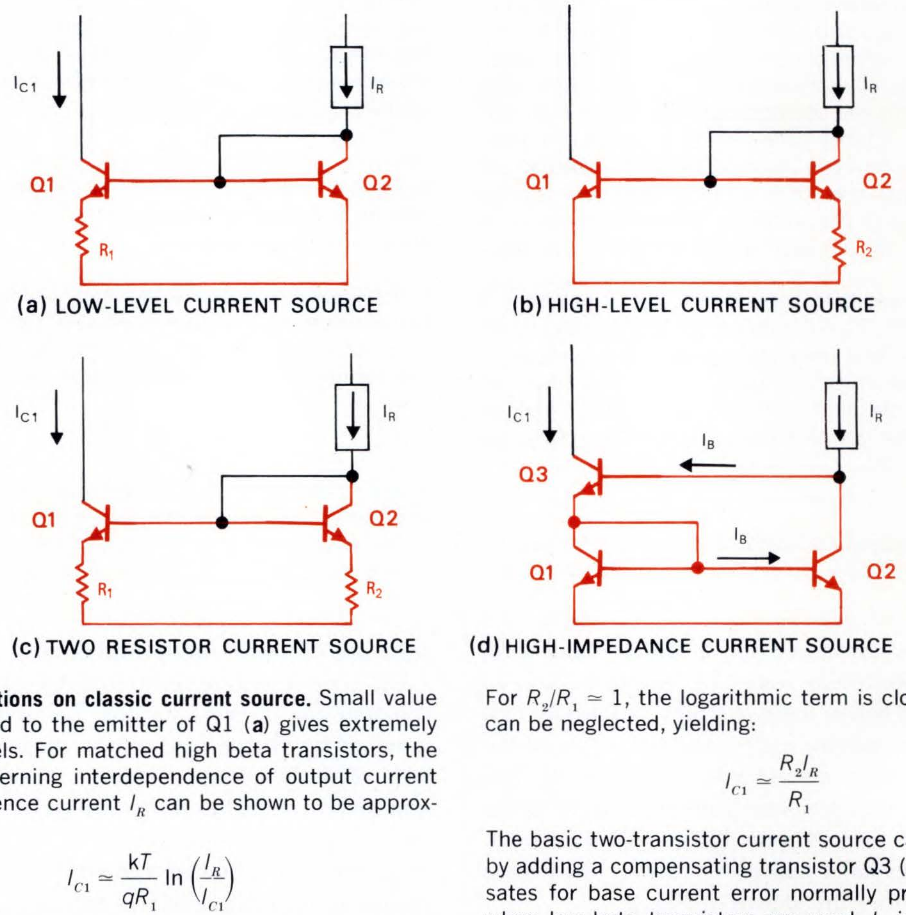


Fig. 4—**Variations on classic current source.** Small value resistor added to the emitter of Q1 (**a**) gives extremely small I_{C1} levels. For matched high beta transistors, the equation governing interdependence of output current I_{C1} and reference current I_R can be shown to be approximately:

$$I_{C1} \simeq \frac{kT}{qR_1} \ln\left(\frac{I_R}{I_{C1}}\right)$$

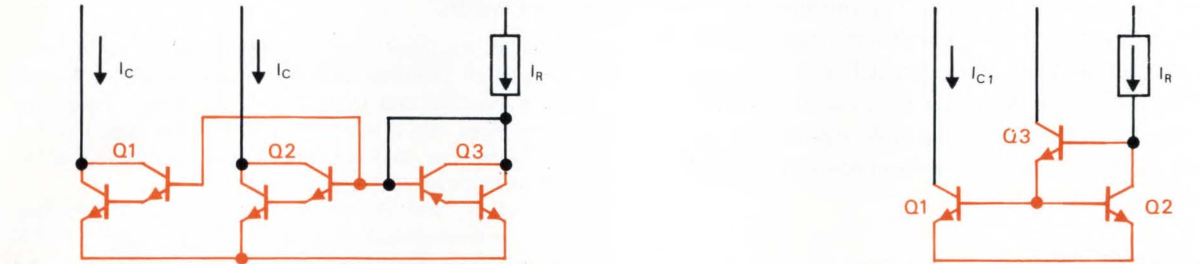
which can be solved by iteration techniques. Placing a single resistor in series with the emitter of Q2 (**b**) results in a current source where $I_{C1} > I_R$. However, strong dependence on transistor current gain makes this form of current source relatively unusable. Adding resistors to both emitters (**c**) gives a moderate value current source with improved (higher) output impedance and adjustable current output. With matched, high beta transistors, the equation for output current can be derived as approximately:

$$I_{C1} = \frac{R_2 I_R}{R_1} + \frac{kT}{qR_1} \ln\left(\frac{I_R}{I_{C1}}\right)$$

For $R_2/R_1 \simeq 1$, the logarithmic term is close to zero and can be neglected, yielding:

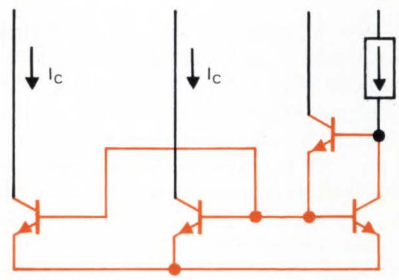
$$I_{C1} \simeq \frac{R_2 I_R}{R_1}$$

The basic two-transistor current source can be improved by adding a compensating transistor Q3 (**d**). Q3 compensates for base current error normally present in **Fig. 3** when low beta transistors are used. I_R is reduced by a single I_B while I_{C1} is increased by a single I_B. Thus, while the two-transistor current source (**Fig. 3**) relationship for low gain transistors is $I_{C1} \cong I_R - 2I_B$, the relationship for (**d**) has no I_B term, providing that current gains are matched. Without the I_B error, current source (**d**) is more stable with temperature variations and more accurate, especially in the low current, low beta region. Output impedance also is vastly improved by the feedback arrangement and emitter diode. Modifications made in **a, b, c** also apply to **d**.



(a) MULTIPLE OUTPUT DARLINGTON CURRENT SOURCE

(b) BUFFERED CURRENT SOURCE



(c) MULTIPLE OUTPUT BUFFERED CURRENT SOURCE

Fig. 5—**Multiple-tracking current sources.** Simplest modification (**a**) of the basic structure to eliminate loading effects on the reference unit is to substitute Darlington connected units (Q1, Q2, Q3) for each of the single transistors in **Figs. 4** and **5**. The main advantage of the Darlington connection is the improvement of the equivalent current gain by an additional factor of beta and lowering required base current for each section, thus reducing this source of error. Another approach for use where reference loading is a factor is to add a third transistor Q3 in (**b**) which supplies base current for the current source transistor Q2, thus diminishing base current error by a factor of beta and making this circuit a natural for multiple current sources as in (**c**).

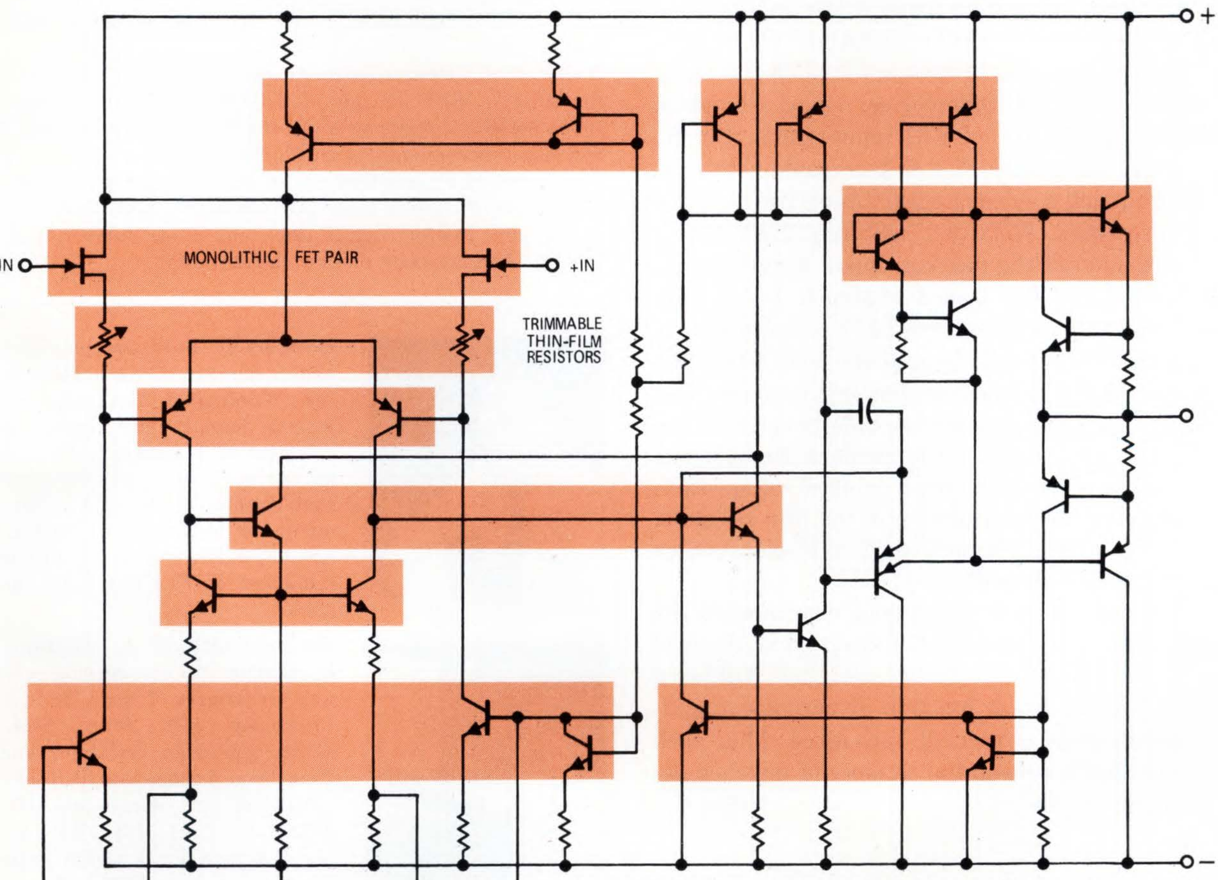


Fig. 6—**AD 503 FET input op amp** illustrates application of the matched design concept. Color areas define matched design blocks.

Matched Design (Cont'd)

other examples could be cited. The purpose here has been illustrative, rather than all-inclusive. While an ingenious new building block can still save the day for many future designs, there is a wide variety of possible circuit solutions available by simply combining existing techniques with various forms of positive and negative feedback.

What Lies Ahead

Linear integrated circuits have been shown capable of achieving high performance in a variety of circuit applications, and this success must be attributed partially to capitalization on matched design techniques. However, as the functions to be realized become more and more complex, it will become advantageous to combine in the same can the performance advantages of IC chips manufactured by different processes, along with stable thick- and thin-film components. Thus hybrid techniques will play an important role in future linear designs.

The idea is too pervasive to expect that matched design techniques will wither away if the linear microcircuit balance tilts to hybrid technologies. On the contrary, one should expect a mating of matched designs realized from different technologies. A good example is the Analog Devices AD 503 FET-input op amp (**Fig. 6**), where a monolithic dual FET chip is mated with a bipolar IC chip and a substrate containing two matched thin-film resistors. With this approach, TO-5 can op amps have entered the picoamp input current range.

The hybrid matched design approach can be contrasted to that of making the FETs simultaneously with bipolar components on a single monolithic die. The latter results in much higher input current and offset voltages, since it is not possible to optimize the FETs at the same time as the bipolars. Because the hybrid approach also lends itself to offset voltage nulling by means of laser trimming of the film resistors, the low offset voltage characteristics of bipolars can be achieved in a FET amplifier.

IC users can expect to see a good deal more of the thinking built into the AD 503 in next generations of linear microcircuits. In the future, designers will learn to realize a given linear function by arriving at optimum combinations of specially processed chips, each chip containing a substantial number of matched design building blocks. ▭

DATABANK

Maidique, M. A., Jewell, R. G., and Sullivan, D. R., "A Flexible Ultra High Performance Operational Amplifier Family – Characterization and Comparative Analysis", Transitron Electronic Corp. Application Note, July 1969. Refers to 741 family (Transitron) and contains a detailed analysis of the 741 circuit and matched design blocks.

Sullivan, D. R., and Mamie, H. W., "A Monolithic Voltage Regulator with Foldback Current Limiting", 1968 NEREM Record, pp. 90-91. Discusses Transitron TVR 2000 regulator circuit which utilizes many matched design elements and few resistors.

Sullivan, D. R., and Maidique, M. A., in "Designing with Linear Integrated Circuits", J. Eimbinder, editor, Chapter 6, High-Input Impedance Monolithic Amplifiers, pp. 74-86. Describes design and analysis of Darlington 709 input stage.

Widlar, R. J., "Some Circuit Design Techniques for Linear Integrated Circuits", IEEE Trans. on Circuit Theory, December 1965, pp. 586-590. Discusses many matched design blocks.

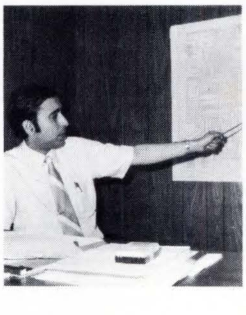
Maidique, M. A., and West, L., "A Generalized D.C. Analysis of the Two Transistor Current Source", to be published IEEE Journal of Solid State Circuits, 1970. A design analysis of matched design current sources, all types.

Widlar, R. J., "A New Monolithic Operational Amplifier Design", National Semiconductor Application Note, TP-2, June 1967. LM101 Application Note – uses many of the matched design blocks.

Widlar, R. J., "Design Techniques for Monolithic Operational Amplifiers", IEEE Journal of Solid State Circuits, August 1969, Vol. SC-4, Number 4, pp. 182-191. Updates Number 4 and discusses some new circuit blocks.

Camenzind, H. R., and Grebene, A. B., "An Outline of Design Techniques for Linear Integrated Circuits", IEEE Journal of Solid State Circuits, August 1969, Vol. SC-4, Number 4, pp. 110-121. Another point of view on LIC design.

Douglas R. Sullivan, president and a founder of Nova Devices, Inc., Wilmington, Mass. was previously founder and operations manager of Transitron's LIC department. He also had been assistant director of the MIT Instrumentation Lab. Both his B.S.E.E. and M.S.E.E. are from MIT. He is a member of IEEE and holds one patent.



Modesto (Mitch) A. Maidique is director of engineering and another founder of Nova Devices. Previously with Shure Bros., North American Aviation, and Transitron, he also taught IC and circuit design courses at MIT. Mitch received his B.S.E.E., M.S.E.E. and Ph.D. (Solid State Electronics) from MIT and is a member of IEEE.

FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE L62**

HV Building Block Uses Series Transistor Switches

Less iron and copper (and fewer dollars) are needed to convert standard ac line power to high-voltage dc when conversion is done at high frequency. This unique conversion circuit easily adapts to many requirements.

LARRY G. WRIGHT and WALTER E. MILBERGER, Westinghouse Electric Corp.

High voltage dc can readily be obtained from power lines by the conventional transformer-rectifier-filter combination, if you can put up with heavy components and their attendant cost. If your needs dictate light weight, though, you will probably consider some other approach such as that in **Fig. 1b**. While more complex than a transformer-rectifier-filter combination, it nevertheless will give considerable savings in component weight and cost, as well as high overall efficiency. Along with these virtues it does have some drawbacks, including the need to use high voltage transistors or to devise some circuit that employs lower-voltage transistors in series (as in **Fig. 2**). Such series transistor strings would be a good answer, except for the rather large and troublesome variations in transistor storage time.

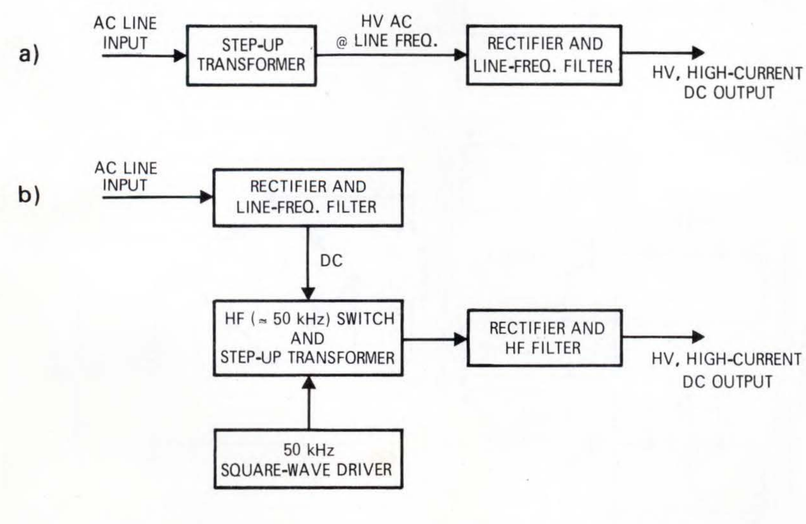


Fig. 1 – **Obtaining HV dc** from ac lines: (a) simple, but costly and bulky, conventional system. (b) Lightweight efficient approach using dc/HF/dc conversion.

Cascode Building-Block Circuit

A circuit that gives automatic equalization of transistor storage time and that also lets you use relatively low-voltage transistors is shown in **Fig. 3**. Many such circuits may, if desired, be connected in either series or parallel to serve various voltage and current needs – hence the term "building-block".

Drive signal input to the cascode push-pull switch must be a symmetrical 50 kHz square wave with 15V pk-pk amplitude, from a 50Ω source. Transistors Q_1 and Q_2 each see only one-half of the dc source voltage because capacitors C_1 and C_2, connected in series across the 280V input, charge to 140V each (ac across each transistor is the full 280V, though).

Storage time of the transistors will automatically equalize, for if Q_1 stores longer than Q_2 it will conduct more current per cycle. When it does, the voltage on C_1 will drop slightly and that on C_2 will rise by the same amount. This will cause Q_1 to store

(Continued)

less and Q_2 to store more, equalizing the storage time. In some 20 such units constructed, the greatest voltage difference noted on C_1 and C_2 was 20V.

Operation at 50 kHz does pose a requirement that fast-recovery diodes be used in the output rectifier. With the newer types available, that is less of a drawback, though.

Summarized, the advantages to be had by using this building-block circuit to provide high-voltage, high-current filtered dc from an ac power line source are:

- high efficiency (≈90%).
- greatly reduced weight and component cost.
- adaptability to a wide range of output voltage and current requirements (identical units can be connected in either series or parallel as needed to achieve the desired rating). □


Larry G. Wright and **Walter E. Milberger**, who share this interesting transistor circuit with us, are both engineers employed by Westinghouse Electric Corp's. Aerospace Div. Both held B.S.E.E. degrees, and Mr. Milberger is a registered Professional Engineer (Maryland).

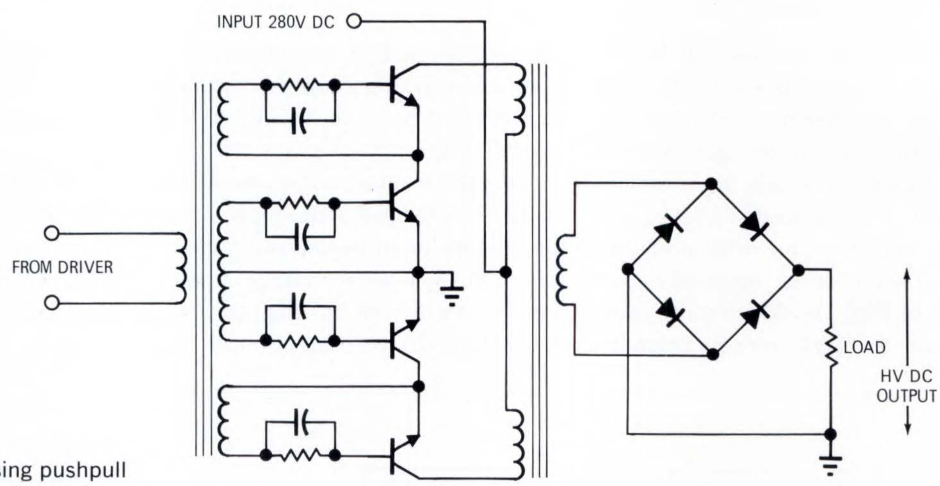


Fig. 2 – **Conversion circuit** using pushpull transistor switch with series transistors.

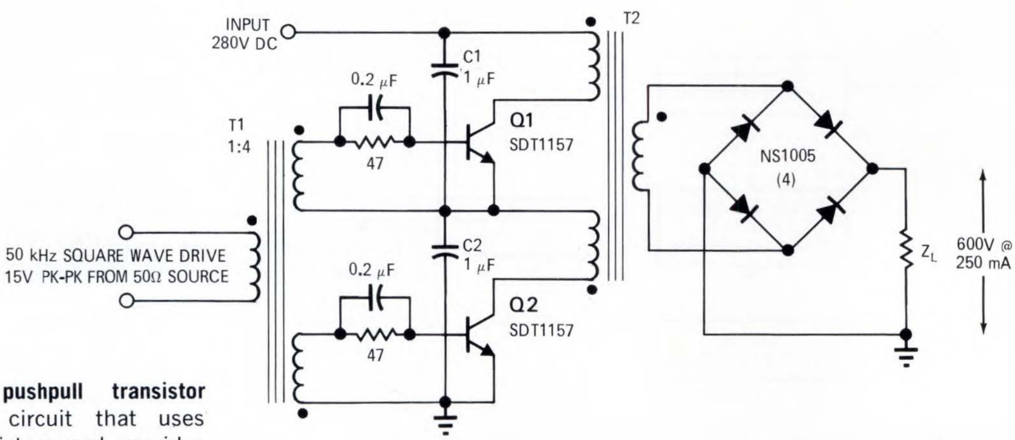


Fig. 3 – **Cascode pushpull transistor** switch conversion circuit that uses lower voltage transistors and provides automatic equalization of transistor storage time.

FOR A FREE REPRINT OF THIS ARTICLE **CIRCLE NO. L63**

Diamond Bridge Improves Analog Switching

Input impedance and current capability improve by a factor of beta (β) when a transistor diamond bridge replaces the more usual diode bridge quad.

WESLEY A. VINCENT, Motorola Gov't. Electronics Div.

Analog signals of up to 3.0V pk-pk can be readily switched in less than 3 ns with a transistor diamond bridge circuit. Such a circuit is used in the multiplexer and sample and hold portions of a 100 megabit/s PCM telemetry encoder developed at Motorola.

The analog gate that uses the diamond bridge to perform the gating function is shown in **Fig. 1**. A diamond bridge is similar to a diode bridge quad except that transistors replace the diodes. This change results in higher input impedance and greater current capability in comparison with the more frequently-used diode bridge quad.

Complete Circuit. In the circuit shown, (**Fig. 1**), two symmetrical drivers interface with system MECL III logic levels. These drivers provide in-phase pulses at the 20 MHz clock frequency, turning the bridge on and off. The symmetrical driving circuits consist of npn and pnp differential comparators (Q1, Q2, and Q6, Q7, respectively) with output drivers Q3 and Q10. During the ON time, the inverting transistors act in push-pull, with Q3 pushing current into the bridge as Q10 pulls current out of it.

During turn-off, pulses from the emitters of Q3 and Q10 are transient-coupled through C1 and C2 to the bases of Q5 and Q9, causing momentary saturation of both transistors which are normally off. These "pull-back" transistors provide low impedance paths to discharge the base storage and the capacitances associated with the transistors in the bridge. Diode-connected transistors Q4 and

(Continued)

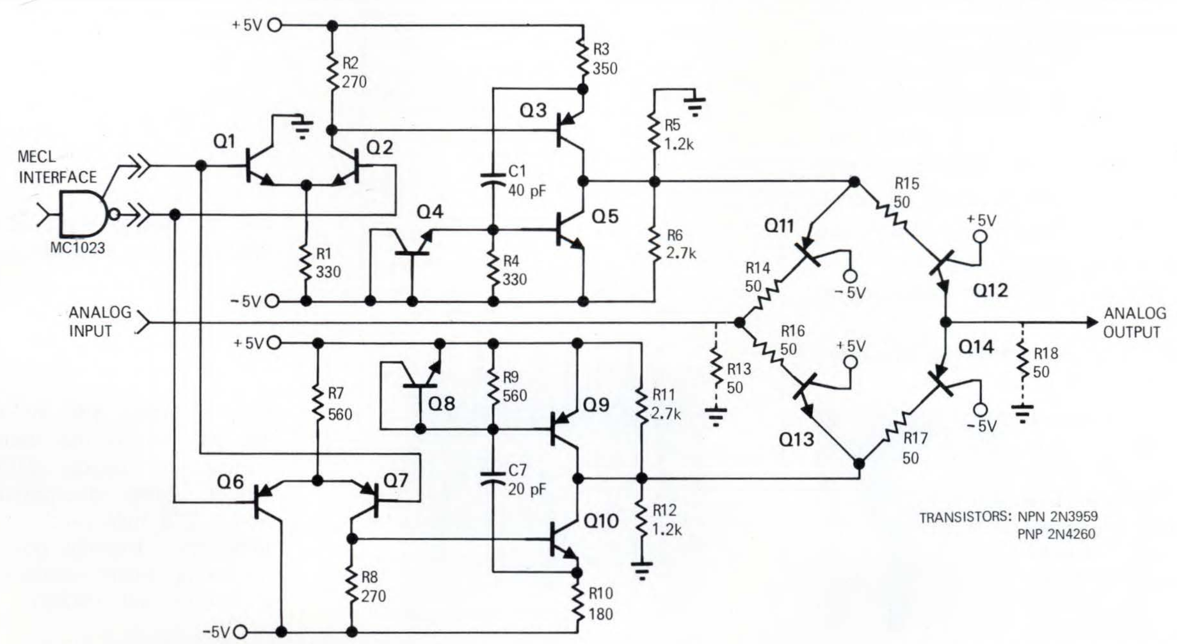


Fig. 1—**Analog gate** using diamond bridge circuit. Symmetrical driving circuits turn the transistor diamond bridge on and off. Transient coupled "pull-back" transistors Q5 and Q9 speed up the turn off. The transistor bridge provides high input impedance, low R_{on}, and up to 3V pk-pk drive capability into a 50Ω load. Typical rise time is 1.5 ns and fall time is 2 ns for a 1V dc analog input.

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(Continued)

Q8 improve the fall time slightly by permitting fast-charging of capacitors C1 and C2. Fall times as low as 1.5 to 2.3 ns with system interfaces of 50Ω are typical for a 1V dc signal. Rise time for the same signal is 0.9 to 2.0 ns, and propagation delay is approximately 5 ns.

During the OFF time, both Q3 and Q10 are biased off by the switching action of the differential comparators. Resistive dividers composed of R5, R6 and R11, R12 set the OFF bias for the base-emitter diodes of the diamond transistors. These dividers also determine the necessary voltage swing for turn-on. Their values can be adjusted to optimize speed performance for a given input level. Isolation through the switch when it is off is greater than 55 dB at input signal frequencies up to and above 10 MHz.

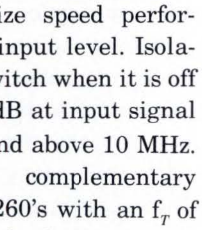
Transistors are complementary 2N3959's and 2N4260's with an f_T of 1.6 GHz. Initially the bridge circuit offset was approximately 30 mV with balanced push and pull currents. This offset was consistently reduced to less than 10 mV by increasing the pull current and reducing the push current. Doing this was necessary to balance out the slightly larger V_{be} drop of the pnp transistor. To match the bridge transistors, each pair was taken from the same npn wafer or pnp wafer.

Static transfer characteristics for the bridge are shown in **Fig. 2** (for 50Ω interfaces).

Bandwidth is greater than 65 MHz, so good high-frequency practices must be observed when building the circuit. Such items as short leads and a good ground plane with power supply decoupling are essential. The 50Ω resistors in series with the bases of the diamond bridge transistors help inhibit potential oscillation of the high frequency transistors. Overshoot and ringing are also reduced. Settling time for the switch is approximately 5 ns.

