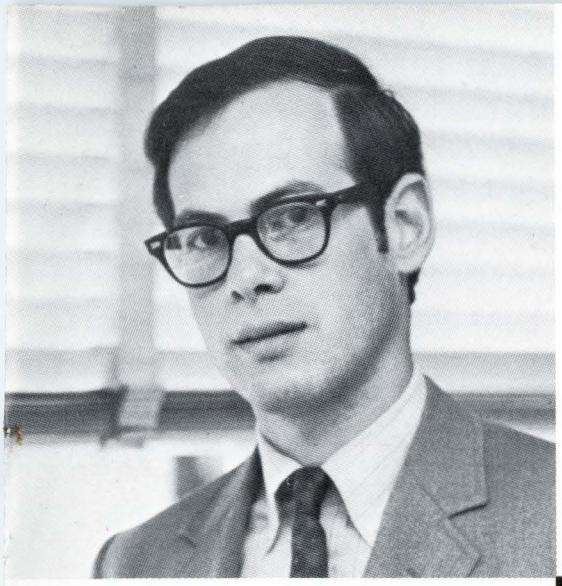


What will EEs design for data comm? S. Mathison tells you.

CHILTON'S

THE ELECTRONIC ENGINEER

VOL. 30 NO. 9
SEPTEMBER 1971

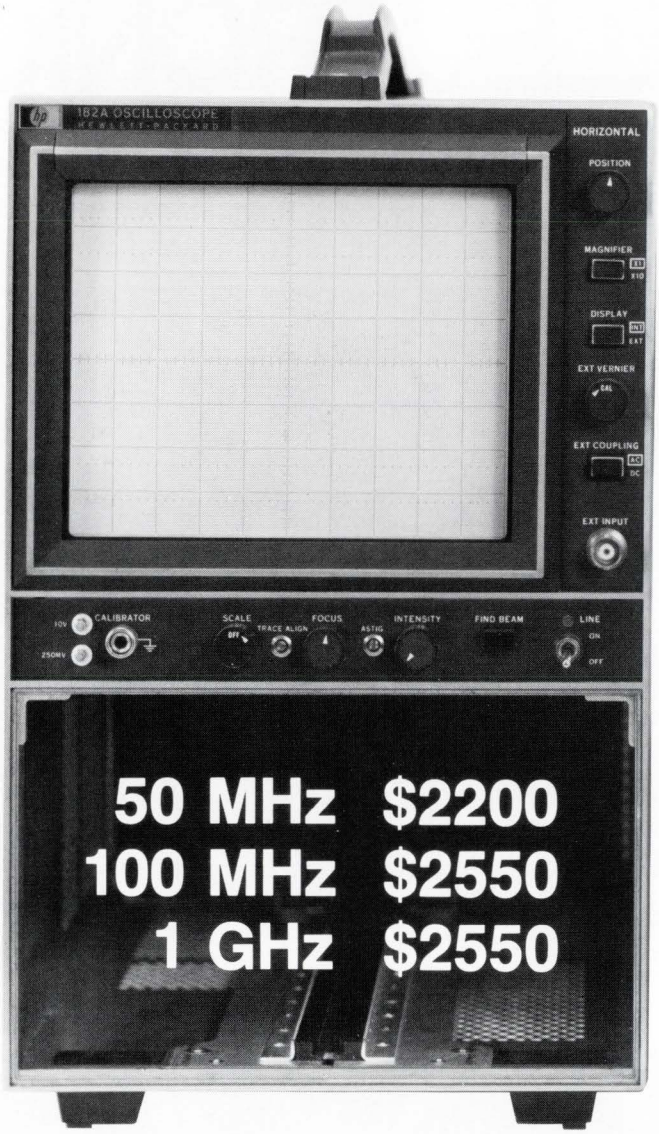
Quadrature filters: what are they & what do they do?

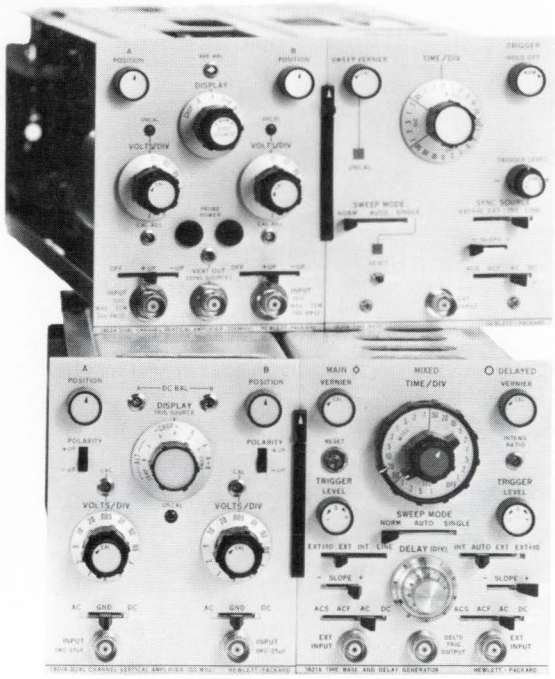
Capacitors: an international story

Data terminals course—taking off the cover

Today's capacitor: mini-sized in maxi-volume production.

The big buy in big-screen lab scopes





You don't have to give up performance capabilities to save money on a big-screen scope; HP's 182A gives you both.

For $2200, you can get a mainframe, a 50-MHz dual-channel amplifier, and a delayed-sweep time base. This combination gives you the **biggest display area of any high-frequency scope** (8-div x 10-div, 1.3 cm/div), 5 mV/div sensitivity, and 10 ns/div sweep time.

And that's only the beginning. **The 182A system isn't limited to 50 MHz** in the plug-ins it can accept. Thanks to HP's pioneering advances in CRT technology, the 182A will take the entire family of 180 System plug-ins.

For $2550 you can get a 100 MHz system (mainframe, dual-channel vertical amplifier, and non-delayed sweep; delayed sweep $450 extra). Also available at $2550 is HP's new 1 GHz sampling system (mainframe and plug-in) that's as easy to use as a real-time scope! And the 182A is the only large-screen lab scope that has these capabilities.

So, if you're in the market for a high-frequency scope—get the 182A in the 50-MHz configuration, and protect yourself against having to buy a whole new system for 100-MHz capabilities in the future. **It's like getting free "bandwidth insurance" with your mainframe!**

Circle Reader Service #1

For further information on the 182A, contact your local HP field engineer, or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

Scopes are changing.
Are you?

081/16

HEWLETT hp PACKARD

Circle Reader Service #2

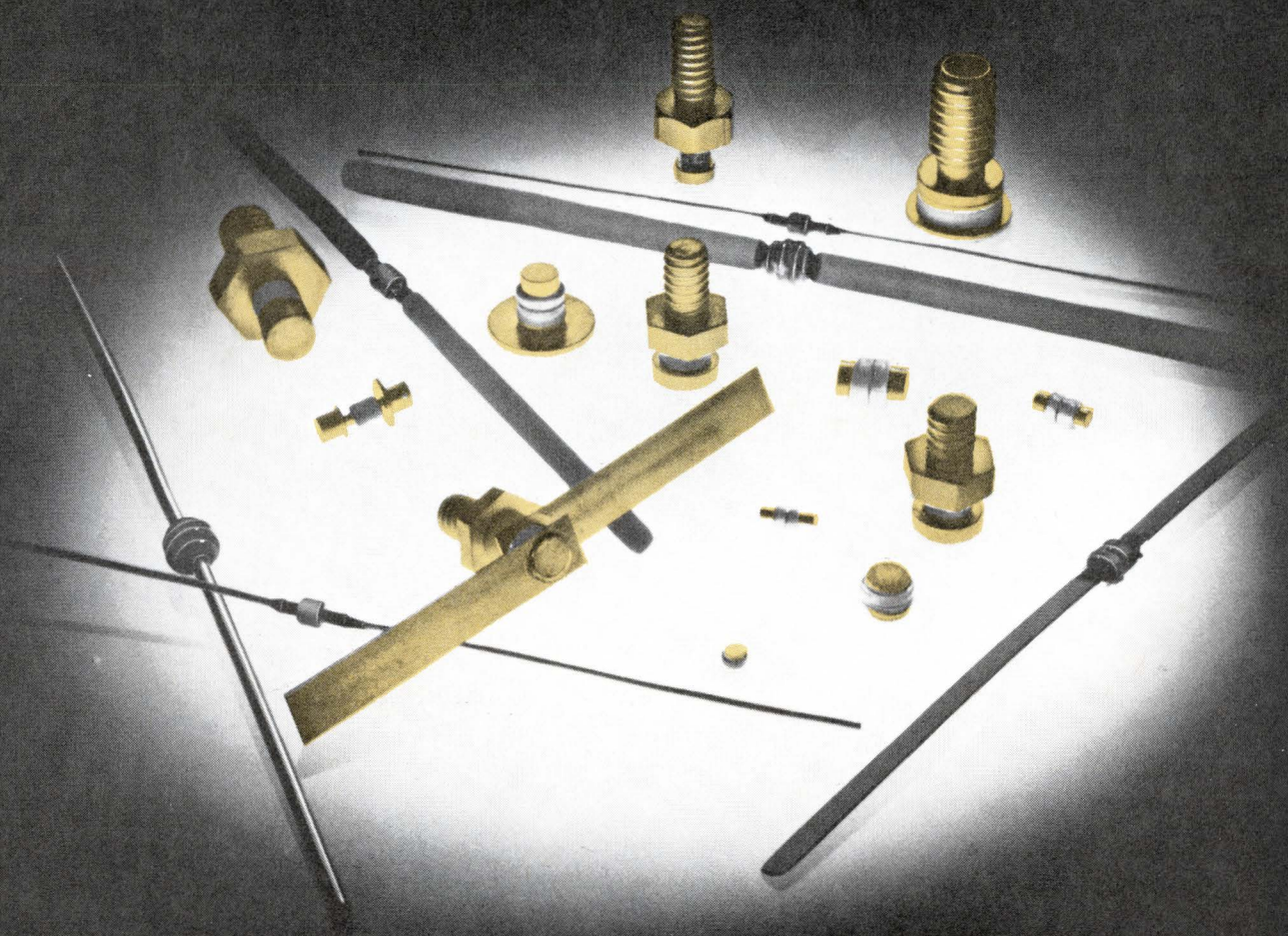
Lowest distortion
and low cost in PIN diodes

If you are designing a VHF or UHF system with strict harmonic or intermodulation product requirements, Unitrode PIN diodes, with industry's longest carrier lifetime (1-10 μsec typical) will put your mind at ease.

In addition to the low insertion loss and high reliability aspects on Unitrode's fused-in-glass PIN diodes, we can now offer the additional advantage of low distortion switching and attenuating. By controlling certain key parameters in our patented manufacturing process we can guarantee second and third harmonic levels of 90 db below fundamental and intermodulation products as low as 60 db. This guaranteed low distortion performance costs no more. (Available under 90¢ in quantity.)

Applications from HF through UHF include TR switches, duplexers and receiver protectors in military and commercial two-way communications systems. They also reduce distortion in AGC loops and tunable filters in CATV systems.

For further information, samples and applications assistance, call Bob Tremblay at (617) 926-0404 or write Unitrode Corporation, Dept. 9D
580 Pleasant Street, Watertown, Mass. 02172



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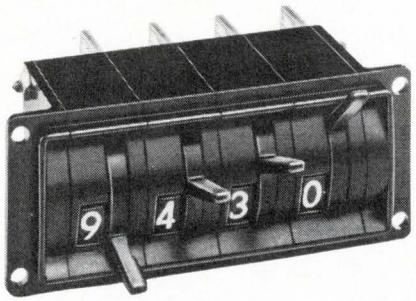
IF YOU HAD TO FLIP SWITCHES 7,843 TIMES A DAY, YOU'D ASK FOR THE MINILEVER.™

Here's the compact switch that's built for switchers. With positive, clear-sounding click-ity-clicks that sweep over a 90-degree arc. So the right setting is easy to hit every time. And just as easy to see. Because the .200 inch high display characters—in up to 12 positions—really pop out at you. A simple sweep of the hand re-sets everything back to zero, too.

So next time your design calls for switches, think of the switchers' switch: The MINILEVER.® It's beautifully designed to be nice to operators and improve their efficiency where ever frequent, rapid switch-settings are a must. Besides, lots of switchers are girls, and they'll love you for it.



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THE ELECTRONIC ENGINEER

September 1971 Vol. 30 No. 9

Cover: Top left. What does the recent FCC decision opening up the special service common carrier market to competition mean in concrete terms to electronic engineers? Answering that question on p. DC-3 is Stuart Mathison, expert on data communications and this month's guest editorialist, who analyzes the technical challenges of data.
Bottom right. Whether in Japan, Western Europe, the U.S., or South America, the story is the same—high volume production of capacitors. For the latest developments in films, dielectrics, and ceramics, check the facts on p. 20. (Photo courtesy of Monolithic Dielectrics Inc.)

THE ELECTRONIC ENGINEER

September 1971
Vol. 30 No. 9

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Monthly publication of Chilton Company, Chestnut & 56th Sts., Phila., Pa. 19139. (Area Code 215) SHerwood 8-2000. Application to mail at controlled circulation rates pending at Cleveland, Ohio. $1 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $12.00; 2 yrs. $20.00. Canada 1 year $14.00; 2 yrs. $25.00. All other countries 1 yr. $20.00; 2 yrs. $35.00.

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Chilton BPA

Chances are you're paying up to 30% too much for this kind of breaker.

Unless you're already using Heinemann's new Series AM1.

It's our low-priced, direct replacement for AM12-type breakers that have been so popular everywhere.

But now you can save 17% on a single-pole model with auxiliary switch. Or 30% on a three-pole, 400-Hz model with auxiliary switch. Over comparable AM12s.

That ain't hay.

And AM1s are UL-recognized in any current rating up to 50 amp, at 240Vac or 65Vdc.

We offer you a bunch of options, too. Custom current ratings, choice of time-delay or non-time-delay response, special-function internal circuits. You can even get multipole models with all poles identical or with different voltage and current ratings, time-delay curves, and internal circuits for each pole.

If you've been using AM12-type breakers (incidentally, the most copied design in the world!), it's a cinch for you to work our AM1s right into your production. And you might even be able to lower your selling price. Or pocket some extra profits.

For all the details, write for Bulletin 3306. Heinemann Electric Company, 2806 Brunswick Pike, Trenton, N.J. 08602. Or Heinemann Electric (Europe) GmbH, 4 Düsseldorf, Jägerhofstrasse 29, Germany.

HEINEMANN

4975

EDITORIAL

Look abroad for growth at home

In a series of sweeping economic moves, President Nixon let us and the whole world know that he no longer depends on the self-regulating mechanism of free enterprise to solve our economic problems, when we are competing against directed economies in the international arena.

To be sure, the effects of the moves that are beneficial to the electronics industry are probably more psychological than practical, because no tolerable amount of government intervention could by itself solve the problems that beset our industry.

The wage freeze does not affect electronic engineers, many of whom today would be glad to have a job commensurate with their skills, let alone one with a frozen salary. To the consumer electronics industry, one that depends heavily on labor, the freeze is but a puny relief from the huge gap between labor costs in this country and those in the Far East. Nor could the 10% surcharge on imports (another of Nixon's measures) help offset the cost disadvantages this industry faces.

Even the investment tax credits are of more psychological than real economic value, since it is their spirit, rather than the small amount of those credits, that could convince the American electronics industry and its customers to continue the high investment so necessary to modern technology.

The real helpful measure is, paradoxically, an unwritten one. In suspending the convertibility of dollars into gold, the President has effectively floated the dollar to let it seek its own level against other currencies—primarily, against other strong currencies such as the German mark and the Japanese yen. And this level will be certainly lower than the present one, making it easier for American technological products to sell abroad. This is most important today because the growth opportunities for the electronics industry are shifting fast to the international market.

For the past twenty years, the opportunities for expansion were provided (and even paid for) by military and aerospace procurement in this country. Now the growth potential of this market has dried up. While the Department of Defense will continue to be an important customer for electronic manufacturers, its *growth potential* has all but disappeared. The poor performance of our industry in 1970 shows not only how drastically the defense reductions affected it, but also how poorly prepared the industry was to cope with them.

It is high time—worse, it is desperately urgent before it's too late—that American electronic companies stop looking at the military markets for growth, and start paying more than lip service to the international market. The growth opportunities of those two markets are of completely different nature, and so are the technical and economic strategies required to capture them. They pose, therefore, a challenge to both engineering and management. Floating the dollar may be the best incentive government can provide to meet this challenge. Meeting it may become your most important job in the decade ahead.

Alberto Socolovsky
Editor

Philbrick Data Converters.

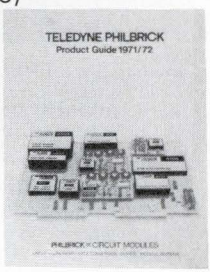
Highly reliable. Priced as low as $18.

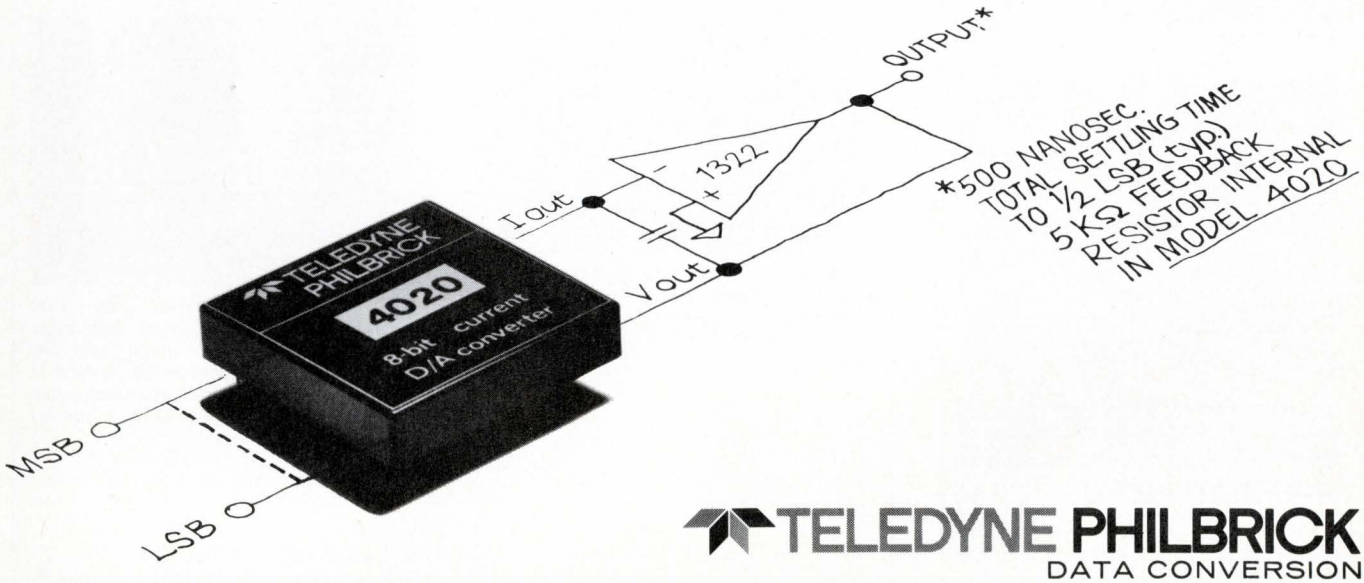
Everything from economy grade through state-of-the-art custom DAC's. Economy DAC's are for unipolar or bipolar operation, are TTL/DTL compatible, include internal referencing, exhibit a 200 nanosec settling time and have zero offsets less than ½ LSB. Low cost, $18 in 100 Qty., **Model 4020** 8-bit D/A converters offer high reliability for many applications such as analog monitoring of digital data. They combine maximum speed and can simultaneously sum the output of several devices. **Model 4021** 8-bit voltage output DAC features an internal IC op amp providing either 0 to −10 volts or +5 to −5 volts output range. Price: $18 in 100 Qty.

Model 4110 8-bit A/D converter, with a low price of $74.50 in 100 Qty., tracks up to 3kHz analog input, has a 25μsec conversion time and a 10 MHz stepping rate. Ideal for continuously converting analog signals into a digital binary output.

These are just representative samplings of our economy data conversion line. A complete data package and an evaluation module are available through your local field representative or Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. TWX: (710) 348-6726. For toll-free ready data, phone (800) 225-7883. In Mass. call (617) 329-1600.

Write for your free 1971/72 Product Guide.





TELEDYNE PHILBRICK
DATA CONVERSION

10 new ways to improve system performance

MECL 10,000 means optimum performance

MECL 10,000 improves your system performance 10 ways — actually 16 when you consider devices previously introduced. This new "systems-oriented" logic family combines high speed (typically 2.0 ns propagation delay per gate), with low power (25 mW dissipation per gate), yielding the best speed/power combination available today.

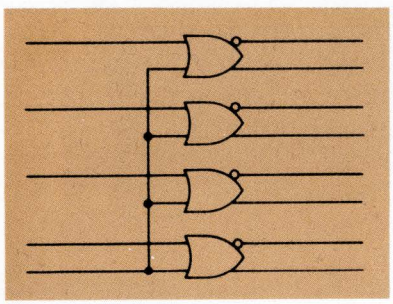
But speed and power are only part of the story. Take a look at the design advantages of MECL 10,000.

Features such as collector and emitter dotting on chip allowing multiple functions with only single gate delays. Or open emitter outputs and Hi-Z inputs which permit you to select the optimum termination method for your system.

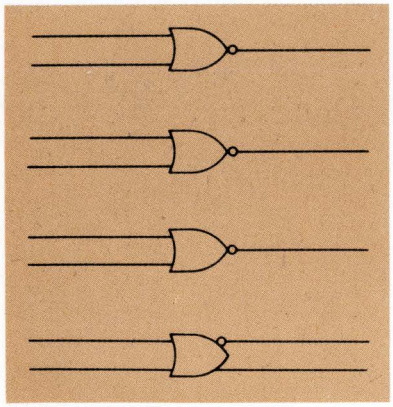
Interested in driving capacity? MECL 10,000 offers 50 Ω to 2 K Ω driving capability. High Z inputs with parallel terminated lines allow "stubbing" off of a line at several points. Popular series terminating and series damping techniques may be used with no loss in noise immunity.

Worried about cooling? Forget it! MECL 10,000 low power gates (25 mW/gate, 52 mW/gate with 50 Ω load) eliminate cooling and power distribution problems and ensure long term reliability. In fact the devices are so low power you can use them in any environment—from still air to specialized cooling.

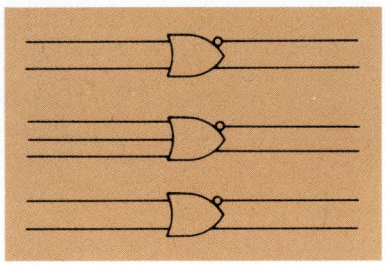
These are only a few reasons for choosing MECL 10,000, — your evaluation will discover the rest.



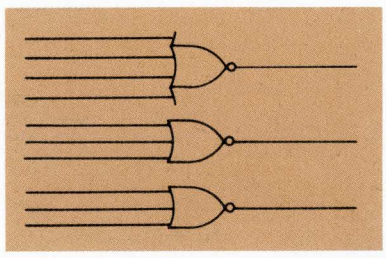
MC10101 Strobed Quad OR/NOR Gate — Very useful for distributing 4 bits of parallel information on or off card. With both OR/NOR outputs available, 4 twisted pair lines may be driven at data rates of 100 megabits/second. Use the single strobe input to gate the data on or off in 2 ns.



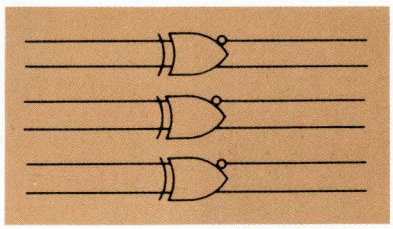
MC10102 Quad 2-Input NOR Gate — Offers four 2-input NOR gating functions with an additional OR output available. Input pulldown resistors on all devices eliminate need to tie unused inputs to an external supply.



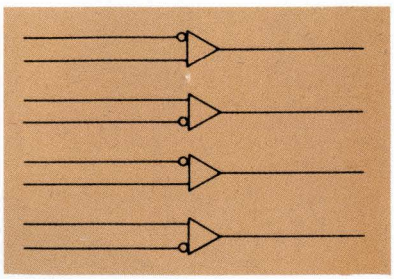
MC10105 Triple 2-3-2 OR/NOR Gate — A system oriented device aimed at reducing package count by providing three OR/NOR gates within one package. This versatile logic element provides manipulation of Boolean functions in typically 2 ns.



MC10106 Triple 4-3-3 Input NOR Gate — Basically a triple 3-input logic NOR function plus an additional input on one gate to provide added design versatility for maximum package use.



MC10107 Triple 2-input Exclusive OR/Exclusive NOR Gate — A three gate array providing the positive logic Exclusive OR and Exclusive NOR functions for high speed applications. Temperature compensated internal bias on 10,000 series devices insures that the threshold point remains in the center of the transition region over temperature.



MC10115 Quad Line Receiver — Useful for receiving 4 bits of differential data transmitted over twisted pair or ribbon cable from the MC10101. Also recommended for MOS to MECL interfacing and is ideal as a sense amplifier equivalent for MOS 1103 type memory translation to MECL.

MECL 10,000 ...

(of course)

MECL 10,000 — a comprehensive family

Originally designed as a computer-oriented logic family, MECL 10,000 also offers the optimum combination of parameters and flexibility required for high-speed digital communications, telemetry systems, and instrumentation. In addition to these 10 functions, here is a look at the line.

Previously announced and available:

MC10109 Dual 4-5 Input OR/NOR Gate
MC10110 Dual OR 3-Output Gate
MC10111 Dual NOR 3-Output Gate
MC10119 3-3-3-4 Input OR/AND Gate
MC10131 Dual D Flip-Flop
MC10181 4-Bit Arithmetic Unit

These functions will be added in 1971:

Memory Elements

MC10133 Quad D Latch
MC10134 Dual D Latch W/2D Inputs & Select
MC10135 Dual J-K Master Slave Flip-Flop
MC10136 4 Bit Universal Counter
MC10139 256 Bit Fusible Link ROM
MC10140 64 Bit RAM
MC10141 4 Bit Universal Shift Register

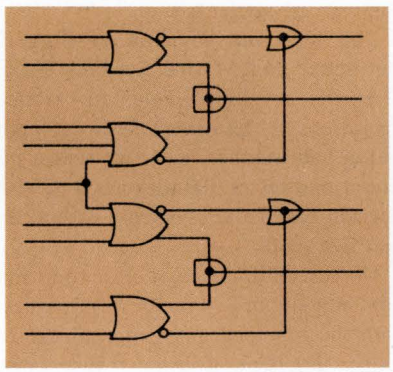
Line Receiver

MC10116 Triple OR/NOR

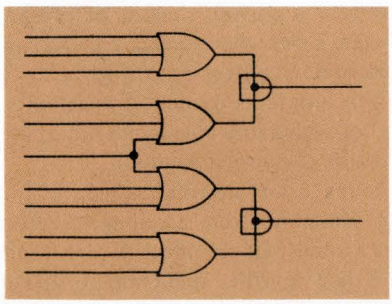
Complex Functions

MC10160 12 Bit Parity Checker/Generator
MC10164 8 Line Multiplexer With Enable
MC10179 Look-Ahead Carry Block
MC10161 Three Bit Decoder w/two Enables
MC10162 Three Bit Decoder w/two Enables

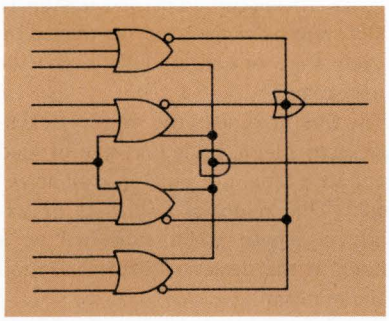
Your local Motorola representative has complete MECL 10,000 data yours for the asking — or write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036. And for evaluation call your nearby Motorola distributor.



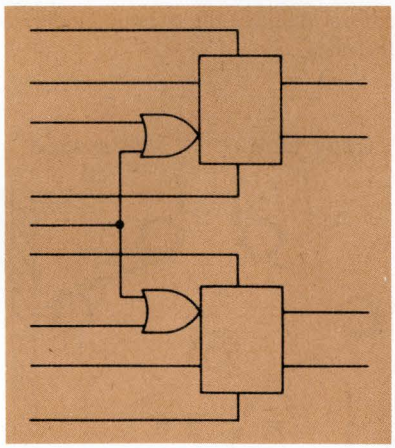
MC10117 Dual 2-Wide OR-AND/OR-AND-INVERT Gate — A powerful logic function featuring the first available OR-AND/OR-AND-INVERT emitter coupled logic gate. The internal collector AND/emitter OR dotted logic gate will perform the OR-AND/OR-AND-INVERT logic function in 2.4 ns. Useful for data multiplexing and data distribution.



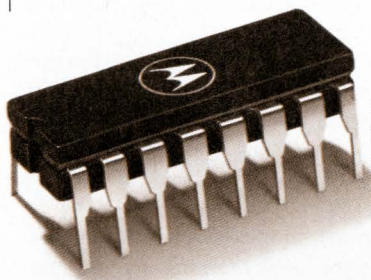
MC10118 Dual 2-Wide 3-Input OR-AND Gate — A highly functional basic building block to provide the OR-AND function. Recommended for digital multiplexing and data control applications.



MC10121 4-Wide OR-AND/OR-AND-INVERT Gate — Another system oriented building block providing the simultaneous OR-AND/OR-AND-INVERT function, a natural for data distribution applications.



MC10130 Dual Latch — A clocked dual D type latch. Each latch may be clocked separately by holding the common clock in the low state, and using the clock enable inputs for the clocking function.



MECL 10,000 eliminates the alternatives. The proof is in the comparison!

MOTOROLA MECL

. . . for faster computers & systems

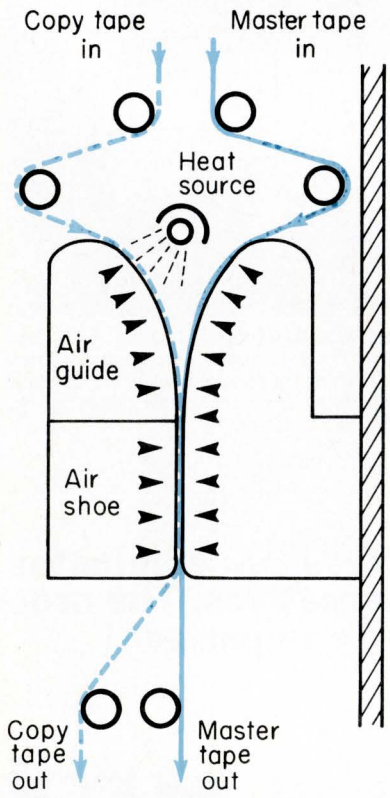
UP-TO-DATE

A hot recording

Until now, video tape recording has suffered from a bottleneck in tape duplication. So Du Pont has come up with a new thermal method that is less expensive, produces tapes of better quality, and is about 10 times faster than electronic re-recording methods.

The thermal copying process uses chromium dioxide videotape to produce both master tapes and copies with identical properties. Chromium dioxide (CrO_2) is ferromagnetic and has a Curie temperature of 130°C, above which coercivity and residual magnetism become zero.

To duplicate a recording, the CrO_2 magnetic tape is heated slightly above 130°C. As it cools in contact with the master tape in a small magnetic field, it acquires the signal from the master tape. Recordings are stable at room temperatures, and the moderate heating does not damage the organic binders or substrates.



Video tape recordings can be reproduced rapidly using Du Pont's heat process.

Du Pont has a developmental tape-to-tape copy machine. The master and copy tapes are drawn together by an air clamp, and as the copy tape is heated by a 1000-W tungsten-halogen lamp. A common stepped vacuum capstan performs the differential stretching of master and copy tapes. Tape speeds of 150 in./s are attained with servo-controlled tape feed and take-up.

Du Pont has no plans for selling tape copiers, but will assist in the design of commercial models by licensees.

Motion by piezoelectricity

A new idea for precision film transports uses piezoelectric techniques instead of rotary mechanisms to advance film. Developed by Teledyne Ryan Aeronautical of San Diego for the U.S. Air Force, the transport advances or reverses film in 1- to 20-micron steps at rates up to 2,000 steps/s. Tape can be moved in discrete steps or continuously over wide speed ranges.

The film drive uses the lengthwise displacement of an elongated bar of lead zirconate titanate, a poly-crystalline ceramic. This material contracts or expands in length when subjected to a voltage in the direction of polarization of the material.

The film is placed next to a bar of the material, and the bar is then energized by timed voltage pulses. The pulses contract and expand the material in the same direction as the film is moving. At the same time, two other bars of the lead zirconate titanate are alternately energized by timed voltage pulses. This movement clamps the film to the first bar and synchronizes with the motion of the first bar.

Through timing of the pulses the film may be moved in either direction in increments equal to the change in length of the bar moving the film, and at a speed determined by the rate of the pulses.

There are no mechanical devices involved; the only motions are the contraction and expansion of the ceramic bars. Wear is negligible, occuring only where the bars make contact with the film.

Stepping rates as low as 1 to 100 steps/s in steps of 1 to 10 microns have been demonstrated. The transport can work with electron beam or laser recorders, or any high quality image recorder which builds up imagery from a succession of evenly spaced lines.

