Electronic Design 18

VOL. 20 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

SEPT. 2, 1972

Cassette or cartridge? Which recorder for digital information? The choice isn't easy, as specs and pricing are confusing. And the performance of a unit can't be judged from the spec sheet alone. There's controversy, too: A new cassette standard is in the offing, but some firms may ignore it. For confusion reduction, see page 40.

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for circuits that care

■ When bandwidth is critical, ferrite inductors and transformers must deliver electrical performance over your entire frequency spectrum. Or else your circuit is dead.

Broad Band-Rated Ferramic components guarantee the electrical performance required in critical circuits for communications, instrumentation, data transmission, telemetry, and radar applications.

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Broad Band-Rated components are part of our growing line of new ferrites designed to meet specific design needs. With guaranteed electrical specs to match their improved performance.

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INFORMATION RETRIEVAL NUMBER 245

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...come some of the dirtiest waveforms ever.

Because the new Model 132 generates precise calibrated outputs of digital or analog noise. And because it's really two generators in one, the 132 also puts out super-clean sine, square and triangle waveforms over the frequency range of 0.2 Hz to 2 MHz. You can even mix the clean signals with noise and get calibrated signal-to-noise ratios. Cleans and dirties from Wavetek for only $795.

WAVETEK®

P.O. Box 651, San Diego, California 92112
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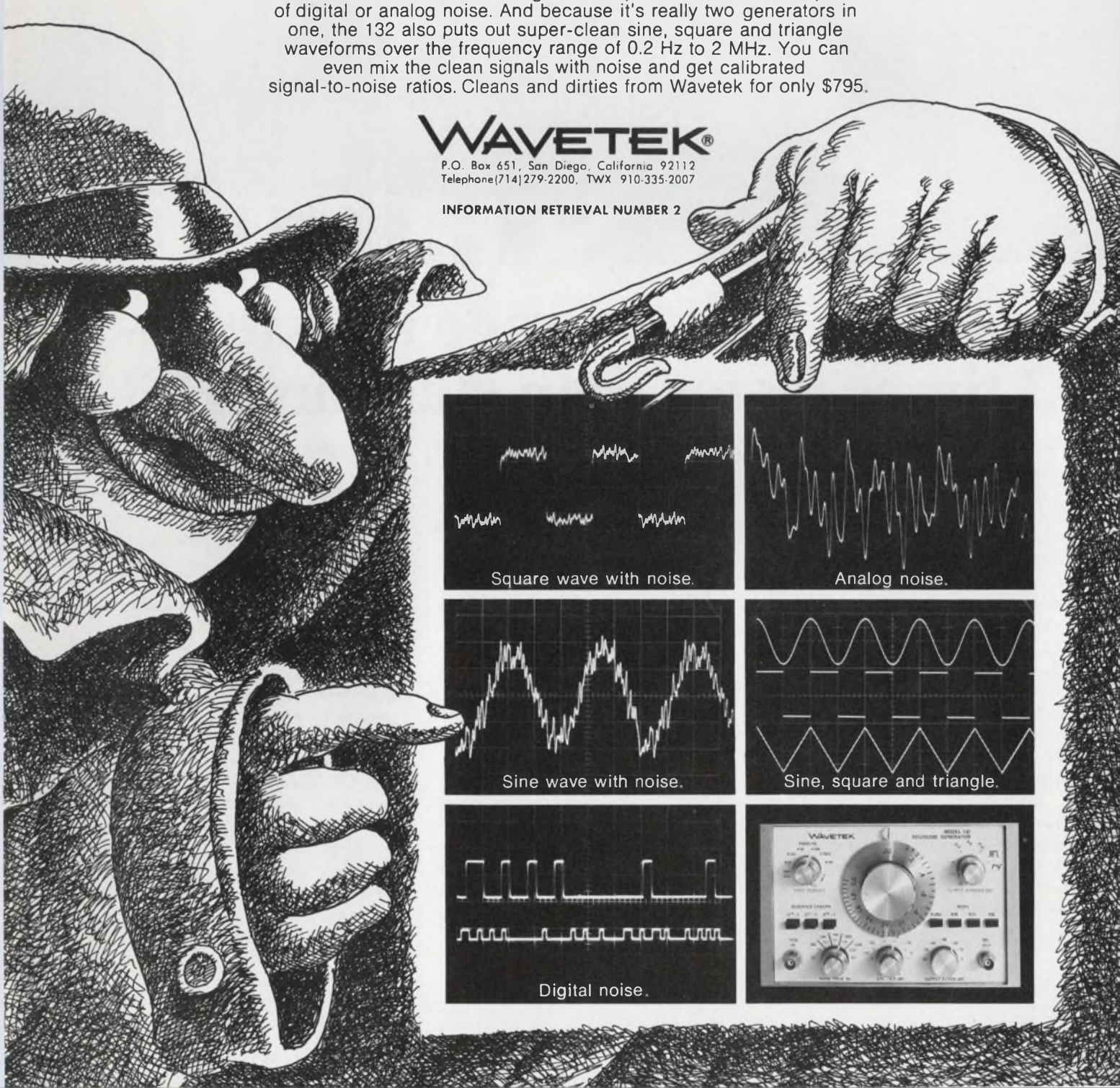
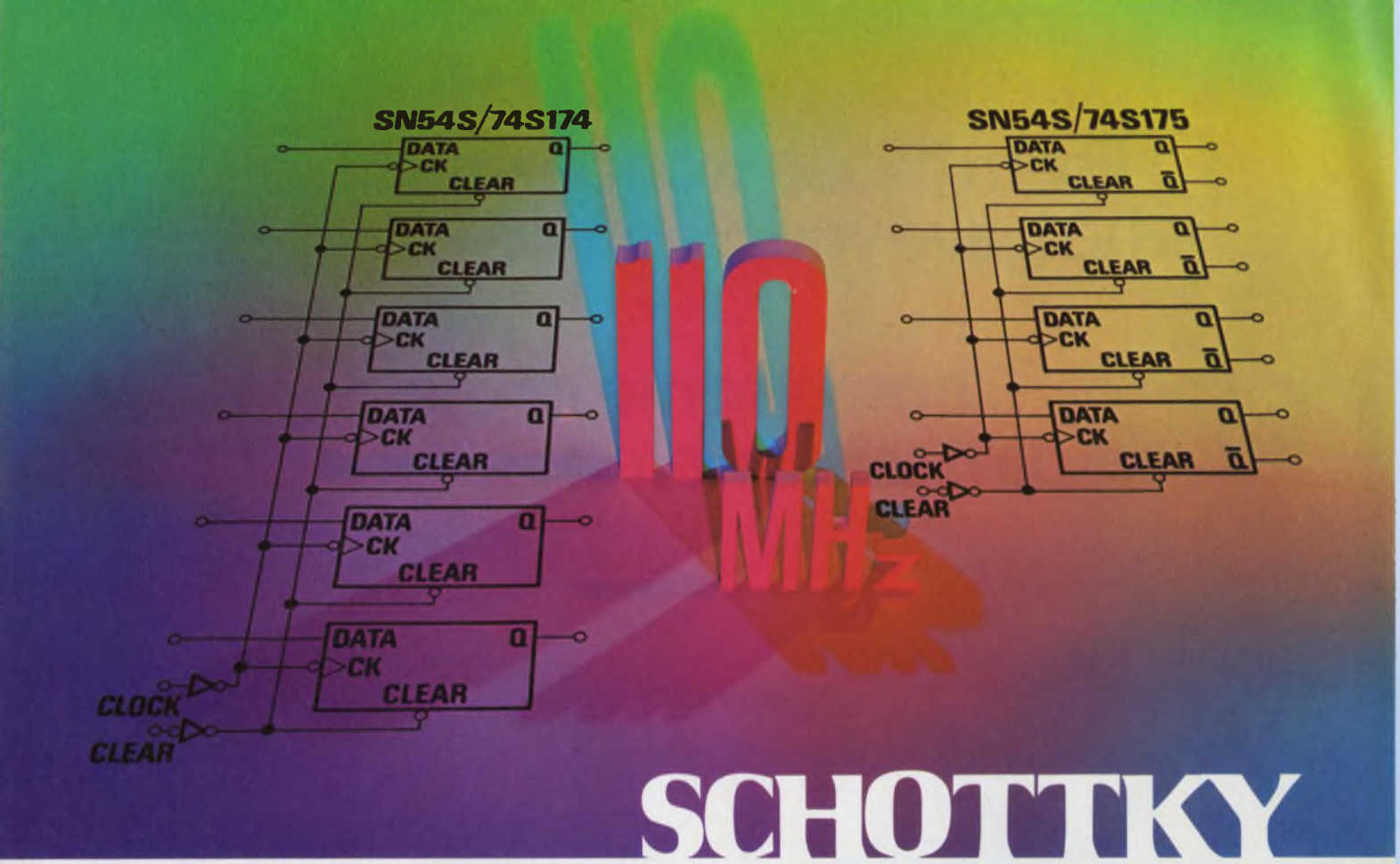
INFORMATION RETRIEVAL NUMBER 2





Fastest TTL storage registers -- 3 times faster than standard TTL.

With clock frequencies of 110 MHz, these new additions to TI's Series 54S/74S Schottky MSI family are three times faster than the equivalent Series 54/74 TTL storage registers (see table).

The new SN54S/74S174 consists of six D-type flip-flops with single-rail outputs and the new SN54S/74S175 consists of four D-type flip-flops with double-rail outputs. Both are designed for use as buffer-register file memories, high-speed memory address registers, high-speed shift registers/counters and pattern generators.

Delay times are typically 2.5 ns per logic level and both devices have clear inputs. All inputs are buffered for a normalized fan-in of 1 to allow for easier system interconnection.

TTL Storage Registers Speed/Power Comparison

	Schottky S174/S175	Standard 174/175
Maximum clock frequency (typ)	110 MHz	35 MHz
Propagation delay (clock to output)	10 ns	20 ns
Power dissipation/ flip-flop	75 mW	37.5 mW

Full compatibility

As with all Schottky MSI circuits, these new ICs are fully compatible with all other TTL forms—standard, high-speed, low-power and low-power Schottky.

Not only will new systems benefit from these new storage registers, but also existing system performance can be easily upgraded. Both devices are pin-compatible and functionally identical to their equivalent Series 54/74 standard TTL circuits.

The new S174 and S175 come in plastic or ceramic dual-in-line packages and in flat packs for use over the −55°C to 125°C and 0°C to 70°C temperature ranges. They're available now from authorized TI distributors or factory stocks.

Send for Schottky brochure

For details on the fastest TTL storage registers available—as well as other new Series 54S/74S Schottky TTL functions—get Brochure CC-408. Circle 212 on the Service Card or write Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
INCORPORATED

84053

VOL. 20 NO.
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SEPT. 2, 1972

NEWS

TECHNOLOGY

PRODUCTS

Departments

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SELECTABLE FIXED RESISTOR*

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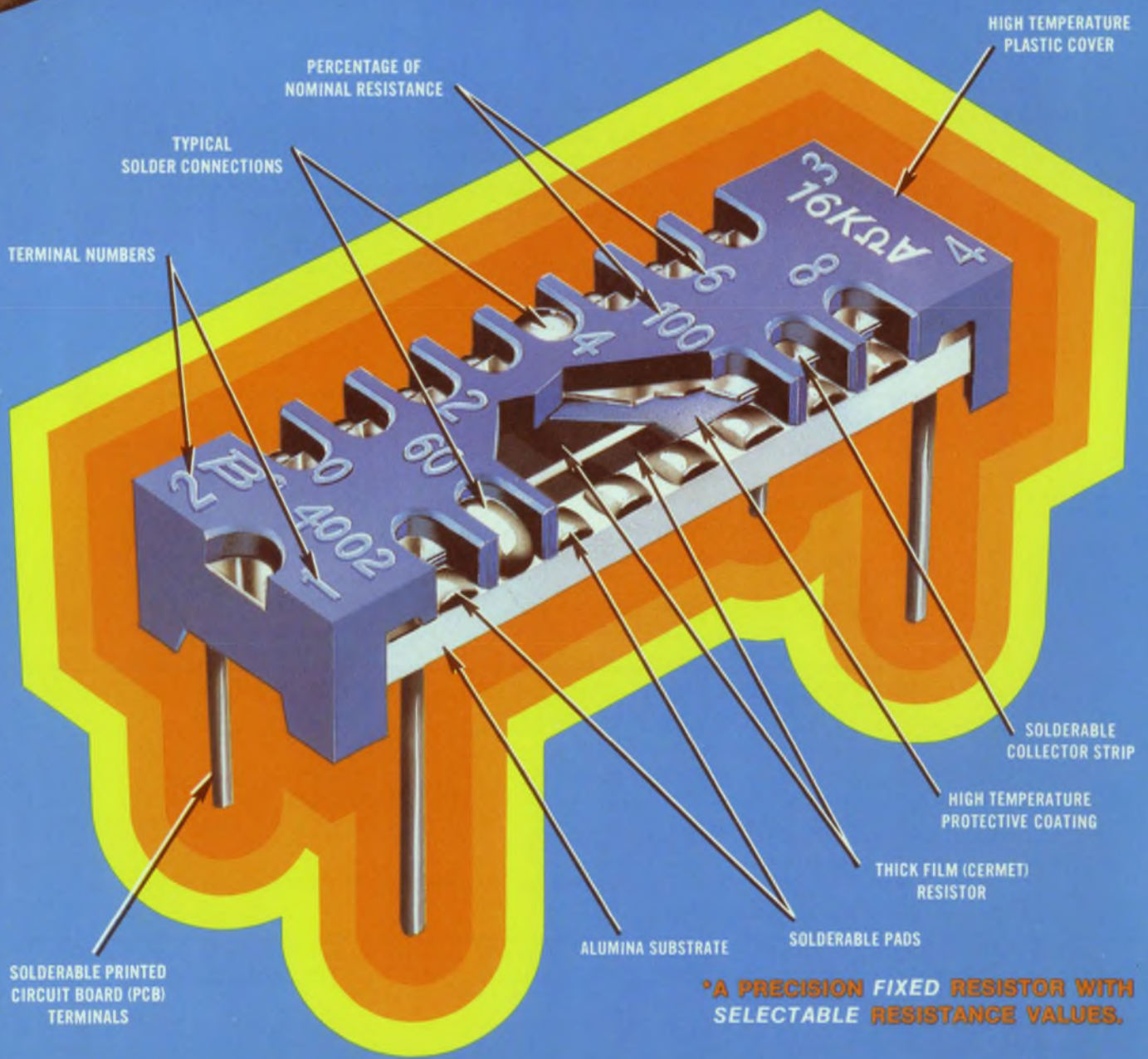

*A PRECISION FIXED RESISTOR WITH SELECTABLE RESISTANCE VALUES.

BOURNS NEW . . . UNIQUE CONCEPT IN RESISTIVE COMPONENTS ALSO OFFERS

* *33 ohm to 1.25 megohm combined resistance range over 15 units*
* *Selectability within ±1% of required resistance value over the entire range*

BOURNS SFR™
SELECTABLE FIXED RESISTOR

. . . IS A STABLE, THICK-FILM, FIXED RESISTOR *WITH ADJUSTABILITY OF ±1% OR BETTER*

. . . REPLACES STANDARD FIXED RESISTORS IN APPLICATIONS WHERE FINAL RESISTANCE VALUE REQUIRED CAN'T BE PRECISELY DETERMINED AT THE DESIGN STAGE

. . . REPLACES "ONE-TIME ADJUST" VARIABLE RESISTORS IN APPLICATIONS REQUIRING LONG-TERM STABILITY

. . . RESISTANCE VALUE IS SELECTED, THEN *PERMANENTLY*, RELIABLY *SET* BY SOLDERING

LOOK AT THE $$ YOU SAVE ON INVENTORY!!

FOR EXAMPLE: Your application requires selection of individual resistance values from 550 ohms to 1000 ohms, or 40 different resistors at 10¢ each. One Model 4002 provides the same resistance selection within ±1% at 76¢*.

Result: **40 different resistor values: 40 x 10¢ = $4.00**
One Model 4002 : 1 x 76¢ = .76

YOU SAVE . . . $3.24!!

*1,000 piece quantity price U.S. dollars, F.O.B., U.S.A.

it's easy to use

After mounting on PCB; probe the COARSE and FINE adjustment taps (Figures 1 and 2) to determine the precise resistance required. Solder the selected taps (Figure 3) and the SFR RESISTOR is permanently set.

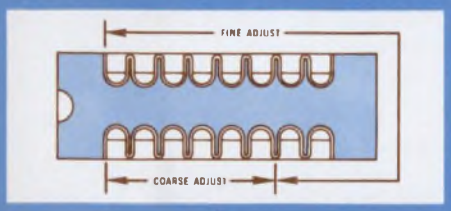

Figure 1


Figure 2


Figure 3

FOR COMPLETE DETAILS AND A BROCHURE:

- *CALL SFR RESISTOR SALES COLLECT (714) 781-0270*
- CONTACT YOUR LOCAL BOURNS REPRESENTATIVE.

FOR A FREE SAMPLE . . . write to the factory answering the following on your company letterhead.

(a) My application for the Bourns SFR Resistor is . . .
(b) It will replace (number) of fixed resistors in my inventory
(c) Approximate anticipated annual quantity usage: (number)

BOURNS

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INFORMATION RETRIEVAL NUMBER 3

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across the desk

Can any reader help this doctor?

We are completing a design for an analog simulation of glucose metabolism, to be used to give diabetic patients an understanding of their problem by illustrating the effects of eating, exercise, insulin and insulin overdosages on blood sugar, fat stores and insulin response.

I write concerning display devices for showing the output parameters. The subtle interactions of the variables are such that they are difficult to follow on conventional panel meters. Edgewise panel meters offer some improvement. Somewhere I have seen display devices in which a meter movement is used to drive a loop of plastic with colored segments, which is displayed in a window. In another system a meter movement rotates a cylinder that has a colored triangle printed on it. A slot in the window presents a view of the long axis of one side of the cylinder. I think that a display device of this type, giving graphic, semiquantitative data, would be more appropriate for our application than conventional panel meters.

Can you suggest where we might find such devices?

Dr. G. E. King
Medical College of Georgia
Biomedical Engineering
Augusta, Ga. 30902

Mislabeling detected in Idea for Design

I have read with interest the Idea for Design of "Edge-Triggered Sequence Generator Results From Johnson Counter" (ED 14, July 6, 1972, p. 78), and I have found that the first D flip-flop, as drawn (FF_1) with the Event serving as the clock input, makes the timing diagram, as drawn, incorrect. A possible solution would be to change the waveforms labeled FF_1 and FF_2 to FF_2 and FF_3, respectively, for G_1 to decode the "delayed pulse output."

Mike Kleidermacher
Digital Design Engineer
RCA
Camden, N.J. 08102

The author replies

Mr. Kleidermacher is right. The third and fourth lines of Fig. 2 are incorrectly labeled and should be FF_2 and FF_3, respectively.

T. L. Urquhart Jr.
Radiation, Inc.
Box 37
Melbourne, Fla. 32901

Anybody out there like to sell relays?

"Focus on Relays" in the July 6 issue was rather timely for me. In casting about for a general-purpose (pardon the expression) reed relay for our stores stock, the Electronics Stock Committee of the Brookhaven National Laboratory attempted to get specifications for Form A, Form B and Form C reed relays in a TO-116 package, with a coil voltage of 5 V. We found 13 manufacturers that advertised this kind of relay, and we wrote to each, enclosing a specification sheet we had developed.

The results were rather negative. Here we were, begging for information, begging to be sold relays, and some manufacturers couldn't have cared less. And that's just about par for the course. In all of the years that I've been contacting manufacturers and manufacturers' representatives, letters and phone calls of inquiry have been ignored, been misread, been referred elsewhere, etc. Of course, there have

(continued on p. 10)

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

MORE THAN A TAPE MOVER

(Or why 167 OEM's and system builders choose CartriFile® over other cartridge/cassette tape memories)

Complete subsystem, easy to install

Our 167 OEM and system-building customers are enthusiastic about CartriFile. It's a new way of life, free from the tape control and interfacing hassles of mere "tape movers."

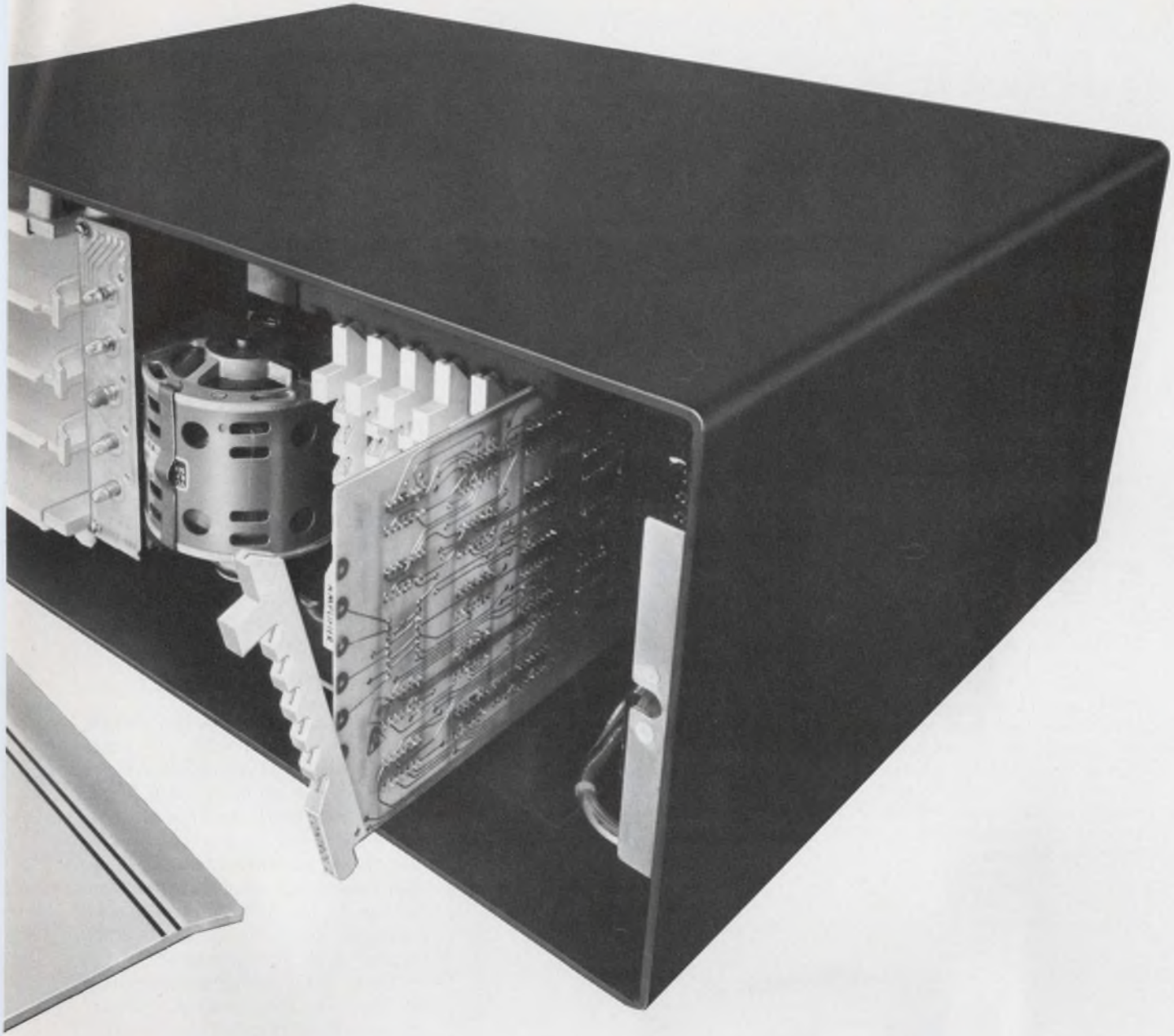
Of all the tape mini-memories, they've found that CartriFile is the one add-on that's really complete. Supplied WITH: multiple drives in one unit, read/write electronics, controller, interface (available for ALL popular minicomputers), integral power supply, interconnecting cables, and basic software. It's plug-compatible, ready to go, and PROVEN (more than 1,000 CartriFiles shipped since 1968).

True computer quality

CartriFile is no compromise, either. Unlike most small-sized tape memories, it was designed "from scratch" for on-line computer applications. It zings along at 18,000 bits per second. It effectively packs 1800 bpi on two tracks recorded in the center of a quarter-inch, computer-grade tape (where they're virtually invulnerable to error). A four-drive system, loaded with 150-foot cartridges, can hold nearly 13 million bits. Data reliability compares favorably to sophisticated, big-system drives—with bit-error rates approaching 1 part in 10^9.

A simple, straightforward machine

With more complete electronics than other tape memories, CartriFile is STILL a simple machine.



No mechanical gimmicks. Nothing exotic to go haywire. It uses only 3 parts to move tape: a motor, a capstan, and a pinchroller actuator (a pinchroller is built into each CartriFile cartridge). For each additional tape drive, we only add ONE more moving part: an actuator. CartriFile's mechanical simplicity results in unbelievably long MTBF. Just ask our customers.

ONLY cartridge/cassette with 6 months guarantee

You'll get a nice, secure feeling with our certified Tri-Data 1000 Series endless-loop cartridge. It's good for MORE than the "several hundred" passes of a digital cassette. It performs so well, in fact, we've given it an unconditional 6-month guarantee. Typical life for a 50-foot cartridge is a conservative 12,000 passes at CartriFile's high reliability rates. Cartridges are available in 10-, 25-, 50-, and 150-foot lengths.

Great price/performance family

Investigate the CartriFile family. You'll find a pleasing array of mini-peripheral memory power. You can choose models with one, two or four tape drives. You can choose a complete subsystem, a system without interface, or a "bare essential" version that's just for OEM's. Prices range from $750 for the smallest version (in OEM quantities) to $4950 for a single, 4-drive subsystem. There's a model to fit just about every application.

End your "tape mover" hassles right now. Go CartriFile, a dependable system you can plug in and forget.

TRI-DATA

800 Maude Ave. / Mountain View / CA 94040
Phone (415) 969-3700

INFORMATION RETRIEVAL NUMBER 5

(continued from p. 7)

been some noble exceptions.

Why manufacturers are reluctant to sell their wares, I'll never understand. I've been complemented several times on the rather complete catalog library I maintain at Brookhaven, but I sure do have a time convincing some manufacturers to part with their precious catalogs. I know and appreciate what a really good catalog costs, but I also appreciate the fact that profits on our purchases with these manufacturers certainly cover all cataloging they can give us for years to come.

James A. Hallock, Chairman
Electronics Stock Committee
Brookhaven National Laboratory
Associated Universities, Inc.
Upton, N.Y. 11973

More about relays—from a manufacturer

As a manufacturer's representative, I have spent over 25 years selling relays to manufacturers of all types of equipment. As I see it, the biggest single problem that relay manufacturers face is a lack of knowledge on the part of the design engineers about contact behavior under different loads and confusion over various levels, such as low level, dry circuit, etc.

There is an excellent explanation of this in the Engineers Relay Handbook, a Hayden publication.

J. F. McElligott
Masin-Esco, Inc.
333 Jackson Ave.
Syosset, N.Y.

'Tiger' approach to job stirs growl of protest

Herb Sobel's "tiger teams" (see "Put 'Tiger Teams' in your Managing Game," ED 13, June 22, 1972, p. 90) may sound like heroics to some, but it raises the following disturbing questions for me: If Sobel's six-man tiger team can replace as many as 30 engineers, why did Sobel's firm put 30 engineers on the job in the first place? The high standards that Sobel delineates for his tigers are the same

(continued on p. 14)

Why invest in wire-wrapping facilities,

when you can use ours?

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

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

The unit further tests for continuity resistance, insulation resistance, DC hipot, and features programmable dwell time.

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

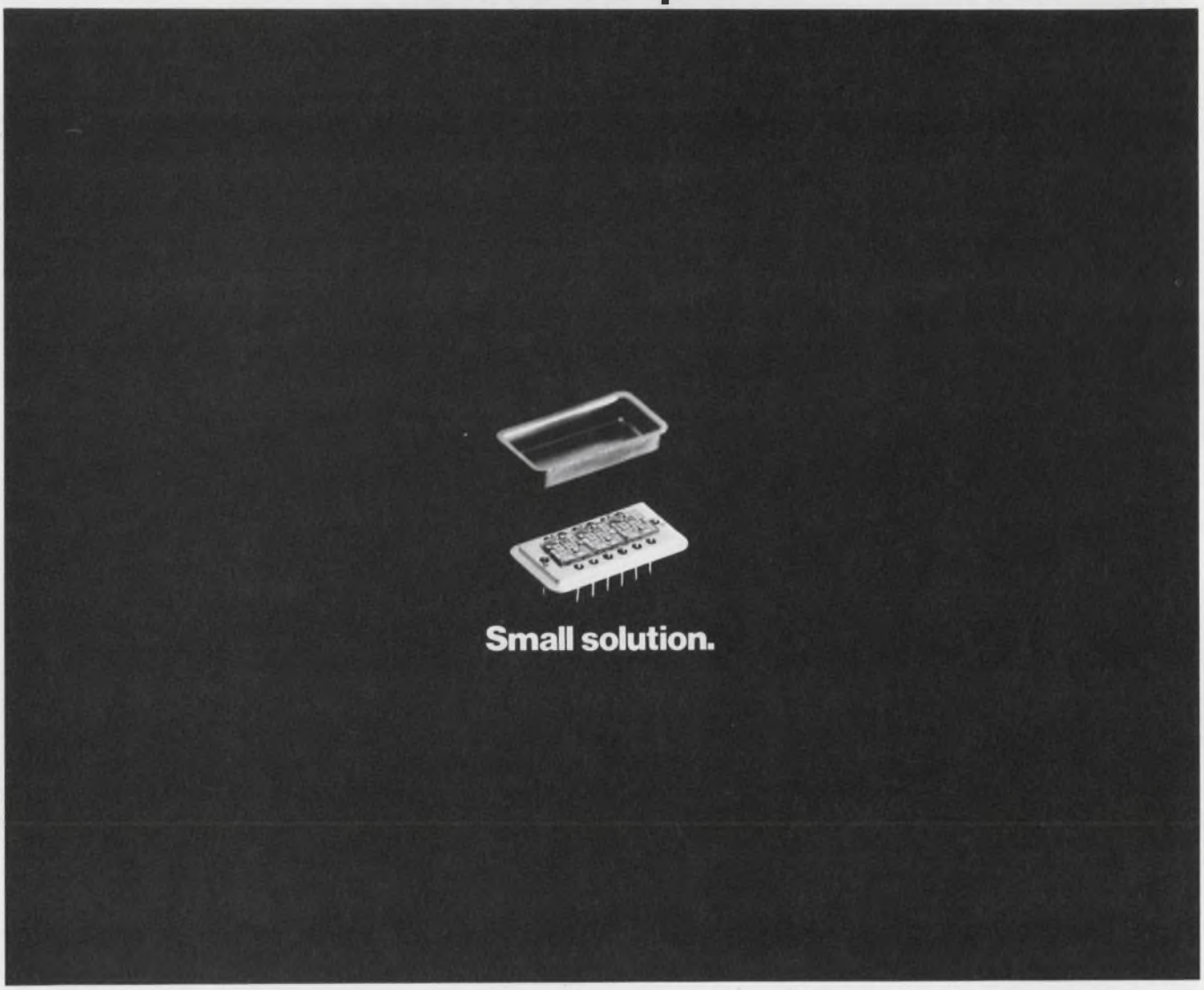
Delivery? Just 2 to 8 weeks, depending on the job and material availability. And we have two locations: Longmont, Colorado or Endicott, New York. For more details just call your nearest Amphenol sales office or write us direct. Amphenol Cadre Division, Bunker Ramo Corporation, 20 Valley St., Endicott,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

BUNKER RAMO AMPHENOL

INFORMATION RETRIEVAL NUMBER 7

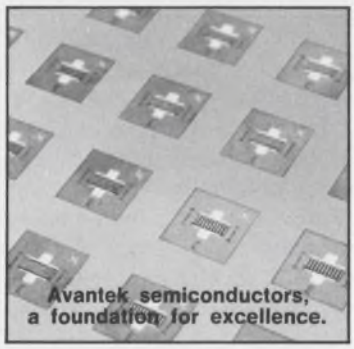
Big problems

with size and weight in high-performance microwave amplifiers?



(shown actual size)

Avantek's leadership in microwave transistor development and thin-film technology has made possible the UDP Series of high-performance amplifiers in miniature dual inline packages.



These amplifiers, occupying only 0.1 cu. in. and weighing a mere 0.15 oz., set a new standard of miniaturization, a critical consideration in airborne applications.

Now you can connect amplifiers directly to mixers or detectors with no cables or connectors to degrade reliability. The UDP Series offers this unique advantage to designers of pod-mounted ECM equipment, collision avoidance and beacon sets as well as telemetry and communications systems for aircraft and space vehicles.

Initially, Avantek is offering three models, covering the 1 to 4 GHz frequency range. Representative specifications include:

	Freq. (GHz)	Gain (dB)	N.F. (dB)	P_{out} (dBm)
UDP-2032	1-2	24	5.5	+8
UDP-2332	2.2-2.3	22	5.5	+8
UDP-4003	2-4	6	9.0	+11

Models covering additional frequencies will be introduced later this year.