To satisfy system packaging requirements, the complete analog gate was packaged in a 3/8- by 3/8-in flat pak as shown in **Fig. 3**. Several symmetrical resistor chips were used to reduce the component count. Resistors R1 and R4 share the same chip as do R7 and R9. Capacitors C1 and C2 are unbalanced, to provide approximately the same RC product and allow resistor chip sharing. □

Wesley A. Vincent, with Motorola since 1965, is task leader on the Mariner-Mars '71-Flight Command subsystem support equipment at Motorola's Government Electronics Division. Holder of a B.S.E.E. from Univ. of Iowa and an M.S.E. from Arizona State Univ., he is a member of both the IEEE and Eta Kappa Nu.



DC INPUT (volts)	DC OUTPUT (volts)
+1.500	+1.339
+1.000	+0.920
+0.500	+0.468
0	+0.002
-0.500	-0.462
-1.000	-0.922
-1.500	-1.378

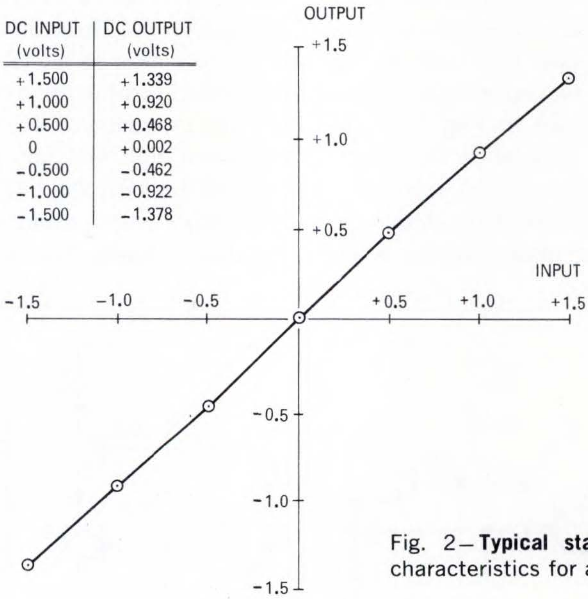


Fig. 2—**Typical static transfer** characteristics for analog gate.

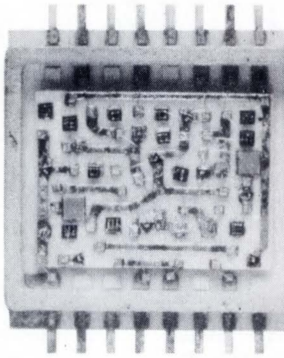


Fig. 3—**Single 3/8- by 3/8-in flat pak** houses the complete nanosecond analog switching circuit. Power dissipation of about 275 mW calls for low-impedance thermal paths to mounting board surface (to give some heat sinking).

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CUSTOMER ENGINEERING CLINIC—

Single Discrete Output Controls Tristable Display

JOHN DEMELIA, Singer-General Precision, Inc.

Problem: For optimum use of available computer lines, a single discrete line must perform a tristable function.

Discussion: While tristable functions are generated easily with two discrete outputs ($2^2 = 4$), available capacity in an airborne computer is limited in I/O capability. Therefore, maximum use of existing output discretes and programming must be carefully reviewed.

To illustrate, a control of one discrete responds to "flash on" and indicates on the display panel that "IN AIR ALIGNMENT" is in progress. This panel display, in turn, alerts an operator that the inertial system is in the process of aligning an inertial platform to inertial earth's coordinates. To achieve this alignment, the program must perform a tristable condition—turn on, flash and turn off.

Solution: Logic, as shown, enables the "Alignment Control" display. One output discrete state produces a three-state function and controls this event. Since the event is a one-time requirement, the computer is powered ON by the signal which repeats when the computer is powered OFF, making this design feasible.

Flip-flop **A** (see circuit) is set when computer power is applied. It is logically ANDed with the output discrete from the computer and the reset condition for flip-flop **B** (P_{ON}). Flip-flop **B** is set when flip-flop **A** is ON, and no command is issued. Both flip-flops are reset when power is removed. The 28V lamp driver operates when flip-flop **A** is ON and flip-flop **B** is OFF.

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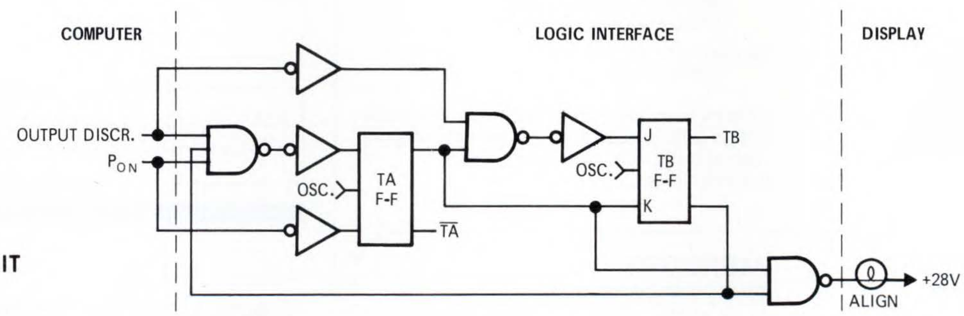
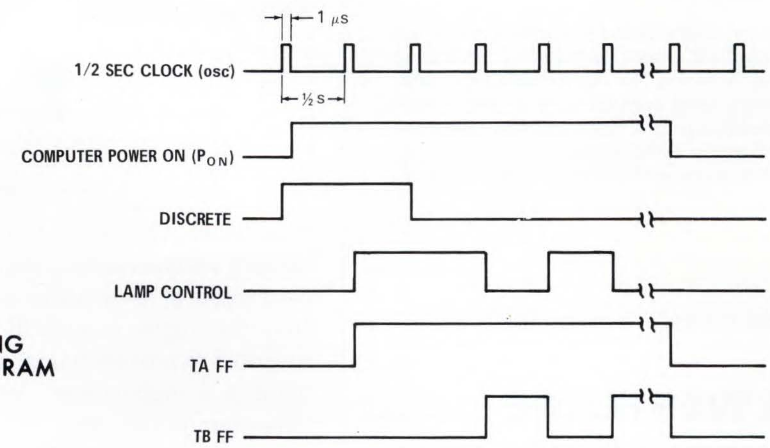
CIRCUIT



TIMING DIAGRAM



MNEMONIC DEFINITIONS

P_{ON} = COMPUTER POWER ON
DISCR = OUTPUT DISCRETE FROM COMPUTER
OSC = 2 Hz CLOCK (1 μs pulse width)
NOTE: TB IS A J-K FLIP-FLOP

LOGIC EQUATIONS

$STA = (P_{ON})\ (disc)\ (\overline{TB})$
$RTA = \overline{P_{ON}}$
$STB = (TA)\ (\overline{DISC})$
$RTB = TA$
LAMP DRIVER OUTPUT = $(\overline{TB})\ (TA)$

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(Continued)

Discrete Output (Cont'd)

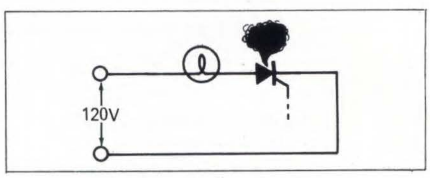
Timing diagram illustrates the sequence of operation.

The timing diagram also shows how a one-time set IOC command from the computer turns on the lamp display with the logic that eliminates programming bookkeeping requirements and uses a single discrete to perform a tristable function. When the computer resets the program-commanded output discrete, the hardware interface logic times the flashes, consistent with human retention. Only upon computer "POWER ON" (P_{ON}) can the process lamp repeat and display the logic function. Commonality of this process occurring only once during (P_{ON}) fulfills the requirement to perform the tristable function. □

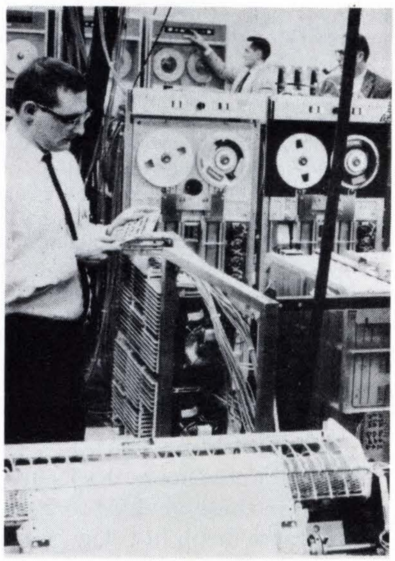
EDN will pay $50 for any problem-solution article accepted for publication.

NEXT ISSUE'S PROBLEM:

"Lamp Load Burns Out SCR at Turn-On"



Once more, too little attention to a device's unique characteristics causes destruction of associated components. Here the victim is an SCR that was supposed to provide phase control for lighting a high-current, low-voltage lamp from the ac line.



Are There Other Fields? Are They Greener?

You have been notified you are on this week's list of "adjustments". Which way do you turn? Should you even try to look for one of those scarce engineering jobs, or should you look elsewhere? "Elsewhere!" says this "defector".

JAY FREEMAN, Ideal Corp.

Recent estimates indicate that more than 25,000 electronic engineering jobs have been terminated. This represents an unemployment rate of approximately 10%. It qualifies EEs for hardship status, along with West Virginia coal miners and high school dropouts.

This time, the scarcity of EE jobs does not look like a transient phenomenon. For aerospace EEs, it looks like the end of one era and the start of a totally different one. The fickle taxpayer, guided by the pragmatic politician, no longer wants his money spent on defense and space. He's tired of those fads. He's discovered some "new" problems, and these new problems don't need engineers . . . at least not yet. Perhaps they never will in the large numbers needed for the technological achievements of the past decade.

The displaced EE has two choices: He can wait for the public to react to some enemy and again want defense or space exploits. He can look for a new career.

It may be 5 or 10 years before the public again wants defense . . . and perhaps longer. Therefore, I think displaced aerospace EEs should take the second course of action. As a guide, I have listed nine job categories outside electronic engineering that represent possible new career areas to which EEs may transfer. These careers, unlike engineering, are affected by the short-term dips in the business economy rather than the long-term drops in defense expenditures. As such, they offer a bright near-term future. **Table 1** lists these, and each will be discussed in turn.

If you need a job right away, only some of these nine will be applicable. But remember, the job that is easiest to move into may not be the best in the long run. The easier-to-get jobs—like technical writing and sales—may well share some of the same flaws as aerospace engineering, such as lack of long-term stability.

Others of the nine—like teaching—will offer more security, but one can't always move into them right away. However, don't be completely discouraged by the closed doors you find in some of these professions. Often a clever thinker like you can "engineer" himself into them by a series of planned lateral jumps. Often entering a profession is just a matter of getting a grip on any available bottom rung.

But among the nine, it must be admitted there are some tightly closed professions—like patent law. These can be entered only by going back to school and obtaining the required degree. Still, the sooner you start, the sooner you'll be there.

Whatever you do, don't wait around, using up your savings, going deeper into debt, hoping for the soulful hand of government to help you remain a contributing, practicing EE. Your profession just does not have the organized pressure to get anything but token help from the government.

(Continued)

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1 – Teacher

One would think that the public schools which have been trying to upgrade their teaching of science and technology would welcome engineers. The average engineer has a far better and, to students, a more convincing background in physics, mathematics and electronics than those now teaching these subjects.

Yet the engineer will not find an "open arms" reception. As with other professions, there are certain barriers that the insiders hold up against outsiders. One of these barriers is the demand for a teaching degree. For college-level teaching, a master's degree is mandatory. However, these barriers are a state and local matter, and the engineer interested in teaching must explore the individual situation himself. He may find openings in the barriers where local needs have caused authorities to relax their requirements temporarily. He may also find trade and night schools more interested in his engineering degree and experience than in credentials from a teacher's college.

The second barrier that the engineer who hopes to switch to the teaching profession will find is a very low starting salary range – down around $8000 a year. But if the engineer is young and thinks he would like teaching, he should not let these low initial salaries discourage him. He should persevere, with the thought of the short days (teachers are through at 3:30 p.m.), long vacations (teachers only work 185 days a year), the job security and the fact that his salary will rise steadily and eventually will reach a secure $17,000 a year.

2 – Patent Lawyer

Patent law has many of those professional features for which engineers have long yearned. As one EE who made the transfer to patent law said: "I am finally treated with respect. I no longer fear layoffs, and eventually I will become a partner in the firm."

But like all good clubs, this profession has its high initiation fees. One does not suddenly decide to become a patent lawyer upon being terminated by UXZ Electronics. Patent law requires years of night-school preparation, for you must have a law degree (the ads read "electronics deg plus LLB").

However, the financial rewards will inspire those who elect to work in this direction. Starting salaries are between $18,000 and $23,000 a year. The engineer will have the reassuring knowledge that his past experience will be of direct usefulness, and once an "insider", he'll find many high-level doors open to him.

3 – Technical Editor

The writer's life has a certain glamor. The work schedules are flexible, the opportunity for personal creativity high, and there is more varied social contact than in routine engineering. To some minor degree, the writer shares in the glamor of the "big-time" writer, though he does not approach the remuneration of the writer for mass-media magazines or consumer advertising agencies. He is many "light years" removed from the extravagant remuneration received by successful "best seller" book and screenplay writers.

> ## Why We Print This Article
>
> There are two good reasons for EDN readers to learn about fields other than electronics. One is that these days you never know when you'll have to offer advice to an unemployed aerospace engineer. The other is that the same loosely allied fields that offer new employment opportunities for discharged EEs also offer new opportunities for the application of electronic technology.
>
> If we are to rebuild our electronics industry into the mature, diversified industry it deserves to be, then we must extend our marketing and application tentacles deep into many strange and alien fields. The best way to infiltrate these foreign fields is to send in subversive agents, and who would make more knowledgeable agents than ex-EEs?
>
> "Where EEs go, ICs are sure to follow."

The main advantage the technical editor has over the engineer in these troubled times is that the technical editor has more flexibility. The editor finds it easier to slide laterally into another field. It is much easier for a writer to teach himself to write about a new field than it is for an engineer to learn to design equipment in that new field.

This flexibility is really a necessity for writers, since their profession is just as affected by hard times as engineering. During recessions, the advertising support for trade magazines is reduced, ad agencies have to cut their payrolls, and commercial firms tend to amputate service groups such as manual writers first.

4 – Sales Engineer

This, like technical editing, is another field whose prosperity is closely tied to the industry that it serves. However, a salesman gets out into the real world in a very realistic manner and so is quicker to sense when trouble is brewing and is more prompt in taking action. Also salesmen tend to be thought of by employers as generalists and can switch from losing to winning fields easily.

Certainly, a technical background is an asset for selling a technical product. However, a salesman's personality is his most essential asset. This eliminates many, but by no means all, engineers. Superficially, a "salesman's personality" means that you must like people, that is, be an extrovert. More profoundly, as one sales engineer said, it means "you must be recharged rather than defeated by repeated 'no's' from prospects. You must be able to face your family and friends and say 'I am a peddler'

An engineer trying to break into sales will find he can "buy in" by accepting a relatively low-base salary . . . say, $12,000 to $14,000 a year, which he will draw to support himself until, hopefully, within a year he can match and surpass it with commissions. He will know that he is on probation, for sales managers are pragmatists, and they will not "carry" a man who after a year of trial, shows no ability to meet his quotas.

5 – Programmer

If you have been fortunate enough to have worked with computers and have picked up a "hands-on" familiarity with in-demand programming languages such as FORTRAN, COBOL or ASSEMBLY, your path is clear to a career in programming. If not, there are many schools which teach programming in a matter of weeks.

Combined with an engineering background, programming work can lead you toward the attractive regions of systems analysis (No. 7 to be discussed). Programming is also one of the best "interim" jobs for a man who plans to stay close to engineering and to return to it when times get better.

You will have the good feeling of knowing you are in a growth area. Forecasters predict decades of unremitting growth in this "service" field. True, they said the same thing about engineers, but engineers served only one customer, the military branch of the federal government. Programmers, especially business programmers where the demand now is, serve thousands of different customers. Thus, the demand for programmers should be much more stable.

6–Systems Planners and

7–Management Consultant and Systems Planner

A recent ad in the *New York Times* said that the prospective employer was one of the nation's largest manufacturing companies and had set up a small team of "thinkers" at corporate headquarters to do "operational research" on the company and its markets. The members of this select team would be, in effect, in-house consultants, and they would report directly to top management. The ad said the company was looking for men who "liked to solve complex problems, had 2 to 5 years background in management consulting and were presently earning from $13,000 to $16,000 a year".

Another ad nearby indicated the prospective employer was a private consulting firm that did planning for municipalities on urban problems. The employer was looking for men with backgrounds in mathematical programming and operations research who were interested in becoming deeply involved with analyzing and planning public systems.

Still another ad said that a company which designed software and procedures of large data-flow networks for finance and business was looking for bright young men who "could deal in an effective, relaxed manner with the top executives among their clients".

The jobs described by these ads are the result of a steadily growing awareness that engineering-type systems analysis can be effectively applied to analyzing and "designing" the behavior of businesses and governments. The job titles in this new field—"systems analyst", "management consultant", "operations research", "information-flow architect"—all tend to sound alike. But whatever the title, the techniques will be familiar to the EE, for they have been freely borrowed from electronics systems analysis.

There are two levels in this young field. There is the down-to-earth task of designing information-flow systems (Career No. 6). The emphasis here is on laying out the routing and transformation of data (from computers) so that it gets to top management in the proper form to be used as a decision-making tool. This task amounts to designing software packages that tell the hardware (and humans) how to behave. It is a task that an ex-aerospace engineer with experience in large military command and control systems would find familiar.

The other level is quite cerebral. The idea is to serve as a thinker for top management in business and government (Career No. 7, Management Consultant). Your task is to pre-analyze and pre-digest situations and then feed your compact summaries, including your suggestions for action, to top management. Some engineers would find this far-from-hardware atmosphere too rarified for their liking, but others will be thrilled by the enlarged scope. But, to operate on this level, the engineer must have skill in written and verbal communication to present his findings to top management.

Your assignments in this second level might be to solve such problems as:

—What is the most profitable new product or venture for the corporation?

—What are the future projections for the city's growth in terms of real estate use, utility needs, etc.?

The salaries are attractive, as the following listing indicates:

Table I - New Careers for Displaced Aerospace Engineers - All Figures are Rough Estimates

CAREER	REQUIREMENTS	OPTIMUM STARTING AGE	STARTING SALARY ($)	NEW POSITIONS/YEAR	
				General	Technical
1 - **Teacher** (Eng., Phys, Math)	Masters Degree	22-25	8,000	30,000	7,000
2 - **Patent Lawyer**	Law Degree	25-35	18,000-22,000	15,000	100
3 - **Technical Editor** (trade journal)	Writing Skill	22-30	12,000-16,000	10,000	100
4 - **Sales Engineer**	Extrovert Personality Self Motivating		12,000 (plus commission and auto)	100,000	10,000
5 - **Programmer**	Programming Experience	22-35	12,000-15,000	50,000	25,000
6 - **Systems Planner**	Computer systems experience plus knowledge of programming	25-40	14,000-18,000	5,000	2,500
7 - **Management Consultant**	MBA (helpful) plus courses in management science, etc.		14,000-18,000	1,000	200
8 - **Security Analyst**	MBA	22-30	12,000-15,000	erratic	
9 - **Entrepreneur** (small businessman)	Cash, judgement and guts			?	?
∞ - **Engineer**	BSEE, (plus proof of ability to carry computer-type systems (TTL and MOS) rapidly to completion with minimum manpower)		(You know this)		–5,000

(Continued)

Age	Salaries (in terms of % of those earning over $20,000 a year)
30-39	15%
40-49	25
50-59	28
60-over	39

The data is from *Profile of a Systems Man*, an ASM brochure with data from the year 1969.

While I personally feel that this general area is one of the most attractive new career areas of all for EEs—precisely because it permits them to use their unique training in analysis—I must point out candidly that it again is not a field that can be entered without some time and effort. For one thing, there is a limit on the number of job openings in this field. As the column that estimates job openings in **Table I** indicates, there are fewer job openings in computer systems analysis than in computer programming, and there are still fewer job openings in management consulting. But, it is my bet that this has to be a growth field. Whatever else, the problems in business are growing more and more complex and sweeping. Computers are helping only at the lower, more routine levels of data handling. To take the data that is becoming more and more available in computer memory banks and make it flow into meaningful decisions will take a great deal of thought and planning of the caliber that EEs are uniquely equipped to supply. EEs will also be in the best position to work with hardware vendors for the equipment needed to implement and round out these data-flow systems.

8—Securities Analyst

Engineers can consider becoming securities analysts in the financial field. Perhaps because of Wall Street's love affair with electronics (now long past, of course) a number of EEs did drift into securities analysis. They found that the job was in line with their scientific and logical dispositions, and the financial institutions felt good about having at least a few people around who knew something about the technology they were touting so vociferously.

Starting salaries for securities analysts are between $12,000 and $15,000 a year. To grow into the much higher salaries that do exist in finance, an engineer must plan to learn the jargon of the field by taking courses in accounting and finance.

There is no more job security or financial reward in this occupation than in engineering right now, but, during good times, a securities analyst has a much better chance at dramatic earnings increases from raises and bonuses customary in this field. However, to hit the big money in this field, the engineer must have a knack for picking the winners.

9—Entrepreneur (Hiring Yourself)

The author knows of an engineer who is attempting to start a new business in his garage. About the only thing I am sure he is doing is exhausting all his capital on new equipment. I don't see him going out after customers enough.

Engineers tend to start a business at the wrong end, and, in times like these, that can be disastrous. They build up technology, then wait to see if someone wants it before their money runs out. A much better way to start is the way salesmen start. They try to sell something—a salesman will try to sell almost anything—and when they have stumbled onto something people want, then, and only then, do they put money in to build up and expand a business around it. After a while they may even hire engineers.

∞—An Engineer to the Death

If you enjoyed movies like "Charge of the Light Brigade" or "The Alamo", where the heroes are massacred, you may decide to stay in engineering. If so, your resume should not recite every military contract you ever worked on—nobody cares about that any more. Instead, emphasize computer-related experience. Indicate your willingness to learn new areas.

Be aggressive. Write unsolicited letters offering your services. Use the telephone. Call and offer to come down in person with your resume.

I won't belabor the point. There are plenty of books and articles on the ways to seek a job.

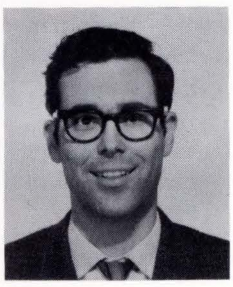
Actually, a study of employment ads will show that there are still jobs for engineers. And there are more of these than there ever will be openings for some of the other specialties (like No. 3). (EDN has noted promising new growth areas in MOS LSI systems design, in computer peripheral and terminal equipment and in industrial and communication systems.)

Conclusion

The real problem, as we have noted, is that there never can be as high a ratio of engineers on a company payroll when that company is doing commercial rather than military work. A company funded to develop new exotic weapons systems for the military can afford to have 10 or more engineers on the payroll for every million dollars worth of annual income. But a company doing commercial work is lucky to be able to carry one engineer for each million dollars worth of annual sales.

Simple arithmetic tells us that the step-function decrease in the total number of engineers must happen. However, we hope that those engineers who do transfer to other fields, such as those mentioned, will help spread the gospel of what electronics can do to a wider audience, and that by 1975 we'll find our industry with broader, more stable roots, selling its products to a wider spectrum of the economy. ▭

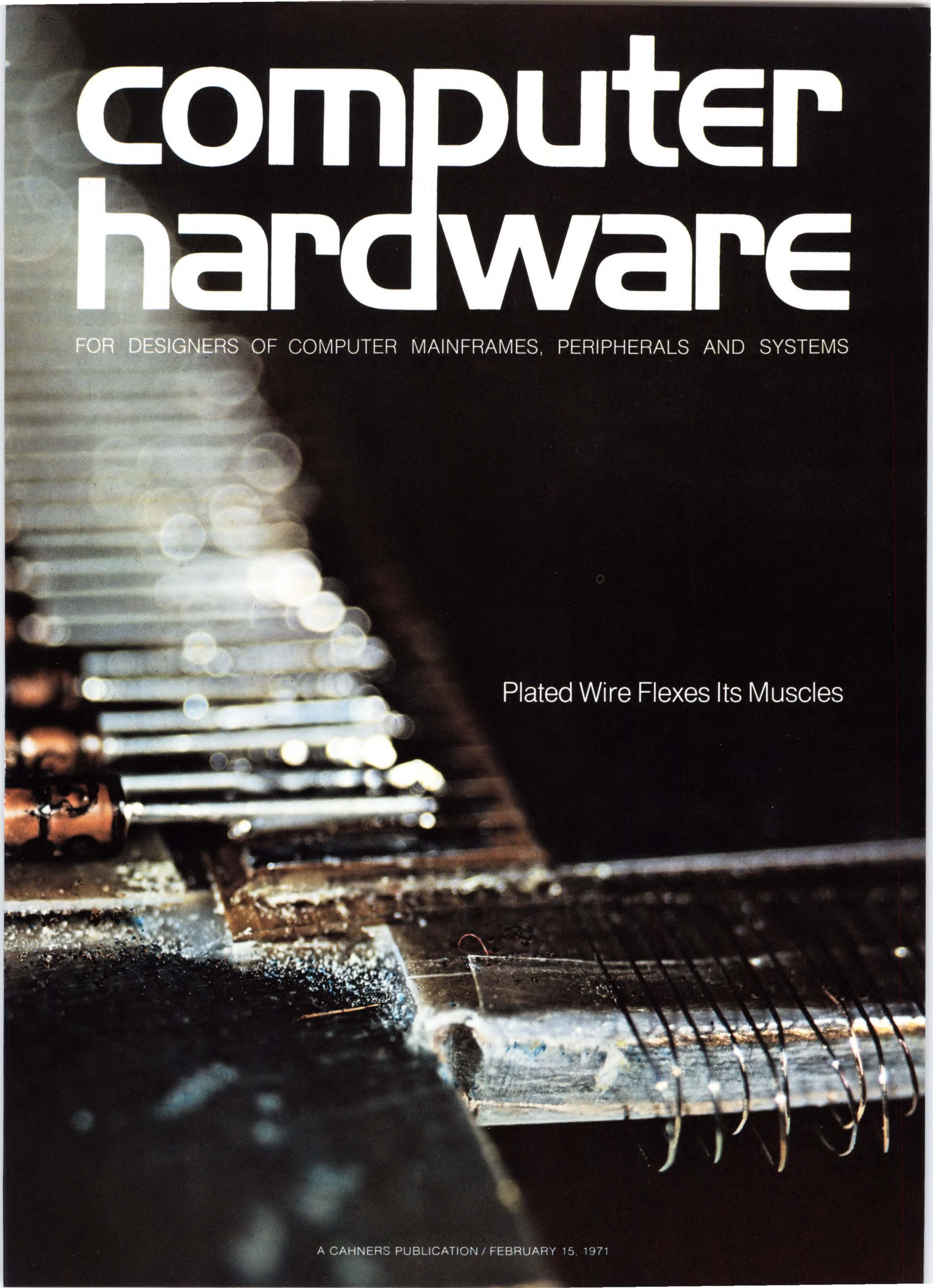
Jay Freeman, author, started as an engineer. About a year ago, he was laid off. He began edging himself out of our wonderful rat race. First he edged himself into the marketing department of an electronics firm on Long Island. Then he sold himself into a management consulting firm in Manhattan. And now, finally, he has arrived at a staff position in a large automotive parts manufacturer that has "absolutely nothing to do with electronic engineering".



FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. L66**

computer hardware

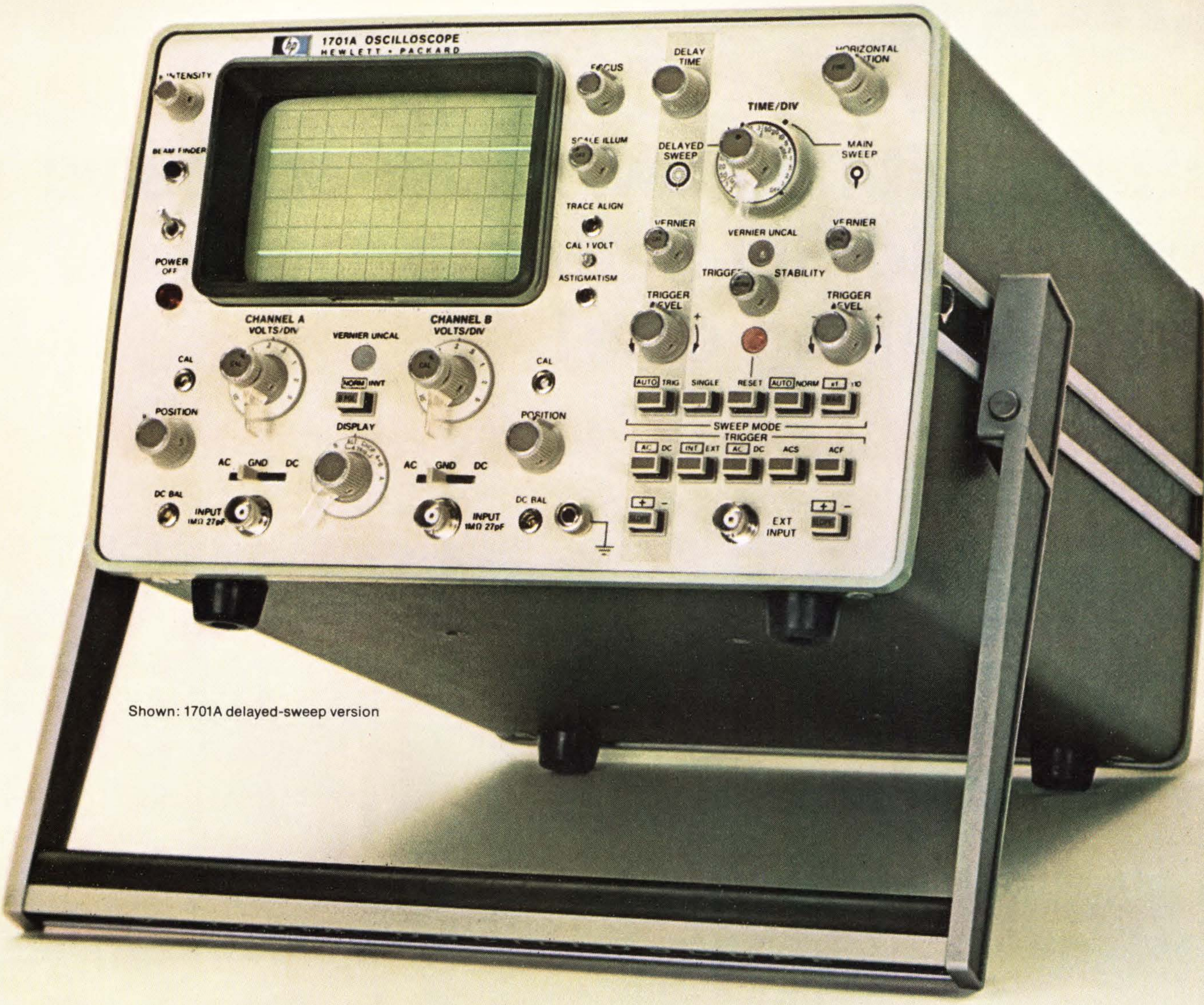
FOR DESIGNERS OF COMPUTER MAINFRAMES, PERIPHERALS AND SYSTEMS



Plated Wire Flexes Its Muscles

A CAHNERS PUBLICATION / FEBRUARY 15, 1971

Introducing: "The Portables" from HP



Shown: 1701A delayed-sweep version

They make your budget seem bigger.

HP's new dual-channel, portable scopes make slim budgets look fatter. At only \$1850, our delayed-sweep model, the 1701A, weighs in at \$200 less than the competition, which adds up to a 10% savings for you. (Our non-delayed-sweep model, the 1700A, is even lower—\$1680.)

The 1701A weighs less in pounds, too—24 as compared to 28—which makes it easy to carry around in the field. But the 1701A is no "lightweight" in its performance. It gives you all the necessary capabilities for digital field service work.

Its 10 ns/div sweep time and <10 ns rise time (35 MHz) let you measure T^2L pulse timing and propagation delay. And its simple-to-use delayed sweep allows expansion of complex waveforms, for easy observation on the large 6 x 10 cm screen.

Another advantage is the 1701A's low power requirement. This HP breakthrough eliminates the need for fans (or even vent-holes), which means that dust and moisture are kept out of the circuits. It also assures extreme reliability, as all components are operating at less than 20% of rated capability. And, this low power requirement allows battery operation in the field—a capability you get with no other scope in this class. (Internal battery pack, \$200 extra.)

For further information on "The Portables"—HP's new 1700 Series scopes—contact your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

Scopes are changing.
Are you?

081/7

HEWLETT hp PACKARD

CIRCLE NO. 401

FEBRUARY 15, 1971

computer hardware

EXCLUSIVELY FOR DESIGNERS OF COMPUTER MAINFRAMES, PERIPHERALS AND SYSTEMS

cover

Cover photo shows end view of a plated-wire memory plane developed at Nemonic Data Systems, Inc. For further information on plated-wire memories, see p. 001100. (Photo by EDN's Art Director Ray Lewis.)

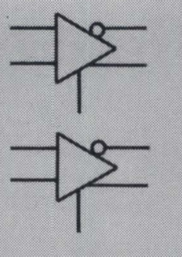
directions

features

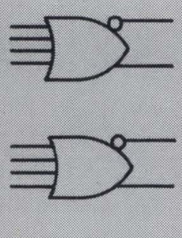
events

feature products

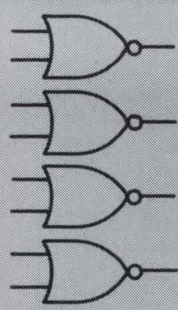
WHEN EVERY NANOSECOND COUNTS . . .



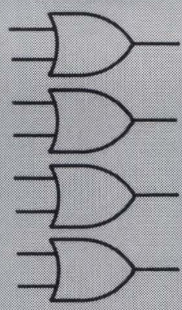
MC1650
Dual A/D Comparator



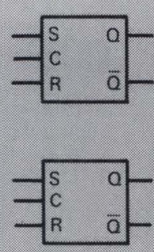
MC1660 (High Z)
MC1661 (Low Z)
Dual 4-Input
OR/NOR Gate



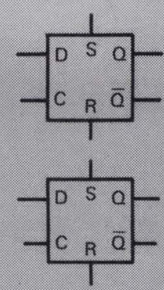
MC1662 (High Z)
MC1663 (Low Z)
Quad 2-Input
NOR Gate



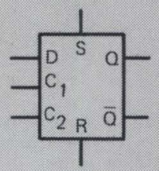
MC1664 (High Z)
MC1665 (Low Z)
Quad 2-Input
OR Gate



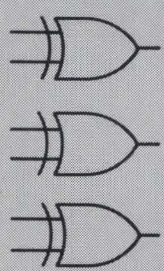
MC1666 (High Z)
MC1667 (Low Z)
Dual Clocked
R-S Flip-Flop



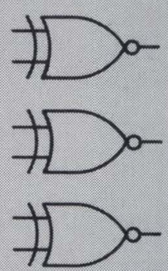
MC1668 (High Z)
MC1669 (Low Z)
Dual Clocked Latch



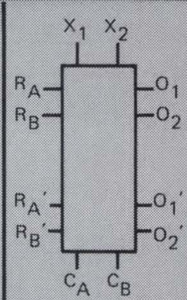
MC1670 (High Z)
MC1671 (Low Z)
Master Slave
Type D Flip-Flop



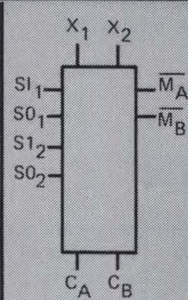
MC1672 (High Z)
MC1673 (Low Z)
Triple 2-Input
Exclusive OR Gate



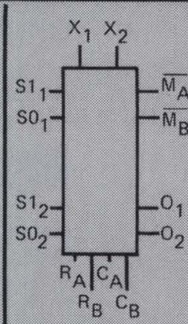
MC1674 (High Z)
MC1675 (Low Z)
Triple 2-Input
Exclusive NOR Gate



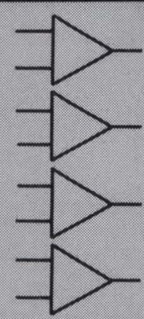
MC1680 (High Z)
MC1681 (Low Z)
Random Access Memory
(RAM) Cell



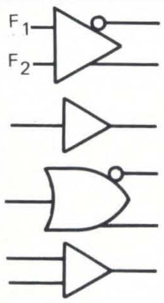
MC1682 (High Z)
MC1683 (Low Z)
Content Addressable
Memory (CAM) Cell



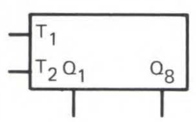
MC1684 (High Z)
MC1685 (Low Z)
Content Addressable
Random Access (CARAM)
Memory Cell



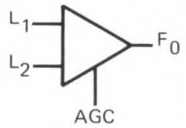
MC1692
Quad Line Receiver



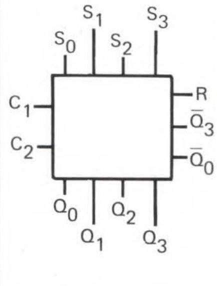
***MC1644**
Digital Mixer
MECL/TTL



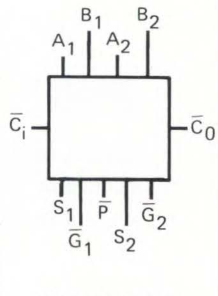
***MC1646**
Prescaler —
Binary Counter/
TTL Translator



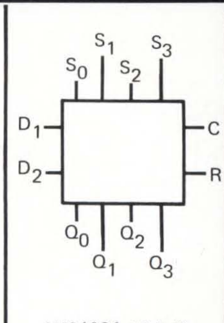
***MC1648**
Emitter Coupled
Oscillator



***MC1678** (High Z)
MC1679 (Low Z)
Bi-Quinary Counter



***MC1686** (High Z)
MC1687 (Low Z)
Dual Arithmetic
Unit



***MC1694** (High Z)
MC1695 (Low Z)
4-Bit Shift
Register

***AVAILABLE EARLY 1971**

. . . MECL III HAS THE ANSWERS

As a chain is as strong as its weakest link so are system capacities limited by logic speed. MECL III nanosecond logic is providing the answers to today's increasing data handling demands. Answers in the form of high-speed memories operating at 2.5 ns access times, A/D conversion at 3.5 ns rates, a shift register capable of 300 MHz shift rates, gates with 0.9 ns propagation delay, and a master slave type D flip-flop toggling at 350 MHz.

But speed is only part of the MECL story. Designers have discovered that MECL's Complementary Outputs and the Wired OR Capability have increased circuit flexibility and reduced overall system package count. And if you have high fan-out requirements, MECL III is equal to the task.

MECL offers a definite advantage above 30 MHz by showing a minimal increase in power dissipation even with high capacitive loading or the driving of terminated lines. As the complementary MECL gate is switched from one state to another, power supply current remains constant within 5%. The result — fewer power supply decoupling problems and reduced system fabrication costs.

And take note of MECL's extremely low system cross-talk and noise generation . . . single supply operation . . . voltage and temperature compensated logic swing . . . and driving capability for 50 ohm lines . . . need we say more?

MECL III is now available in stud-mounted flat packs and 16-pin ceramic dual in-line packages to meet your circuit requirements. And in case you haven't noticed, MECL III offers a comprehensive family plus more on the way, all at new lower prices.

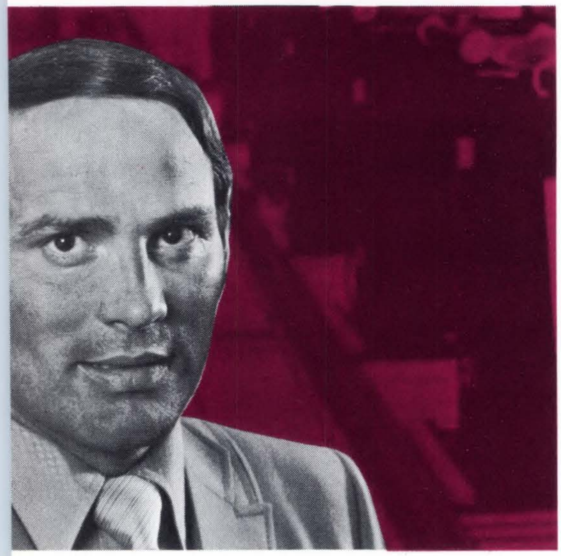
Get the whole MECL story. Just write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036 and ask for the "MECL High-Speed Systems Design Library." It's full of FAST ANSWERS!

MECL - Trademark of Motorola Inc.

MOTOROLA MECL
the only way to go . . . FASTER

CIRCLE NO. 403

tape drive maker eyes disc drive market—



While maintaining its present position in the tape drive market, Peripheral Equipment Corp. is planning to enter the disc drive business. Presently, PEC is negotiating the acquisition of an Arizona based disc drive company. If the acquisition fails to be consummated, PEC aims to develop its own capability to manufacture IBM-compatible disc drives.

PEC President Hal Kurth expects that there will be profitable coexistence between the tape and disc drive lines. As he points out, tape storage will predominate for data entry—whereas the disc storage will be the optimum medium for rapid-information access.

When queried about the cassette transport market, Kurth responded, "If IBM comes out with one . . . we may want to become involved. But right now, the market size is undefined. Almost everyone in it has lost a lot of money . . . and there is going to be a lot more money lost before that market gets defined."

As PEC plans to ship over 10,000 tape drives in 1971, their future peripheral-transport line, whether tape, disc or cassette, will have very definite earmarks. Kurth emphasizes that their future product will be "simple and elegant—and IBM-compatible."

printer converts to off-track betting—

Keep your mind, eyes, and ears open and you will find ways of designing your product into the most unexpected new systems. That's what Di/An Controls, Dorchester, Mass., did with the printer they originally designed for airline ticketing systems. They developed a computer-controlled ticketing terminal for New York City's off-track betting system which prepares betting tickets individually as each bet is made. The printed ticket shows the amount and type of bet, track name, race number, horse number and a 10-digit ticket code number.

Also developed by Di/An is a special reader terminal to transmit winning ticket information to a central computer which then determines the payoff. This information is automatically printed on the ticket at a payoff window.

minicomputer evolution continues—

Discussing the impact of new technologies on the minicomputer industry at NEREM '70, L. Seligman of Data General Corp. concluded that they are evolutionary, not revolutionary. Their principal byproduct is a strong pressure to improve performance and reduce price at steady rates rather than by dramatic jumps. The pressure of impending new technologies also forces improvements and price reductions in older but proven ones. And when new, more powerful, and more economical central processor architecture is designed, an equally new and sophisticated memory, I/O system and mechanical package are also designed to realize potential cost savings fully.

For the past 5 years cost/performance ratios have halved every year, and every aspect of the minicomputer is affected as newer technologies evolve into production. This trend should not stop or even level off.

Better performance and lower costs result in a constant widening of applications. Seligman listed a few examples that are the results of improved performance only.

Inside the IBM 360/25 is a minicomputer-like device that simulates a 360 processor, data channel, and controller hardware at Model 30 performance levels. Not only will minis find wide use as emulators in similar systems, but the same principles also can be used in small computer programming to simplify the programming task.

Reduction in cost and size has designers looking at minis as simply a part of their new system, rather than the central element. Sometimes this results in systems using a number of small computers rather than one large one. The major hangup here is in job partitioning.

Many new applications lend themselves to a multi-processor system with advantages of individual processor programming, real-time operation, and even processors reserved as back-up spares. Some major minicomputer manufacturers are making available multiprocessor systems like the Data General Multiprocessor Communications Adapter that permits interconnection of up to 15 "Nova" or "Supernova" computers. Blocks of data can be transferred among computers using their data channel facilities, with a number of transfers concurrently sharing the interconnecting communications bus.

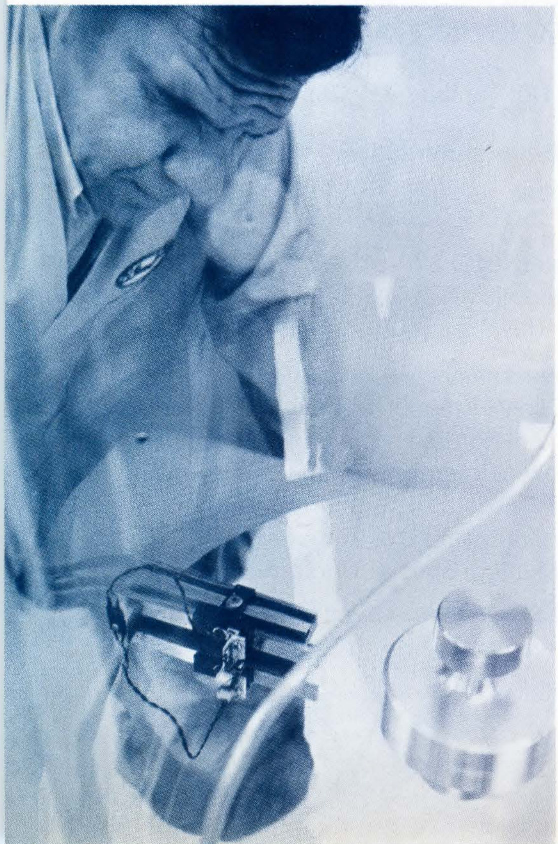
Thus increased volume allows use of more sophisticated technologies resulting in lower costs, and again more new applications areas open up. The evolution continues.

computer memories — $3 billion market by 1980 —

"Semiconductors today account for about three percent of the $700 million memory market. By 1980, they will have captured two-thirds of the market, which will then be $3 billion," according to Joseph Levy of the New York based research firm Frost and Sullivan, Inc.

Frost and Sullivan released an in-depth forecast of the digital computer memories market. The report forecasts through 1975 each type of memory, and equipment such as calculators, data communication, computers and industrial systems.

plated-disc technology gets "total" boost —



With a 2.5 million dollar investment in plated-disc technology, Ampex is producing a wide range of plated discs to meet specific system requirements. Available in diameters ranging from 2 to 16 inches (larger on request), the recording surface is a plated nickel-cobalt-phosphorous alloy that permits high packing density.

Compared to conventional oxide-coated discs such as those used in IBM's 2314 and 3330 storage units, these non-oxide discs store two to three times as many bits. Units are already available with a packing density of 10,000 bpi — and by mid-decade, Ampex expects to deliver a 14,000 bpi density unit using the same manufacturing process. It should be pointed out, however, that these plated discs are not intended to compete with the less expensive oxide types that are widely used in large computer systems. Instead the prime target is the minicomputer market, because in these areas, high-speed data transmission rates are essential.

Based on a marketing survey, Ampex reports that there are about 25 manufacturers who presently use plated discs — however, none of these users are realizing an optimum configuration. It was pointed out that the less-than-optimum configurations that prevail stem from operating the discs with wide tolerances — because users can't depend on a consistently uniform and reliable recording surface. As an example, they cite users who fly their recording heads 60 to 100 μin above the disc — when they should be able to confidently fly them at 5 μin.

In MOS, 2nd source doesn't mean second best.

Device Number	Device Description	Replacement For	100-Pc Price
	FULLY DECODED P-CHANNEL STATIC MOS RAM		
IM7501	256-bit	1101	$25.60
	FULLY DECODED P-CHANNEL STATIC MOS ROMS		
IM7601	1024-bit (256x4)	421/521	12.00
IM7602	1024-bit (128x8)	422/522	17.20
IM7603	2048-bit (256x8/512x4)	4230/5230	26.00
IM7604	2560-bit (512x5)	4240/5240	29.10
IM7605	2560-bit (256x10)	---	29.10
	P-CHANNEL MOS SHIFT REGISTERS		
IM7703/4	Dual-512-bit/1024-bit	1403/4	12.00
IM7706/7	Dual-100-bit	406/7	4.00
IM7713/14	Dual-512-bit/1024-bit	---	12.00
	(shift rate equals clock rate)		

With our memories the little extras count.
We don't make the world's longest line of MOS memories. But what do you care? The ones we have are the ones you want, with a few little extras tossed in. For instance each of our five MOS ROMS is much faster than the one it replaces. The IM7501 RAM boasts a 500 nsec access time with only 1 mW/bit power. And the IM7703/4 Shift Register uses only 0.1mW/bit at 1 MHz.

And more in the oven.
But the best is yet to come. By tax time, a 1024-bit dynamic RAM replacement for the 1103. And then a batch of N-channel silicon gate devices: A 256-bit static RAM and a 1024-bit dynamic RAM, each twice as fast as its P-channel equivalent: and a dual 100-bit shift register that cruises at 10 MHz.

1st choice in MOS. Intersil. 10900 No. Tantau Ave., Cupertino, CA 95014.

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CIRCLE NO. 405

directions

memory hierarchies generate new job title

A new design task or job function called *memory system architect* will evolve during this decade in memory systems organization. A memory system of a computer will consist of several memories of different performances and capacities and will communicate with each other under internal "storage control". Thus a real memory system architecture will develop justified by the need for better performance per cost ratio—so says Joseph F. Kruy, President of Cambridge Memories Inc.

The "virtual memory" principle which makes external storage look like internal storage from a programmer's point of view will find more extensive use. The really major steps in the development of a highly efficient memory system architecture will only occur when a truly low cost solid-state mass memory is commercially available. This memory has to match performance characteristics of the main storage much closer than present disc and drum systems are capable of doing. The two most important parameters are fast access time and static storage. Kruy predicts that such memories will be used in the middle '70s and will employ a "bubble-DOT type" technology. Sequential semiconductor memories consisting of MOS shift registers could be another candidate, but their high cost and dynamic nature will limit them to just a few applications, even if their reliability proves to be sufficiently good.

The most popular two level memory hierarchy in the middle to late '70s will be a medium capacity high-speed semiconductor memory backed up by a large capacity bubble-DOT type storage. The optimum performance/cost hierarchy will consist of a fast semiconductor memory system (which may be hierarchical on its own), a large bubble-DOT type storage and a very large disc system.

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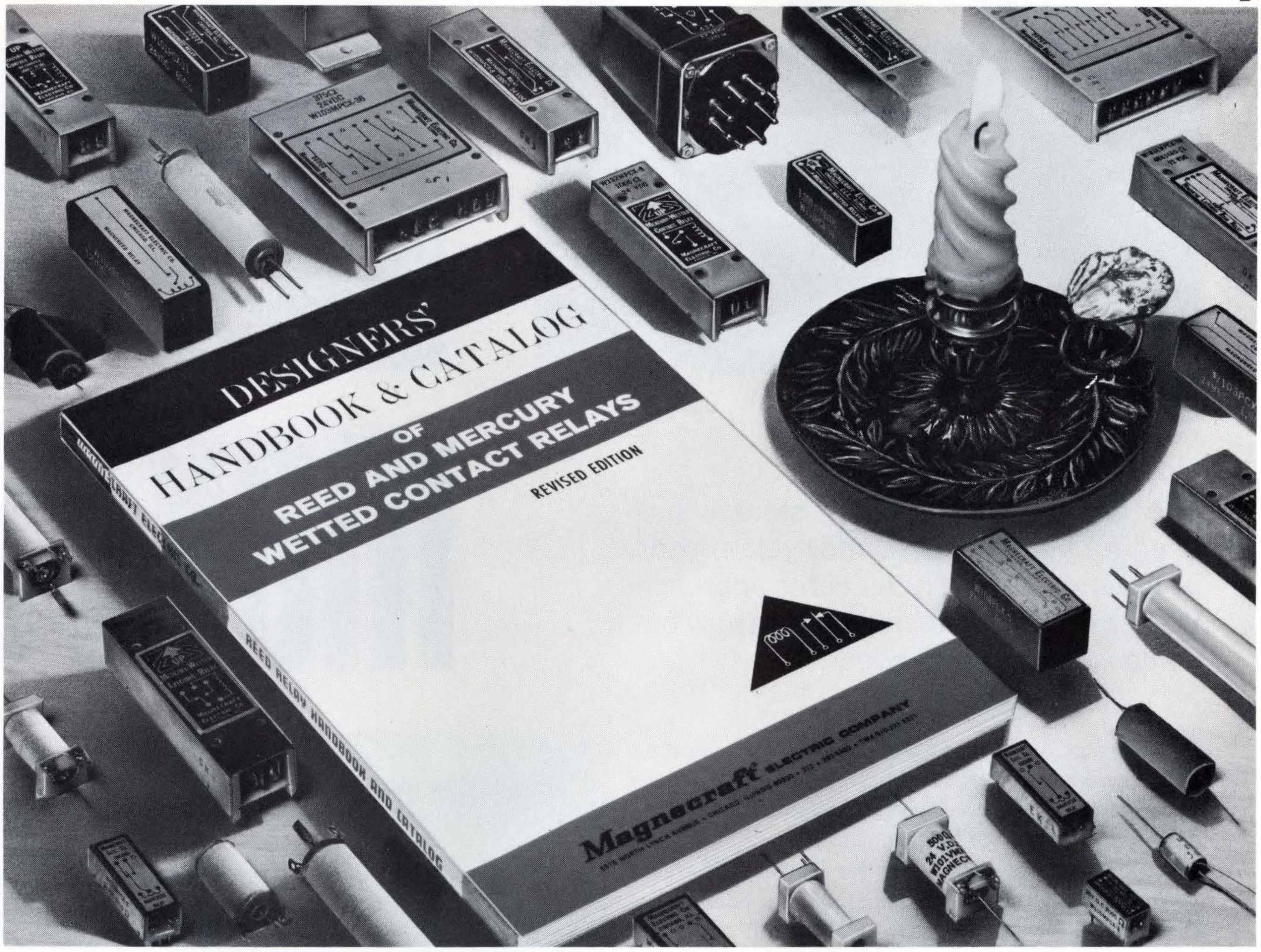

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CIRCLE NO. 407

plated wire makes

The big push in memory storage has been for higher access and cycle speeds at lower cost per bit. As cores approach their inherent limits, plated wire may become a strong contender.

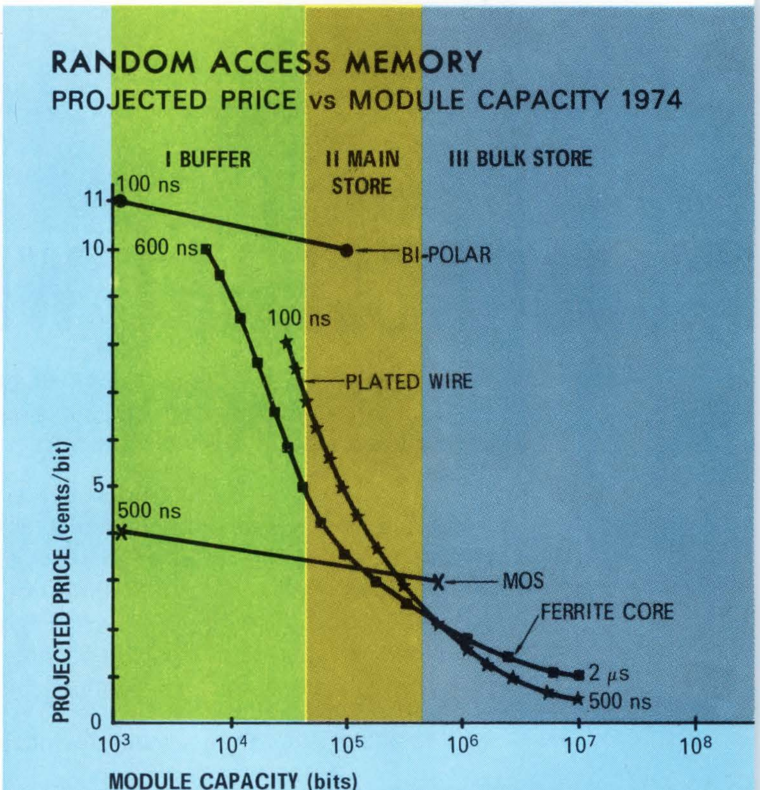
Evolutionary replacement of ferrite cores is beginning in the newer computers. Although semiconductors are bidding for their share of the market, plated wire offers advantages over both technologies in many applications. Today, plated-wire memories represent about six percent of the total random-access market, but by 1973 this should grow to 23 percent – a $143 million market.

The most essential factor in this growth is the number of manufacturers both in the United States and overseas who now offer plated-wire memory systems. This is justified by the fact that the problem of instability was investigated and solved in the laboratory. This solution has since been field-proven by the thousands of plated-wire memories installed throughout the world during the last several years.

Automation is the obvious and immediate means of making a memory device cost-competitive. Presently, automation is not possible with cores, but it is inherently adaptable to the production of a plated-wire plane or stack.

Another favorable point with plated-wire is its nondestructive readout (NDRO). This unique property drastically reduces electronic circuitry requirements and permits packaging organization similar to ferrite core layout, yet permits high speeds at a low cost – even for small modules. The NDRO property reduces a computer's processing time by one-third because a read instruction is executed in half the time required by a destructive readout memory.