Microwaves breakthrough

Armed with high accuracy and low price, microwave systems have opened the door to greater and safer use of the 3,000 U. S. airports with minimal or no instrument landing systems. The Western Regional Office of the FAA has approved the use of the Talar Microwave Landing System by Golden West Airlines at the Municipal Airport in Fullerton, Calif. This is the world's first microwave landing system approved for commercial carrier use.

The Kearfott Division of Singer's Aerospace and Marine Systems Group originally developed Talar for tactical operations in Southeast Asia at night and in bad weather. Kearfott sees a potential market of 300 airports and 3000 aircraft for Talar systems within the next five years.

With installation costs close to $1 million, only about 310 major airports have both the financial and geographical resources for the conventional instrument landing system. The ground transmitter for the microwave system costs $38,500, sets up in minutes, and operates at 15.5 GHz with a maximum acquisition range of over 30 nautical miles (10 miles during rainfall of 10 mm/hr.). The airborne receiver, at $3,900, consists of two solid-state units, the antenna-receiver and electronics control amplifier. The receiver interprets ground transmissions and provides steering signals for standard airborne instrumentation.

Using Talar, aircraft can reduce landing minimums from a ceiling of 800 ft. and visibility of one mile, to 500 ft. and one mile. Further reduction to 400 ft. and ¾ mile is expected. On many days, visibility fluctuates between ½ and one mile, severely restricting flights. With the ¾ mile minimum nearly all flights would get through.

Output Limit Indicator Light, Variable Width Pulse, Sweep Width Control, Frequency Analog Output, Manual Trigger, etc.

More features for $495 than any other Function Generator

The new F34 proves that a Function Generator doesn't have to be expensive to be great!

Read the panel! The Output Limit indicator Light — unique! It guarantees you an unclipped waveform. The Sweep Width control — foolproof and calibrated. Frequency analog output, variable width pulse and manual trigger — they're all there and more. See for yourself! For details on IEC's complete Function Generator line, contact John Norburg today.

The new SERIES 30 includes 3 other models costing even less, starting at just $295!

INTERSTATE ELECTRONICS CORPORATION

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Telex Nos.
655443, 655419

UP-TO-DATE

The seal's the thing . . . After solving a problem with the bottom glass seal of its leadless package (**The Electronic Engineer,** Feb. 1971, p. 27), Diacon is now in full production. The lead frame is sealed in a 600° glass, edged with a 450° glass. This prevents the lead frame from moving around and pulling bonds loose when the final seal is made to an identical 450° glass on the top cover. The company has also developed a variable-viscosity DIP seal.

Congress hears engineers . . . The House of Representatives held hearings on June 22-23 on its version of the "Conversion Research and Education Act" sponsored by Reps. Giaimo and Davis. This act would establish national policies on engineering employment and R&D investment. Senator Kennedy, who has sponsored a similar bill in the Senate, will schedule hearings for later this year.

Why not? It's free! . . . Robert A. Yereance of Battelle's Columbus Labs states that industry is overlooking valuable commercial product applications developed in military and space programs. He believes there are three reasons for this: techniques developed on Government programs are thought to be costly; many of the knowledgeable engineers and scientists involved in the techniques are young people who find it difficult to get recognition of their ideas from management; and memories of unhappy experiences with new techniques often may cause a company to resist them.

Intech Inc., of Santa Clara, Calif., has purchased the modular products operation from Fairchild Camera & Instrument. Intech will continue the line to Fairchild's original specs.

The mushroom farm . . . In an effort to dispel what Assistant Secretary of Defense Barry Shillito referred to as their "mushroom farm" image ("keep everything in the dark, with plenty of fertilizer"), DoD top brass recently explained their new procurement posture. At a symposium sponsored by the National Security Industrial Association, Deputy Secretary Packard acknowledged the end of former Secretary McNamara's Total Package Procurement policy with the new DoD directive 5000.1. The directive calls for the separation of production options from the development contract, the establishment of cost as a design parameter and logistics support as a principal design parameter, and emphasis on prototyping in advanced technology efforts using small design teams and minimal documentation.

Tapless cable . . . Anaconda Cable Co. and RCA have joined forces to develop a classified communications cable system. Should an intruder try to tap the cable to intercept secure information, the system automatically sounds an alarm.

Look before you leap! . . . was the advice the Seattle Professional Engineering Employees Assn. (SPEEA) gave in an advertisement directed at the undergraduate engineering students registered at the University of Washington. The ad spelled out a few prevailing "facts of life" such as technical unemployment, average salaries below those of tradesmen, and the need for periodic relocation.

Space contract . . . NASA has asked aerospace firms to make proposals for developing an automated high energy astronomy observatory (HEAO) that will serve as headquarters for the study of high energy radiation from space. The contract is expected to be awarded in early 1972, *if* the project is approved in fiscal year 1972.

Data terminals and communications . . . A study by the Diebold Group states that digital communications will become increasingly more available and will decrease in cost, and cites these as two reasons for their prediction that the number of remote terminals will quadruple to 2 million between now and 1975. Other reasons for the increasing use of data communications include: the volume of data processed (this will double in the same period), labor costs, requirements for higher communications speeds, and the decrease in the price of minicomputers.

Here come da memories, . . . Berne Broadbent, Manager of Engineering for Digital Development Corp. of San Diego, feels that semiconductor-implemented disc and drum memories will take over the ½- to 1-Mbit capacity range within the next 18 months. Digital's new 6000 series of single disc memories range from 16 to 128 tracks of 66,000 bits each (1 to 8½ Mbits). Average access time is 10 ms; unit price is $4-7,000. And, they may be seen at this year's FJCC.

Commercial educational TV . . . Texas Instruments Inc. is presenting a course on MOS technology on closed circuit TV. It will be shown in 17 locations simultaneously from Sept. 22-24. For more details, see our "Calendar" on p. 16.

Second source for MOS . . . Although it built its reputation as a custom circuits house for MOS LSD, American Micro-systems Inc. (AMI) is expanding its standard products line to include two random-access memories: the S4006 (second-sourcing Mostek), and the S2103 (after Intel's best-selling 1103).

Bits of information . . . **Tyco Laboratories** has successfully grown single crystal sapphire ribbons as wide as 1 in. in continuous lengths (over 4 ft) without slicing or machining of any type . . . **Bell Labs** scientists are using a laser to identify polluting gases in the air . . . **The Army Electronics Command** at Fort Monmouth has come up with a lightweight thermoelectric generator. The 500-W, 28-V dc generator weighs only 57 lbs. It can operate unattended as long as the fuel supply lasts, and burns diesel oil, gasoline, or aircraft fuels with consumption about ½ gal. per hour . . . **RCA** has developed a method of "freezing" single TV pictures on a home screen for cable TV systems.

Two plants for ITT's new Cable-Hydrospace Division are being completed just south of San Diego in National City, Calif. They will manufacture commercial and military submarine cable . . . **North American Philips** has acquired Electra/Midland from Transitron Electronic Corp. . . . **Bell & Howell** has doubled the recording time of instrumentation tape recorders without frequency response loss. Recorder VR-3700B reproducer can record frequencies up to 2 MHz at a tape speed of only 60 in./s.

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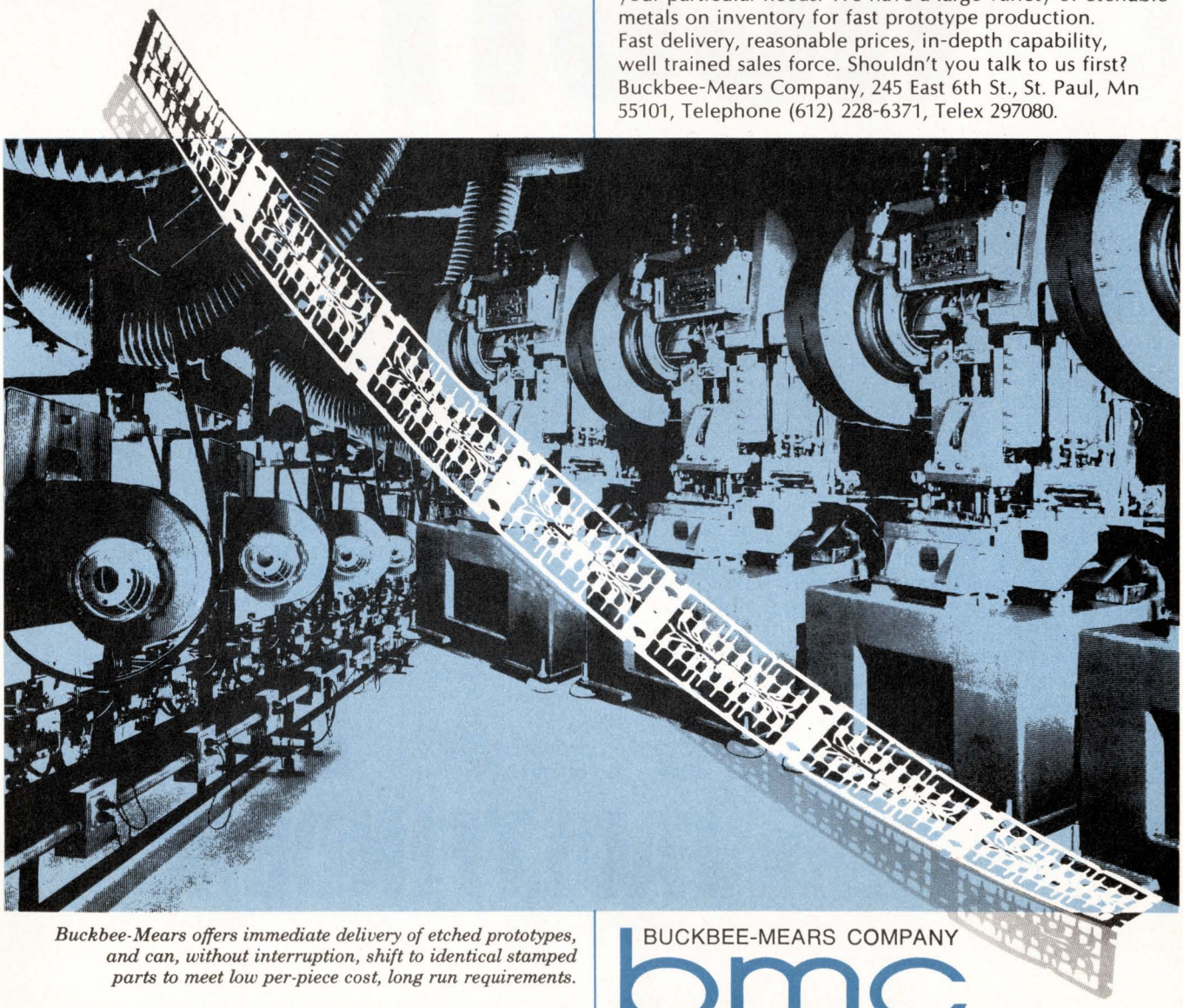

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CALENDAR

SEPTEMBER						
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Sept. 22-24: Computer Technical Conference, Sheraton Boston Hotel, John B. Hynes Aud., Boston, Mass. Addtl. Info.—Norman Rasmussen, IBM Corp., 545 Tech. Sq., Cambridge, Mass. 02139

CCTV MOS course . . . In an unique application of educational TV, Texas Instruments is presenting a course on MOS technology over closed circuit TV. The course will run for three consecutive days, Sept. 22, 23 and 24, and will be available in 17 locations. These are Baltimore/Washington, Boston, Chicago, Dallas, Dayton, Denver, Detroit, Indianapolis, Los Angeles, Minneapolis, New York, Palo Alto, Phila, Phoenix, Rochester and San Diego. The cost is $195 which includes lunches and publications. To enroll, send check or M.O. to Texas Instruments Incorporated, MS 84, Box 5012, Dallas, Texas 75222. Late registrations can be made by calling Frank Walters at 214-238-3741.

OCTOBER						
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3	4	5	6	7	8	9
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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Oct. 6-8: Electronic & Aerospace Sys. Convention (EASCON), Marriott Twin Bridges Motor Hotel, Washington, D.C. Addtl. Info.—L. Goldmuntz, 29 Kalorama Circle, Washington, D.C. 20008

Oct. 11-13: 1971 Int'l Microelectronics Symposium, Pick-Congress Hotel, Chicago, Ill. Addtl. Info.—Int'l Society for Hybrid Microelectronics, 1410 Higgins Rd., Park Ridge, Ill. 60068

Oct. 18-19: Consumer Electronics Symposium, McCormick Place, Pick-Congress Hotel, Chicago, Ill., Addtl. Info.—Wayne Luplow, Zenith Radio Corp., 1851 Arthur Ave., Elk Grove Village, Ill. 60007

Oct. 18-19: Digitronics Users Conference, Holiday Inn, Tysons Corner, Va. Addtl. Info.—Mort Siegelbaum, Executive Secretary, Digitronics Users Assoc., P.O. Box 113, Albertson, N.Y. 11507

Oct. 18-20: IEEE Fall Electronics Conference, Pick-Congress Hotel, Chicago, Ill. Addtl. Info.—P.B. Haff, Manager Chicago Area Public Relations, Western Electric Co., 20 N. Wacker Drive, Chicago, Ill. 60606.

Oct. 20-21: Fourth Annual Connector Symposium, Cherry Hill Inn, Cherry Hill, N.J. Addtl. Info.—William Rees, Jr., Box No. 3104, Philadelphia, Pa. 19150.

Oct. 31-Nov. 3: Seminar on "Fundamentals of Computers," Pheasant Run Lodge, St. Charles, Ill., Addtl. Info.—National Electronics Conference, Oakbrook Executive Plaza # 2, 1211 W. 22nd St., Oak Brook, Ill. 60521

NOVEMBER						
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Nov. 2-5: Northeast Electronics Research & Engineering Meeting (NEREM), Sheraton-Boston Hotel, War Mem. Aud., Boston, Mass., Addtl. Info.—IEEE Boston Office, 31 Channing St., Newton, Mass. 02158

Nov. 16-18: 1971 Fall Joint Computer Conference, Las Vegas Convention Center, Addtl. Info.—AFIPS Hdqs., 210 Summit Ave., Montvale, N.J. 07645

'71 and '72 Conference Highlights

NEREM—Northeast Electronics Research & Engineering Meeting, Nov. 3-5; Boston, Mass.

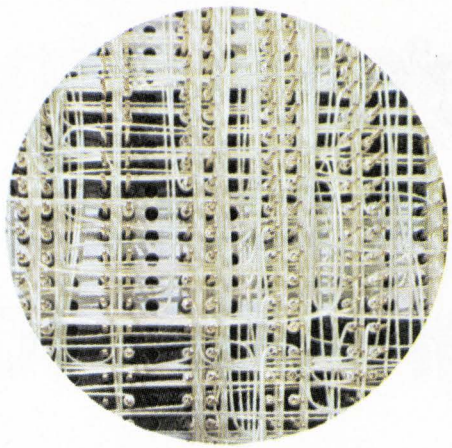
INTERCON '72—IEEE International Convention and Exposition, March 20-23; New York, N.Y.

Call for Papers

April 24-26: 1972 International Conference on Speech Communications and Processing, Boston, Mass. Submit a 100 word abstract of your paper by Nov. 1, to: Charles Teacher, Philco-Ford Corp., 3900 Welsh Rd., Willow Grove, Pa. 19090

May 16-18: 1972 Spring Joint Computer Conference, Atlantic City, N.J. Submit 6 copies, including an abstract and a draft (not exceeding 6,000 words) by Oct. 1, to: Dr. Jack Schwartz, 1972 Spring Joint Computer Conference, Box A-Computer Science Dept., Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

TO WRAP OR NOT TO WRAP



That is the question that invariably arises when you're designing a new circuit. You can either take the wire-wrapping route for design flexibility. Or you can choose p.c. wiring for manufacturing economy. Either way, you have to accept trade-offs.

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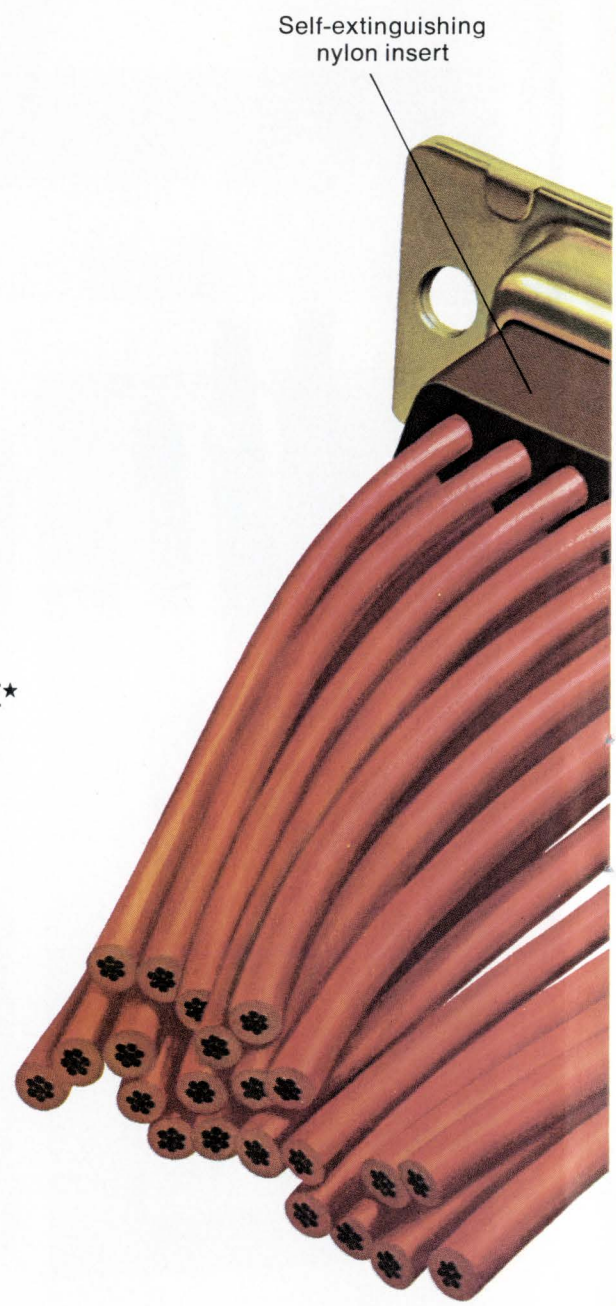

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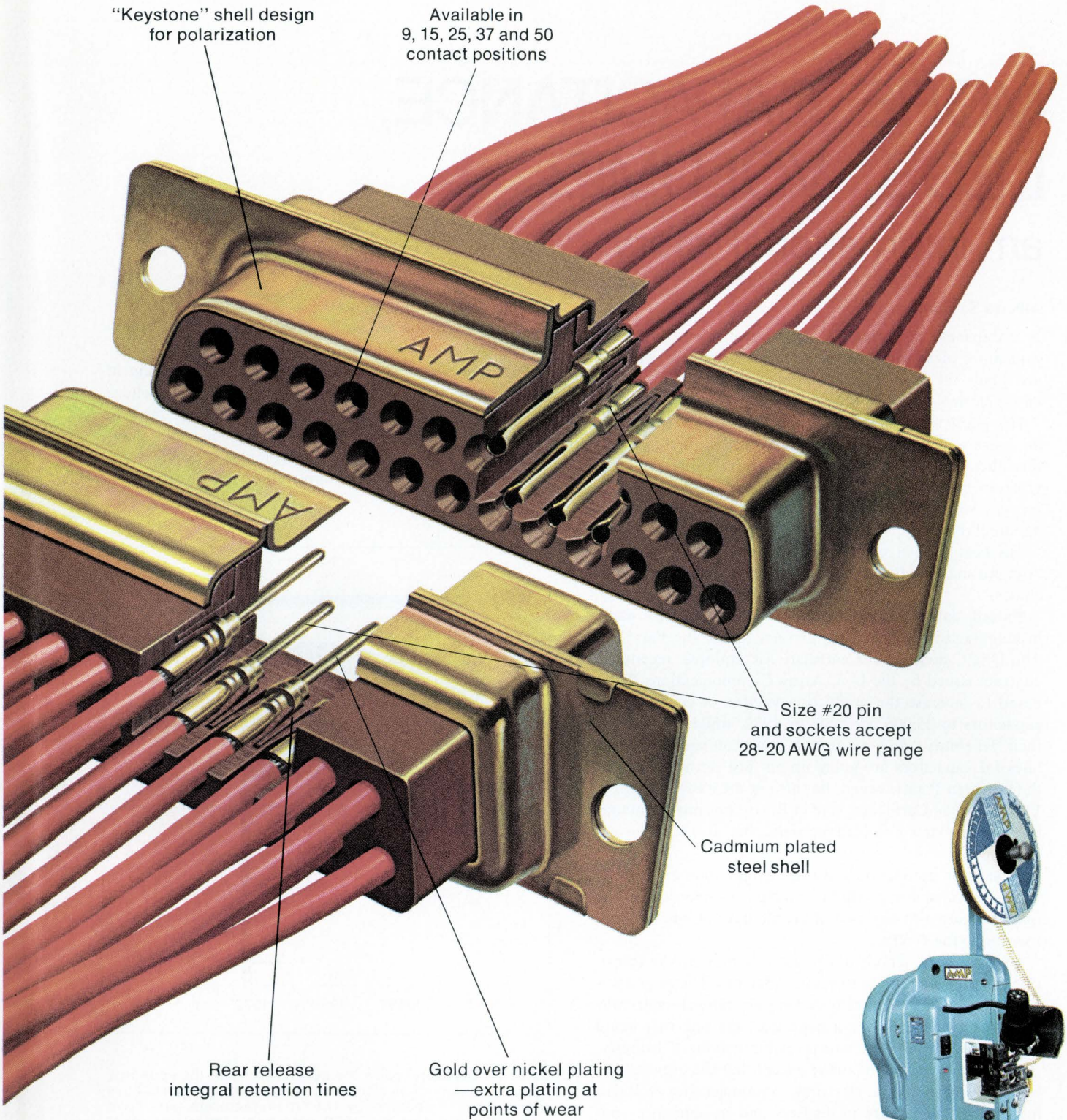


Stripper/crimper machine strips wire and attaches open barrel terminal during each machine cycle. Capacity: 1500 terminations per hour.

MORE CAPACITANCE, LESS VOLUME:

an international story

Alberto Socolovsky, Editor

In a Japanese restaurant, a well-known manufacturer of capacitors played host to an American engineer. He had just made the point that his company specializes in miniature electrolytic capacitors.

His guest held one of the chopsticks clumsily between his index and middle fingers, while his thumb slipped off the other one. He watched the rice grains easily elude the grasp of his chopsticks and commented pensively: "I can see why you people specialize in miniature capacitors. Just handling these chopsticks must be excellent training."

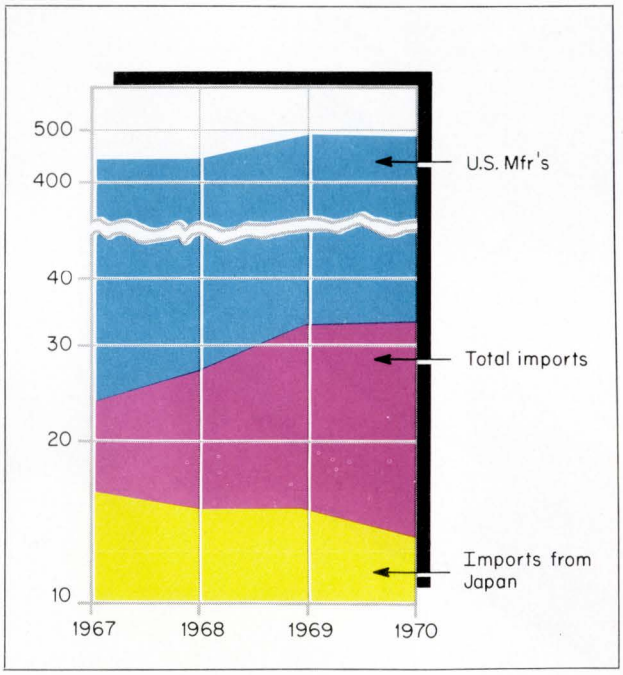
His host nodded with a faint smile. *"Arigato"* he said, "but we make capacitors with high-speed automatic machines."

Indeed, automated production is the name of the game in manufacturing capacitors, and not just in the Far East. The USCC division of Centralab, for example, received a contract issued by the U.S. Army Communications Command to increase the production volume of ceramic chip capacitors to 25,000 per hour by 1972, while maintaining their reliability. And automatic, high-volume production lines for capacitors are going up not just on both sides of the northern Pacific ocean, but also in the eastern U.S., in Europe, in the Caribbean, and in Brazil; not just for aluminum electrolytics and ceramic units, but also for film capacitors.

Thus, high production and price competition are the key words in capacitor production today, as opposed to the miniaturization-at-any-cost of the old days of military contracting in the 1960's.

In those days, circuit designers were making the transition from vacuum tubes to semiconductors. The most critical parameters for capacitors were *capacitance* and *voltage*. The best design for a capacitor was one that could cram more CV product into a certain volume. Obviously, the same rule holds true today except that the only strongholds that remain in electronic equipment for voltages higher than 100 V are in displays and in appliance controls. Most other circuits, made with ICs and discrete semiconductors, rarely need more than 50 V, a voltage that any dielectric can take handily, even the thinnest film. The *CV/volume* battle, then, has turned into a quest for packing more capacitance within a constantly decreasing volume. Electrolytic capacitors have always won this battle. But most impressive, even to the casual observer of the capacitor field, are the giant strides that other dielectrics—especially films and ceramics—have made lately in stacking high capacitances into small volumes.

Following are some highlights of what is happening in the capacitor field, with the developments that we believe are significant for you. Rather than try to describe them in detail, we'll capsulate them here and refer you to the manufacturer(s) responsible for each development or who have an interesting product line. Simply circle the Reader Serv-



Sales of capacitors follow the general trend of the economy and particularly of all electronic components. Imports have grown faster than sales by U.S. manufacturers, and have not declined during the 1970 recession. Japan and West Germany, in that order, have been the source for most of the imports, but their share has declined now in the face of increasing imports from Mexico, Taiwan, the Netherlands, Canada, Italy, Jamaica, Portugal and Hong Kong. Actually, Japan's total sales to American manufacturers of electronic equipment have not declined. What happens is that some of those sales take place now in the Far East, where many (especially consumer) electronic manufacturers have moved their plants.

ice Number on the inquiry card corresponding to the manufacturer from whom you desire more information.

Film capacitors

Unquestionably, there are two clearly defined areas of endeavor in this field. The first one has been the introduction of very compact, very low voltage capacitors of metallized polycarbonate. Since polycarbonate film can be wound even when the capacitor is made with gauges as thin as 80 μm, these capacitors have enjoyed tremendous advantage in volumetric efficiency. Siemens has even chosen to manufacture such a capacitor with a method that resembles a monolithic capacitor, by stacking alternate films of metallized polycarbonate. This capacitor has about half the volume of units of similar capacitance and voltage, with a tolerance as close as 5%.

There is also a trend to an increased use of metallized film capacitors, thanks to their smaller size and self-healing properties. When an arc occurs, it burns out a portion of the deposited metal, clearing out the fault. In general, this burning process does not affect the dielectric film, although it certainly reduces the amount of capacitance slightly. However, in special capacitors with low dielectric absorption, it may spoil slightly this characteristic.

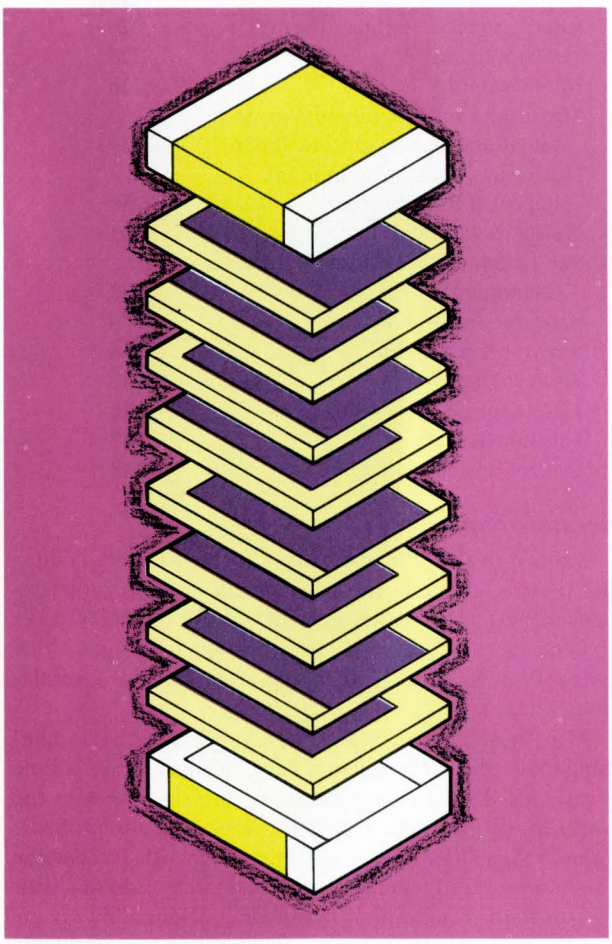
Also, Siemens has developed a very small cellulose acetate capacitor which is radiation resistant and can take surges up to four times its voltage rating. Sprague has already been licensed to manufacture it in the U.S.

However, Mylar^{R} (polyester) is still the workhorse of the capacitor film dielectrics. A newcomer in the field is polysulfone, which resembles Mylar, but it is used for high temperatures in applications such as sensors for jet engines and deep well transducers for oil exploration. Polysulfone, a resin that was developed by Union Carbide, and first converted into film by General Electric, is now used as capacitor dielectric by several manufacturers.

Many of the domestic and most of the foreign-made capacitors are going into consumer and some industrial equipment. Because of the fire hazards, particularly with color TV, the pressure is on for fireproof capacitors. A non-burning conformal coating looks like a possible solution to the burning problem.

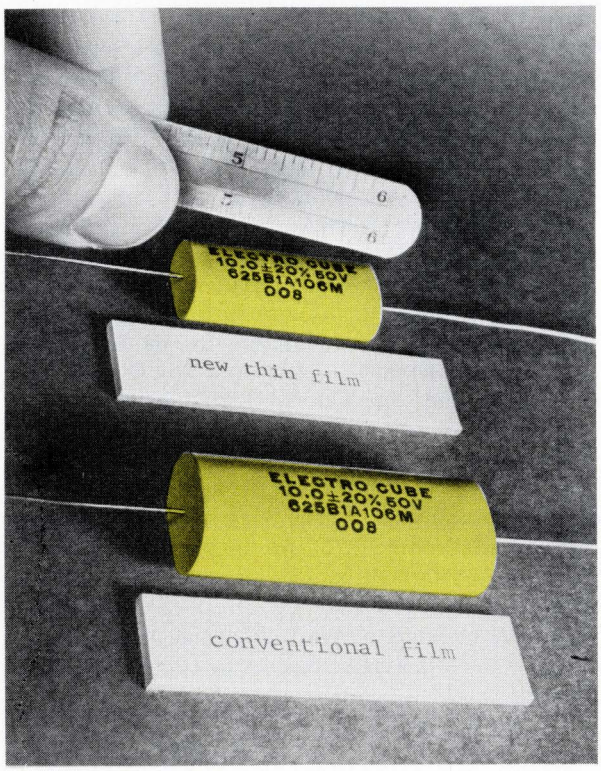
For more literature on those developments, may we refer you to the following companies by circling the appropriate numbers.

	Reader Service Number
Aerovox (met. polycarbonate, met. polysulfone)	**201**
Balco (met. polycarbonate)	**202**
Capacitor Specialists (polysulfone)	**203**
Condenser Products (polysulfone)	**204**
Electrocube (polysulfone, met. polycarbonate)	**205**



Construction of monolithic chip capacitor (Sketch courtesy of Monolithic Dielectrics, Inc.)

	Reader Service Number
Elpac (polysulfone, met. polycarbonate)	206
General Electric (polysulfone)	207
International Electronics (met. and non-met. polyester and polycarbonate)	208
Matsushita (polypropylene, polyester, met. polyester)	209
Midwec (polysulfone, polycarbonate, mylar, met. mylar)	210
Nucleonic Products (mylar)	211
Nytronics (met. polycarbonate)	212
Paktron Div., ITW (met. polyester, met. polycarbonate)	213
Potter (met. mylar)	214
San Fernando, West-Cap Arizona (polysulfone, met. polycarbonate)	215
Seacor Inc. (polypropylene, polycarbonate, mylar, polystyrene)	216
Siemens (met. polycarbonate, acetate)	217
Sprague, including Dearborn (met. acetate, polycarbonate, polysulfone)	218
TRW (met. polycarbonate)	219
Union Carbide (polysulfone)	220



A metallized film capacitor can be from 20 to 50% smaller than a similar unit rolled with conventional film and metal foil. In addition, the metallized unit heals itself after a short burns a portion of the electrode. However, metallized film capacitors have higher dissipation factor and lower insulation resistance, and cost more than conventional film units. (Photo courtesy of Electro Cube, compares metallized polycarbonate unit, above, with one rolled with film and metal foil.)

Electrolytic capacitors

There are developments in both types of dielectrics, tantalum and aluminum oxide. In tantalum, the most important development is the increasing number of product lines that feature chip capacitors, whether these chips are encased (as is the case with those sold by Sprague) or bare (as are the ones sold by Union Carbide.)