Avantek... *years ahead today.*

Avantek, Inc., 2981 Copper Road, Santa Clara, California 95051. Phone (408) 739-6170. TWX 910-339-9274. Cable: AVANTEK

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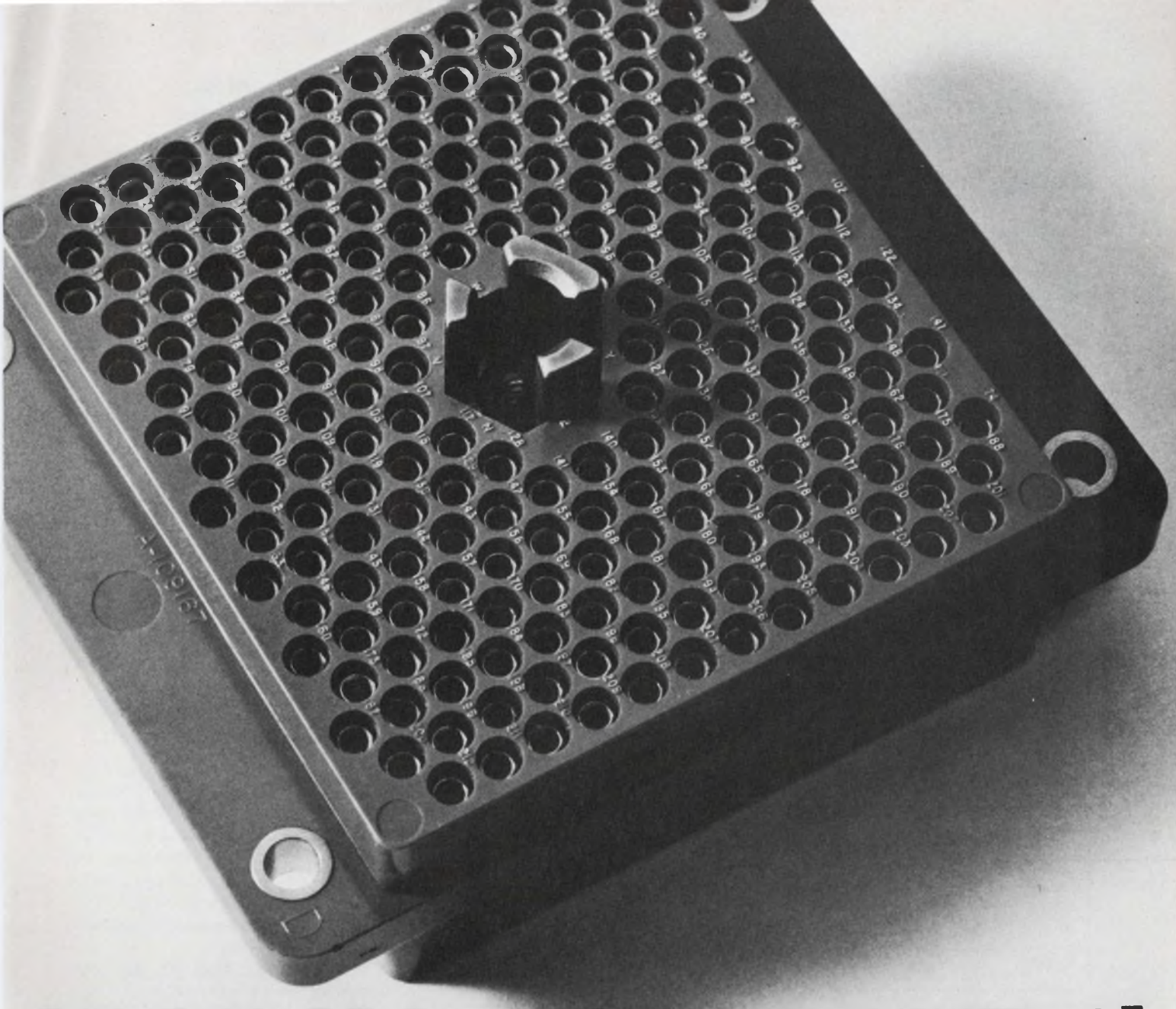

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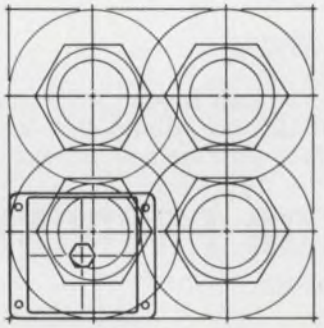
One of our 212-contact models, like the one shown here, does the job of four 55-pin circular mil-spec connectors.

And does it in one-fourth the space!

Plus greater reliability (thanks to 16-gage contacts) and better contact retention.

And besides standard sizes, miniature and subminiature sizes are available, too.

Hughes high-density connectors. One of the few times more cavities is something to smile about.



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CONNECTING DEVICES

CONNECTORS, CABLES, CIRCUITS . . . ONLY HUGHES PUTS IT ALL TOGETHER.

INFORMATION RETRIEVAL NUMBER 9

ACROSS THE DESK

(continued from p. 10)

standards that should apply to every engineer.

If U.S. industry would consider engineers as professionals pursuing a permanent career and would mandate continuing education as a part of every engineer's workday, most engineers could at least approach "tiger" status.

If managers like Sobel could only make use of all of their employees, they would see that tiger teams are only a temporary fix for a serious, industrywide problem.

James P. Lynch
Assistant Electronics Engineer
Cornell Aeronautical Laboratory, Inc.
Computer Center
Cornell University
P.O. Box 235
Buffalo, N.Y. 14221

Forget the self-praise; Let's compete, U.S.!

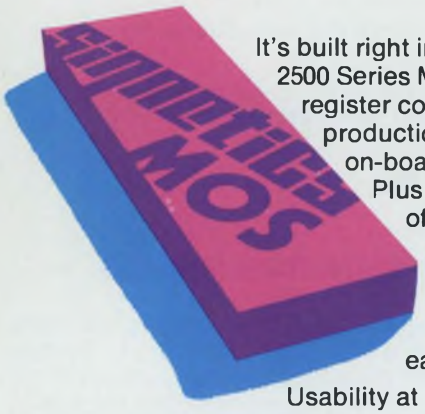
With reference to the editorial in the July 20 issue ("Innovate in New Designs or Let the World Slip By," ED 15, p. 53): Our nation is nearly 200 years old. When are we going to grow up and stop mouthing infantile phrases like "our technological leadership," "exporting our know-how," etc.

It is obvious that we are not dummies, with our trips to the moon and solid-state development, but neither are the engineers abroad. How about the "know-how" that we have absorbed: steam engine, gas engine, jet engine, major automobile and aircraft innovations, sonar, radar, nuclear physics, electrical generators and motors, battery, radio, clock, hydraulics, synthetics, iron, steel, concrete, to name but a few. Prof. A. B. Usher of Harvard states that we have received about three times as much know-how from abroad as foreigners have from us.

Moral: Let's drop all this self-praise and the notion that everybody is taking advantage of our brilliance, and let's buckle down to deal with the competition.

F. W. Stevens
Naval Undersea Center
Code 636
San Diego, Calif. 92132

Get a clock driver free...with each Static Shift Register you order.



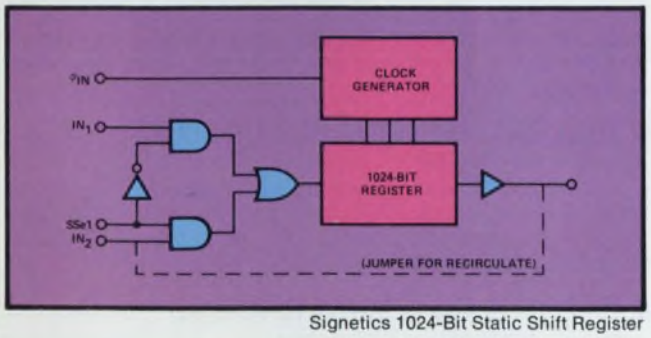
It's built right into the chip. Every 2500 Series MOS static shift register comes off Signetics' production line with its own on-board clock generator. Plus a real windfall of other major improvements. To help lower total systems cost, and make the parts easier to use.

Usability at a reasonable price. That is what you've been after. And usability runs in the family of Signetics new MOS static shift registers, the most complete collection in the field.

Operating from DC up to 3 MHz, these optimized devices eliminate minimum frequency headaches. Go right down to DC without adding extra logic.

And because the Signetics line can be treated like TTL itself, no level shifters are necessary at either input or output—again lowering your overall component count and cost. Just as the built-in clock generator demands no expensive high-level clock drivers.

Power requirements are standard +5V, −12V. And you recirculate data without external logic.



Signetics 1024-Bit Static Shift Register

For the first time, with the 1024-bit static shift register you can have the benefit of easy-to-use static shift registers for long bit length applications. And, a dual-128 for 128 column printers, or a quad-80 for 80 column CRTs.

Combine the on-board clock generator, with TTL compatibility and the wide range of bit density (from 50 up through 1024), and you've got more flexibility to work with, in both design and application, than you ever hoped to find in static shift registers.

PARTS LIST

ORGANIZATION	DIP PACKAGE	CLOCK FREQUENCY	100 PIECE PRICE	SIGNETICS PART NUMBER
1024 x 1	8 pin	2.0	$9.90	2533V
Quad 80	16 pin	2.0	4.00	2532B
Dual 256/250/240	8 pin	3.0	4.80	2527/28/29V
Dual 128/132	8 pin	3.0	4.50/4.00	2521/22V
Hex 32/40	16 pin	3.0	4 00	2518/19B
Dual 200/100/50	14 pin	3.0	5.00/4.00/3 00	2511/10/09A

You save on parts, on engineering no longer required. Yet end up with maximum memory on the board, at minimum cost in time, space and dollars.

Write Signetics for our helpful MOS Wall Chart and new Handbook, which organize the specs, technical data, and applications of all our MOS memory products—the broadest, most versatile line of static shift registers ever put on distributors' shelves, as well as optimized RAMs and ROMs.

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811 E. Arques Avenue
Sunnyvale, California 94086
(408) 739-7700

Please send us your MOS Wall Chart and new Handbook, with complete technical and applications data on Signetics user-oriented static shift registers.

Name

Title

Company

Address

City State Zip

Telephone

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signetics

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HAYDEN SERIES IN MATERIALS FOR ELECTRICAL & ELECTRONICS DESIGN

ALEX. E. JAVITZ, Editor-in-Chief, Technical Consultant; Senior Member, Institute of Electrical and Electronics Engineers; American Chemical Society, Society of Plastics Engineers.

This series of practical design references has been specifically planned to help you and your colleagues meet the challenge of proper materials selection on all fronts. These volumes place at your disposal — in engineering terms — the concepts, data, and techniques you need in order to

- understand how fundamental properties of materials affect their ultimate performance
- exploit the potential of advanced materials
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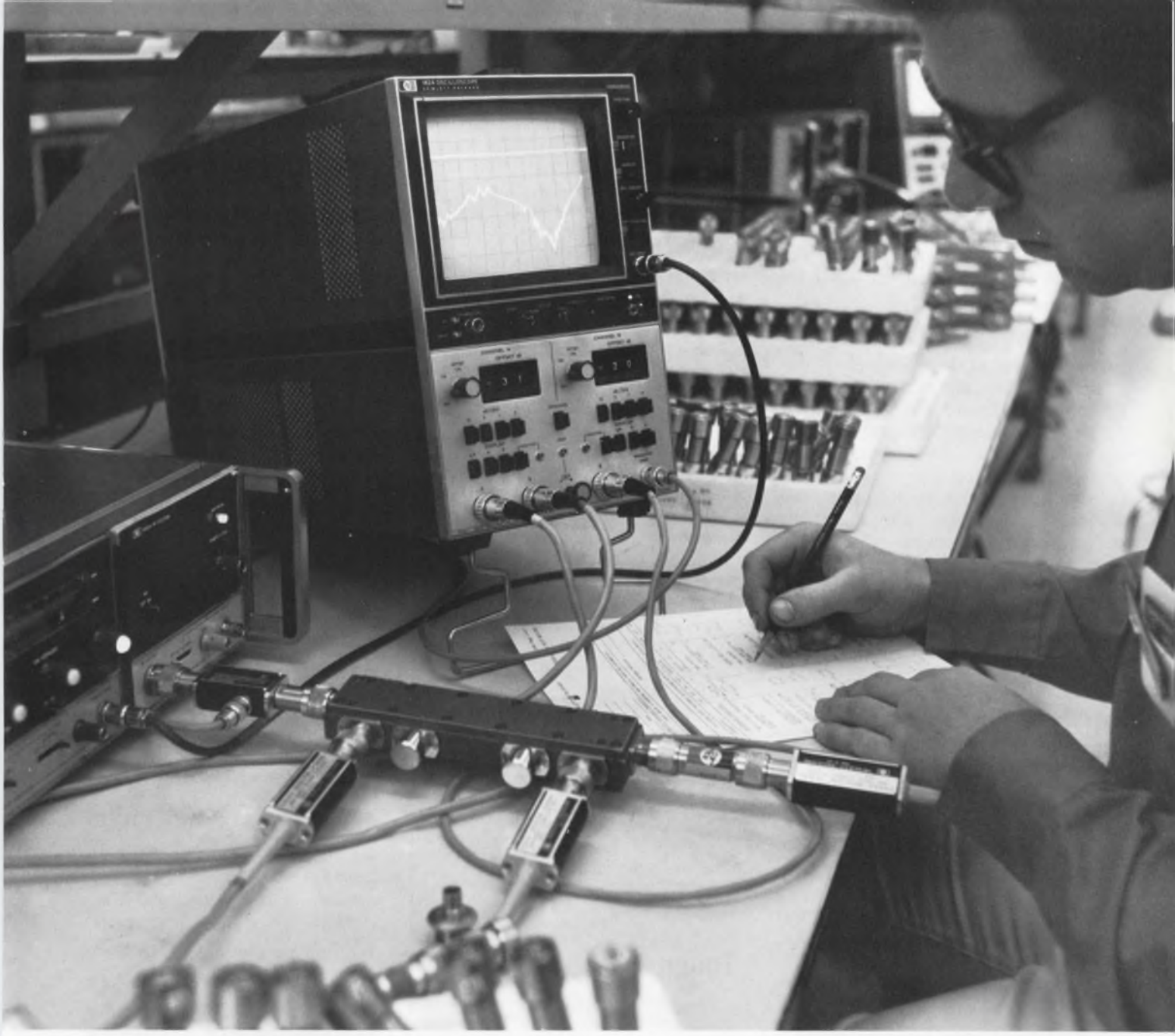

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(continued from p. 14)

Applied research aiding handicapped

The article "Space-Age Technology Opening New Doors for the Blind, Deaf and Crippled" (ED 11, May 25, 1972, p. 24) is excellent—at least for the material it covered. It would appear to us, as we have been aware of these projects previously, that the writer used as sources agencies that are funded by Government R&D grants.

We do not object to this coverage, but we feel a serious injustice was done to the handicapped—and also to engineers who might be interested in working in this field—by limiting the article to basic research and by omitting mention of our agency and others that provide a direct, low-cost engineering service to handicapped people.

We do have an applied-research program, but we do not do basic research. Under our applied research we have provided many total quadriplegics with breath-operated electric wheelchairs, with built-in respirators and waste-collection systems, at a cost of $2800 per wheelchair. We make miniature electronic speaking aids (just recently perfected) to amplify and clarify the speech of the cerebral palsied, Parkinson's victims, etc., at a cost of $400 per unit.

These items are not mass-produced; they are needed by small numbers of people only. We take pride in our quick-reaction capability; we make anything for anybody who needs it. Every case we handle is a research project—applied research, not basic research.

Donald Selwyn
Executive/Technical Director
National Institute for
Rehabilitation Engineering
Pompton Lakes, N.J. 07442

'New' idea turns up in an old Porsche

I think that I will never cease to be amazed at the reappearance of good ideas as new ideas. Shortly after reading about the new synthetic bridge in ELECTRONIC DESIGN's June 22 issue ("Replace Your Bridge Circuit," ED 13, pp. 84 - 87), the temperature gauge in my 14-year-old Porsche failed. Upon disassembly of this vintage VDO instrument, what should I find but an old synthetic bridge. Possibly I have uncovered yet another area of engineering pioneered by Porsche.

L. G. Smeins
Member of Technical Staff
P.O. Box 1062
Boulder, Colo. 80302

The author replies

The possibility of similarities between "new" design techniques and existing methods always exists. If, as reader Smeins reports, my suggested metering system has fallen into this category, then I disclaim any credit for the basic novelty of this technique.

However, it should be noted that my article was geared to presenting an application that results in a flexible metering instrument that can cope with a wide range of current monitoring tasks. This variation of the basic concept, to the best of my knowledge, is not being exploited.

Bernard J. Petrillo
Staff Engineer
Rhodes Instrument Corp.
Rye, N.Y. 10580

Tough TO-5 relays

This isn't for everybody. But if you need a relay for a projectile you plan to launch from a cannon, you might look into a new TO-5 relay about to be introduced by Teledyne Relays. The 412K can tolerate a shocking 12,000 g for 6 ms—which is one heck of a lot rougher than 80 g for 11 ms that's called out by M5757. For very shaky environments, Teledyne has already introduced the 412V, which can take 250-g vibration up to 2000 Hz (vs M5757's 30 g to 3000 Hz). And for those really hot days in Hawthorne, California, the company has the 412H, which can tolerate 200 C continuously.

All three are electrically identical to the dpdt relays already available in the company's 412 series.

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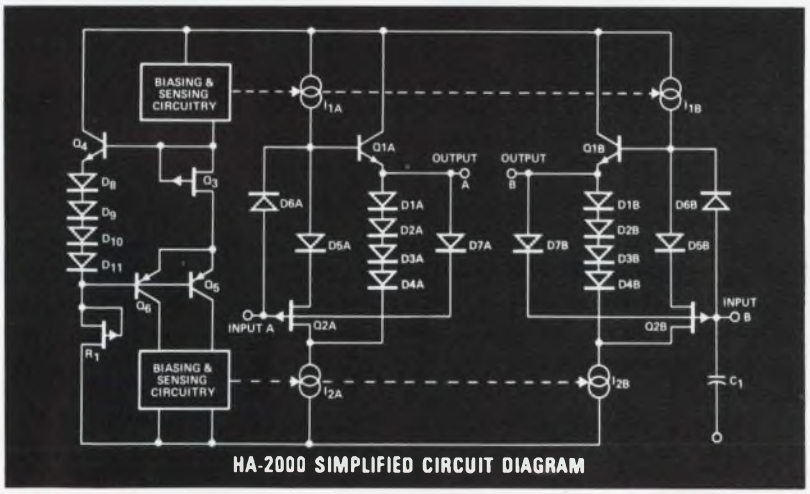
As a result, the HA-2000 offers almost limitless possibilities for low-input current, high source impedance applications such as buffers for op amps and comparators. In addition, because of its compatibility with so many other components, the device permits the user great flexibility in systems design at optimum prices. Find out about our new "universal" F.E.T. preamp. See your Harris distributor or representative.



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For information on other new F.E.T. Op Amps incorporating the HA-2000, see the adjacent column.

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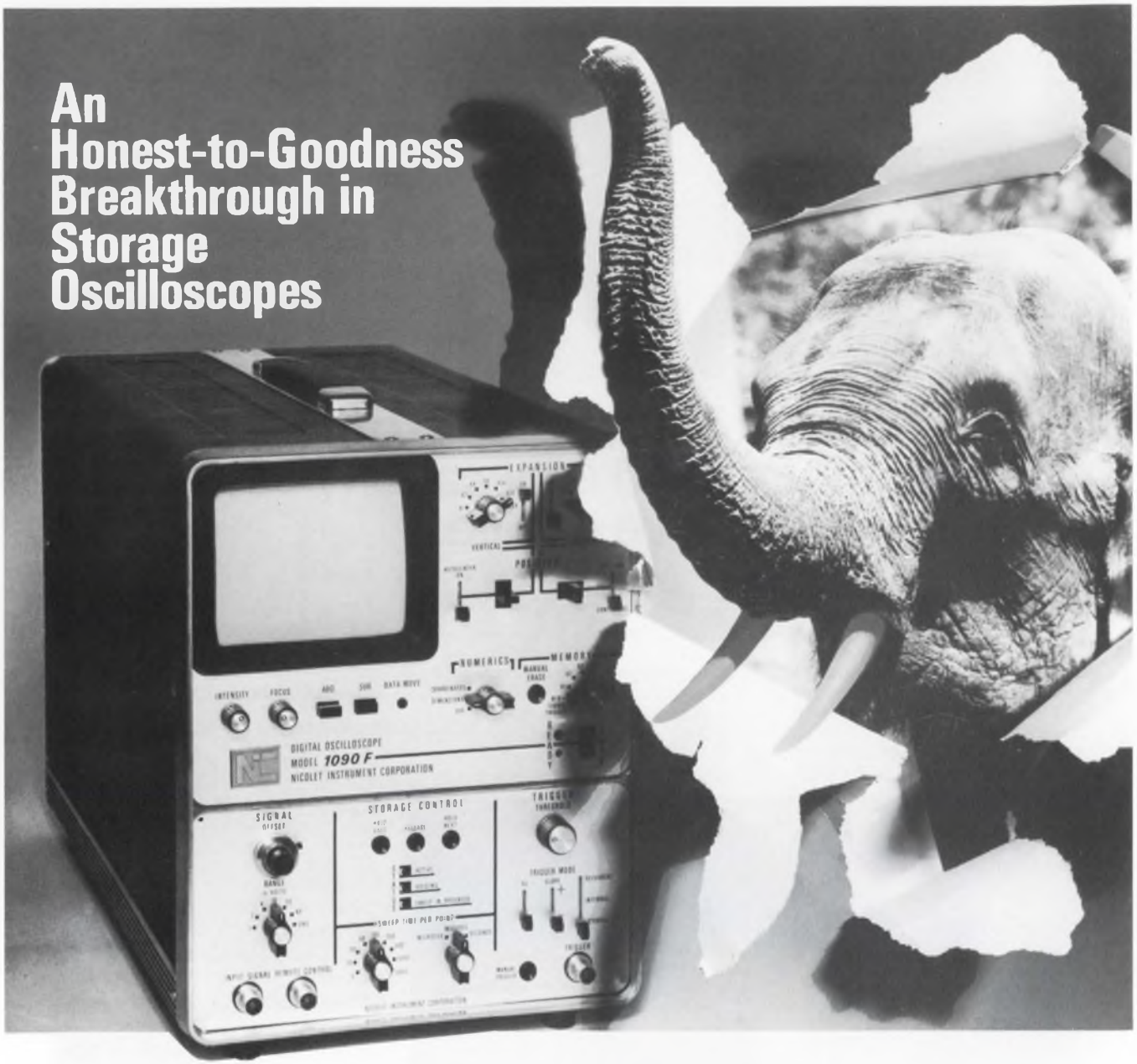
INFORMATION RETRIEVAL NUMBER 142

An Honest-to-Goodness Breakthrough in Storage Oscilloscopes



The Nicolet 1090 digital storage oscilloscope looks like a storage oscilloscope, acts like a storage oscilloscope, and is operated like a storage oscilloscope — except —

- It has about 20 times the resolution in both time and voltage. It would require hundreds of storage tubes to capture as much information about a single waveform as is recorded in the 1090's memory.
- It is about a hundred times as accurate.
- It has far greater equivalent writing speed than most storage oscilloscopes.
- It is easier, by far, to operate.
- Its stored information doesn't fade away.
- It provides normalized numerical information about any point in the waveform.
- It has sweep speeds as slow as you wish, even days in length.
- It can be told to retain a waveform before, during, or after the signal occurrence, with local or remote control.
- It can provide accurate voltages for operating a pen recorder.

Other than these exceptions, it is like an ordinary storage oscilloscope. If you know how to operate an oscilloscope, you don't even need to look at an operator's manual to make the 1090 serve your needs. Bandwidth 100 KHz ($2x10^5$ samples/second). Resolution 4096x4096. Price, with model 90-1 single channel plug-in unit: $4500. (Pen recorder drive and binary output are extra cost options.)

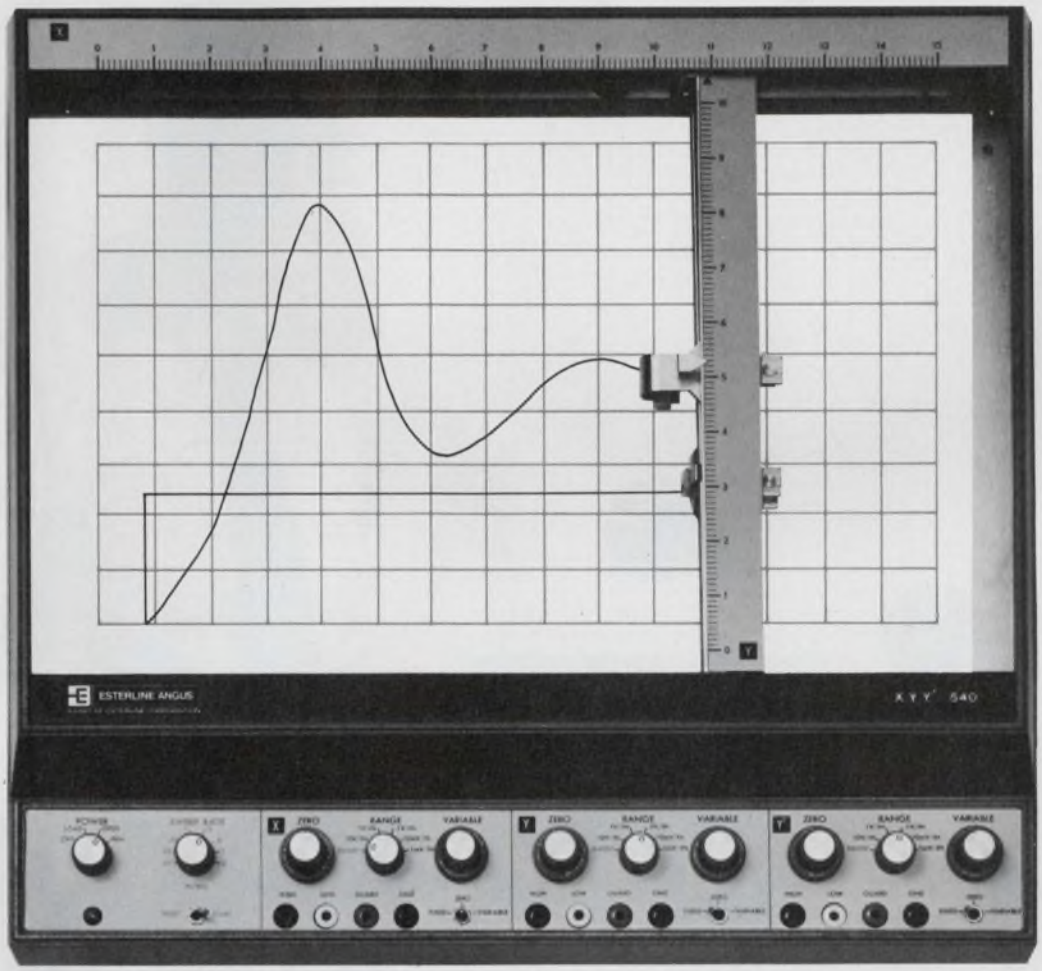
NICOLET INSTRUMENT CORPORATION

5225 Verona Road, Madison, Wisconsin 53711
Phone 608/271-3333 TWX: 910-286-2713

Write for complete information or to arrange a demonstration.

INFORMATION RETRIEVAL NUMBER 121

eX-Yllence now comes under a different name



Honeywell X-Y recorders now made and sold by Esterline Angus

Whatever your needs in X-Y recorders, Esterline Angus is the name to remember.

The complete Honeywell X-Y line—three primary units — now is made and sold by E-A.

Capabilities? Standard sensitivities from 10 microvolts to 50 volts per inch and with slewing speeds to 30 inches per second. With high impedance, differential and guarded input configuration to permit measurement of any parameter from any source without loading the source.

Single- and two-pen (X-Y-Y′) units are available with 11″ x 17″ chart size.

Parts are available—for new and existing units—from the international operations of Esterline Angus. Service will be handled nationwide by Honeywell's Metrology Service.

So, whatever your needs in X-Y recording, drop us a line. We'll tell you the whole story — in our new X-Y catalog. Write Esterline Angus, P.O. Box 24000, Indianapolis, Indiana 46224. Or call 317/244-7611.

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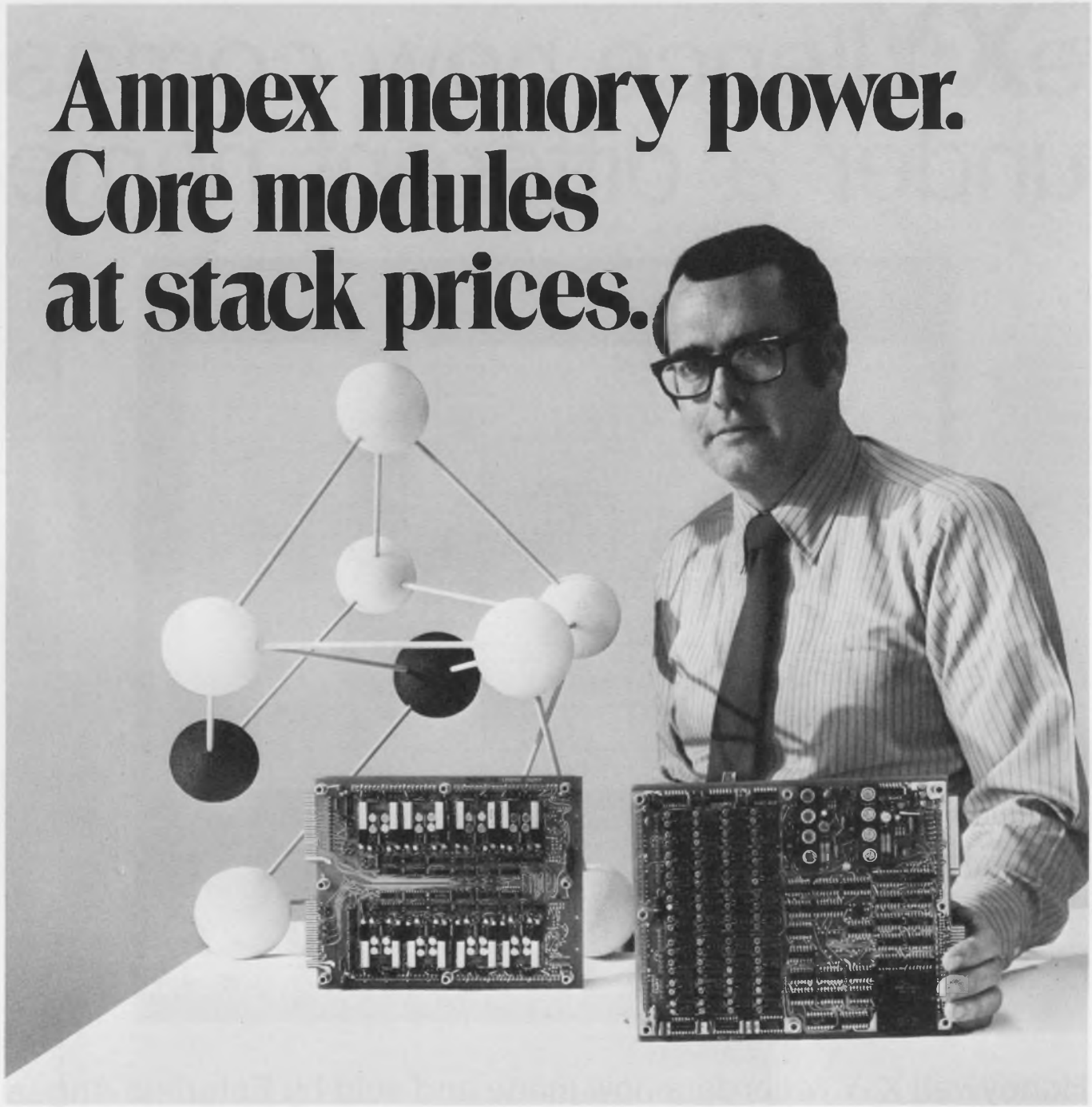
INFORMATION RETRIEVAL NUMBER 12

Ampex memory power. Core modules at stack prices.



So why design your own memory?

Ampex 1800 memory modules make real economic sense in both performance and design. No longer any need to design around purchased stacks.

The compact 1800 series modules give you twice the memory in half the space. Up to eight thousand 18 bit words in just 170 cubic inches. Combine any number of modules for the capacity and word length you need. High performance, too: access times of 250 and 340 nanoseconds.

For effortless design, all 1800 modules have decoding circuits, buffered data outputs, require only two voltages, need no temperature compensation or power sequencing. In other words, no external logic required.

Ampex 1800 modules were the first of their kind . . . and are still the best, and, of course, they come with Ampex worldwide service.

For details on how to get best memory module performance with least design effort, call your Ampex computer expert. He can fill you in on Ampex tape and disk drives, too. Or write.

AMPEX

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INFORMATION RETRIEVAL NUMBER 13

news scope

SEPTEMBER 2, 1972

Western Union gets green light on satellite

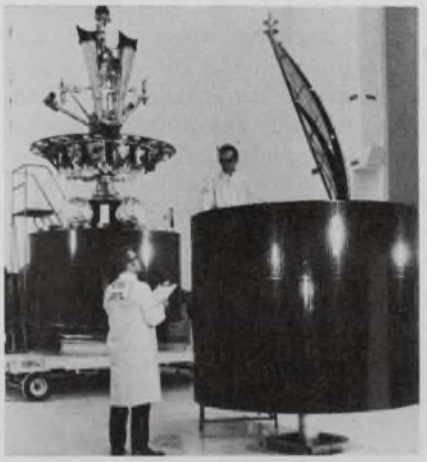
With an application still pending before the Federal Communications Commission for a construction permit for a domestic communications satellite system, Western Union has placed an order with the Hughes Aircraft Co. for three satellites. The FCC gave Western Union a waiver to proceed, so it might take advantage of a Hughes production line that produced a nearly identical communications satellite for Canada, the Anik I. The latter is scheduled to be flown later this year.

Western Union will pay $20.7-million for the Hughes satellites and will spend more than $48-million for seven ground stations. A special incentive clause in the satellite contract can give Hughes considerably more than $20.7-million. If nine or more of the 12 high-capacity microwave channels in the satellite are operating after 10 years in orbit, Western Union will pay Hughes $83.67 per channel, per day for the 10-year period—or about $6-million for 10 channels. If eight are operating, the fee will be $75 per channel, per day.

One of the few differences between Western Union's satellites and Canada's Anik I is in the feed horn. The U.S. satellite will require a wider beam in the north-south direction, and it will have extra feed horns for spot beams for Hawaii and Alaska.

Western Union will connect its satellite system with its terrestrial line of microwave links. The satellites will be used for long-distance Telex, for the company's voice system and for Mailgram. When a new electronic data switch goes into operation in 1974, it will be used for TWX.

Each of satellite channels will accommodate a color television program or be used for multiplexed voice signals—as many as 1200 signals when used with a single carrier. Each channel will have a bandwidth of 36 MHz and at least 33 dBm of effective radiated power. The spacecraft will weigh slightly more than 1200 pounds when launched.



Canada's communications satellite the Anik I, to be launched later this year, is almost identical to three that Western Union has ordered from Hughes Aircraft (right).

Subcontracting time nears for space shuttle

North American Rockwell, happy holder of NASA's $2.6-billion space shuttle contract, is meeting with the space agency to settle on a final design. Plans originally submitted by losing competitors will be reviewed to see if any features in these should be incorporated in the final version. North American says it expects to give subcontracts to some of the companies that participated with it in the original bidding. These include IBM, which helped design the data-management system; Honeywell, the flight-control system; American Airlines, the ground-maintenance systems, and General Electric, the reusable surface installations.