Closer Look Significant numbers of today's computers contain logic packages incorporating high-speed ICs



Costs per bit of complete memory systems for different memory technologies are projected as functions of module capacity. Also given are estimates of cycle times. Expected crossover points will move to much lower module sizes during 1971 to 1973.

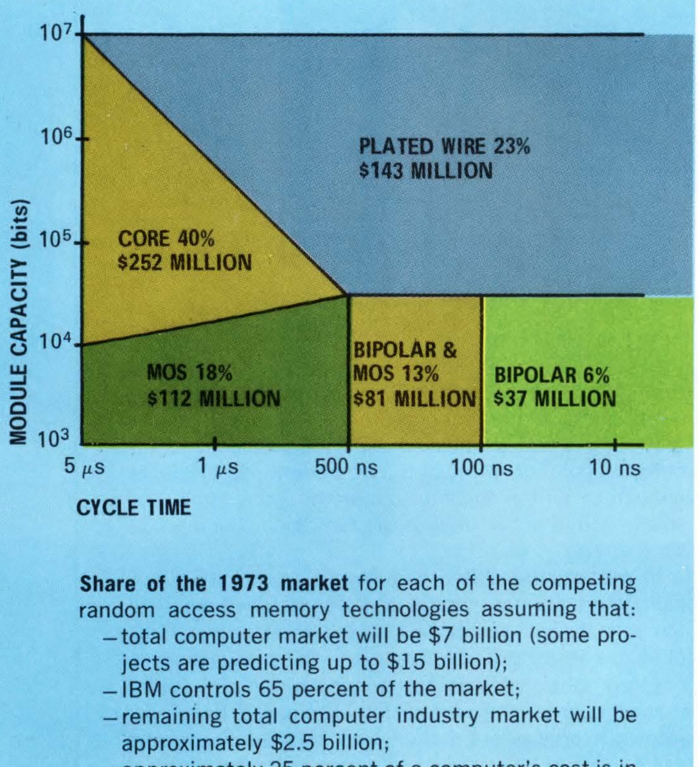
FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. 450**

its move

having propagation delays of 5 to 10 ns per stage. Main-frame memories with 600 to 750 ns cycle times and 300 to 350 ns access times are sufficiently fast for these systems. But with the coming of high-speed ICs exhibiting delays in the range of 3 to 5 ns, the computers will be able to make use of higher-speed memories – 200 to 400 ns cycle and 100 to 200 ns access. Present core technology is straining to attain 500 ns, and cores become uneconomical for cycle times of less than 400 ns. plated-wire memories will be used to a large extent as main-frame storage for the newer computers.
one to two cents per bit. Therefore, it is very likely that plated-wire memories will be used to a large extent as main frame storage for the newer computers.

It is generally recognized that as memory capacity grows into the multimegabit region, the cost of the electronics becomes progressively less in comparison to the cost of either the magnetics or the stack. Since plated wire requires considerably less labor to assemble into a stack, large memories are where plated wire can shine. For instance, 5- to 10-megabit plated-wire memories can be priced profitably at 0.5 to 0.6 cent a bit. An added bonus is that these modules can be cycled to 1 μs without overtaxing the electronics. Some experts have predicted that by 1975 half of the dollar volume of solid-state memories will be in multimegabit or bulk memories. It seems reasonable to expect that plated wire will find its way into a number of these systems.

RANDOM ACCESS MEMORY
MARKET BREAKDOWN 1973



Share of the 1973 market for each of the competing random access memory technologies assuming that:
- total computer market will be $7 billion (some projects are predicting up to $15 billion);
- IBM controls 65 percent of the market;
- remaining total computer industry market will be approximately $2.5 billion;
- approximately 25 percent of a computer's cost is in its high-speed random access memory.

Storage Element "Plated wire" is a magnetic film electrodeposited around a cylindrical substrate. A 0.005-in-diam beryllium copper wire is the most commonly used base material. To eliminate topographical defects, the wire is polished and plated with copper prior to the deposition of the memory element which is a zero magnetostrictive nickel-iron composition of approximately 81 percent nickel and 19 percent iron.

The wire is prepared in a continuous process that incorporates on-line thermal stabilization at temperatures greater than 400°C. Nondestructive readout (NDRO) characteristics are easily attained by forming an external field around the circumference of the wire during the plating and stabilization process – producing a fully closed flux path. Functional operating parameters such as output voltage, write threshold and various disturb thresholds, are influenced by process variables. Among these are film thickness, substrate condition and thermal stabilization temperatures.

Plated Wire Stack To use plated wire effectively, the wires are housed in a "mat" (see "Memory Plane Assembly"). A typical mat contains 256 word straps and 576 plated wires. Thus, each time a word current is passed through a word strap, 576 outputs will appear at the ends of the plated wires. When the word current

(Continued)

recedes to zero, all information bits rewrite themselves without bit currents. This is what is known as nondestructive readout (NDRO) operation.

A stack consists of one or more planes. Each plane has two mats, one mounted on each side of a glass-epoxy base board. A typical stack consisting of two memory planes contains 1024 word lines by 576 bit lines. The 1024 word lines constitute the practical limit for fast memories (2 to 10 MHz). Slower or bulk memories can have several times this number of word lines.

System Organization Because of the NDRO properties, a plated-wire memory can be organized in a modified 2D configuration, illustrated in **Fig. 1**. Note that this type of organization is possible only with equal read and write NDRO word currents. A word current applied to a word line affects four words. However, the actual

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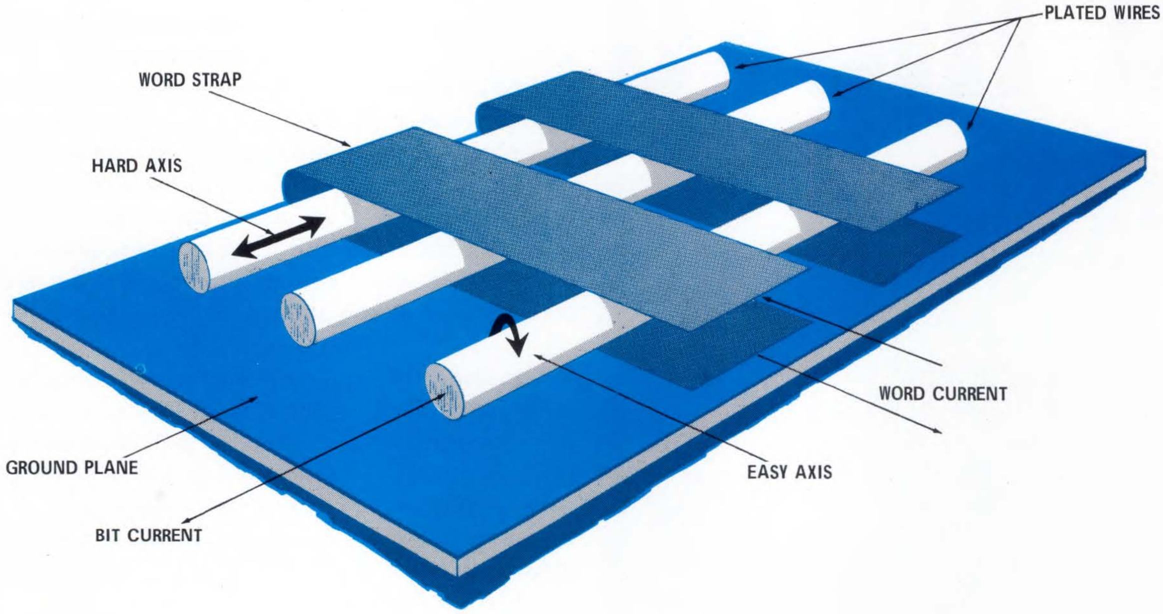
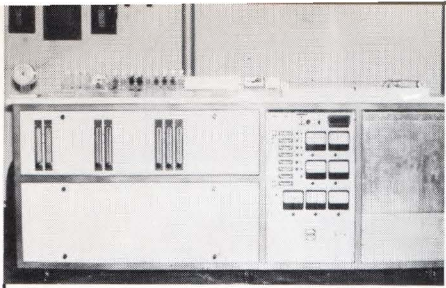
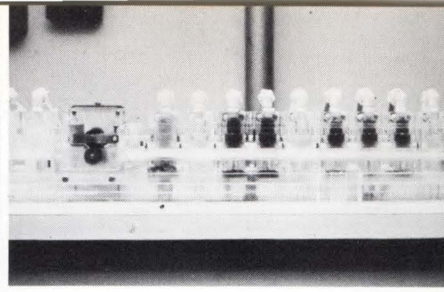
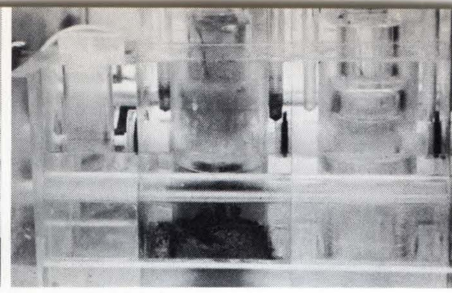


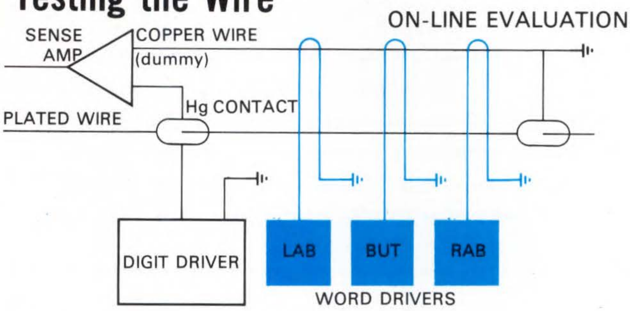
PLATED-WIRE OPERATION—Plated-wire has an anisotropic magnetic structure that has an easy axis in the circumferential direction resting in either clockwise or counter clockwise sense. In essence, this represents the binary form of the stored information. Each intersection of a plated wire and a word strap is a storage cell for a bit.

In writing, the plated wire serves as its own bit wire. At the same time that the magnetization vector is partially rotated by a word-current field, a small current is driven through the bit wire. This current generates a circumferential field that orients the magnetization in the proper direction. In other words, writing is a coincident-current operation in which the bit current must be large enough to switch the film under the word strap, but small enough not to disturb the film under the inactive word straps.

In reading, the plated wire serves as its own sense line. Word current creates a field that switches the film's magnetic vector 45° at the intersection. This change causes a flux change to induce a positive or negative voltage, depending upon the information stored in the line. When the word current is removed, the vector returns to original orientation, thus completing the read cycle.

Testing the Wire



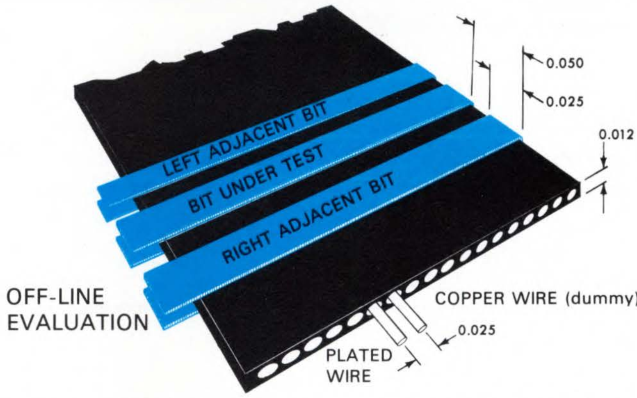
ON-LINE TESTING means cost reduction when producing plated-wire memory elements. A big advantage is immediate data feedback. Operational quality of the wire is usually monitored using a pulse test under simulated memory conditions.

In testing, the wire element itself serves as a sense digit line and three solenoids or word lines are placed around the wire as shown. Write requires time coincidence between word- and digit-line currents. When reading, an interrogation current is passed through the word line and the output is detected along the digit line.

Because of closed flux path anisotropy, a properly prepared wire possesses NDRO characteristics in that original stored information is still present after reading an infinite number of times without rewriting. Disturb effect is achieved by writing a hard history into the bit under test and into each adjacent bit, using two outside word lines. Then opposite polarity is written once into the bit under test. Any degradation of information in the bit under test caused by adverse information written into adjacent bits is called "**creep**". A given element specification fixes the on-line test program and a discriminator detects minimum output and maximum ratio of disturb output voltage/undisturb output voltage (dV/uV).

Unacceptable wire is automatically cut and rejected. Otherwise, an on-line automatic cutter is engaged only when a preset length of wire passes through the test station and meets test specification. This on-line capability alerts a production operator that one or more magnetic parameters fail to meet requirements for memory operation, at which time an evaluation is performed off-line.

OFF-LINE EVALUATION is usually performed in a plane environment as shown. Primary disturb phenomena that affect operating range of the plated wire are "**creep**", "**crawl**" and "**wall motion disturb**".



Creep is that effect of fringing fields produced by writing adverse information into bits adjacent to bit under test. An output voltage versus digit current plot with fixed word current determines creep threshold. This curve, called "digit window", indicates the digit current at which stored information is useful.

The digit window is obtained by writing a hard history into the bit under test and into each adjacent bit. An attempt is then made to write a single time with a fixed word current and a digit current that is gradually varied from 0 to 100 mA. The output after each single write is displayed on the vertical axis of an oscilloscope while the digit current is displayed as the horizontal sweep.

Crawl phenomenon is the susceptibility of the wire to adverse current down the digit line in the presence of a normal word disturb field. This curve is obtained by maintaining all currents constant except for the adverse digit current which is gradually varied from 0 to 10 mA. In system operation, this small current may be the result of leakage in digit drivers or from coupling of current from adjacent wires. The amount of current the wire can withstand under this condition without deterioration can be related to the destructive readout threshold.

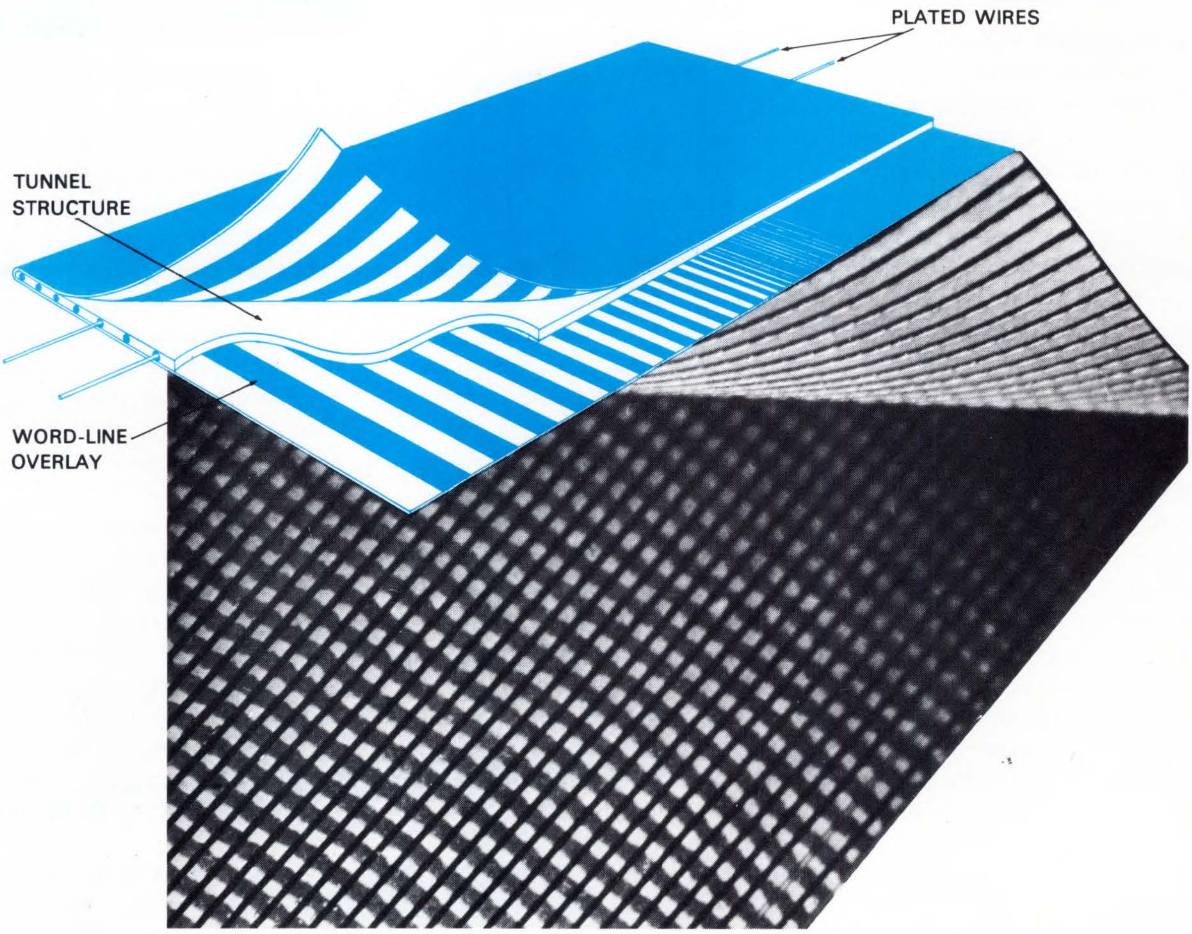
Wall motion disturb is the amplitude at which a unipolar pulse down the wire will destroy any information that has been written. By varying the digit current from 0 to 100 mA, the wall motion threshold can be obtained. Both creep and crawl thresholds are dependent upon the test package in addition to the wire characteristics, whereas wall motion disturb is solely a function of the wire element and is independent of the package. Combination of the three disturb conditions determines the usable region in which the wire is stable under NDRO operation. In each case, high disturb thresholds provide wider operating range for the plated-wire element.

"DIGIT WINDOW" EXAMPLES ARE SHOWN ON PAGE 010100

(Continued)

word selected in read or write is determined by what gate has been enabled. The other three words are not disturbed due to the NDRO property. Trade-off in organizing an optimum memory is the cost of the word-selection circuits, the low-level gates, the sense amplifiers and the bit drivers.

A typical memory may consist of a stack, previously described. A 1024-diode matrix selects the desired word line and the bit lines are connected to bit drivers and sense amplifiers through 576 low-level gates. The computer word determines the required number of drivers and sense amplifiers. Thus, the NDRO charac-



MEMORY PLANE ASSEMBLY—A mat is a simple structure composed of copper straps, 0.03 in wide on 0.05-in centers, around a thin plastic sheet containing many "tunnels" (0.007-in diam on 0.02-in centers). Fusing two sheets of "Teflon"-coated "Kapton" around accurately spaced forming wires forms a tunnel structure orthogonal to the copper straps. The forming wires are removed, leaving "Teflon"-coated tunnels through which plated wires are inserted to form the bit or sense lines of the memory. This structure of word straps and tunnels is less than 0.013-in thick.

A typical mat may be 13-in long for 256 word straps and 13-in wide for 650 tunnels. Intersection of word straps and plated wires define bit location of the stored information. Continuity of the magnetic coating on the wire removes any requirement for registration of the wire along a tunnel within the mat. Two mats, one mounted on each side of a glass epoxy base board, represent a memory plane.

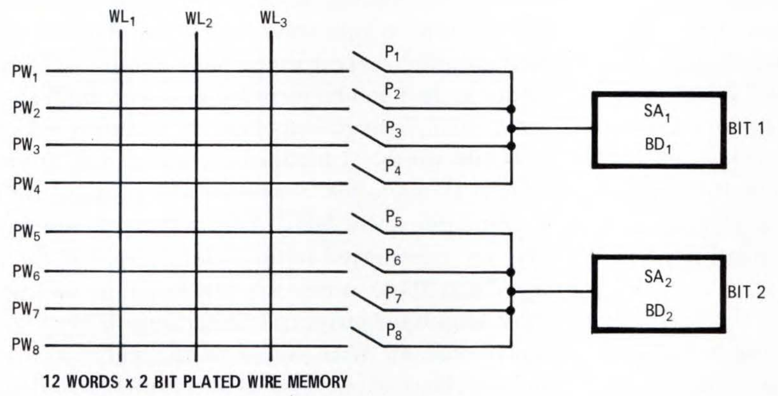


Fig. 1—**Diagram illustrates** a 12-word by 2-bit plated-wire memory. Internally, the memory is organized with three word lines ($WL_1 - WL_3$) and eight plated wires ($PW_1 - PW_8$). Also indicated are two sets of low-level gates ($P_1 - P_8$) that connect the wire to sense amplifiers SA_1 and SA_2 and bit drivers BD_1 and BD_2. When WL_1 is energized, words 1 through 4 are selected. Depending on which gate is enabled, word 1, 2, 3 or 4 is selected. Similarly, WL_2 and WL_3 select words 5 to 8 and 9 to 12, respectively.

teristics allow this memory to be organized as an 8k × 72, 16k × 36 or 65k × 9 memory system. A 16k × 36 system is illustrated in **Fig. 3**.

Modularity In the system previously described, if the timing and control, address register, word current generator and the low-level gates are considered as a basic unit, then the memory becomes expandable simply by expanding the stack from one plane with one mat, to one plane with two mats, to two planes with four mats. Furthermore, adding and subtracting the number of sense amplifiers and bit drivers satisfies the different word lengths. The following table illustrates this modularity concept.

STACK	NUMBER OF SENSE CHANNELS			
	72	36	18	9
2 planes, 2 mats	8k × 72	16k × 36	32k × 18	65k × 9
1 plane, 2 mats	4k × 72	8k × 36	16k × 18	32k × 9
1 plane, 1 mat	2k × 72	4k × 36	8k × 18	16k × 9

From this table, it is evident that further refinement of this concept can be realized by packaging the sense electronics in such a way that different numbers of sense channels can be easily put into a memory system. Thus, systems of 8- to 72- or more bit word lengths can be accomplished without altering the basic design and construction.

Electrically-Alterable ROM Read-only memories have received considerable attention within recent years and are found in many diverse applications. Typical examples are disc controllers, micro programming of tape controllers, character generators, code converters and numerical control.

In many cases, however, the ROM approach has certain economical drawbacks. In the case of the semiconductors, the user faces the additional cost of mask-programming for every change needed as well as the loss of time and reinstallation costs. Braided core ROMs and diode matrices present essentially the same problems of factory rework, retesting and necessary installation for every modification.

Plated-wire memories, by definition, are ROMs that are electrically alterable and are sometimes called "Read Mostly" memories. In other words, stored information in a plated-wire memory can be modified at will with the standard interfacing circuits that usually already exist within the systems. Also, program changes are easily accomplished without the cost and down-time delays of removing the memory unit for the mechanical changes. In fact, with a modem, a plated-wire ROM in a field installation can be reprogrammed and verified from the factory. This is done by simply running a program from the factory through standard telephone lines to each installation using a low-cost data set. Besides having the capability of being read at 100 to 200 ns, absolute program integrity is assured —through the NDRO properties—even with power failure and in high noise environments.

Read/Write and ROM Combined A variation of the ROM is a memory partitioned into two sections, one a ROM and the other a normal read/write memory. In **Fig. 4a**, division of the 16-bit memory is 50 percent ROM and 50 percent read/write. One set of 16 sense amplifiers and digit drivers is used for the read/write portion and another set for the ROM. Power to the drivers in the

(Continued)

ROM portion can be removed either manually or by remote control. When driver power is disconnected, this portion becomes a ROM. Proportions other than 50/50 are achieved through appropriate design. By making one stack and a set of peripheral electronics exclusive of the sense digit electronics do for the two portions of the memory, some real economy can be achieved. Many applications require a small ROM with a fair-sized read/write memory. When a plated-wire memory is partitioned as described, the small ROM is almost free.

High-Speed Input Buffer Plated wire finds use in buffers requiring high data-write-in rate. For example, in a high-speed data acquisition system, the data may be coming in at 10 to 30 MHz. In the organization of the plated-wire memory, many bits can be written simultaneously into storage without the penalty of high cost. This is because each word line goes over many wires. By simply generating a number of bit currents (40 mA), data is written into the appropriate plated wires. By accumulating several words before entering them into memory, data can be recorded at a very high speed.

An example of this application is shown in **Fig. 4b**. This 10k word × 7 bit memory stores data from a 30 MHz A/D converter. Seven-bit words enter the input accumulator at 30 MHz. After ten words are entered, they are transferred to the input register of the memory. Then these words are written into the memory stack simultaneously at 3 MHz. Data is read out in a similar fashion. With proper timing and control, stored data can be read out later in a first-in, first-out fashion —an added feature. Furthermore, the readout is performed while fresh data is being entered into the memory. In essence, a high-speed delay line (but nonvolatile and with variable clock rate) has been built by adding

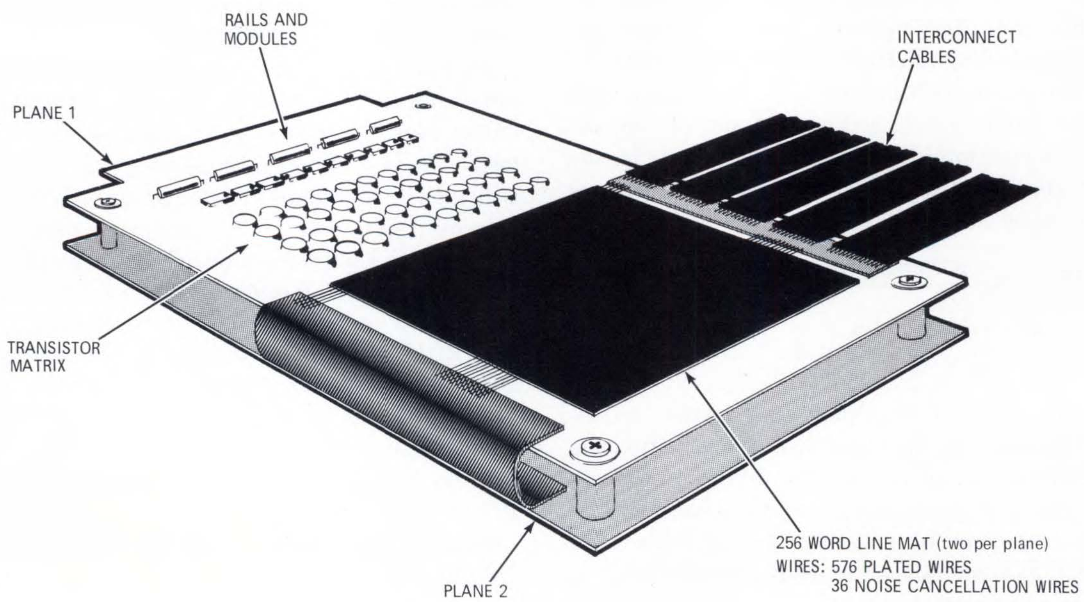


Fig. 2—**Measuring 16 by 16 in,** a 589,824-bit memory stack is made up of two planes mounted back to back. There are two plated-wire mats per plane and each mat has 256 word lines and 576 bit lines plus 36 noise-cancellation wires.

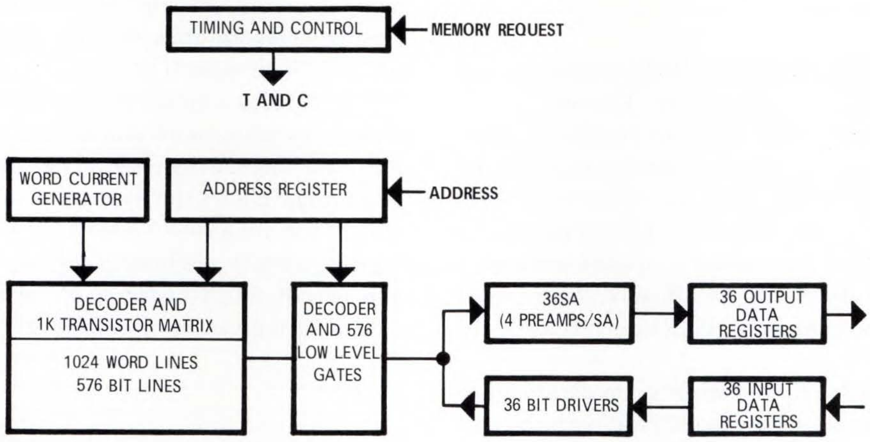


Fig. 3—**Block diagram** depicts a 16k × 36 memory system.