The latter company applied two years ago for a patent covering a new type of copper metallization which produces a conformal copper layer on tantalum chips. Such chips can then be dip-soldered up to 300°C, and can be operated up to 175°C.

Siemens makes a very large (up to 1240 μF at 360 V) aluminum capacitor for electronic flash applications. Both this company and Sprague specialize in this application which requires low leakage and high capacitances of more than 300 V.

For more information on electrolytic capacitors, circle the appropriate Reader Service Numbers below.

	Reader Service Number
Amperex (aluminum)	221
Components Inc. (tantalum)	222
Cornell-Dubilier (both)	223
Dickson Electronics (tantalum)	224
General Electric (both)	225
International Electronics (both)	226
JFD (tantalum)	227
Mallory (both)	228
Matsushita Electric (aluminum, some tantalums, imported from Japan)	229
Nucleonic Products (aluminum, imported from France)	230
Nytronics (tantalum)	231
San Fernando, West-Cap Arizona (aluminum)	232
Sangamo (aluminum)	233
Siemens Corp. (both)	234
Sprague (both)	235
TRW Capacitor (tantalum)	236
Tansitor (tantalum)	237
Union Carbide (tantalum)	238

Ceramic capacitors

Unquestionably, the main trend in this field is to chips. But there is an interesting development in temperature-independent (NPO) capacitors. Several companies have recently increased the dielectric constant by almost three times (from K = 30 to K = 80). Aerovox has formulations with a K of 45.

Also, most companies have developed expertise in handling these chips in production lines. Such expertise will be greatly aided by standardization of chip sizes, now in the works at the Electronic Industries Assn. Mr. Joseph Scordato of Monolithic Dielectrics, Inc., claims that capacitor chips are perfectly suitable for automatic soldering with the standard metallization (silver or palladium silver) offered by most manufacturers. The reliability problems come in desoldering a chip, especially when the user ap-

plies a 100-W soldering iron to a tiny chip. Union Carbide Corp., on the other hand, states that silver terminations invariably suffer from leaching or scavenging problems and claims that UCC's "Solder Guard" coating on chip terminals solves that problem.

For a good background on chip capacitors, we highly recommend a reading of San Fernando Electric's "ceramic chip capacitor handbook." For this handbook circle Reader Service Number **239.**

USCC also offers an applications note on chip capacitors. For a copy, circle Reader Service Number **240.**

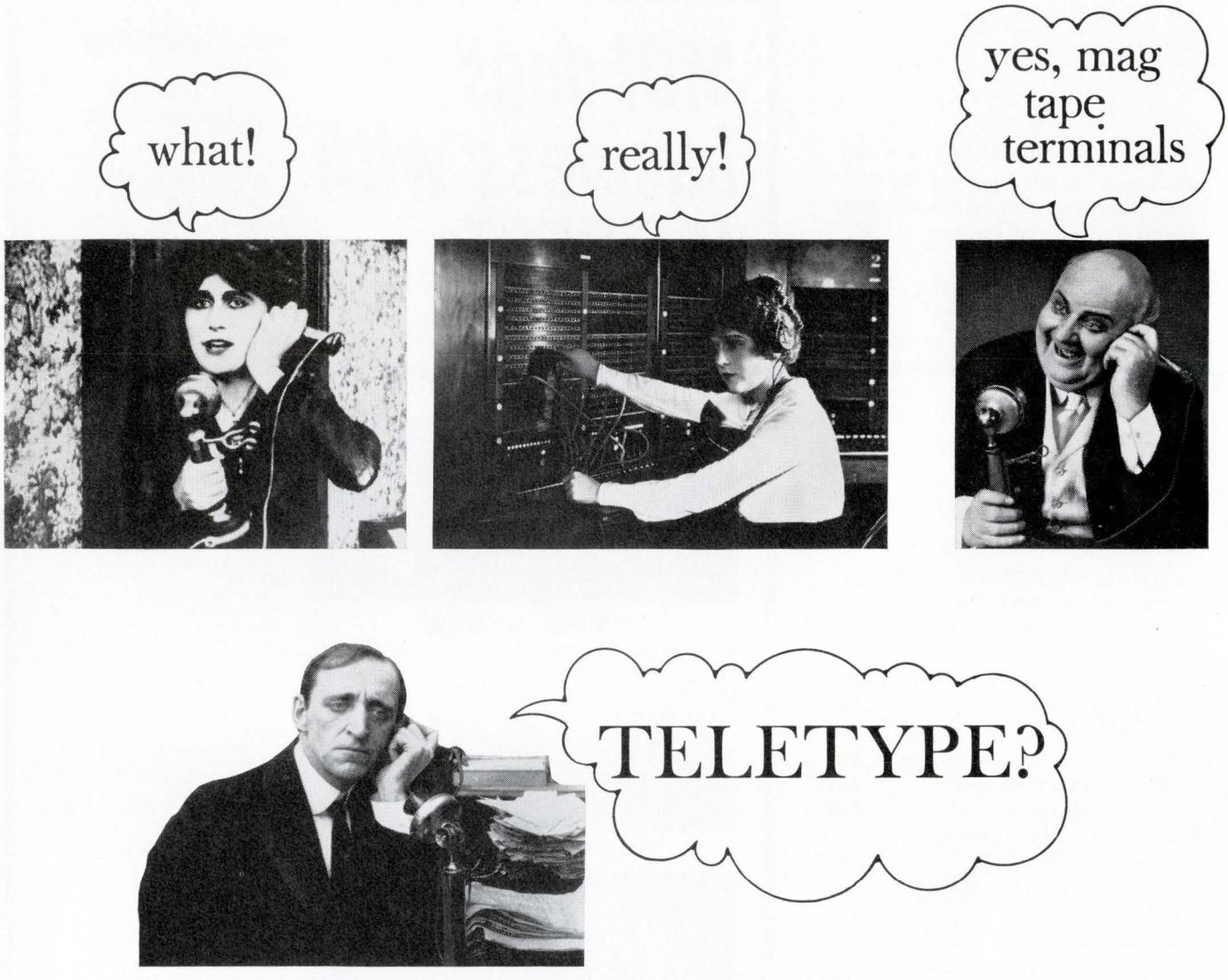
For more information on ceramic capacitors, please check the appropriate Reader Service Numbers below.

	Reader Service Number
Aerovox (all types)	241
American Lava (chip)	242
American Tech. Ceramics (chip)	243
USCC-Centralab (all types)	244
Cornell-Dubilier (chip)	245
Corning Electronics (general purpose)	246
Electro Materials Div., ITW (all types)	247
Erie Technological (all types)	248
JFD (temp. compensated, chip)	249
Johanson (all types)	250
Marshall Industries (all types)	251
Matsushita (all types)	252
Mepco (gen. purpose, temp. compensated)	253
Monolithic Dielectrics	254
Nucleonic Products (all types)	255
Nytronics (all types)	256
Potter (gen. purpose, chip)	257
Republic Elec. (all types)	258
San Fernando (gen. purpose, chip)	259
Siemens (all types)	260
Sprague (all types)	261
Union Carbide (all types)	262
Varadyne (gen. purpose, chip)	263
Vitramon (all types)	264

Also, Siemens has introduced a high capacitance (not compensated) ceramic capacitor, with a K of 50,000. For this development, circle Reader Service Number **265.**

INFORMATION RETRIEVAL

Passive components

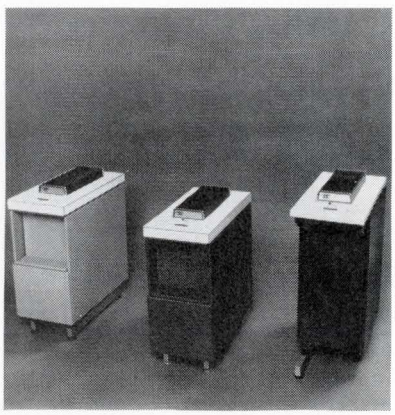


It's true.

After helping a jillion feet of paper tape wind and unwind its way through communications systems everywhere, Teletype announces the addition of magnetic tape data terminals.

There are some basic advantages in both mediums. But as you are well aware, the medium that's right for a system depends a lot on the application criteria.

The new magnetic tape data terminals have many operational features that make life less complicated for the operator.



New, modular line of Teletype® 4210 magnetic tape data terminals.

For example, take a look at the tape cartridge, which was specifically designed for reliability required for data transmission.

Its vital statistics are: 3″ x 3″ x 1″.

It contains 100 feet of ½″ precision magnetic tape.

It will hold 150,000 characters of data, recorded at a density of 125 characters per inch. The equivalent of a 1000 foot roll of paper tape.

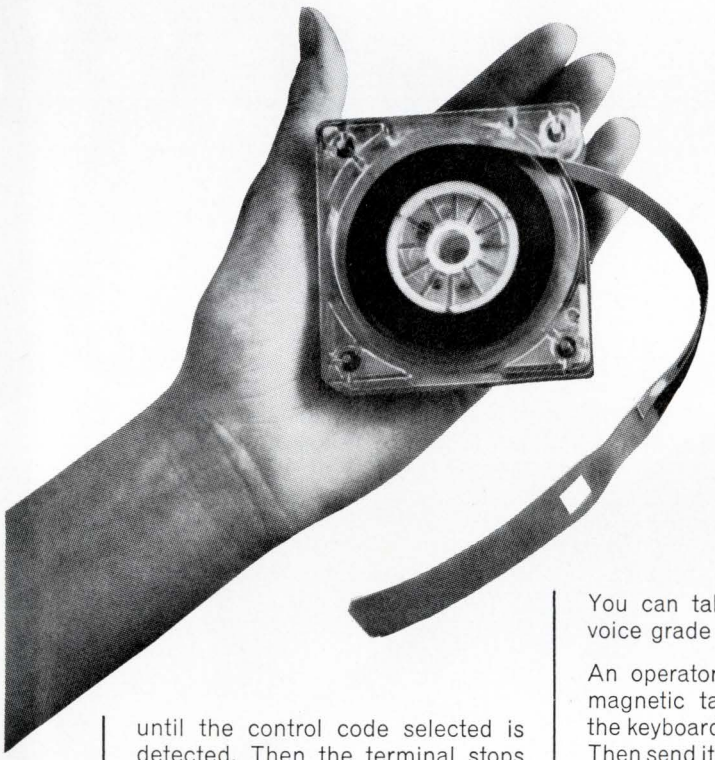
This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

Teletype is a trademark registered in the U.S. Pat. Office.

The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate various areas of the tape.

Four ASCII control code characters can be recorded in the data format to aid character search operations. When the terminal's "search" button is pressed, tape moves at the rate of 400 characters per second until the control code selected is detected. Then the terminal stops the tape automatically.

A "single step" switch is also provided which enables you to move the tape forward or backward one character at a time. In editing or correcting tape, you can send a single character using this feature.



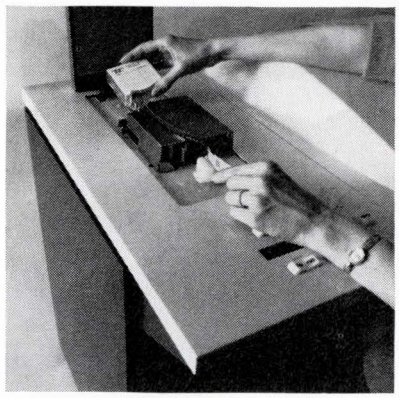
Also magnetic tape adds high speed on-line capability to low speed data terminals.

You can zip data along the line at up to 2400 words per minute. For example: Take a standard speed Teletype keyboard send-receive set, and a typical typist. Add a new magnetic tape unit to this combination and the on-line time savings can pay for the magnetic tape terminal in short order.

You can take better advantage of voice grade line speed capabilities.

An operator can prepare data for magnetic tape transmission using the keyboard terminal in local mode. Then send it on-line via the magnetic tape terminal up to 2400 words per minute.

These new modular magnetic tape data terminals offered by Teletype are perfectly compatible with model 33, model 35, model 37 and model 38 keyboard send-receive equipment.



Straight-through threading makes tape loading and unloading exceptionally easy.

They can send or receive at high or low speed. Or can be used independently as stand-alone terminals on-line.

If you would like to know more about this new line of Teletype magnetic tape data terminals, please write Teletype Corporation, Dept. 55-15, 5555 Touhy Avenue, Skokie, Illinois 60076.

Teletype 4210 magnetic tape data terminal with 37 keyboard send-receive set.

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A NEW KIND OF KEY

with gold "crosspoint" contacts that eliminate the two main causes of contact failure—(1) formation of insulating chemical film on contact surfaces and (2) mechanical interference of foreign particles on contacts. This proven design concept (Gold prisms at right angles to each other) provides high force per unit of contact area and virtually eliminates contact closure interference from foreign particles.

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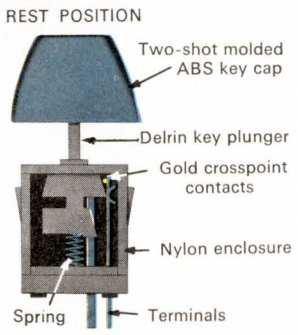

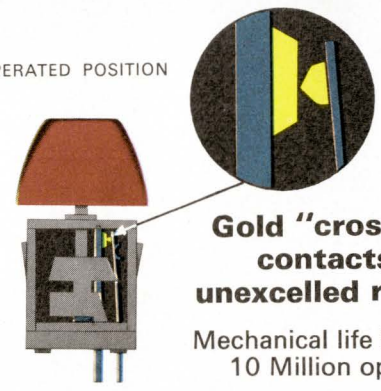

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Circle Reader Service #17

Circle Reader Service #18 →

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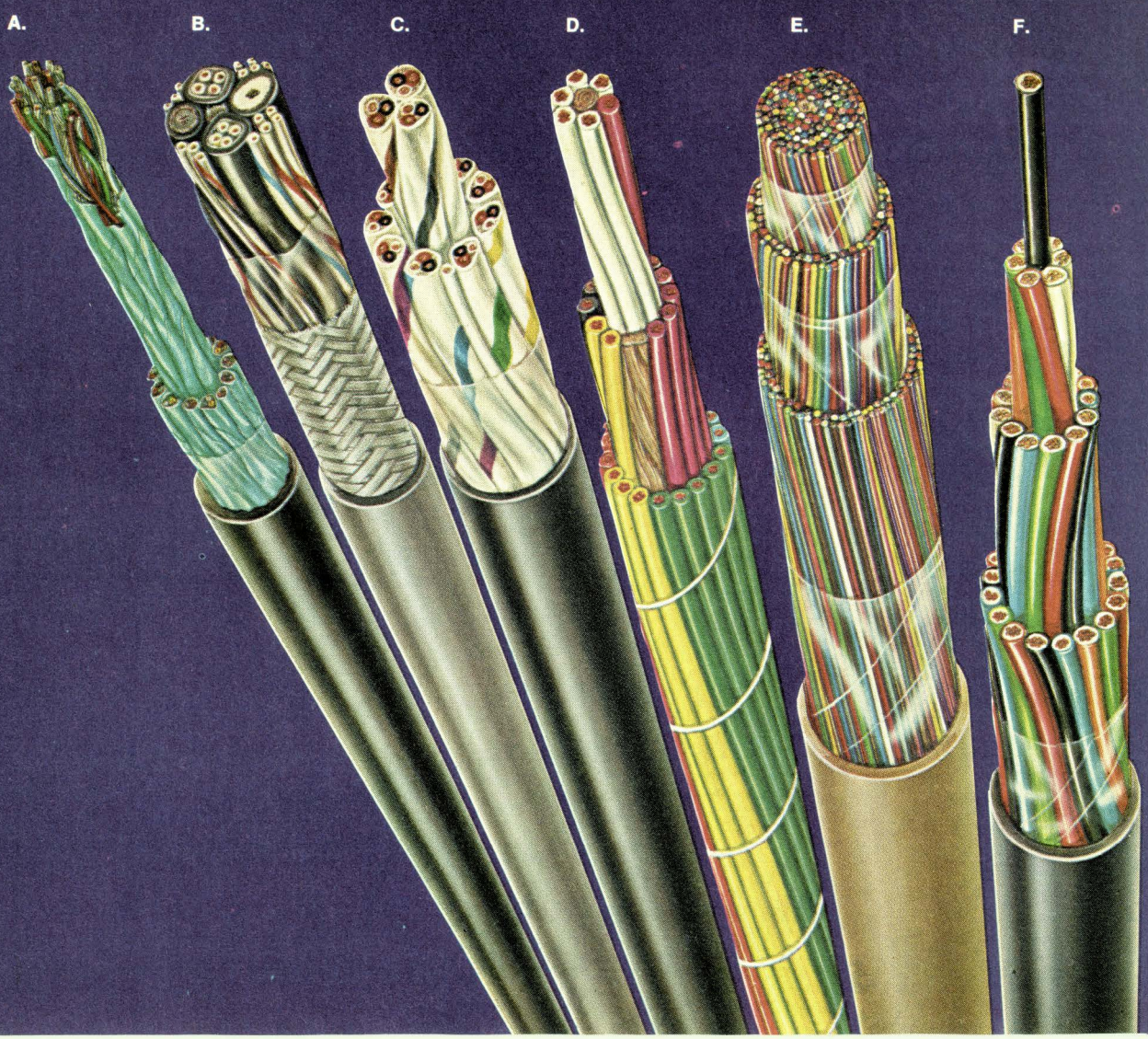

A. RECORDING STUDIO: Audio sound cable: 25 shielded pairs, stranded copper conductors, low loss insulation, twisted with uninsulated drain wire, isolated aluminum tape shields, cabled, PVC jacket.

B. TV CAMERA MFR.: Camera control cable for Audio and Video signals: a composite of PVC and polyethylene insulated conductors, cabled, overall braid shield, PVC jacket.

C. AIRCRAFT SIMULATOR MFR.: Control cable: 12 triples shielded jacketed, stranded copper conductors, PVC insulated, individual shield jacket color coded, cabled overall PVC jacket.

D. ELEVATOR MFR.: Control cable: 35 conductors, stranded copper, PVC insulated, conductors coded by colors and printed numbers, cabled with open binder; individual conductors U/L listed.

E. INTERCOM EQUIPMENT MFR.: 250 conductor inter-office communication and signaling cable: solid bare copper, PVC insulation, paired, cabled, PVC jacket; U/L listed.

F. ELECTRIC UTILITY CO.: Station control cable for general use: 37 conductors, stranded, polyethylene and PVC insulated, color coded, cabled, overall tough PVC jacket; per NEMA/IPCEA Specifications.

G. LARGE CITY: Communication cable: 50 pairs, polyethylene insulated, cabled, continuous layer of copper shielding tape, PVC jacket; per spec. IMSA-19-2, 600 volts.

H. LEADING SHIPBUILDER: shipboard cable: stranded conductors, nylon-jacketed PVC insulation, pairs shielded and jacketed, cabled, PVC jacket, and aluminum braid armor overall; per spec. MIL-C-915.

I. U. S. GOVERNMENT: Coaxial cable: type RG-218/U, solid copper conductor, polyethylene insulated, copper braid shield, PVC jacket; per spec. MIL-C-17/79.

J. BROADCASTING COMPANY: Remote control broadcasting cable: stranded conductors, polyethylene insulation, pairs & triples shielded and jacketed, cabled, PVC jacket overall.

K. COMPUTER MFR.: Computer control cable: 55 conductors, stranded copper conductors, PVC insulated, formed into 7 groups of 7 conductors, cabled, PVC jacket; U/L listed.

L. MACHINERY MFR.: Bus drop cable: 3 PVC insulated stranded conductors, with split uninsulated grounding conductor, cabled, overall PVC jacket; U/L listed; per NEC.

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WELCOME

Power products

If you're looking for power transistors and hybrids for microwave and mobile communications applications, you might look in on Power Hybrids Inc. Founded earlier this year, they're developing into a source for ruggedized discrete power transistors capable of 100 W at 30 MHz to 2.5 W at 4 GHz, and for hybrid ICs capable of 15 W at 130 MHz to 2 W at 4 GHz. They're located at 1742 Crenshaw Blvd., Torrance, Calif. 90501.

Circle Reader Service #418

Interface modules

Cycon, Inc., a newly formed Sunnyvale, Calif. firm, recently introduced more than 50 functional-circuit modules for its entry into the marketplace. The modules, besides serving the electronics industry itself, also find application wherever a user needs an interface between a real-time, physical process and digital equipment. The initial product line thus includes DACs, ADCs, and instrumentation amplifiers. Cycon has managed to break the $100 price barrier on 12-bit ADCs of the non-dual-slope type. Company spokesmen claim that their CY3235 performs on an equal-to-or-better-than basis, when compared to competitive units costing between $140 and $300. Cycon, Inc., 1080E Duane Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #419

Analytical test system

Comaltest Inc. specializes in IC test equipment and failure analysis. The company's primary product, a microtest analyzer, is an electro-optical system for inserting or extracting signals or voltage levels from any point on the surface of an LSI semiconductor chip. The analyzer, used in conjunction with an IC test console, comprised of a word generator and a 4-phase clock tester, offers a failure analysis system for semiconductor manufacturers and users. The test console has the capability of checking almost any type of device—bipolar and p- and n-channel MOS—with up to 50 pins. Both static and functional tests can be run and programming is done via front panel switches and a matrix board. The IC test console sells for $20,000; the word generator is priced at $3,000; and the clock generator at $2,500.

Circle Reader Service #420

Circle Reader Service #20 ⟶

Some think their working day is a real challenge. Some don't.

If you sat for eight hours sticking tiny little components into even tinier little holes, you might not be too excited about your job either.

But, even if people don't like the work, there are machines that do, the Dyna/Pert electronic component inserting machines from USM.

Dyna/Pert offers an entire line of component inserting equipment from small bench models, to semi-automatic units, to totally automated conveyor systems. Many of them can be either NC or computer controlled. Dyna/Pert also has automatic sequencing systems and DIP inserters.

What's more, Dyna/Pert machines don't take coffee breaks, call in sick or look for new jobs. They just keep on producing at up-time rates in excess of 90%.

A Dyna/Pert machine will even pay for itself after a short period of time, and then start paying you. So don't you think it's time you woke up to Dyna/Pert?

For further information contact your local USM office, or write USM Corporation, Dyna/Pert Dept., Machinery Division, 181 Elliott St., Beverly, Mass. 01915.

Visit the USM display at Booth 3600 during Nep/Con East.

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Introducing the little counter that can.

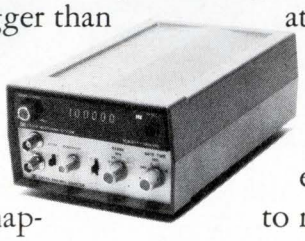
It can become four different systems.

It can go anywhere you do.

It can protect you against obsolescence.

It can make buying and maintaining a counter less expensive than ever before.

Meet the Hewlett-Packard 5300, the snap-together counter that's not much bigger than the palm of your hand. It has six digit accuracy, solid state display and autoranging. It'll make period, frequency, time interval and ratio measurements, operate on its own snap-on battery pack and drive a printer. Prices start at only $520.



If everything sounds too good to be true, we'll tell you how we did it: snap-together construction that lets you choose the module that makes the counter you want and also avoid obsolescence. Plus the most advanced LSI circuitry ever used in a counter. That means you get a compact instrument with high reliability, performance and versatility at a cost lower than ever before.

To make the counter you need, take the $395 mainframe and add any of the following 4 modules (more are on the way). They lock right onto the mainframe in an instant.

- 10 MHz frequency module. Direct frequency counting to greater than 10 MHz. Model 5301A, just $125.
- 50 MHz all-purpose module with period average, time interval, and ratio functions. Model 5302A, $250.
- 500 MHz frequency module, both 50Ω and 1 MΩ impedances. DC to 500 MHz. Model 5303A, only $750!
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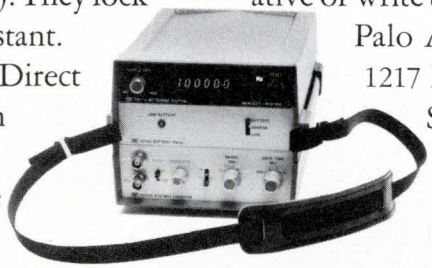
You ought to be able to take a counter as small and useful as the 5300 anywhere. And you can. All you have to do is snap on the battery pack (Model 5310A, $175) for 4 to 8 hours worth of cord-free operation. The pack fits between the mainframe and any module. The system's rugged dust-proof aluminum case resists almost any of the bumps it might get in the field.

The 5300 is one system you have to use to appreciate; there is simply no other way. To get you started we'd like to send more data on this amazing instrument. Call your HP field representative or write to Hewlett-Packard, Palo Alto, CA 94304; or 1217 Meyrin-Geneva, Switzerland. Counters that promise a lot and deliver it all.



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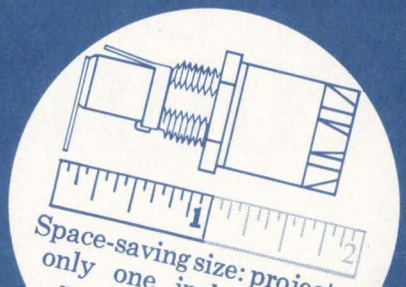
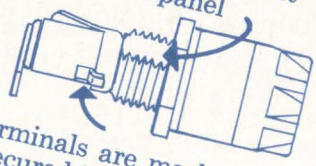


Space-saving size: projects only one inch behind panel, only 1-25/32 inches overall length

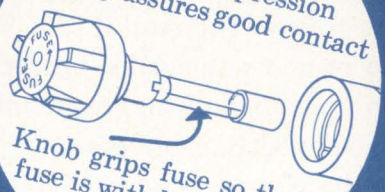
Space Saver!

Made for installation in D-hole to prevent turning in panel



Terminals are mechanically secured in holder as well as soldered

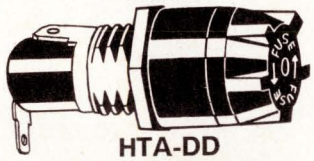
Easy-grip bayonet-type knob –sturdy compression spring assures good contact



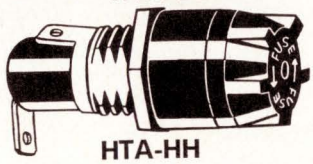
Knob grips fuse so that fuse is withdrawn when knob is removed

BUSS

HTA



HTA-DD



HTA-HH

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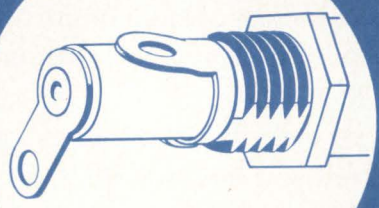
Knob has break-out hole to allow use of test probe



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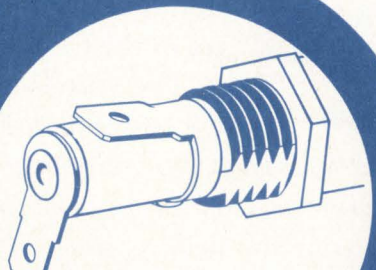
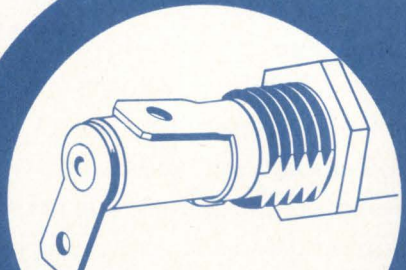
Dielectrically capable of withstanding 1500 volts A.C. between terminals and between terminals and panel



3/16" Quick-Connect Terminals (HTA-DD)



¼" Quick-Connect Terminals (HTA-HH)

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BUSS QUALITY FUSES

Quadrature filters: what they are and what they do

Their ability to eliminate the quadrature components of signals makes these filters important for systems with ac carriers.

By Martin A. Weiner, Senior Staff Engineer
Singer General Precision Inc., Kearfott Div., Little Falls, N. J.

In order to use quadrature filters effectively, you must understand their properties and characteristics. To help you accomplish this, the most important characteristics of these devices have been defined and interpreted. Following these explanations is a series of test measurement setups that demonstrate the applications of quadrature filters.

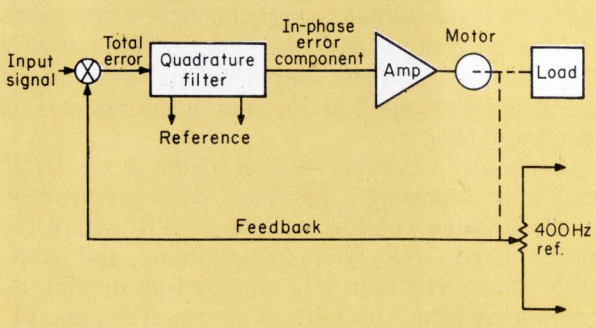
The quadrature filters discussed in this article are of the waveform-averaging type, employing some form of phase-sensitive demodulation and modulation. The input signal is usually sinusoidal but the device will accept other waveforms. The output is a square wave.

Gain

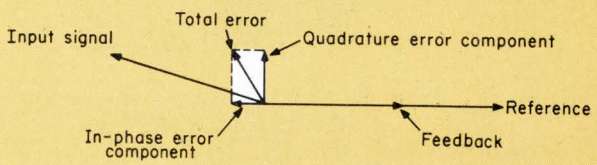
The gain of the quadrature filter is a function of the waveform and phase of the input. The device, which responds to the average level of the input, can have

Here's what it does:

Quadrature filters, or quadrature rejection circuits, are used in systems employing ac carriers where information is contained in the carrier modulation.



A typical ac position servo system shows the implementation of a quadrature filter. The error derived from summing the input signal and the feedback is applied to the quadrature filter. Undesired noise and quadrature voltage are filtered out, while the in-phase error component is amplified and excites the motor.



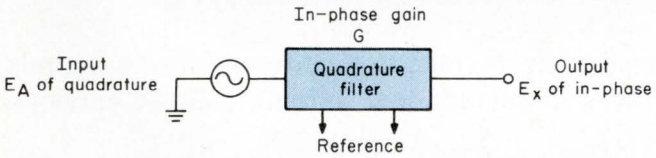
A vector diagram is used to visualize the generation of the quadrature component when input signal and feedback voltages are summed. Often, the quadrature voltage, resulting from the phase difference between the input and the feedback, is considerably larger than the in-phase voltage. In high-accuracy systems, this level of quadrature can saturate a high-gain amplifier and make it insensitive to the in-phase error component. By putting a quadrature filter between the summing point and the amplifier, quadrature saturation problems are eliminated.

different output levels for input waveforms that have the same rms level. For example, a 1-V rms square wave and a 1-V rms sine wave have half-cycle-average levels of 1 V and 0.9 V, respectively.

The output of the quadrature filter is a square wave. However, in an application where an amplifier and motor follow the quadrature filter, the significant factor is the fundamental sine-wave component of the output. Thus, the input and output waveforms required to determine the gain depend upon the particular application of the filter.

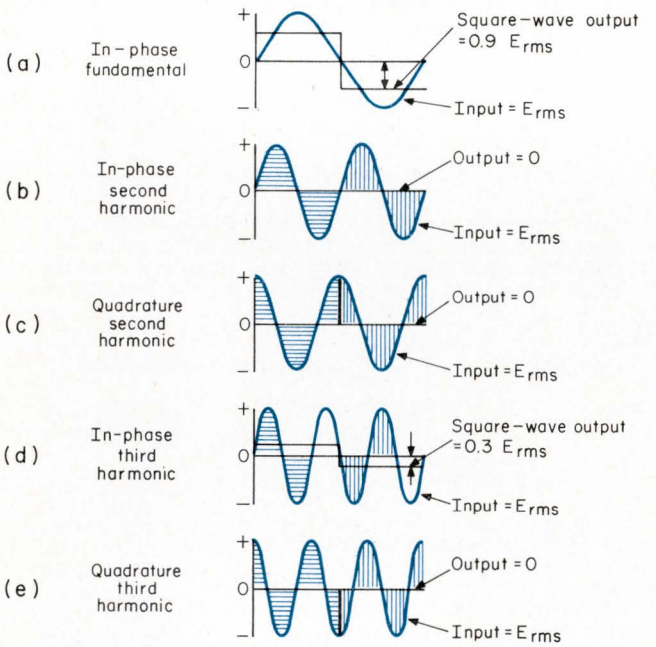
The quadrature filter output is a direct function of the cosine of the angle between the input and the reference. For convenience, the gain is evaluated in terms of its in-phase and quadrature components.

In order to define the in-phase gain, the sine output/sine input gain is normalized to unity by amplifying the



The in-phase component of the output resulting from a quadrature input is an error voltage. A quadrature input, E_A, causes an in-phase output, E_x. The equivalent in-phase input error is E_x/G, where G is the in-phase gain. The QRR_i (quadrature to in-phase rejection ratio) is $\frac{E_A}{E_x/G}$. In this case, QRR_i is defined as

$$QRR_i = \frac{\text{Quadrature input}}{\text{in-phase output/in-phase gain}}.$$



Signal harmonics in the input affect the output of a quadrature filter. The in-phase fundamental is shown in (a) as a reference. Since the quadrature filter is a waveform averaging device, it is not susceptible to even-order harmonics as shown in (b) and (c). In-phase odd harmonics produce a fundamental in-phase output seen in (d) and (e). Note that in the above figures the cross-hatched areas cancel.

average content by 1.23. All other gain definitions are then made relative to the sine-to-sine gain. All the gain ratios use rms values.

$$\text{Gain (sine output to sine input)} = \frac{\text{In-phase sine wave component of output}}{\text{In-phase sine wave input}}$$

Gain (sine output to square input) = 1.11 (sine-to-sine) gain

Gain (square output to square input) = 1.23 (sine-to-sine) gain

Gain (square output to sine input) = 1.11 (sine-to-sine) gain

Phase shift

In a linear device, such as a passive network, the phase shift of the transfer function is constant at a fixed frequency. In the quadrature filter, the phase of the output does not follow the phase of the input because the quadrature component is rejected. The output of the device is either in phase or 180° out of phase with the *reference* input. The in-phase component of the input is defined as in-phase with the reference. Therefore, the phase of the output is in phase or 180° out of phase with the in-phase component of the input.