North American expects to start proceedings for awarding subcontracts within 90 days, with most items open to competitive bids. It plans to subcontract out 53% of its $2.6-billion award and has located potential subcontractors in 48 states. Grumman, Lockheed and McDonnell Douglas have already been doing some earnest talking with North American in hopes of getting in on the action.

Long-lead time items, such as electronic systems and major structural components, are expected to be put in the contracting arena first. Some of the big items that North American will call on others to build include the mid-fuselage section, tail, wings, landing gear, some avionics items and portions of the propulsion systems. Hardware will be confined as much as possible to proven, off-the-shelf equipment, the company says.

Army hopes to salvage part of the Cheyenne

The Army is working to determine what elements of the avionics developed for the abandoned Lockheed Cheyenne helicopter can be adapted for a new, smaller copter it plans to develop.

Major electronic subcontractors affected by the cancellation of the Cheyenne program include Teledyne Systems (the computer central complex), Hughes Aircraft (a night-vision sight for the TOW missile); Bourns/CAI (the pilot's direct sight), Honeywell (the pilot's helmet sight) and Bendix Navigation and Control Div. (the weapons' control panel and the inventory control subsystem).

In canceling the Lockheed program, the Army cited as reasons excessive size, lack of maneuverability and cost. "The avionics contributed to the cost problem," an Army spokesman said.

In recent Congressional testimony Army officials said that the Cheyenne program cost would average about $4.6-million per helicopter. Avionics are understood to have accounted for almost half the cost of each aircraft.

Approximately $400-million has already been spent by the Army on the Cheyenne program, and the service has asked Congress to approve $40-million for developing a

smaller, more maneuverable copter in place of the Cheyenne.

Army sources indicate privately that they feel the new aircraft will have to be developed. Officials of Lockheed, heavily hit by the loss of the Cheyenne contract, say the company will undoubtedly compete for the new helicopter program.

Solid-state system synthesizes voice

Voice synthesis, which has generally required complex electromechanical systems, is said to be accomplished more simply and reliably with a new solid-state system. Developed by the Master Specialties Co. of Costa Mesa, Calif., the voice-response system uses MOS read-only memories to generate a natural-sounding voice.

The first application is an automatic number announcer in telephone company offices. The system is helping field men to identify pairs of lines by providing an audible voice message with seven digits that make up the telephone number.

According to Stuart B. Brown, vice president of marketing for Master Specialties, the number-announcing system uses one 16-k ROM from Electronic Arrays, Mountain View, Calif., to synthesize the voice for each digit or monosyllabic word. The output of the ROM then goes to a digital-to-analog coverter, four bits at a time. Three of the four bits contain amplitude information, while the fourth determines the sign. The output of the digital-to-analog converter is an audio tone—the synthesized voice—which is then fed to a speaker.

While good for this application and such others as warning systems, credit-card verification and inventory status, the present system is not efficient enough for long, complete messages, Brown concedes. Work is now being done, he adds, on a system that will synthesize words from basic sounds, so that an unlimited vocabulary will be available.

Such a system, Brown continues, will require storage of synthesis information for about 200 basic sounds, and it should be available in the next two years.

The applications of a voice synthesizer with an unlimited vocabulary are many. A computer would be able to respond audibly to an inquiry or convert written text into voice for blind people. All that would be needed would be a means to enter the written material into the computer memory. The synthesizer would then convert it into an audible message.

Another possible use, Brown notes, might be the reproduction of music, although much work would have to be done before such a system would be feasible. If bandwidth and fidelity could be increased and the price kept reasonable, electromechanical magnetic tape recorders might one day be replaced by all-solid-state recorders.

RCA quietly showing a new TV disc player

RCA has demonstrated privately a new television disc player that could compete with the Teledec system being developed in Germany (see ED 16, "Low Cost TV Recorder-Player Systems on the Way —Finally," Aug. 3, 1972, p. 32). In contrast to Teledec's paper-thin disc, which turns at 1500 rpms and can play for five minutes, the RCA disc is thick, like a conventional long-playing record. The RCA platter is played at about 500 rpms, has a viewing time of 12 minutes and can record on both sides.

RCA has refused to confirm or deny publicly that the system is under development. It is expected to sell in the $140-to-$400 range.

Leo Hofberg, manager for special products for London Records, Inc., New York City—the U.S. representative for Teledec—asserts that the RCA unit should pose no real competitive threat. He says the Teledec disc—which is about seven inches in diameter, sized to an international mailing standard —has a potential for mass-media distribution. Because the disc is paper thin, it can be bound into magazines, newspapers and other printed media, as well as incorporated in education texts, according to Hofberg.

Senate unit backs bill for metric conversion

It won't die overnight, but the English system of measurement, now the standard in the United States, appears to be doomed.

Under legislation approved by the Senate Commerce Committee, the metric system would be phased in over the next 10 years and the old miles, yards, pounds and quart eased out. The bill would not make metric measurement compulsory, but it would set a national goal of switching "predominantly, although not exclusively."

The next step, expected some time after Labor Day, will be a vote on the bill by the full Senate.

To avoid production of equipment with both English and metric measurements, the bill would set up an 11-member National Metric Conversion Board to synchronize each major industry's switch. The board would not have coercive power but would help those who requested it.

An allowance for permitting a fast tax write-off for new equipment for the conversion was proposed, but it was killed by the Administration. Industry itself would pick up the tab under the Senate bill.

News Briefs

The Federal Communications Commission is asking for comments from interested parties on the extent of public demand for "data phone" or an equivalent service between the United States and overseas points. In the meantime it has rejected Western Union International's application for overseas dataphone services.

The Air Force reports it has completed testing an advanced aircraft navigation system that has been nine years in development. The system employs electrically suspended gyros to provide inertially derived position, velocity and attitude information for use in weapon delivery, navigation and flight control.

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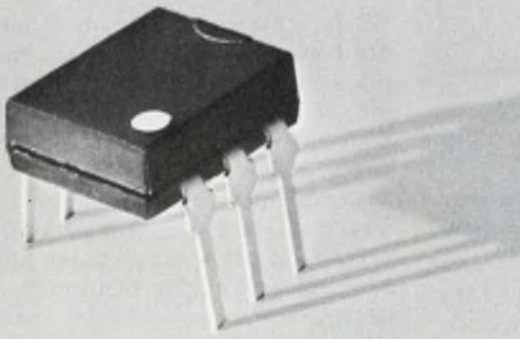

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BEST BUY
Our No. 1 Goal
QUALITY...SERVICE...VALUE

Live radio is becoming passe; Enter the automated station

The newscaster sits in front of a wide table arranging his copy as he waits for his cue. Opposite him sits a disc jockey doing a commercial in the voice of one of the many radio characters he creates, while an engineer nearby cues up the next record as he waits to switch in the newsman's microphone.

The scene is Radio Station WNEW-AM in New York City. Walking through the studios at 565 Fifth Ave., you can see a radio station that is very similar to those operated 10 years ago. True, the equipment has been improved to maintain a high-quality sound, but the basic operation hasn't changed much. The engineer still uses records instead of tapes, the disc jockey still does the intros and small talk, and except for some pretaped commercials, most everything else is live.

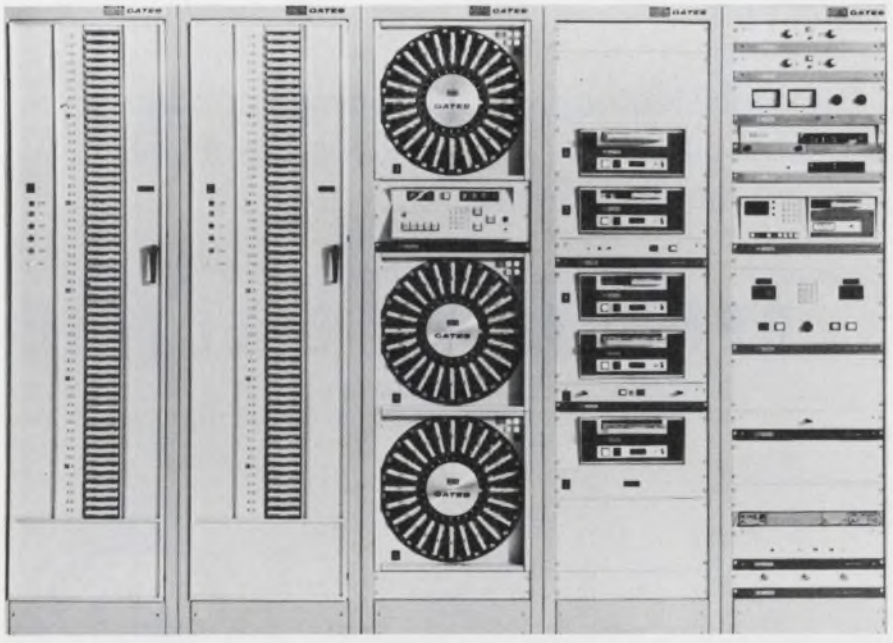
But WNEW is part of a vanishing scene. Automation is taking over in the broadcasting industry slowly but steadily, and in the not-too-distant future most radio stations may be like WNBC-FM.

If you listen to WNBC-FM, you hear music, disc jockeys, commercials and newscasts—all similar to the programming on WNEW or WNBC-AM. But if you go to the studio to watch a WNBC-FM broadcast, all you can see is an array of reel-to-reel tape players, cartridge players, a digital clock and a large assortment of other electronic equipment. You see tape players mysteriously turned on and just as mysteriously turned off in proper sequence. And when it's time for a newscast, the station automatically switches to a network broadcast. After the news, the equipment switches back to the station's regular programming.

If you look hard enough in a rear corner of the studio, you can see one WNBC-FM engineer sitting at a desk, possibly reading a paper, occasionally glancing at a monitoring console before him.

The engineer is there only as a safeguard. The station is programmed to play music, commercials and other features early in the day, and it performs unaided.

Jules H. Gilder
Associate Editor



Automated programming system by Gates Radio uses cartridges for both music (racks on left) and commercials (carousels in center). A digital clock controls station operation according to a preprogrammed magnetic tape.

A multitude of new trends

Automated station programming is only one of many trends developing in the radio broadcasting industry. Others include:

- Transmitters monitored by computers for more precise control with fewer people.
- AM stereo for rural and automobile reception, without the fading and multipath distortion generally associated with FM.
- Pulsewidth-modulated AM transmitters for less power consumption and increased efficiency.
- Dolby noise-reduction circuitry for improved signal-to-noise ratio and other advances.

Minicomputers are starting to make strong inroads into broadcasting, reports Lee Facto, executive vice president of International Good Music Corp., Bellingham, Wash., a broadcast-equipment manufacturer. In addition to automating station programming, computers will be able to control transmitters by the end of this year, he says.

The primary goal of such a system is to insure continued operation. To do this, a computer must be programmed to monitor such parameters as power level, modulation and frequency. In addition

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CITY	COURSE	PRESENTATION DATES	DEADLINE FOR POSTMARK OF REGISTRATIONS
Washington/ Baltimore	Memories	Sept.25-26	Sept.11*
	MOS	Sept.27-28	Sept.13*
Philadelphia	Memories	Oct.2-3	Sept.18*
Dallas	Memories	Oct.5-6	Sept.21*
Newark, N.J.	Memories	Oct.10-11	Sept.26*
	MOS	Oct.12-13	Sept.28*
Long Island, N.Y.	Memories	Oct.17-18	Oct.3*
	MOS	Oct.19-20	Oct.5*
Norwalk, Conn.	Memories	Oct.24-25	Oct.10
	MOS	Oct.26-27	Oct.12
Boston	Memories	Oct.31-Nov.1	Oct.17
	MOS	Nov.2-3	Oct.19
Rochester, N.Y.	Memories	Nov.8-9	Oct.25
Dayton	Memories	Nov.13-14	Oct.30
Indianapolis	Memories	Nov.16-17	Nov.2
Chicago	Memories	Nov.27-28	Nov.13
	MOS	Nov.29-30	Nov.15
Denver	Memories	Dec.5-6	Nov.21
Palo Alto	Memories	Dec.11-12	Nov.27
	MOS	Dec.13-14	Nov.29
Los Angeles	Memories	Jan.8-9	Dec.26
	MOS	Jan.10-11	Dec.27
Orange County, Calif.	Memories	Jan.15-16	Jan.2
	MOS	Jan.17-18	Jan.3
San Diego	Memories	Jan.22-23	Jan.8
Phoenix	Memories	Jan.25-26	Jan.11
Houston	Memories	Feb.1-2	Jan.18
Orlando	Memories	Feb.6-7	Jan.23
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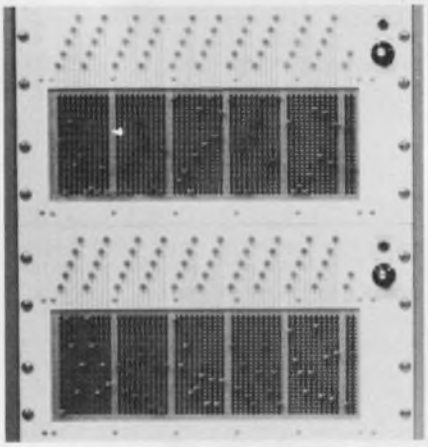
the machine can be used to calculate transmitter tube efficiency, to minimize noise and distortion, and to provide diagnostic messages, logging and operator signaling.

The computer's function need not be limited to reporting conditions as they exist, Facto notes. It may also be used as an interactive device, by having it perform predetermined corrective adjustments stored in memory. In short, a computer can do practically anything an engineer can.

The cost for computer systems, Facto says, ranges from less than $10,000 to more than $120,000, depending on the complexity of the station. International Good Music will have a system available next month that uses a PDP-8 mini. A typical FM installation would cost about $20,000, Facto says, while an AM one would sell for about $30,000.

One obstacle that could prevent the immediate use of computer-controlled transmitters is a lack of approval from the Federal Communications Commission. According to Bruce Longfellow, supervisory engineer for the FCC's Broadcast Bureau, Congress must first amend the Communications Act to allow for computerized radio transmitters. While this could take time, Longfellow admits, he doesn't see any major objections to ultimate approval.



Manual random access memory is generally used to automate carousels which contain commercials, public service announcements, etc.

AM stereo appears imminent

Another area of growing interest is AM stereo radio.

AM stereo is not new. It was first tried about 10 years ago. At that time several companies, including RCA, Philco and Westinghouse, experimented with stereo systems. None, however, was very successful. The reason is that they used either phase and amplitude modulation or phase and frequency modulation to achieve the stereo effect. Those techniques resulted in high negative modulation peaks, which caused interference and noise.

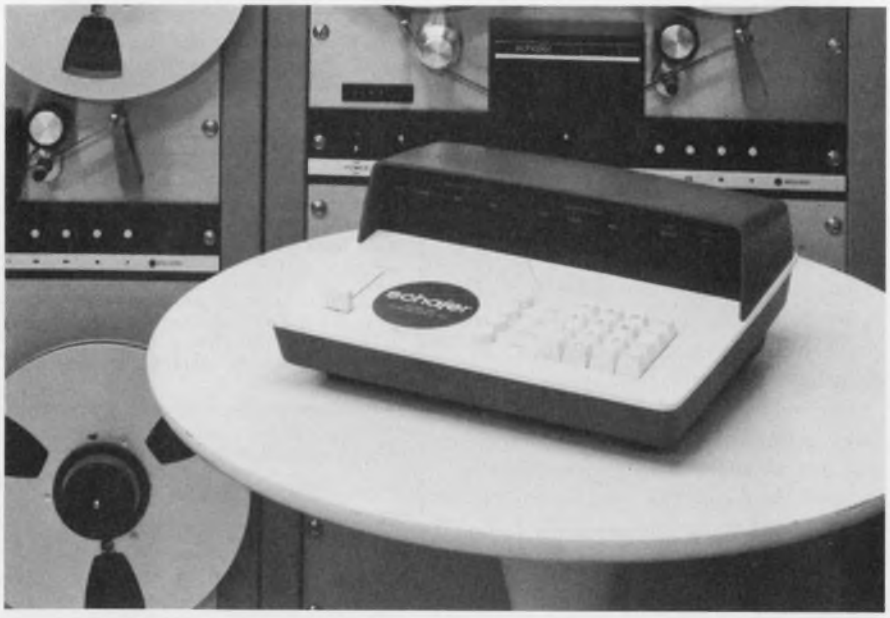
A system that has apparently overcome these problems has been developed by Kahn Research Laboratories of Freeport, N.Y. According to Leonard Kahn, president of the company, the sum and difference signals—required for stereo reception—are transmitted via the upper and lower sidebands of the AM signal, and thus stereo transmission requires no more bandwidth than conventional AM transmission.

The system has been successfully tested in the laboratory, Kahn reports, and it has made its commercial debut in Tijuana, Mexico. Several stations are reportedly interested in testing the system but must await FCC approval.

In the meantime radio listeners in the San Diego-Los Angeles area can hear AM stereo from XETRA, the Mexican station.

If AM stereo does become popular, a special receiver costing about 30% more than present ones will probably become available. An alternative, Kahn says, is to use two radios to receive AM stereo. Each radio is tuned slightly off center—one on the high side, the other on the low side.

Kahn reports his sideband system is capable of a channel separation of 30 dB and a frequency response of from 50 to 13,000 Hz, with harmonic distortion at 1%.



Keyboard memory unit from Schafer Electronics uses an MOS random access memory to store the operating program instead of magnetic tape. The unit holds an entire day's scheduling and can be loaded directly from the keyboard or from a prerecorded cassette.

Transmitter efficiency improved

Another new development is a pulsewidth-modulated AM transmitter developed by Gates Radio Corp. of Quincy, Ill. The modulator is almost 90% efficient—instead of the usual 50 or 60%—and results in an over-all transmitter efficiency of about 65%. This increase in efficiency means that total power requirements can be cut by as much as 33%.

In operation, the pulsewidth modulator adds the audio signal to be transmitted to a 75-kHz sawtooth signal. The combined signal then goes to a level detector, which determines the point on the sawtooth wave at which a pulse amplifier will conduct. The output of the pulse amplifier is a series of square pulses that vary in duration with the input audio. The square pulses are then passed through a low-pass filter that removes the 75-kHz signal, leaving just the high-power audio signal to

EXTRA NOTORIETY EXTRA

VOL. 1 No. 1 Santa Clara, California 95051, June, 1972 1 Page 0 Cents

NATSEM WOWS WINDY CITY CONFAB

5 Watt Audio Amp Bows, Car Mfg's say 'Socko'

Raves and kudos continue to be heard about NatSem's new LM383K IC audio amp, the only monolithic 5-watt RMS IC audio amp that's fully short circuit and thermally protected and has a preamp and power amp on the same chip.

Cost effective with discrete designs, the new LM383K also offers adjustable voltage gains from 50 to 500.

10-Watt Audio Amp Intros, Hi-Fi Phono Mkt Wowed

National Semiconductor has introduced a 10-watt monolithic power amp designed for use by manufacturers of hi-fi phonographs.

The new LM384 will deliver 10 watts RMS into an 8 ohm load at 28-30V supply voltage. The LM384 is fully short circuit and thermally protected, has both a preamp and power amp on the same chip and is cost effective with discrete designs.

KIDDIE PHONO, PAGING AMP REAL 'LONER'

A new 4-watt IC audio amplifier that requires one external component has been unveiled by National Semiconductor.

Available in a 14-pin DIP package, the new LM380 audio amp was designed specifically for use in kiddie phonographs, paging systems, intercoms and toys which require an amp for their operation.

CERAMIC PHONO CARTRIDGES FIND FRIEND IN NEW DUAL CHANNEL AUDIO AMP

National Semiconductor has added a dual 2-watt audio amplifier to its expanding line of consumer linear integrated circuits. The new LM377 provides up to two watts of continuous RMS power into an 8 ohm load on each of its channels with a high impedance equal to 10 megohms, ideal for the ceramic phono cartridges found in most home stereo sets. Gain is 100 dB and distortion is only 0.5 percent at 1 kilohertz, while power bandwidth is 65 kilohertz.

TV SIGNAL PROCESSOR PACKED WITH POWER

A complete 2-watt TV sound system, utilizing proven circuit techniques, has been incorporated into National's new LM1805. The FM IF portion of the LM1805 uses a three-stage limiting amplifier and a differential peak detector combined with a DC volume control.

Designed for use with a minimum number of external components, the audio power amp section of the new LM1805 may be operated over a wide range of power supply and speaker impedance combinations.

OPEN LOOP GAIN, HIGH INPUT IMPEDANCE MAKE 4-WATT STEREO AMP 'WINNER'

A new dual 4-watts-per-channel stereo amp, the LM378, has been introduced by National Semiconductor.

An internally-compensated IC stereo amp, the new LM378 features a 100 dB open loop gain, typical 10 megohm input impedance, a dual internal power supply regulator and optimum turn-on, turn-off characteristics to eliminate turn-on delay and speaker pop.

Possibilities 'Unending' For New NatSem Quad Amp

National's new LM3900 is the first operational amplifier developed to operate from a single +4 to +36V supply and split supplies as well. It consists of four complete amps on a single monolithic silicon chip and is priced at only 75 cents in quantities of 100.

The new LM3900, which is internally frequency compensated for unity gain and completely short circuit proof, has an open loop gain of 70 dB and a unity gain bandwidth of 2.5 megahertz. Input bias current is only 30 nanoamps.

The combination of four independent amps on a single chip and single power supply operation opens up scores of new applications for op amps in industrial and automotive equipment applications where only one power supply is available.

Intros IC Preamps, Audio Amps

Chicago—One of the bigger coups pulled off at the Spring Conference on Broadcast and Television Receivers was the unveiling of a new line of integrated circuits that perform preamp and audio amp functions within recording, stereo, hi-fi, phono and other entertainment and broadcast-oriented systems.

The new IC preamps and audio amps are being manufactured in volume by National Semiconductor Corporation, a company who's no stranger to the integrated circuit business.

"What we've done," says a NatSem spokesman, "is to take the functions which normally require a combination of discrete transistors, IC's, resistors and put everything on a single chip, with little or no external components required."

In addition to their basic advantages of better systems reliability and lower systems costs, each of NatSem's new IC preamps and audio amps has its own distinct advantages. The LM381, for example, is the lowest noise dual preamp in the business, while the new LM382 is a low noise dual preamp which offers full R.I.A.A. and N.A.B. equalization with a minimum of external components.

Each of NatSem's new consumer IC's, available now at all National Semiconductor distributors, is described in more detail elsewhere on this page.

Kudos for Super Low Noise Preamp

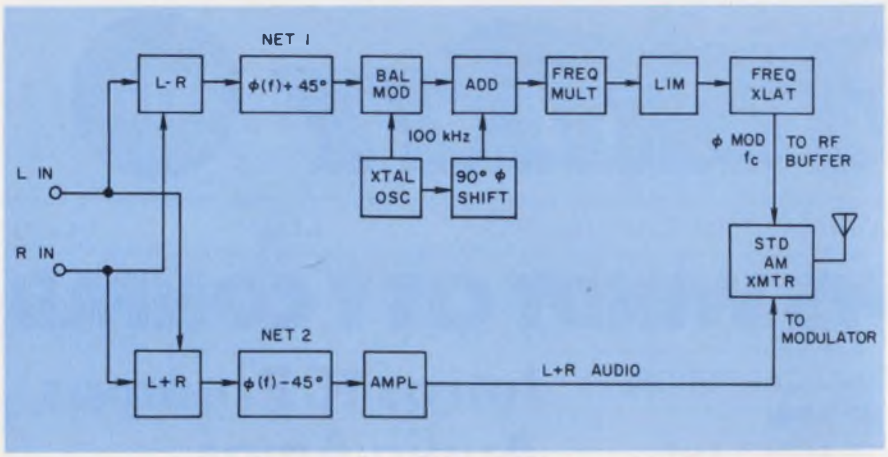
A growing army of former discrete NPN and PNP transistor users are touting the merits of NatSem's new LM381 IC dual preamp. Designed for extremely critical low noise applications, the new LM381 offers a wideband equivalent input noise of 450 nanovolts with 600 ohms source impedance and 10 kilohertz noise bandwidth.

As a result, the new LM381 offers users a single-chip dual amplifier that's as performance effective as a transistor-resistor combo, with much better reliability in the long run.

R.I.A.A., N.A.B. EQUALIZED PREAMP PREEMS, USERS HAIL SIMPLICITY

A cost-conscious low noise IC preamp aimed at the auto tape, tape player, recorder and phonograph market is now available from National Semiconductor.

The new LM382 not only offers the advantage of low noise operation, but requires just three additional external components for full R.I.A.A. or N.A.B. equalization.



AM stereo system developed by Kahn Research uses sum and difference signals to transmit stereo information. Stereo signals are transmitted via upper and lower sidebands of the AM signal.

modulate the power amplifier.

While it is only now becoming available to the broadcast industry, this type of transmitter has been tested and used in Vietnam by the U.S. military for several years.

For the future, industry sources see increased use of Dolby noise-reduction circuitry. Developed in England by Dr. Ray M. Dolby, the circuit reduces noise during the quiet periods of a recording. This is done by using an expansion-compression technique. The system passes high-level signals with unity gain. For low-level signals during soft passages, the Dolby circuit raises (expands) the signal level just before recording. During playback, the circuit attenuates (compresses) the raised signal back to its original level, reducing the noise added during recording.

FM stations are just now beginning to use the Dolby circuit, but it is very expensive, says Facto of International Good Music. What the industry needs, he continues, is an inexpensive retrofit kit that can be used to modify existing tape recorders and players.

Another current need in the broadcasting industry, Facto notes, is instantaneous random access to program material. One possible approach, he suggests, is adapting the high-speed tape equipment used in the computer industry. However, there is a trend in the broadcasting industry away from electromechanical devices and to solid state, Facto says. If a way could be found, he adds, to memorize audio in a solid-state system and to recreate it with broadcast quality at a reasonable price, it could be the biggest step forward in broadcast audio since the development of the tape recorder itself.

This step may not be far off. A new device developed by Master Specialties Co. of Costa Mesa, Calif., known as an automatic number announcer, uses read-only memories to synthesize the human voice. Although this new voice-response system can store only simple messages, it is not inconceivable that this system can be expanded to store music. ■■

Improved waveguide built of graphite

A new graphite epoxy composite material is being used to build waveguides, and the result is structures that have less than half the weight and thermal expansion of devices made of invar material.

Moreover there are savings in manufacturing costs, says the Hughes Aircraft Co., maker of the new waveguides. Brian Keller, manager of the company's Materials and Processes Laboratory in Culver City, Calif., notes:

"Our cost analysis indicates that silver-plated graphite composite waveguide devices can be produced at less cost than their invar counterparts. We feel that these devices will be used in such areas as satellites, airborne radar and missiles."

Invar waveguide is used in most applications where thermal stability is important. Invar has a temperature coefficient of 0.9 $\times$ 10^{-6} in/in/F. But it is very heavy. Graphite epoxy composite has a temperature coefficient of 0.4 $\times$ 10^{-6} in/in/F, and it weighs about 70% less than invar.

The graphite material is similar in structure to fiberglass. It contains long strands of graphite fibers, bonded together with a proprietary epoxy. It comes in sheets with thicknesses down to about 7 mils. To construct a waveguide with good structural rigidity, four plys are used to give a wall thickness approaching 30 mils.

Waveguide made of the composite material, according to Keller, works fine over a temperature range of at least -250 to $+250$ F. Hughes compared a four-cavity graphite composite filter with an identical invar filter over a temperature range of 0 to 140 F. Both filters were plated with silver, and both were tested at a center frequency of 4.16 GHz. The insertion loss of the graphite filter was a nominal 0.29 dB against 0.30 dB for the invar filter, according to Keller. The frequency shift, measured over the entire temperature range, was 0.40 MHz for the graphite filter against 1.15 MHz for the invar filter.

Keller notes that the breakthrough in making graphite composite a practical material came in the area of plating. "It took a while," he says, "but we finally found a process that allows us to put down a uniform coat of high-conductivity silver plating."

Keller, who uses a plating thickness of about 1 mil on his waveguides, says they will work fine up to the low-millimeter frequency range. Above that dimensional changes may occur. ■■

War electronics proving useful in search for oil in jungles

Early this month a variety of modified military electronic equipment, some of it of World War II vintage, began the peaceful but formidable job of exploring for petroleum and mapping 130,000 square miles of the Amazon jungles of Peru.

Expected to take about three months, the work is being carried out by Grumman Ecosystems Corp. for Petroleos de Peru, an oil company owned by the Peruvian Government. Ecosystems is a subsidiary of the Grumman Corp. of Bethpage, N.Y.

"Although the pacified military gear works well, newer systems for ecological jobs will eventually evolve," says Thomas W. Attridge Jr., vice president of Ecosystems.

The position-locating techniques now used, for example, range from Shoran, a highly accurate, transportable bombing system used during World War II, to Transit, the navigation satellite.

"We set up Shoran transmitting towers on hills throughout the area being mapped, and these give the aircraft its distance from each tower," explained R. W. Pate, Ecosystems' manager of systems technology. "We determine the position of the hills themselves by taking 35 position fixes on each one with the Transit navigation satellite." Averaging out the results determines the tower's position within 10 meters. "Eventually," Pate says, "we want a navigation and locating system that does not depend on setting up sites on hills."

Map-making is being done now by Motorola's sidelooking radar, the AN/APS-94. The latter is the prototype of the APS-94D, which has been highly successful in Vietnam in the Army's Mohawk OV-1D surveillance planes. The radar's mapping capability has been improved by elimination of its moving-target indicator.

Grumman Ecosystems' manager of systems technology, R. W. Pate, **searches for mineral deposits in Peru with Texas Instruments' AN/ASQ-81 magnetometer. In another aircraft the same area is mapped by sidelooking radar.**

This has freed an entire CRT to present the fixed target seen from the righthand side of the plane, and an entire CRT for the lefthand side. On the military version half of each CRT is dedicated to fixed targets and the other half to moving targets.

The sidelooking radar in Peru is being flown in a modified World War II Douglas A-26.

Sub chaser looks for oil

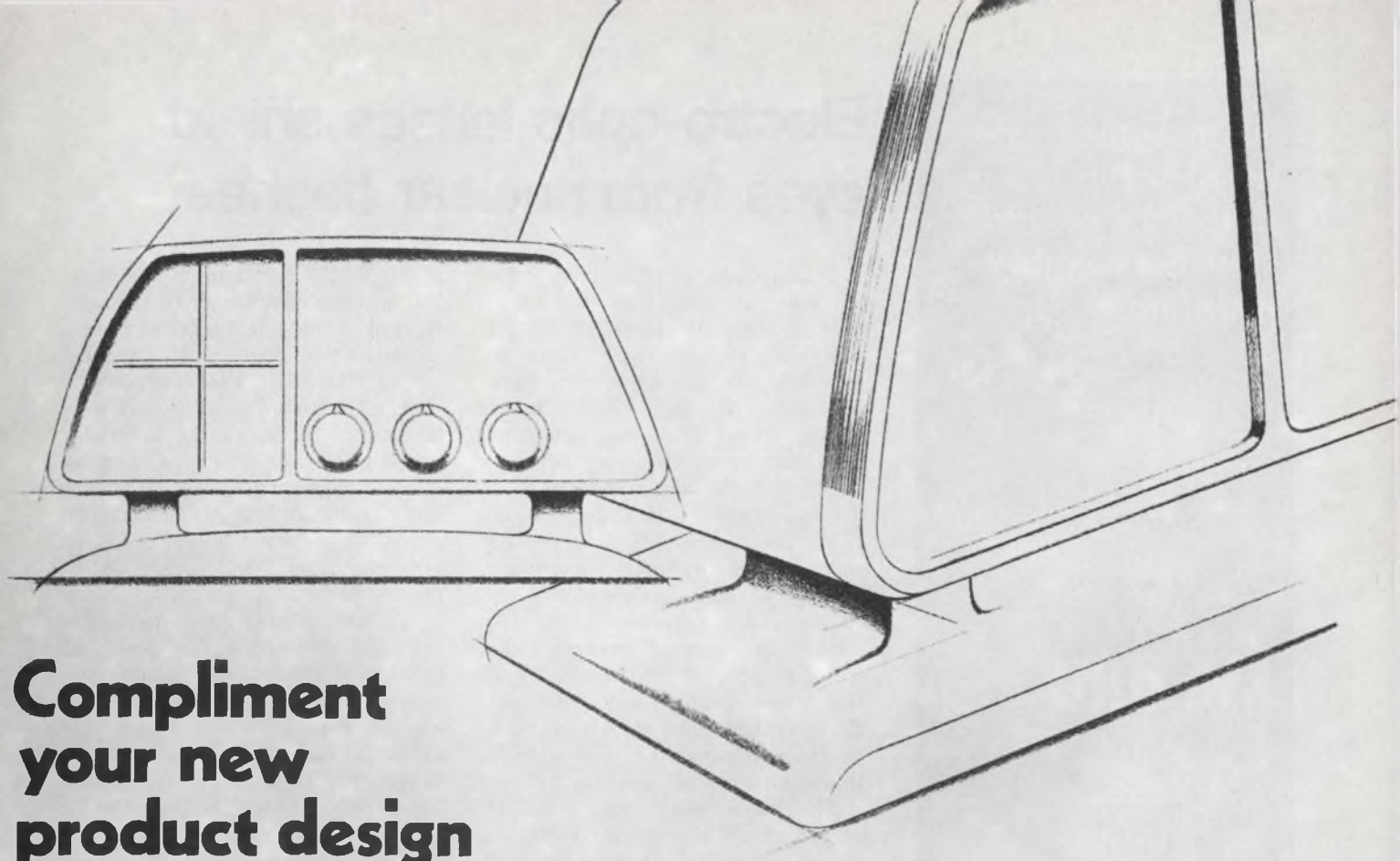
The search for oil and gas is being made by a Texas Instruments' AN/ASQ-81 magnetometer, the type usually used by U.S. Navy patrol planes to detect intruder submarines. Ecosystems' sensor protrudes from the tail of Grumman's Gulfstream I, a turboprop corporate craft.

In the future, Pate said Ecosystems plans to augment its magnetic findings by sending out a ground team to make a variety of measurements—seismic, gravity, geochemical and electromagnetic, "the whole gamut of tricks in the prospector's bag."

Also looking down through the floor of the Gulfstream I is an IRSA 8 infrared line scanner made by Daedalus. The scanner operates at 0.5 to 5.5 μ or 8 to 14 μ. The data output is continuous 70-mm film converted from magnetic tape.

The plane's Doppler navigation system, a GPK-1000, built by General Precision, has been modified to give more precise readings than are normally needed. It reads out at 1/50th mile increments instead of the conventional 1/5th mile. The system has been tied in with the flight director.