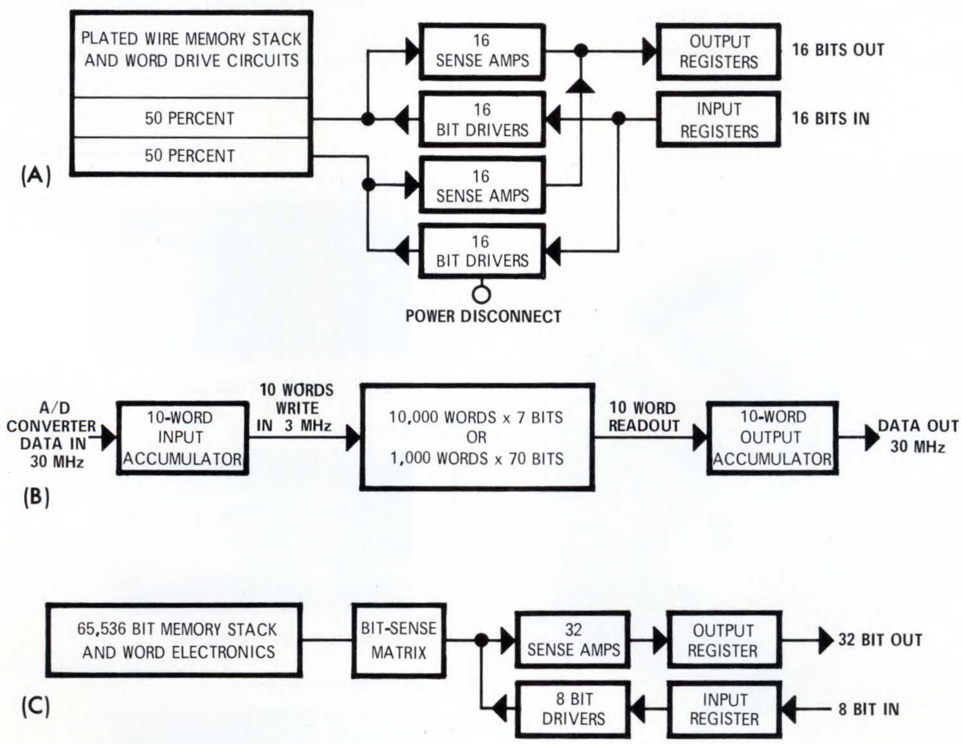


Fig. 4—**Various organizations** make use of plated-wire stacks. Configuration (a) is a 16-bit word memory partitioned into 50 percent read/write and 50 percent read only. System (b) illustrates a superspeed buffer using slower speed plated-wire memory and (c) is an unequal read/write word length memory.

accumulators and some housekeeping circuitry to a standard memory.

Unequal Word Lengths Using the NDRO properties and low-level gate matrix, a plated-wire memory can be organized to accommodate different read/write word lengths. An example of this is illustrated in **Fig. 4c**. Here a 65,546-bit memory acts as a 2k × 32 in read mode and an 8k × 8 in write. This type of memory is desirable where high read speed is needed and a slow write cycle can be tolerated. Conversely, longer write and shorter read words can be configured just as easily.

Military And/Or Airborne Plated wire is especially suited for military applications. Low power requirements, coupled with a wide temperature range and ruggedness, have convinced the military that they should specify plated-wire in a number of new systems. For instance, in an airborne guidance system, core memories have a tendency to drop or lose bits during the rewrite cycles in the high-noise environment generated by the aircraft engines. Plated wire, with its NDRO property – and elimination of the rewrite cycle – is much more resistant to such noisy environments.

Future Growth Plated-wire memory systems in production today generally use the 0.005-in-diam plated wire. A number of laboratories are now actively working on the 0.002-in-diam wire. The 0.002-in-diam wire, or "mini-wire", provides a number of significant advantages, including reducing word and digit currents by factors of 2 to 3 and increasing packing density by a factor of 10. The former allows the memory element to more easily match the integrated circuit drivers. The increased packing density would both reduce the cost of the array and permit much faster cycle times by reducing the delays for a given number of bits.

Coauthors of this article are **Carlos F. Chong, Lloyd D. Ransom** and **Richard A. Batiuk** – employees of Nemonic Data Systems, Inc., Denver, Colo. Mr. Chong, Vice President of Engineering, is a recognized authority in the application of plated wire and has been awarded five patents with six pending. Mr. Ransom, Vice President of Material Processes, has an extensive background in the investigation of chemical and electro-chemical properties of magnetic films and coatings. Mr. Batiuk, a member of the technical staff, has been involved with numerous development programs that include optimum configurations of word lines, flux keep and plated-wire spacing.

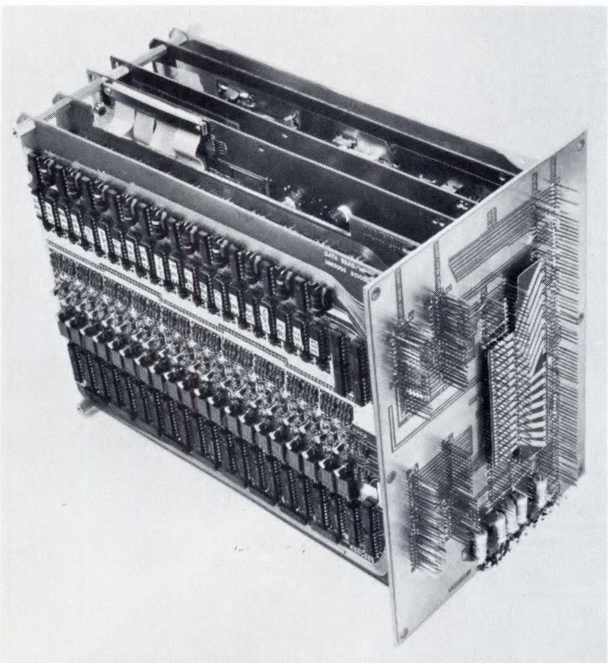
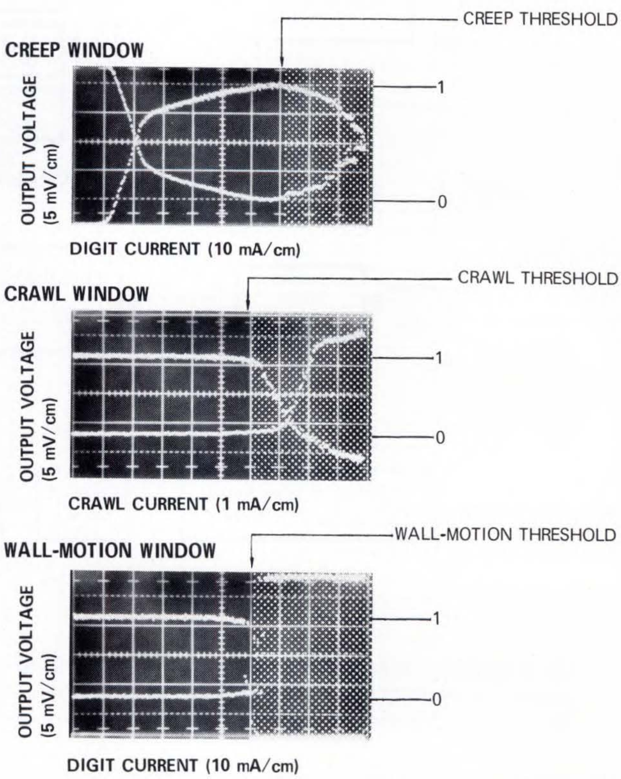


Fig. 5 – **A medium capacity,** high-speed random access memory system has 150 ns access time, 250 ns read time and 500 ns write time. Maximum storage capacity is 81,920 bits.



get out of the rut—combine counter types

Designers quickly fall into the habit of using only one type of counter in all of their designs. In view of the desire to save components, it behooves these designers to consider combining subcounter types and/or moduli to attain a favorable period.

Suppose that a counter has an even period. A single J-K flip-flop (with common input logic) represents a modulus-2 binary counter that can be driven by a twisted-ring (Johnson counter) or shift-register short-cycle subcounter to achieve the desired period—often with fewer components. A twisted-ring counter (full or short cycle) combined with a single or double stage binary counter is attractive where complete decoding of the counter states is necessary. Each state requires only a three- or four-input gate, respectively, for decoding.

A combination approach should be considered any time the modulus can divide into two or more moduli, each of which can be easily designed. The technique is particularly simple when all moduli are "relatively prime" (two integers having no common factor other

Two examples demonstrate potential advantages of combining counters.

EXAMPLE I

PROBLEM: Design a decade counter using minimum of J-K flip-flops and combinational logic.

DISCUSSION: Modulus factors in only one non-trivial way, 5 times 2 equals 10. A mod-5 counter requires three flip-flops—simplest type being a short-cycle, twisted-ring counter. Since moduli 5 and 2 are prime, they are by necessity "relatively prime", thus, mod-5 subcounter may optionally drive mod-2. Both drive and non-drive options are shown in **Fig. 1** together with counting sequence.

Note that the drive function is merely the state of flip-flop Y, that is "1" for three of five states of the mod-5 subcounter. On the other hand, $\bar{Y}$ cannot be used as drive function because it is "1" for only two states—a number that is not "relatively prime" to mod-2 subcounter period.

Both configurations in **Fig. 1** require two J-K flip-flops with two R-S, D or more J-K flip-flops without combinational logic. Although counting sequences are non-weighted, each state can be decoded with a 3-input AND or NOR gate.

EXAMPLE II

PROBLEM: Design a mod-45 combination counter with as few J-K flip-flops and NAND gates as possible. Assume both single and multiple-input J-K flip-flops are available.

DISCUSSION: Modulus can be factored in the following ways: 3, 3 and 5; 9 and 5; 15 and 3. Factoring 3, 3 and 5 indicates three subcounters with two identical moduli and requiring seven flip-flops. Factors 9 and 5 imply two subcounters which have relatively prime moduli, but this scheme requires seven flip-flops. The third, 15 and 3, entails two subcounters with non-relatively prime moduli requiring a total of six flip-flops—minimum possible for mod-45 counter.

Choosing the third factoring, a full-cycle shift register counter illustrated in **Fig. 2**, provides mod-15 portion while the mod-3 is a short-cycle (self-starting) two-stage, twisted-ring counter. Since 15 and 3 are not relatively prime, a drive function is essential—preferably mod-15 subcounter driving the mod-3 to minimize enabling connections. Examining the mod-15 output, note that there are 7 zeros and 8 ones. Thus, either the Q or $\bar{Q}$ output of any stage can serve as the drive function because both 7 and 8 are relatively prime to 3.

Using two multiple-input J-K flip-flops, the mod-3 counter with enabling inputs is readily developed as shown in **Fig. 2**. The Q side of the last stage of the mod-15 counter was arbitrarily selected for the drive function. The mod-15 requires two NAND gates (3-input and 2-input) to provide synchronous self-starting capability. The first stage is a J-K, the other three can be R-S, D or J-K flip-flops, whichever is convenient.

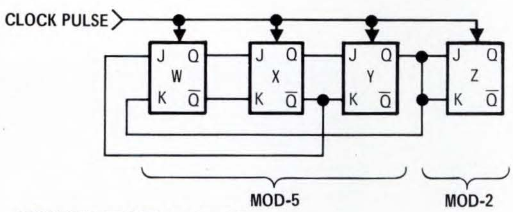
In comparison with a single mod-45 counter, a minimum design requires three NAND gates to attain short-cycle, self-starting shift-register counter using a multiple-input first stage J-K. Two of the NAND gates have a fan-in of five, the other a fan-in of two (see **Fig. 2**).

than unity) because it is not necessary for one subcounter to drive another in order to attain the final counter. However, if the modulus is factored in such a way that two of its moduli, P_i and P_j, are not relatively prime, an appropriate function of subcounter p_i must be used to drive (or step) subcounter p_j to obtain the count. Drive may be a function of one state of the driving counter or a set of n states (sum of n-minterm/valid states), where n is relatively prime to p_j. With reference to the driven counter, the drive function must be incorporated as an enabling variable for the input gating of each flip-flop. Thus the importance of multiple-input J-K flip-flops is apparent since a gate-free subcounter can be readily realized (**Fig. 2**).

In short, if the factored modulus results in relatively prime moduli, cascaded drive is optional. Although it may be desirable from, say, a design or maintenance standpoint, cascaded drive entails additional combinational logic of one type or another. Without relatively prime moduli, cascaded drive is essential.

Examples I and II illustrate some alternatives that are available for combining counter types. Whether to use a single modulus counter or two or more subcounters depends upon the respective number of components for each approach (including associated decoding logic), as well as such factors as system code and component constraints.

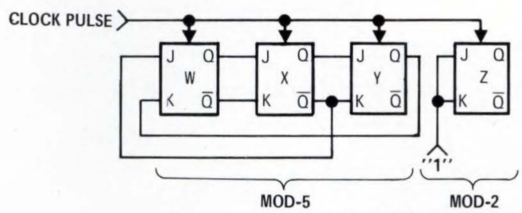
George E. Goode is President of Datotek in Dallas, Texas, and a visiting associate professor at Southern Methodist University. George received a B.A. from Southwestern at Memphis and an M.A. in mathematics from Duke University. He has given papers at several conventions, written many articles, and holds three patents. Material for this article was taken from his forthcoming book.



COUNTING SEQUENCE (P = 10)

W	X	Y	Z
1	1	1	1
0	1	1	0
0	0	1	1
1	0	0	0
1	1	0	0
1	1	1	0
0	1	1	1
0	0	1	0
1	0	0	1
1	1	0	1

(A)



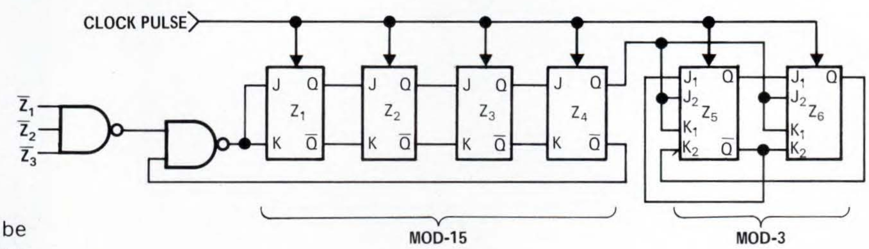
COUNTING SEQUENCE (P = 10)

W	X	Y	Z
1	1	1	1
0	1	1	0
0	0	1	1
1	0	0	0
1	1	0	1
1	1	1	0
0	1	1	1
0	0	1	0
1	0	0	1
1	1	0	0

(B)

Fig. 1 – **Mod-10 counter** combines mod-5 and mod-2 subcounters. In configuration (**a**), flip-flop Y is drive function for mod-2 counter and in (**b**), mod-2 requires no drive function.

(A)



(B)

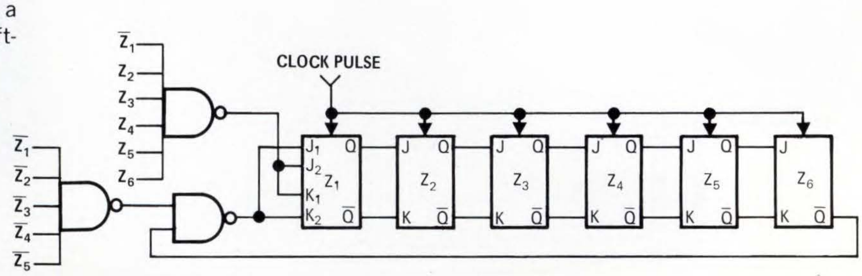
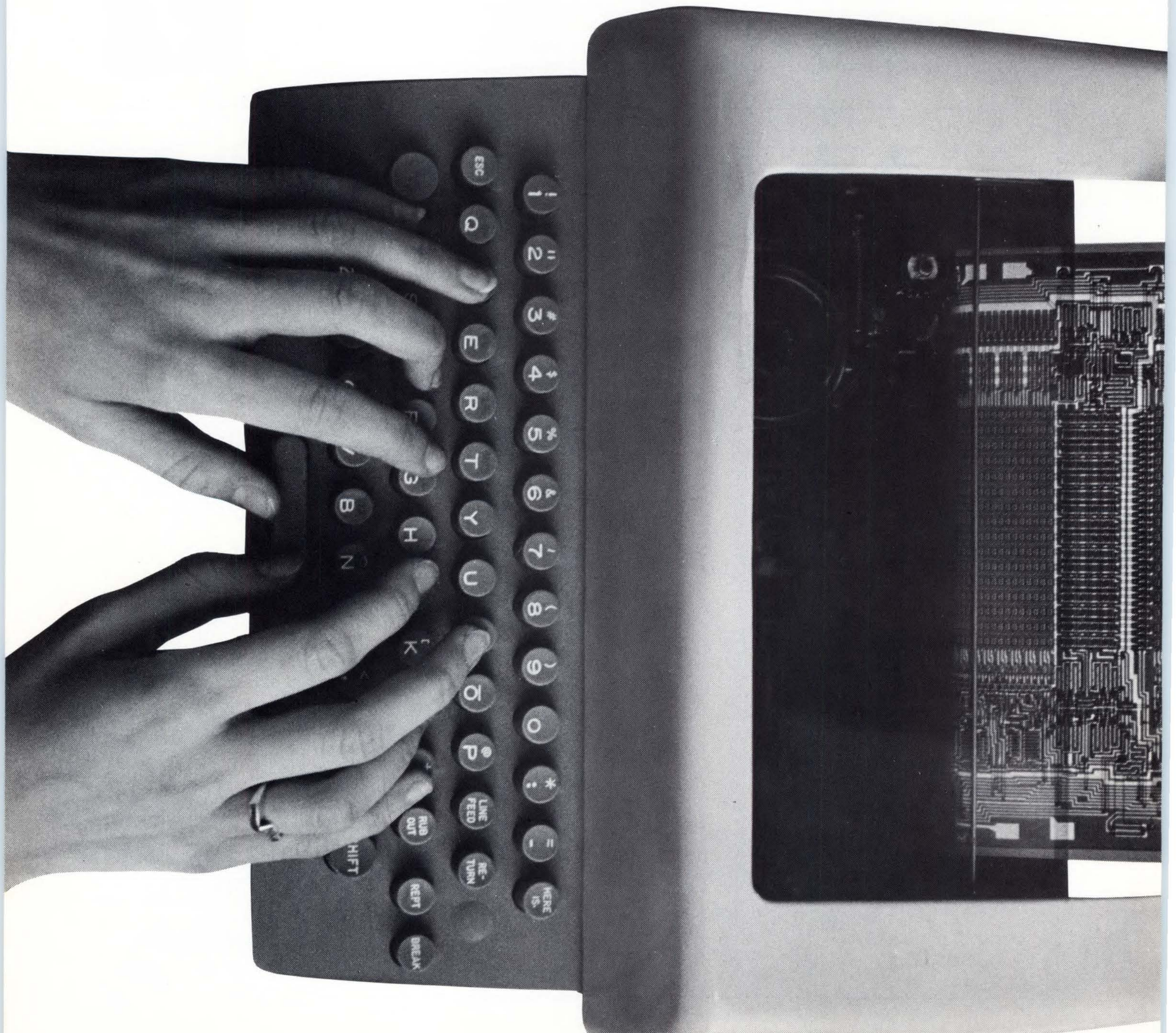
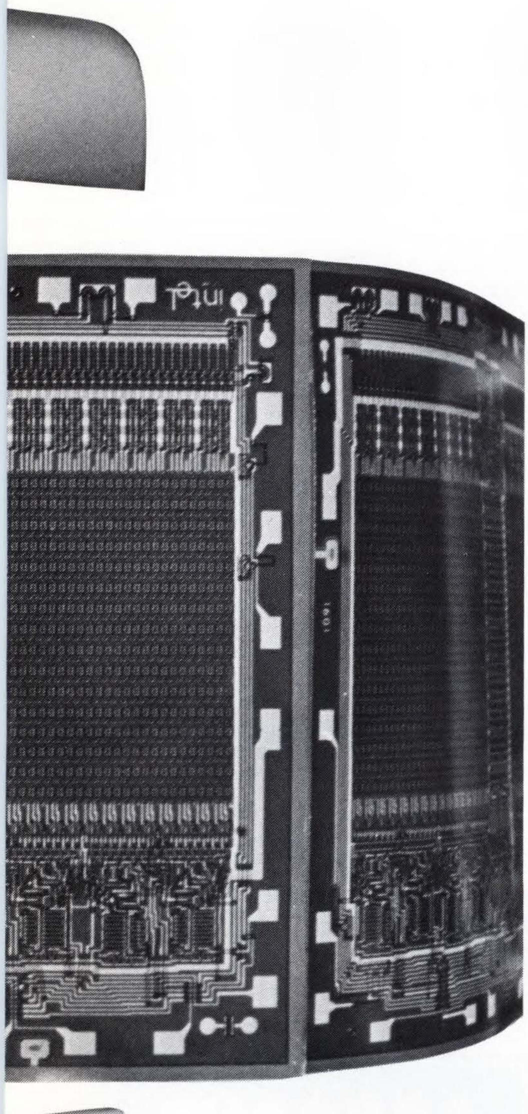


Fig. 2 – **Mod-45 counter** can be developed two ways. Configuration (**a**) combines mod-15 and mod-3 subcounters and (**b**) is a single mod-45, short-cycle shift-register counter.

Annou
Instant



ncing MOS ROM!



Introducing Type 1601, a 2048-bit monolithic MOS ROM that Intel will ship within 24 hours after receiving your custom programming instructions.

Only Intel can deliver MOS ROM's so quickly because only Intel has developed a MOS ROM that's programmed electrically instead of with a mask.

To get custom ROM's fast, you simply transmit to us a teletypewriter tape containing your program instructions. We load the tape in a simple programmer, insert finished 1601's from stock, and push a button to enter your program.

When you're ready for large quantites and want to cut costs, Intel will give you mask-made ROM's, Type 1301, that are operationally identical and plug compatible with your 1601's.

Programming is available at Intel and at many of our distributors and representatives in the U.S., Europe and Japan. Or you can do it yourself with an Intel programmer that costs about $5,000.

Intel 1601's and 1301's are fully decoded, packaged in a 24-lead DIP and interface directly with DTL/TTL logic. Decoded dynamically, they have an access time of 750 nsecs and power dissipation of 0.1 mW/bit. With static decoding, access time is 1 μsec and dissipation is ¼ mW/bit.

Programmed 1601's cost about 3¢ per bit in small quantities. Fixed programmed 1301's cost about 1¢ per bit in quantities of 1000.

For immediate U.S. delivery of Type 1601 programmed for EBCDIC to 8/ASCII-8, phone your local Intel distributor, Cramer Electronics or Hamilton Electro Sales. If your distributor isn't stocked, just call us collect at (415) 961-8080 for same-day shipment.

In Europe contact Intel at Avenue Louise 216, B 1050 Bruxelles, Belgium. Phone 492003. In Japan contact Nippon IC, Inc., Parkside Flat Bldg., No. 4-2-2, Sendagaya, Shibuya Ku, Tokyo 151. Phone 03-403-4747.

Intel Corporation is in high-volume production at 365 Middlefield Rd., Mountain View, California 94040.

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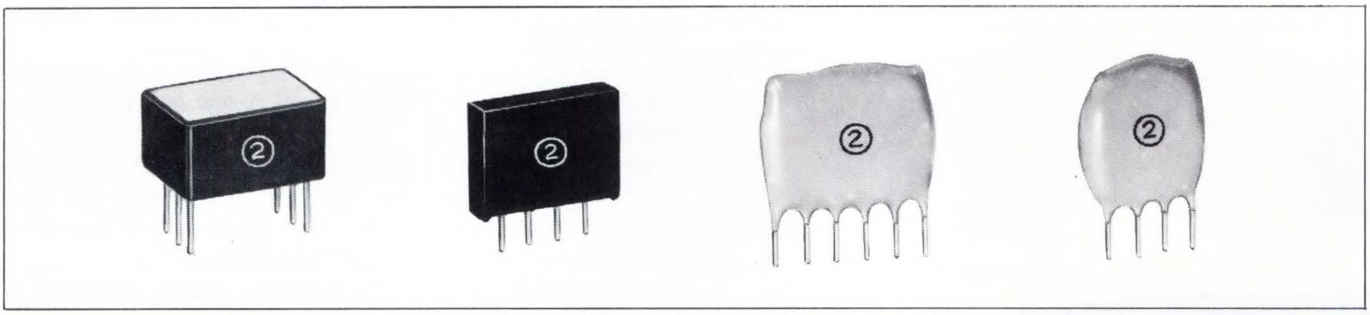
CIRCLE NO. 417

Now from Sprague Electric!

Your *custom* pulse transformer is a *standard* DST® transformer



Some of the case styles in which Sprague DST Pulse Transformers are available. Note the in-line leads.

You can select the transformer design you need from the new Sprague DST Family, a fully-characterized series of Designer Specified Transformers which Sprague Electric has pioneered. It's easy. Start with the two basic parameters dictated by your circuit requirements: primary (magnetizing) inductance and volt-second capacity.

New Sprague engineering data gives basic information from which all nominal sine wave parameters are derived. This data allows you to specify the one transformer from thousands of possibilities which will optimize performance in your application.

Design Style A minimizes magnetizing inductance change as a function of temperature. Typically it's $< \pm 10\%$ change from 0 to 60C; $< \pm 30\%$ from -55 to $+85$ C.

Design Style B and C give you broad bandpass characteristics, and still keep magnetizing inductance change $< \pm 15\%$ from 0 to 60 C.

Design Style D is *fast*. Associated leakage inductance and coupling capacitance are kept at a minimum. This style is just what you need for interstage and coupling devices in computer drive circuits.

The Sprague DST Series packs a lot of transformer into minimum volume packages — epoxy dipped for minimum cost, or pre-molded. The 100 mil in-line lead spacing is compatible with integrated circuit mounting dimensions on printed wiring boards.

To solve your pulse transformer design, start now. Write for Engineering Bulletin 40,350 to the Technical Literature Service, Sprague Electric Company, 491 Marshall St., North Adams, Massachusetts 01247.

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coming soon...

INTERNATIONAL CONFERENCE AIMS AT BRIDGING "COMPUTER GAP", Aug. 16-20. Prof. Gerald Estrin of UCLA is playing a key role in organizing the Jerusalem Conference on Information Technology, which will be held in Israel.

In line with the shirt-sleeve approach to the conference, a key feature will consist of "traveling" panel discussions, which will meet at different sites throughout Israel.

Proposed panel topics range from interactive graphics, personnel systems, communications, and government utilities to archeology, publishing, urban studies, and social impact of computers.

Working with Dr. Estrin in planning the conference are seven regional vice chairmen, including Dean O. J. Fagbemi, Univ. of Lagos, Nigeria, for Africa; Prof. V. Rajaraman, Indian Institute of Technology, Kanpur, India, for Asia; Prof. John M. Bennett, Sidney Univ., for Australia; A. A. Benjamin, Systems Programming Ltd., London, for Europe; Uziyah Galil, Elbit Computers, Haifa, for Israel; Prof. Sergio Beltran, Latin American Institute of Information and Computer Sciences, Mexico City, for Latin America; and Prof. Jack Minker, Univ. of Maryland, for North America. Contact: University of California, Los Angeles, Office of Public Information, 405 Hilgard Ave., Los Angeles, CA 90024. Telephone: "UCLA-585".

1971 JAPAN ELECTRONICS SHOW, Oct. 1-7, Osaka, Japan. Exhibits: Electronic equipment, related devices and parts. Exhibit Classification: Exhibit space will be allocated in terms of product categories. An international exhibits area will be separately assigned. Booth Rates: U.S. $400 per standard booth. Application for Space: Application for space should be made on the official application form provided by the sponsor. Space Assignment Closing Date: Feb. 28, 1971. For further details contact: Mamoru Tsukamoto, EIAJ News Bureau, The Electronic Industries Assn. of Japan, 437 Fifth Ave., New York, NY 10016. Telephone: 686-0731.

coming courses...

DATA CAPTURE—ENTRY—COLLECTION—COMMUNICATION—GATHERING—ORGANIZATION Seminar, presented by The Institute for Advanced Technology of Control Data Corp., Feb. 17-19, Washington, D. C., March 15-17, New York, N.Y. This seminar is designed for individuals seeking more efficient ways to procure data for their data processing systems. It will cover the traditional methods of data collection (punched cards, paper tape, magnetic tape), more recent techniques (data collection devices, optical scanning devices, remote terminals) and current specialized areas (CRTs, graphic records, on-line teller systems).