Bandwidth

The quadrature filter has an effect on the modulation of the carrier. It has the form of a single lag whose transfer function is

$$\frac{k}{1 + sT}$$

where k is the gain constant.

Offset and noise

With zero input to the quadrature filter, there will be some residual output consisting of in-phase, quadrature, and noise voltages. The in-phase output voltage (square wave or sinusoidal component) can be divided by the appropriate gain figure to find the equivalent input error. Output noise and quadrature must be small enough so that they will not adversely affect the device which follows the quadrature filter.

Quadrature rejection characteristics

The term *quadrature rejection ratio* has been much abused because its definition varies with the user. When a quadrature voltage is applied to the input of a quadrature filter, the output consists of three components—in-phase, quadrature and noise voltages. The paragraphs that follow discuss these output components and define ratios useful in applications and measurements of a quadrature filter.

Quadrature rejection ratio is denoted by *QRR;* a small letter following it indicates which output characteristic is being considered. Thus QRR_i refers to in-phase voltage, QRR_q refers to quadrature, and QRR_n to noise. Each *QRR* term is normalized by dividing it by the in-phase gain. This permits simple evaluation of the effect the quadrature filter has on the signal-to-undesired disturbance ratio. (The undesired disturbance can be an input to the quadrature filter or can be internally generated.)

The in-phase output resulting from a quadrature input is an error signal that is expressed by QRR_i. The equivalent in-phase input is obtained by dividing the output by the in-phase gain. Then the QRR_i is

$$QRR_i = \frac{\text{Quadrature input}}{\text{In-phase output/In-phase gain}}$$

or in other words

$$QRR_i = \frac{\text{Quadrature input}}{\text{Equivalent in-phase input error}}$$

QRR_i is usually expressed as a positive ratio but it can include polarity. It is used in several ways:

- Equivalent in-phase input error $= \dfrac{\text{Quadrature input}}{QRR_i}$
- In-phase output error $= \dfrac{\text{Quadrature input}}{QRR_i} \cdot$ In-phase gain
- With in-phase and quadrature inputs,

$$\frac{\text{In-phase input signal}}{\text{Equivalent in-phase input error}} = \frac{\text{In-phase input signal}}{\text{Quadrature input}} \cdot QRR_i$$

With quadrature input, the in-phase output of a quadrature filter is proportional to the cosine of the angle between the input signal and the reference. Internal phase shift in the signal or the reference can cause an in-phase output that is proportional to the sine of the phase shift. External phase shift in the signal or the reference produces the same result. The phase shift can either decrease or increase the QRR_i depending upon the polarities involved.

QRR_i is an inverse function of phase shift. For example, with a QRR_i of 100, 1/100 of a quadrature signal is converted to an in-phase error. A phase shift of 1/100 of a radian (0.57°) will do the same thing. Therefore, it is important that phase shifts (in radians) of the reference and input be smaller than the reciprocal of the QRR_i when using a quadrature filter with a high QRR_i.

QRR_q is the normalized transmission of quadrature through the filter.

$$QRR_q = \frac{\text{Quadrature input}}{\text{Quadrature output}} \cdot \text{In-phase gain}$$

QRR_q is used to determine the level of quadrature in the output. A simple rearrangement of the above equation shows how the determination is made.

$$\text{Quadrature output} = \frac{\text{Quadrature input}}{QRR_q} \cdot \text{In-phase gain}$$

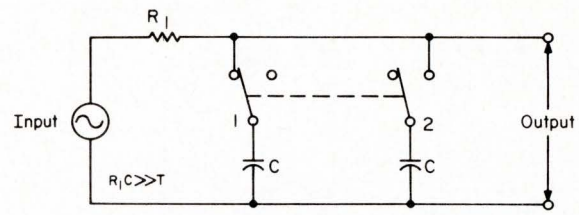
Similarly QRR_n is the normalized noise in the filter output due to a quadrature input.

$$QRR_n = \frac{\text{Quadrature input}}{\text{Noise output}} \cdot \text{In-phase gain}$$

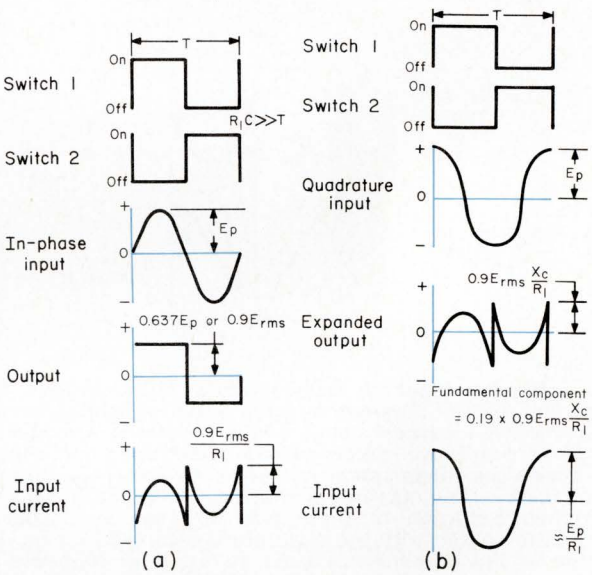
QRR_n is used to determine the level of noise in the output. Rearranging the above equation,

$$\text{Noise output} = \frac{\text{Quadrature input}}{QRR_n} \cdot \text{In-phase gain}$$

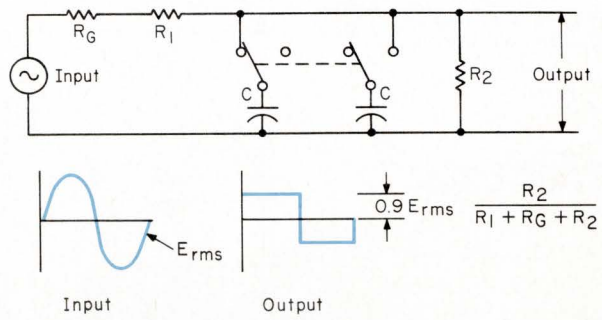
The basic circuit



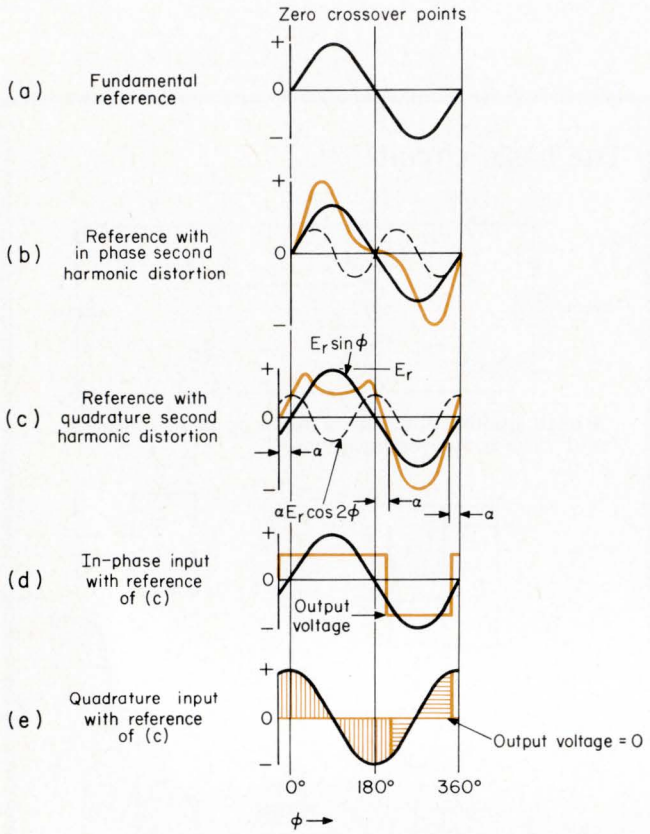
A basic quadrature filter is made up of RC networks and time-controlled switches.



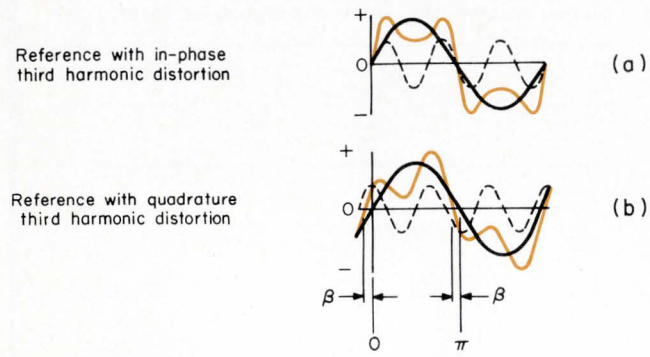
The waveforms for an in-phase input voltage are shown to the above left (a). With an in-phase input, each capacitor charges to the average value of the half-sine wave applied to it. The output is a square wave whose peak amplitude is equal to the average level of the input sine wave. The input current is proportional to the difference between the sine input and square output voltages which appears across R_1. The input impedance is not linear. To the above right (b) are the corresponding waveforms when a quadrature voltage is applied to the input. Notice that the output is quite small and is not a square wave. Instead it now depends on R_1 and C. On the other hand, the input current is sinusoidal and the input impedance is linear.



A quadrature filter modified by additional input and output resistors is shown above. This modification reduces the output voltage by the factor given in the output waveform.



The reference input to a quadrature filter controls the switching of the internal circuitry. The switching occurs near the zero-crossover points of the waveform. Any change in the zero-crossover points affects circuit operation. Figure (a) shows the fundamental reference. As shown in (b), the zero-crossover points are unaffected by in-phase second-harmonic distortion of the reference. The zero-crossover points are shifted with the quadrature second-harmonic distortion of the reference as seen in (c). It is important to note that this is not phase shift in the usual sense, because the 0° and 180° points are shifted in opposite directions. It can be shown that angle α (in radians) $\approx$ harmonic distortion level. The results of the shifts when the filter is excited with an in-phase-input signal is shown in (d). The rectangular waveform is slightly unbalanced. The fundamental sinusoidal component phase does not change significantly. Its amplitude is only slightly changed to the extent of the cosine of the angular shift. With quadrature-input excitation (e), the output is unaffected by the quadrature second-harmonic distortion of the reference, because the zero-crossover shifts do not affect the integrated half-cycle outputs.



Third-harmonic distortion of the reference. In (a), with in-phase third harmonic, there is no shift in the zero-crossover points. With a quadrature third-harmonic (b), there is an effective phase shift of β whose magnitude (in radians) is given by $\beta \approx$ third harmonic $\div$ fundamental. A similar condition exists for higher order odd harmonics.

Effects of external impedances

Extreme care must be exercised when determining the input and output effects of external impedances. The effect on in-phase and quadrature transmission must be evaluated separately since linear analysis is not applicable. An impedance level can be given for a specific characteristic such as the effective input resistance for in-phase signal attenuation. However, there will be a different impedance level for a quadrature input.

Sometimes a buffer amplifier is used in a quadrature filter to prevent the internal filter network impedances from being reflected at the external amplifier terminals. In that case, the amplifier operates in a linear manner with linear impedances appearing at the external terminals of the amplifier. In cases where impedances are not specified, no assumptions should be made as to their nature or magnitude.

At the input to a quadrature filter with or without a buffer amplifier, phase shift (in a coupling network or driving impedance of a signal source) is usually more critical than in-phase signal attenuation. As previously mentioned, phase-shift can deteriorate QRR_i. Devices without output-buffer amplifiers are usually specified with fixed load resistances. A change in load resistance on some of these devices can change the quadrature rejection characteristics, bandwidth, and in-phase gain. Devices with output-buffer amplifiers generally are not susceptible to changes in quadrature rejection characteristics and bandwidth due to different loads.

Harmonic distortion

Harmonic distortion of the input or the reference will affect the output of a quadrature filter. Odd input harmonics produce a fundamental in-phase output. The effect due to an in-phase odd-harmonic input is:

$$E_o = 0.81 \frac{G}{N} E_{rms} \cos\theta$$

where

E_o is the fundamental in-phase sinusoidal component of the output.

G is the fundamental in-phase (sine input to sine output component) gain.

N is the odd harmonic number.

E_{rms} is the harmonic voltage.

θ is the phase of the harmonic relative to the reference.

In-phase odd-harmonics appearing in the fundamental in-phase input of a quadrature filter are converted to a fundamental in-phase output and usually appear as an insignificant change in gain. Odd-harmonic distortion of a quadrature input produces slight reduction or increase in the QRR_i characteristic depending upon the magnitude and phase of the harmonic.

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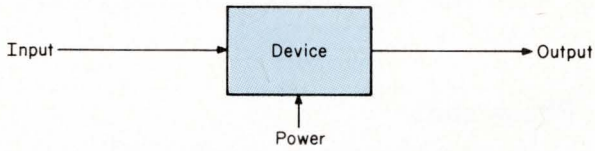
Measuring quadrature filter characteristics

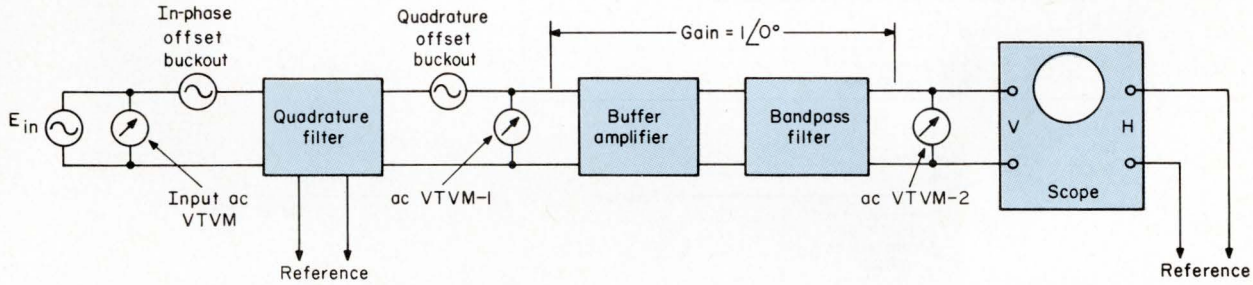


$$\text{Input} = E_1 + E_2 + E_3 \cdots + E_n$$

$$\text{Output} = E_x + E_1G_1 + E_2G_2 + E_3G_3 \cdots + E_nG_n$$

A general device used in an analog control system. The input consists of **n** different components. The output consists of E_x, the zero-signal residual output, and the **n** different inputs multiplied by the gain for each signal. In the case of the quadrature filter, the gains for in-phase, quadrature, harmonic, and noise input signals are different. This form of signal analysis is most useful for application purposes and the measurements described in the remainder of this article follow this form.

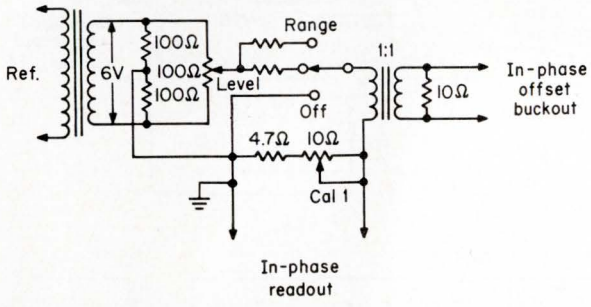
Offset and gain



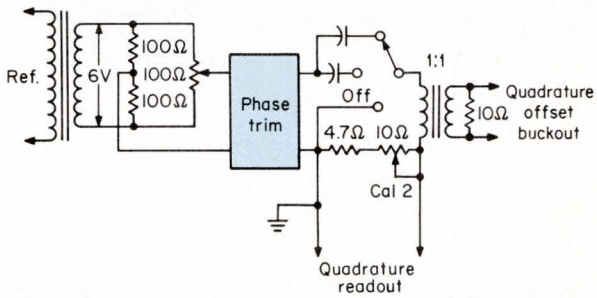
Setup for offset and gain measurements. The buffer amplifier has a high-impedance input and does not load the quadrature filter. The bandpass filter should be a low-phase-shift type with only a few degrees shift over the frequency range. It will be necessary to trim both the amplitude and phase of the amplifier-filter combination to reduce measurement errors below those parameter errors being measured. Residual output components are measured by setting E_{in} to zero. The in-phase offset buckout is used to eliminate the residual in-phase voltage at the output. It is introduced in series with the input so that any quadrature it contains due to phase shift will not appear at the output. The quadrature offset buckout is introduced at the output.

The in-phase and quadrature buckout voltages are adjusted for a null at ac VTVM—2 (and the oscilloscope). The in-phase offset voltage is equal to the in-phase buckout voltage multiplied by the in-phase (sine-to-sine component) gain. The quadrature voltage is equal to the quadrature buckout voltage. Ac VTVM—1 indicates the residual noise output.

In-phase gain is also measured with this setup. The in-phase and quadrature generators are left at the levels of the zero-input-signal tests to eliminate the residual output. Sinusoidal input to square-wave or sine-wave output can be measured by reading ac VTVM—1 or ac VTVM—2, respectively. Note that an average-reading meter will indicate 10% high on a square wave.



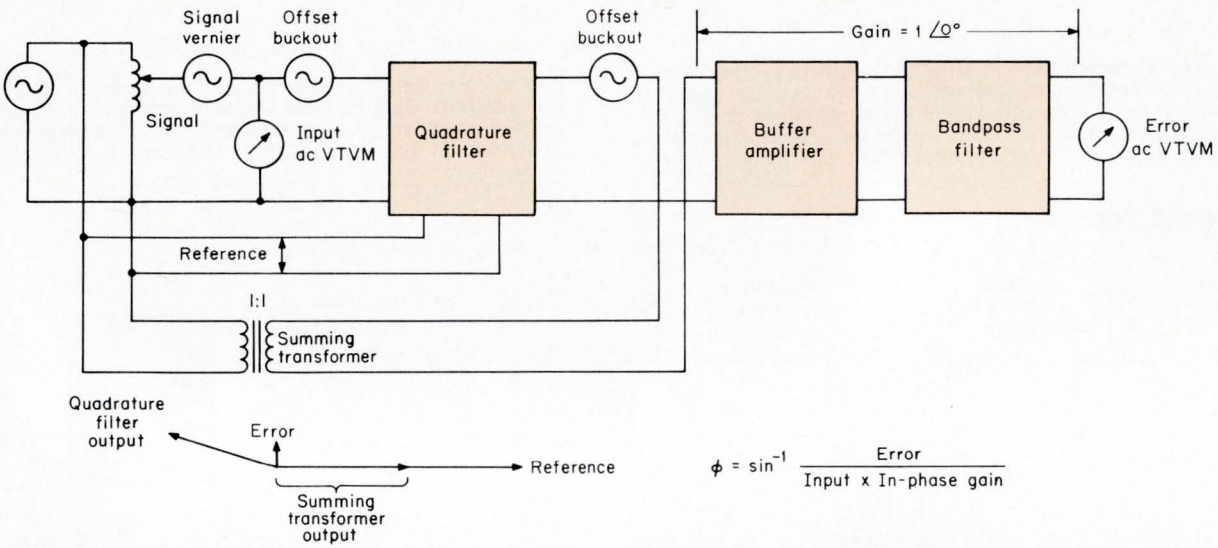
Details of the in-phase and quadrature buckout generators. The double-transformer arrangements provide isolated in-phase voltages of 0° and 180°, isolated quadrature voltages of 90° and 270° and have the convenience of level measurements with one side of the meter at ground level. The input transformer secondary center-tap is obtained from resistors instead of the winding center-tap to prevent residual quadrature at the zero position of the level control. The 10-Ω Cal 1 control sets the in-phase readout equal to the in-phase offset buckout across the isolated 10-Ω resistor. The output resistance is low to keep the series-injected impedance to a minimum. Since the voltage across the primary of the output transformer



is also kept to a minimum, the secondary voltage is induced by inductive rather than capacitive coupling between primary and secondary. This provides an accurate primary readout of the isolated secondary. The resistances of the range resistors depend upon the voltage ranges and the output-transformer winding resistances.

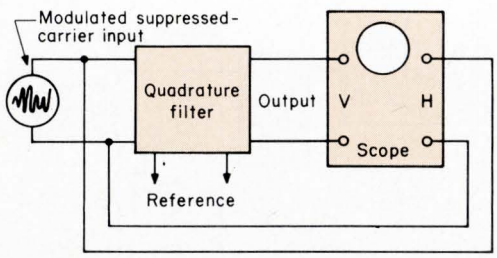
The quadrature offset buckout voltage is generated in a similar manner with capacitors substituted for the range resistors and an additional phase-trimming network. Any phase-angle error of the quadrature offset buckout voltage will appear as an in-phase voltage. This in-phase voltage will equal the quadrature voltage multiplied by the sine of the angular error.

Phase shift

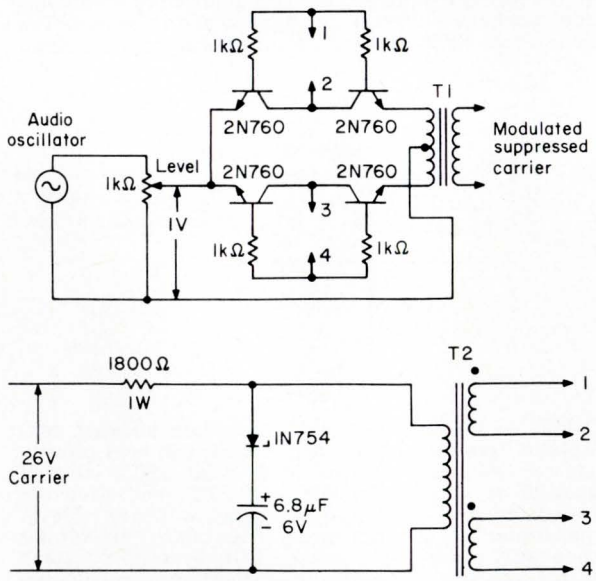


Measuring the phase shift. The signal control should be a low-phase-shift variable transformer. It can be a low-resistance potentiometer if no phase shift is introduced by the load on its arm. The signal vernier is the same type of in-phase generator as the in-phase offset buckout generator. The summing transformer should have low phase-shift and low series-leakage inductance and resistance. The signal controls are adjusted for a null on the error ac VTVM. The summing transformer is phased to buck out the quadrature filter output. The vector diagram shows the several component voltages in the circuit and the expression for the phase shift is used for the calculation. This setup is used when the gain of the quadrature filter is ≥ 1. For a filter with gain < 1, the configuration should be modified so that the signal input is fixed and the summing transformer primary is connected to the variable transformer.

Bandwidth



Bandwidth is measured using this setup. A Lissajous pattern of the modulation appears on the oscilloscope. The carrier also appears on the oscilloscope but can be disregarded. Since the quadrature filter appears as an RC network to the modulation, the 3-dB bandwidth is at the modulating frequency where the phase angle of the Lissajous pattern is 45°.



Details of the modulated suppressed-carrier generator. It is, in essence, a full-wave-chopper modulator. The audio oscillator provides a modulating signal and should be adjusted for maximum-amplitude output. The level is then set with the 1000-Ω potentiometer. This will result in the best signal-to-noise ratio, since the line noise and bounce output of most audio oscillators is independent of output level control. The zener-capacitor clipper, and transformer T2 provide a clipped sine wave for the chopper excitation. The capacitor does not permit any dc to saturate the transformer or to be fed back into the supply. Transformer T_1 is a 2:1 stepdown (end to end) while T_2 is a 1:1:1. Both must have 10-H minimum primary inductance. All values in the circuit are based on a 400-Hz carrier.

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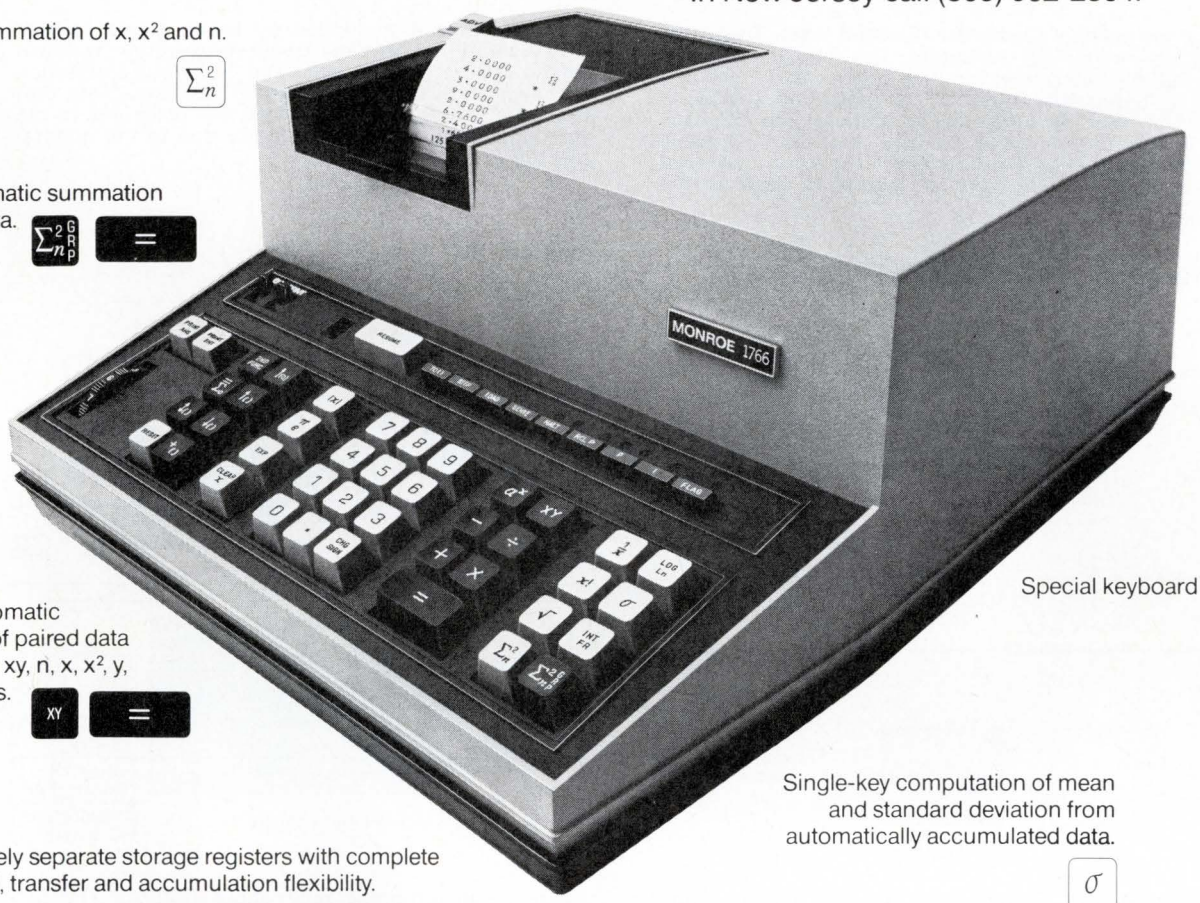

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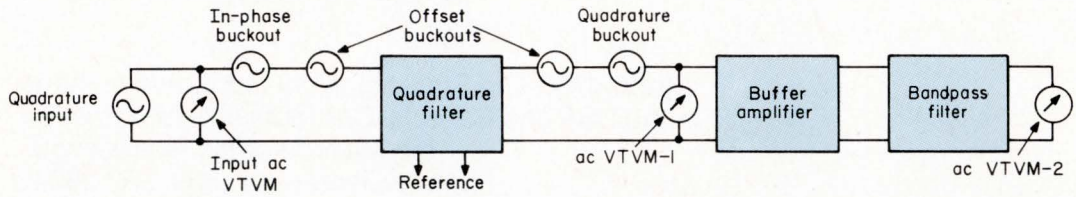
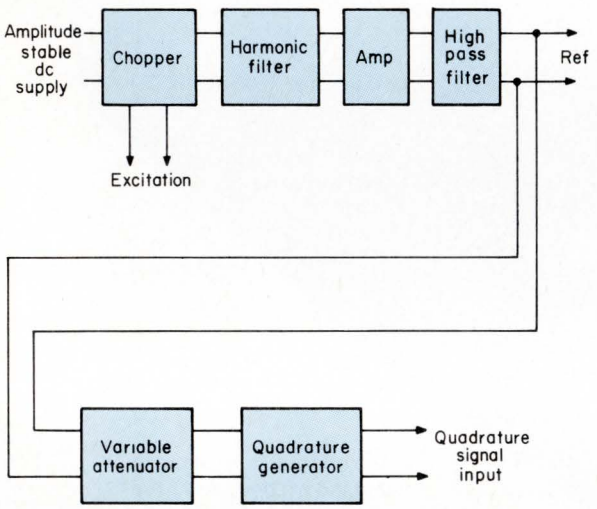
Quadrature rejection characteristics

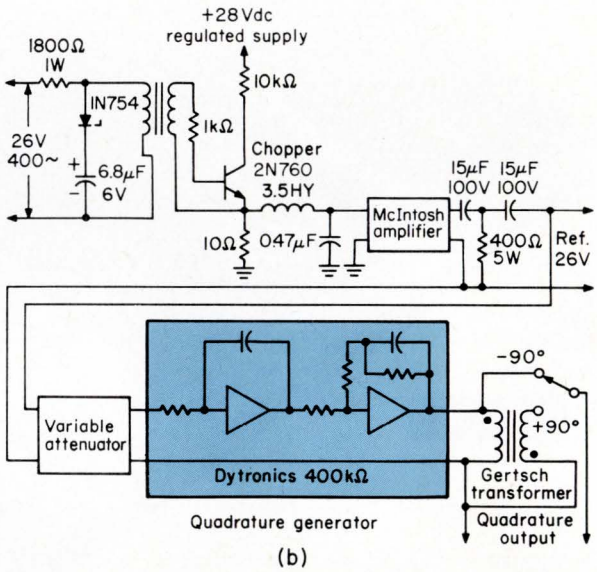


Setup for making quadrature-rejection tests. The offset buckouts remain set as before. The in-phase buckout is used to determine the in-phase output resulting from a quadrature input. It is placed in the input circuit so that its phase is not critical. The in-phase and quadrature buckout controls are adjusted for a null on ac VTVM—2. The noise output is then read on ac VTVM—1. The in-phase output is equal to the in-phase buckout multiplied by the in-phase gain of the quadrature filter. The quadrature output is equal to the quadrature buckout. The quadrature rejection ratios can now be obtained using this data. Note that the noise output (ac VTVM—1) is the noise due to the zero-input condition plus the noise due to the quadrature input.

Reference and quadrature sources



(a)



(b)

The phase shift between the reference and the quadrature input must be accurate enough so as not to degrade the quadrature rejection of quadrature input to in-phase output. Harmonic distortion and amplitude stability of the reference and quadrature input must be maintained at a low level. The block diagram (a) of the reference and quadrature sources shows a method of accomplishing these requirements. An amplitude-stable dc supply is chopped, producing a square wave which is fed to a harmonic filter. A high-quality amplifier is then used to raise the signal to an appropriate power level. The high-pass filter removes line jitter and bounce from the amplifier output. The quadrature is taken from the output of the quadrature generator. Note that the only phase shift of importance is that attributable to the variable attenuator and the quadrature generator.

The circuit details of the block diagram (a) are shown in (b) for a 400-Hz system. The chopper is excited by a clipped sine wave. The 28-V supply is the stable dc source. A square wave of 28 mV peak-to-peak appears at the emitter of the chopper. The 3.5-H choke and 0.047-μF capacitor make up the harmonic filter. With a circuit Q of only 15, for example, third-harmonic distortion is only about 0.25%. The two 15-μF capacitors and 400-Ω resistor comprise the high-pass filter. The variable attenuator can be a resistive or inductive divider provided it has low phase shift.

The quadrature generator consists of two amps. The first is an integrator whose phase shift is almost +90° and the second provides the compensation for the angular error of the integrator. In this configuration, the pair of op amps track over a ±5% frequency range. Attention should be given to loading of the variable attenuator and the quadrature generator to keep phase shift to a minimum. While harmonic distortion entering the quadrature generator is reduced by the integrator, low frequency bounce and jitter are amplified by the integrator. The phase of the output of the quadrature generator is −90°. A high-quality 1:1 transformer is used to obtain +90°. The transformer should not introduce any appreciable phase shift; it also reduces low-frequency jitter and bounce. The quadrature generator in this setup is a specially designed device. A sinusoidal-output regulating transformer is used to supply it with power to reduce output jitter and bounce.