All the sensors and navigation equipment feed into a digital data-acquisition system that records on magnetic tape. One modification under way, Pate says, is the addition of a verifier and printer for the tape recorder. "Now, we have no read capability," he points out. "We know the tape recorder is recording, but we don't know if it's valid or recording correctly. With a read-and-write capability we'll know." ■■



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Electro-optic lenses shield eyes from nuclear flashes

Transparent goggles have been developed that can sense a dangerous increase in light in 50 μs and then darken their lenses to save the wearer's eyes from damage. When the light level returns to a safe level, the lenses automatically become transparent again.

Developed by researchers at Sandia Laboratories in Albuquerque, N.M., the electro-optic lenses could serve as a valuable protection against nuclear flashes. And they could be a safety device for arc welders and metal workers. To shield equipment sensitive to light, the lenses could filter the light that reaches light detectors, such as image intensifiers and vidicon tubes, the researchers say.

The lenses might also serve as an electronic shutter for cameras, an optical switch or light gate or a variable-density transmission window that could provide a gray scale over four orders of magnitude.

Photochromic glass, produced by Corning Glass and used by several optical companies to make clear glasses that become sunglasses on exposure to strong light, takes several seconds to react—not fast enough to guard against nuclear flashes.

The Sandia device is a sandwich consisting of a polarizer, an electroded PLZT (lanthanum-modified) lead zirconate-lead titanate) ceramic and a second polarizer crisscrossed at 90 degrees with respect to the first. The PLZT surface is overlaid with an interdigital electrode array in which the electrodes are 2 mils wide and separated by 40-mil gaps. The electrodes are either sputtered copper or vacuum-deposited chromium-gold. Each lens measures 1-1/2 inches in diameter.

Sandia inventors J.T. Cutchen (left) and J.O. Harris examine electro-optic flashblindness goggles.

A flash of light—or its beginning—is detected by an array of five tiny photodiodes placed between the two goggle lenses. The diodes—each of which has a different angle of visibility—are integral parts of a discriminator circuit that senses the light-intensity threshold and switches the goggles to their opaque state. This is done by applying voltage to the ceramic that alters the alignment of the ferro electric domains within the material so the alignment prevents light from passing through. The level at which this occurs may be adjusted by changing the values of resistors in the circuit.

The power supply consists of a 5.4-V battery, a dc-dc converter and electronics. It displaces 12 cubic inches and weighs 10 ounces. And, Sandia says, it can be miniaturized still further.

Operating the goggles requires only a few picoamperes of current, although the converter has a potential of 950 V. The battery will power the goggles for about 200 hours. The units Sandia has already developed have been triggered several thousand times without measurable degradation.

Light transmission through the goggles when they are turned on is about 21%, and they are almost colorless. U.S. Air Force sunglasses transmit 15%. When desired, the transmission may be set to any level between 21% and "opaque" —0.003%—by means of a simple rheostat control. "Near opaque," to which the lenses automatically adjust when a bright flash starts, is 0.01% transmission. ■■

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INFORMATION RETRIEVAL NUMBER 18

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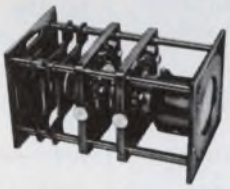

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INFORMATION RETRIEVAL NUMBER 19

technology abroad

Low-loss fiber-optic waveguide experiments are being conducted at Southampton University in Britain. So far they have produced an unusually low transmission loss, on the order 10 dB/km, with liquid-core fibers. The liquid core internal diameter was 50 μm. (Bell Telephone Laboratories in the United States recently claimed a loss of 13.5 dB/km). The low-loss transmission region of the new fiber extends to longer optical wavelengths—for example, the wavelength range for a 20 dB/km loss was found to be 0.8 to 1.1 μm. The experiments are expected to increase interest in multi-mode fiber-optic transmission systems, previously neglected because of high attenuation and narrow bandwidth limitations. A research team at Southampton University has been investigating various materials for use in viable optical communication systems since 1967.

CIRCLE NO. 441

The sound-attenuation properties of glass windows can be measured in the laboratory with a black box developed by Pilkington Brothers, a glass manufacturer in Britain. Pilkington's Spectrum Shaper reproduces electronically the sound-insulation "performance" of any window. Signals representing raw traffic noises or the sound of a 747 jet taking off are fed into the equipment. The Spectrum Shaper adjusts its volume and frequency to give the true level of noise attenuated by glass windows made with different materials in different configurations. A simulation of the degree of insulation, which varies from 12-mm-thick glass to dual windows with wide air-spaces, is selected by a patch-board.

CIRCLE NO. 442

A novel constant-voltage-supply transformer has been developed by Brandenburg, Ltd., an English high-voltage power supply manufacturer. The transformer was designed for photomultiplier supplies in which voltage stability was the prime requirement. The output voltage of the transformer remains constant despite large changes in input voltage or the load. The transformer has a high leakage reactance with at least two secondary windings. The combined output of the two secondary windings is related—if the output of one increases, the output of the other decreases. Thus the output to the load can be controlled by varying the load on either secondary winding. In use, the transformer is supplied with a fraction of the primary line voltage. This fraction is compared with a reference voltage. When a differential voltage appears, it is applied to the control winding, which in turn induces a correction in the main output winding. The same design technique can be applied to constant current supplies.

CIRCLE NO. 443

A technique that increases the radiation resistance of silicon planar devices has been developed by the Siemens AG Research Laboratories in Germany. Improvements of radiation resistance by factors of 10 to 100 are reported to have been achieved with only relatively simple post-fabrication radiation and temperature treatment. This treatment is in contrast to the usual method that involves the replacement of silicon dioxide by other passivation layers. Arising from a Government-sponsored program to investigate damage to electric components caused by high-energy radiation in and around the Van Allen radiation belts, the new radiation-hardening technique can be applied to other components without additional development costs, Siemens says.

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That's right . . . for a limited time we are offering the ultimate display — *nimo 64* — for a cool $29.95. Or, how about the complete display kit which includes: the *nimo* 64-position tube, socket, filament transformer and power supply. Everything you always wanted to have to display the ultimate image. Price of the kit: $49.95.

What's so great about *nimo?* Consider the following: *nimo 64* displays the full typewriter keyboard (ASCII/EBCDIC), symbols, image combinations, 5-line messages, etc. — all this requiring but 1.5" of panel space. The display is sharp, distinct, and true to form, and no translation is required from coded messages as in competitive devices. Name the parameter: cost, value, aesthetics, human factors . . . *nimo 64* is the answer to today's display applications. And, it's uses are endless:

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You name it, *nimo 64* fits it.

This offer is good through December 1, 1972, **so act now**.

Fill out the order form on the reverse side, check the appropriate squares and attach your purchase order, check, money order or hot cash and mail it in. **We'll act . . . like now!**

EBCDIC

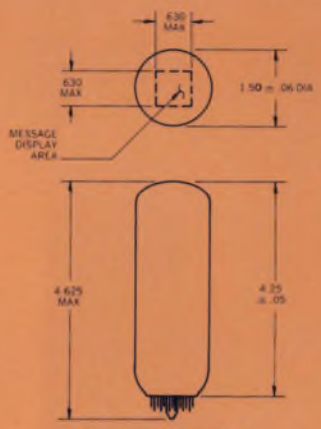
ASCII

UNIVERSAL

ACTUAL SIZE

MECHANICAL CHARACTERISTICS

Operating position ..... Any
Envelope T12ZD1
Base ..... 26 pin
Anode connection.....Through base
Socket .....IEE p/n 21049
Outside diameter ..... 1.50″
Max. overall length.....4.750″
Seated height .....4.250″ ± .05



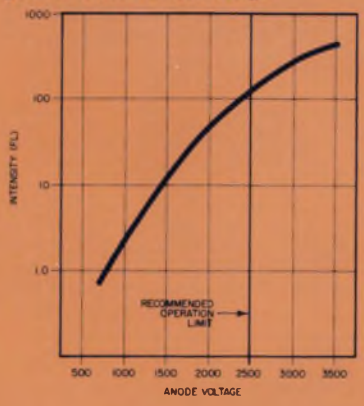
Physical Dimensions

ELECTRICAL CHARACTERISTICS

Filament voltage, AC or DC .....1.75 ± .15V
Filament current.....0.8 amps max.
Anode voltage (normal)....2.0 KVDC
Anode current (max.).....80 μA
Normal brightness.....70 ft.-L
Blanking grid voltage "off"..−10 VDC
Blanking grid voltage "on"..+2.5 VDC
Aperture grid voltage "off"..−10 VDC
Aperture grid voltage "on"..+2.5 VDC
Phosphor (standard).....Color code 2
Fluorescence ..... Green (optional red and blue phosphors available on special order)
Persistence ..... Medium

DISPLAY CHARACTERISTICS

Display area ..... .63 x .63 max.
Character height.....0.562″ max.; 0.125″ min.
Message capability.....Up to 5 lines, 8 letters per line
Character style.....Modified alternate gothic #3, or custom design



Anode Voltage Curve

ENVIRONMENTAL CHARACTERISTICS

Vibration ..... 10-50-10 cps at .06 double amplitude on all axes
Shock ..... 35g's, 11 milliseconds
RFI..... Meets MIL-I-26600
Phosphor Life..15,000 hours at nominal brightness without catastrophic failures

POWER SUPPLY

This 15 VDC-in/3 KVDC-out anode power supply was specially designed for the nimo 64 and is capable of driving up to 8 tubes simultaneously. Dimensions: 1⅛″ x 1⅛″ x ¾″ solder connections.

FILAMENT TRANSFORMER

1½″ x 1⅝″ x 1-15/16″. 2⅜″ mounting centers. Input 117V, 50/60 Hz, or 220V, 50 Hz. Commercial quality.

DRIVER/DECODER

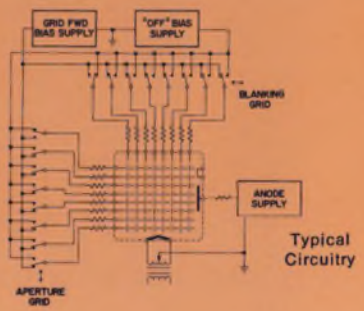
nimo®64 grid structure is arranged such that 8 parallel aperture grid bars are oriented at right angles to 8 blanking grids with cathodes spaced inbetween. Each one of the 64 so formed grid intersections constitutes an electron gun. A gun is activated when both the intersecting grids are biased sufficiently positive. The gun will remain in OFF position if one grid member is negative. There are 16 lines required to address this 8 x 8 matrix.

The driver/decoder reduces the necessary number of control lines to six. By using five integrated circuits, 8 blanking grid control lines can be decoded from 3 binary weighted lines, while 3 additional binary lines can be decoded into 8 aperture grid control lines. Such an 8 by 7 matrix may be treated as an ordered pair of numbers (a pair of 3 character binary numbers), hence, a message may be addressed i.e., one, eight (001, 100 in binary) to display the message in the upper right corner of the mask.

The above decoder/driver function requires the following:

2 SN 7442N — Decoders; 3 MC1820P — Hex Inverters.

(Complete driver/decoders, memory/non-memory are available for remote mounting from IEE).



Typical Circuitry

nimo 64 Super Special Sample Order Form

O.K. IEE, send me the following:

☐ nimo 64 display and socket $29.95 *
☐ nimo 64 display, socket, transformer, power supply $49.95 *

Filament transformer required (check one)
☐ 117V, 50/60 Hz ☐ 220V, 50 Hz

Mask selected is (check one).

☐ ASCII ☐ EBCDIC ☐ UNIVERSAL

Return Form To:

Industrial Electronic Engineers, Inc.
7740 Lemona Avenue
Van Nuys, CA 91405

*Prices shown do not include local taxes and/or import duties and transportation costs if purchased outside continental United States.

Name_____
Title_____
Firm_____
Dept._____
Address_____
City_____
State_____ Zip_____
Telephone_____
Amount enclosed $_____
Purchase order #_____

☐ Have your local Representative call me for a demonstration.

washington report

The McGovern defense program: Some clues

Where would Senator George McGovern slash the defense budget to save the $30-billion he says he would over two years? Robert Sherman, a member of the Presidential candidate's staff on defense strategy, has given ELECTRONIC DESIGN the following clues:

Conversion of Minuteman missiles to more powerful warheads would be held to 250 missiles, about half the number the Pentagon wants. Twenty Polaris submarines would be converted to the Poseidon configuration instead of 30. Deployment of the Safeguard system would be halted and the ABM work would be confined to research and development. Prototype development of the B-1 bomber would be stopped; any future research and development and procurement decisions would be aimed at increasing the potency of existing bombers. While older B-52 bombers would be phased out, McGovern recommends buying SRAM and SCAD missiles for the B-52 and the FB-111 force. He would continue research on the super submarine, Trident, but hold off freezing design "until the nature of the Soviet threat that it is designed to face is proven to his satisfaction," Sherman said.

Senator McGovern would cancel the F-14 program, turning instead to a lightweight fighter now being studied by several companies or to an improved F-4. He recommends six aircraft carriers instead of 12, and no further funds for escort ships. He would, however, plan for a nuclear attack submarine fleet of 84 subs.

Such a budget, Sherman says, would provide the "necessary elements of national interest, including nuclear deterrents, protection of NATO, protection of Israel, and would give the U.S. some ability to operate in waters off Asia and Latin America, if necessary."

While many jobs in the defense industry would conceivably be threatened by such a budget, Sherman says, "that McGovern has detailed plans, for transfer of such talent to greatly expanded Government programs on environmental problems, mass transit, emergency medical care and traffic control."

Military programs facing tests in Congress

New threats to military hardware projects are looming as Congress returns from recess to consider Defense Dept. money bills. Among the major targets will be Grumman Corp.'s F-14 aircraft and the Litton DD-963 destroyer. Both programs are now projected at substantially over their initial estimates.

The Senate and the House already have slashed the DD-963 program for this year from $610-million to $247-million, but both bodies of Con-

gress reluctantly approved $773-million requested for the F-14. The E-3A fighter aircraft's airborne warning and control system was slashed by $309.9-million in procurement funds, but $83-million was added for research and development. In other items the House approved the President's request for ABM protection of Washington, D.C., but the Senate voted it down. While the House voted to provide six Advanced Airborne National Command Post aircraft, the Senate approved only four.

These differences are being settled in a conference of House and Senate members on the Military Authorization Bill. The next round begins when the House Appropriations Committee reports on the Defense Appropriations Bill, which provides the actual amount the Defense Dept. can spend this year within the ceiling of the Authorization Bill.

U. S. may ease exports to Soviet bloc

Congress is considering legislation that could greatly increase the export of high technology items to the Soviet Union and other Communist countries. A proposed bill would require the Secretary of Commerce to restudy the list of prohibited export goods and remove those that already are freely available from foreign sources. The Commerce Dept. would also be required to justify any unilateral controls imposed on items and to set up industry-government committees to review specific items. The bill, S.3727, has been passed by the Senate and is being considered by the House.

FCC decision due on TV uhf tuners

The Federal Communications Commission is expected to decide the end of August on a request by the electronics industry to modify the government's requirements for future television uhf tuning equipment.

The Electronic Industry Association urged the FCC late in July to reconsider a requirement that all TV receivers sold after July 1, 1974, have 70-position channel mechanisms, with afc, and a reset accuracy within the pull-in range of afc circuitry in use today.

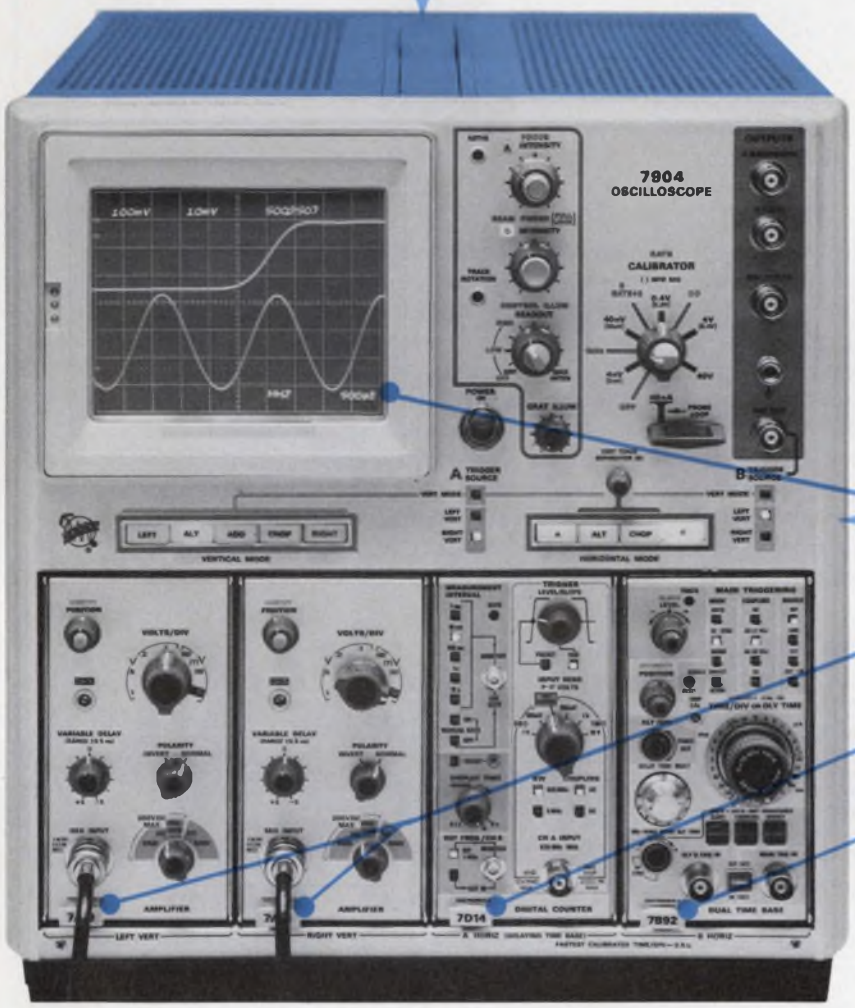
EIA told the Commission that the afc circuitry would price black-and-white TV sets and low-cost color sets out of the market. The association also has asked that the Commission relax the deadline date, since such tuners are not now available for sets already under construction for marketing in that time frame. In addition the EIA has asked the FCC to limit the uhf TV channels that must be received to channels 14 through 69, effective July 1, 1974.

Capital Capsules:

The Naval Electronics Laboratory in San Diego will have the last word on the design of many of the Navy's most important electronic systems due to a revision in the Naval Electronics Systems Command's charter. The Command's responsibilities now include command, control and communications. . . . The Bureau of Labor Statistics says that while average salaries for white-collar workers in private industry rose 4.4% over the nine months from June, 1971, to March, 1972, **engineers salaries rose 3.9%.** . . . The Electronic Industries Association is calling for papers for its **23rd Electronic Components Conference,** to be held next May 14-16 in Washington, D.C. . . . **Power-tube sales were up 19.8% in the first quarter of this year,** reaching $7-million, according to the EIA. . . . The Pentagon has decided to go forward on development of a **more accurate and destructive re-entry vehicle for its Minuteman force.** The vehicle is called the Mk-19.

TEKTRONIX® 7900 FAMILY

1 GHz Direct-Access Oscilloscope



TEKTRONIX 7904

featuring extended performance or general purpose use, from one mainframe and a family of plug-ins.

Extended Performance — 20 kHz to 1 GHz

Plug in the 7A21N and install a simple vertical amplifier bypass to directly access the CRT. The bandwidth — 1 GHz, and risetime — 350 ps. Less than 4 V/div driving signal required — single ended or differential. Sorry — no CRT READOUT — vertical amplifier bypassed.

General Purpose — DC to 500 MHz

Plug in the 7A19 — 500 MHz bandwidth at 10 mV/div, 7B92 — delaying sweep rates to 500 ps/div, 7D14 — direct counting to 525 MHz. As your applications and measurement requirements change, choose from 24 plug-ins for: • sampling • TDR • spectrum analysis • curve tracing • digital multimeter • etc., etc. TEKTRONIX 7904 . . . A product of technical excellence.

For further information or a demonstration call your nearby TEKTRONIX Field Engineer or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

OR . . .

500 MHz real-time Oscilloscope System

- 8 x 10 cm display
  CRT READOUT
  8 cm/ns writing speed
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  500 MHz @ 10 mV/div
- 7D14 Digital Counter
  525 MHz direct counting
- 7B92 Dual Time Base
  500 ps/div

OR . . .

choose from 24 compatible 7000-Series plug-ins for virtually any measurement

7904 Oscilloscope	**$2900**
7904 Oscilloscope, without readout	**$2500**
7A19 Amplifier	**$500**
7A19 Amplifier, with variable delay	**$700**
7D14 Digital Counter	**$1400**
7B92 Dual Time Base	**$1400**
7A21N Direct Access	**$350**

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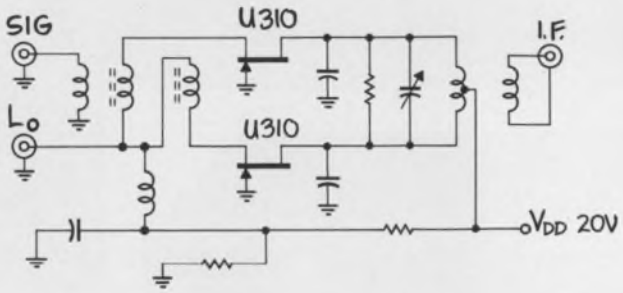
INFORMATION RETRIEVAL NUMBER 21

to build a better VHF/UHF FET mixer:



Try our U310 junction FET in this balanced mixer and make your own performance comparison. Our results are below. The inherent square-law transfer characteristic of the FET ensures high intermodulation intercept and signal desensitization. The grounded-gate connection is most stable, while source injection of both the signal and local oscillator make easy impedance matching into the FETs. Also, the balanced configuration reduces l.o. radiation from the signal port and suppresses the generation of even harmonics (which helps reduce intermodulation).

How do you select an optimum JFET for a mixer? Low gate capacitance is needed for wide bandwidth – the Siliconix U310 typically has C_{gs} = 4.5 pF and C_{gd} = 1.9 pF. Useful conversion gain comes from high transconductance. Our U310 has typical g_{fs} = 14,000 μmhos. Dynamic range is bracketed by the lowest drain current for an acceptable noise figure and the maximum drain current – typically I_{DSS} = 40 mA for the U310. For an optimum balance, matched pairs are available.

50-250 MHz Mixer Performance Comparison

Characteristic	JFET	Schottky	Bipolar
Intermodulation Intercept Point	+32 dBm	+28 dBm	+12 dBm†
Dynamic Range	100 dB	100 dB	80 dB†
Desensitization Level (the level for an unwanted signal when the desired signal first experiences compression)	+8.5 dBm	+3 dBm	+1 dBm†
Conversion Gain	+3 dB*	−6 dB	+18 dB
Single-sideband Noise Figure	6.5 dB	6.5 dB	6.0 dB

† Estimated * Conservative minimum

There's a lot more to this, so

write for data

and get the complete story on VHF/UHF mixing and the Siliconix U310.
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editorial

Why 'waste' money on space?

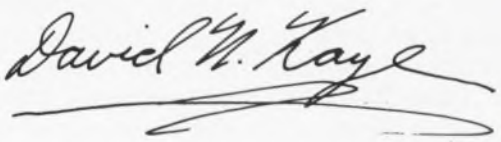
With the successful launching of the ERTS (Earth Resources Technology Satellite), the eyes of the public have finally been focused on some of the benefits of the space program to the quality of life here on earth. ERTS will provide data that will help solve problems in agriculture, forestry, geology, land-use management, hydrology, pollution control, oceanography, meteorology and ecology.

While the space program has the public's eye, you can ease the path of NASA's budget through Congress by making your legislators and your neighbors aware of the good that space research does on earth. Here are but a few of the items to mention:

Did you know that NASA paid for the development of the principle of freeze-drying foods? Today you buy freeze-dried coffee and freeze-dried foods to be used when camping. Did you know that Teflon (a duPont trademark) coating was developed primarily for NASA? How many people have Teflon-coated pots and pans? Did you know that the intensive-care units that monitor heart-attack victims were originally developed to monitor astronauts? Some other recent applications of NASA-developed technology include digital clocks; super-fireproof suits and thermal underwear for firemen; antifogging compounds for helmet visors, windshields and eyeglasses; a caulking compound for bathroom tile; sight switches for paraplegics, so that the blink of an eye can turn a page in a book or call a nurse; the telemetry of EKG readings from a patient or ambulance, and a lightweight torch that can cut through steel plate at the rate of a foot a minute to release people trapped in cars after an accident.

Let's not forget communications satellites for watching Presidents on distant trips or weather satellites to help us plan next weekend's picnic. The same type of navigation system that took the Apollo astronauts to the moon now guides our commercial jets from coast to coast. NASA is even working on nonpolluting automobile engines.

Think twice when someone asks, "What good does it do here on earth to land a man on the moon?" Yes, it's true. Problems here on earth are solved by more technology, not less.



David N. Kaye
Senior Western Editor

FOCUS on Cassette and cartridge recorders

Digital cassette and cartridge recorder users are all looking for the same product. Ideally, it should store as much data as a disc, start and stop instantaneously, run at high speeds, use a medium that is interchangeable from drive to drive, operate forever, require no power and cost nothing.

Cassette and cartridge manufacturers start out on equal ground in trying to satisfy these desires. That is, they both use magnetic tape as the recording medium. From that point on, the similarity ends. Although cassettes and cartridges are technically the same animal, the digital-recorder industry has chosen to call the Philips-type cassette a cassette and any other type of cassette, a cartridge. ELECTRONIC DESIGN will adhere to the same basic definitions. In the industry a further distinction has arisen. While cassettes have 0.150-inch tape width, most cartridges use 1/4-inch wide tape.

Since cassettes were originally intended for audio use rather than digital use, they are not designed optimally for the digital world. Cartridges, on the other hand, are designed for digital applications from the start. Cartridges can, therefore, be more readily designed with high performance in mind.

Many unusual driving and tape-guiding schemes have been incorporated in cassette systems to increase system performance. The complexity of these designs has made the purchase of cassette recorders more difficult. This condition has also led to much specsmanship in such areas as capacity, speed, reliability and cassette interchangeability from one drive to another.

Cartridge drive manufacturers, also, are prone to play many of the same specsmanship games as the cassette industry. With cartridges, one of the problems is that every cartridge is different. At least, all cassettes are very similar.

In fact, ANSI (American National Standards Institute) and ECMA (European Computer Manufacturers Association) have recently agreed upon an international standard governing cassettes and the data-recording method for them.

This, at first glance, is certainly a step in the

Bell & Howell's model 410 digital cassette decorder pulls tape out of the cassette in order to wrap it around a large capstan. This allows much more precise tape control than is possible with the small capstans that many other manufacturers use.

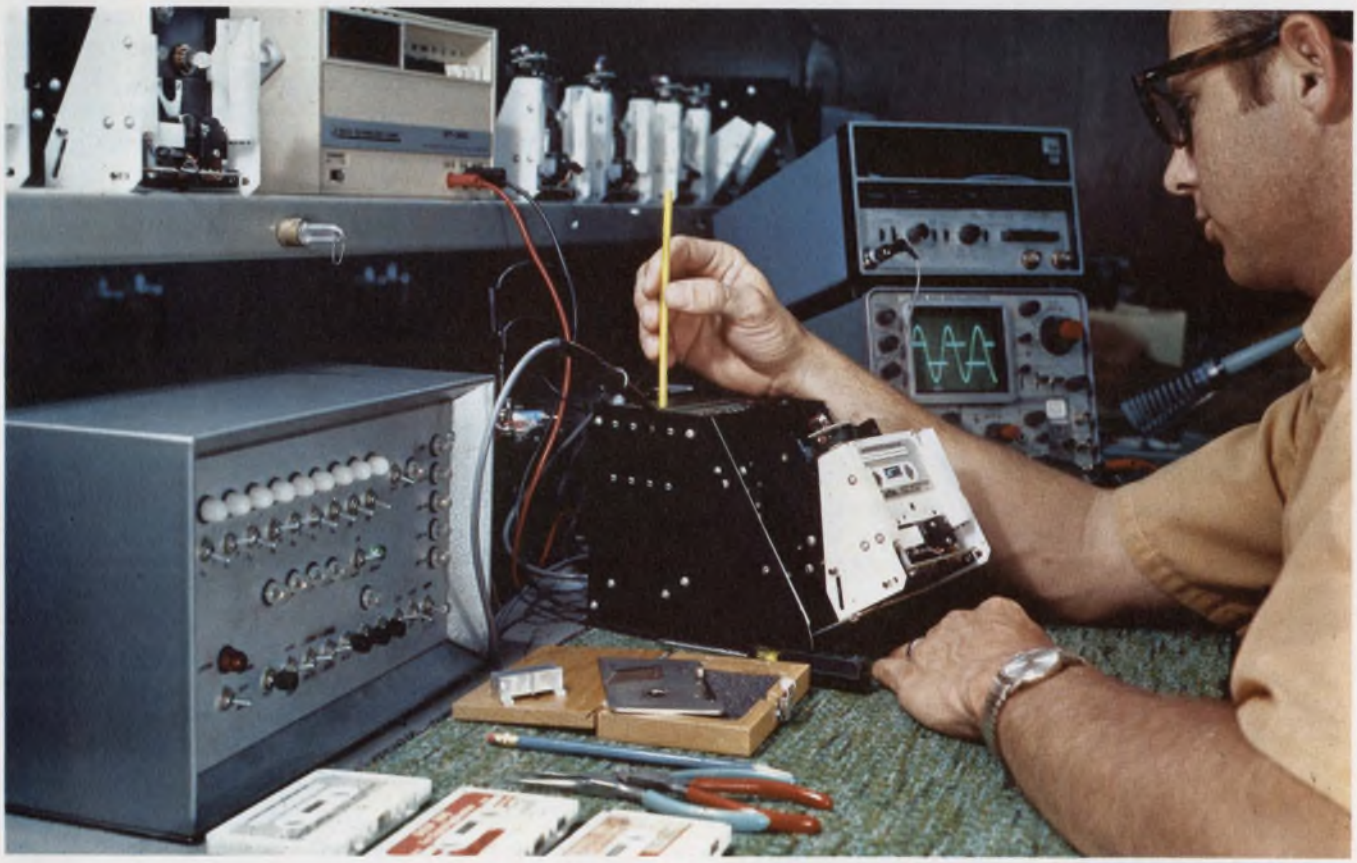
David N. Kaye
Senior Western Editor

Data General has packaged three transports in a single package for use as a peripheral with its Nova minicomputers. The transports are of a reel-to-reel type with constant reel speed but variable tape velocity. Read-after-write recording heads are standard on this drive. An unusual encoding scheme avoids an extra clock track.

as paper-tape replacement, CRT terminal loading or a large number of inexpensive business applications. These markets call for a recording scheme that is incremental by character. This type of recording makes extremely inefficient use of tape if done in accordance with the ANSI-ECMA standard. The aim of the new standard is to allow a cassette recorded on any machine to be played back on any other machine. At present, ANSI, recognizing the problem, has set to work on developing an incremental-by-character standard to complement the existing standard. Until this standard is completed, many of the cassette recorder manufacturers—those making incremental recorders—will not sell ANSI-compatible machines.

When to use cassettes or cartridges?

Most cartridge recorders have been designed

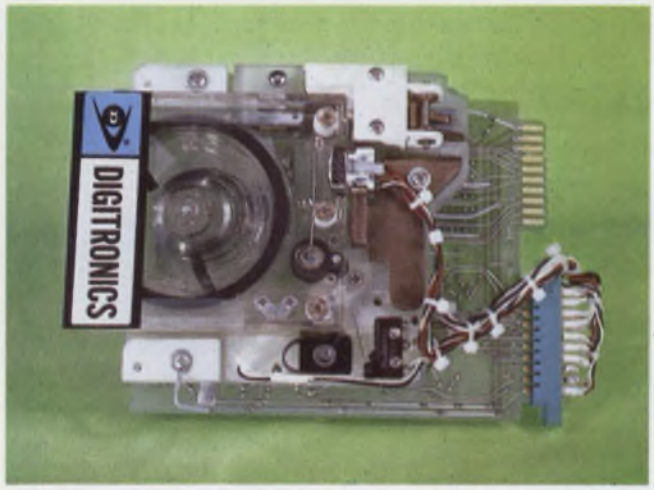


Threshold voltage adjustments are made in the electronic circuitry of an International Computer Products Digideck. The technician uses a specially constructed test console of a type that most manufacturers have constructed for use in testing their own tape decks. The Digideck drive is primarily aimed at the paper-tape replacement market.

right direction. It turns out, however, that it is a step in the right direction only for those manufacturers making file-oriented recorders aimed at on-line computer peripheral applications.

More than 75 percent of the digital cassette recorders sold to date are asynchronous, byte or character oriented and aimed at such markets to be on-line minicomputer peripherals. Some cassette recorders have also been designed for the same application. If this is your application, you will find good recorders of both types. If, on the other hand, your application is of the type calling for incremental-by-character recording, the choice is clearly a cassette system. Available

One of the few cassette drives to meet the new ANSI specifications for cassette recording is the Electronic Associates, EAI CT 1000. It uses a capstan, pinch roller drive with a proprietary tension-adjust servo.



Cartridge recorders compete with cassette recorders for high performance applications. Digitronics MCT-7 mini cartridge transport uses a special spring-loaded cartridge and only a single dc drive motor. It has a 7 ips read/write speed and an 18 ips file search.

Tri-Data produces several digital cartridge recorders. The drives handle either two or four cartridges at a time. The 1/4-inch tape is contained within the cartridge as an endless loop. Tri-Data's drives all output data in parallel format of either 8, 12 or 16 bits.

recorders in the latter category have been getting better and better recently.

In the past, the marketplace was cluttered with companies that had merely modified an audio cassette recorder for the digital job. These recorders were notorious for their unreliability and they almost killed the cassette recorder industry before it had a chance to begin to mature.

One indication of the increasing maturity of the cassette industry is that the larger mainframe minicomputer houses, such as Digital Equipment Corp. and Data General, have finally become convinced of the reliability of cassette recorders and have begun to market their own.

Cassette recorders have physical problems

Since even the best designed cassettes do not provide accurate tape alignment across the surface of the magnetic recording head, the tape transport must do this job. Among the techniques used are: little metal finger guides connected to one side of the recording head; a pair of metal rails across the surface of the head through which the tape is passed; small grooved guides that are placed a small distance from the head either on one side or the other (sometimes these are placed on both sides of the head); and spring loaded guides placed on both sides of the head a short distance away.