TERMINALS IN DATA COMMUNICATIONS Seminar, presented by The Institute for Advanced Technology of Control Data Corp., Feb. 17-19, Chicago, Ill., March 15-17, New York, N.Y. This seminar emphasizes the concepts behind all terminal devices and relevant system design and programming considerations. The required computer hardware and software to support terminals will be discussed. A comprehensive reference manual will be provided which includes characteristics of most terminal devices.

ADVANCED EDP SYSTEM DESIGN Seminar, presented by The Institute for Advanced Technology of Control Data

Corp., Feb. 22-24, Washington, D. C., March 22-24, New York, N.Y. The purpose of this seminar is to discuss the most recent information processing developments and concepts and portray some newly developed approaches to the solution of problems. It will survey the latest information processing techniques, talk of their implementation and discuss difficulties associated with their use. Further information for the above Seminars can be obtained from: Registrar, The Institute for Advanced Technology, Control Data Corp., 5272 River Rd., Washington, D C 20016. Telephone: (301) 652-2268 EXT. 245.

Modern logic design and total digital system design will be the subjects of seminars conducted by GTE Sylvania. **MODERN LOGIC DESIGN SEMINAR** held in New York, March 1-4; Washington, D. C., March 29-April 1; East Orange, N. J., April 19-22, Cleveland, Ohio, May 3-6; and Chicago, Ill., May 17-20. The four-day modern logic design seminar, in workshop and lecture sessions, includes instruction in logic gates and symbology, graphical reduction techniques, simple and multiple function design, and digital package characteristics. Integrated circuit logic families, sequential logic design, counter design techniques, register configurations, arithmetic unit design, and digital subsystem design techniques also will be covered.

TOTAL DIGITAL SYSTEM DESIGN SEMINAR presented in San Diego, March 9-11; San Francisco, March 16-18; Boston, March 30-April 1; Philadelphia, May 4-6; East Orange, N. J., May 17-19; and Washington, D. C., April 20-22. System planning, study, and design will be treated in the total digital system design seminar. The three-day course will include lectures and practical exercises in such areas as system conception and study; data communications, presentation, and coding; arithmetic units and computations; analog to digital conversion; multiplexers, displays, printers, memories, and sensors; decision making, corrective feedback, and industrial and military logic standards. Additional information may be obtained by writing on letterhead stationery to GTE Sylvania Training Services, 63 Second Ave., Waltham, MA 02154.

DESIGN AND APPLICATIONS SEMINAR will be coupled with a one-day seminar on applying integrated circuits to calculator designs. Schedule for the four-day seminar is March 8-11, with the one-day calculator seminar on March

12. In addition to teaching sessions, an extensive laboratory of experiments is included so that the seminar attendee can actually apply integrated circuits in subsystems and systems configurations. The four-day seminar cost is $500 per person, which covers tuition, course material, text and luncheons. The one-day seminar is $175 per person. Contact: Harold Bell, Seminar Director, Integrated Circuit Engineering Corp., 4900 East Indian School Rd., Phoenix, AZ 85018. Telephone: (602) 959-4760.

call for papers

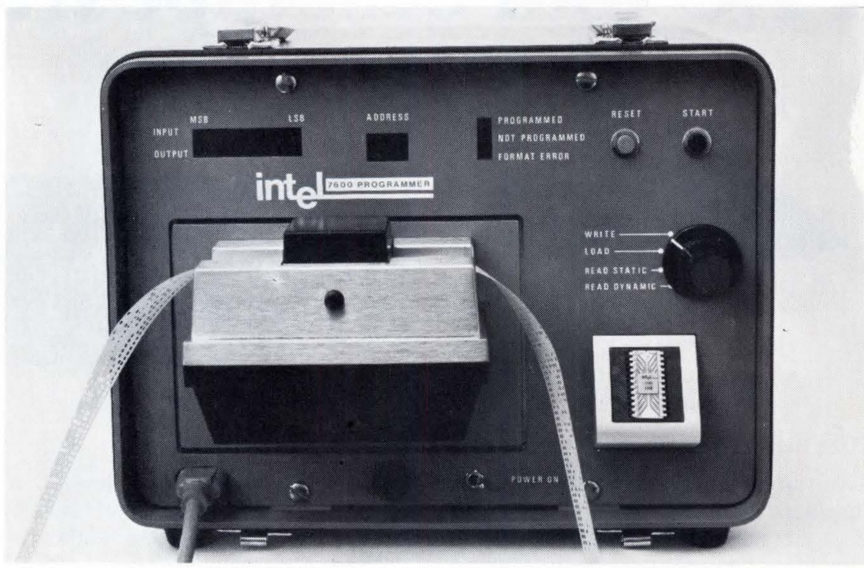
EUROCON 71, the first IEEE Region 8 Convention, will be held in "Le Palais de Beaulieu" in Lausanne, Switzerland, Oct. 18-22. Papers, not previously published, describing significant contributions in the following or related areas, are invited: *Information Processing in Large Systems*—in power, navigation, space, telecommunication and traffic systems. *Computer Applications*—computer control, data and signal processing, including data processing computers, signal processing systems, and man-machine interfaces; minicomputers as system components; mask layout; test generation and fault diagnosis. *Long Distance Communication*—terminals, switching and transmission for telegraph and data; telephone systems, message transmission on ground and with satellites; flight navigation and landing systems; electromagnetic compatibility. *Integrated Electronics*—monolithic and hybrid; digital, including logic and switching; LSI; new and novel circuits for digital signal processing; reliability; testing; compatible packaging; cost. *New Devices and Their Applications*—memories, including semiconductor, magnetic and electrooptical; opto-electronic devices, including sensors, detector and display arrays; scanning, access and processing circuitry; storage, and information processing. Authors must submit *both* a 35-word informative abstract and a 300-500 word summary in English, appropriate to a 20-minute paper, to reach the EUROCON 71 office before April 1, 1971, to: Dr. Alain Jenny, Local Sec. EUROCON 71, Swiss Federal Institute of Technology, 24 Chemin de Bellerive, CH-1007 Lausanne, Switzerland. Telephone: (21) 26 46 21.

1971 FALL JOINT COMPUTER CONFERENCE, Nov. 15-18, Las Vegas, Nevada. Program objective will be to explore in depth specific areas where computers have maximum impact upon our society, and to seek out those other areas where potential is greatest for computing technology to assist man. In addition, original papers dealing with system design in general and hardware/software technology are welcome. While the major thrust will be toward "computers and the quality of life", as in past JCCs there will continue to be strong emphasis on all major new innovations in hardware, software, significant applications, and important services. Initial submission must include six copies of the publishable material, including an abstract (100-200 words) and a draft (not exceeding 6000 words) of the paper for the Proceedings. These should be sent no later than April 1, 1971 to: Dr. Martin Y. Silberberg, 1971 Fall Joint Computer Conference, Box 11337, Palo Alto, CA 94306.

are binary numbers a bunch of boole?

Many comments, pro and con, have been received concerning Computer Hardware page numbers expressed in binary notation. So that we can satisfy the majority of our readers, please circle Reader Service Number 420 to indicate "Yes, I approve of the binary page numbers" or 421 for "No, I do not approve of the binary page numbers".

at last—a reprogrammable MOS ROM



Until now, the electrically-alterable ROM has been the sole domain of magnetic memory technology—and more recently the "Ovshinsky effect". Intel's newest entry is a fully decoded monolithic 2048-bit device.

Designated 1601, Intel's reprogrammable ROM comes in a 24-pin plastic DIP that is quantity priced at \$36—unprogrammed configuration. A similar masked-programmed version, the 1301, is quantity priced at \$10. Both versions are TTL compatible and can be operated dynamically (500 ns access time) or statically (800 ns access time).

To program the 1601, Intel has developed a "blue box" called 7600 Programmer (photo). The programmer contains nine 256-bit RAMs—eight of which accept data from punched-tape before writing it into the 1601. It takes about 2 min to load tape and an equivalent time to record data into the ROM. Programming signals are 50V, 1 ms pulses.

Although Intel aims to sell the programmer for \$5000, users may get the ROM programmed at the factory or at a "ROM service center" that will soon be established. If the users supply the properly programmed tape, the set-up charge to program the ROM will be \$10—\$90 if only a truth table is supplied.

Another "blue box" forthcoming will erase data stored in the 1601. Exposing unpackaged chips to ultraviolet radiation will erase the information. However, in a sealed package, the erasing is accomplished with X-radiation. Intel Corp., 365 Middlefield Rd., Mountain View CA 94040

422

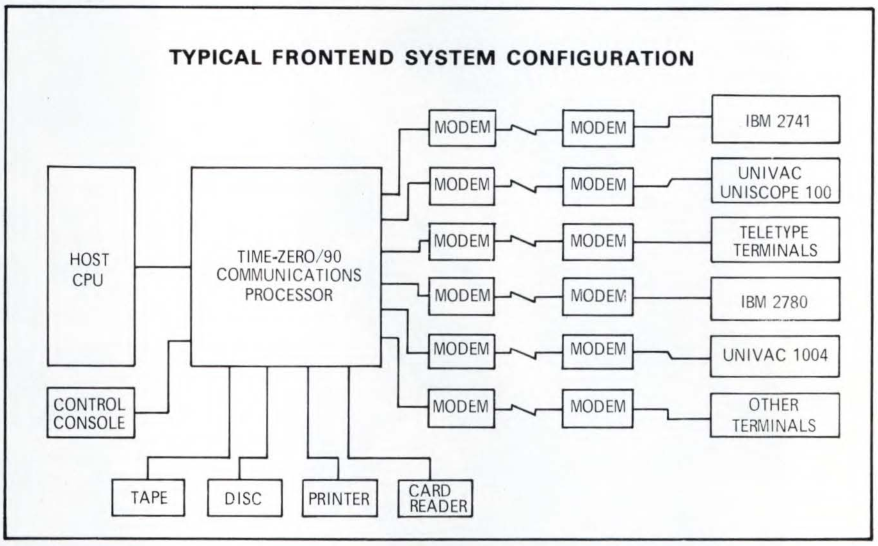
flexible processor debuts

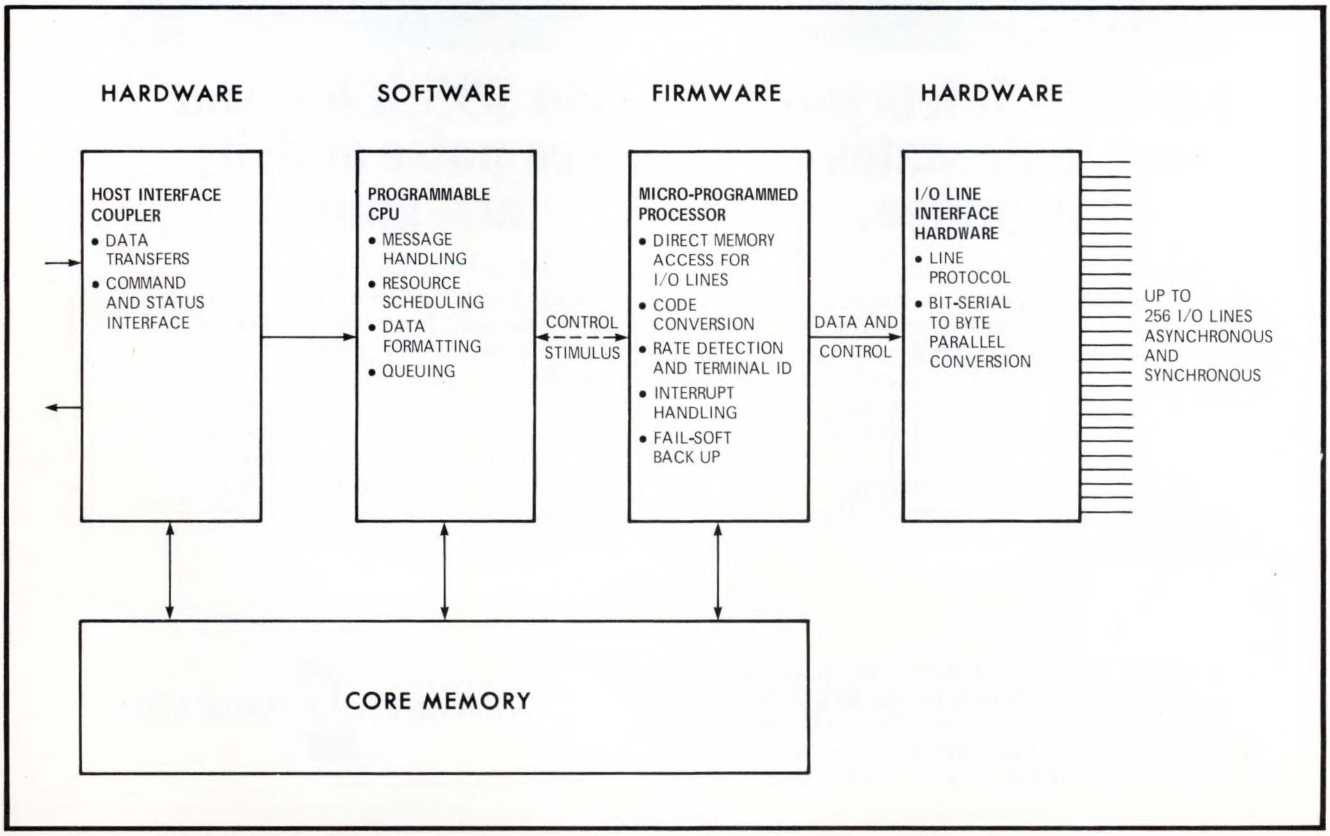
Time-Zero Corp., a company that for ten years has developed high speed communications systems for high reliability programs such as Apollo, Pioneer and Mariner, now has turned its attention toward the commercial market.

Designated Time-Zero/90, this system is both hardware and software compatible with central host computers and many terminals on the commercial market. It will communicate with terminals that operate over a wide range of speeds, synchronous or asynchronous, automatically adapting to different speeds and codes.

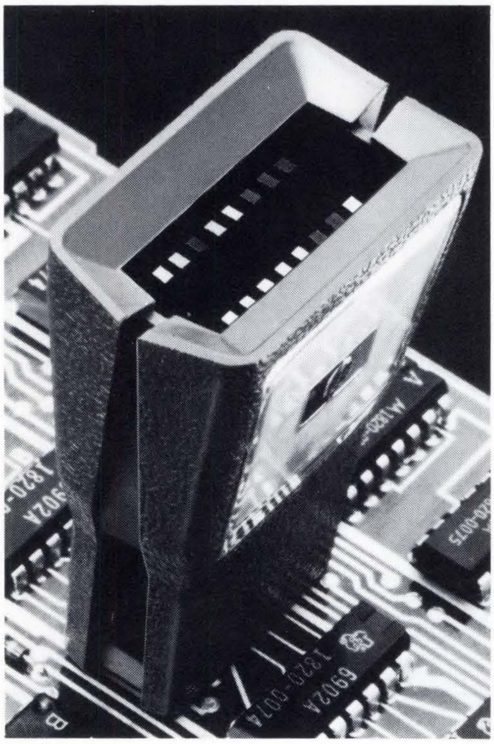
With judicious use of software, firmware and hardware (see sketch), this communication processor was configured to offer the greatest amount of data handling at low cost. Bonus to the user is that as his needs for more capability increase, his cost follows a smooth rate of increase instead of stairstepping as is the case with other units of this type, because of the incremental growth capability with this system.

Comprised of five functional elements that include a high speed control unit with sixteen 16-bit general registers, a 980 ns full cycle core memory expandable from 8k to 65k bytes and adaptors for synchronous 2k to 50k baud and for asynchronous 40 to 9600 baud, the Time-Zero/90 system prices start at $50,000. Time-Zero Corp., Data Products Div., 12701 S. Van Ness Ave., Hawthorne, CA 90250. **423**





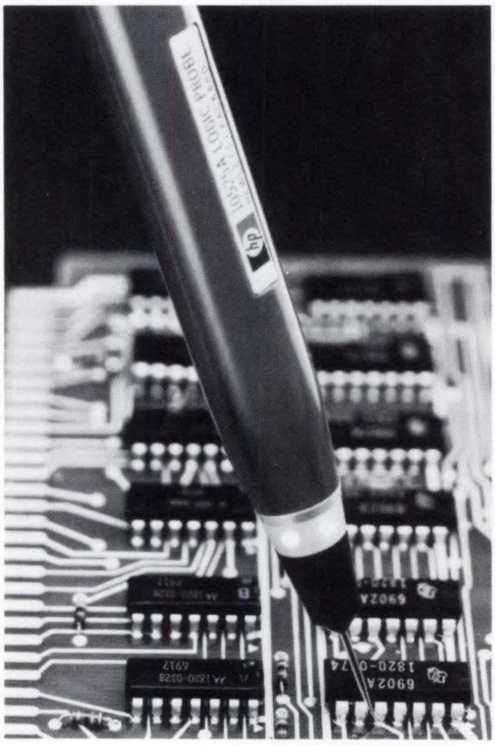
The IC troubleshooters.



For $125, it lets you see logic states at a glance.

Engineers testing the logic states of DTL or TTL IC packages no longer have to go the troublesome voltmeter route. The new HP 10528A Logic Clip shows you the state of all 16 (or 14) pins. This simple tool clips over the IC package, uses the circuit's power, is auto-seeking of Vcc and ground.

Bright LED's light up, indicating a high logic state. All this for just $125. Or less in quantity.



For $95, it lets you see pulse activity at a glance.

The HP 10525A Logic Probe makes tracing pulses through integrated circuits a painless task. Just touch the DTL or TTL circuit with the probe, and the tip flashes a signal for pulses as narrow as 25 nsec. A light in the tip indicates pulse, polarity, pulse trains, logic state.

It's almost like having an oscilloscope squeezed into a ball-point pen. And it only needs 5 volts and $95 to start troubleshooting your circuits.

Your local HP field engineer is your source for the clips and probes to speed up your IC testing. So give him a hurry-up phone order. Or you can write for full information from Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

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CIRCLE NO. 415

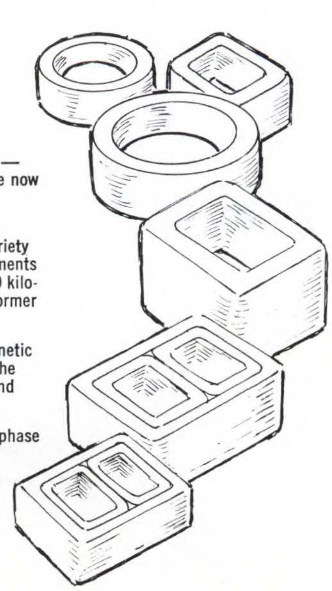
Four-digit DMM for Systems or Lab Use

A full multimeter that has five dc, four ac and six ohms ranges, the new Dana Model 4700 is well suited for low-cost systems use. Its isolated BCD output and remote programming capability permit it to be interfaced without losing the 100 dB of CMR that it provides. Basic accuracy is (±0.03% of reading ±0.01% FS) for dc, (±0.1% reading ±0.03% FS) for 50 Hz to 10 kHz ac and (±0.1% reading ±0.01% FS) for 1, 10 and 100 kΩ ranges. At reduced accuracy, the 4700 measures ac voltages at up to 100 kHz and resistances to 10 MΩ.

Autoranging and auto-polarity, coupled with 100% overranging, give its user an easily-operated, yet versatile instrument. There is even a remote programming "override" that takes control precedence over the entire set of front panel controls. This insures remote programming, even if a control has been left in a nonremote position.

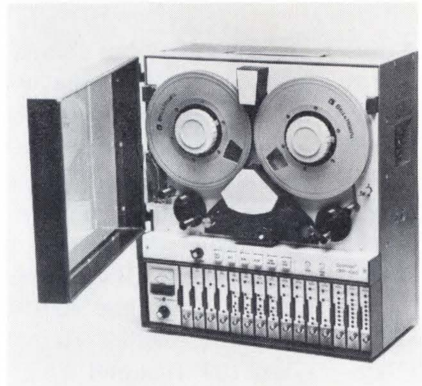
Overload protection is so complete that up to 100V can be applied, without damage, to the input terminals, regardless of range or function setting.

The instrument's systems interface digital output is solid state, 1-2-4-8, positive true, TTL levels. Programming is solid state, switch closure to ground, with all ranges and functions programmable. Price complete is $985. Dana Laboratories Inc., 2401 Campus Drive, Irvine, CA 92664 **200**



Computer Products

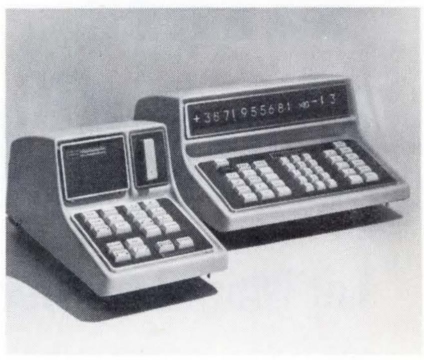
Magnetic Tape



Instrumentation tape recorder/reproducer, CPR-4000, weighs only 70 lb and has seven electrically switchable speeds from 15/16 to 60 ips. The unit records and reproduces up to seven channels on 1/2-in magnetic tape and will accept 8-in diam reels. Bell & Howell, Electronics & Instruments Group, 360 Sierra Madre Villa, Pasadena, CA 91109. **201**

Magnetic tape drives, 6000 Series, include five models. Tape speeds range from 25 to 200 ips and data rates from 41 to 320 kb/s. Models in this series are direct replacements for the IBM 3420 Series. Telex Computer Products, Inc., 6433 E. 41st, Tulsa, OK 74135. **202**

Systems



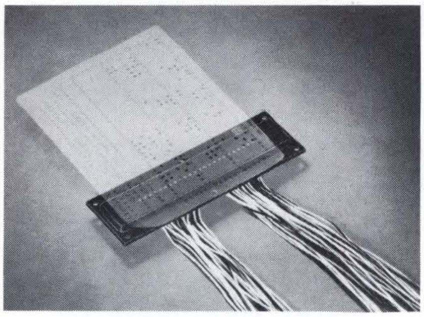
Programmer, Model 926, adds looping, branching and storing capabilities to the Scientist 909 and Statistician 911 computing calculators and their accessories. Any program on a magnetic tape cassette can be located in <27s worst case, 2.7s program-to-program. Because cartridges are available in blocks of 10 programs, up to 5120 steps may be stored on one tape. Cintra, Inc., 1089 Morse Ave., Sunnyvale, CA 94086. **203**

Computer Products

Communication line adaptor, UNIMUX, interfaces 16- or 18-bit COMP minicomputers with remote devices over either telephone or "Teletype" lines. The system consists of a data modem buffer, "Teletype" line buffer and multiplex controller. Unicomp, Inc., 18219 Parthenia St., Northridge, CA 91324. **204**

Data coupler, Model 4200, links up to 100 parallel lines to as many as three output devices such as magnetic tape, punched-paper tape and teleprinters. Standard input code is BCD with 18-bit binary and 4221 as optional codes. Monitor Labs, Inc., 10451 Roselle, San Diego, CA 92121. **205**

Hard Copy



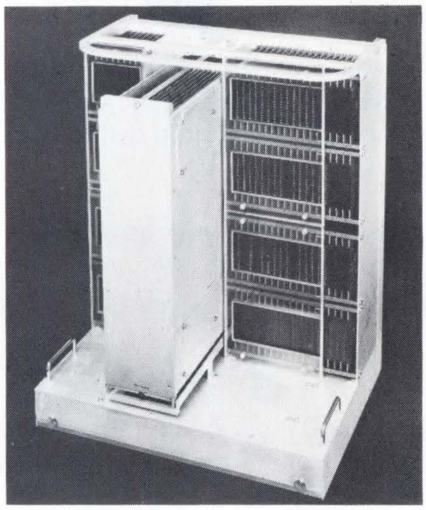
System/3 Card Reader photo arrays come in three series: CR-600 (high speed), CR-700 (low cost) and CR-800 (high sensitivity). These units contain 18 or 24 photo chips that are mounted on 0.087-in centers. Price is $32.20 each in 100-lot quantities. HEI, Inc., Jonathan Industrial Center, Chaska, MN 55318. **206**

On-line paper-tape punch P-120 punches standard 5- to 8-channel alphanumeric tape at 50 characters/s under automatic control. Word length varies for alphanumeric data and is up to 15 digits plus sign for numeric. Block length is variable up to 128 characters. Philips Business Systems, Inc., 100 E. 42nd St., New York, NY 10017. **207**

Curve plotter, Model 20, generates a smooth curve using only initial and final slopes at specified end points. Less data per display means reducing computer memory requirements, thus making feasible use of a minicomputer for supporting interactive graphics. Computek, Inc., 143 Albany St., Cambridge, MA 02139. **208**

Digital printer, Model 722B, prints 10 to 40 lines/s, numeric or alphanumeric, 1 to 22 columns. Units accept input from TTL, DTL or discrete devices. Dimensions are 7 by 19 (reduces to 16.5 in with rack-mounting hardware removed) by 18 in. Datadyne Corp., Bldg. 37A, Valley Forge Center, King of Prussia, PA 19406. **209**

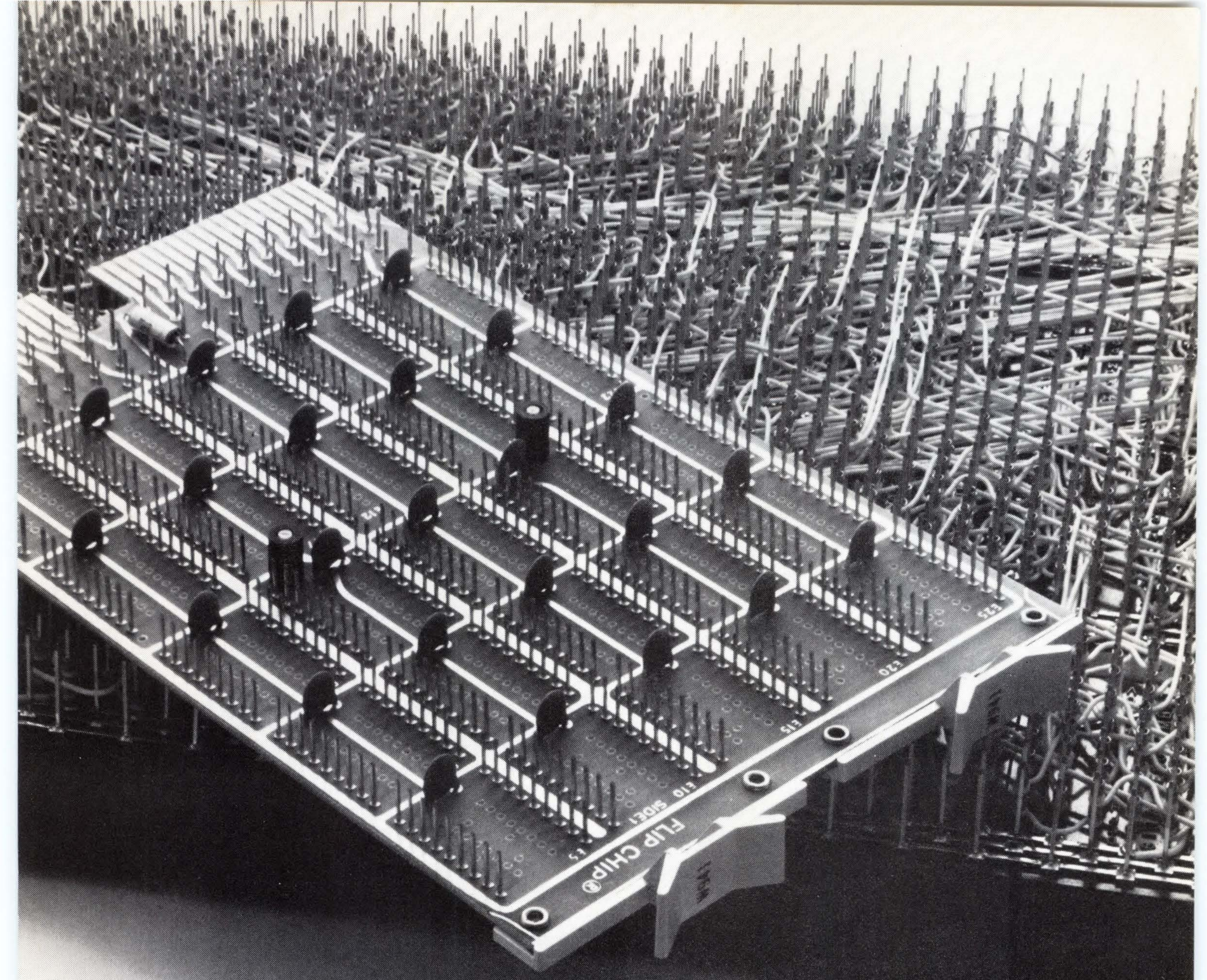
Memories



A two-wire, 2-1/2D core memory system, MEGAMEMORY 1000, has storage capacities ranging from 32,786 words (32 to 160 bits/word) up to 524,288 words (8 to 14 bits/word). Access time is 850 ns with a 1.5 μs cycle time. The unit can be mounted in a 19- or 24-in rack. Electronic Memories, 12621 Chadron Ave., Hawthorne, CA 90250. **210**

Disc-pack drive, Type 171, is designed to be used in Series 200 computer systems and requires only one read/write channel instead of two. Each unit stores and retrieves up to 4.6 × 10^6 characters on standard 10-surface disc packs. Average seek time is 80 ns and transfer rate is 147,500 characters/s. Honeywell Information Systems, 60 Walnut St., Wellesley Hills, MA 02181. **211**

Fixed-head disc storage unit, RS64 DECdisk, with the RC11 controller gives PDP-11 users extra storage capacity at a low cost. The RS64 stores data in a 32 by 16 bit word block format with error detection capability. Transfer rate is 16 μs/word and average access time is 16.9 ms. Digital Equipment Corp., 146 Main St., Maynard, MA 01754. **212**



Sometimes, wrapping up takes a little knowhow.