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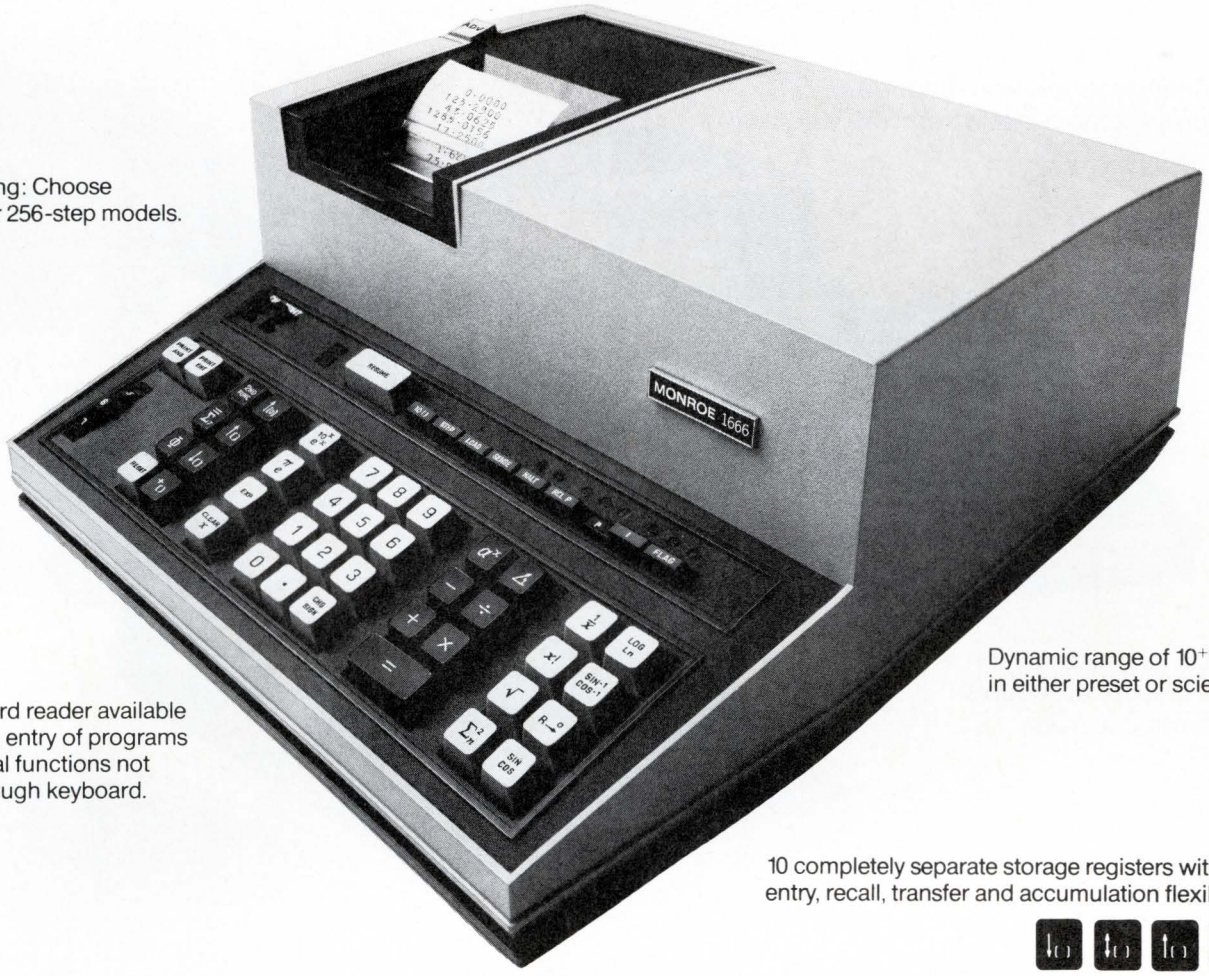

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U.S. Army Production Equipment Agency, Rock Island, Illinois. 61201. 388 pages.

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If you are looking for the latest developments in IC processing, then this rather large handbook is not for you. But if you have a need for a good, basic reference source then it should prove to be a welcome addition. The document is available from the Defense Document Center, Cameron Center Station, Alexandria, Virginia. 22314.

An Illustrated Guide to Linear Programming

By Saul I. Gass. Published 1970 by McGraw-Hill Book Company, 330 W. 42 St., New York, N. Y. 10036. Price $9.95.

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Linear Ferrite Devices for Microwave Circuits

By W. H. von Aulock and C. E. Fay. Published 1968 by Academic Press, 111 Fifth Ave., New York, N. Y. 10003. Price $12.00. 349 pages.

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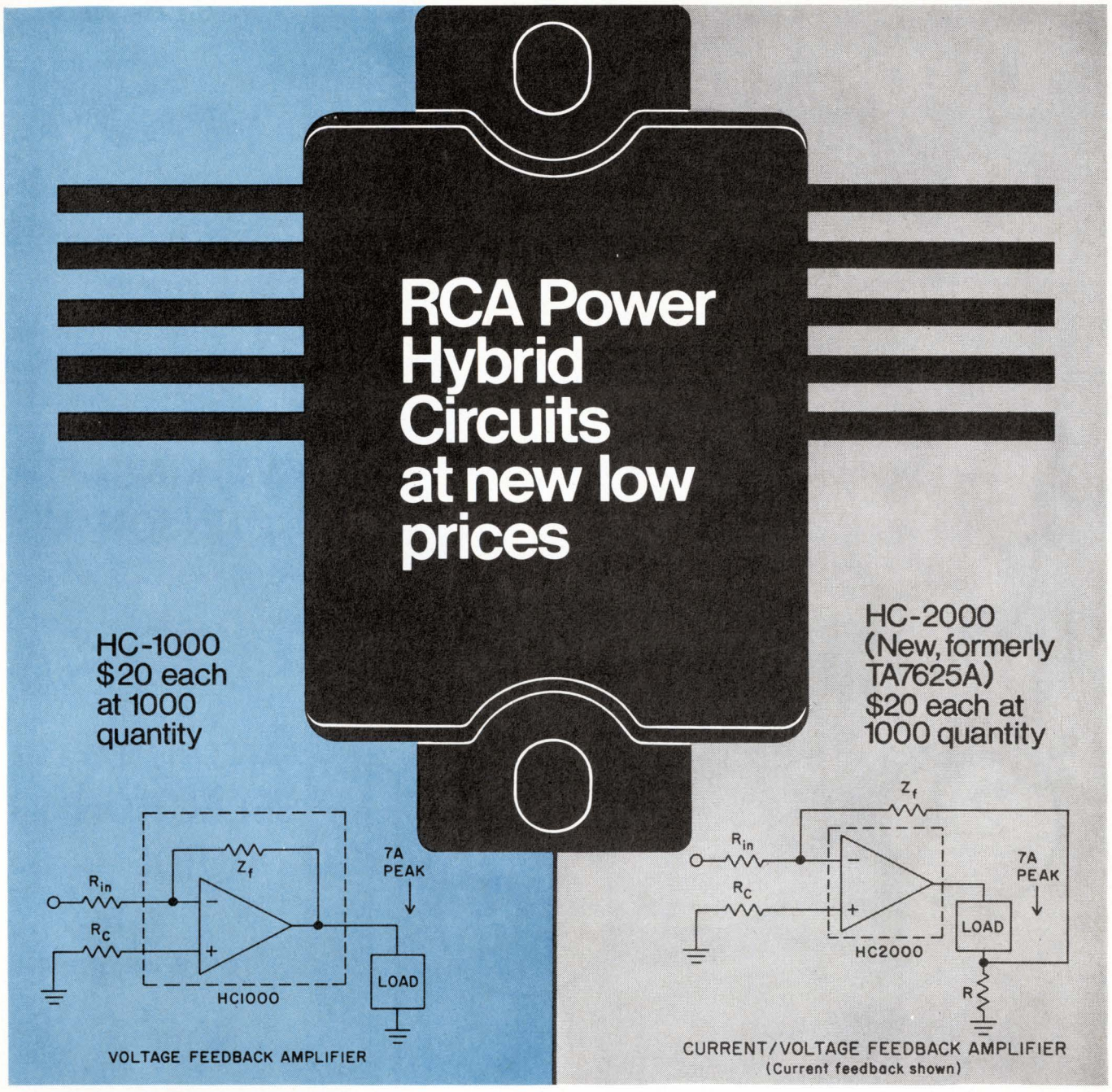

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	PART NUMBER	DESCRIPTION	LEADS/PKG.	FREQUENCY RANGE	NUMBER OF BITS	TYPICAL POWER DISSIPATION	CLOCK LEVELS	GATE THRESH-OLD
DYNAMIC SHIFT REGISTER	RD55G	Dual 50	10 TO5	10KHz - 1MHz	100	240mw	-27V	HVT
	S1708	Quad 40	12 TO8	10KHz - 1MHz	160	200mw	+5, -12V	LVT
	RD63G	Triple 66	10 TO5	10KHz - 1MHz	198	125mw	-27V	HVT
	S1724	Variable 256	14 DIP	10KHz - 1MHz	2-257	200mw	+5, -12V	LVT
	S1606	Quad 84	16 DIP	10KHz - 2MHz	336	200mw	+5, -12V	LVT
	RD65G	Single 426	10 TO5	1KHz - 5MHz	426	280mw	+5, -12V	LVT
	S1723	Dual 256	10 TO5	10KHz - 2MHz	512	150mw	+5, -12V	LVT
	S1705	Dual 256	10 TO5	10KHz - 1MHz	512	300mw	+5, 0V	LVT
	S1685	Dual 480	12 TO8	10KHz - 2MHz	960	200mw	+5, -12V	LVT
	S1687	1000/1024	12 TO8	10KHz - 2MHz	1000/1024	150mw	+5, -12V	LVT
	S1701	Dual 512	14 DIP	10KHz - 2MHz	1024	250mw	+5, -12V	LVT
	S1709	FIFO 8 x 13	24 DIP	10KHz - 100KHz	104	500mw	+5, -12V	LVT
STATIC SHIFT REGISTERS	SP51L	12 bit Serial/Parallel	24 DIP	DC - 2MHz	1-12	250mw	-27V	HVT
	RS53G	Dual 40	10 TO5	DC - 1MHz	80	150mw	-27V	HVT
	S1463	Dual 64	12 TO5	DC - 3MHz	128	180mw	+5, -12V	LVT
	S1670	Dual 100	14 DIP	DC - 3MHz	200	250mw	+5, -12V	LVT
RANDOM ACCESS MEMORIES	S1509	128 x 1, 64 x 2, 32 x 4	28 DIP	1.5 MHz	128	300mw	+5, -12V	LVT
	S4006	1024 x 1, Static	16 DIP	1.5 MHz	1024	600mw	None	I2 *
	S2103	1024 x 1, Dynamic	18 DIP	1.5 MHz	1024	320mw	-15V	SIGATE
READ ONLY MEMORIES	S8452	256 x 4	28 DIP	DC - 200KHz	1024	500mw	None	HVT
	S8457	128 x 12 Hollerith to ASC II	24 DIP	DC - 300KHz	1536	500mw	None	I2 *
	S8539	128 x 12 ASC II to Hollerith	24 DIP	DC - 300KHz	1536	500mw	None	I2 *
	S8538	2048 x 1	24 DIP	20KHz - 1MHz	2048	400mw	+5, -12V	LVT
	S8453	512 x 4	28 DIP	DC - 200KHz	2048	500mw	None	HVT
	S8502	256 x 8	28 DIP	DC - 1MHz	2048	650mw	+5, 0V	LVT
	ME51L	2240 - 5 output	28 DIP	DC - 1MHz	2240	300mw	None	LVT
	S8327	2240 - 5 output	24 DIP	DC - 2MHz	2240	400mw	+5, -12V	LVT
	S8499	2240 - 7 output	28 DIP	DC - 300KHz	2240	300mw	None	HVT
	S8501	256 x 10	40 DIP	DC - 1MHz	2560	650mw	+5, 0V	LVT
MULTIPLEXERS	MX52D	6 Channel	14 FP			NA	NA	HVT
	MX53C	10 Channel	22 FP			NA	NA	HVT
	MX54C	4 Channel, 50Ω	22 FP			NA	NA	HVT
	MX55C	4 Channel, 50Ω	22 FP			NA	NA	LVT
STANDARD LOGIC ARRAYS	UL51L	Dual FF, Dual Excl OR	24 DIP	1 - 100KHz		60mw	-27V	HVT
	UL52L	Quad 2 NAND Expandable	24 DIP			40mw	-27V	HVT
	UL53L	Quad 2 NOR Expandable	24 DIP			120mw	-27V	HVT
	MX53L	10 Input Expander	24 DIP					HVT
	SP51L	12 bit Serial/ Parallel	24 DIP	DC - 2MHz	12	250mw	-27V	HVT
	S1694	8 bit Counter/ Shift Register	40 DIP	DC - 1MHz	8	15mw		LVT

	PART NUMBER	DESCRIPTION	LEADS/PKG.	RON @ -15V	PROTECTION	TYPICAL V_{GST}
DISCRETES	DM01B	Dual Matched 50mw	6 TO5	1250	No	-4V
	DM02B	Dual Matched 100mw	6 TO5	1250	No	-4V
	DM03B	Dual Matched 150mw	6 TO5	1250	No	-4V
	DM05A	Dual	8 TO77	250	Yes.	-4V
	DM06A	Dual	8 TO77	250	No	-4V
	DD07K	Single	4 TO72	125	Yes	-4V
	DD08K	Single	4 TO72	125	No	-4V
	DD09K	Single	4 TO72	250	Yes	-4V
	DD10K	Single	4 TO72	125	Yes	-2V
	DD11K	Single	4 TO72	700	Yes	-4V
	DD12J	Single	3 TO5	32	Yes	-4V
	DD13K	Single	4 TO33	32	Yes	-4V
	DD15K	Single	4 TO33	18	Yes	-2V
	T1368	Quad	14 FP	125	Yes	-2V
	T1337	Quad	14 DIP	125	Yes	-2V

*I2 is a registered trademark of the American Micro-systems, Inc. Ion Implant Process . . .

Design opportunities for EEs

In 1963 a company formed by a young salesman, Jack Goeken, filed an application with the FCC to build a specialized common carrier microwave system between Chicago and St. Louis. The established carriers violently opposed the would-be entrant on the grounds that it would be "cream-skimming"—that is, undermining the system of nationwide uniform rates by selecting to serve only the lucrative intercity business communications markets. The applicant, Microwave Communications, Inc. (MCI), in turn, argued that it would provide a fundamentally different type of service—one permitting considerable "customization" to meet user requirements. The Federal Communications Commission, first in a narrow ruling on the MCI application itself, and subsequently in a broad policy statement on specialized common carriers in general, concluded that the public interest would be served by the entry of these carriers into the communications industry.

The FCC's action, which was based in part upon comments submitted by more than 100 interested organizations, creates in effect two new types of common carriers. In fact, it may represent the first step in the development of two additional nationwide networks, paralleling the telephone system and the Western Union network.

One system, proposed by the Data Transmission Co. (Datran), will offer switched digital data service in and among major cities. The remaining applicants, including MCI, plan to provide multi-purpose (voice, data, facsimile, etc.) intercity channels to business and institutional users.

These developments should be of particular interest to the electronic engineer, since new equipment and systems will be required. The Datran network, for example, requires the development of rapid-connect line switching exchanges, low-cost digital communication consoles for the user/network interface, special time-division multiplexing equipment, and digital microwave equipment. Also, the provision of high-speed, full-duplex data transmission channels may encourage development of data terminals quite different from those normally used with telephone channels.

Introducing Stuart L. Mathison

Stuart L. Mathison can speak with authority of the expanding opportunities for electronic engineers in communications. As co-author of a recently published book, ***Computers and Telecommunications: Issues in Public Policy,*** he managed to unscramble the garbled issues of data communications. As a member of the Management Sciences Division of Arthur D. Little, Inc., he has specialized in system design and public policy studies in the computer and telecommunication fields. He was formerly an independent technical consultant to both the President's Task Force on Communications Policy and the Antitrust Division of the U.S. Department of Justice on public policy problems in the areas of data communications and computer-based services.

The technical challenges

☐ Local distribution facilities—both for the Datran and MCI-type systems—present one major area for development. Today, two-wire pairs and limited portions of subscriber carriers are used for local telephone channels. The specialized carriers seek alternatives so that they can quickly provide local service without depending upon lease of telephone company local circuits. Short-haul millimeter wave radio, for example, is one approach under consideration.

☐ A second critical area involves multiplex gear, most of which is, at present, patterned after the standard telephone network hierarchy—that is "packages" of 12, 60, or 240 multiplexed voice channels. To accommodate the wide range of channel bandwidths and data speeds offered, in particular, by the MCI-type carriers will require more flexible multiplexing—using both frequency-division and time-division techniques.

☐ A third area for additional development work will increase the channel capacity of microwave radios. Typical radio beams today operate at 1200 and 1800 voice channel capacities—with a few systems capable of 2700 channels. Both expanded capacity and development of digitally modulated microwave radios require more work by electronic engineers.

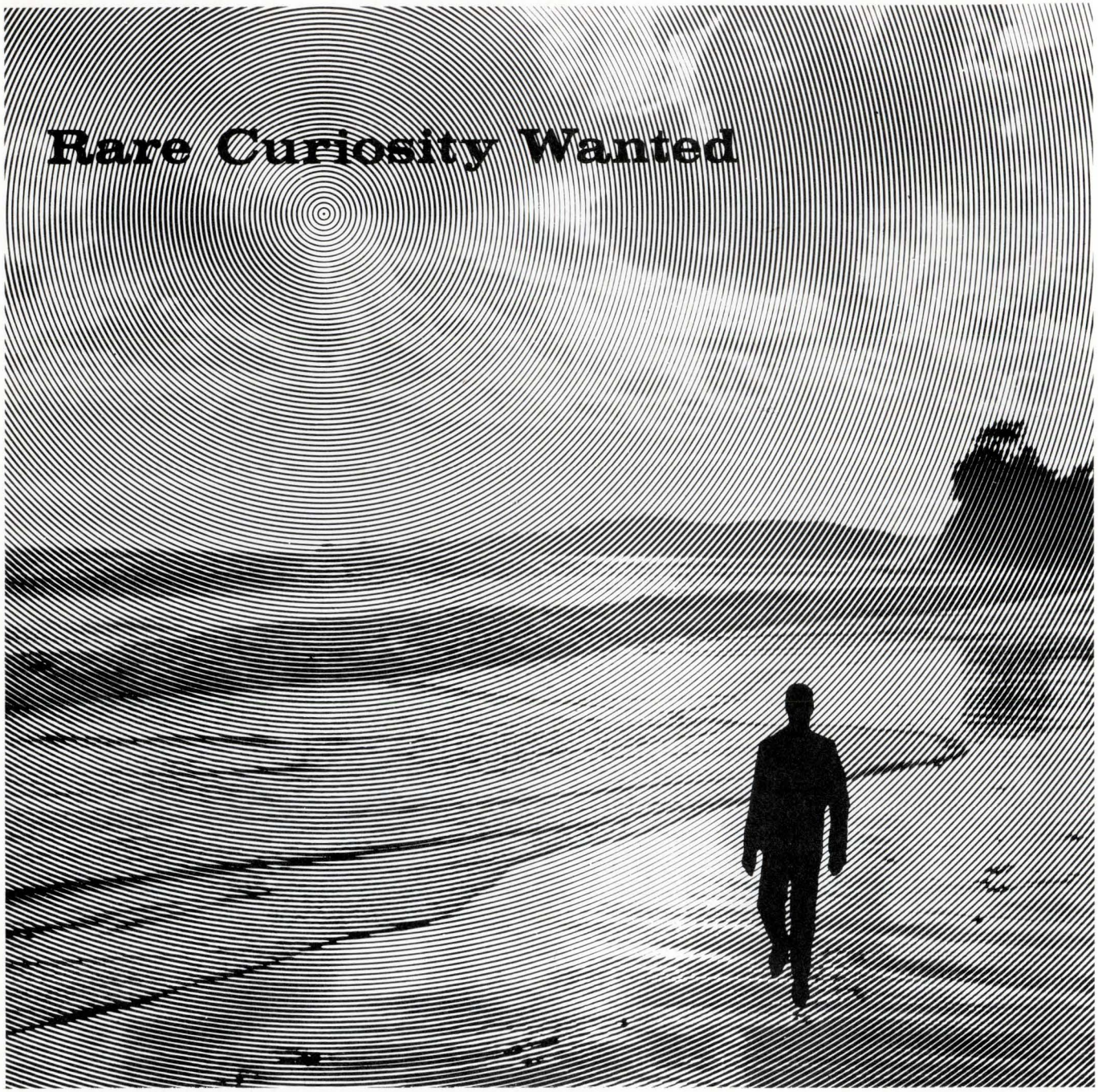
These are a few of the product development areas being sparked by the emerging specialized carrier networks. Other development work, not apparent today, is likely to be required as these systems become operational and customer requirements are specified in detail.

The economic problems

These developing opportunities for equipment manufacturers, however, are not without certain risks. The companies establishing specialized carrier systems will, very likely, look to their suppliers for a portion of the necessary system financing. The manufacturers will, in effect, be asked to share the risks of these new ventures through generous deferred payment plans for equipment. The successful start-up of the larger specialized carriers may well be contingent upon manufacturer support.

In any event, the FCC's rulings have opened new market opportunities, created employment for a receptive engineering community, and perhaps stimulated the offering of new services by the established carriers. Unless the specialized (and present) carriers and their suppliers fail to be innovative, the business communicator of the future will certainly benefit.

Stuart L. Mathison
Management Sciences Division
Arthur D. Little, Inc.



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Data Terminals - Part 2

Arthur J. Boyle, Technical Editor

While starting with Beefeater's may not guarantee the success of your martini, it certainly does get you off on the right foot. What goes in a data terminal is equally important, and has a similar effect on the outcome of the project. If we generalize about the functions performed by a terminal, we can group them into four categories: data entry, data display, the transmission and reception of data, and perhaps some form of storage.

Let's put off, for a moment, the problems associated with entering data and instead look at the display portion of our terminal. Presenting information to the operator involves two separate functions. First, the information must be translated from its coded form (ASCII, EBCDIC, or whatever) and then the problems of the actual display mechanism must be considered. The first two articles in this installment of our course deal with the problems of displaying data. First you will see how the MOS read-only memory can greatly simplify the problem of character generation. Next, we will show you how to select the optimum CRT on which to display your characters.

Since a data terminal is primarily a communications instrument, it must be able to transmit and receive data. The problems of sending error-free data between physically separated units are many and complex. However, the introduction of integrated line driver and receiver circuits has greatly eased the burdens of the terminal designer in this area. The third article in this installment shows you what to look for in these devices.

A very common function of our generalized terminal is the collection of data over a period of time and its rapid transmission at some later time. In this kind of application, magnetic tape is very often used as the storage medium. This installment looks at mag tape from the view of the designer who wants to incorporate a tape system in his terminal design.

To face up to the problems which we skipped earlier, there is that function of the terminal known as data entry. This means keyboards, and it also means some method of encoding the mechanical action of a switch into our communication-compatible codes. In the article entitled, "The monolithic keyboard encoder," you will see how MOS technology can perform the encoding function economically and reliably.

And to wrap up this installment, we are going to talk about keyboards. (In addition, see the "KEYBOARD SELECTION GUIDE" in the September 1971 issue of **The Electronic Engineer.**) The choice of a keyboard may well be the most difficult decision facing the terminal designer. On one hand there are the engineering and economic tradeoffs associated with the particular type of switch action used. And, on the other side of the coin, there are those difficult to measure considerations such as appearance and operator efficiency. There is no clear-cut choice in any case, but in the concluding article of this installment, you will find an enlightening discussion of the problems you will have to face when selecting a keyboard.

In this installment of the course, we have sat on the outside, looking inside a terminal. Next time, we are going to turn around and look the opposite way. Our next installment will treat some of the kinds of equipment with which the terminal must interface. Among the topics covered, you will find modems, multiplexers and the minicomputer.

Character generation using MOS read-only memories

Richard M. Eiler, Electronic Arrays, Inc., Mountain View, Calif.

Upon the receipt of an encoded input signal, a character generator will output a series of characters for visual observation or data recording. Character generators have existed for years, certainly long before the current popularity of MOS integrated circuits.

These early character generators, however, were costly and quite large. Most often they were fabricated from diode matrices, which required, in addition to the matrix itself, decode logic, drivers and sense circuitry. The resultant size and cost was such that in multiple terminal installations, often only one character generator was used per system, and the character itself, rather than its digital code, was transmitted to the remote terminal.

The low-cost, compact MOS ROM, however, has made the self-contained character generator for each terminal location a very practical approach. This organization results in simplified data transmission and unlimited portability. It also adds several degrees of freedom to the individual terminal display, since the shape of the display, the page organization, the font size and the matrix size can all be governed by the terminal itself—not slaved to a central character generator or the transmission system used.

Organizations

A vertical scan display consists of a matrix or array, organized as a set of parallel vertical columns. Upon successive stimulation of the columns, the excited segments within each column combine to produce a complete character. In this system, it is the function of the character generator to accept a character input code, and present the character to the display, one column at a time.

A horizontal scan (or row scan) display is very similar to vertical scan, except that it is organized as parallel horizontal rows instead of columns.

The segmented stroke (or random beam) display generates a character by serially exciting a pattern of segments or strokes which combine to form the character. The number of segments depends upon the system. Random beam refers to the CRT segmented display in which the electron beam continuously retraces a segmented stroke pattern and requires the use of a "random beam" CRT. For this system, the character generator must be organized to accept the character code and present to the display a series of 1's and 0's equal to the number of segments in the display. These outputs are used to either blank or excite each segment.

By far the most popular organizations are the horizontal and vertical scan systems. This popularity arises from the fact that they are ideally suited for a TV raster scan type of display—currently the least expensive CRT available.

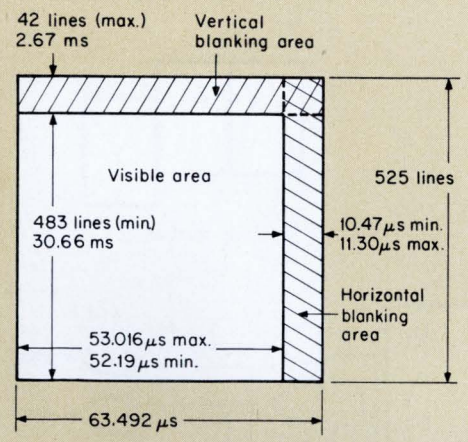
Font considerations

The design of a character is quite a subjective consideration since there are aesthetic qualities associated with forming each character. But governing the aesthetic features of a given character is the more restricting aspect of dot, or stroke, matrix size. Since any given matrix contains only a fixed number of discretely excitable points, the actual design of the character is limited by the size of the matrix used. With MOS ROMS, the character generator is no longer the major cost factor in determining matrix size. Actually, the limitations of the display mechanism itself, and the type of characters displayed are now the major influences on matrix size. With a fixed number of lines on a standard TV raster, the number of characters per line and per page will determine what font size can be incorporated. If the display is a high-speed, non-impact printer, a higher resolution matrix may be necessary to give acceptably readable characters. For non-Roman characters of a cursive nature (such as Japanese *Katakana*) a larger matrix will be required for acceptable legibility. Also, the need for a center line both horizontally and vertically may dictate a matrix with an odd number of rows and columns.

Most pre-programmed MOS ROMS use a 5 x 7- or a 7 x 9-dot matrix. By going to a custom pattern, or by combining two or more ROMS, any matrix size is feasible. Mr. Allen Vartebedian* of Bell Telephone Laboratories tested different symbol formations using actual subjects observing the characters on a CRT. The test results indicated that 7 x 9-dot matrix symbols were superior to the other types tested (5 x 7-dot matrix and stroke type symbol) in both subject reaction time and recognization error rate measures.

Another consideration in determining matrix size is the need, in some cases, for descenders, i.e., characters which descend below the bottom line—normally lower case letters such as g, j, q, p and y. Although fonts have been designed which keep these letters on the same bottom line, a larger matrix can be used to provide two extra bottom lines. This does, however, result in considerable wasted space in the ROM. An alternative is to use some peripheral circuitry to effectively drop the whole matrix for this type of character.

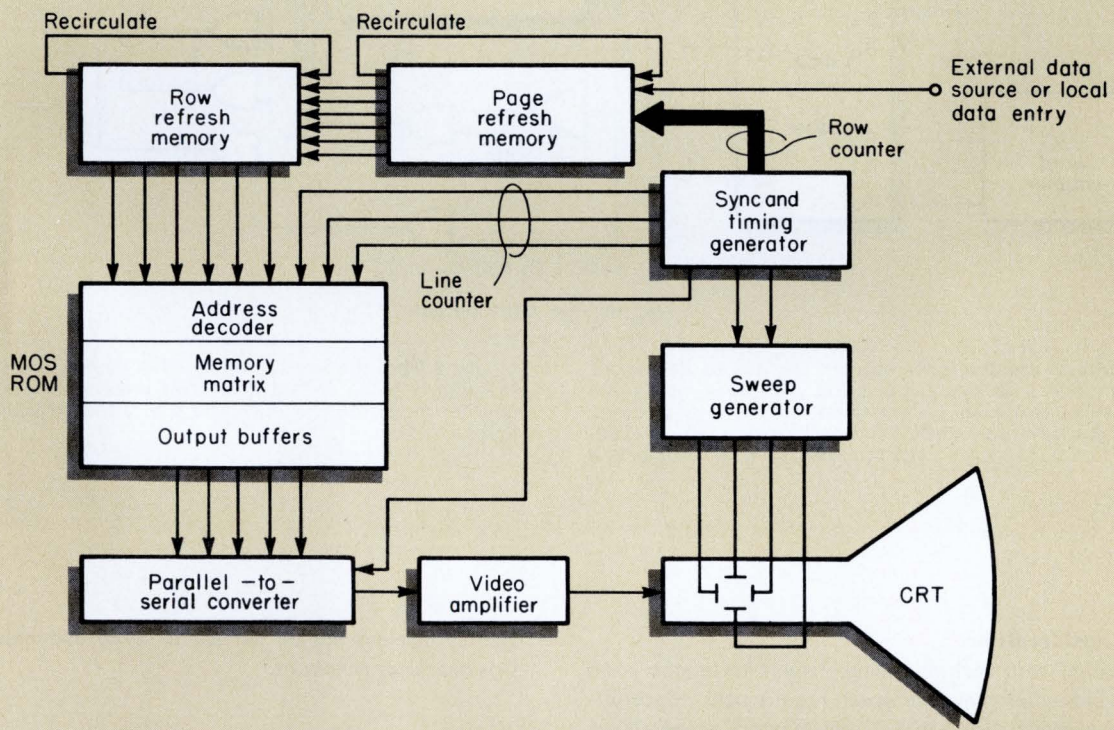
*Vartebedian, Allen G., "Effects of Parameters of Symbol Formation on Legibility." *Information Display*, May 1970, pp 23-26.



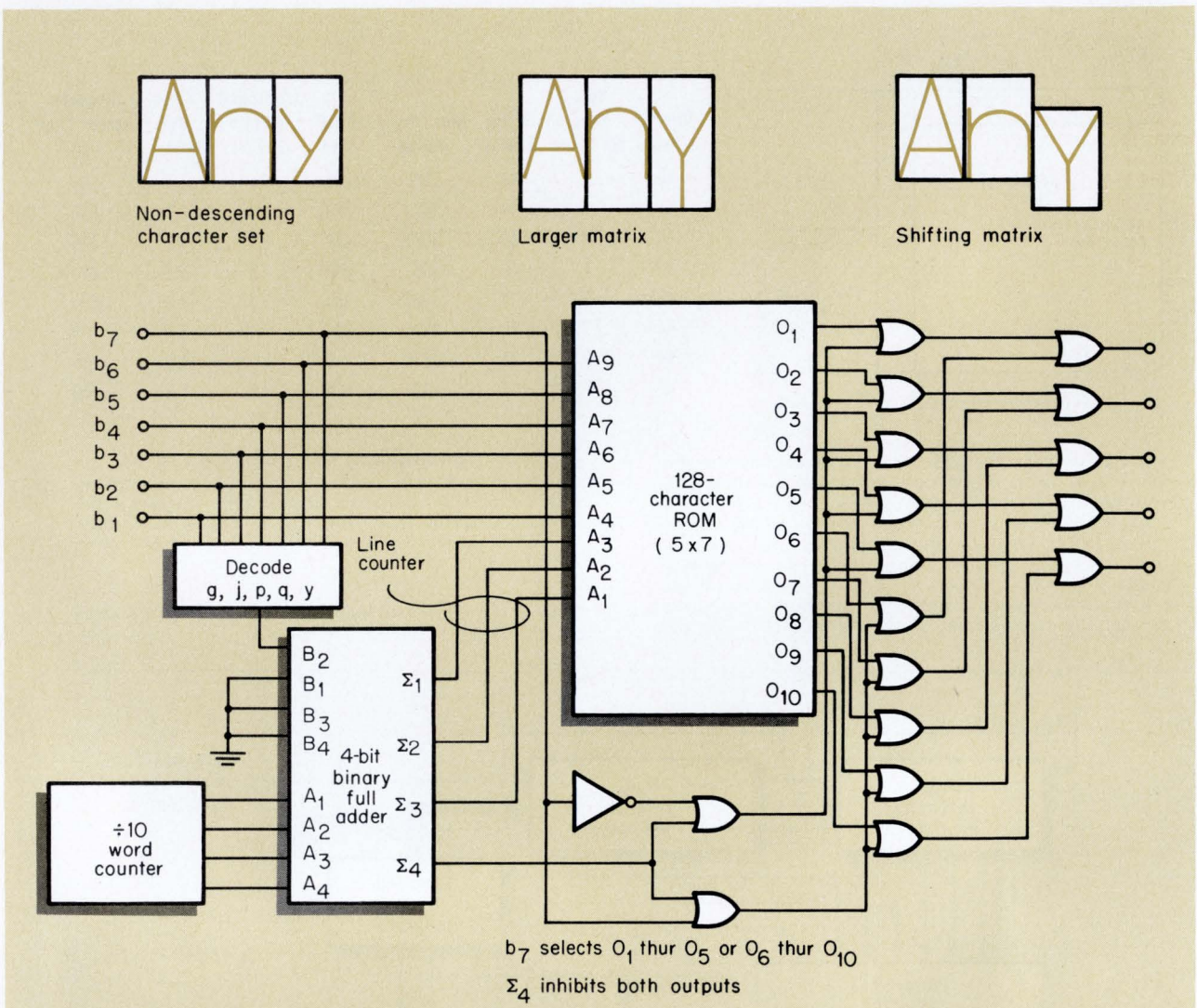
Char's/ row	Inter-char. dot spaces	Rows/ display	Max. char./ display	Bits/ rows	Horizontal bit rate (MB/s)	Video BW (MHz)	Character access Time (ns)
40	2	48	1920	280	5.4	2.7	1300
64	1	48	3072	384	7.4	3.7	815
64	2	48	3072	448	8.6	4.3	815
80	1	48	3840	480	9.2	4.6	650
40	2	24	960	280	5.4	2.7	1300
64	1	24	1536	384	7.4	3.7	815
64	2	24	1536	448	8.6	4.3	815
80	1	24	1920	480	9.2	4.6	650

The visible area for a 525-line TV scan is shown in the figure*. A great many configurations are possible, and the table shows the more popular 40-, 64- and 80-character per row configurations (based on a 5 x 7-dot matrix ROM). The table shows the characters per row; the dot spaces between characters in the same row (usually 1 or 2); the rows per display (based on three dot spaces between rows); the maximum characters per display; the number of horizontal bits in the visible area; the horizontal bit rate (bits/52.19 μs); the video bandwidth required; and the ROM character access time. The character access time becomes the limiting factor in ROM selection since the ROM must deliver a new word to the display within the allowable time.