Each of these schemes has problems. However, some additional guiding definitely is necessary, and, therefore, one or a combination of these schemes is used on most every recorder. The main problem caused by these guides is that as the tape skews to one side or the other, the guides can cause edge damage to the tape. Some companies get around the problem by pulling the tape out of the cassette for a few inches and then more carefully guiding it around a large capstan and past the recording head. This scheme is used by such companies as Dicom, Bell & Howell and Electronic Processors. These techniques have the advantage of more accurate guidance, but the disadvantage of more moving parts and, therefore, less reliability.

Cassette recorders can be classified into two basic categories, determined by the method of driving the tape. The basic methods are: capstan drive and reel-to-reel drive.

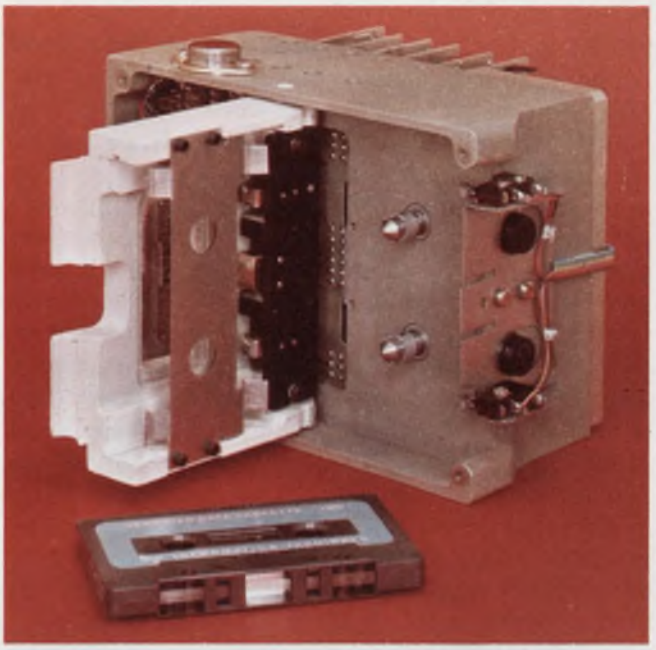
In a capstan drive system, the tape is forced against a capstan (a rotating cylinder) which is turned by a dc motor. The motor may either be continuously rotating or may be servo controlled. If it is continuously rotating, the tape is forced against it only when tape motion is desired. If it is servo controlled, the tape is against the capstan at all times and is completely controlled by it.

In the continuously rotating capstan drives, when contact with the tape is desired, a pinch roller clamps the tape to the capstan and holds it there, hopefully without slippage. The pinch roller is driven by a solenoid in most cases and is the cause of most of the problems that occur with this type of drive. Pinch rollers can grind dirt into the tape and can damage the tape when they clamp down on it repeatedly. Sometimes the tape has even been known to get stuck on the capstan and wrapped around it.

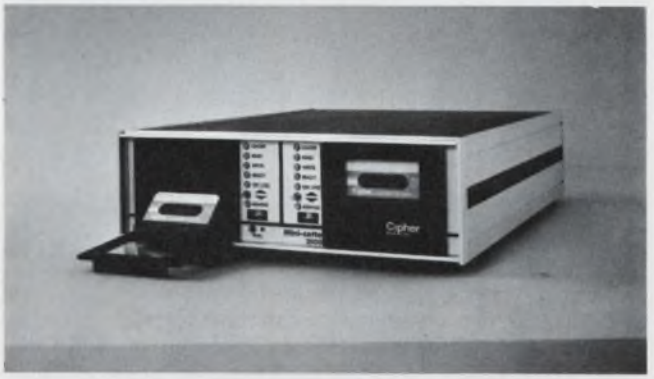
All is not bad with capstans, however. They do have the advantage of careful tape-speed control in the vicinity of the recording head. Capstan drives that keep the capstan in contact with the tape at all times eliminate the need for solenoids that can fail. Also they eliminate the action of the pinch roller banging into the tape. But the capstan motor must have better performance than is needed for other systems, and it must have speed-control circuitry associated with it. Some machines use a capstan on either side of the head. This provides a certain amount of redundancy and allows for more accurate tape control. Of course, it takes an extra motor and costs more.

Reel-to-reel drives use servo-controlled reel motors on the two hubs of the cassette. They often have a servo-controlled tension adjust system as well as a servo-controlled speed adjust system. They derive their servo information either from the back emf of the motors, from tachometers or from a prerecorded clock track on the tape. These drives are much easier on the tape and have less objectionable failure modes. However, they have trouble maintaining tape speed and tension within the tolerances that a capstan machine meets routinely.

Cartridge drives are primarily of a capstan variety. However, they usually have a method of tension adjustment that eliminates the need for pinch rollers. Guiding of the tape in the vicinity of the head is done within the cartridge, and, therefore, cartridges can usually be interchanged from one drive to another as long as they are all made by the same manufacturer.



High speed and high density are characteristics of the Peripheral Dynamics 4200 Digital Cassette Tape Recorder. It is a reel-to-reel drive with servo-controlled tape speed and tension. It records on 4 tracks in order to store up to 8 million bits on a standard cassette.



Cipher Data's Mini-cette 2000 is a high performance read-after-write cassette system. It is one of the few cassette recorders that is compatible with the ANSI specifications. It is also one of few recorders that allow recording on both sides of the cassette. One track of data is recorded on each side.

Specs are often confusing

Reliability is the most important and least understood spec of all. In fact, it doesn't even appear on most spec sheets. Reliability encompasses error rate, MTBF (mean time between failures) and MTTR (mean time to repair a failure once it occurs).

Error rate breaks down into two categories: hard error rate and soft error rate. Hard errors are errors that will not be corrected no matter how many times you try to reread the tape. Soft errors are errors that can be corrected upon one or more rereadings of the tape. Typical hard error rate is 1 in 10^8. Typical soft error rate is 1 in 10^7. Sometimes these numbers are measured after a given number of passes of a cassette over the head. Some manufacturers provide controllers that will detect a bit error and automatically go back and reread the tape location of the error a fixed number of times or until the error is corrected. Error detection is usually either by parity bit or cyclic redundancy code. Some drives have a dual-gap read-after-write recording head to facilitate error detection.

MTBF is quoted, for cassette and cartridge

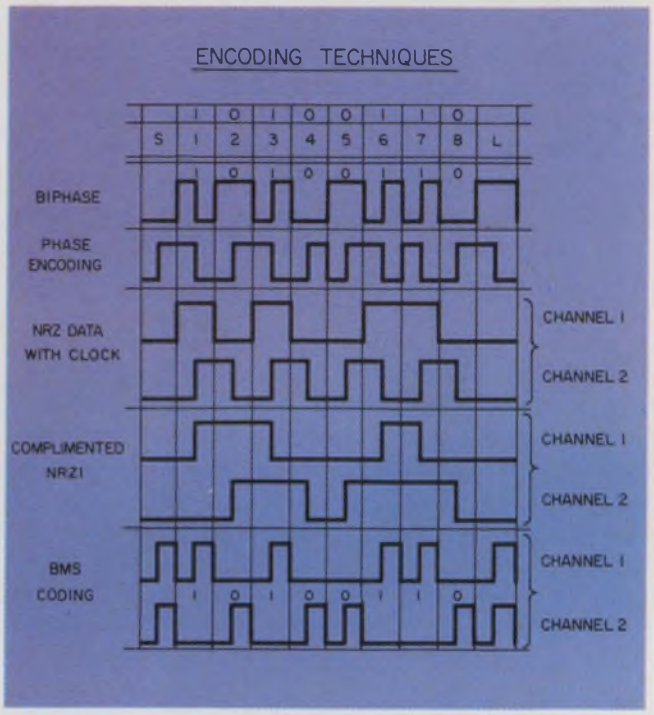
recorders, at between 2000 hours and 5000 hours. MTTR is usually quoted at about 30 minutes. Few manufacturers, however, will tell you how they arrived at these figures. Some manufacturers just guess. Others quote experience on units in the field. Unfortunately, those units are not necessarily the same model as the one you are buying. Some companies calculate the figures and others do some form of accelerated life testing. These figures also depend upon the manufacturer's definition of a failure. For example, although a motor might normally fail after 2000 hours, a manufacturer might quote 5000 hours MTBF on the condition that the motor is replaced every 2000 hours.

MTTR is important only if you can repair the machine yourself or get a service man out to do it. Many manufacturers require that the recorder be returned to the factory for service.

Remex RCP drives can be packaged with up to 3 drives to a case or can be bought as a transport for a single cassette. Remex stresses cassette interchangeability between systems and between decks in the same system. The drive is of the dual capstan variety.

Capacity is not an extremely important spec, neither is access time. In fact access time is so long that it is never quoted. Capacity can range from 0.2 Mb to over 11 Mb for cassettes and cartridges. Sometimes it is also quoted in bytes or characters.

Most manufacturers quote a capacity that is derived by taking the bit density on the tape and multiplying it by the length of tape, and then again by the number of tracks. But this is not realistic. Most data are recorded either in the form of 8 or 11 bit characters separated by inter-character gaps, or in the form of multibit records separated by multi-bit inter-record gaps. The gaps are not usable capacity. Neither are the preambles or postambles associated with each data record. These gaps and other nondata bits must be subtracted out to get usable data capacity. Inter-record gaps depend on the start and stop



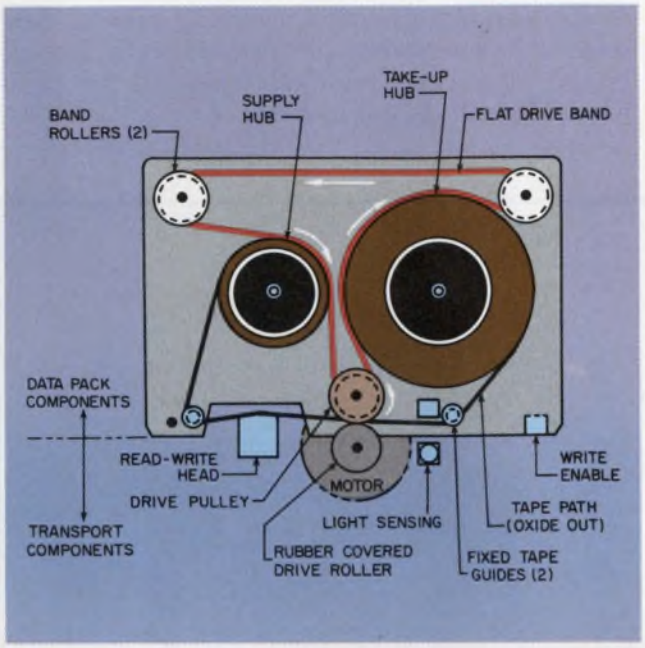
Five of the more popular data encoding techniques are illustrated in the table. Phase encoding is the method accepted by the new ANSI-ECMA standard.

times of the drive being used. These times are usually tens of milliseconds and they vary according to the read/write speed of the particular drive being used. Start and stop times are often given on data sheets, but it is often not clear which running speed is associated with them.

Spec sheets will often call out the method of recording. It may be phase-encoded, biphase, NRZ, NRZI, BMS, or some other technique. Phase encoding is the method called out by the ANSI standard. The accompanying table illustrates the differences between some of the more common recording techniques.

Speed is often an unclear spec. Often more than one speed is called out. For example, the data sheet might say: Speed—2, 20, 80. This usually means that 2 and 20 inches per second (ips) are a pair of read/write speeds. Rewind or file search is most likely done at 80 ips. Most capstan drive cassette machines do not read/write at a higher speed than 15 ips. Reel-to-reel cassette drives can occasionally read/write up to 30 or 40 ips. Some cartridges can go even faster.

Environment is an often neglected factor in specifying a cassette or cartridge drive. Is the system going to operate on a factory floor, in an office, a gas station or maybe a computer room? If the answer is not a computer room, the environment may be crucial. Tape is not happy at temperatures above 120 F and at humidities of 95 percent or higher. Tape can get soft and



Data cartridge from 3M Co. uses 1/4-in tape wound on two coplanar reels. This cartridge accepts four tracks of data recorded at a density of 1600 bpi. A unique plastic drive band maintains tape tension within the cartridge and allows single-point driving at speeds of up to 90 ips.

stretch. Or tape can stick to itself in the reel and cause uneven tension as it pulls apart.

Price is the stickiest subject of all. What does the price include? Does it include: a controller, power supply, mounting hardware, case, read/write electronics, more than one speed of operation, bidirectional operation, motor controls, read/write or read-after-write recording head? If it contains a controller, does the controller have: serial/parallel conversion, error detection, error correction strategy, level shifting or special interface to your digital system. Often, for OEM customers, the price includes only the mechanical transport with no electronics of any kind. To make a fair comparison, you must specify all the desired options and get a written quote from a variety of manufacturers.

Above all, it is necessary to run benchmark tests. Never buy a cassette or cartridge recorder without first trying it in your system. When checking the quoted specs, make sure you test in accordance with the manufacturer's test procedure, not your own. The manufacturers all make the measurements differently.

Cassettes galore but few cartridges

A whole array of companies have recently joined the cassette recorder scene. They include Ross Controls, Memodyne, Interdyne, EAI, Peripheral Dynamics and several others. Long-standing companies in the business include Cipher Data, Sykes, Sycor, International Computer Products and Dicom. Many others fit into an in-between category in terms of longevity and penetration in the cassette business. Of the cartridge drive companies, Tri-Data and Digitronics are the best known. Most talked about of the 1/4-inch cartridges is a one-year-old entry from 3M Co.

Single-point motor drive, internal tension control and a dual-hub coplanar package are some of the features of the 3M cartridge. It operates at speeds to 90 ips reliably and can stand tape acceleration and deceleration of 2000 in/s^2. Recording densities of 1600 bpi are recommended on four tracks. This gives the 3M cartridge a 400-percent capacity advantage over ANSI standard cassettes. ANSI standard recording density is 800 bpi on only 2 tracks. Soon to introduce a drive for the cartridge is 3M itself. Others stating intentions in that direction include Hewlett-Packard, Kennedy and Mohawk Data Sciences.

Tri-Data calls its cartridge systems Cartri-files. The cartridges are of an endless-loop design and the read/write speed is 10 ips.

Digitronics makes the MCT-7 cartridge drive. This has a read/write speed of 7 ips and a file search speed of 18 ips. The cartridge is spring loaded to maintain constant tape tension.

Few current cassette drives on the market meet the new ANSI standard. Manufacturers that do have drives meeting the standard include: Dicom, Computer Access Systems, Peripheral Systems, Raymond, Sycor, EAI, Interdyne, Sykes, Ampex and Cipher Data. Some of these drives are reel-to-reel and some are capstan types. All of these drives are capable of being on-line minicomputer peripherals.

Among the drives aimed at the paper-tape-replacement market are units from: Kybe, Memodyne, Telex, Bell & Howell, Chalco, Remex, International Computer Products and others. Many of the companies that make ANSI standard drives also make paper-tape-replacement types. Most of these drives are either incremental-by-character in format or have a built-in buffer memory for outputting data in the proper format. The major advantage that these drives have over paper-tape systems is ease of editing data on the tape. With a cassette system you just rewrite over the record to be corrected. For applications which merely involve program loading or data loading, most of these drives come in a unidirectional configuration. That is, they can drive the tape in one direction only and can not back up and rewrite a record.

Unidirectional drives also find a home in inexpensive computer terminals where they serve as

buffer memory for a CRT. Better terminals use bidirectional drives to allow more flexibility in data manipulation.

Cassettes and cartridges are getting more flexible and more reliable month by month. They provide a reasonably inexpensive data storage medium that can considerably expand the capability of small digital systems. ■■

Need more information?

The products cited in this report have, of necessity, received only cursory coverage. And they don't represent the vendors' full lines. Readers may wish to consult the manufacturers listed here for more details. For quick response, circle on the retrieval card the boldface numbers that are shown below:

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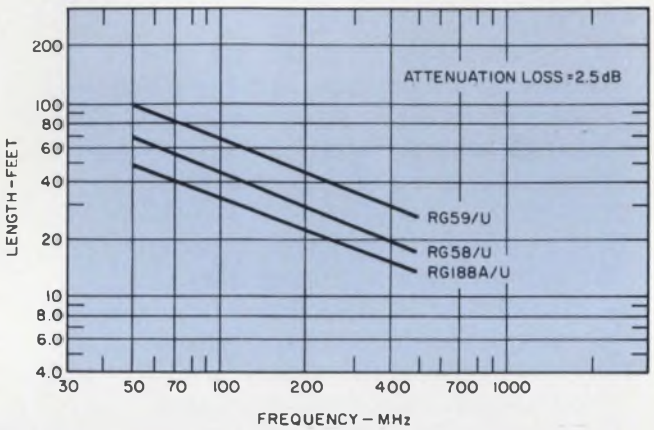
INFORMATION RETRIEVAL NUMBER 23

Avoid ECL-10,000 wiring problems with board-to-board interconnects and Wire-Wrap techniques that preserve the performance of PC-board layouts.

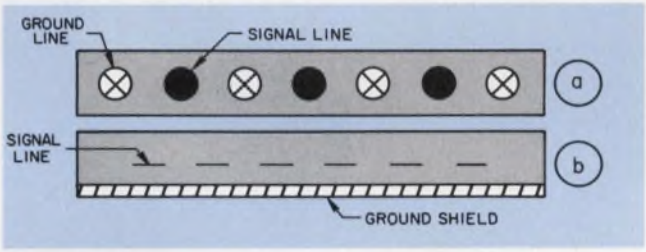
Second of two articles

An important part of ECL-10,000 design begins with the PC-board layout. The high-speed advantages of this logic family cannot be maintained without careful attention to board interconnects. But there's more to the design than that: The complete design also calls for board-to-board interconnects with the possible use of Wire-Wrap techniques, and each of these can adversely affect performance if recommended guidelines are not followed.

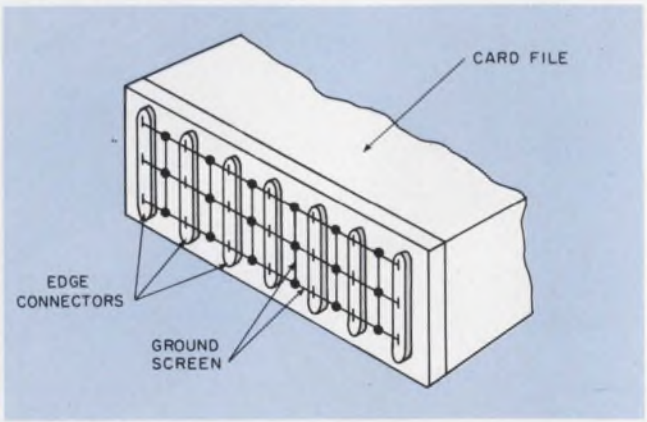
In the design of system interconnections, four parameters must be accounted for: line propagation-delay, line attenuation, crosstalk between lines and reflections due to mismatched impedances. Whether you use single-ended lines or go to twisted-pairs for board-to-board interconnections—or use Wire-Wrap techniques—each parameter affects system performance.



1. **Maximum coaxial line lengths for a constant 2.5-dB attenuation loss** depend on the operating frequency. This plot of three common cable types assumes that the lines have matched terminations.



2. **Multiconductor ribbon cables** of the conventional type (a) or with a ground shield (b) are flexible and can be easily wired to connectors.



3. **Ground screen simulates a ground plane.** This construction is useful when a solid plane is not practical, as can be the case in point-to-point wiring.

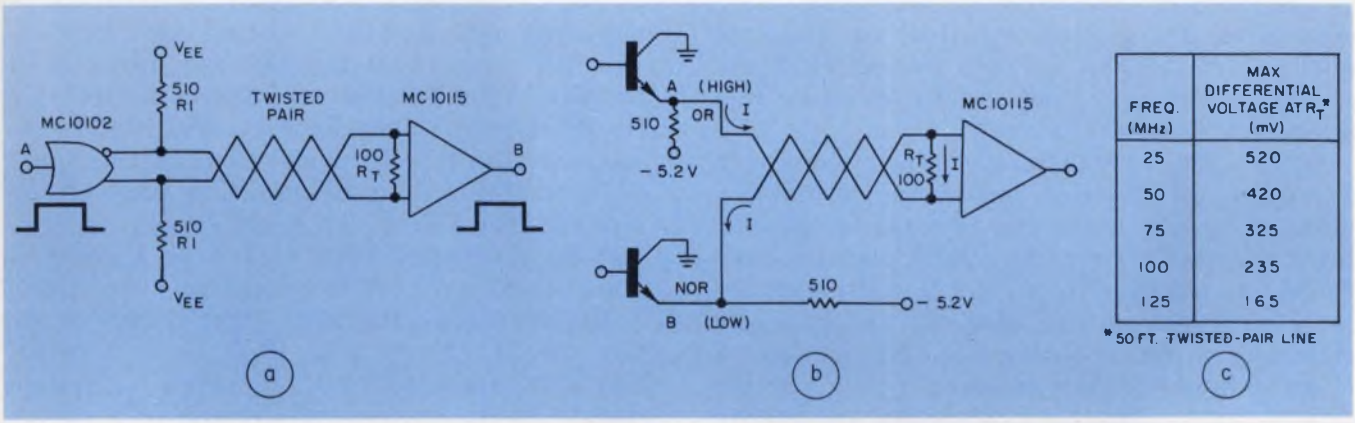
Single-ended lines as interconnects

The types of single-ended lines that may be used are as follows:

1. *Coaxial Cable.* The well-defined characteristic impedance of this cable permits easy matching of the line, and the ground shield internal to the cable minimizes crosstalk between lines. In addition low attenuation at high frequencies allows the cable to transmit the rise times associated with ECL-10,000 signals.

Bandwidth and attenuation are the limiting factors in coaxial cable use. The bandwidth required for ECL 10,000 is $f \approx 0.37/\text{rise time} = 0.37/3 \times 10^{-9} = 125$ MHz (for a 50-Ω load). Attenuation, caused mainly by skin effect in the cable and resulting in signal loss, limits the maximum usable length of line. For a maximum signal reduction of 100 mV from the logic ONE and ZERO levels (800 mV pk-pk to 600 mV pk-pk) the allowable total attenuation is 20 log $(V_{in}/V_{out}) = 20 \log (0.8/0.6) = 2.5$ dB. The maximum line length can then be calculated as 100

Tom Balph, Applications Engineering, Motorola Semiconductor Products, 5005 E. McDowell Rd., Phoenix, Ariz. 85008



4. **Twisted pair lines provide maximum noise immunity.** Crosstalk noise for a typical line driver/receiver configuration (a) can be tolerated up to 1 V or 2.5 V, depending on the direction of the common-mode signal. From the dc equivalent circuit (b), the voltage across R_T can be calculated. However as frequency increases, this voltage decreases because of line attenuation (c). Maximum line length depends on frequency.

ft $\times$ 2.5 dB/α, where α is the cable attenuation in decibels per 100 feet at the operating frequency.

Curves of maximum line lengths vs operating frequency for a 2.5-dB loss and for three cable types are shown in Fig. 1. Generally a high-bandwidth cable is sought to preserve fast signal edges, regardless of the system bit rate.

The curves are plotted for the case of a coax line terminated with a resistive load that is equal to the characteristic impedance of the line. Standard carbon 1/8 or 1/4-W resistors work well as line terminators. However, when using precision wire-wound or film resistors, determine the high-frequency properties of these devices. It's possible that they may become highly inductive at high frequencies, and thus be unusable.

Coaxial cable are well suited for sending single-ended signals over long lines. The constant impedance and low attenuation of the cable allows transmission with minimum distortion.

2. *Parallel-wire cable.* Multiple-conductor cable, as purchased or as constructed by lacing interconnecting wires together, is not normally recommended with ECL-10,000 or other high-speed logic families because of crosstalk. The crosstalk results from capacitive and inductive coupling of signals between parallel lines. This type of line is also susceptible to coupling of external signals. Accordingly multiple-conductor, single-ended cable is recommended only when shields are used on each wire.

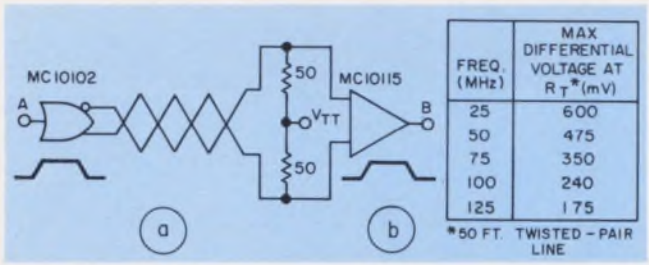
3. *Ribbon cable.* For systems requiring many board-to-board interconnections, multiconductor ribbon cable is often useful. In conventional ribbon cable (Fig. 2a), the side-by-side arrangement of signal lines, with alternate ground wires, defines a constant characteristic impedance.

For ribbon cable with a ground shield (Fig. 2b), the characteristic impedance is determined by the shield. Every other conductor can still be grounded for improved immunity to crosstalk.

As with coaxial cable, the maximum allowable attenuation for a total signal loss of 100 mV is 2.5 dB. Attenuation per foot is generally higher for ribbon cable than for coaxial. Consequently the maximum line lengths for ribbon are normally limited to 10 or 15 feet.

4. *Point-to-point wiring.* A system consisting of several logic cards can be assembled with edge connectors to form a card file. Point-to-point wiring via the board connectors is then useful for system interconnections.

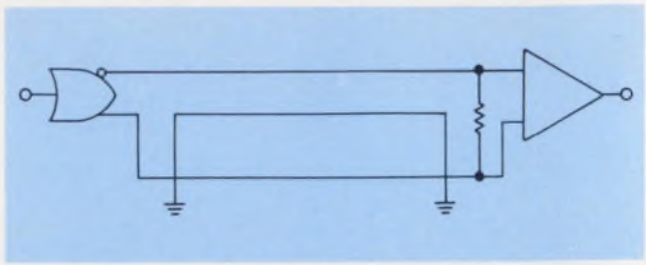
A ground plane is often formed by a large printed-circuit board, to which the connectors are mounted. Metal can be left on one side of the PC board to form the system ground, or on both sides of the board to supply power to the system



FREQ. (MHz)	MAX DIFFERENTIAL VOLTAGE AT R_T*(mV)
25	600
50	475
75	350
100	240
125	175

*50 FT. TWISTED-PAIR LINE

5. **Pulldown resistors can also terminate a twisted-pair line** (a), providing full output levels to the receiver. Attenuation data for 50 feet of twisted-pair line and 50 Ω pull downs (b) show higher differential voltages.



6. **When using conventional ribbon cable as twisted-pair line,** every other wire should be grounded to provide a constant impedance. This connection may be avoided with ribbon that comes with ground shields.

logic cards. The ground plane may be connected to the frame holding the card connectors. These card-file systems are commercially available from a number of manufacturers.

When a solid ground plane is not practical, a ground screen should be constructed on the back plane. A ground screen can be made by connecting bus wires (wire size compatible with connector) to the edge connectors in a grid pattern prior to signal wiring (Fig. 3). About every sixth pin on the card edge connectors is used as a ground, providing connection points for the ground grid. This interconnection of ground points forms a grid network of approximately 1-inch squares over which the signal lines are wired. A characteristic impedance of around 140 Ω can be expected for a wire over ground screen.

To provide maximum signal purity a motherboard, composed of multilayer or two-layer board, can be used to mount the card connectors. Striplines or microstrip lines are designed on the circuit board, along with ground and voltage planes. Connectors are available to interface between cards and the motherboard with little line discontinuity. The motherboard technique is normally used when the system design is advanced to the point where few changes in the back-plane wiring are expected.

For point-to-point wiring with a ground plane or screen, soldered connections or Wire-Wrap techniques are feasible. In general, a good technique is to parallel-terminate with approximately 100 to 140 Ω to −2 V. The load resistor, with a value near that of the characteristic impedance of the line, minimizes ringing.

Series damping or termination can be used to further reduce ringing. An unterminated line with a fanout of 4 can be up to 15 inches long when a ferrite bead is placed on the line.

For high-speed lines, such as those for clock distribution, coaxial cable and twisted-pair lines should be used between cards. Maximum integrity of clock signals should be maintained for best system performance.

Twisted-pair lines, differentially driven into a line receiver, as in Fig. 4a, provide maximum noise immunity. Any noise coupled into a twisted-pair line appears equally on both wires as a common mode. Because the receiver senses only the differential voltage between the lines, crosstalk noise has no detrimental effect on the signal up to the common-mode rejection limit of the receiver. The line receivers shown have a common-mode rejection limit of 1 V to a positive-going signal and 2.5 V to a negative-going signal.

The minimum differential input voltage to obtain the ECL-10,000 logic level on the twisted-pair lines is about 70 mV. However, for system design, several factors call for use of a higher value. These include noise, amplifier offset voltage and voltage gain vs frequency characteristics. In general, a minimum voltage of 150 mV is recommended.

Except at slow bit rates, attenuation is the limiting factor for twisted-pair line length. From the dc equivalent circuit of the twisted-pair line in Fig. 4b, the voltage across the terminating resistor is (with the small dc line resistance neglected)

$$V_R = \frac{(5.2\text{ V} - 0.9\text{ V})\ 100\ \Omega}{510\ \Omega + 100\ \Omega}$$
$$= 0.705\text{ V}.$$

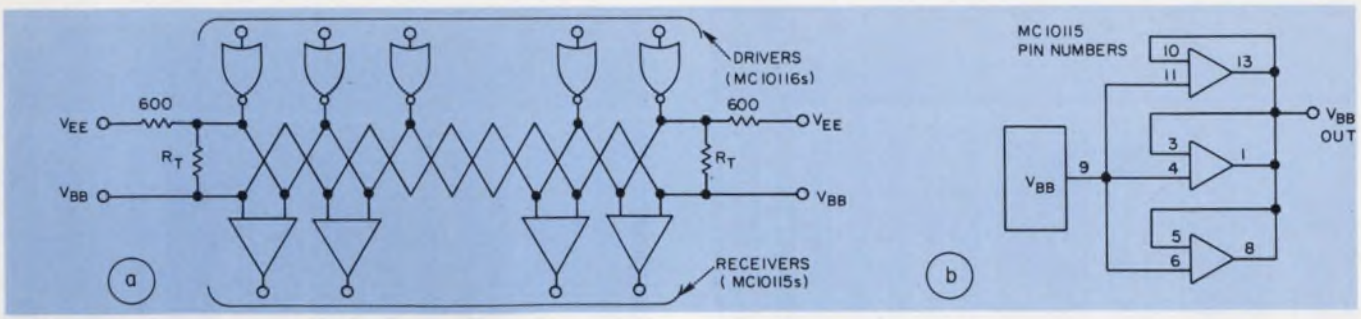
If V_R exceeds 800 mV, the logic ZERO level of −1.7 V is reached, and the NOR output then clamps the voltage at node B.

The voltage across the terminating resistor decreases as frequency increases because of attenuation in the line. A tabulation of the maximum available differential voltage across the termination resistor vs frequency for a 50-feet line is shown in Fig. 4c. Maximum line length is determined by operating frequency.

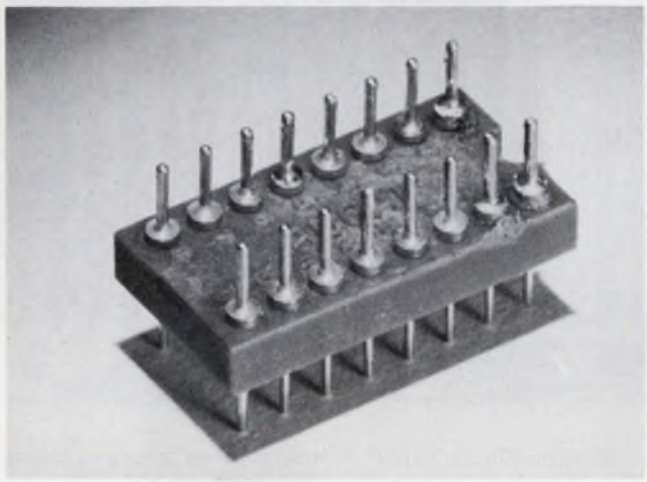
Another method for terminating twisted-pair lines uses pulldown resistors as terminations (Fig. 5a). As a result, full output levels are presented to the receiver. Attenuation data for this line are shown in Fig. 5b.

Regardless of the type of termination, two types of cable can be used with differential twisted-pair lines:

1. *Bundle twisted-pair cable.* When running ECL-10,000 signals in parallel with higher voltage analog or logic signals, use shielded twisted-



7. **Twisted-pair lines offer this party-line technique** (a). The driving-gates are emitter-dotted. Bias voltage, V_{BB}, available from the drivers and receivers, can be buffered to handle the termination current (b).



8. **A dual-in-line adaptor plug** for discrete components extends the versatility of Wire-Wrap techniques.

pair lines. Such lines have a foil shield on each twisted pair that can be tied to the system ground. Cables with several bundled twisted pairs are available commercially.

2. *Ribbon cable.* Ribbon composed of several twisted pairs is one type of ribbon cable available. Conventional side-by-side cable may also be used with differentially driven signal lines (Fig. 6). With every other wire grounded, the signal lines then have a constant characteristic impedance.

Under adverse conditions, differential twisted-pair lines offer several advantages over single-ended lines. These include power-supply and temperature variations between panels or cabinets of a system and corresponding shifts in logic levels within the system, all of which lessen noise margins.

Differential lines are unaffected by variation in logic levels, since the receiver detects only the differential voltage between the driver outputs rather than absolute logic levels. With single-ended lines, noise generated on the signal line by crosstalk and inductive coupling directly reduces noise immunity. Noise is coupled equally to both wires of a twisted pair line, so the differential voltage is unaffected. As a result the receiver does not detect noise as long as it is within the common-mode range of the receiver.

Data bussing, another interconnection technique, usually requires large fanout, long lines and several driving points. An ECL-10,000 bus, or "party line," can be made by emitter-dotting gates together, provided only one driver is allowed to go high at one time.

Data bus lines on PC boards can be extended for board-to-board use. The characteristic impedance of board-to-board interconnections will generally be from 100 to 150 Ω, so the termination resistors must be adjusted accordingly.

Another scheme for bussing is the twisted-pair party line of Fig. 7. The driving gates are emitter-dotted, with all outputs held low when they are not sending data.