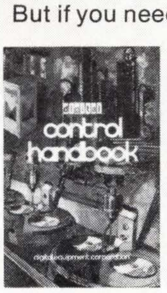
Digital can provide its customers with automatic, computer-controlled wire-wrapping services. Automatic wire-wrapping is faster and much less expensive than either soldering or wire-wrapping by hand and greatly reduces the chance of human error. And, of course, it eliminates all those nasty little problems associated with soldering.

We've got other production services, too. And hardware if you need it. And pieces of modules, all the way up to a module itself. And modules in combination with other modules, all the way up to a computer itself.

And if need be, we'll manufacture a module to your idea.

Frankly, we don't think you'll have to go that far. DIGITAL has over 300 standard modules to pick from, and we think we have the fields of digital logic pretty well covered. Positive logic. Negative logic. Fast logic. Noise-immune logic. All these are already done.

But if you need something we don't have as standard, we'll make it for you. The engineering and design knowhow, the production design skills, and the manufacturing facilities that have already produced millions of modules – they're all available.

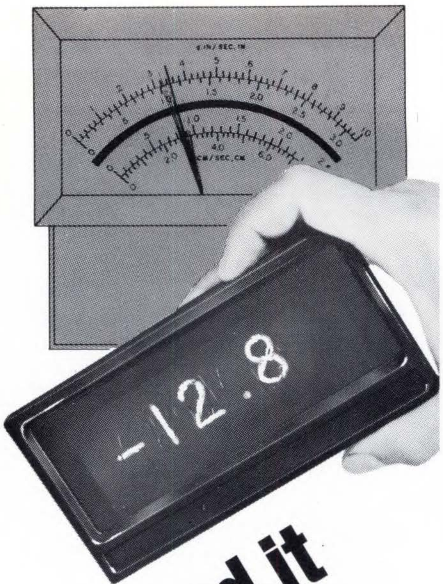


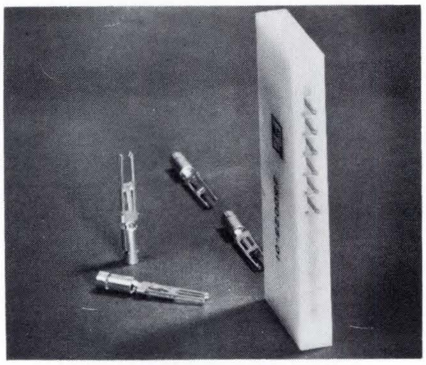
Write.

Doing it yourself has some pitfalls. Remember what happened last time?

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

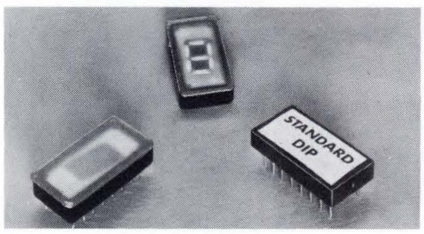
digital





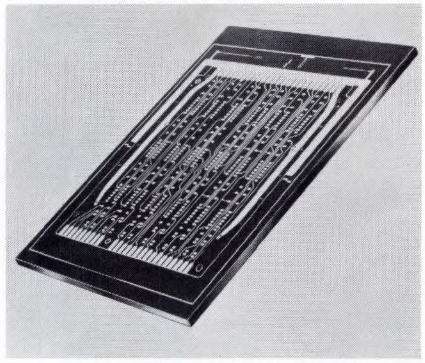
Card-edge connector for 1/16-in PC boards features a nylon connector block that retains removable gold-plated crimp connectors for #18 AWG wire. Ten-terminal (250025) or 15-terminal (250052) sizes are available, spaced on 0.156-in centers, single readout. Cost for 10-terminal model is $1.27 (100 lot). National Connector Div., Fabri-Tek, Inc., 9210 Science Center Dr., Minneapolis, MN 55428. **213**

Four pulse transformers are mounted within a 16-pin low-profile DIP package measuring 0.15 by 0.25 by 0.85 in. Values are designed to customers' specifications, and the units, designated DIP-X-2303, are made to be compatible with automatic insertion equipment. Prices are as low as $2.50 each in 1000-lot quantities. Trueline Instruments, Inc., 4002 S. Clay St., Denver, CO 80236. **214**



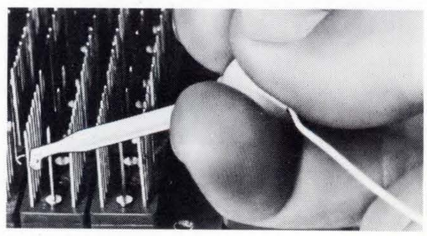
Seven-segment incandescent display, Series 90, plugs into 16-pin DIP socket. Package dimensions are 0.867 by 0.453 by 0.024 in and character height is 0.36 in with 5° slant. Each segment requires 5V dc at 8 mA. Price is $2.90 each (1000 quantities). Luminetics Corp., Box 1943, Pompano Beach, FL 33061. **215**

Key-operated rotary switches feature a behind-panel switch as small as 0.5 inch in diam—lock mechanism is a standard 0.25 in barrel diam double-bitted lock. Various characteristics such as 30°, 36°, 45° or 60° angle of throw with up to 0.250 mA rating, 115V ac are available to choose from. Prices are as low as $7.32 (100-piece lot). Grayhill, Inc., 555 Hillgrove Ave., La Grange, IL 60525. **216**



A 72-in vacuum deposit coater makes possible a process that produces a positive or negative configuration in metallic chrome on glass, thus yielding an opaque line four microinches thick. Called CHROME LINE process, the thick film negative or positive masters can be handled and cleaned without degradation. Micro-Line, Div. of Bausch & Lomb, Jamestown, NY 14701. **217**

Reed switches, DRVT Series, feature tungsten contacts that handle up to 20 kV dc. This series is comprised of four SPST form A switches (5, 10, 15 and 20 kV dc). Minimum trim length of all switches is 2.4 in and maximum glass diam is 0.218 in. Actuating time of the 5- and 10-kV units is 2 ms; 20 ms for the 15- and 20-kV units. Hamlin, Inc., Lake & Grove Sts., Lake Mills, WI 53551. **218**

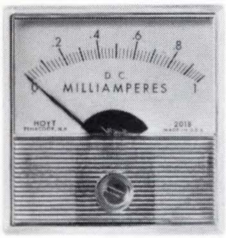


Miniature test connector with "hypo-action" slides vertically onto 0.025-in² wrap pins on 0.01-in centers. Units also connect laterally with positive spring action. Price range is $0.59 to $6.25 each, depending on quantity. E-Z Hook, A Div. of Tektest, Inc., Box 1405, Arcadia, CA 91006. **219**

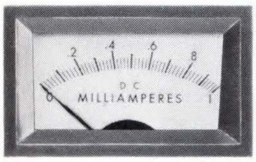
Double pole, double throw 1A relay operates within −56 to 125°C. Models 3101H, 3101L and 3101J make up the series, with each unit having a pick-up sensitivity of 160 mW at 25°C. Standard coil resistance ranges from 65 to 2000Ω. This series withstands 100G shock for 11 ms and 20G vibration up to 2000 Hz. Deutsch Relay Div., 65 Daly Rd., East Northport, NY 11731. **220**

NEW from Hoyt

1½" CUSTOM PANEL METERS



Model #2018, above,
Model #2018-B below



The new Hoyt #2018 offers the same frictionless, self-shielded taut band movement as the 2½" and 3½" models.

Two or more meters may be mounted side by side, as the movement is completely shielded and will not interact with other meters or be affected by stray magnetic fields.

Replaces other types on equipment panels with speedy 2-STUD mounting.

The #2018 is available in sensitivities from 100 Micro-amperes up to 5 Amperes, and as a D.C. Voltmeter up to 300 Volts D.C., self-contained.

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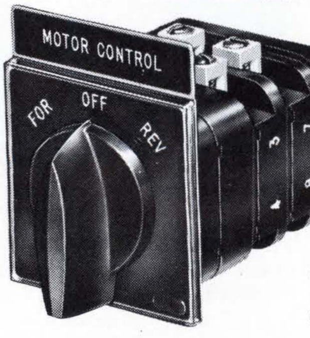

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CIRCLE NO. 35

This unit makes the output typewriter

in the Facit 3851 — the conventional typewriter with input/output. It is also available in two other versions — output only and input only. All three provide full utilization of the 7-bits code.

There is further interesting information on the new Facit 3851 in this publication.

Facit 3851 - the conventional typewriter with input/output

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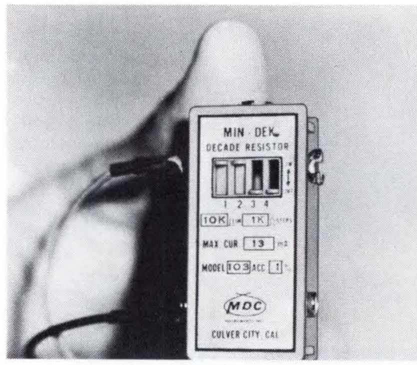
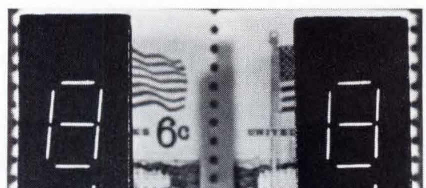
CIRCLE NO. 36

Components



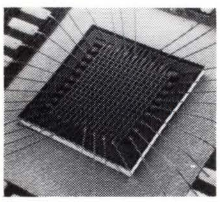
Decade boxes, called Min-Deks, cover the ranges of 1Ω to 100 MΩ for resistors, 10 pF to 10 μF for capacitors and 100Ω to 10 MΩ for potentiometers. More than 50 different models are available. Prices for the 2- by 1- by 0.5-in units range from $9.50 to $18.00. MDC Instruments, Inc., 11822 W. Jefferson Blvd., Culver City, CA 90230. **221**

Heat shrinkable "Teflon" tubing, Penntube II-SST, exhibits a shrink-down ratio of 1-2/3:1. Available in 10 sizes, the transparent tubing covers objects within the range of 0.056- to 2.0-in diam. Penntube Plastics Co., Inc., Div. of Dixon Industries, Inc., Madison Ave. and Holley St., Clifton Heights, PA 19018. **222**



Incandescent readout, Series 5, requires only 5 mA per segment at 5V dc. These 0.88- by 0.46- by 0.24-in units mount in 14-pin DIP or can be soldered directly to PC boards. Display size is 0.37 by 0.20 in with 5° slant. In quantities of 1000, the price is $3.02 each. Readouts, Inc., Box 149, Del Mar, CA 92014. **223**

Resistor network in a 14-pin DIP features 13 cermet resistors, a 96 percent alumina substrate and tin-plated alloy pins in a high-temperature polymer enclosure (0.75 by 0.3 by 0.2 in). Characteristics include 1W at 25°C power dissipation, 50Ω to 100 kΩ resistance range, up to one percent tolerance and <200 PPM temperature coefficient. Mepco, Inc., Morristown, N J 07960. **224**



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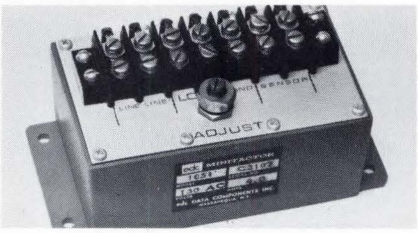
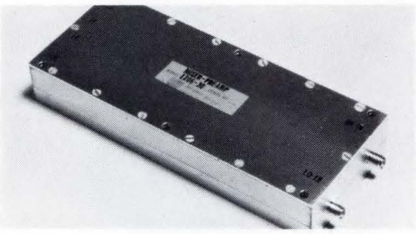
CIRCLE NO. 32



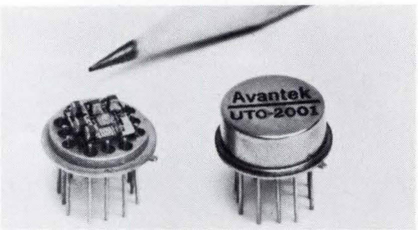
AC relay capable of sensing signals as small as 5 mV and switching ac loads of 4A at 115V uses zero-crossing load switching and has adjustable hysteresis set points. Model 1051 is priced at $24.75 in 100 lots. EDC, Data Components Inc., Box 279, Massapequa, NY 11758. **225**

PIN diode switches for the 225 to 400 MHz band handle up to 5 kW peak (200W average or CW). They are available in SPST, SP2T, SP3T and SP4T versions, and typically show insertion loss of 0.6 dB maximum and isolation of 60 dB minimum. American Electronic Labs., Inc., Box 552, Lansdale, PA 19446. **226**



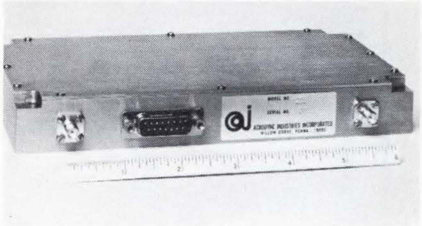
Stripline mixer/preamp that covers from 2 to 12 GHz offers low input power—as low as 1 mW. The 1200 Series units use hot-carrier mixer diode chips, so achieve typical S-band noise as low as 8 dB. Microwave/Systems, Inc., 1 Adler Dr., East Syracuse, NY 13057. **227**

Frequency standard with accuracy to ±0.005% is designated Type FS 500 and is available from 300 Hz up. Output is compatible with logic circuitry, and the operating temperature range is from −55 to 85°C. American Time Products, Bulova Watch Co., Electronics Div. 61-20 Woodside Ave., Woodside, NY 11377. **228**

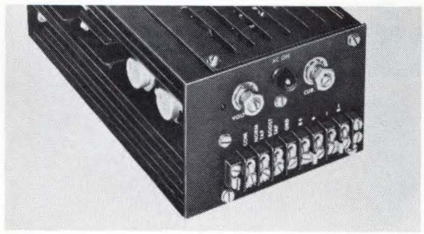


VHF/UHF amplifiers in TO-8 cans are available for operation up to 2 GHz. Intended for cascading, the new UTO-1000, UTO-1500 and UTO-2000 series devices are priced in the $130 to $260 range. Avantek, Inc., 2981 Copper Rd., Santa Clara, CA 95051. **229**

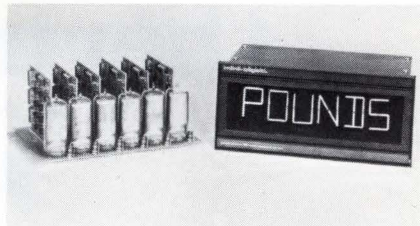
Analog multiplier, Model 427 with pulse height/width modulation, is factory-trimmed for 0.1% accuracy. Bandwidth is 100 kHz, output drift is 150 μV/°C (dc offsets), and 2 μV/°C is the maximum overall accuracy drift. Price is $189 each. Analog Devices, Inc., 221 Fifth St., Cambridge, MA 02142. **230**



UHF broadband amplifier has 100 MHz/1 dB bandwidth between 800 and 900 MHz and delivers 50W CW with 27 dB gain. Power input is 28 ±1V dc, source and load impedance are 50Ω and operating temperature range is −20 to +50°C. Acrodyne Industries, Inc., 666 Davisville Rd., Willow Grove, PA 19090. **231**



Power modules for IC logic cover the voltage range from 5 to 28V dc with current ratings from 3 to 25A. Operating temperature range is −25 to +71°C without external heat sinking or forced air. Units of the CP series are priced in the $150 range. ERA Transpac Corp., 67 Sand Park Rd., Cedar Grove, N J 07009. **233**

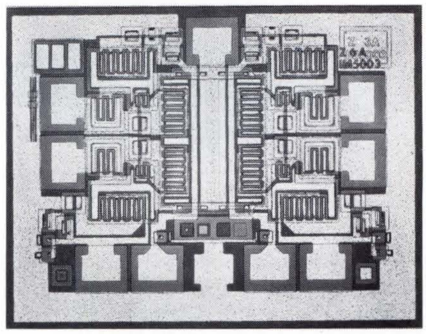


Alphanumeric annunciator, Model MDDA, available in from 3 to 8 decades, uses 1.4-inch character-height cold cathode display tubes. Models are available with either straight 13-line input or with a memory stage that permits multiplexing. Instrument Displays, Inc., 18 Granite St., Haverhill, MA 01830. **235**

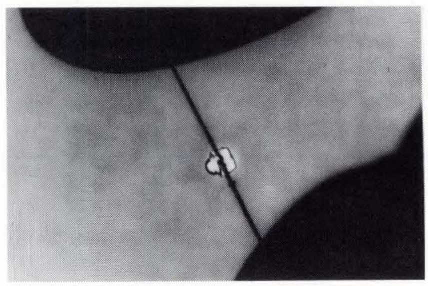
Oscillator for scope calibration provides a 10-kHz signal and also serves as ground reference. Operation is in feed-through, ground reference or signal source mode. Price, including batteries, is $49.50. Frequency Control, Inc., Box 1565, Austin, TX 78767. **232**

Stripline hybrid couplers of the 600 Series feature quadrature outputs, low VSWR and 3-mm coaxial connectors. Available models span from 0.0625 to 1 GHz and handle power to 200W cw. Microwave/ Systems, Inc., 1 Adler Dr., East Syracuse, NY 13057. **234**

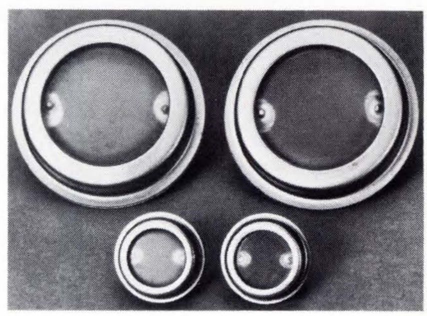
Frequency-to-dc converter changes frequency or repetition rate of signals to a proportional dc voltage. Models include 410KF (0 to 100 Hz), 420KF (0 to 1 kHz), 430KF (0 to 10 kHz) and 440KF (0 to 100 kHz). Solid State Electronics Corp., 15321 Rayen St., Sepulveda, CA 91343. **236**



Monolithic clock driver IM5003 contains four independent driver circuits capable of sourcing and sinking 500 mA. Packaged in the standard 14-pin dual in-line and TO-8 containers, prices in lots of 100 to 999 are $16.10 (−55 to 125°C) and $10.70 (0 to 75°C). Intersil Memory Corp., 10900 N. Tantau Ave., Cupertino, CA 95014.
237



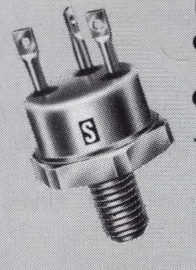
LED Red-Lit 50 offers a luminence of 750 fL at a low 20 mA current. The output light is visible over a minimum 45° angle, and price in lots of 100 to 999 units is $1.15 each. Litronix, Inc., 10440 N. Tantau Ave., Cupertino, CA 95014. **238**



Matched pair end-view cadmium sulfide photocells can be matched for various light levels and will withstand 30V continuously applied with maximum continuous power of 250 mW at 25°C and 100 mW at 60°C (free air). The cells can also withstand 900V RMS (60 cycles) for one minute without breakdown between leads and the metal case. The units are available in 1-in and 1/2-in sizes from Pioneer Electric & Research Corp., Forest Park, IL 60130.
239

10 Amp Radiation Resistant

HI-GAIN, HI-VOLTAGE POWER TRANSISTORS



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- h_{FE} 150 @ 3 A, 5V

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Isolated and
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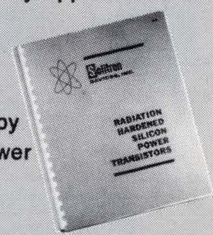

TYPE NUMBER	CASE TYPE	V_{CBO} V	V_{CEO} V	I_C A	P_T 100°C CASE W	PRE RADIATION I_C A	h_{FE}⊙ —(min)	$V_{CE(s)}$△ V(max)	POST RADIATION I_C A	h_{FE}⊙ —(min)	$V_{CE(s)}$△ V(max)	θJ-C °C-W
SDR2720	TO-61	60	50	25	50	10	40	1	10	10 ▫	2 ▫	2
SDR2721	TO-61*	60	50	25	50	10	40	1	10	10 ▫	2 ▫	2
SDR2722	TO-61	90	75	25	50	10	40	1	10	10 ▫	3 ▫	2
SDR2723	TO-61*	90	75	25	50	10	40	1	10	10 ▫	3 ▫	2

Base Width ≈ 0.6 microns. *With isolated collector. All other TO-61 packages with collector connected to case. ⊙ VCE = 5V. △ IC/IB = 5. ▫ $\Phi = 1 \times 10^{14} n/cm^2$. ⊕ $\Phi = 3 \times 10^{14} n/cm^2$.

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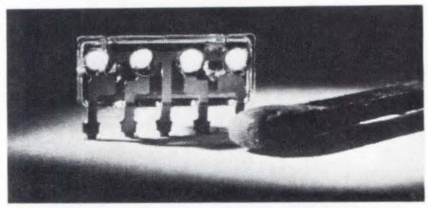
EUROPE: Solidev Ltd., Tubbs Hill House North Enlrance, London Road, Sevenoaks, Kent, England, TEL: (0732) 57541-2-3

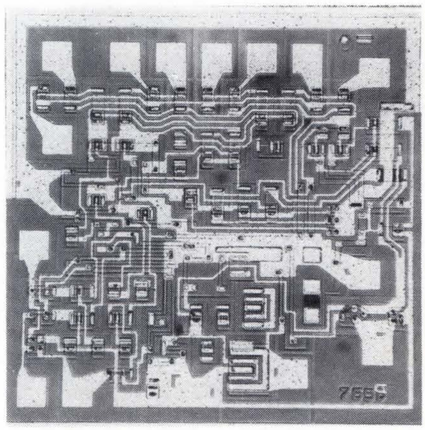
ISRAEL: A.E.L. Israel Ltd., 51 Hayarkon Street, Bene Baraq, TEL: 78-21-41

JAPAN: Matsushita Electric Trading, 5 Chrome Kawamachi, Hegashi - Ku, Osaka, TEL: (06) 202-1221 or World Trade Centre Bldg., No. 5, 3-Chrome, Shibahamamatsu-cho, Minato-Ku, Tokyo, TEL: (03) 435-4501

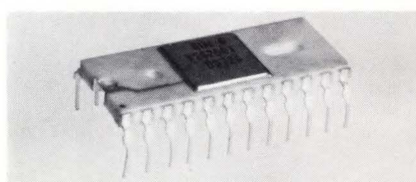
CIRCLE NO. 39



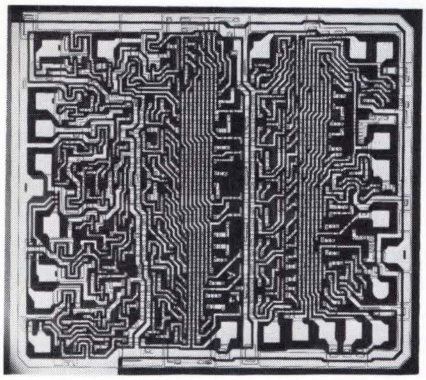
Array MV5040 contains four light-emitting diodes for indicator panel and PC board applications. The diode chips have a center-to-center distance of 0.1 in, provide an output of 750 fL with an input of 1.6V dc at 20 mA, and, in lots of 1000, price is $4.20 each. Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, CA 95014. **240**



Monolithic sense amp NE528B is a 4-channel unit designed for plated-wire memory systems. It offers a propagation delay of 20 ns, differential input threshold voltage of ±3 mV, bias current of 15 μA and input resistance of 2000Ω. Power supply requirements are +5 and −6V, and power dissipation is 270 mW. Signetics Corp., 811 E. Arques Ave., Sunnyvale, CA 94086. **241**

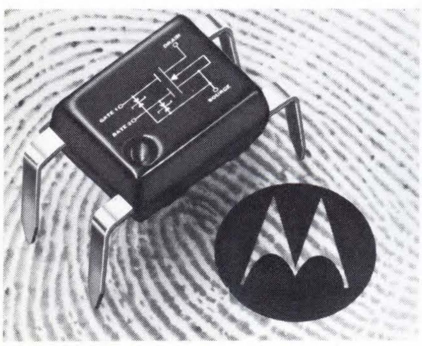


Monolithic dual 4-bit static shift register SS-6-2004 features reversible shift direction, parallel input and output, zener protection circuits on inputs and outputs, dc to 1 MHz operation, direct TTL/DTL interface, temperature range from −55 to 125°C and, at the 100-piece level, price of $14.40 each. General Instrument Corp., 600 W. John St., Hicksville, L.I., NY 11802. **242**

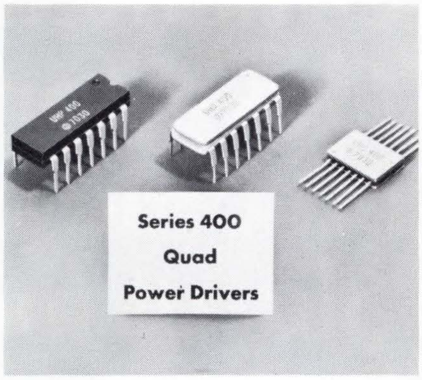


Four-bit arithmetic units AM74181 and AM9341 can perform 16 arithmetic operations, including addition, subtraction, double and compare on two 4-bit binary words. Typical addition and subtraction speeds are 19 and 23 ns, respectively, and prices in the 100-up mix quantity range from $3.60 to $33 each, depending on package and temperature range. Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, CA 94086. **243**

Dynamic random access MOS memory MK4006 P is produced with ion implantation techniques. The 1024-bit read/write chip features a maximum access time of 400 ns and a minimum write cycle time of 650 ns. The only supplies required are +5V and −15V, and price, in lots of 500 to 999, is $39.25 each. MOSTEK Corp., 1400 Upfield Dr., Carrollton, TX 75006. **244**

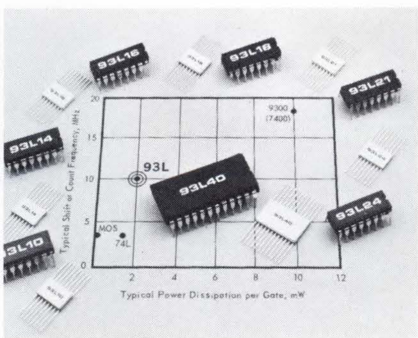


Dual-gate MOSFETs include three new items that furnish low-cost, high-performance amplifier/mixer applications in communications equipment, IF strips and color demodulators. The MPF120 is an RF amplifier to 105 MHz with two separate channels; the MPF121 is a VHF amplifier to 200 MHz; and the MPF122 mixes RF with guaranteed frequencies of 104 and 244 MHz. In lots of 1000 pieces, prices are in the $0.50 range. Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036. **245**