* Muoio, Tony, "Character/symbol generation by MOS ROM," *Proceedings of SID*, first quarter 1970, pp 6-15.



The block diagram of a typical dot matrix CRT character generator shows the components required. The refresh memory is required to both buffer the incoming data and to continually refresh and/or update the display. In most cases, this refresh memory consists of recirculating MOS shift registers. The row memory is loaded from the page memory and recirculated for the number of times required to form a complete character row (or column). A new row is then loaded, and the process is repeated until the full raster area has been scanned. The sync and timing generator synchronizes the character generator with the CRT and contains counters for controlling the refresh memory and the ROM itself. The ROM outputs are always presented in parallel in order to achieve an acceptable access time. The parallel-to-serial converter which is used to control the ON/OFF condition of the beam is usually bipolar for speed considerations. The timing generator determines when the ROM outputs are to be sampled by the converter.



Some character fonts require the use of descender characters such as g, j, p, q and y. A larger matrix can provide two extra bottom lines for these characters, or you can use a circuit such as this one. The descender characters are detected and an adder subtracts a binary 2 from the word counter. This causes the entire matrix to be shifted down two lines via the line counter inputs on the ROM and the output blanking gates.

Speed considerations

Associated with each character display technique is an inherent character generator speed requirement. Since different MOS designs result in different memory access times, you must consider speed requirements at the outset before selecting a MOS ROM.

The most demanding type of display in this respect is the TV raster scan. Most other displays are much less stringent with respect to access time because the display mechanism itself cannot maintain electronic speeds. Printers, whether impact, electrostatic or ink jet, are slow relative to ROM access time. Gas discharge tubes, LEDs and other segmented displays put no particular speed demands on the MOS character generator.

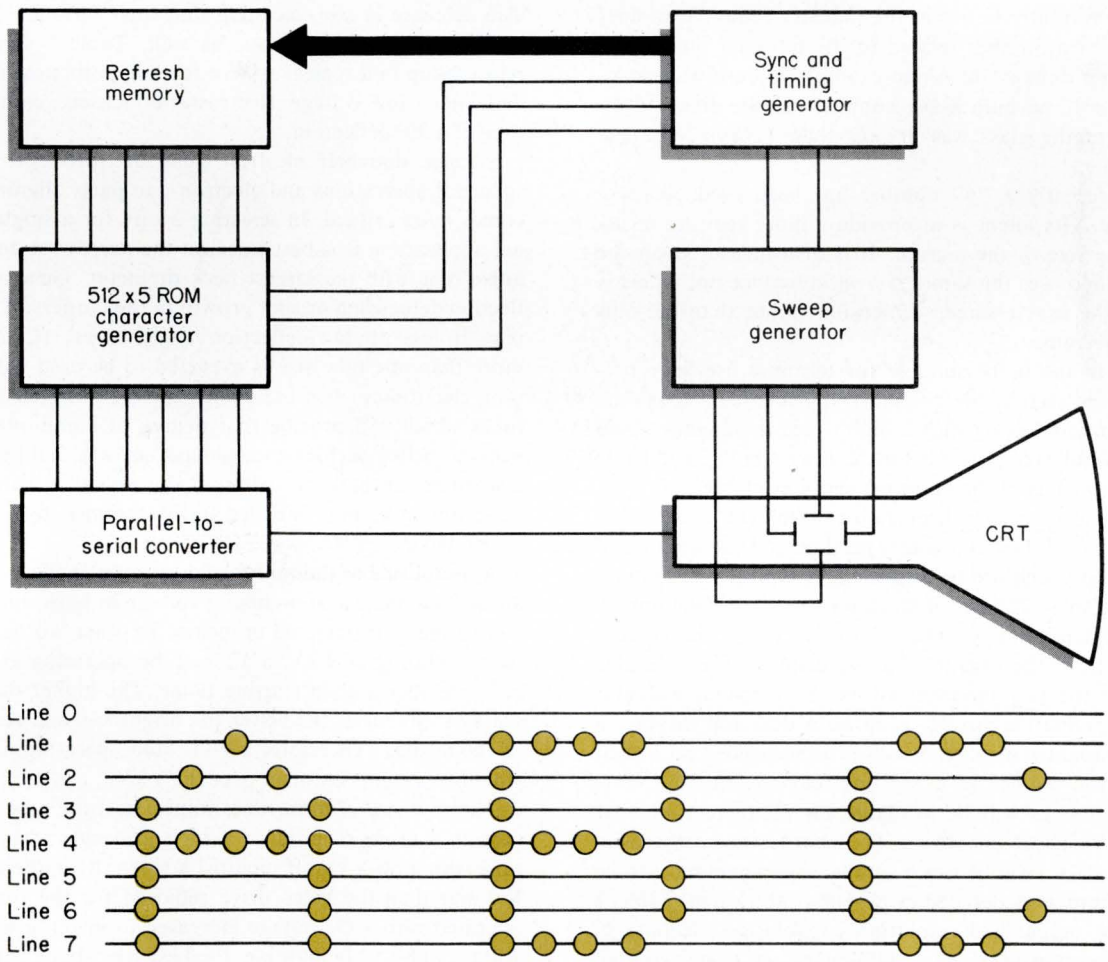
Summary

The popularity of the MOS ROM as a character generator is evidenced by the fact that they now dominate all new designs in the field. This is one of those rare cases where a technology and an application are a perfect match. And, in the future, this dominance will continue as MOS ROM size and performance increases and the cost per bit continues to decrease.

How the ROM generates characters

Michael R. McCoy, Electronic Arrays, Inc.

A character generator, converts the coded alphanumeric representation for a character into a dot matrix code that visually represents the character. In this case, a MOS ROM displays on a CRT the character set A, B, C. During the first sweep of the beam (line 0), three lines from the sync and timing generator tell the ROM that line 0 is being displayed. As long as the code for line 0 remains on the ROM inputs, no dot pattern is displayed because line 0 represents the vertical space between characters. When the line 1 sweep is started, the first character code (A) is clocked into the ROM from the refresh memory. The character code combined with the line 1 code cause a 00100 to appear at the ROM output. As the sweep generator moves the beam across the face of the CRT, the 00100 is shifted to the CRT blanking circuit. This causes a single dot to occur on the CRT face in the middle of the line 1 position of the first character field. Next, a new character (B) is shifted into the ROM. The code 01111 now appears at the ROM output and the blanking circuit causes four dots to appear in the first four locations of line 1 in the second character field. After the line 1 dot code for the third character (C) is written, the horizontal sweep returns the beam to start line 2. The same three character codes will be sequenced into the ROM, but the new line code will cause dot representations appropriate for line 2 of the character field. This process is repeated through line 7 when vertical sweep return occurs and begins another cycle.



DATA TERMINALS COURSE

Select the right CRT for alphanumeric data terminals

A. D. Johnson GTE Sylvania Inc., Seneca Falls, N.Y.

One problem facing the designer is to choose the most efficient cathode-ray tube for high-volume, low-cost, alphanumeric displays using resonant-scan, TV-raster circuitry. We will be concerned primarily with the 5- through the 24-in. tube sizes which can present 40 to 80 characters per line, and up to 30 lines of information. In all cases, these tubes are magnetically deflected with low-voltage electrostatic focus.

Display size

The first consideration in selecting a CRT is the size of the display. The display size, in turn, will call for a particular bulb dimension. There are two methods to delineate tube size currently in use in the industry today. The older system used a number related to the nominal outside diagonal bulb dimension. As an example, a bulb was designated as a 12-in. bulb if the nominal outside diagonal dimension of the glass was greater than 11½ in. but less than 12½.

More recently a "V" number has been used denoting "viewable." Its intent is to provide a more realistic measure of the size of the picture. It is also measured on the diagonal and uses the same ± ½ in. tolerance but is measured on the usable screen dimension rather than the outside of the bulb.

Many of the bulbs suitable for terminal use have previously been used by the TV industry. There is an economic advantage to selecting such a bulb, since the quantity used by the TV industry provides for the lowest bulb cost. Table 1 shows a matrix of the bulbs presently available.

Choosing the proper display size means you must determine the number of characters per line and the number of lines of text which will be displayed. A typical 12-in. monitor may display 20 lines of 80 characters each. One important consideration is selecting a display size is the viewing distance from the operator to the display. The available space for the CRT monitor within the terminal will also help determine the size. It is to be a desk-top display, a counter-mounted display, or will it be suspended on a shelf or from the ceiling? In a 525-line scan system, the same number of lines will be available for characters whether the tube size is 5- or 16-in. The characters on the 5-in. tube, of course, will be much smaller and would have to be viewed from a closer distance. Tubes shown in Table 1 have light output and resolution capabilities adequate to display densities of at least 2000 characters. The required light output of the characters and the resolution of the characters will be determined in part by the ambient illumination in the display area. We will discuss contrast enhancement and the methods of reducing specular reflection later.

Operating requirements

Choosing a CRT for a data terminal means making trade-offs between deflection angle, deflection power and the resolution capability of the tube. Alphanumeric terminals can generally use wider deflection angle tubes than random access systems. In the past, the neck diameter of the CRT was decreased as deflection angles increased. This technique reduces deflection power and is acceptable so long as it does not reduce the resolution capabilities of the tube to an unusable degree. This is true because as neck diameter decreases, the electron gun electrodes must also decrease in size, meaning that their ultimate capability for resolution decreases, as well. Table 2 shows this relationship in a typical system for a hypothetical magnet-deflection, low-voltage electrostatic-focused, cathode-ray tube of a 90° deflection.

Smaller diameter electron guns are prone to higher spherical aberrations and electron gun parts alignment becomes more critical. In selecting a CRT for a single terminal application, it is best to select the narrowest deflection angle tube with the largest neck diameter. Generally, deflection defocusing or spot growth in the corners of the display is less on low-deflection angle tubes. If, however, more than one tube size is expected to be used with common electronics, then the choice must be limited to those tubes which will provide that degree of commonality. In general, better performance on spot growth and geometric distortion can be expected from the use of a wider-angle deflection yoke than is called for by the CRT; for instance, a 110° yoke on a 90° tube.

A useful rule of thumb for selecting the anode voltage of a CRT is to operate at an anode voltage in kilovolts equivalent to the tube diagonal in inches. In other words, a 9-in. tube operating at 9 kV, a 12-in. tube operating at 12 kV, etc., provides a good starting point. The higher the anode voltage, of course, the better the brightness and resolution of the display. Therefore, a 9-in. tube operating at 12 kV would be an improvement over the 9 kV.

The spot size of most tubes improves if the tube is operated in a mode to produce a high grid cutoff voltage. A tube with a 50-V cutoff requires a video drive about 5 or 6 V lower than the video drive required for the same tube operated with a G_2 voltage increased to give a grid cut-off voltage of 80 V. In addition, the best spot shape can be obtained by the use of a beam alignment magnet over the control grid cylinder of the electron gun. This magnet strength, adjustable from 0 to 10 Gauss, is optimized for

TABLE 1
CRT PHYSICAL CHARACTERISTICS

JEDEC bulb no.	Nominal Tube size (in.)	"V" size (in.)	Useful screen dimensions (in.)	Diagonal deflection angle (deg.)	Neck diameter (in.)	Typical length (in.)
J43 1/2A	5	5	3.25 x 4.30	70	0.788	7-3/4
	7	6	4.37 x 5.75	70	0.870	8-3/4
	8	7	4.70 x 5.80	85	0.788	8-3/8
J67 1/2 A1A	8	8	5.37 x 7.18	90	1-7/16	10.0
J74 1/4A	9	9	5.69 x 7.37	85	0.788	9-1/2
J76 1/4A	10	9	5.85 x 7.81	85	0.788	9-1/2
J99Y	12	12	6.00 x 9.50	70	1-7/16	16-3/4
J99 F1A	12	12	7.68 x 10.12	90	0.788	11-3/8
J99B	12	12	7.68 x 10.12	90	1-1/8	11-3/8
J99V	12	12	7.68 x 10.12	110	0.840	11-3/8
J99P1A	12	12	7.68 x 10.12	110	0.788	11-3/8
J99A	12	12	7.68 x 10.12	110	1-1/8	10.0
J112A	14	13	9.50 x 12.18	90	1-7/16	15-3/8
	14	13	9.87 x 12.37	110	1-1/8	11-1/2
J118 1/4B	15	14	8.58 x 11.31	70	1-7/16	19.0
J118 1/4A	15	14	9.01 x 11.56	110	1-1/8	11-1/4
J125G	16	15	10.25 x 12.94	100	0.840	12.0
J125A	16	15	10.25 x 12.94	114	1-1/8	11-1/4
J133B	17	16	11.13 x 14.44	70	1-7/16	18-3/4
J133G	17	16	11.13 x 14.44	90	1-7/16	14-5/8
J137 1/4A	17	16	10.62 x 13.62	114	1-1/8	11-1/2
J149D	19	18	12.06 x 15.25	92	1-7/16	15-1/2
J149F	19	18	12.00 x 15.19	114	1-1/8	11-1/4
J157 1/2A	20	19	12.12 x 15.50	114	1-1/8	13-1/4
J171F	21	20	15.06 x 19.06	72	1-7/16	23-1/4
J171E	21	20	15.06 x 19.06	90	1-7/16	18.0
J171G or H	21	20	15.06 x 19.06	110	1-1/8	14-3/4
J165 1/4A	21	20	13.25 x 16.87	114	1-1/8	13-1/2
J187J	23	22	15.13 x 19.25	92	1-7/16	18-1/2
J187L	23	22	15.13 x 19.25	114	1-1/8	14-5/8
J192C	24	23	16.87 x 21.43	110	1-1/8	15-5/8

best spot shape in all four corners.

The heater power required for most tubes is between 1 ½ and 3 W. Typical voltages and currents are 12.6 V at 150 mA and 6.3 V at 450 mA. In a family of tubes for use with common electronics for more than one terminal display size, most tube suppliers can provide the same heater voltage and current ratings on all of the selected tube sizes.

Interaction between the deflection yoke and electron gun should be considered. In the TV industry, the styling requirements of the cabinet have generally required that the CRT be made as short as possible, often resulting in corner spot degradation. In a A/N terminal, this overall length is usually not as critical. Any deflection of the electron beam before it exits from the limiting aperture of the electron gun will cause severe deflection defocusing problems in the corners of the display. Therefore, sufficient neck length must be provided for the given yoke length. Overall tube lengths shown in Table 1 are approximate for most standard deflection yokes used today.

Many of today's alphanumeric terminals operate with the same scan characteristics as a standard television format: 15,750-Hz horizontal and 60-Hz vertical with 2:1 interlace. This type of scan produces between 480-500 active horizontal scan lines. The difference between the number of active lines and the 525 lines which make up the total display results from vertical retrace blanking. In a system where the characters are produced by a 5 x 7 dot matrix, seven scan lines are needed to produce a row of characters. A minimum of three more scan lines are needed between rows of characters so that 10 scans are needed for each row of characters. Therefore, 48 rows of characters could be displayed if it were not for other limitations, such as refresh memory capacity. As a result, 20 to 30 rows of characters is a common number to be displayed. Under these conditions, alternate rows of dots, in the dot matrix of the displayed character, are refreshed at 30 Hz due to the 2:1 interlace. This frequency can produce an annoying degree of flicker in medium to short persistence phosphors such as P4. The longer persistence P39 phosphor eliminates this flicker.

Another scan technique often used is 15,720 Hz and 60 Hz without interlace. This reduced the number of scan lines to 262 per field and, with 11-20 lines blanked during vertical retrace, still provides about 240 active horizontal lines. At 10 lines per row of characters, this display could still produce over 20 rows of characters. This technique results in one-half the vertical picture height resolution capability of the CRT, but if only a few rows of characters are needed, character resolution is still acceptable. Because each character is now refreshed at 60 Hz, flicker is no longer a problem. Consequently, the choice of character format can play a part in the brightness and color capability ultimately chosen.

DATA TERMINALS COURSE

X-ray considerations

While most monitors will operate at relatively low anode voltages, some concern may arise in regard to X-ray radiation problems.*

The glass industry, during the last several years, has done much to modify their glass composition to provide greater shielding. Today, the larger bulb sizes can be run at over 20 kV without exceeding the 0.5 mR/hr (milli-Roentgens/hr) limit.

Implosion control, mounting, and contrast

With any CRT for terminal applications, the problem of implosion control, tube mounting and contrast must be considered. Every CRT is under a high vacuum and the external pressures on the bulb wall must be considered as potentially hazardous in the event of breakage. Most implosion safety considerations relate to the faceplate of the bulb in its mounted configuration. Since the curvature of the face can be considered as an arch, most explosion control techniques are some form of compression system to preserve the strength of this arch. The implosion control technique does not prevent implosion but only maintains the form of the bulb as the air enters the tubes. In other words, the object of an implosion control system is to keep glass from being forcibly ejected from the display unit in case of tube breakage. The following types of configurations have been used for implosion control. Not all of these systems have been tooled for all of the tube sizes shown in Table 1.

The simplest measure uses the tension band or T-band. The T-band, a steel band ⅝- to ¾-in. wide, is pulled around the faceplate skirt of the bulb, at a tension of about 1800 lbs.

A second method of implosion control is the filled rim of shelbond. This is a metal member with corner mounting holes formed to the faceplate contour and attached to the bulb with a rigid epoxy.

*A pamphlet which describes X-ray test equipment and procedures is helpful on this problem. For $1.00, copies of this pamphlet, JEDEC Publication No. 64A, can be obtained from: Electronics Industries Assoc., Engineering Dept., 2001 Eye St., N.W., Washington, D.C. 20006.

A third system is known as the bonded rim band with tension band (Kimcode). Kimcode consists of formed metal halves, which together resemble the tooled shell, that are epoxy-bonded to the tube face. A steel band similar to the T-band is then tensioned around the Kimcode. Mounting brackets are also available.

Maximum protection is provided by a separate piece of tempered glass formed to the contour of the faceplate and bonded directly to the tube. This is known as the integral safety panel or PPG cover. This cover plate is attached to the tube by means of a transparent resin system and, due to the laminated construction, provides a high degree of strength from frontal impact. The resin bonding material is selected to have the same index of refraction as glass so that no inter-surfaces are visible. This cover plate also provides a vehicle for contrast enhancement by making use of glass compositions with varying degrees of absorption to provide neutral density filtering. It is also possible to etch these laminated cover plates for specular reflection control. It should be remembered that the etched surface also diffuses the light from the phosphor, thereby reducing the tube resolution by approximately 20%.

Summary

We have been concerned with the various parameters of CRTS for use in low-cost alphanumeric terminals displaying between 800 and 3,000 characters. Sizes, deflection angles and neck diameters have been discussed with the aim of making the optimum selection of a tube. While we have limited ourselves to monochrome types, there are further considerations that can be carried over into color, such as the use of the standard shadow mask tube, the specialized shadow mask tube for two-color displays, penetration color tubes and special multi-beam tubes for very high density A/N displays. All of these will be subject to further display requirements.

Appreciation is expressed to many people for their assistance in the preparation of this material, especially to W. A. Dickinson, A. W. Keen and E. O. Stone, all of GTE-Sylvania Incorporated, Electronic Tube Division.

TABLE II

RELATIONSHIP OF NECK DIAMETER TO RESOLUTION AND POWER REQUIREMENT

Neck Diameter (In.)	Gun Part Diameter (In.)	Relative Resolution (%)	Approximate Deflection Power (%)
1-7/16	0.520	100	100
1-1/8	0.395	75	75
0.788	0.315	65	55

Integrated line drivers and receivers

Dale Pippenger

Texas Instruments Incorporated, Dallas, Tex.

Of major concern to the designers of data terminals are the problems involved in transmitting data between two physically separated units. The noise margins of most types of logic circuits are adequate for transmitting data for only a few inches. The transmission of error-free data over longer distances in noisy environments requires the use of special transmission line drivers and receivers plus the careful selection of a suitable transmission line.

Studying the problems involved in the transmission of data shows that a terminated transmission line is most desirable because it offers improved performance. Such a line makes high-speed transmission possible because signal reflections are eliminated.

Also desirable is a balanced, or two-wire, system. Because system noise is primarily common-mode, a differential input receiver with adequate common-mode rejection can reduce noise problems considerably.

A high-speed system designed for use with long transmission lines is most often used since it can be adapted for use with shorter lines or for low-speed transmission. Such a system would use a standard supply voltage and be compatible with the usual forms of logic. At the transmitting end, the system should be capable of driving low impedance terminated lines, and the transmitters should have an inhibit capability and a high impedance in the inhibit mode. In addition, the receivers should have a high sensitivity (< 50 mV), a high input impedance, and a high common-mode rejection with the receiver speed insensitive to overdrive.

The most popular type of transmission system uses a current mode driver (see Fig. 1). Another type of driver for balanced line transmission uses a voltage mode drive. Basically, most voltage mode drivers have outputs which look like high current gates and typically have TTL level voltage outputs. Their disadvantages when compared with current mode drivers are that they do not allow as much noise margin at the receiver; they need more power to drive long, low impedance balanced lines and they are not adaptable to large party line systems. On the other hand, they can operate single ended or balanced; they can use a TTL gate as a receiver on short (< 10 ft) lines and they operate from a single power supply.

Up to now, we have only considered the case where the transmission of data was over relatively short distances. For long distance transmission over telephone lines, the line drivers and receivers are required to successfully interface with a modem. A brief summary of the EIA RS232C specification which defines the requirements for drivers and receivers in this application is given below.

Drivers

- ☐ Slew rate $<30V/\mu s$
- ☐ Short circuit output I <0.5 A
- ☐ Open circuit output voltage <25 V
- ☐ Power off source impedance $>300\ \Omega$
- ☐ Time in transitional region <1 ms

Receivers

- ☐ Data rates to 20 kb/s
- ☐ Input range ± 24 V
- ☐ Input resistance 3 to 7 kΩ
- ☐ Input capacities 2500 pF, max.
- ☐ Input must be noninductive
- ☐ Open circuit output voltage $<|2.0|$ V
- ☐ Must treat open inputs as an off condition

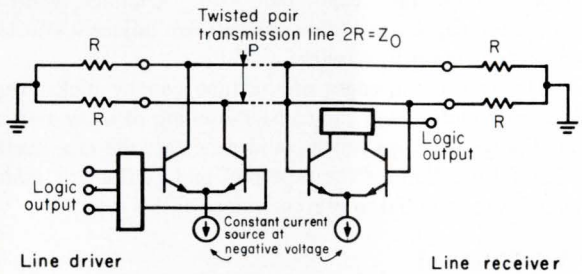
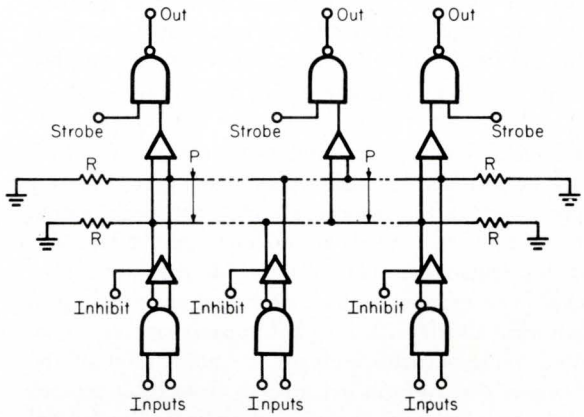


Fig. 1. This functional diagram shows a current mode driver and receiver operating over a balanced transmission line. The twisted pair line is terminated at each extreme end in its characteristic impedance. The driver has a stage to convert logic levels into voltage levels which control a current switch. The input stage of the receiver serves as differential input stage that has high rejection of common-mode signals. Intermediate stages convert the polarity of the input signal to the desired logic levels at the receiver output. An important feature is that provisions can be made for removing the driver output current from both lines. In this inhibit mode, another driver may be used to transmit data over the line.



This party line system is made possible by the strobe provision on the receivers and the inhibit feature of the drivers. Any driver may communicate with any or all receivers in such a system.

Magnetic tape for data terminals

R. H. Kearns Magnetic Tape Div., Ampex Corp., Redwood City, Calif.

What makes a good tape? There are numerous parameters that can be compared to answer this question but they can all be lumped into a simple statement. A computer tape must deliver reliable preformance on the customer's tape drives and do it consistently. The only conclusive evaluation for computer tape is to observe its performance over a period of time under normal programming and operating conditions.

To understand the basic relation between tape drives and tape quality, you need a knowledge of the tape's structure and composition. Magnetic tape consists of a thin oxide coating, firmly bonded to a flexible base material. The coating generally represents 20-30% of the total tape thickness.

The heart of all magnetic tape is the oxide particle itself. In virtually all precision tapes, the oxide used is gamma ferric oxide particles. The oxide particles make up approximately 60% of the formulation; the remaining portion is the binder. Because oxide particles are highly abrasive, each individual particle must be completely coated with the binder formulation. Among the bonder's various functions are, most importantly, to bind the particles to each other with a cohesive bond, and also to provide an adhesive bond of the coating formulation to the base film.

Wear characteristics of a tape are determined primarily by the binder. Wear results from the frictional forces and associated heat that build up when tape is used.

Proper tape design must consider all aspects of its performance cycle. A long wearing tape, with an extremely hard surface, could be designed to last indefinitely. However, it would not be acceptable if it were not softer than the heads or machine components. In the case of tape and magnetic recording components, the tape should wear faster than the heads. This is why a slight amount of shed oxide will be present on any transport after a tape has been used.

The surface finishing technique will often determine the ultimate performance characteristics of the tape. Treating the tape's surface will achieve a highly polished, smooth surface. If abrasive methods are used to treat the tape surface, it is possible that many of the oxide particles will be fractured. This exposes the bare oxide and gives the tape a highly abrasive surface, although it appears smooth. Also, fractured oxide particles increase the noise level of the tape because non-uniform fields result from the fractured particles. An ideal tape surface has only the binder exposed with the individual oxide particles completely encapsulated in the protective binder covering. The binder will not wear the heads at all, but the abrasive oxide will, if exposed.

Drop-outs and drop-ins

Now you have a perfect reel of tape, with oxide particles equally dispersed on the tape surface, lightly yet firmly encapsulated in binder, and polished to a perfectly smooth surface.

Most problems related to computer tape occur after the reel of tape has been incorporated into the customer's tape system. Computer tape is fragile. It is easily damaged and, since many of these damages are not apparent to the naked eye, they are often overlooked.

It is an established fact that computer tape does not "wear out." It is retired from service when drop-outs exceed an acceptable number. Virtually all drop-outs are caused by tape imperfections that lift the tape away from the head, causing an unacceptable loss in signal. Drop-outs not present in the tape on initial use may come later from the computer room environment. Drop-outs can be temporary, such as a hair or bit of dust which clings to the tape, and can be cleaned from the tape surface. In other instances, foreign particles become so deeply imbedded into the binder as to become permanent drop-outs.

Most importantly, extreme care should be used in handling tape, in order to maintain reliable tape performance. The increasing use of off-line equipment, such as key-to-tape devices, has intensified the problem related to adequate tape maintenance.

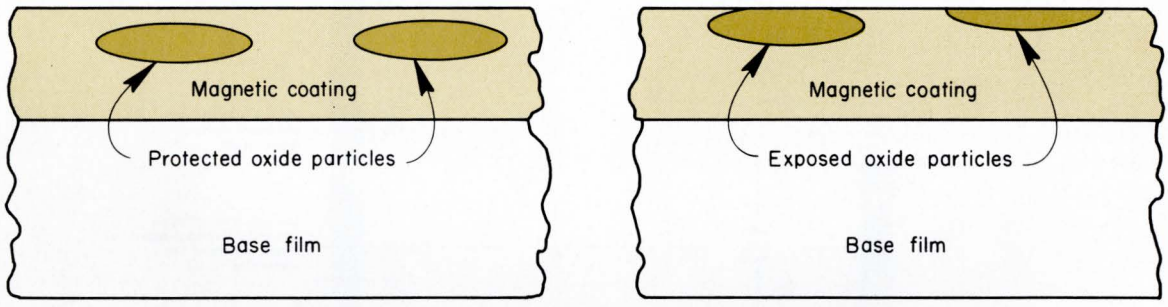
The most critical part of the tape is the edges. Most drop-outs occur on edge tracks and are usually related to physical deformation of the tape. This is particularly true in a 9-channel recording, where the edge tracks are much closer to the tape edge than with 7-channel recording. Also, the guard band (distance between adjacent tracks) is narrower on the 9-channel.

Defects on the edges of the tape can be nicks, raised edges or curling and can cause loosening of oxide particles and polyester chips which could penetrate the tape surface. Careful handling of the tape reel and equipment maintenance are essential to prevent errors of this type.

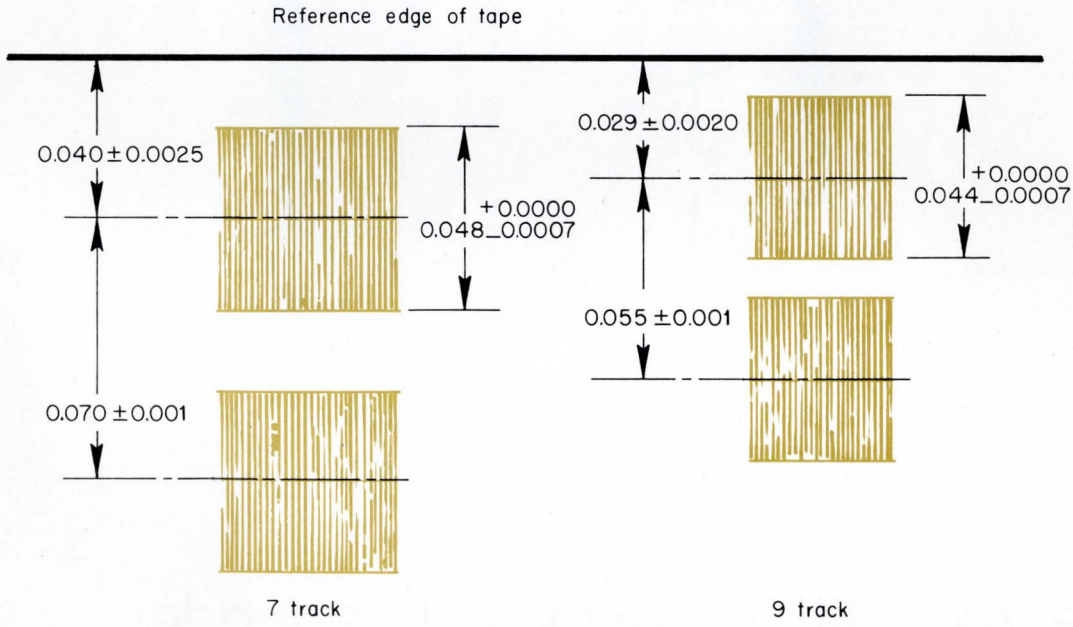
What's ahead

The trend will continue toward tapes and tape drives which provide higher packing densities, faster speeds and improved performance. Innovations in equipment design for tape handling are direct steps in the upgrading of tape performance. Care in design of tape handling and guiding mechanisms, combined with controlled cleaning and maintenance, are critical areas of tape performance.