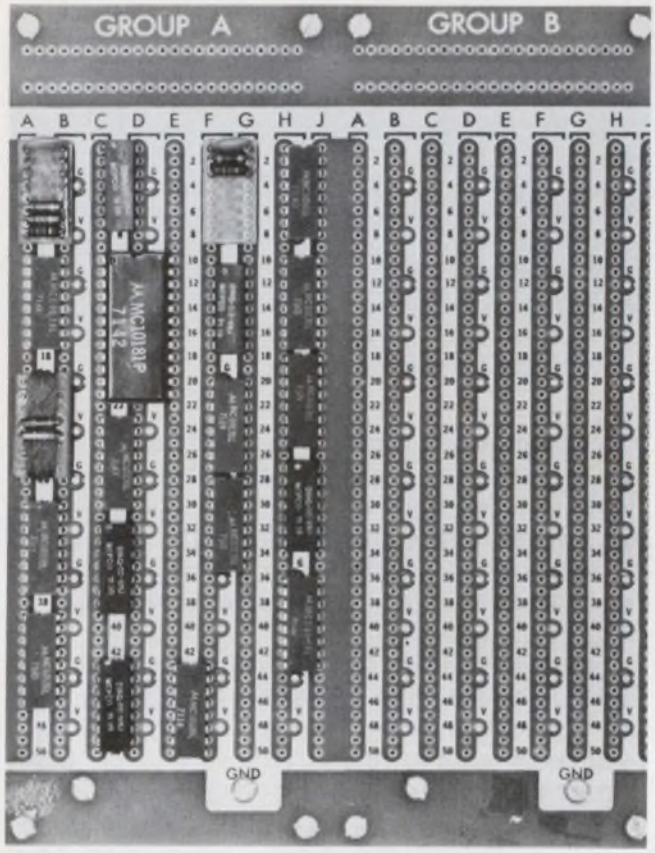
In both bussing schemes the driving lines are operating single-ended. However, the twisted-pair bus retains the advantage of the common-mode rejection of the line receivers.

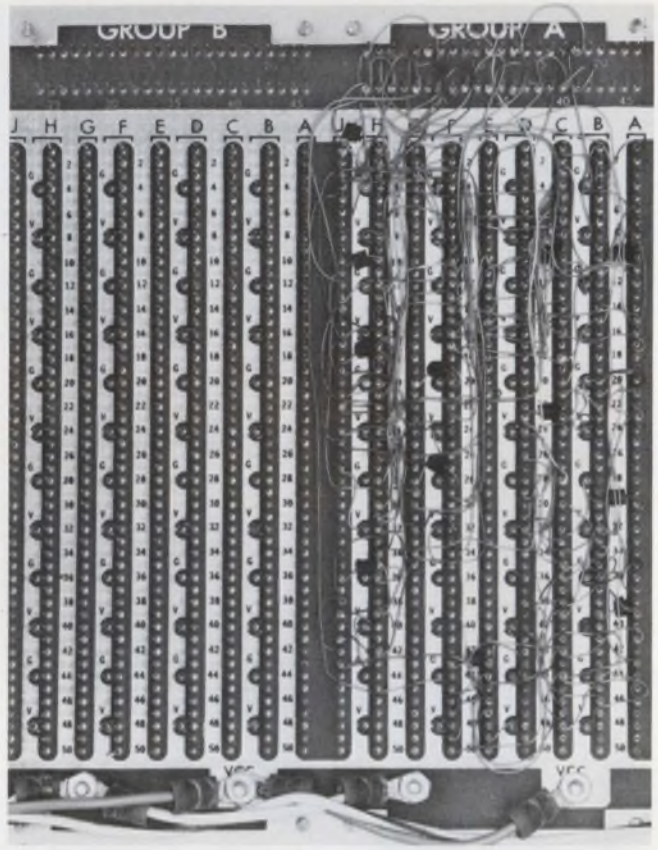
Wire-Wrap techniques

Wire-Wrap is a popular technique for breadboarding large system prototypes and for interconnecting system logic boards. Because it permits changes in interconnections to be made easily, it is extremely useful for breadboarding new system designs. ECL-10,000 systems may be Wire-Wrapped with high-density, dual-in-line packaging boards. In addition Wire-Wrap can be used for board-to-board interconnections when the logic boards are mounted in a card file in edge connectors.

Several types of Wire-Wrap boards for dual-in-line packages are commercially available. For ECL-10,000 systems, use a board that has voltage planes on both sides and low-profile device mounting. Device mounting via pins set in the board is also recommended.

The V_{CC} pins of the mounted device should be soldered to the V_{CC} voltage plane (the voltage plane on the device side of the board). When the V_{CC} pins are Wire-Wrapped to the V_{CC} voltage source, a ferrite bead on a wire between the V_{CC_1} and the V_{CC_2} pins of the same package help avoid high-frequency noise and prevent oscilla-





9. **This 4 × 4-bit multiplier prototype** shows Wire-Wrap with MECL 10,000 logic. Signals are taken on and off the board with commercially available conventional multiconductor ribbon cable. Alternate lines are grounded. With Wire-Wrap, maximum clock rates of 100 MHz can be obtained when using twisted pairs.

tion. Long leads from the ground plane to the V_{CC} pins help induce oscillation, and may pick up noise caused by the added inductance. V_{EE} pins may be Wire-Wrapped to the V_{EE} voltage plane with no detrimental effects. Bypassing on the board should be provided in a manner similar to that for two-sided PC boards with a ground plane.

Wiring rules for Wire-Wrapped interconnections are similar to those for a wire over ground. If a voltage plane is present, the characteristic impedance of a Wire-Wrap interconnection is 100 to 150 Ω. Parallel termination, series damping and unterminated lines can all be used.

With Wire-Wrap, the pulldown resistors can be provided by commercial resistor networks in a single or dual-in-line package or by adaptor plugs. Many manufacturers are marketing resistor networks in a variety of values suitable for ECL-10,000 terminations. Resistor networks with good high-frequency characteristics should be used. Networks composed of discrete resistor chips mounted in a package, or thick-film cermet resistors with a minimum of interconnect metal within the package, provide the best high-frequency characteristics. Wire-Wrap equipment manufacturers have dual-in-line adaptor plugs available to allow discrete components to be mounted for use on the Wire-Wrap board.

An example of a Wire-Wrap system is a 4 × 4-bit multiplier that uses ECL 10,000 (Fig. 9). The delay-line oscillator has a frequency of 30 MHz, and the total system multiplication cycle time is about 175 ns. The multiplier uses an add-shift algorithm.

The clock distribution for this system uses a parallel-terminated Wire-Wrap line (Thevenin equivalent). Twisted-pair lines may also be used for clock distribution and are helpful for higher clock rates. With Wire-Wrap, the maximum clock rates are about 100 MHz.

To get signals on and off the board, commercially available multiconductor ribbon cable is used. Commercial cable adaptors, which plug into the Wire-Wrap board, are also available. Alternate lines are grounded to minimize cross-talk and to generate a characteristic impedance for the signal lines. ■■

Bibliography:

Balph, T., *Interconnection Techniques for Motorola's MECL 10,000 Series Emitter-Coupled Logic*, Application Note 556, Motorola, Inc., 1972

This concludes a two-part series on ECL-10,000 interconnection techniques. The first article, which ran in the Aug. 17 issue, dealt with PC-board interconnects.

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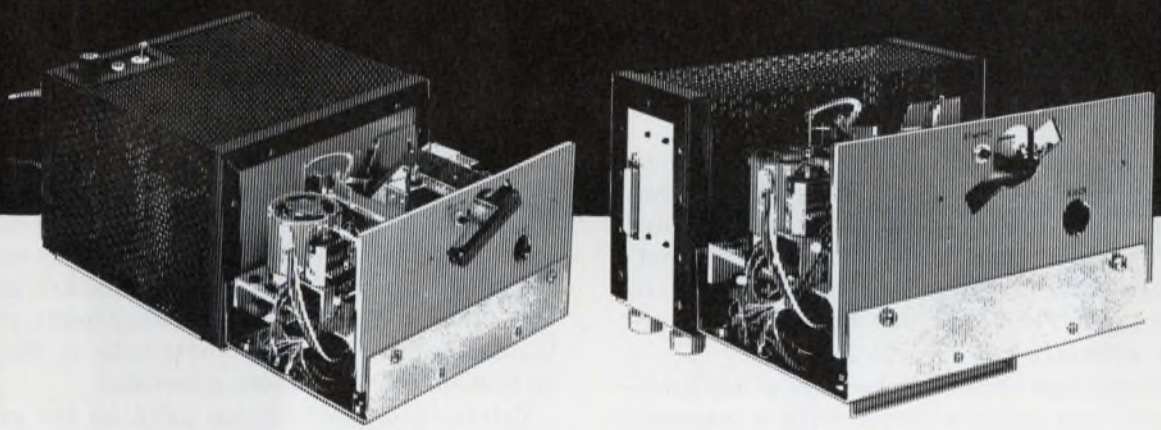

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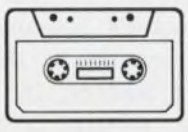

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INFORMATION RETRIEVAL NUMBER 24

Need a hard-copy peripheral? Before you select a printer/plotter, know how they work. Here is a quick review of the techniques used.

The wide variety of techniques used in printer/plotters makes selection difficult. The tradeoffs are many. Some units print better than they plot. Some plot better. And some do both equally well. Many are difficult to interface. A few need frequent adjustments. And still others can be nuisances—they're noisy, they spray ink or wax, and they give off burning odors.

In selecting a printer/plotter, an engineer must consider the problems of interfacing the unit to his data source, the kind of type styles he would like, the form and type of paper he wants and the way the printed copy looks. He must also consider the systems' accuracy, resolution and speed.

The interface tradeoffs

Unless a printer/plotter is designed to work with the voltage levels, timing, word format and architecture of a particular data source, some minimum of hardware will be required to match them.

Above this minimum the nature of the data source determines the best tradeoff between hardware and software. In a large computer installation, advantage can be taken of the greater memory and programming capability available, and a printer/plotter that has less hardware but more software can be selected.

A minicomputer, however, because of its limited memory, can operate better with a printer/plotter that needs a minimum of software and uses hardware to create the graphics and characters. In addition hardware can control the details of the printer/plotter's sequence of functions, which is dictated broadly by the computer. For instance, a printer/plotter, in receiving a turn-on command, may require a sequence of detailed commands (start paper drive, heater on, activate power supply, etc.) that a hardware-microprogrammer (ROM) can furnish.

Hardware/software tradeoffs must also be made for applications-oriented requirements. These could include such items as the storage of data for special, selectable headers; the availability of a variety of standard forms (preprinted, or computer or hardware composed); the selection of type styles; or even printing in different colors. Information for each item can be stored, and the sequencing directed by either hardware or software.

Fonts, printing media and cosmetics

The printer/plotter technique used determines the style and the way characters are generated, the printing media that can be used, and the resulting cosmetic qualities of the printed copy.

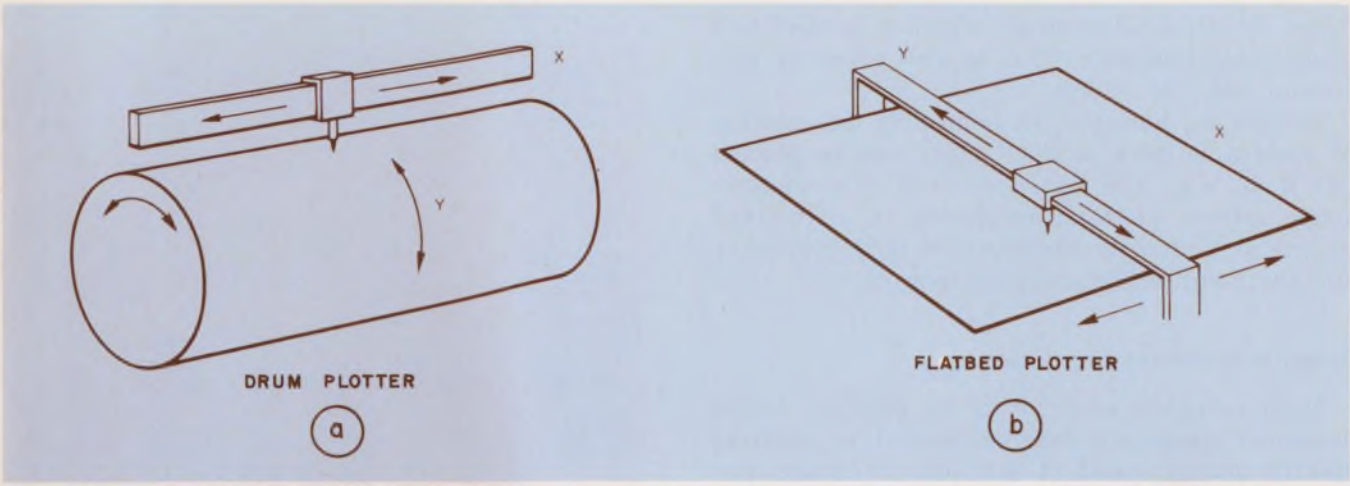
Either hardware alone or a combination of hardware and software can determine the font, or particular style of the characters and symbols. Many impact printers create a character in one stroke with hardware alone. Like a typewriter, impact printers offer a large variety of fonts that often can be easily changed in the field.

Other types of printers—both impact and non-impact—use a dot matrix to form a character, typically a 5×7 or 7×11 array of dots. Software or circuit hardware provides the codes to determine which dots in the matrix are printed. The relative spacing and arrangements of dots (squared-off or slanted) contribute to the style, or font of the characters generated.

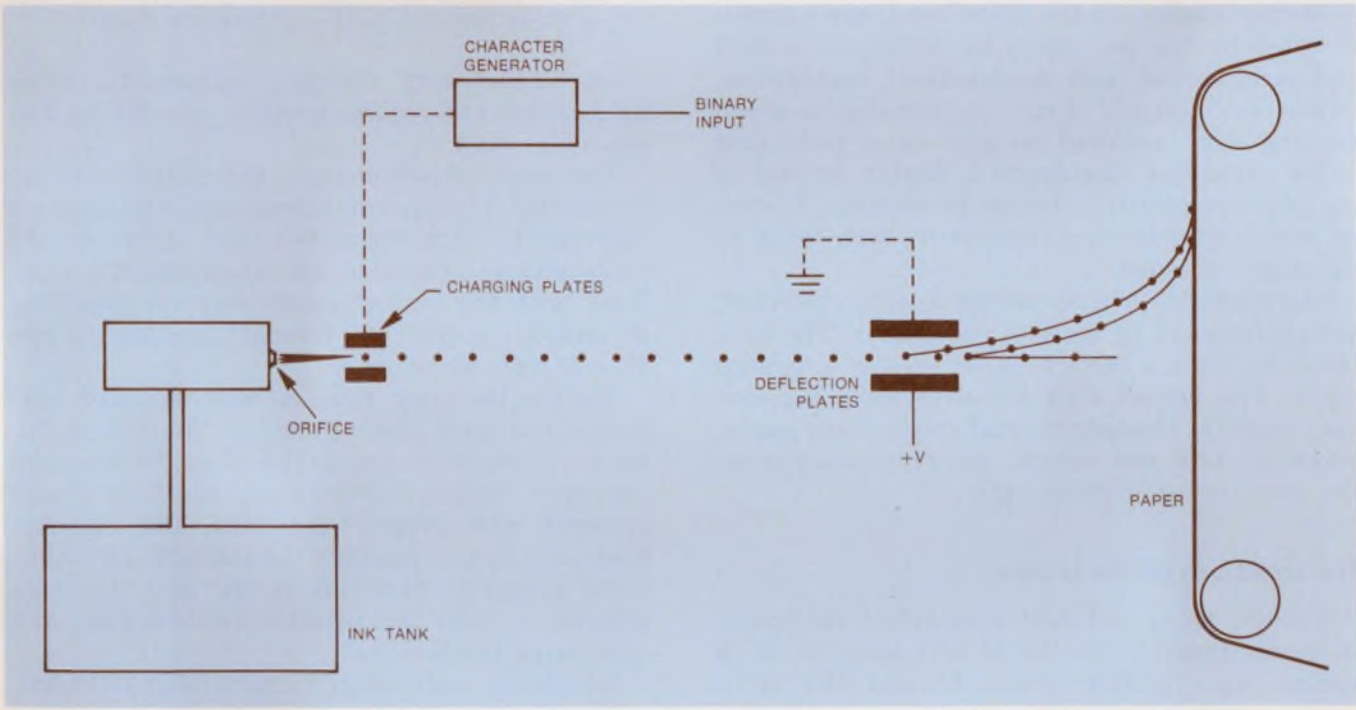
Printer/plotters that can print on the greatest variety of paper forms and types (called printing media), and have the least restrictions in the selection of font styles, can produce the best looking printed copy, all else being equal. The forms of printing media are categorized by physical characteristics such as width, length and style (sheets, roll or fanfold), transparency (opaque or translucent). Paper types refer to the need for special paper that may require chemicals or special handling.

While good printing media and well-designed fonts provide the potential for good cosmetics via the subjective reactions of "looks" and "feel," there are measurable cosmetic qualities such as intensity, contrast, definition and distortion. These measurable qualities are determined direct-

Jill Peters, Project Coordinator, Varian Data Machines, Palo Alto, Calif. 94303.



1. **Pen plotters are slow** but find many uses, usually in noncomputer applications.



2. **Jet-squirt printers claim speed of 200 characters per** second, but fog-up the environment with ink mist.

ly by the printer/plotter technique used.

In addition, an undesirable quality like wet (or damp) printed copy can result in wrinkling, stretching or shrinkage. In general, a sharp, black image on crisp-white paper is considered good cosmetics.

Accuracy and resolution untangled

Accuracy and resolution are two terms which are often confused. Each has a distinct meaning and each separately contributes to "good" printed copy. In printer/plotters accuracy is determined by how close a line, dot or character can be placed to any given point on the paper on a repeatable basis.

For a pen plotter, accuracy is mostly determined by mechanical limitations such as backlash. It is usually measured in percent of the length or width of the plot. Typical values would be 5 mils or 0.5%.

In an electrostatic printer/plotter, on the other hand, accuracy can be virtually "perfect" in the lateral direction. Since lateral-image position is determined by electrically switching the signals to styli in fixed positions across the paper, the lateral accuracy is fixed at the time of manufacture and will not change over the life of the device. The stepping accuracy of the paper-drive mechanism in the longitudinal direction deter-

mines longitudinal accuracy which is subject to a measurable tolerance. This is also given in percent of the plot length.

Resolution, however, is defined by the number of resolvable lines or dots which can be plotted per inch, e.g., 100 lines per inch. For electrostatic printer/plotters, resolution is determined by the styli density (number of styli per inch) and the longitudinal stepping increment.

Speed is a determining factor

Each category of printing or plotting device measures speed in a different way. Line printers specify output speed in lines of characters per minute. Up to about 200 lines per minute is considered slow, 800 to 1400, medium, and above this to about 5000 lines per minute, is fast.

Plotter speeds, on the other hand, are normally rated by the pen speed in inches per second and acceleration (and deceleration) capabilities. Often, an "average" figure, in minutes, is given for the time required to plot on a particular paper area. But this figure is highly subject to the plot complexity. Though interesting, it may be misleading, because there is no such thing as "average" complexity.

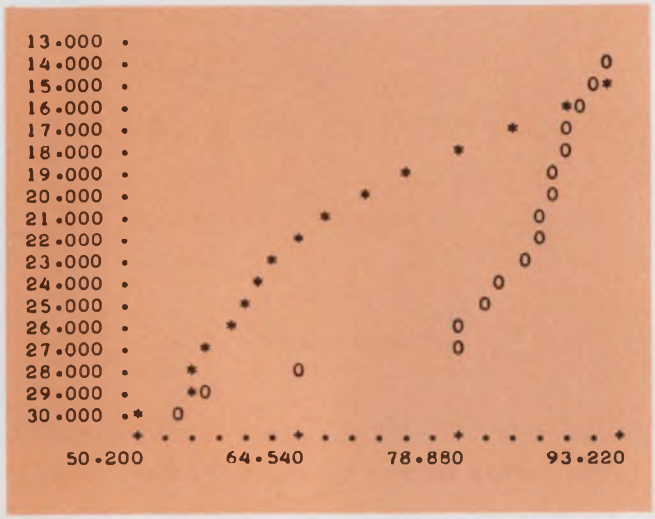
Electrostatic printer/plotter speeds, however, are independent of the plot complexity. The time taken to cover a certain paper area is a definite value. The lateral styli are electrically scanned very rapidly. The longitudinal speed of the paper, given in steps per second, therefore determines the printing or plotting rate.

The direct-pen plotter is slow

Though many different mechanical configurations are possible, the usual arrangement for a pen-on-paper plotter (Figs. 1a and 1b) is to move a carriage-mounted pen along a bar. This bar bridges across the paper to produce the X-axis. The Y-axis motion can be produced by either rotating the paper fastened to a drum (Fig. 1a), or more commonly, by moving the bridge-bar itself (Fig. 1b) across a flat sheet of paper, in the flatbed version.

In these plotters, the pen must be manually located at the zero or other starting position, making sure to take out the backlash. This procedure must be followed at the beginning of every new plot to avoid "zero point" errors. Also, for no-write positioning, a mechanism for raising the pen off the paper must be provided.

Cheaper pen drives use analog dc-servo motors. The position accuracy can be quite poor, with the least expensive models off by 2% or more. High-accuracy units approach 0.1%. They often employ very complex, incremental drive mechanisms and require precision machining and assembly work.



3. **Impact printers are fast** and economical but have only a crude plotting ability and they are noisy.

The speed of producing a plot varies with its complexity. The pen must trace each line segment individually. Alphanumerics and symbols are painstakingly generated one character at a time. Even with the highest-speed unit (approaching 50 inch/s), a plot of "normal" complexity can take 20 minutes or more.

Though the copy from a well adjusted ink-plotter can have good cosmetics, the line width tends to vary with speed. Therefore, in the more expensive models, capillary-ink pens have been replaced with pressure-fed pens. But complex feedback systems regulate the ink flow and additional reliability problems result. And this does nothing to help the original pen-clogging and splattering annoyances.

Ink-plotter costs range from $1000 to $10,000, for either the drum or small-flatbed plotter. Paper costs are relatively inexpensive (0.3 cents per square foot), but most applications require preprinted paper. This saves time in plotting recurring data, but it can raise paper cost to 10 cents per square foot.

The jet printer squirts ink

While direct-pen units are primarily plotters, ink-jet or "squirt"-type units are printer/plotters (Fig. 2). They shoot a stream of electrically charged ink from a small jet. The stream is acoustically treated to break the ink into a spray which then passes through a set of electrostatic deflection plates to form an image on the paper.

Because the deflection range is limited to a fraction of an inch, the jet mechanism must be

moved across the paper by a carriage for each new character. Single-jet devices normally print about 10 char/s (and cost about $7000) but some have achieved speeds of 100 char/s.

For higher printing speeds (to 200 char/s) multiple jets are used instead of a mechanical carriage. However this presents an inherent reliability problem (besides costing about $10,000), since one clogged jet can ruin the entire output record.

Many other problems also plague jet systems. Air currents and humidity can shift dots and blur and distort printing. Also, all the aberrations familiar to users of CRT devices exist in the deflection system, too. In addition, a fine ink mist may develop near the printer.

Impact-on-inked ribbon are widely used

Many of the problems with liquid-ink methods are eliminated in inked-ribbon systems. But an inked ribbon requires an impact mechanism, so it's noisy. The complex eletcromechanical systems need frequent, often tedious adjustments. Critical alignments, when upset, cause both vertical and horizontal printing distortions.

Impact printers produce reasonably good copy. They use inexpensive paper, work at high speeds, and even have a very elementary plotting capability (Fig. 3) though with poor resolution. They are very popular for high-speed printing of computer outputs.

The price of an impact printer is directly related to its speed. For example, 2000 lines/min costs over $45,000, 1100 lines/min about $20,000 and 8 lines/min about $1800. Slow-to-medium speed (500-600 lines/min) printers, with 80 and 132 columns of characters, are available for $5000 to $15,000.

Most impact printers have a fixed, though in many cases field-changeable, font. Characters are often arranged on a rotating drum which directly strikes the ribbon, or they can be on a moving-flexible chain, which is struck by a hammer against the ribbon. There are many other mechanical arrangements used to hold the font set and strike the ribbon.

Less common is the matrix-hammer type. This uses individual spikes that are preset by coded-input data. Direct impact against the inked tape produces the variable dot-matrix character.

Electrolytics solve some problems

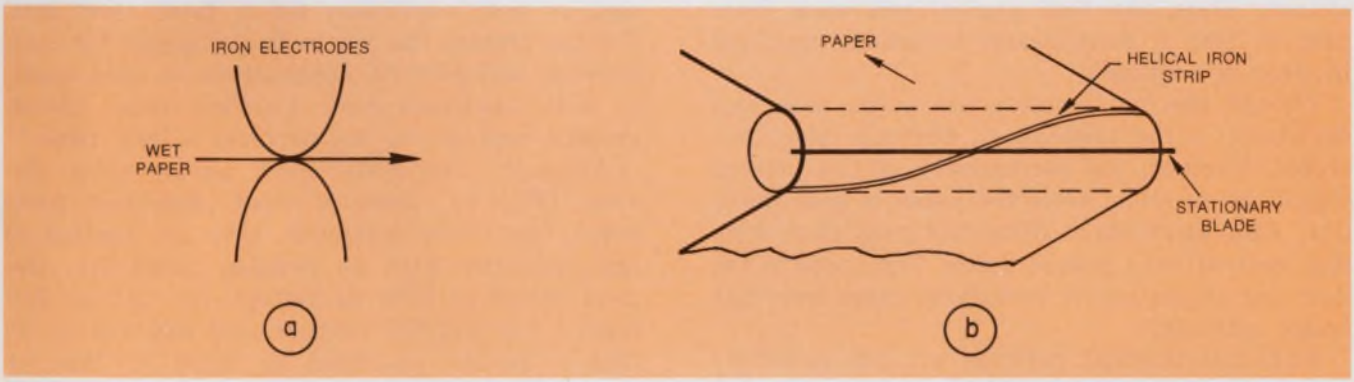
In electrolytic printing, a mark is created where an electric current passes through chemically treated paper. Though acceptable for inexpensive, nonarchival (short-lived) printing, the method has many disadvantages. Its slow speed and poor cosmetics result in limited use. The paper is brownish and produces a light pink record of low contrast. Further, the record fades completely in a matter of days.

In its favor is the moderately priced paper at two cents per square foot. The device itself is priced between $4000 and $10,000.

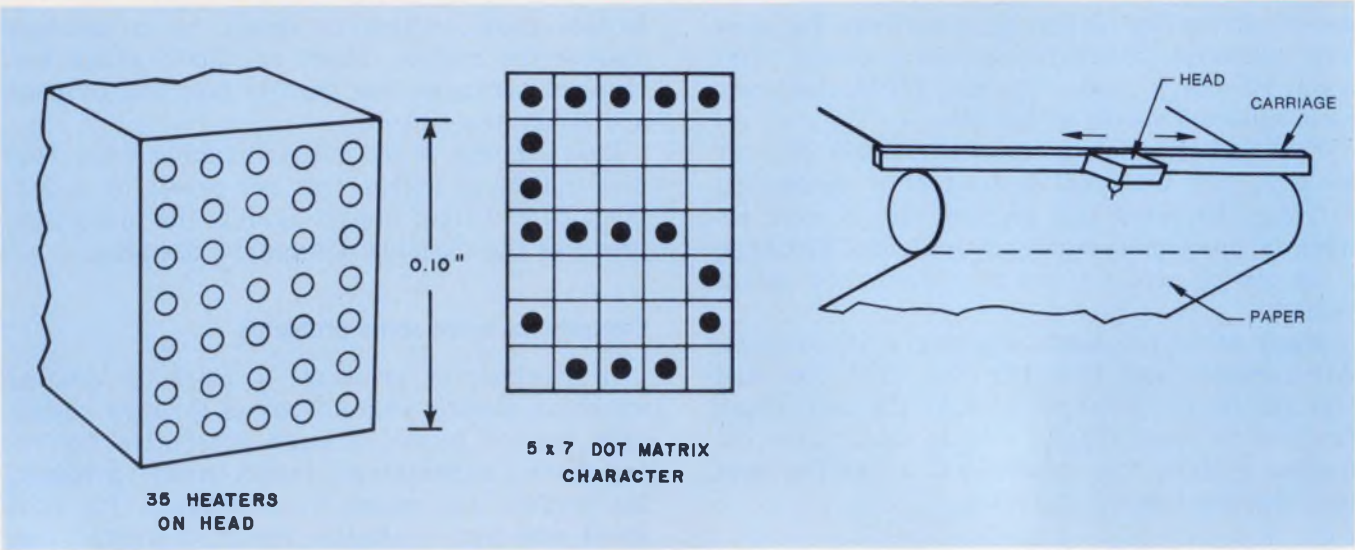
In operation, chemically-treated wet paper is moved between two iron electrodes (Fig. 4a). As a modulated current passes between the electrodes, iron is deplated from the positive eletcrode onto the paper proportionately to the current. In a practical mechanism (Fig. 4b) the paper is placed over a roller containing a raised helical iron strip. This helix becomes one of electrodes. A stationary sharp blade, which bridges and passes current through the paper, forms the second electrode. The helical electrode must be changed periodically, since it is deplated with use.

As the helix turns, the "point" region of contact (through the paper) between the helix and the bridging blade scans across the paper and marks it whenever current passes. Alphanumerics are produced in 7 to 10 scans (or revolutions) of the roller at speeds up to 100 lines of characters per minute. Plots are similarly produced.

With Z-axis modulation of the current, con-



4. **Electrolytic printer/plotters are inexpensive,** but the poor cosmetics and short life of the copy limit applications. Further, the helix must be changed periodically, since it is depleted with use.



5. **Thermal printers are quiet,** but they need special paper, are slow and create unpleasant odors.

tinuous-tone copies can be produced, but this is usually of more interest in facsimile work than computers.

Thermics provide another approach

Thermic printers use special paper, too. Some merely heat the paper (thermal types) and others use an arc to evaporate wax from the paper. In thermal systems the surface of the paper undergoes a chemical change, resulting in a visible image. The chemically treated paper is "off-color," usually pink or yellowish, and the image comes out blue. Contrast is low.

In one form of thermal printer (Fig. 5), heat is applied to the paper with a single heating head containing a 35-dot heater in the form of a 5 × 7-dot matrix. To print a chracter, the head contacts the paper while the data source activates the appropriate dot pattern. To print a line, the heater head is moved across the width of the paper on a carriage.

Because the heater time constant is relatively long, this printing method is limited to about 30 char/s. In addition, the time constant tends to change. Thus, the heat applied will vary from time to time or from heater to heater, resulting in uneven contrast.

Though thermal printers are quiet, a serious drawback is the unpleasant, burning odor they create. Further, the permanency of the printed copy is in question, since the paper is heat sensitive. Also, attempts at obtaining good plots with this method have proved futile. The speed is too slow and excess heater variations cause irregular image intensity.

Although thermal printers are inexpensively priced ($2000 to $3000) and the paper costs moderate (three cents per square foot), the slow speed, poor record quality and lack of plotting capability, limit their use.

Arc burn-off printers employ a dark paper with a light wax coating which evaporates when exposed to a high current, revealing the dark paper beneath. The voltage must be high enough to form an arc. The rotating-helix configuration (as in Fig. 4b) is often used as a scanning mechanism.

While small helix printers can cost as little as $200 and the paper expense is only about three cents per square foot, the printing speed is very slow, the records produced have poor cosmetics and the evaporation of the wax creates an unpleasant odor. Also, the "burned-off" wax contaminates the area. Thus, the equipment needs periodic cleaning. Burn-off printers are not generally considered as computer-output devices.

Photographics go to extremes

Of the methods employing special paper, the photographic approach provides the greatest range of quality and costs. The photographic process can provide fine resolution at very high cost or poor resolution for a fairly low cost. But the process has yet to be developed for both printing and plotting applications at good quality with moderate cost. Further, most photographic methods do not perform in real time.

Although "moderate" cost photographic devices (Fig. 6), using a mask projection technique, have been developed, they are limited to alphanumerics with no plotting capability. Devices priced as high as $40,000 can deliver 300 char/s. For $12,000 another unit can deliver 50 char/s. Devices operated by hand (1 char/s) come as low as $6000.

Most troublesome of all is the high cost of

Figures of merit for printers, plotters and printer/plotters

Printers

	Speed	Font	Record quality	Multi-copy	Relia-bility	Environ-mental	Oper-ating cost	Pur-chase cost	Figure of merit
Line printer (impact)	4	4	3	5	4	3	5	2	30
Teletypewriter (impact)	1	2*	2	1	2	3	5	5	21
Thermal	2	2	2	1	3	1	2	4	17
Electrolytic	2	3	2	1	3	4	3	3	21
Photographic	2	3	4	1	3	3	2	2	20
Ink-jet	2	2	3	1	2	2	5	3	20
Electrostatic	5	2	3	1	5	4	3	3	26

*Impact, but comparable to dot-matrix in quality

Plotters

	Speed	Accuracy	Resolu-tion	Record quality	Relia-bility	Environ-mental	Oper-ating cost	Pur-chase cost	Figure of merit
Direct pen	2	5	5	5	3	3	2	2	27
Photographic	1	5	5	4	3	3	2	1	24
Line printer (impact)	3	1	1	2	2	2	5	2	18
Thermal	3	2	1	2	2	2	2	4	18
Electrolytic	3	2	4	2	2	3	3	3	22
Electrostatic	5	4	4	4	4	4	3	3	31

Printer Plotters

	Speed	Accuracy	Resolu-tion	Font	Record quality	Relia-bility	Environ-mental	Oper-ating cost	Pur-chase cost	Figure of merit
Line printer (impact)	3	1	1	4	2	3	3	5	2	24
Thermal	3	2	2	2	2	3	2	2	4	22
Electrolytic	3	2	2	3	2	3	3	3	3	24
Photographic	1	5	5	3	4	3	3	2	1	27
Ink-jet	2	3	3	2	3	2	2	5	3	25
Direct pen	2	5	5	1	5	3	3	2	2	28
Electrostatic	5	4	4	2	4	4	4	3	3	33

Printer speed (lines per minute)
1. 0-15
2. 15-300
3. 300-800
4. 800-2000
5. 2000 and up

Font quality
1. Helical scan
2. Dot-matrix
3. Vector
4. Impact
5. Projection Mask

Multiple-copy capability
1. Single
5. Multiple

Purchase cost (dollars)
1. 50-200k
2. 15-50k
3. 5-15 k
4. 1-5 k
5. up to 1 k

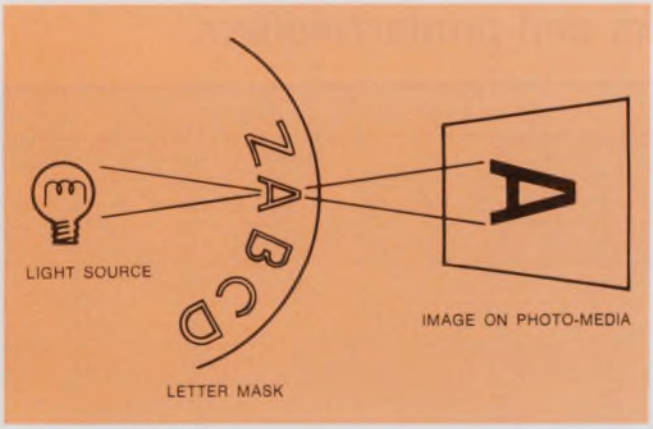
Operating cost (per copy)
1. 10¢ and up
2. 2-10¢
3. 0.5-2¢
4. 0.1-0.5¢
5. up to 0.1¢

Plotter speed (time to produce a typical plot)
1. Over 10 minutes
2. 2-10 minutes
3. 30-120 seconds
4. 10-30 seconds
5. up to 10 seconds

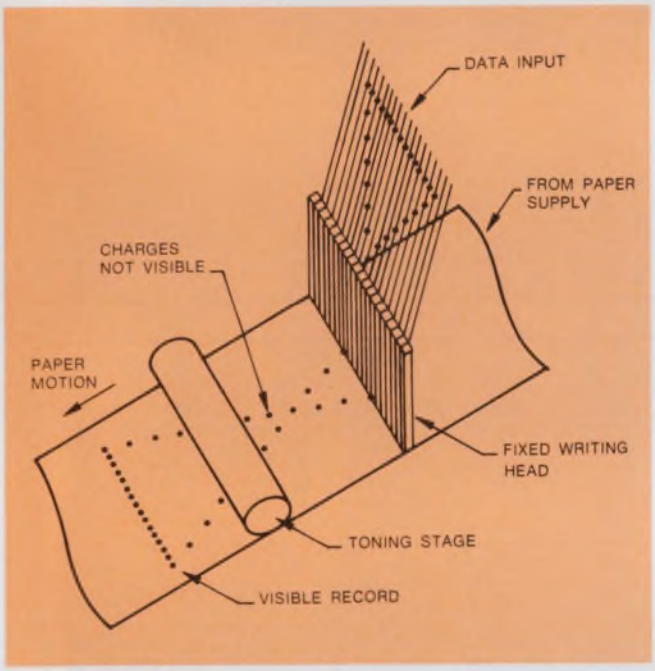
Resolution (lines per inch)
1. 5-10
2. 10-25
3. 25-50
4. 50-100
5. Over 100

Accuracy
1. ±10%
2. ±5%
3. ±1%
4. ±0.5%
5. ±0.1%

A first approach to selection can be helped by these figures of merit. But one must be aware that such figures are often arrived at subjectively, depending on the bias of the author. Figures are given from 1 (poorest) to 5 (best). The sum of the figures for all the features appears in the right-hand column as an over-all Figure of Merit. Frequency of use, however, doesn't follow the ratings.