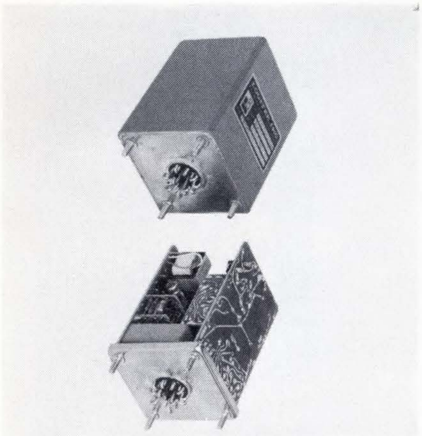


Power drivers in the Series 400 feature a standard breakdown voltage of 50V, and each driver output transistor is capable of sustaining 40V in the OFF state while sinking 150 mA in the ON state. Variations in the series include quad 2-input AND drivers, quad 2-input OR drivers, dual 4-input AND drivers, 2-wide 2-input AND-OR drivers and 2-wide 2-3-input AND-OR drivers. Sprague Electric Co., North Adams, MA 01247. **246**

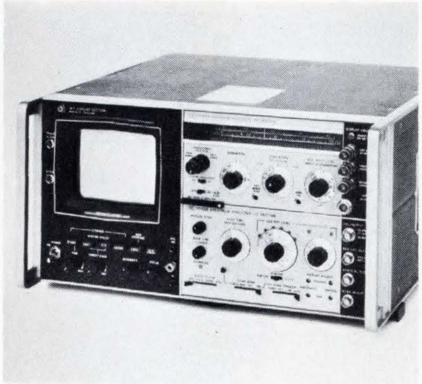
A TTL/MSI line has had added six new products that include 2-bit and 4-bit binary full adders, decade and binary counters, a BCD-to-decimal decoder and a 4-bit bistable latch. In lots of 100 to 999 units, prices range from $2.30 to $4.20 each. Philco-Ford Corp., Microelectronics Div., Union Meeting Rd., Blue Bell, PA 19422. **247**



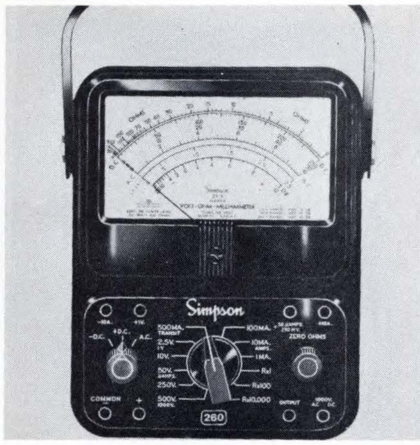
MSI devices in the low power TTL family have had added seven new devices, and prices have been reduced up to 63% on existing products within this family. In lots of 100 to 999, prices for the seven new devices range from $2.45 each for a 4-bit latch to $14 each for a 4-bit arithmetic logic unit. For the eight existing low-power circuits in the family, new prices in lots from 100 to 999 range from $2.45 to $7.45. Fairchild Semiconductor, 464 Ellis St., Mountain View, CA 94040. **248**



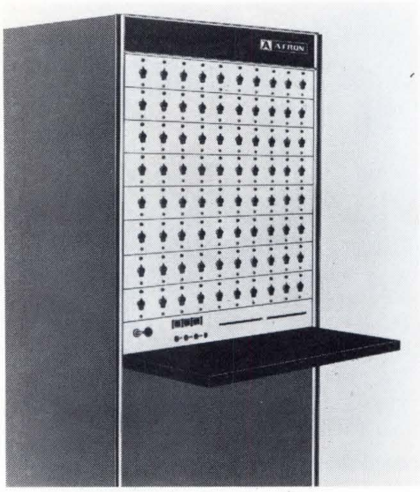
Power monitor series, Type PMA, provides time-delayed alarm or shut-down signals when voltage, frequency or phase characteristics of single or three phase 60 or 400 Hz power lines depart from normal. Sensing accuracy for both voltage and frequency is ±1 percent. All versions are hermetically sealed and meet MIL Spec requirements including operation from −55 to 125°C. Logitek, Inc., 42 Central Dr., Farmingdale, NY 11735. **249**



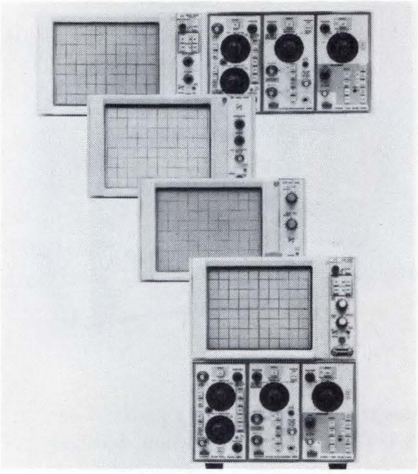
Microwave spectrum analyzer that features both absolute calibration and resolution to 100 Hz uses thin-film hybrid circuits. Range is 10 MHz to 18 GHz with absolute calibration from −125 to 10 dBm. Model 8555A uses automatic frequency stabilization to cut residual FM to <100 Hz on fundamental mixing, making that 100-Hz resolution useful to 6 GHz. Price ranges from $9000 to $10,525 depending on options. Inquiries Manager, Hewlett-Packard Co., 1601 Califronia Ave., Palo Alto, CA 94304. **250**



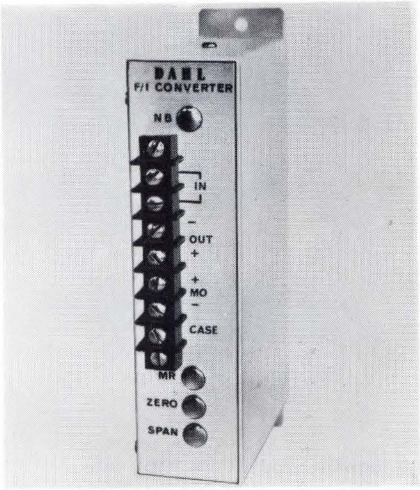
Improved multimeter, the Simpson Model 260 Series 6, now has an external-access battery and fuse compartment along with a 0 to 1V dc range and positive grip rubber feet that hold the instrument securely on a bench. Sensitivity is still 20,000 Ω/V dc and 5000 Ω/V ac. The taut-band meter is varistor protected. Accuracy is ±2% of full scale for dc, ±3% for ac. Simpson Electric Co., 5200 W. Kinzie St., Chicago, IL 60644. **251**



PC assembly tester incorporates a random number generator along with clock pulses for the input signals, and compares a known good assembly with the one under test. Test rate is up to 1,800,000 per second and the unit is expandable to accommodate 140-pin assemblies in 10-pin increments. Atron Corp., 1256 Trapp Rd., St. Paul, MN 55118. **252**

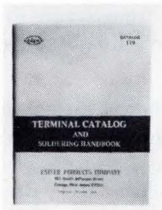


Oscilloscope system provides plug-in versatility for low frequency uses. Model 5103N system consists of four interchangeable display modules, six amplifier plug-ins, three time base plug-ins and one power supply/amplifier module with three plug-in compartments. Various units provide single or dual beam display with or without storage. Tektronix, Inc., Box 500, Beaverton, OR 97005. **253**



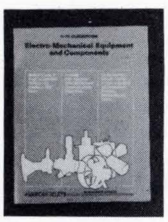
Two-wire frequency-to-current converter with adjustable noise barrier accommodates frequency ranges between 10 Hz and 20 kHz. Both zero and span can be adjusted without interaction. Models are available for either 4 to 20 mA or 10 to 50 mA, and both list for $189.50. G. W. Dahl Co., 86 Tupelo St., Bristol, RI 02809. **254**

"A/D-D/A Converters, Accessories & Hardware", 1971 short form catalog, contains information on 38 models of 10 series. Varadyne Systems, 1020 Turnpike St., Canton, MA 02021. **260**



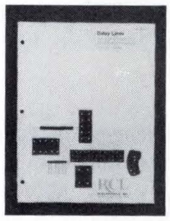
"Terminal Catalog and Soldering Handbook", No. 119, contains 64 pages of information on over 300 off-the-shelf terminals and features a comprehensive 18-page soldering standards handbook. United Products Co., 55 S. Denton Ave., New Hyde Park, NY 11040. **261**

Shaft encoders are explained in a new series of technical bulletins that cover pin contact, optical and gallium arsenide optical encoders. Encoder Div., Litton Industries, 20745 Nordhoff St., Chatsworth, CA 91311. **262**

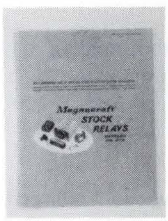


Electromechanical components, equipment and test instruments are the subject of 116-page Guidebook 11-70. Blowers and fans, capacitors, oscillographs, potentiometers, relays, servo motors, synchros and transducers are among the items covered. Electronics Div., American Relays, 39 Lispenard St., New York, NY 10013. **263**

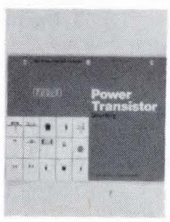
"Miniature Ceramic Capacitors" is a 16-page catalog that covers a multitude of sizes and capacitance values in both NPO and W dielectrics. USCC/Centralab, 2151 N. Lincoln St., Burbank, CA 91504. **264**



"Delay Line Handbook", No. DL70, is believed to be the first complete handbook on delay lines. It includes how to specify, practical limits, definition of characteristics and use of test and measuring equipment. RCL Electronics, Inc., 700 S. 21st St., Irvington, N J 07111. **265**



"Stock Relays Catalog No. 272" contains 24 pages listing over 550 different relays. It is a virtual designer's encyclopedia for all relay control and switch needs. Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, IL 60630. **266**



"RCA Power Transistor Directory", No. PTD-187B, contains 24 pages of information on more than 200 device types. Up-to-date information on the latest commercial devices, as well as preliminary data on developmental units, is included. RCA Commercial Engineering, Harrison, N J 07029. **267**

"Imaging Devices", Quick Selector Guide SA-110, gives performance vs applications. It is available from Westinghouse Electric Corp., Electronic Tube Div., Box 284, Elmira, NY 14902. **268**

"Alfa Catalog 1971" contains 464 pages of information on over 2500 in-stock research materials, including inorganic, organometallic and ultrapure chemicals and pure metals. Ventron Corp., Chemicals Div., Congress St., Beverly, MA 01915. **269**

"Function Module Instrumentation" is a 24-page full-color brochure that describes more than 40 standard analog function modules. Control Products Div., Bell & Howell, 706 Bostwick Ave., Bridgeport, CT 06605. **270**

"Capacitor Insulation & Packaging Systems" covers the insulating and packaging material needs of capacitor makers. Included are plastic film capacitors, aluminum electrolytics, tantalum electrolytics, ceramic and mica. Dielectric Materials & Systems Div., 3M Co., 3M Center, Box 3050, St. Paul, MN 55101. **271**

Dynamic IC testing is covered in eight-page Brochure S257 from Teradyne Dynamic Systems, Inc., 9551 Irondale Ave., Chatsworth, CA 91311. **272**

Teleprinter control units are solid-state equipment for reducing teleprinter expenses in message switching systems. They are described in literature from Pulse Communications, Inc., 5714 Columbia Pike, Falls Church, VA 22041. **273**

Hard-to-find tools are covered in a new expanded 32-page catalog from Brookstone Co., 1413R Brookstone Bldg., Peterborough, N H 03458. **274**

Portable and rack-mounted recorder 480 with eight 40-mm channels is the subject of Bulletin 934-18 from Brush Div., Gould, Inc., 3631 Perkins Ave., Cleveland, OH 44114. **275**

Plastic products 24-page catalog contains information on almost 4000 standard molded E-case encapsulation shells, headers, covers and module packages. Epoxy Plastic Molders, Inc., 119 Coit St., Irvington, N J 07111. **276**

TTL and low power TTL guide with pin connection diagrams is available from National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. **277**

Digital system analyzer applications are covered in a single-page sheet from Data Display Systems, Inc., Dept. 401-AN, 139 Terwood Rd., Willow Grove, PA 19090. **278**

"Spray Cleaning With 'Freon' Cleaning Agents" is the title of six-page Bulletin No. FS-22 from Public Relations Dept., Du Pont Co., Wilmington, DE 19898. **279**

Thirteen different silicone products, ranging from potting compounds through adhesives, coatings and sealants to foams, are described in a folder from Emerson & Cuming, Inc., Canton, MA 02021. **280**

Channeltron electron multiplier array (CEMA) is a miniature array of approximately 50,000 single-channel amplifiers which creates electron amplification. A two-page data sheet is available from Bendix Electro-Optics Div., 1975 Green Rd., Ann Arbor, MI 48105. **281**

New ac power receptacle No. EAC-301 is covered in a bulletin from Switchcraft, Inc., 5555 N. Elston Ave., Chicago, IL 60630. **282**

Molybdenum and tungsten sheet, foil, rod and wire four-page stock list and accompanying 14-page, four-color brochure on their uses are available from Schwarzkopf Development Corp., Marketing Div., 140 Lowland St., Holliston, MA 01746. **283**

"SPST Momentary Pushbutton Switches", two-page data sheet, describes this new subminiature line. C&K Components, Inc., 103 Morse St., Watertown, MA 02172. **284**

Building-block approach to solving light measurement problems is covered in an eight-page, three-color brochure, SF70, from Gamma Scientific, Inc., 3777 Ruffin Rd., San Diego, CA 92123. **285**

Infrared photovoltaic detectors with elevated cut-off frequencies are made with mercury cadmium telluride and are described in Bulletin DC 2070E from Eltek Corp., 7 Woodland Ave., Larchmont, NY 10538. **286**

Direct reading colorimeters for water and pollution testing are the subject of a brochure from Hach Chemical Co., Box 907, Ames, IA 50010. **287**

Low-cost bidirectional counter display, Series 510, is covered in a technical bulletin from Electronic Systems Group, Anocut Engineering Co., 2375 Estes Ave., Elk Grove Village, IL 60007. **288**

AC-DC ammeter, Model 705A, is covered in a new two-page catalog from Pacer Industries, 17035 Burnham Ave., Lansing, IL 60438. **289**

Adjustable speed eddy-current drives are the subject of 12-page Bulletin No. 021-2001 from Dynamatic Div., Eaton Yale & Towne, Inc., 3122 14th Ave., Kenosha, WI 53140. **290**

Microminiature edgeboard connectors in the Minimate Series are available with 40 to 184 contacts and wire sizes 28 through 24. They are described in Bulletin PIB 7-6 from Microdot, Inc., Connector Div., 220 Pasadena Ave., South Pasadena, CA 91030. **291**

Precut wire leads and how they can save costs are the subject of a brochure from Storm Products Co., 2251 Federal Ave., Los Angeles, CA 90064. **292**

Digital synchronous computer, amplifier discriminator, data converter console, power supply console and PM tube housings are covered in a four-page catalog from SSR Instruments Co., 1001 Colorado Ave., Santa Monica, CA 90404. **293**

Hollow cathode system for atomic spectroscopy is covered in eight-page Brochure AA from Barnes Engineering Co., 30 Commerce Rd., Stamford, CT 06902. **294**

High-loss dielectrics and electromagnetic absorbing materials are the subject of a four-page colorful folder from Microwave Products Div., Emerson & Cuming, Inc., Canton, MA 02021. **295**

Self-powered IC tester with flexible cable design for in-system testing of dual in-line ICs is described in a two-page bulletin from Emcee Electronics, Inc., 173 Old Churchman Rd., New Castle, DE 19720. **296**

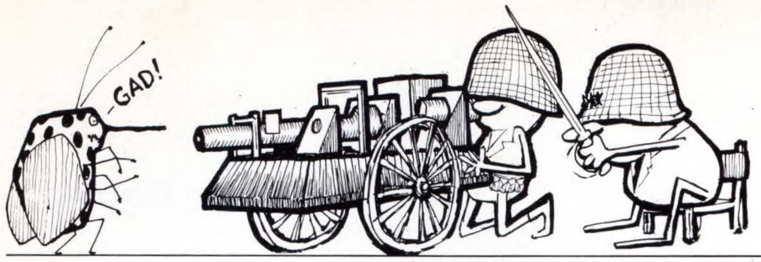
Frequency sensitive relay, Model 476, is the subject of a two-page data sheet from Solid State Electronics Corp., 15321 Rayen St., Sepulveda, CA 91343. **297**

Electron beam evaporation as a production technology is the subject of Bulletin No. 11-4 from Standard Products, Airco Temescal, 2850 Seventh St., Berkeley, CA 94710. **298**

Self-clinching solder terminals are covered in two-page Bulletin ST-670 from Penn Engineering & Mfg. Corp., Box 311, Doylestown, PA 18901. **299**

Pressure-sensitive adhesives, their use and annual dollar savings are covered in a four-page cost-saving calculator, 22-022, from Dow Corning Corp., Midland, MI 48640. **300**

Trimming potentiometers in the Series 89 are low-profile rectangular cermet units and are covered in a two-page publication. Technical Information Section, Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, CA 92634. **301**



.... Inquiry on the Use of Laser Beams for Insect Control

Gentlemen:
This inquiry is directed to you since in this way we hope to reach many knowledgeable people. We are a civic organization of about 600 families, residing on 1000 acres of wooded land—however, our territory has been invaded by the Gypsy Moth, threatening to kill virtually all our lovely trees and shrubs in a matter of a few years. Thirty-five thousand acres of our Monmouth County; 300,000 acres along the Eastern Seaboard are infested—we are desperate!

We would like to use laser beams to destroy egg masses of the Gypsy Moth which have been deposited on the bark of trees, all the way up to the tree tops. These egg masses are fluffy, oval shaped, about 1 by 1/2 inch, containing about 500 to 1000 individual eggs.

Considering the large investment of the homeowner in a wooded lot, it might prove very attractive to use, among others, a laser, rather than chemical sprays.

Since the electronics industry is desperately looking for new fields of endeavor, one might find this a wide-open area.

Your office would be in a wonderful position to disseminate information for our mutual benefit.

You are hereby authorized to use the content of this letter in any way helpful to the aforementioned cause.

Please feel free to contact us anytime; naturally, demonstrations could be arranged on short notice. We are located close to the N. J. Parkway, about 20 miles south of New York City.

Harold G. Lenz
Gypsy Moth Committee Oak Hill Assn. Inc.
Middletown, N. J.

Before You Split...

Gentlemen:
I read with interest Mr. Ruff's design idea (J-K Properties Ease Karnaugh Map Application) in the November EDN.

The splitting of the Karnaugh map is certainly a labor-saving idea in solving complex sequential circuit problems. However, it should be pointed out that, although the problem is simplified, the solution may in fact become more complex. Minterms location in adjacent squares of the Karnaugh map may become isolated when the map is split. If the problem involves "don't care" conditions, such as in a BCD counter, splitting the Karnaugh map may prevent the combining of "don't care" terms with adjacent minterms to minimize the solution.

Donald D. Stake
Saratoga, CA 95070

Tit for Tat

Dear Sir:
You and EDN are to be commended for your fine work on Sounding Board/70. I have a suggestion for a badly-needed service which some yet-to-be-formed organization should perform.

We engineers need an organization which will allow *engineers* and engineers *only* to evaluate the companies for which they have worked. The accumulated data would then be available to any member who is seeking new employment. If, for instance, an engineer contemplated going to work for XYZ Co., he could find out:

1) how many engineers (not managers) are on the staff.
2) how many engineers had left the company in the last 2 years.
3) how many engineers the company had hired in the last 2 years.
4) of those who left, how many said they would be willing to work for XYZ Co. again—and what percentage said "never again".

Members might also want other information, such as:

5) what percentage of engineers (present and departed) think XYZ Co.'s hospitalization plan is absolutely worthless, etc.

Industry would object to such an evaluation, probably claiming that other companies could use the information and that one disgruntled engineer could blacken a company's name. Security could take care of the first objection, and the second is patently ridiculous.

When an engineer states all his previous employers on his resume, they are regarded by a prospective employer as possible references. It is only fair that the engineer should have a reciprocal resume of the company. Just as companies would indicate whether or not the engineer would be rehired, so the engineer would indicate whether he would ever work for the company again.

Many engineers have voted against poor management by leaving. This vote is useless; we desperately need an organization that will make this vote count.

Sr. Electronic Engineer

"Now there's a word you don't hear much anymore."

Cartridges to Rot Your Mind

Among the less-inspiring news releases of this, or any other year:
Some titles from American International films to be released in video cartridge form and "expected to have strong home appeal" are "Rock All Night", "Drag Strip Girl", "I Was a Teen-Age Werewolf" and "Brain Eaters". Other titles are of similar ilk, but the release does continue: "Our films . . . will be exposed to large new young audiences that haven't had the opportunity to see them before. *Video cartridges may soon be a very meaningful market for feature films—and we are anxious to stimulate its growth in any way we can.*"

Like a supply of "sick sacks" with each cartridge?

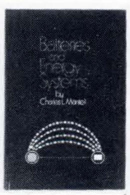
New Ideas for A Better Economy

Two books have been published recently that discuss imaginative if not revolutionary approaches to economic reform.

The Contax Plan, by Robert Morrison, looks in detail at trends in wages, prices and productivity. As might be expected, these trends are frightening and, if allowed to continue, spell economic disaster for the United States. After reviewing the hard economic facts, the author proposes a new approach to wage and price structure that reflects a great deal of research and original thinking. Though probably not flawless, the Contax Plan could vastly improve real income and productivity in the U.S. For more information, circle **No. 356.**

4 Days, 40 Hours examines the 4-day work week at 27 firms. While not necessarily trying to promote the 4-day week, the book does so anyway merely by reporting how it has worked in the studied firms. Going beyond reporting results, it includes chapters on organizing for and converting to the 4-day week, labor relations, interfacing with the outside world, and other pertinent aspects of the plan. For more information, circle **No. 350.**

Batteries and Energy Systems



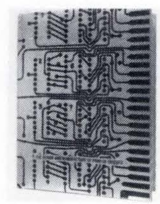
Charles L. Mantell; McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036; August 1970; 221 pages; $14.00.

Both primary and secondary batteries are discussed in this book. Large amounts of practical information are presented in an easy-to-use format. For the reader's convenience, practical characteristics of various batteries are tabulated by comparing their voltages, amperages and power capabilities. Also, an up-to-date look at energy conversion systems is included. In addition to providing enough theory for understanding batteries and energy conversion systems, some of the other topics include zinc-alkali-manganese dioxide system, silver batteries, water activated systems, nickel-cadmium system, conversion of solar energy and how to select a battery. Circle R.S. **No. 357.**

Crystal Filter Manual

"Selecting, Specifying, Optimizing Modern Crystal Filters"; Bulova Watch Co., Woodside, N.Y.; $3.00. For the circuit designer who must select and specify modern crystal filters, this should prove a handy library addition. It deals tersely but fully with such topics as filter theory, nomenclature, symbology, specification, tradeoffs and optimization of parameters, standard filter families and typical filters. The manual is offered free to qualified designers involved in application, specification or purchasing of crystal filters. Others may purchase it for $3.00. For further information, circle R.S. **No. 351.**

The Design and Manufacture Of Printed Circuits



F. W. Kear; Scientech Publishing Co., Champaign, Ill.; 176 pages, 8-1/2 by 11 in; $13.95.

Covers the entire field of printed-circuit design and fabrication in a comprehensive manner. Profusely illustrated with photos, diagrams, charts and samples of pertinent documentation. Includes bibliography, appendixes. Fully indexed. Author Kear is chief production engineer at Sparton Southwest, Inc., and is widely published. Order direct from author at 1729 Shirley N.E., Albuquerque, NM 87112 or for more information circle **No. 352.**

Materials for Structural And Mechanical Functions

Gabor Koves; Hayden Book Co., Inc., New York, N.Y.; 368 pages, 6 by 9 in; illus.; cloth; $13.95.

This second volume in the Hayden Series in Materials for Electrical and Electronic Design satisfies informational needs of those who design hardware for electrical and electronic equipment. The author is a metallurgist and manager of mechanical technology at IBM's General Systems Div. His text opens with an overview of major classes of materials and devotes the remainder to functional applications. Discussions include means for improving mechanical properties, primary and secondary fabrication methods, and problems of fatigue and impact load. Materials looked on as exotic are not the least of the author's concerns.

The text will be useful primarily as a practical design tool and a reference source; secondarily, it can contribute to engineers' continuing education. For further information, circle R.S. **No. 353.**

BASIC For Beginners

Wilson Y. Gateley and Gary G. Bitter; McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036; June 1970; 152 pages; $3.95.

Primary purpose of this book is to acquaint the reader with the computer language BASIC. This book is written as a do-it-yourself manual. Most of the chapters contain explanatory material, a set of problems and at least one exercise that actually requires the reader to write a program to run on the computer. Solutions to the questions are at the end of each question section. Additional exercises illustrating other applications and challenging the reader's ingenuity are given in the appendices. To complete this manual requires about 10 hours of the reader's time and 1 hour of computer terminal time. Circle R.S. **No. 358.**

Also Worth Nothing

"**Proceedings**—Kodak Photoresist Seminar" contains 11 technical papers, 180 graphs, tables and illustrations on photoresist technology. 96 8-1/2 by 11 pages; $1.50. From Kodak dealers or Dept. 454, Eastman Kodak Co., Rochester, N.Y. **14650**

"**Printed Circuit** Handbook" details and illustrates four techniques for printed-circuit fabrication. Useful for prototype or full-scale manufacture. GC Electronics Div. of Hydrometals, Inc.; $0.50. Circle R.S. **No. 355.**

Indexes

Advertiser's Index

Subject Index to Articles

Index to Ads, Products and Literature

Application Notes

"EMI/RFI Filter Engineering Handbook" contains 16 pages for measuring EMI/RFI interference and explains techniques of protecting equipment. Components Corp., 2857 N. Halsted St., Chicago, IL 60657. **375**

"Beam-Lead Sensor Arrays", Publication CB-128, explains beam-lead sensor array technology and the advantages of such an array compared to one comprising individual phototransistors mounted and wired separately. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308, Dallas, TX 75222. **376**

"A Guide to Judging Microwave Capacitors", AN103, is a technical discussion of capacitor performance from the standpoint of loss tangent, dielectric characteristics and insertion loss. American Technical Ceramics, 1 Norden Ln., Huntington Station, NY 11746. **377**

"Applications of a DC Constant Current Source" is the title of 32-page Booklet AN 128. Subjects such as resistance measurements, semiconductor device measurements and component testing are discussed as common applications for dc constant current sources. Inquiries Manager, Hewlett-Packard Co., 1601 California St., Palo Alto, CA 94304. **378**

"Matrix Selector Switches" is the title of a comprehensive four-page illustrated application note from Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, IL 60085. **379**

Furnace sealing processes for integrated circuit packages are the subject of Technical Bulletin No. 1R1 and data sheets TL-TH-1150 and IQ/VQ/VIQ. Final sealing, done with solder and a metal lid as well as with frit and ceramic cover plate or lid, is covered. BTU Engineering Corp., Bear Hill, Waltham, MA 02154. **380**

"COMBAT Boron Nitrides—A New and Superior Diffusion Source" is the title of Technical Bulletin A-2082 that outlines the preparations for three deposition firings of COMBAT boron nitride wafers. The Carborundum Co., Niagara Falls, NY 14302. **381**

Product evaluation and application literature on the Y-2075 avalanche diode includes "TRAPATT Diode Test Circuits" (ETD-6024), "TRAPATT Diode Application Notes" (ETD-6022) and "TRAPATT Diode". This three-piece set includes 20 pages of information. Product Information, Tube Products Dept., General Electric Co., 316 E. 9th St., Owensboro, KY 42301. **382**

"Shaker Isolation and Related Inertial Considerations", No. 425, discusses the problems and dangers of shaker-excited ground vibration. Ling Electronics, 1515 S. Manchester Ave., Anaheim, CA 92803. **383**

"Mounting of High Power Silicon Semiconductors" is the title of 12-page Application Note AD 54-050. Mounting of stud-type, flat-base, Pow-R-Disc, individual, parallel and stack-mounted configurations is covered. Westinghouse Semiconductor Div., Westinghouse Electric Corp., Westinghouse Bldg., Pittsburgh, PA 15222. **384**

Analog Dialogue, December 1970, features 16 pages of application information, circuits and product insights covering theory of op amps, data conversion devices and related circuit and system components. Analog Devices, Inc., 221 Fifth St., Cambridge, MA 02142. **385**

"General Information on Using Unitrode PIN Diodes in RF Applications", App Note MW-70-1, and "Design Curves for RF Switches Using the UM4000 Series PIN Diodes", App Note MW-70-2, provide information on characteristics of the UM4000 Series. Inquiry Processing Dept., Unitrode Corp., The Prince Bldg. 7E, 63 Atlantic Ave., Boston, MA 02110. **386**

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