Tape manufacturers continue to research for improved formulations and production processing methods to increase tape performance and reliability. Industry acceptance of current standards on tape, such as ANSI docu-

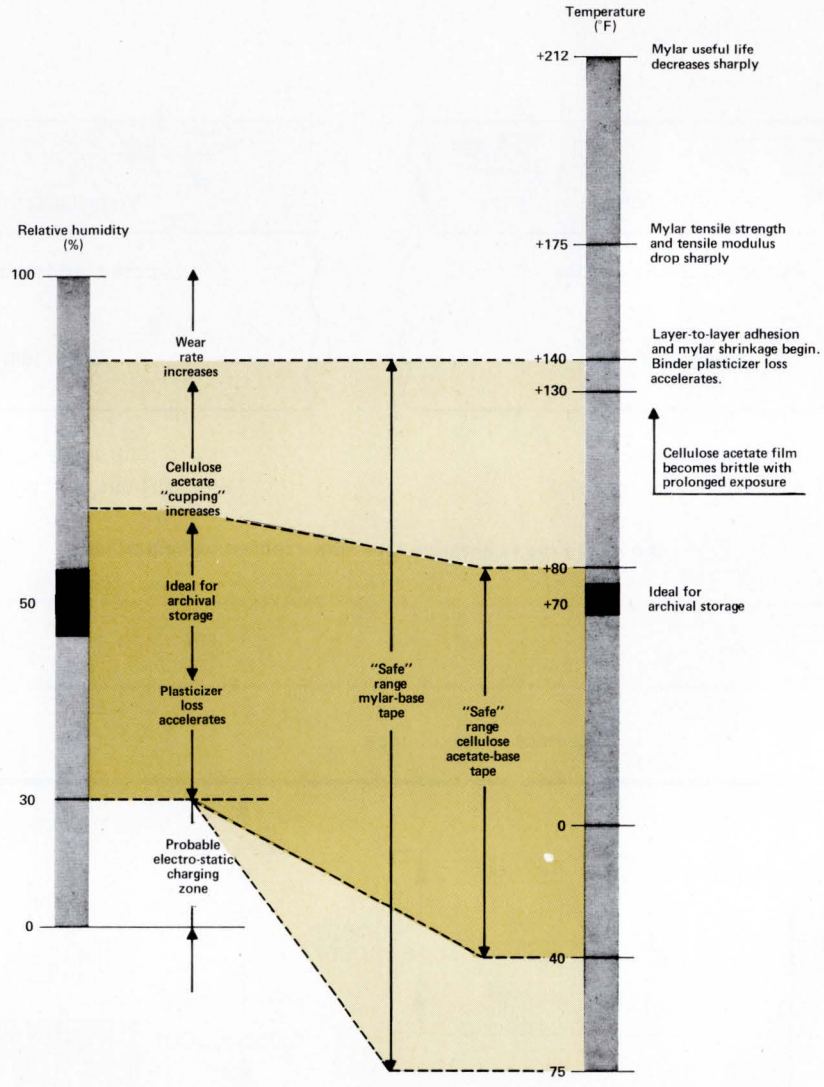


An ideal tape vs abrasive tape with exposed oxide particles



The relationship of 7- and 9-track tape layout

ment on Unrecorded Magnetic Tape for Information Interchange and GSA W-T-0051B, are guidelines that will be applied to new developments both in tape and equipment. A combined effort between the tape and equipment manufacturers is essential to the future development of the use of magnetic tape as a data-recording storage media.



The effects of environment on magnetic tape

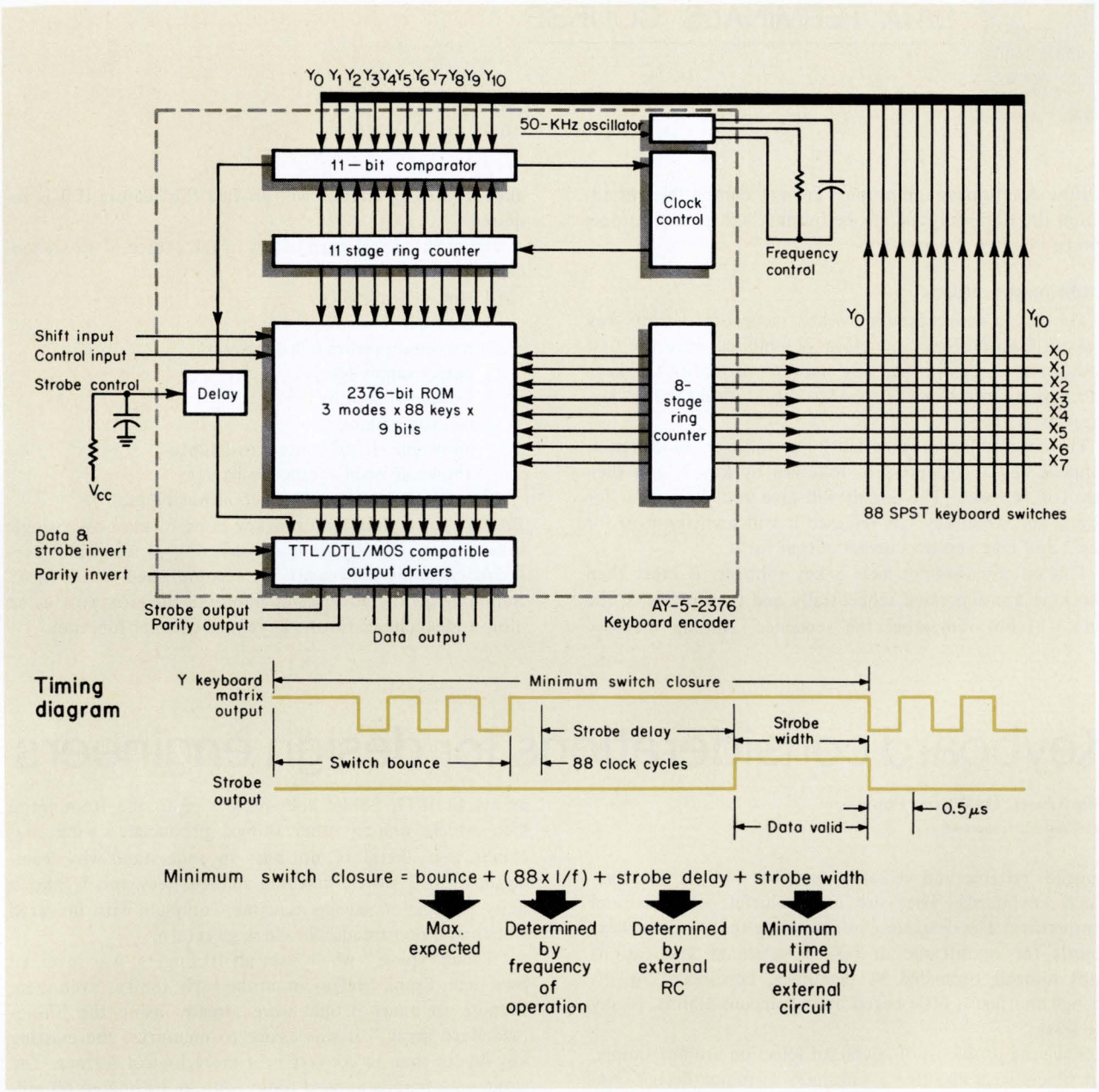
The monolithic keyboard encoder

Frank Yoerg,
General Instrument Corp., Hicksville, N.Y.

The application of MOS technology to the problem of keyboard encoding has produced a monolithic chip capable of converting the action of depressing a keyboard switch into a binary code which can be used to display or transmit that particular data. In the past, the encoding function had been performed by a diode matrix and its associated control circuits. Using a MOS ROM, however, has the advantages of fewer parts, lower cost, and higher reliability. In addition, the encoder is immediately available, and you can change patterns without expensive changes to the circuit board layout.

A typical circuit

The figure shows a typical MOS encoder connected to 88



normally open SPST keyboard switches. Each key has three modes of operation: the normal lower case alphabet and character set of a typewriter keyboard; the shifted mode which is the normal upper case and character set; and the control mode which the user can define for his own specific needs. The ROM can therefore be subdivided into three modes with 88 keys of 9 bits each for a total of 2376 bits. Normally three modes are sufficient for most applications, however, if needed a fourth mode can be supplied.

Looking at the figure, you will see that our design also includes eight-bit and 11-bit ring counters, each of which has a single 1 always recirculating. When all the keys are in the normally open position, the two ring counters are clocked and sequentially address the ROM. Data outputs not valid at this time are indicated by the absence of a strobe output. When a key is depressed, there is a single path between one output of the eight-bit counter (X_0 thru X_7) and one input of the 11-bit comparator (Y_0 thru Y_{10}). After a number of clock cycles, the level on the selected path to the comparator will match the level on the corresponding comparator input from the 11-stage ring counter. At this time the comparator generates a signal which, after being delayed, is presented at the strobe output. This strobe output indicates that valid data is present at the outputs of the encoder. Simultaneously, the comparator transmits a signal to the clock control which inhibits the clocks to the eight- and 11-bit counters. This stablizes the data output until the key is released.

The delay in the strobe output compensates for contact bounce. The length of time it takes for the bounce to dampout will vary depending on the type of switch used in the keyboard. To compensate for the varying bounce, the encoder design allows you to control the delay by means of an external resistor and capacitor.

The internal oscillator in the circuit has a frequency which is controlled by another resistor-capacitor combination. The frequency will depend on the particular keyboard and the speed at which the keyboard will be used.

All the data inputs and outputs are TTL compatible. In addition the data outputs, strobe outputs and parity outputs can be inverted if necessary.

Additional features

The design shown here inherently incorporates the N-key lockout feature. Since the clock is inhibited once the first key is depressed, hitting any number of additional keys will have no effect on the encoder output until the first key is released.

The circuit also has inherent 2-key rollover. In this case, suppose key 1 is depressed, followed by key 2, and then key 1 is released. The circuit will give you the output for key 1, and when key 1 is released it will scan the ROM for key 2 and give you the correct output for it.

This circuit does not have N-key rollover. If more than two keys are depressed sequentially and then released, the chip will not remember the sequence. Adding memory and/or latching circuits will provide this feature if it is required.

The most critical parameters in the choice of MOS encoders are:

- ☐ storage capability
- ☐ the logic levels required
- ☐ maximum power consumption
- ☐ power supply levels
- ☐ lockout capability
- ☐ rollover capability
- ☐ allowable closed contact resistance
- ☐ allowable open contact resistance
- ☐ special logic function, such as parity, etc.

Because the coding for each key is performed by a single mask change during the manufacturing process, any keyboard encoding can easily be accomplished in the ROM. Summing all the advantages points to the MOS ROM as an almost ideal choice for the keyboard encoder function.

Keyboard considerations for design engineers

Don Arnett, DuWayne Pople
Micro Switch, Freeport, Ill.

Rugged, reliable and versatile describes today's data terminal keyboards. They are also colorful, complex and competitive. The designer contemplating the choice of keyboards for mainframe or remote terminal applications finds himself bedeviled by deadlines, bewildered by offerings and just a little bored by outrageous claims, to say the least.

Since the problems of keyboard selection are not simple, our objective is to offer a summary of major design considerations based on experience, application needs, and most frequently encountered trade-offs. (See also the KEYBOARD SELECTION GUIDE in the Sept. 1971 issue of **The Electronic Engineer**) We have kept in mind that many design aspects of any man-machine interface are influenced greatly by *de facto* practices and human emotions. Engineering objectivity has often proven to be secondary.

Many of us take keyboards for granted, in typewriters, adding machines, comptometers, courtroom stenographic devices, and telephones. We are, however, confining our discussion to electronic keyboards. We define an electronic keyboard as a man-machine interface consisting of several finger-operated key stations (usually 10 or more) that convert mechanical energy into coded electrical energy.

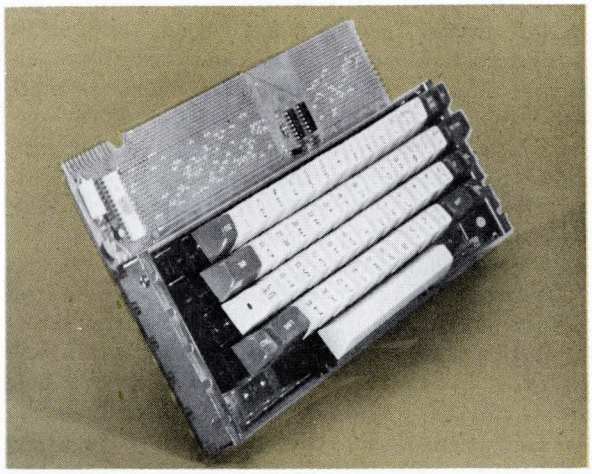
History

The history of the office typewriter holds many significant parallels for the data terminal designer. Credit for the first practical office typewriter is generally given to Christopher Sholes, an American, who invented his machine primarily for numbering book pages in 1867. No one is quite sure why Sholes created the QWERTYUIOP keyboard array. In 1873, Sholes sold his device to the Remington Co., which, among other things, produced sewing machines. It is, therefore, not hard to understand why Remington's 1873 office machine looked very much like a hefty Remington sewing machine, complete with flowered sides and a foot treadle for carriage return.

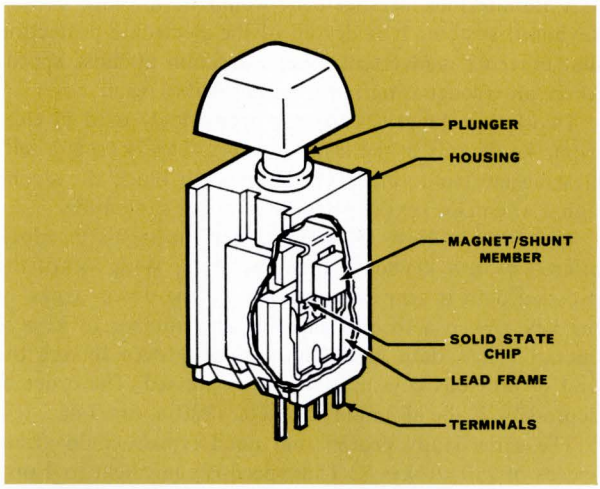
"Touch typing," which uses all 10 fingers, was invented by a man, Frank McGurrin, in the early 1880's. Even then, because so many people were already using the Sholes "standard array," it was easier to memorize the existing key layout than to convert to a more logical format. The same reasoning is applied today with an estimated 60 million Americans. The cost of conversion, in spite of the possible savings, has buried every attempt since Frank McGurrin won his first speed typing contest handily in 1888.

The manufacturers of electric typewriters solved one of the great keyboard problems—errors caused by "burst speed" typing. Burst speeds are easily attained when operators use both hands to type familiar digrams and trigrams such as "or," "the," "and," and the like. The operator can "type" so fast through touch typing procedures that one letter might be depressed before the preceding letter has been released, often producing erroneous output. The mechanical typewriters, reduced errors under these conditions by jamming the input arms. However, this jamming interfered with speed. The electric typewriter manufacturers solved the problem of burst speeds through electro-mechanical linkages and encoding bars with mechanical storage of characters.

The development pace in the electronic keyboard industry was much more rapid than that of the typewriter. In 1964, Micro Switch entered the keyboard industry with a mechanical encoding switch, which generated an 8-bit



This solid-state keyboard from Micro Switch combines MOS memory with n-key rollover technology. It provides an electronic shift lock, three operating modes, a lighted shift lock key, full 128 character set and ASCII coding.



A cutaway of the Hall-effect, solid-state key switch module shows the IC chip and its actuation by the magnets as the button is depressed.

code by means of eight mechanical switch contacts. Then in 1966, dry reed contacts offered a considerable improvement over the mechanical switches. Encoding for the dry reed contacts was generally accomplished via a diode matrix. Keyboard requirements soon became more sophisticated with the rapid advancement in semiconductor technology and the production of more complex data terminals. Reliability and cost per function became paramount. In 1968, the first practical solid-state keyboard was introduced, employing the long known, but little utilized Hall-effect principle.

Each key in the Hall-effect keyboard held an integral circuit (IC) chip, which was actuated by passing magnets around it when the key was depressed. With no moving parts, the 1968 solid-state keyboard offered an amazing life span. In 1969, MOS encoding was added to the Hall-effect keyboard. In 1970, "n-key rollover" was accomplished by feeding pulsed input from the Hall-effect IC chip to the MOS encoder memory. It had taken 60 years to go from Sholes to the electric typewriter. Mechanical switch contacts to n-key rollover took six!

Industrial design

Appearance, one of the major factors in any operator-oriented product, plays an obvious role in keyboards with the design of the key tops—better known as buttons. The variety of shapes, sizes, colors, legends and materials available may be somewhat unbelievable to someone not directly involved with the keyboard industry during the last two years.

The industrial design of the system plays a less obvious but more important role in the mechanical design of the keyboard and vice versa. The considerations here are keyboard structural rigidity, envelope size, weight, modularity and mounting.

Obviously, we are trying to say that keyboard selection should be considered in every design state during the industrial design of the system. Experience has shown that the keyboard, all too often, is not considered until the later stages of system development. The inevitable result is higher cost.

Operating characteristics

A recent study completed for Micro Switch by Honeywell's Systems and Research Division produced four principal conclusions about displacement and related keyboard operating characteristics of importance to designers:

☐ Efficiency in the use of electric keyboards is greatest if force and displacement are held within the following limits: 0.9 to 5.3 oz and 0.05 to 0.25 in., at the full travel of the keys.

☐ There is no advantage to having a snap or audible click in the keyboard operation.

☐ There is no difference in performance between stepped and sloped keyboards.

☐ Most typists who are already familiar with electric keyboards should be able to bring their throughput to normal standards on an electronic keyboard within 10 days, usually less. Throughput is defined as speed minus errors.

An interesting sidelight of numerous studies has been the long-argued value of contacting individual operators for their opinions about keyboards. The universal conclusions are that operators tended to favor their present machines over any changes, but that the adjustment to technological improvements was generally highly satisfactory if approached with proper psychology by managers.

Interlocks

The most expensive part of the data terminal keyboard operation is a input error. The error rate is a direct function of the interlock system built into the individual key-

board. These interlock systems range from a "no-interlock" arrangement through "2 key rollover" to "n-key roll-over."

A no-interlock arrangement would be a "bare bones" keyboard system. It is devoid of the electronic protection that prevents inadvertent 2-key operation at those speeds where an erroneous output would probably result.

Two-key rollover (2KRO) has been widely used in electronic keyboards in the last two years. The 2KRO is a self-clearing electronic interlock designed to block the strobe signal when two keys are depressed at the same time.

The n-key rollover (NKRO) is a new electronic interlock offered by few keyboard manufacturers. With NKRO, the encoded data is sent into memory on the down stroke of the key. When a second, third or any number of keys is operated, new data is sent into memory even though the first or previous keys may still be depressed. The order of depression is the all important item: first-in/first out.

The same study proved that good typists could attain speeds of 250 strokes/s! That speed is equivalent to 4 ms/stroke. The normal "burst speed" range had been assumed to be about 33 strokes/s. This was one reason why 2-key rollover resulted in a number of throughput errors. The operator was actually still holding the first key down when the third key of a trigram was depressed and the result was the skipping of the middle letter.

Switching principles

The single most significant component of an electronic keyboard is the key switch. The key switch is that element that converts mechanical motion into electronic energy. All the more exotic aspects of the keyboard may be perfect, but if the key fails to function or functions improperly, the keyboard is worthless.

Therefore, the designer's first concern is for the reliability of switching, and second, the marriage of the switch to its electrical interface. Picking a switch concept without regard to the associated electronics could result in higher costs and/or a marginal design.

There are two basic switching categories into which all electronic keyboards associated with data fit: mechanical contact switches, such as snap action basics, dry reeds, sliding or budding contacts; and solid-state devices, such as capacitance, inductance or cores, Hall-effect and photoelectric elements. With this variety to choose from, a complete test and evaluation program becomes expensive, if not prohibitive. At this point, a designer would be well advised to learn what potential vendors have to offer in the way of reliability data and field experience. Information obtained at this point could be of great assistance later on while evaluating electrical and environmental requirements and in reviewing quality assurance claims.

Reliability

The quality of a product is as integral to the design as its application. Our experience has demonstrated that the concept sells, but quality resells. Perhaps the best way to assure one's self of a quality product is to evaluate both the vendor and the design. Have you had previous experiences with the vendor? What reputation has the vendor earned in the marketplace? Will the vendor allow you to review quality-control procedures and in-process controls early in the program? Will you be permitted to witness production?

Basic design evaluations to substantiate design objectives and application needs should be performed by the keyboard supplier. These include keyboard performance under the expected environmental conditions of shock, vibration, temperature, humidity, radio frequency interference (rfi), corrosive atmospheres, and so forth. By outlining the above, we do not mean to suggest that the vendor should qualify each and every variation in keyboard array. The keyboard manufacturer's basic design evaluations should be all that is necessary to give a designer the confidence that is necessary.

It has already been observed that input error is the most expensive worry of data terminal keyboards. Input errors are not always generated by the operators. Electronic keyboards could generate a miss, especially if the switching device is a mechanical contact. Our definition of a "miss" is the failure of a switch to close and open once, and only once, for one complete cycle of the actuating member. Mechanical contacts, regardless of the packaging or operating mechanisms, can miss sporadically. No misses have ever been recorded with the Hall-effect switch. Facts are not available to us on the miss characteristics of other solid-state switching concepts.

Of nearly equal importance is the cost of a repair call. The two factors to consider are the actual costs of the service call and the less obvious cost of the system downtime. Service call estimates known to us range from $40 to $100 per visit. The obvious glow of the low initial cost may pale considerably in the glare of this simple arithmetic. Therefore, designers should face the facts that the keyboard should be able to meet the operating and service life of the terminal and, the reliability of all the components used in the keyboard, primarily the key switches, must be sufficient to meet the system requirements for servicing.

Conclusions

In the terminals market of the 70's, electronic keyboards are, and will continue to be, the primary means of data entry, information retrieval and information interchange. The single most important component in a keyboard is the key switch. The switch establishes the operator interface, which is all important for performance and throughput; and the basic reliability of the keyboard.

Electronic keyboards incorporate one of two principal switching methods: mechanical contacts and solid-state techniques. In our best judgment, the trend is toward solid-state applications because of increased reliability and overall lower costs.

Faced by the problems of reliability, interlock arrangements, encoding, quality, switching techniques, repair costs, on-line costs, essential features versus desirable features, it has been difficult to generalize the overall problem since each design problem presents unique requirements.

One can buy a keyboard for a data terminal today for under $100. One may also pay over $500 for a keyboard. Keyboard manufacturers offer general purpose off-the-shelf keyboards as well as many tailored to specific requirements. The purpose of this article has been to suggest a number of trade-offs, which will help the designer in his quest for the most suitable keyboard for his needs.

DATA COMMUNICATIONS PRODUCTS

PHOTOELECTRIC KEYBOARDS

The Series PK-200 uses photoelectric techniques to detect keyboard actuation. Operating life of the keys is 10^8 operations, and the lamps have a minimum life of 20,000 hours. Digitronics Corp., Albertson, N.Y. 11507.

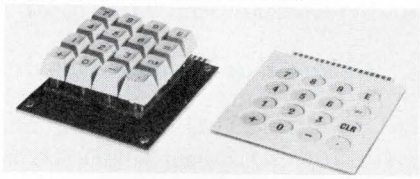
Circle Reader Service #275

TWO SPRING KEYBOARD

This line of keyboards uses the manufacturer's BI-PAC switch modules. These modules are about as simple as you can get; they consist of just two springs. The springs form two sets of parallel contacts, both of which are gold plated. Mechanical life of the contacts is greater than 50 million cycles, and bounce is less than 5 ms. Controls Research Corp., 2100 S. Fairview, Santa Ana, Calif. 92704.

Circle Reader Service #276

DIAPHRAGM KEYBOARD



Because of its unique mechanism, you can get these keyboards in standard configurations or with extremely low profiles. The switch itself uses a gold plated elastic diaphragm to contact a gold plated pad on a printed circuit card. Datanetics Corp., 18065 Euclid St., Fountain Valley, Calif. 92708.

Circle Reader Service #277

LSI/MOS KEYBOARD

Here's a unit that combines reed switch capsules with a MOS/LSI chip. Standard and custom codes are available as are a wide variety of enclosures. Clare Pendar Co., Box 785, Post Falls, Idaho 83854.

Circle Reader Service #278

MERCURY KEYBOARDS

These units have a mercury switching element that eliminates the need to compensate for contact bounce. Signal generation is accomplished by moving mercury in a sealed, flexible tube. Minimum life is spec'd at 25 million actuations. Mechanical Enterprises, Inc., 5249 Duke St., Alexandria, Virginia 22304.

Circle Reader Service #279

MAGNETIC CORE KEYBOARDS

The Series 550 keyboards use a magnetic core switching element to give you a completely electronic keyboard. The switch mechanism has a minimum life of 25 million operations. The keyboard comes with standard or custom coding and either single-, dual- or tri-mode configurations. Licon Division of Illinois Tool Works, 6615 West Irving Park Road, Chicago, Ill. 60634.

Circle Reader Service #280

REED SWITCH KEYBOARD

This series of keyboards uses a reed switch in combination with a "flying magnet" to provide a tactile feel closely resembling that of an electric typewriter. The keyboards are available in a variety of electrical and mechanical configurations to suit a broad range of requirements. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085.

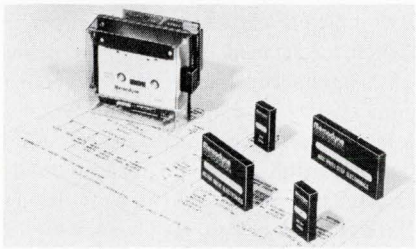
Circle Reader Service #281

DATA COMMUNICATIONS PRODUCTS

True incremental recorder carries a significantly lower price tag

Many approaches to the problem of incremental data recording use a continuous recorder and stop and start it after each byte or record. Because of the nature of the recorder, this means a finite gap between records on the tape which corresponds to the stop plus start times of the recorder. In an application such as key-to-tape systems, this approach leaves a great deal to be desired. Because of the varying data rates, you are faced with the tradeoff of adding buffer electronics (and cost) versus tape waste because of the start and stop gaps.

Memodyne Corp., a new company in the Boston area, has taken specific aim at this problem with the Model UIW-101, the first in its line of digital cassette recorders. The UIW-101 is a unidirectional, write-only unit which records digital data in a true incremental, bit-by-bit mode. It accepts serial, NRZI data at random rates from 0 to 300 b/s. The recorder uses a standard



Philips cassette and achieves a packing density of 120 b/in for a total of 432,000 bits (or 43,000 characters) on one cassette. Character error rate is less than 1 in 10^7.

An examination of the recorder quickly shows that someone at Memodyne spent a great deal of time on the problems of the OEM who might want to adapt the recorder to his equipment. The construction is modular, and you can arrange the mounting in enough configurations to suit just about any need. All the control and record electronics are packaged in dual-in-line compatible plastic packages and these packages are electrostatically shielded to minimize noise problems. Cassette loading is from the front and the entire front of the transport is protected by a clear plastic cover.

Two tracks are used to record, with data on one track and data complement on the other. To avoid synchronization problems, a 1 is written on both tracks at the end of each character (this replaces the stop bit in ASCII). During playback this sync bit is decoded to identify the end of each character, and allows resynchronization even if several bits of a character are lost.

Of as much interest as the technical details of the recorder, is its price tag. In single units, the complete recorder is $189. In OEM quantities, the price drops to $99. Memodyne Corp., 369 Elliot St., Newton Upper Falls, Mass. 02164.

Circle Reader Service #282

SYNCHRONIZED GENERATOR

Model 9390 is intended as a remote timing terminal capable of functioning with relative immunity to transmission system problems, system noise, dropouts or power failure. It is particularly suited to applications where duplication of a master timing center is required at a remote site. Datum, Inc., 170 East Liberty Ave., Anaheim, Calif. 92801.

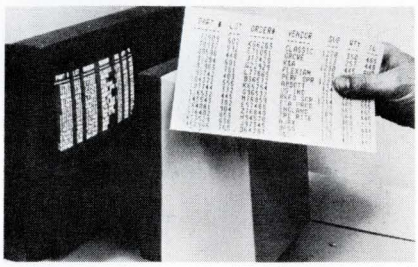
Circle Reader Service #283

MODEM TESTING

Sangamo Electric Co. has established a Data Test Center to allow their customers to test their communications systems under actual operating conditions. By dialing the special numbers, you can test the entire communications or is the heart of the system and can scan-type CRT terminals and facsimile. and Canada. Sangamo Electric Co., Box 3347, Springfield, Ill. 62708.

Circle Reader Service #284

CRT COPIER



The Model 9750 will give you hard paper copies of a CRT display. Cost per copy is less than two cents each. Copying speed is 12 s for the first reproduction, and 8 s for each additional copy. The standard unit comes with a 9-in. CRT monitor, but the copier is also available without the monitor. A. B. Dick Co., Videograph Operations, 5700 W. Touhy Ave., Chicago, Ill. 60648.

Circle Reader Service #285

LOWER TERMINAL RENTAL

Hazeltine Corp. announces a reduction in the rental price of the "Hazeltine 2000" CRT terminal from $108 per month to $88 per month effective August 1, 1971. The new price includes maintenance. Hazeltine Corp., Greenlawn, N.Y. 11740.

Circle Reader Service #286

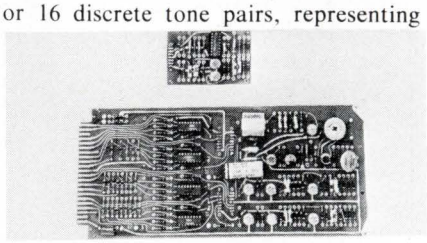
THERMAL TELETYPEWRITER

The NCR 260 is about half the size of a conventional teletypewriter and requires no ribbon or ink. Instead, this unit uses a matrix-type printhead consisting of 35 small heat sources which prints up to 300 words/min on heat sensitive paper. The National Cash Register Co., Dayton, Ohio 45409.

Circle Reader Service #287

TONE RECEIVER/DECODER

The Model QTTR-20 can convert 12 or 16 discrete tone pairs, representing



each telephone push-button digit, into a corresponding level output on 12 or 16 lines. You can select BCD or some other output coding, and the unit can provide unique digit format decoding to perform a variety of control functions. Quindar Electronics, Inc., 60 Fadem Road, Springfield, N.J. 07081.

Circle Reader Service #288

one second wrap-up

(with no waste of binding material)

Now you can zip thru cable binding jobs at machine gun speeds. New Gardner-Denver air tool wraps, tensions, locks, and cuts off tape on one squeeze of trigger. Gives you a neat, secure tie in one second flat.

New cable binding tool automatically adjusts to size of bundle, up to a maximum diameter of 1″. Desired tension can be pre-set. Special nylon tape is fed thru back of tool from a continuous roll. Tape is extremely durable. Resists corrosion, shock, and temperature changes. Nylon closures are magazine loaded.

You automatically eliminate material waste since each tie is tailored to the bundle diameter. You stock only one size tape and closure. Tool is easy to operate, too. Weighs only 4½ lbs. Measures a compact 14½″ x 7¾″. Air consumption is 5 cfm at 80 psi. Get a full demonstration today from your Gardner-Denver sales engineer or write us.

GARDNER-DENVER
Gardner-Denver Company, Quincy, Illinois 62301

DATA COMMUNICATIONS PRODUCTS

Terminal produces hard copy from CRT display

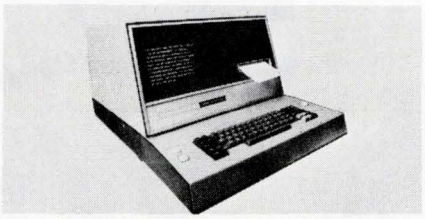
Two new data terminals combine keyboard entry, 2400-baud operation, and a CRT display with the convenience of a paper copy.

Upon command from either the operator or a remote computer, Models 40 and 44 produce a 4.5-x-5-in. copy of the CRT display. The first copy takes five seconds; additional copies (same or different displays) take only two seconds each.

The difference between the terminals is in the display. Model 40 has a 25-line display, with each line having up to 40, 0.125-x-0.150-in. characters. Model 44 produces 12 lines of up to 80 characters each, character size is 0.075 x 0.140 in.

The CRT display on both models has a 9-in. diagonal, and uses 5-x-7 dot matrices to form the characters.

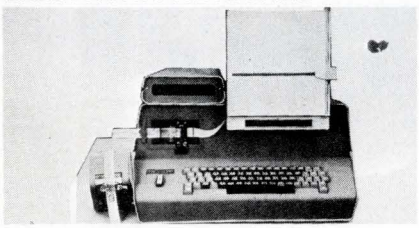
What makes these hard-copy, CRT terminals possible is a company-proprietary process called Quantafax™. This is a high-speed, electro-photographic process that uses a large, uniform, photoconductive sheet to produce high-resolution—10 line pairs/mm—copies on a bond-like paper. The 4.5-x-5-in. copies cost less than a penny each, are archival, and the paper accepts notations in pen or pencil.



Model 40 and Model 44 can replace IBM's 2260/2848 and 2265/2845 display terminals and controllers, and use RS232B (or C) interfaces. Price ranges from under $6600 to $8900, depending on quantity. Leases are available. Photophysics, Inc., 1601 Stierlin Rd., Mountain View, Calif. 94040. (415) 969-9500.

Circle Reader Service #289

ELECTRONIC KEYBOARD



The Electro/Set 450 Editor is designed for speed and economy in making corrections and then producing a clean tape for high speed computerized equipment. The unit includes a floating display which offers 128 different symbols. Fairchild Graphic Equipment Division, 221 Fairchild Ave., Plainview, N.Y. 11803.