6. **Photographic methods tend to extremes** in cost and abilities. Cheap ones have poor qualities and good ones are very expensive.



7. **Electrostatic methods,** when properly implemented, provide a good approach to building a combined printer/plotter. Speed is independent of image complexity.

silver halide paper (10 cents per square foot). This plus the long wet-developing time (minutes to hours), limit the wide use of this technique.

A dry-silver method, though lower in price (exposing device costs $3000), and not as messy as the wet process, delivers less resolution and accuracy, and poorer contrast. Further, the record does not remain stable over long periods of time, especially when exposed to wide swings in temperature and humidity.

A still cheaper zinc-oxide paper, used in low-cost copiers ($1000), requires a liquid toning system. In addition, it has poor sensitvity, low resolution and poor contrast. Besides, its surface has a slick coating that inhibits writing. The coating also makes paper separation difficult.

And at the highest end of the cost spectrum, the best resolution obtainable is with a silver-halide, wet process medium (paper or Mylar backed) using a high-resolution cathode ray tube as scanner and exposing device. Resolutions up to 0.001 inch have been faithfully reproduced by this method. Such a complete photographic-printing/plotting peripheral as used in computer output to microfilm (COM) systems can cost as much as $200,000, with prices starting at $30,000 for only the alphanumeric capability.

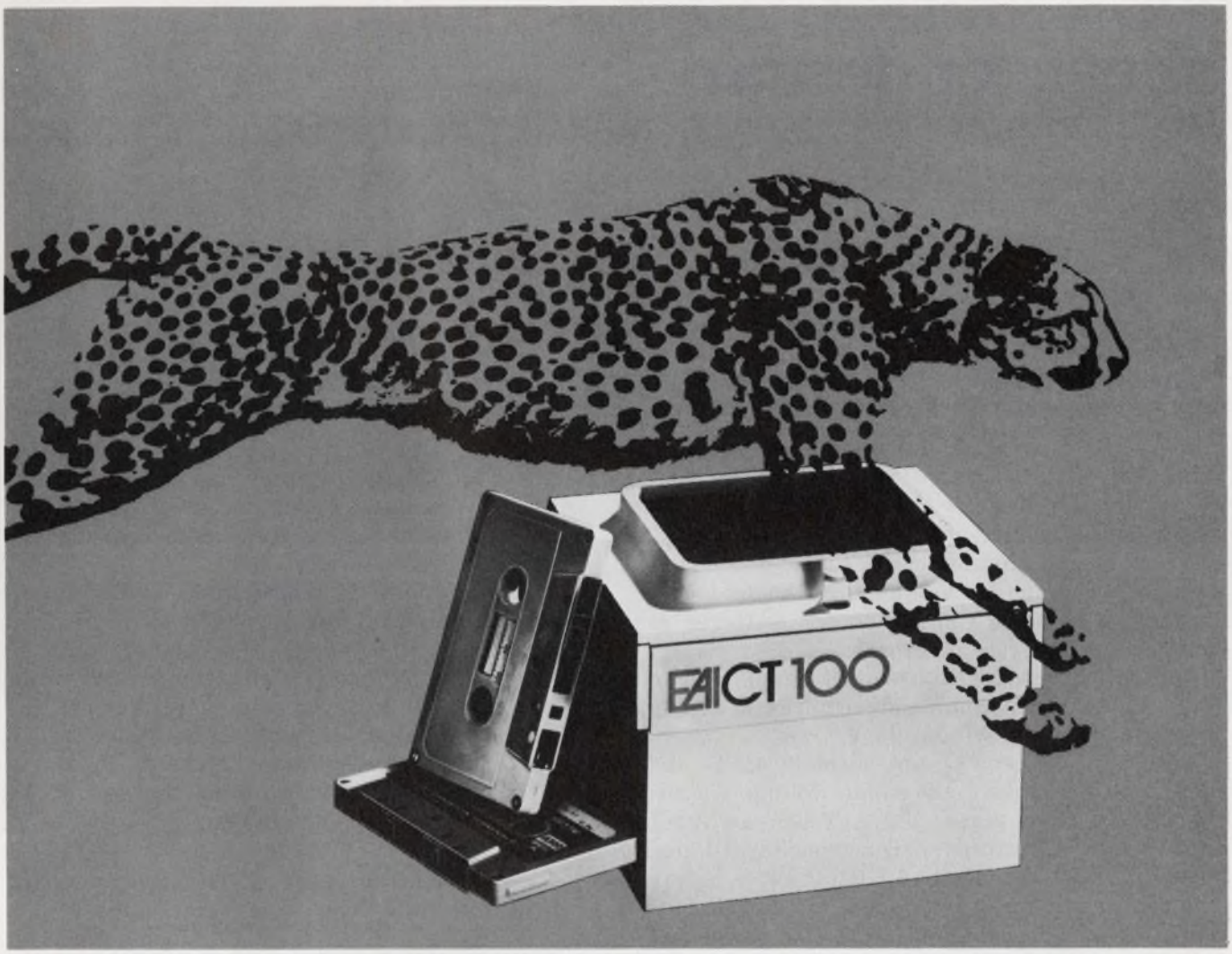
Electrostatics may have the answer

Eliminating the need for expensively treated paper, complex or noisy mechanical systems and clogging-liquid inks, electrostatic printer/plotters (Fig. 7) employ a low-cost dielectric-coated paper. The recording paper is electrostatically pre-charged in a dot pattern representing the desired image, and then passed through a liquid-toner suspension of charged particles. The toner particles adhere to the paper whenever a charge exists, resulting in a permanent, high-contrast image on the paper. A wide variety of electrostatic printing media are available, with the basic paper types ranging from one to three cents per square foot. Other recording media such as gummed and translucent papers are also used.

This system is mechanically simple. Only the paper transport requires moving parts. Mechanical adjustments are seldom necessary and the entire system is very quiet.

A fixed writing head, containing multiple conducting styli, places electrostatic dot charges across the paper. The styli, fixed in a linear array, are individually activated by binary signals and form the X-axis of the printer/plotter. Resolutions of 80 to 100 styli/inch are common. Usually, a step motion is used in advancing the paper longitudinally forming the Y-axis. Thus the X-axis scanning and Y-axis stepping covers every spot on the paper.

Printing, plotting or combinations of both are done at a speed completely independent of the image complexity. A solid black page takes as little time as a nearly blank page. The speeds of these devices are limited primarily by the capability of the paper drive. Printer/plotters that can deliver up to 5000 lines of characters or sixty plots, each 8-1/2 × 11 inches, in one minute, or a combination of both, can be obtained for less than $13,000. Slower devices with a capability of 1000 lines per minute or a plotting rate of 12 such plots per minute are available for less than $8000. ■■



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(201) 229-1100

INFORMATION RETRIEVAL NUMBER 25

Optical-trigger-link scheme minimizes standby power

When optical trigger links are used for high-voltage level shifting and the elimination of the ground loops, the use of line-operated power supplies may be troublesome. If batteries are used, the power consumption needs to be minimized. A useful technique for minimizing standby power dissipation employs complementary switches as pulse generators (see diagram).

The optical trigger link shown handles up to 1000 pulses per second and requires a supply voltage of between 10 and 24 V.

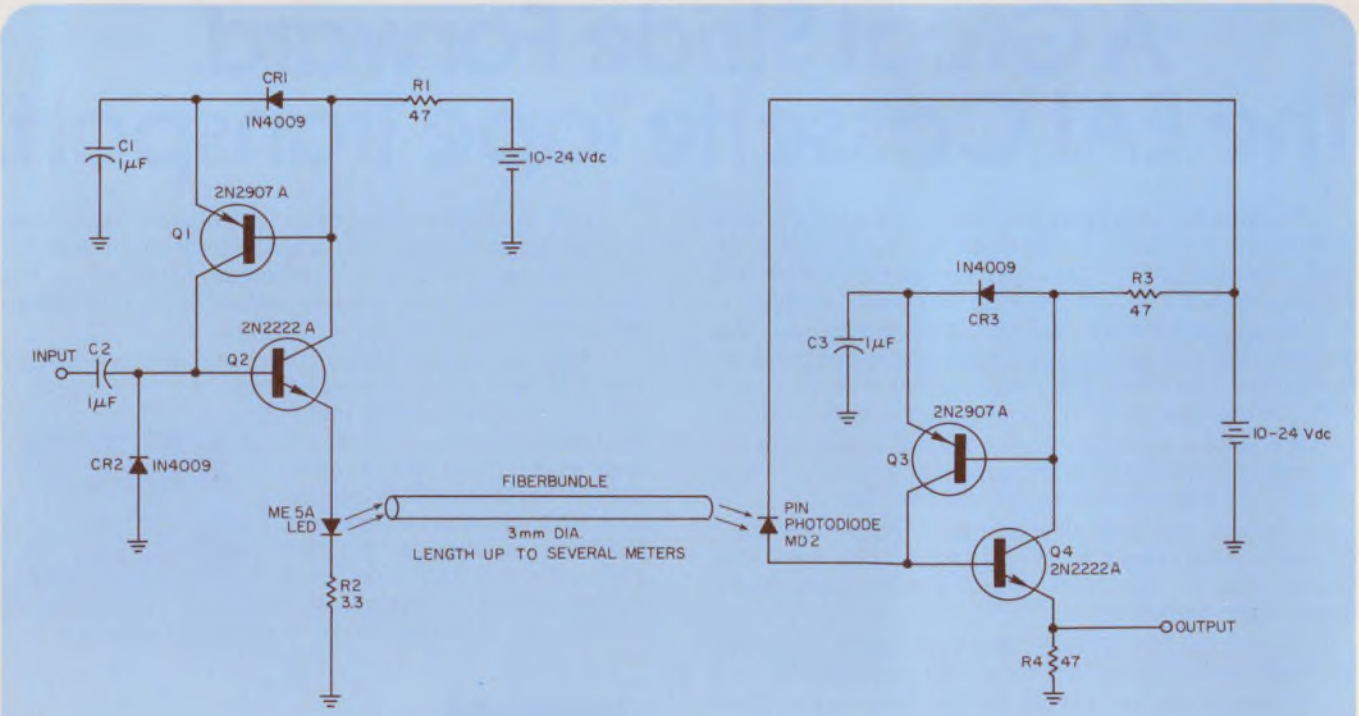
Transistors Q_1 and Q_2 are normally OFF, and capacitor C_1 charges to the supply voltage (minus the voltage drop across CR_1). When an input pulse turns on transistor Q_2, capacitor C_1 discharges via Q_1, Q_2 and the LED.

When transistor Q_2 conducts, diode CR_1 becomes reverse-biased. Hold on is thus prevented because C_1 is no longer charged. As soon as C_1 discharges, both Q_1, Q_2 and the LED turn off. Diode CR_1 becomes conducting and capacitor C_1 again charges to the supply voltage. Resistor R_2 limits the current through the LED.

The light pulse is transmitted by the fiber-bundle to arrive at the remote detector, where it triggers the photodiode. The output pulse is generated by the discharge of C_3 through transistor Q_3 and Q_4 in a way similar to that for the transmitter. Supply current at both the transmitter and detector is approximately fCV, where f is the pulse rate, C is the capacitance of C_1 or C_3, and V is the supply voltage.

C. A. J. Van der Geer, FOM Instituut voor Plasmafysika, Jutphaas, The Netherlands.

CIRCLE NO. 311



Transmitter and detector operate without standby power. Complementary switches Q_1 + Q_2 and Q_3 + Q_4 act as pulse generators. Diode CR_1 acts to achieve hold-on prevention.

Synchronous gating controls complementary clock signals

The synchronous clock gate in Fig. 1 controls clock signals without introducing false edges, lost synchronism, or pulse shrinkage.

The gate is a cross-coupled latching circuit whose operation is synchronously controlled by the MODE input. Synchronous gating proves better than simple clock ANDing because it allows gating signals to occur at any time during the clock cycle without modification of the output transitions determined by the CLOCK input.

The MODE input controls the gate. The level of the MODE control at the positive edge of the CLOCK determines whether the pulse is transmitted to the Q_1 or Q_2 outputs. With the MODE control LOW, output Q_1 follows the CLOCK input and Q_2 is LOW. When the MODE control is HIGH, Q_2 follows the CLOCK, and Q_1 is LOW. The output pulse width always equals the input CLOCK pulse width, and the MODE control has no effect except at the rising edge of the CLOCK.

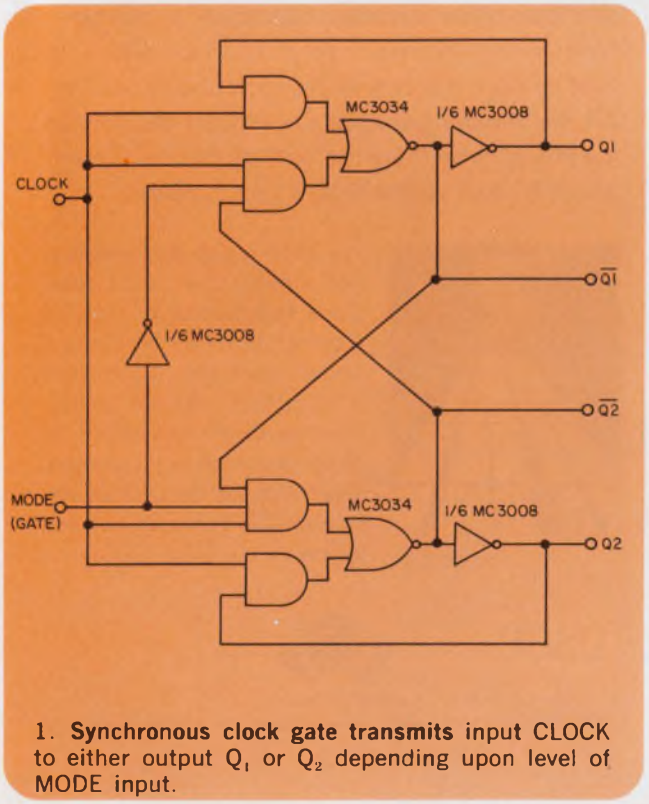
The waveforms in Fig. 2 demonstrate the operation of the synchronous clock gate. It can be seen that the MODE transitions that occur while the CLOCK is either HIGH or LOW have no effect on the output. Only the MODE-control state at the positive CLOCK transition is recognized for each clock cycle.

For applications requiring a gated clock, either Q_1 or Q_2 may be used as the clock output. Output Q_1 is gated OFF with MODE-ONE, and Q_2 is gated OFF with MODE-ZERO. The inverting outputs provide a gated $\overline{\text{CLOCK}}$ when required.

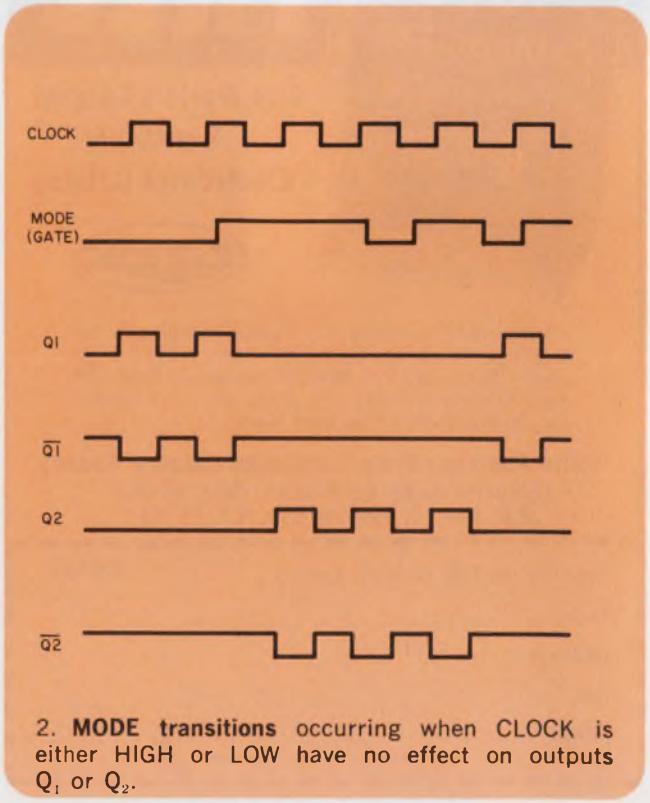
The two sets of inverting and noninverting outputs provide versatility for many applications other than clock gating. If the MODE control is alternately HIGH and LOW for each successive CLOCK pulse, the synchronous clock gate will translate a single clock signal into a two-phase clock. The MODE control signal may be derived from the clock input by using a J-K flip-flop in the toggle mode.

John R. Reinert, Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz. 85008

CIRCLE No. 312

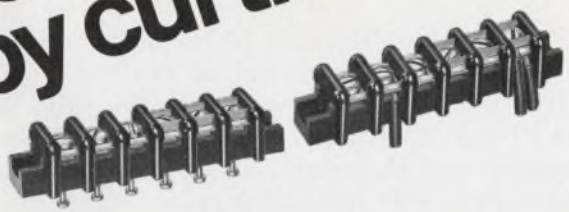


1. **Synchronous clock gate transmits** input CLOCK to either output Q_1 or Q_2 depending upon level of MODE input.



2. **MODE transitions** occurring when CLOCK is either HIGH or LOW have no effect on outputs Q_1 or Q_2.

compact terminal blocks by curtis



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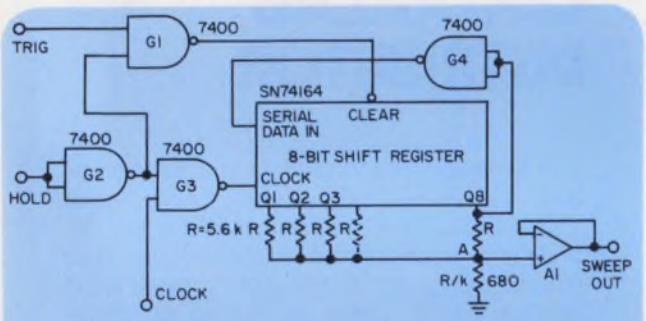
INFORMATION RETRIEVAL NUMBER 31

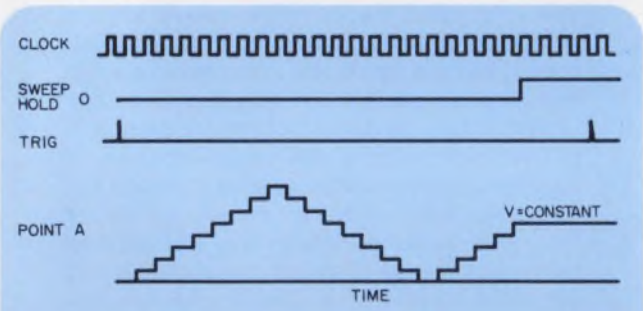
Digital sweep generator maintains constant output voltage at specified time

A triggered triangle sweep generator holds its output voltage constant when a pulse is applied at the HOLD input. The circuit provides versatility not commonly found in digital sweep generators.

A pulse applied at the "trig" input clears the shift register (Fig. 1) when the HOLD input (Fig. 2) is low. The sum of the outputs at point A equals zero. The output of the last stage, a LOW, is inverted and applied to the shift register's input. This HIGH input is clocked down the register, and the output at point A increases in equal steps with each clock pulse.



1. **Sweep generator output level at point A** is held constant when a high pulse is applied at the HOLD input.



2. **Timing sequence for an eight-bit register** is illustrated by the waveform for the output at point A.

After k clock pulses (where k is the number of bits of the shift register), the last stage becomes HIGH. The resultant LOW is clocked down the register, causing a step voltage decrease at point A, equal to the earlier increase, until the cycle repeats. Upon application of a HIGH at the HOLD input, the "trig" and clock are disabled, and the output remains constant. Voltage follower A_1 provides isolation.

The smoothness of the sweep variation (step size) depends on the length of the shift register, k. A capacitor from point A to ground can also help to smooth the output.

If the "trig" circuitry is disconnected, the generator becomes asynchronous. A sawtooth may be obtained by connecting the inverted output of the last stage to the register's "clear" input and placing a HIGH at the register's input.

A divide-by-N counter may be inserted in the clock line if the HOLD input is a function of the circuit's output and clock time—such as for coarse VCO control in code synchronization. A logarithmic or square-law sweep may be obtained by selecting appropriate values of R for each output.

Peter Himmelheber, Senior Project Engineer, and Stanley Thomas, Project Engineer, Naval Electronic Systems Test and Evaluation Facility, St. Inigoes, Md. 20684.

CIRCLE No. 313

IFD Winner of April 27, 1972

Bernie Schmidt, CMOS Design Engineering Manager, Motorola Semiconductor Products, Inc., 5055 E. McDowell Rd., Phoenix, Ariz. 85008. His idea, "Schmitt trigger design uses CMOS logic," has been voted the Most Valuable of Issue award.

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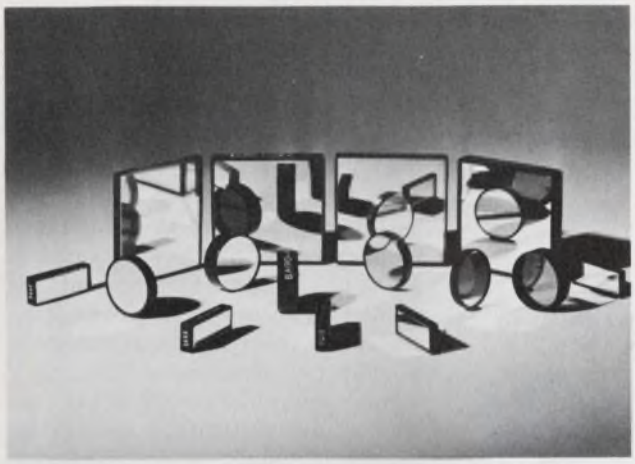

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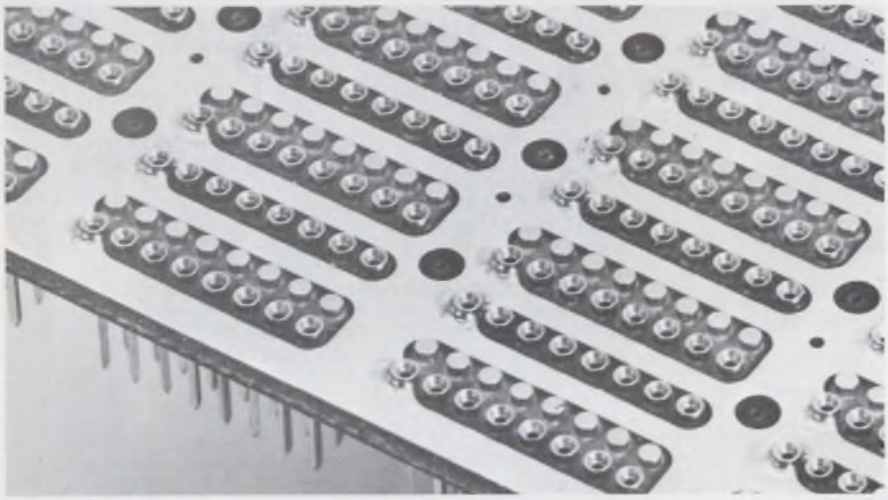
INFORMATION RETRIEVAL NUMBER 35

new products

Solderless-wrap board handles ECL 10,000 logic



Augat, Inc., 33 Perry Ave., Attleboro, Mass. 02703. (617) 222-2202. P&A: See text; 4 wks.

Until now, packaging techniques for ECL 10,000 logic have been limited to two-sided PC (microstrip) and expensive multilayer (strip line) boards. Wrapped-wire terminations—offering lower hardware and layout costs and design flexibility for field changes and repairs—were not widely used with high-speed logic because of problems stemming from the 2-ns rise time of ECL 10,000.

But Augat has announced a new board that accommodates DIP packages and wrapped-wire terminations. The major difference between this and earlier logic boards is that it has a third voltage plane in addition to the usual ground and V_{CC} planes. The added plane, for V_{TT} (−2 V), allows the boards to meet the following requirements for ECL 10,000:

- Characteristic impedance (Z_o) of long circuit lines. This should be controlled.
- A resistive load R_L equal to the characteristic impedance of the line. The load should terminate long circuit lines.
- Maximum circuit efficiency. This results when R_L is terminated by a source of −2 V.
- Voltage bussing for V_{CC}, V_{EE} and V_{TT}. The busses should have low series inductance with sufficient decoupling.

Augat's panel is fabricated in three layers, with the third, V_{TT}, voltage plane sandwiched between two insulating layers and the V_{CC} and V_{EE} planes on the top and bottom of the panel. Each voltage plane forms a low-inductance voltage source. Areas for mounting bypass capacitors to decouple the voltage planes are also included.

Each DIP location has four auxiliary solderless-wrap pins connected to the V_{TT} supply. These are used for terminating a resistive load. The load resistor (R_L) serves as a pull-down resistor and also terminates the line at the gate input.

The characteristic impedance of a solderless-wrapped line on the Augat panel is normally 140 Ω. Termination of a line is generally effected by a 150-Ω, 1/8-W resistor.

The new panel series is initially available in multiples of 30 DIP patterns, up to a maximum of 180, for standard boards in Augat's PG panel style. Prices for a 30-pattern panel range from $40 to $80 each, depending on style and quantity.

CIRCLE NO. 250

Tantalum powder boasts highest capacitance

Norton Co., 1 New Bond St., Worcester, Mass. 01606. (617) 853-1000. $27.50 to $32.50/lb.

A tantalum powder claimed to be the world's highest capacitance commercially available tantalum powder enables development of smaller devices, easier fabrication and lower costs for capacitor manufacturers. Designated the SGV series, the new powders are designed for low voltage devices up to and including 35 V. They provide 8000 μF V/g compared to the next best comparable powder of 6200 μF V/g. The higher capacitance enables a cost saving of from 30 to 50% over previously available Norton powders.

CIRCLE NO. 251

Substrate terminations can be DIP soldered

Berg Electronics, Inc., York Expwy,. New Cumberland, Pa. 17070. (717) 938-6711.

A line of ceramic substrate terminations, some of which are designed to mount onto DIP packs and others for edge mounts, clip onto the substrate rather than fasten into holes drilled through it. They mechanically hold their position until wave soldered for a permanent connection. Since there is no need to drill the substrate there is no resulting breakage.

CIRCLE NO. 252

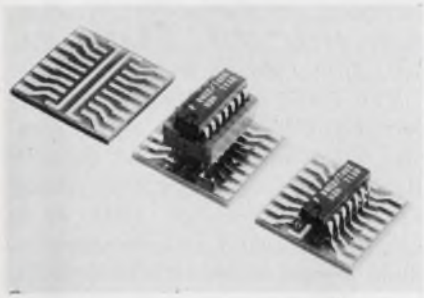
Potting epoxies reduce thermal expansion

Transene Co., Inc., Route One, Rowley, Mass. 01969. (617) 948-2501. $3.25/lb.; stock.

A one-part epoxy for potting and encapsulation of electronic assemblies and components is self-catalyzed to reduce waste and simplify the process by eliminating the need to weigh out and add hardener. Transepoxy 310 is a silica filled epoxy system for general purpose potting and encapsulation. Transepoxy 320 is an alumina filled epoxy system with high thermal conductivity. Transepoxy 330 is an optically clear unfilled epoxy system.

CIRCLE NO. 253

DIP breadboard handles plug-in or hardwired ICs

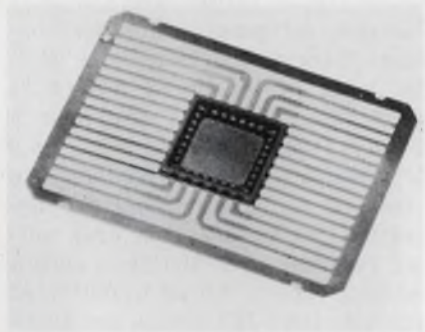


Christiansen Radio Co. 3034 Nestall, Laguna Beach, Calif. 92651. (714) 497-1506.

The Model 14/16 DIP Mini-Mount breadboarding system has a pressure-sensitive adhesive to hold it in place while interconnecting wires are installed. Either 14-pin or 16-pin dual in-line packages may be accommodated. The pressure-sensitive backing allows the Mini-Mount to be moved or exchanged as the circuit develops, yet holds it firmly in place in the finished assembly.

CIRCLE NO. 254

LSI flat pack offers alumina loaded body

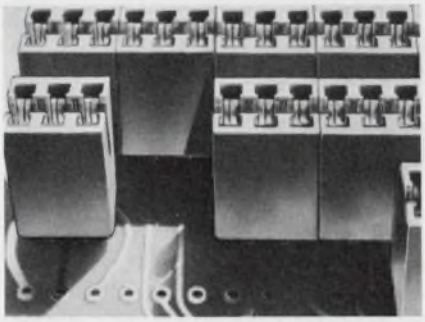


National Beryllia Corp., Sealox Product Div., Greenwood Ave., Haskell, N.J. 07420. (201) 839-1600.

A 30-lead flat pack for MOS/LSI applications, the 051-2268, is 3/8 × 3/8 inch in size, with an alumina loaded glass body, Kovar bottom and Kovar seal ring plated with gold. Metallized lids and preforms are available. Hermetic to 10^{-8}, rugged and dependable, and capable of volume production and high yields, 051-2268 has a 200-mil square die bond area, with overall lead frame dimensions of 1.240-in. × 0.700-in.

CIRCLE NO. 255

Press-fit edge connector offers modular approach



Elco Corp., Maryland Rd. & Computer Ave., Willow Grove, Pa. 19090 (215) 659-7000.

A modular card edge connector provides a means to update connection systems without the need to redesign existing PC cards with their 150 or 156-mil center contact traces. The card edge connector comes in modules of four and six contacts. The modules can be ganged together to custom design connectors to fit the existing PC card, without soldering.

CIRCLE NO. 305

FET op amps combine 1.5 μs settling, 10^5 CMR

Intronics, 57 Chapel St., Newton, Mass. 02158. (617) 332-7350. FA-540: $55; FA541: $68.

The FA540 and FA541 are differential FET op amps which combine a settling time of 1.5 μs with 100,000 CMRR. In addition, Model FA541 offers a low drift of 2 μV/°C, minimum. Others specs include a gain-bandwidth of 5 MHz, 10 pA input current, and 10^{11} Ω input impedance. Both amplifiers are packaged in a miniature 1.25-inch square by 0.4-inch high epoxy case. Mil spec versions of both units are available for operation from −55 to +125 C.

CIRCLE NO. 256

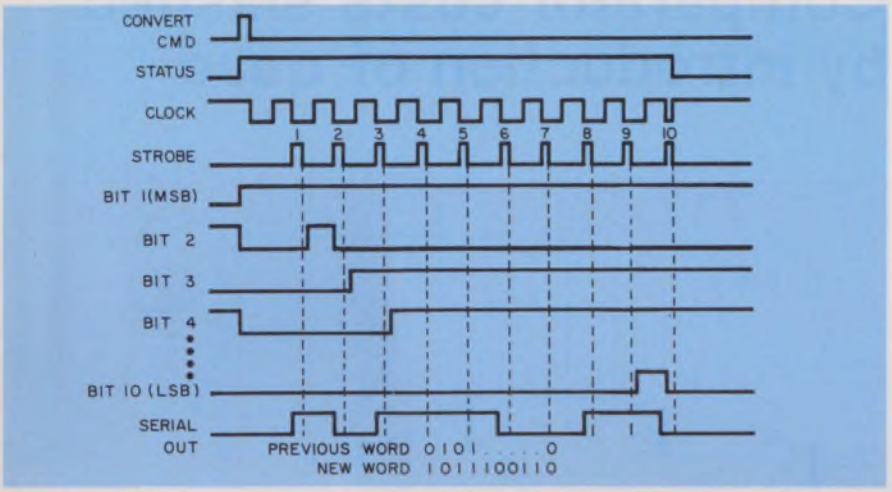
Multiplying d/a settles to 0.01% in 1.5 μs

Datel Systems, Inc., 1020 Turnpike St., Canton, Mass. 02021. (617) 828-6395. 8-bits, $99 ea.; 12-bits, $139 ea.; stock.

The DAC-MV series d/a converters are plug-in modules capable of full four-quadrant multiplication. Input factors are a bipolar variable reference which will operate from dc-200 kHz and a digital word of up to 12 binary-bit resolution. The units also have a built-in voltage reference (+6.2 V), which can be externally pin strapped for conventional d/a operation. Prime features are: output response of dc-200 kHz; output settling time of 1.5 μs to 0.01% of FS. The DAC-MV Series are available in word lengths of 8, 10, 12 binary bits and two or three-digit BCD. Input coding can be straight binary, binary coded decimal, offset binary or two's complement. The analog input reference range is ±5 V and requires a source current of 1 mA. Full scale analog output can be either unipolar (0 to +10 V @ 5 mA) or bipolar (±5 V @ 5 mA). Accuracy specifications include ±1/2 LSB linearity, ±30 ppm/°C tempco and ±0.01% FS accuracy. All models feature a fast output settling time of 1.5 μs for either a FS digital input change or for a FS reference voltage change.

CIRCLE NO. 257

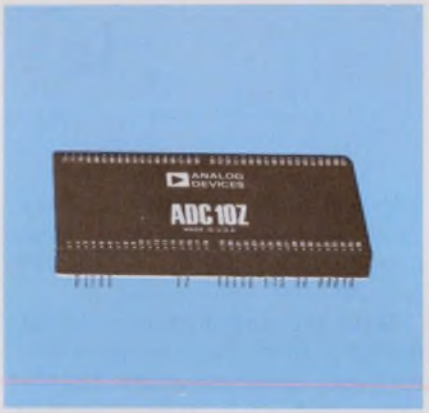
Serial-output a/d converters make data-shuffling easier



Analog Devices, Route 1 Industrial Park, P.O. Box 280, Norwood, Mass. 02062. (617) 329-4700. ADC-10Z: $99 (1-9); ADC-12QZ: $129 (1-9).

By designing-in the circuitry to control the timing of serial-output data from two new a/d converters, Analog Devices has saved the designer time and money.

Both parallel and serial outputs are provided. But unlike competing units—which also offer both parallel and serial outputs—the Analog Devices units provide an additional output: a 200-ns strobe pulse whose ONE-to-ZERO transition indicates a completed, or valid, serial bit. Thus the strobe pulse can be used to clock the serial data into a receiving shift register. No external delay or synchronization logic are necessary.



The $99 and $129 costs of the ADC-10Z and the ADC-12QZ, respectively, make them more expensive than at least three competing converters of similar relative accuracy (±1/2 LSB). However, the ADC-10Z converts in 20 μs—2-1/2 to five times faster than its 10-bit competition. And it exhibits slightly less gain temperature drift: ±40 ppm/°C vs 50 ppm/°C. The 12-bit ADC-12QZ is also faster—40 μs against 100 to 200 μs for competing units—but its gain TC of 30 ppm/°C is about par with similar units.

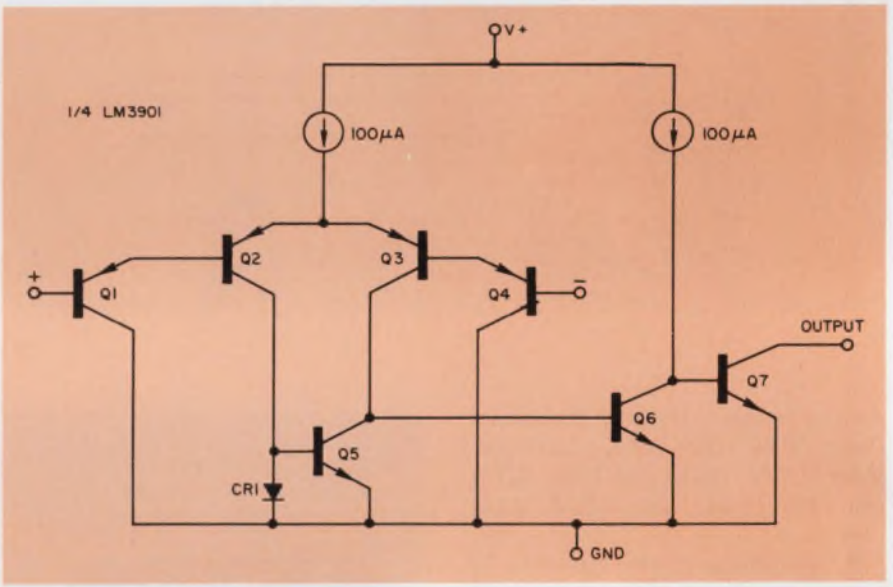
Perhaps more important, both units are guaranteed to be monotonic (have no missing codes) missing codes (monotonicity) over their operating temperature ranges, which are 0 to 70 C for the ADC-10Z and 0 to 50 C for the ADC-12QZ.

In addition to the built-in timing control, two other features make the 10-bit ADC-10Z and the 12-bit ADC-12QZ easy to use: They both contain built-in, temperature-compensated voltage references and, by use of jumpers, allow the selection of any of four input ranges: 0 to +10 V, ±10 V, 0 to +5 V and ±5 V.

The outputs of the two units are TTL/DTL compatible. Both require ±15 V and +5 V, and both come in a 2 × 4 × 0.4-in. package.

CIRCLE NO. 258

Comparator costs slashed by introduction of quad



National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. P: See below; stock.

With the introduction of the industry's first quad comparator—National Semiconductor's LM3901—the cost of a single precision comparator reaches a new low. Consisting of four essentially LM-311 comparators on a single chip, the LM3901 is priced at $3.80 (100-999), or 95¢ a comparator. In 1000-up quantities, the cost drops to 50¢ a comparator. By comparison, a single LM311 sells for $3.15 (100-999).

Moreover the LM3901 features a total power current drain of only 800 μA for all four comparators. This current is essentially independent of the magnitude of the power-supply voltage. And that can be as low as 2 V.

All four comparators are individually available for independent applications. The comparators can operate from a single power-supply voltage over the range of 2 to 36 V dc (or dual supplies over the range ±1 to ±18 V dc).

When operating from a 5-V supply, the power consumption is 4 mW, or only 1 mW per comparator. The output can sink a maximum current of 20 mA, and response time, as measured with a 100-mV input step (5-mV overdrive), is less than 1 μs. Input current is typically 35 nA, with input offset current at 3 nA and input offset voltage of less than 3 mV, typically.

Another important feature is that the input common-mode voltage can range to ground even with one supply (see diagram). The input common-mode voltage range is from ground (or somewhat less than ground) to 1 V less than the power-supply voltage. This allows voltage comparisons to be made with very low-level input signals.

The outputs can be ORed and can also be operated from a different power source. This type of output is useful in many system applications since it functions as a single-pole single-throw switch to ground. Thus a clamping function is provided.

For LM3901

CIRCLE NO. 259

LED/lamp drivers cut component needs

Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74143N and SN74144N: $3.60; stock.

Two monolithic TTL/MSI ICs each contain a four-bit synchronous counter, a four-bit latch, and a seven-segment decoder/LED or lamp driver. Designated the SN54/74143 and SN54/74144, these complex circuits each contain the equivalent of 86 gates. And each can be used to replace the SN54/74160 decade counter, an SN54/7475 four-bit latch, and an SN54/7447 seven-segment decoder/driver.

CIRCLE NO. 260

Counters draw 85 mW with speeds to 23 MHz

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. Molded DIPs: $6 (100 up).

A 4-bit synchronous up/down counter pair, the Am93L60 decade and Am93L66 hexadecimal counters, operate at speeds to 23 MHz with power dissipation of only 85 mW. The power is one-fourth, the speed, one-half of the standard-powered counterparts. The new counters offer separate up and down clocks and asynchronous parallel loading.

CIRCLE NO. 261

SCRs, TRIACs in replacement line

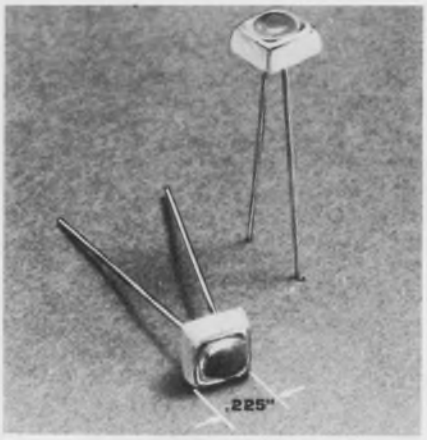
GTE Sylvania Inc., 730 Third Ave., New York, N.Y. 10017. (212) 551-1000.

As part of a replacement line, the company offers a complete family of SCRs (5400 and 5500 series) and TRIAC devices (5600 and 5700 series). The SCRs range from a sensitive 800-mA device to a rugged 34-A unit. Also featured are a full range of stand-off voltage capabilities. The TRIAC devices include a 2.5-A-gate unit, a 40-A device and a selection of power TRIACs. They feature all standard values of stand-off voltages and many have four-mode triggering capability.

CIRCLE NO. 262

ICs & SEMICONDUCTORS

8-A thyristors come in miniature ceramic cells

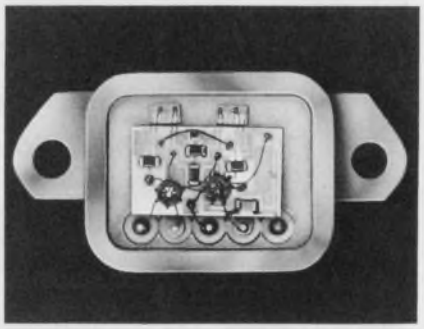


Hutson Industries, 2019 W. Valley View Lane, Dallas, Tex. 75234. (214) 241-3511.

An 8-A triac or SCR is now available in the company's Cermacels—miniature ceramic cells. The thyristors are available in 200 V, 300 V and 400 V (V_{DROM}) ratings. The new devices are hermetically sealed and passivated with inorganic glass and feature the company's Di-Mesa chip construction.

CIRCLE NO. 263

Hybrid CATV modules good to 300 MHz

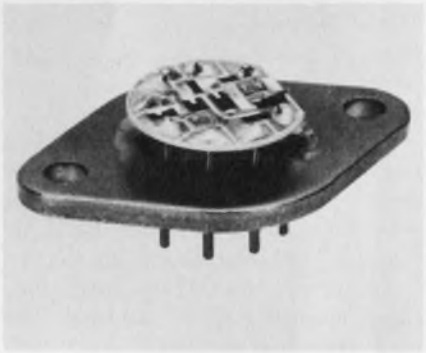


Motorola Semiconductor Products, P.O. Box 20912, Phoenix, Ariz. 85036. (602) 273-3466.

Three hybrid modules, for CATV systems, offer wideband amplification with low noise figure. The MHW560 provides 16 dB of power gain with a bandwidth of 40 to 300 MHz (within ±0.3 dB). A noise figure of 8.5 dB maximum is specified. The MHW561 provides an additional 15 dB gain and is intended as the output function in a line extender. The third module type MHW562 is intended for use as the output amplifier in a trunkline amplifier.

CIRCLE NO. 264

Hybrid circuit forms basic building block

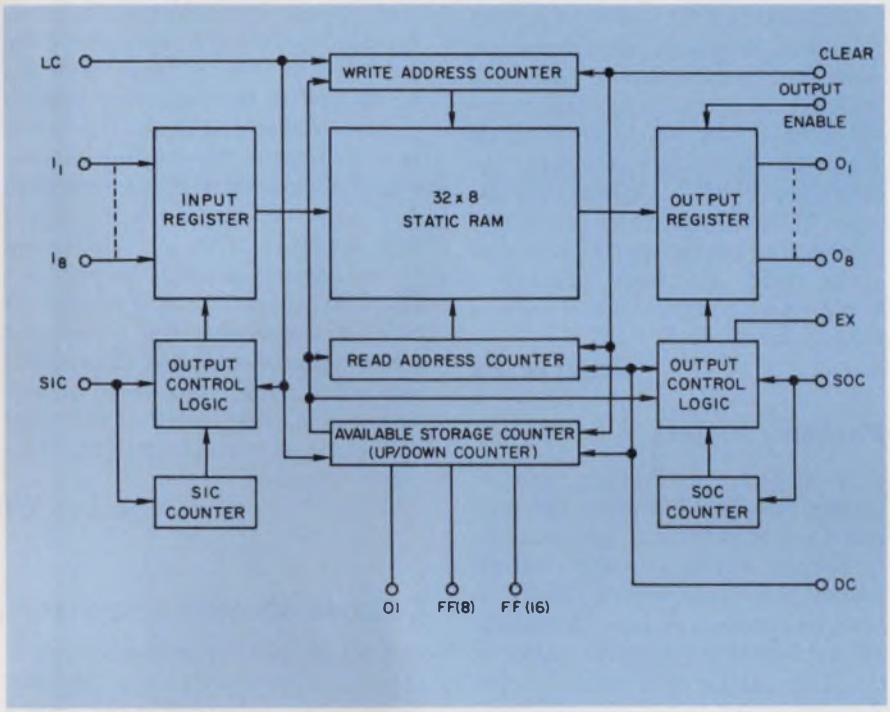


Ledex Inc., 123 Webster St., Dayton, Ohio 45401. (513) 224-9891. $22 (100 up); 48 hrs. (25 units).

Over a dozen circuits to shape, stretch or squeeze pulses can be built using as a basic building block, the LMD-1—a hybrid thick-film control circuit and power driver. With two external resistors, for example, a Schmitt Trigger driver capable of handling 50 V, 10 A loads can be made. With a capacitor and resistor, a programmable pulser can be built with a pulse rate from 1000 pps to less than one pulse every ten minutes.

CIRCLE NO. 265

FIFO memory chip boasts improved data-buffer specs



Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. P&A: See below.

First came Fairchild's 3341 4-bit-by-64 word FIFO (first-in/first-out) memory—a monolithic IC that functions as an asynchronous data buffer. Now, close on the heels of the 3341, Signetics offers the 2535—a monolithic 8-bit-by-32-word FIFO buffer register with decreased fall-through time, serial/parallel input and output and more level indicators for data presence.

The use of either the Fairchild 3341 or Signetics 2535 IC allows two systems with different clock rates to communicate with each other. Each IC operates over a frequency range from dc to 1 MHz.

A major difference between the two FIFO memory chips results from the use of a 32 × 8-bit static RAM in the Signetics 2535 (see diagram). In the Fairchild device, a 64 × 4-bit register is used. The static RAM in Signetics' p-channel MOS device allows a greatly reduced fall-through time—the amount of time required for data transmission starting with an empty buffer. Signetics' 2535 has a fall-through of 2 μs maximum. It's many times higher for the Fairchild device.

Another difference is the capability for serial or parallel operation at the input and output with the Signetics 2535. In the Fairchild 3341, both input and output must be operated serially. Thus additional circuitry would be needed when the 3341 is used to obtain the useful parallel mode of operation.

In another improvement, the Signetics' device provides 1/4, 1/2 and 3/4-fill signals in addition to buffer FULL and EMPTY. With the Fairchild IC, only FULL and EMPTY are given.

The disadvantages of the Signetics 2535 include higher price and larger package. In quantities of 100, the 2535 costs $31.70 (vs $20 for the Fairchild 3341). Packaging of the 2535 is 28-lead ceramic or plastic DIP (vs 16-lead DIP). Delivery of the new IC is two weeks (sample quantities).

For Fairchild 3341

CIRCLE NO. 266

For Signetics 2535

CIRCLE NO. 267

evaluation samples

Header/connectors

A family of H-106 header/connectors have snap-on covers in four heights: 170, 220, 295 and 500 mils. The covers have a smooth surface to facilitate marking of customer part number or other identification. Cover material is glass-filled nylon. The units are available in 14 and 16 pin configurations. JOLO Industries.

CIRCLE NO. 268

Ribbon cable

Flat-bonded round-conductor ribbon cable is available with from 10 to 30 conductors, 7 or 19 strands, and PVC insulation withstanding up to 1000 V. Bi-Tronics Inc.

CIRCLE NO. 269

DIP 22-pin sockets

A high quality socket that takes all standard 22-pin dual-in-line memory packages is available with either standard three-wrap or replaceable three-wrap pins. Molded of diallyl phthalate, the sockets have flame resistance per MIL-M-14, Grade SDG-F. Cambridge Thermionic Corp.

CIRCLE NO. 270

Brazing fixtures

Brazing and other holding fixtures made of alumina ceramic are fired to tolerances of ±0.5 mils without machining. The high alumina content imparts a number of fixture advantages including dimensional stability and resistance to high temperatures (up to 2500 F), thermal shock, and wear factors such as chipping and breaking. Ceram Corp.

CIRCLE NO. 271

Fasteners for fluorescents

Tinnerman fasteners provide support for bent tube fluorescents. The clips provide self-retained support for the U-shaped ends of the lamps, eliminating the need for screws, rivets or crimping. Eaton Corp., Engineered Fasteners Div.

CIRCLE NO. 272

application notes

Magnetic diodes

A four-page data sheet describes magnetic diodes, the new magnetic-sensitive semiconductor devices which change their internal resistance as a function of an external magnetic field. By altering the magnetic field, electrical signals may be obtained which allow the conversion of non-electrical quantities into electrical quantities. European Electronic Products Corp., Culver City, Calif.

CIRCLE NO. 273

Photon couplers

A 32-page application note on photon couplers discusses the pros and cons of different optoelectronic coupler systems, coupler terminology, key parameters, their interrelationships, and a wide variety of applications. General Electric Co., Semiconductor Products Dept., Syracuse, N.Y.

CIRCLE NO. 274

Hybrid package technique

A method of reflowing predeposited solder offers various advantages for standard hybrid packaging. In permitting multiple stacking of double-sided PC boards, many of the advantages of multilayer of equal circuit complexity and reliability are offered. Catalog No. 926-1 contains information on the select solder deposit technique. Amp Inc., Harrisburg, Pa.

CIRCLE NO. 275

Thermistor applications

Thermistor Applications Data Requirements Guide (AG-1A) is designed to assist and reduce the time necessary to select the proper thermistor for applications which most often present the design engineer problems, such as: time delay, transistor compensation, coil compensation, surge suppression, temperature measurement—control and liquid level sensing. Fenwal Electronics, Framingham, Mass.

CIRCLE NO. 276

design aids

Screen conversion factors

A plastic size-selector and conversion factor card measures 3 in. × 6-3/4 in., is durable, and can be carried in the pocket or kept in a desk drawer for ready reference. One side gives the relationship between Tyler and U.S. screens with millimeter and fractional inch openings together with an illustration of the particle sizes. It helps select the size of activated charcoal or other granular material to be used for a specific purpose. The opposite side gives conversion factors to aid in a wide range of chemical and engineering calculations. Barnebey-Chaney.

CIRCLE NO. 277

Cathode spectral response

A 23 × 16-inch wall chart gives spectral sensitivity curves for photo-emissive cathodes and shows transmission characteristics for various window materials and other relevant data. EMI Electronics Ltd., Electron Tube Div.

CIRCLE NO. 278

Plastics properties chart

The first six pages of "Plastics Properties Charts," treat 37 properties of thermoplastics, including a "Highlights" column on 19 plastics that industrial buyers have found helpful—a short primer on each "family" written in simple, direct language. The following six pages treat 36 properties of thermosets, with relevant footnotes. The concluding spread is devoted to 24 significant properties of industrial laminates. Resins and fillers, and characteristics and applications, are shown along the left-hand edge, and across the top are listed mechanical, electrical, and physical and thermal properties of popular laminates used in electronics, aerospace, and other applications. Commercial Plastics and Supply Corp.

CIRCLE NO. 279

new literature

Tone-burst generator

The Universal Tone-Burst Generator is described in a four-page brochure. All proprietary call systems with which the instrument can be used are listed. Operating features and applications are presented together with specifications. Singer Instrumentation, Los Angeles, Calif.

CIRCLE NO. 300

Ac relays

Complete electrical and pricing information on solid-state ac relays is contained in a 12-page catalog. Hamlin, Inc., Lake Mills, Wis.

CIRCLE NO. 301

Modems

The Model 2012, a synchronous modem capable of automatic answer operation at 2400-bits per second over dial-up telephone lines, is described in a six-page brochure. Included are descriptions of important features, detailed theory of operation and complete technical specifications. An outline drawing of the printed circuit card is included, as well as a block diagram, a data mode timing diagram, an illustration showing the transmitted signal frequency spectrum, and a block diagram of both calling and answering station call procedure sequence. Intertel Inc., Burlington, Mass.

CIRCLE NO. 302

Logic modules

Details and prices of the J1000 range of logic modules are given in a brochure. Jasmin Electronics Ltd., Leicestershire, U.K.

CIRCLE NO. 303

Comm connectors

Color-styled, all-plastic 50-contact Vitel connectors and plugs for the telephone industry are described in a 12-page catalog. The catalog also covers bridging adapters, flat cable assemblies, double-ended splices and a splice designed especially for the "interconnect" market. Viking Industries, Inc., Chatsworth, Calif.

CIRCLE NO. 304

Micro 1600 manual

An 88-page reference manual describes the Micro 1600 minicomputer. The manual has seven chapters and an appendix with a microcommand reference table. The seven chapters contain design features, system description, microcommand repertoire, control panel operation, microassembler program, input/output information, physical characteristics and system power. Microdata Corp., Santa Ana, Calif.

CIRCLE NO. 320

Terminal blocks

Detailed specifications on a full line of quick-connect terminal blocks are given in a bulletin which covers 250, 187 and 110-mil terminal sizes. Underwriters Safety Device Co., Chicago, Ill.

CIRCLE NO. 321

Thermal switch

Type R-3 bi-metal thermal switch is presented in a two-page bulletin. Included are a complete description, specifications and an installation drawing. Control Products, Inc., E. Hanover, N.J.

CIRCLE NO. 322

Connectors

A machine-insertable connector for circuit boards that gives a mechanical through connection which resists impact, vibration and thermal shock is described in a four-page bulletin. Berg Electronics, Inc., New Cumberland, Pa.

CIRCLE NO. 323

Graphic and digital recorders

A line of analog and digital recording instruments, programmable data acquisition systems, multipoint and event recorders are described in an eight-page catalog. Esterline Angus, Indianapolis, Ind.

CIRCLE NO. 324

MOS modem

A six-page, two-color brochure describes a MOS modem featuring 4800 bps full-duplex operation. American Data Systems, Canoga Park, Calif.

CIRCLE NO. 325

DIP transformers

A new catalog sheet covers data on 14 and 16-pin dual-in-line quad pac transformers, Series 1900. It includes drawings, maximum ratings, turns ratios, primary inductances and other specifications. Also shown is similar data on general-purpose pulse transformers and balanced center tapped transformers. Muir Industries, Inc., Tecate, Calif.

CIRCLE NO. 326

Four-inch recorder

The Alden 400 "push-to-print" recorder is described in a two-page data sheet. Alden Electronics & Impulse Recording Equipment Co., Inc., Westboro, Mass.

CIRCLE NO. 327

Add-on memories

Basic information on the company's line and add-on core memories and individual storage units are described on data sheets. Computer Hardware Consultants & Services, Inc., Newtown, Pa.

CIRCLE NO. 328

Disc memory

Model L107MS disc memory system is described in a two-page data sheet. In addition to giving technical data and features of the system, the data sheet also contains a complete specifications list and dimensional drawing. The Singer Co., Librascope Div., Glendale, Calif.

CIRCLE NO. 329

Disc system

A four-color, eight-page brochure describes the Model 844 universal controller and disc storage system for OEMs and end-users. Photographs illustrate the cabinetry. In addition, the brochure describes the design and applications and contains a descriptive specification sheet for different disc drives available with the new controller. Peripherals General, Inc., Cherry Hill, N.J.

CIRCLE NO. 330

Data modems

A brochure describes a complete line of low-speed, Bell-compatible data modems. Pulsecom, Falls Church, Va.

CIRCLE NO. 331

Portable chart recorders

Photos and specifications for the Model TR-711 portable analog strip chart recorder are provided in a bulletin. Complete basic specifications, as well as price and ordering information, are included. Prices are also provided for a special starter kit and accessories and options. Gulton Techni-Rite Electronics, E. Greenwich, R.I.

CIRCLE NO. 332

Data processing

"Data on Demand," a 16-page, full-color brochure, explains the services the company provides for commerce, industry and government. These include the design and installation of computer-communications systems which gather data over any distance, process it and deliver it in the form required, as fast as necessary. Teleprocessing, Industries, Inc., Mahwah, N.J.

CIRCLE NO. 333

EMC compatibility

A technical discussion, EDPF part number coding and specifications, dimensional data for EDPF series filters are discussed in a 68-page catalog, which is available for $3. A capacitive and inductive reactance calculator is included. Cornell-Dublier, CDE, Marketing Communications, 150 Avenue L, Newark, N.J. 07101

advertiser's index

Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card
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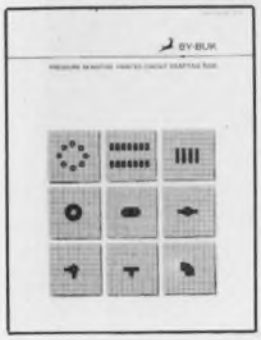
CIRCLE NO. 172

Transistor Devices, Inc.
85 Horsehill Road, Cedar Knolls, N. J. 07927
Tel. (201) 267-1900

PC Drafting Aids Catalog



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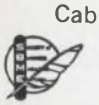


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New precision frequency synthesizer at signal generator price. Covers from .1000 Hz to 9.999 MHz in 8 ranges. Frequency accuracy/plus and minus 10 ppm over 0-50° C./ TTL square wave output. Various options available. Price $495.00. Syntronics, Inc., 169 Millham Street, Marlboro, Ma., 01752. (617) 481-7827.

INFORMATION RETRIEVAL NUMBER 181

Thin-Trim® variable capacitors are designed to replace fixed tuning techniques. Applications include crystal oscillators, CATV amplfiers, communication and test equipment. Series 9410 has high Q's with five capacitance ranges from 1.0 - 4.5 pf to 10.0 - 50.0 pf. Johanson Manufacturing Corporation, Boonton, N. J. (201) 223-2676

INFORMATION RETRIEVAL NUMBER 182

Prototypes of precision snap-action thermostats from Elmwood, widely specified for quick, reliable response; proven industrial and military performance record. Environ. expos. −85° to 550°F; narrow or wide diff.; rated to 15 amps. Wide choice of brackets, terminals. Elmwood Sensors, Inc. (401) 781-6500. TWX 710-381-6413.

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EC offers nearly 100 capacitance values in its new line of 100-Volt Flat-Pak, Axlal and Radlal-Lead Metalized-Polypropylene Capacitors. Capacitors are epoxy encapsulated in Diallyl Phthalate. Stand-off feet are provided on both Flat-Pak and Radial Lead units. Engineered Components Co., 2134 W. Rosecrans Ave., Gardena, Cal. 90249. (213) 321-6565.

INFORMATION RETRIEVAL NUMBER 184

High quality panel meters. Extensive experience gives you a diverse line of reliable panel instrumentation. Please contact us for more detailed information. Sanyo Products Corp., P. O. Box 125, Shinjuku, Tokyo, Japan.

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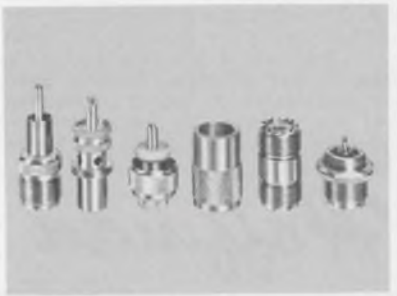


Aside from the various types of connectors, we have plugs, jacks, test leads, semi-conductors, resistors, capacitors, jumper cables, intercom sets, etc. LICHT CORPORATION, Toshin Bldg., No. 1-2, 2-chome, Sotokanda, Chiyoda-ku, Tokyo, Japan. Phone: 253-8785.

INFORMATION RETRIEVAL NUMBER 186

product index

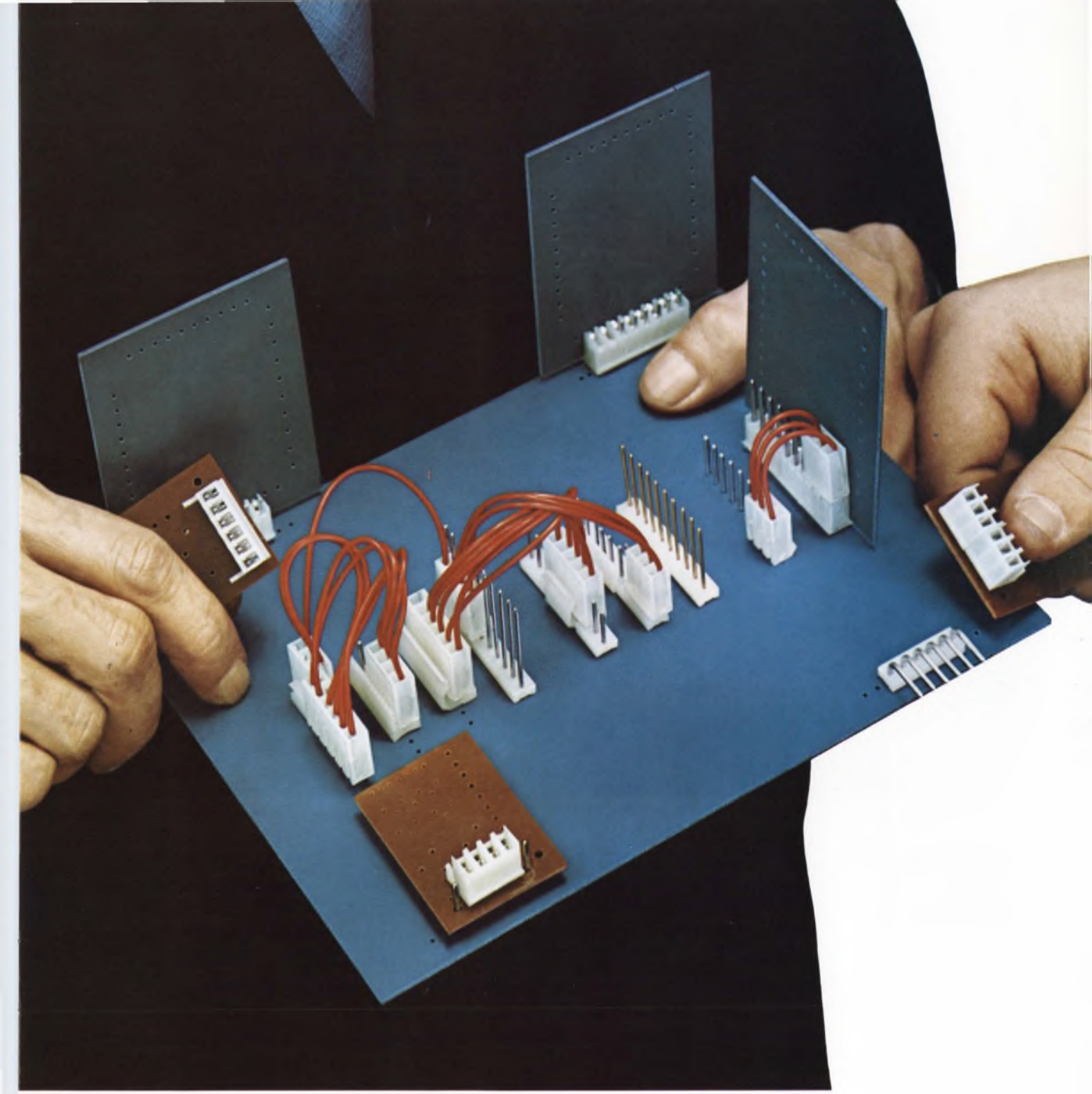
Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

new literature

application notes

design aids

evaluation samples



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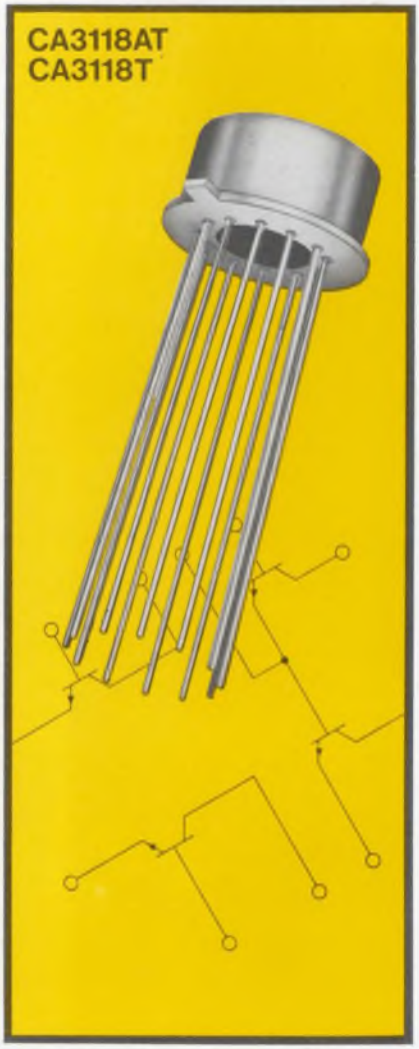

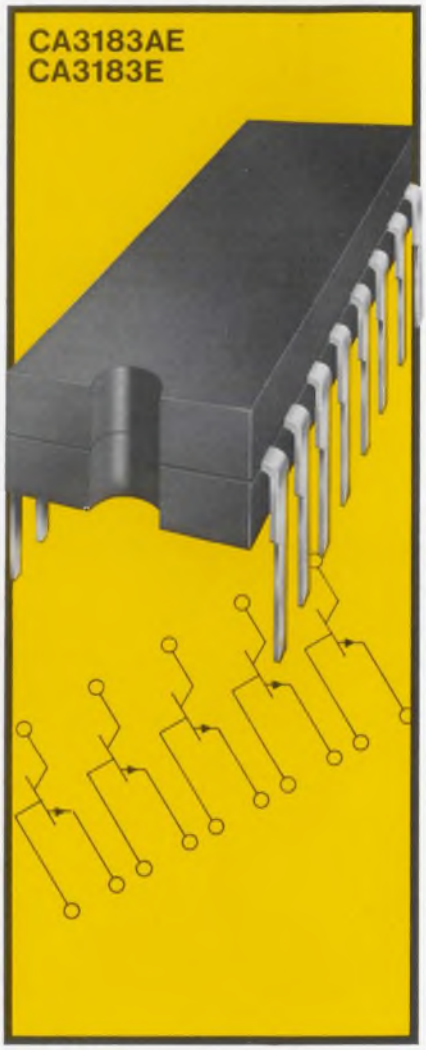

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CA3118T	30	50	12L TO-5*	.98
CA3146AE	40	50	14L DIP**	1.40
CA3146E	30	50	14L DIP**	.98
CA3183AE	40	75	16L DIP**	1.50
CA3183E	30	75	16L DIP**	1.25

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