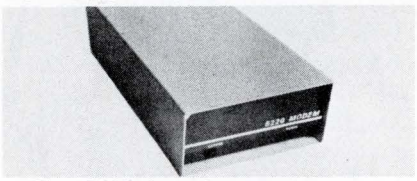
Circle Reader Service #290

PROCESSING SYSTEMS

These systems feature a series of building block modules including a micro-processor, video displays, cassette tapes, printers, card readers, disc drives and other hardware. The micro-processor is the heart of the s system and can be programmed for unlimited applications. Sanders Associates, Inc., Daniel Webster Highway, South, Nashua, N.H. 03060.

Circle Reader Service #291

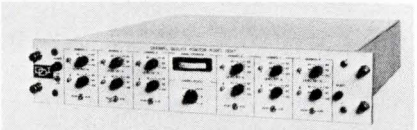
LOW COST MODEM



The 5220 is a low-cost, compact, originate or answer-only modem. It includes power supply and indicating lights for power and carrier detect when supplied. The unit is compatible with the Bell 101, 103, and 113 Series. It will operate full-duplex at speeds up to 300 b/s, is strappable for half-duplex and will interface with Bell couplers. RFL Industries, Inc., Boonton, N.J. 07005.

Circle Reader Service #292

CHANNEL QUALITY MONITOR



The Model 19017 lets you determine signal quality without interrupting service by breaking into a transmission line. It provides direct, on-line indication of data transmission quality over standard phase-shift modems. Digital Devices, Inc., 12 Spielman Rd., Fairfield, N.J.

Circle Reader Service #293

SAMPLES

Stabistors

That's the name for these custom engineered voltage stabilizing diodes. They range from 0.5 to 5.6 V and are packaged in glass-to-metal, hermetically sealed DO-35 cases. The characteristics of these diodes will be tailored to meet your exact requirements. Ask for free samples and complete engineering data. American Power Devices Inc., 7 Andover St., Andover, Mass. 01810.

Circle Reader Service #294

Capacitors

Here's a variety of capacitors to choose from—aluminum electrolytic and metallized mylar. Some are "wrapped and filled" axial lead capacitors; some feature radial construction, and others, axial construction with high temperature thermo-set resin. There's a lot to choose from, so send for samples and choose the one best suited to your application. Illinois Capacitor Sales Co., Dept. EE, Box 352, Highland Park, Ill. 60035.

Circle Reader Service #295

Quick-connect barrier strip

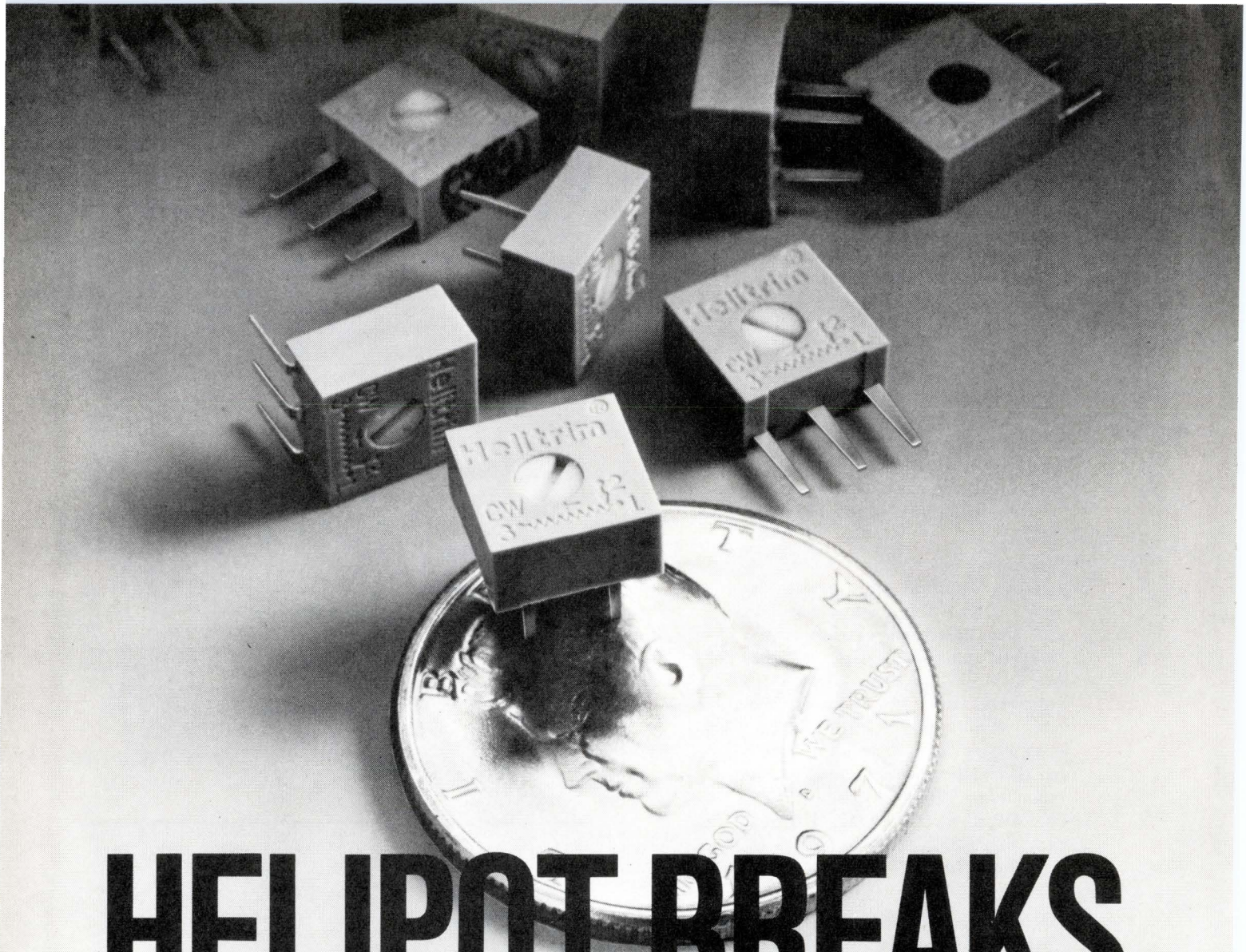
These samples will illustrate the quick-connection option that goes with the Magstrip line, allowing 0.25 in. wide solderless connections to be made on both the top and the bottom of a barrier strip. Featuring feedthru insulator bases, they mount directly to the chassis through slotted or drilled holes. Samples, prices, and specs are offered to you by Magnum Electric Corp., 1000 Streetman, Erie, Mich. 48133.

Circle Reader Service #296

Epoxy molding compound

Recommended for thin-wall applications is this rigid molding compound that provides full hardness on ejection and results in easy demolding. It is a mineral-filled, soft flow, glass-reinforced epoxy molding compound with exceptional early hot strength, low shrinkage, and fast cure. It achieves a heat distortion of 350°F with as little as a three minute cure, and with no post curing necessary. And the low shrinkage means outstanding dimensional stability in molded parts. Epoxy Products Co., Div. of Allied Products Corp., 166 Chapel St., New Haven, Conn. 06513.

Circle Reader Service #297



HELIPOT BREAKS THE HALF-BUCK BARRIER.

Here they are: the best buys. Our new Series 72 single-turn ⅜" cermet trimmers at an eye-opening 49¢ each in the 1,000 quantity. They're equally well-priced in other quantities, too. One alone costs just 70¢.

But there's also that dependable Helipot quality and performance, plus things you don't get elsewhere. Like our resistance and slider stability . . . change is less than 0.5% in the first 1,000 operation hours, progressively less thereafter. Impressive, when the life expectancy exceeds five years' continuous duty under full-rated power. And the Series 72 sealing — compatible with wave soldering, low-viscosity potting, and board washing even with chlorinated solvents.

Add the wide range of values, ±100 ppm/°C tempco, and off-the-shelf availability from 17 nationwide stocking points and what have you got? The best reasons in the world for requesting complete specs and data on this breakthrough line of Helipot cermet trimmers. Do it now — it won't cost you a cent.

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HELPING SCIENCE AND INDUSTRY IMPROVE THE QUALITY OF LIFE.

Circle Reader Service #33

IC IDEAS

THIS MONTH'S IDEAS **PAGE**

VOTE for the one you like best
Write the number of the Idea you like best in the box on the inquiry card and send it to us.

SEND us practical, reproducible ideas that are original with you and have been implemented with linear or digital ICs.
If we publish your idea, you win a check for $25.00.
If our readers vote yours the best of the issue in which it appears, you have your choice of a Simpson 270 or Triplett 602 multitester.
After 12 issues, our readers will vote on the best idea for all 12 issues.
The winner gets his choice of either a Hewlett-Packard 1206A or a Tektronix 5103N oscilloscope.

Submit your IC Ideas to:
Alberto Socolovsky, Editor
THE ELECTRONIC ENGINEER
Chestnut & 56th Sts.
Philadelphia, Pa. 19139

HOW YOU VOTED

The winning Idea for the April 1971 issue is "Simple digital PLL synchronizes clock signals."
Our prize-winning author is Mr. Charles A. Herbst. Mr. Herbst, who is a consulting engineer, is presently on assignment in the Democratic Republic of the Congo., for Bell-Congo.
For his prize, Mr. Herbst has selected the Triplett 602.

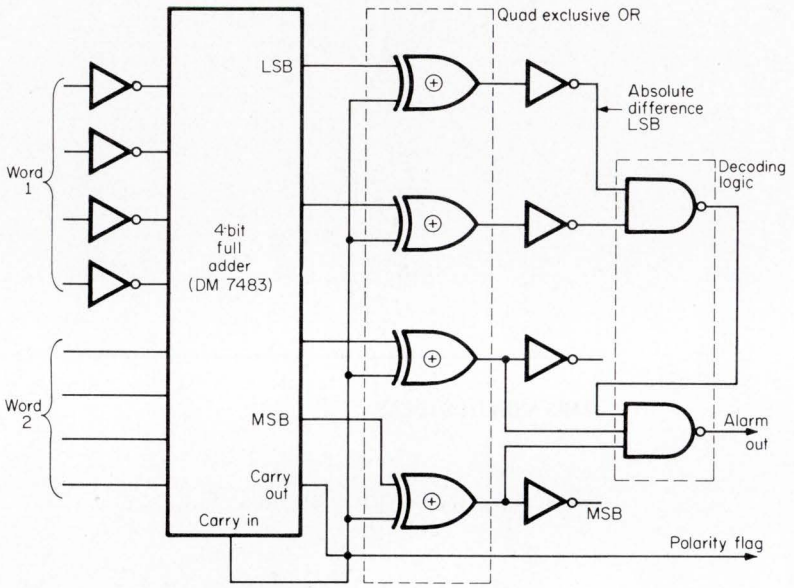
IC IDEAS

Check parity of noisy signals

Roy W. Lewallen, Colorado Video, Inc., Boulder, Colo.

When you compare two binary words which are derived from analog data, least significant bit dither and system noise sometimes prevents the use of a standard parity checker.

You can still make the comparison digitally however by using an absolute-value subtracter. This circuit will produce the absolute difference between the words, and the decoding logic may be wired or programmed to ignore small errors. The decoding logic shown will give a 1 only when the absolute difference between the input words exceeds two least significant digits, thereby ignoring LSB dither but detecting larger errors. If desired, the polarity flag can be used to indicate which of the input words is larger.



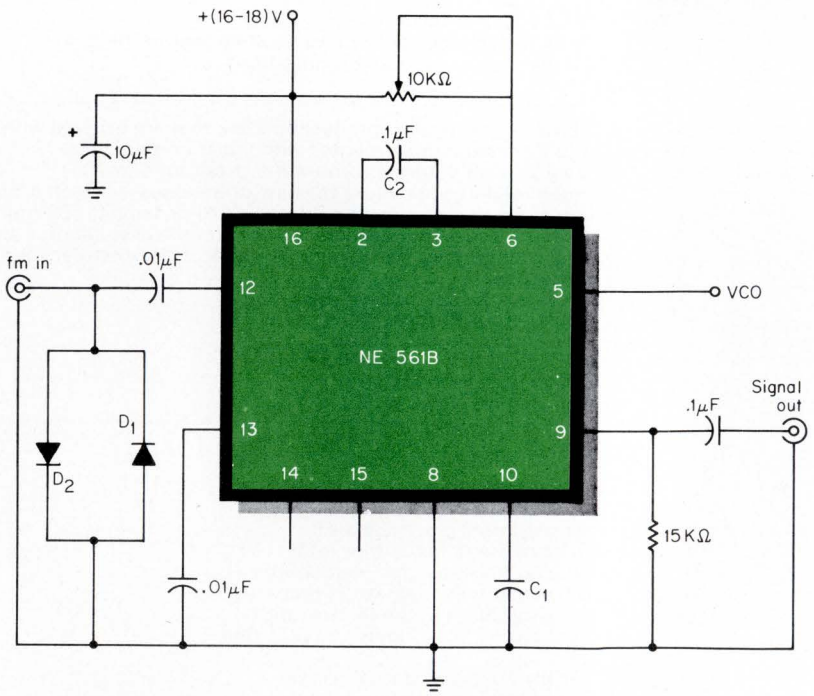
To vote for this IC Idea, circle 992 on the Reader Service Card.

FM demodulator

Robert L. Wilbur, Southwest Research Institute, San Antonio, Texas

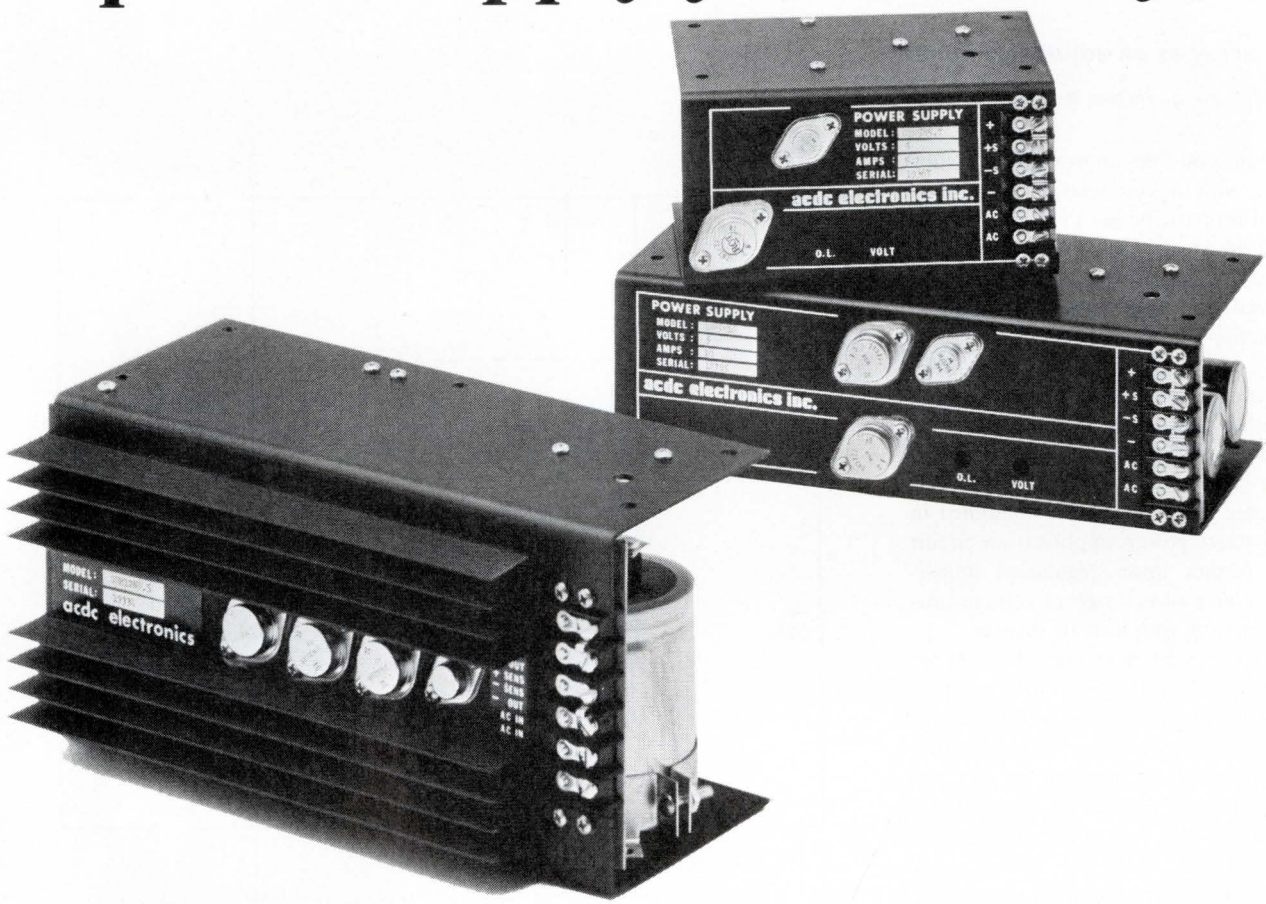
Here is a useful and highly accurate circuit for demodulating fm conditioned signals, particularly physiological signals such as temperature, pressure, ECG, etc. The circuit uses a NE561B phase locked loop (PLL), and a few resistors and capacitors. With the proper choice of external components, the PLL is useful from dc to greater than 15 MHz without tuned circuits.

The voltage controlled oscillator in the unit is set at the transmitter SCO quiescient frequency by C_2 and the potentiometer. The circuit will then capture signals up to deviations of ± 20% of the VCO frequency. Pins 14 and 15 can be used for loop low pass filtering if necessary and C_1 provides low pass rolloff for fm audio signals. Diodes D_1 and D_2 provide input amplitude protection to allow use with a range of receivers and recorders.



To vote for this IC Idea, circle 993 on the Reader Service Card.

Our new OEM series is the best power supply you can buy for applications that don't need the best power supply you can buy.



Most OEM applications don't need all the special features we build into our best line of power supplies. And most OEM power supply users just won't pay for features they don't need. That's why we've introduced a new power supply designed especially for the OEM user.

We call it our OEM Series power supply.

There are now 89 models in this new series from 4 to 32 volts and in current ranges from 0.9 to 36 amps. There are also ±12 and ±15 volt dual output models, with current ranges up to 2.7 amps. The OEM series offers 0.1% regulation instead of our usual 0.01% and comes with open frame construction instead of our usual closed black box. Aside from that, you might never notice any other difference. The OEM series features the same excellent stability, same dependable overload protection, same versatile mounting capability, same "guaranteed forever" performance and same off-the-shelf delivery. The only conspicuous difference is in the price.

So now, when you don't need the best power supply that we sell, we can sell you the best power supply that you need.

acdc electronics inc.

Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880

IC IDEAS

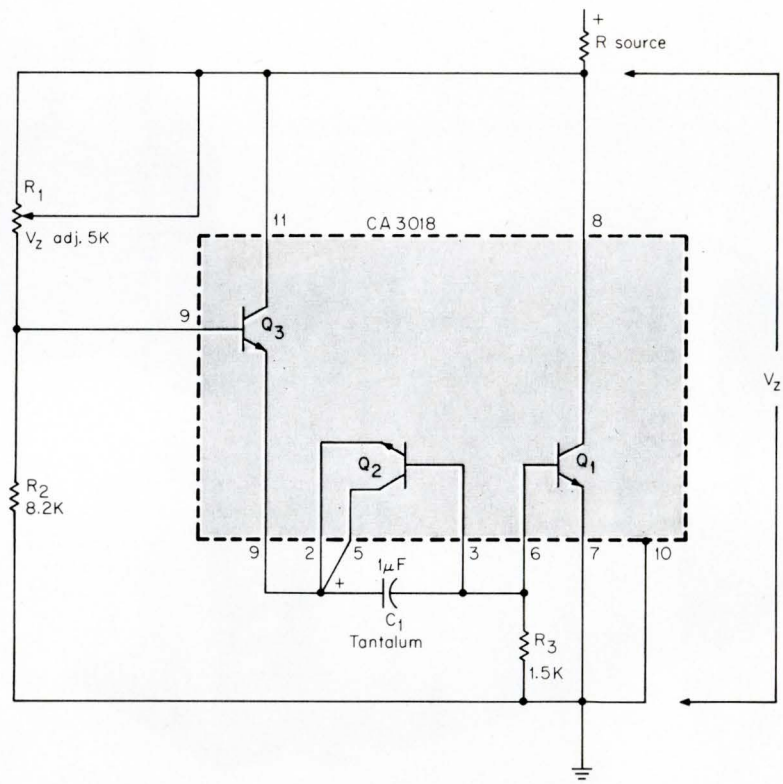
IC array as an adjustable Zener

Walter Jung, AAI Corp., Baltimore, Md.

While you can approximate a voltage with a combination of Zeners and forward biased diodes, you cannot do it with millivolt resolution. In addition, it is difficult to maintain a specific TC with physically separated junctions.

You can achieve very low temperature coefficients by using monolithic transistors is a compensated Zener configuration. Additionally, the same junctions being used as reference junctions can be combined in an active power amplification circuit to further lower regulation impedance and allow external voltage programming with a single resistor.

The circuit here uses this "Zener with a knob" principle with a CA3018 IC array. The E-B junction of Q_2 is used as a Zener with offsetting compensation supplied by the B-E junctions of Q_1 and Q_3. Resistor R_3 and Q_3's V_{be} set the Zener current at 500 μA.



At the base of Q_3, the circuit will exhibit an 8.4 V threshold; the point where Q_1-Q_3 simultaneously begin conduction. Further voltage increase at the base of Q_3 causes rapid current rise in Q_1. Since this collector current is of the proper sense to counteract the original change, it tends to maintain the base voltage of Q_3 constant. With the threshold of Q_3 constant at 8.4 V, a reference current in the R_1-R_2 sensing network can be established by R_2. Thus R_1 can program the terminal voltage across the IC, allowing regulation at any voltage from 8.4 V up to the maximum rating of the IC.

The circuit shown was tested with a 680 Ω source resistance at current levels from 0-40 mA and R_1 set for a 10 volt V_z. Equivalent Zener impedance measured 10 Ω. Capacitor C_1 reduces the Zener noise of Q_2 to below 1 mV pk-pk.

The circuit should prove useful where simple and predictable setting of regulation voltage is required. Even if the programmable feature is not needed, it may prove a good choice because of the low regulation impedance and low TC performance at a very economical price.

To vote for this IC Idea, circle 994 on the Reader Service Card.

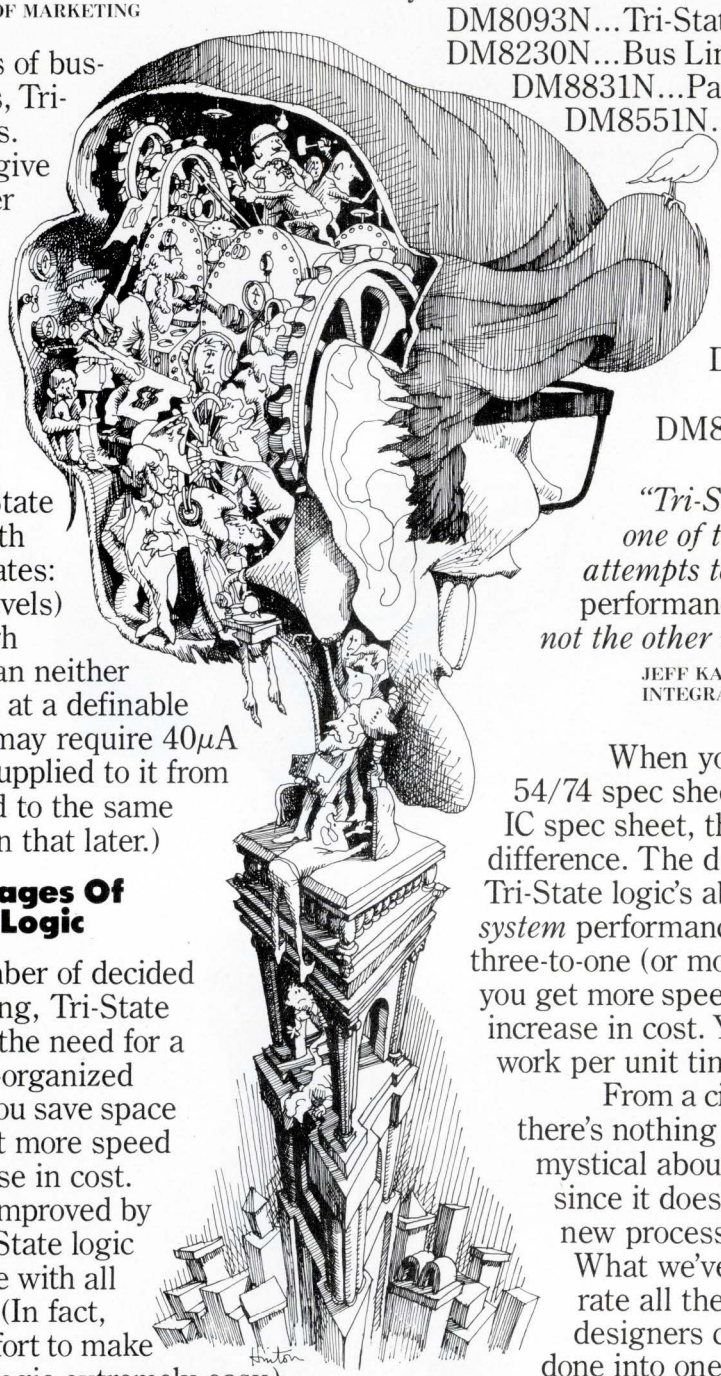
National presents the Tri-State-of-the-art.

(A timely, information-filled discussion of the National Tri-State logic scene featuring systems design input by Jeff Kalb and systems applications data by Dale Mrazek with introductory notes by Floyd Kvamme.)*

*Tri-State is a Trademark of National Semiconductor Corporation

"The first DTL devices were designed with passive pull-up. Then, to improve speed, you went to an active pull-up which caused havoc with the bus OR'able system. So, the next step in evolution was to use an uncommitted collector output.

Tri-State logic, then, is the next step beyond that.". FLOYD KVAMME, DIRECTOR OF MARKETING



To the designers of bus-organized data systems, Tri-State logic is good news. Tri-State logic devices give you all the speed, power and noise immunity of TTL plus the ability to interconnect outputs of similar devices to a common bus line.

Three States, Explained

Basically, a Tri-State IC is a logic element with three distinct output states: "0", "1" (normal TTL levels) and OFF which is a high impedance state that can neither sink nor source current at a definable logic level. (At most, it may require 40μA leakage current to be supplied to it from other devices connected to the same output line. But more on that later.)

The Advantages Of Tri-State Logic

There are a number of decided advantages. For one thing, Tri-State logic totally eliminates the need for a pullup resistor in a bus-organized system. Which means you save space and money. You also get more speed with no effective increase in cost. Noise susceptibility is improved by a factor of 10. And Tri-State logic is completely compatible with all existing 54/74 devices. (In fact, we've made a special effort to make conversion to Tri-State logic extremely easy.)

Tri-State Logic Is, At This Very Moment, Being Second-Sourced

Happily, other companies have jumped onto the Tri-State logic bandwagon. Which is good news for you. And good news for us, since it's always nice to be followed.

Speaking of second-sourcing, it would be well to list *our* devices so you can see what all the others are copying.

Right now, we have eight Tri-State logic devices. All available off-the-shelf. They are as follows:

DM8093N...Tri-State Quad Buffer
DM8230N...Bus Line Demultiplexer
DM8831N...Party Line Driver
DM8551N...Quad-D Flip Flop
DM8094N... Tri-State Quad Buffer
DM8214N... Dual 4-Line-to-1-Line Multiplexer
DM8598N...256-Bit Expandable ROM
DM8599N...64-Bit RAM

"Tri-State logic is really one of the very first attempts to relate systems performance *to circuit design, not the other way around."*.

JEFF KALB, DIRECTOR OF DIGITAL INTEGRATED CIRCUITS

When you compare a 54/74 spec sheet to a Tri-State IC spec sheet, there's really little difference. The difference lies in Tri-State logic's ability to improve *system* performance by a ratio of three-to-one (or more). In the end, you get more speed with no effective increase in cost. You also get more work per unit time.

From a circuit standpoint, there's nothing spectacular or mystical about Tri-State logic since it doesn't require any new processing techniques. What we've done is incorporate all the things that designers can do and have done into one overall *systems oriented* concept. A refinement of existing techniques specifically aimed at solving the problems of bus-organized data systems.

How It's Done

Actually, the concept of creating a

Tri-State TTL device is relatively simple. We've just provided a means of removing the drive current from the totem-pole output of the TTL device. The output then resembles two semiconductor junctions biased in the non-conducting or high impedance state. The only load they offer to the common bus line is the junction leakage which must be provided by the output of the device that's driving the bus line.

In addition, the inputs of many Tri-State circuits also disable and, in doing so, load the driver with only leakage current. In effect, this makes both output bussing and fan-out into other inputs virtually unlimited.

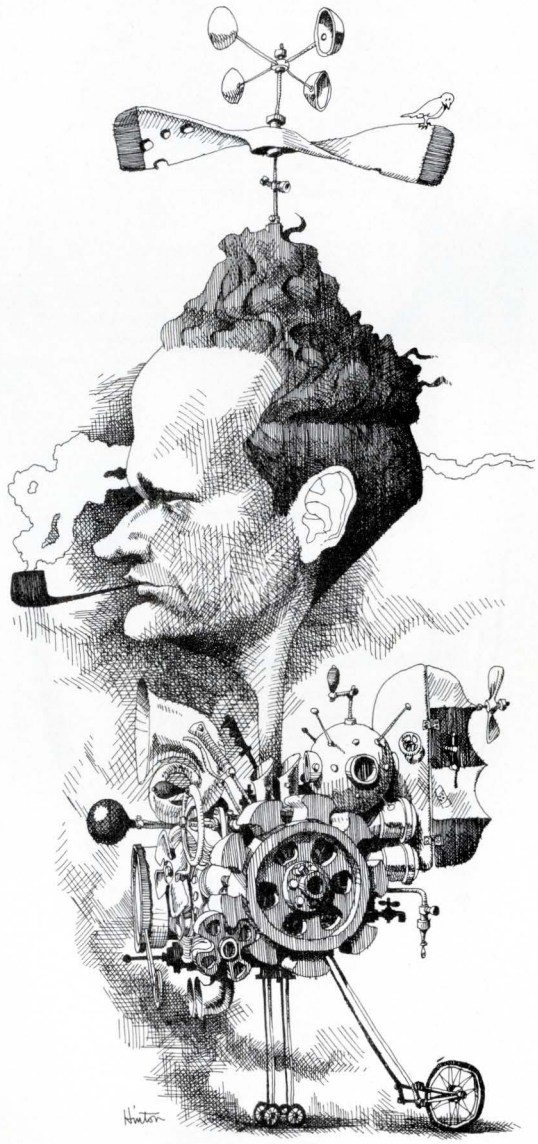
Thus, all Tri-State logic elements have been designed with a Darlington-connected power stage to provide a source current of at least 5.2mA in the logic "1" state (13 times the TTL norm of 400μA!). The lower output transistor sinks the 16mA normally required for a fan-out of 10 in the "0" state.

Some Interesting Calculations

A source current of 5.2mA in the enabled "1" state means that at least 128 Tri-State outputs can be bus-connected. If one output drives while 127 other outputs on the same line are inhibited, the maximum leakage current to be sourced is 127 x 40μA – 5.08mA. Which means at least three TTL loads can be driven with the minimum of 120μA remaining.

Another Tri-State logic benefit is that lines longer than 10 feet can be driven reliably, while standard TTL can drive only 10 to 12 *inches* of line before noise immunity becomes a problem. The higher power of the Tri-State IC output also improves "1" level noise immunity by a factor of 10.

Finally, one of the unique things about the Tri-State logic gating system is that it runs *in parallel* with the existing logic functions. It doesn't slow down the logic function itself while it's operating, it just provides a means of turning it off—in parallel. So, you're not adding any time to the system, you're really adding a control.



"One of the functions of Tri-State logic (as we were designing it) was to make any previously-designed MSI elements bus-structurable"..

DALE MRAZEK, DIGITAL APPLICATIONS MANAGER

Reduced to its most basic and flexible form, a Tri-State IC output is a special kind of gate. And so, the most universal Tri-State devices we've designed to date are the DM8093 and DM8094 Quad Buffers. With these buffers, any other TTL-compatible device or MSI module can be given Tri-State input or output characteristics. Using Tri-State Buffers, many logic circuits can be saved. For example, in Fig. 1, they operate in pairs on a single control line to perform the two-wide multiplex function so commonly needed in logic design. A comparison of this design with a standard design will show that an inverter and four 2-input NOR gates are saved in just this one subassembly. And, the subassembly can be expanded modularly.

More Nice Things You Can Do With Tri-State Logic

There are, obviously, many different

bus-structured systems applications using Tri-State devices. Some are relatively simple, others very complex. On this page we've diagrammed some typical applications. Each contains a Tri-State device or a series of Tri-State devices. All improve overall system performance substantially in addition to reducing the physical number of elements required.

Future Tri-State

Our eight Tri-State devices are just the beginning of a logic family which will continue to expand at a rapid rate.

And as we expand our line of devices, we are looking at each new function *not* from the standpoint of "Is this a nice function?"; but, rather, how does it fit into the system to make the system work better.

As a result, there are a variety of RAMs, ROMs, Low Power TTL devices and more systems-related MSI functions, on our drawingboards.

Very soon, too, we will offer Tri-State logic devices which feature common I/O, which will give even more performance in an already small package.

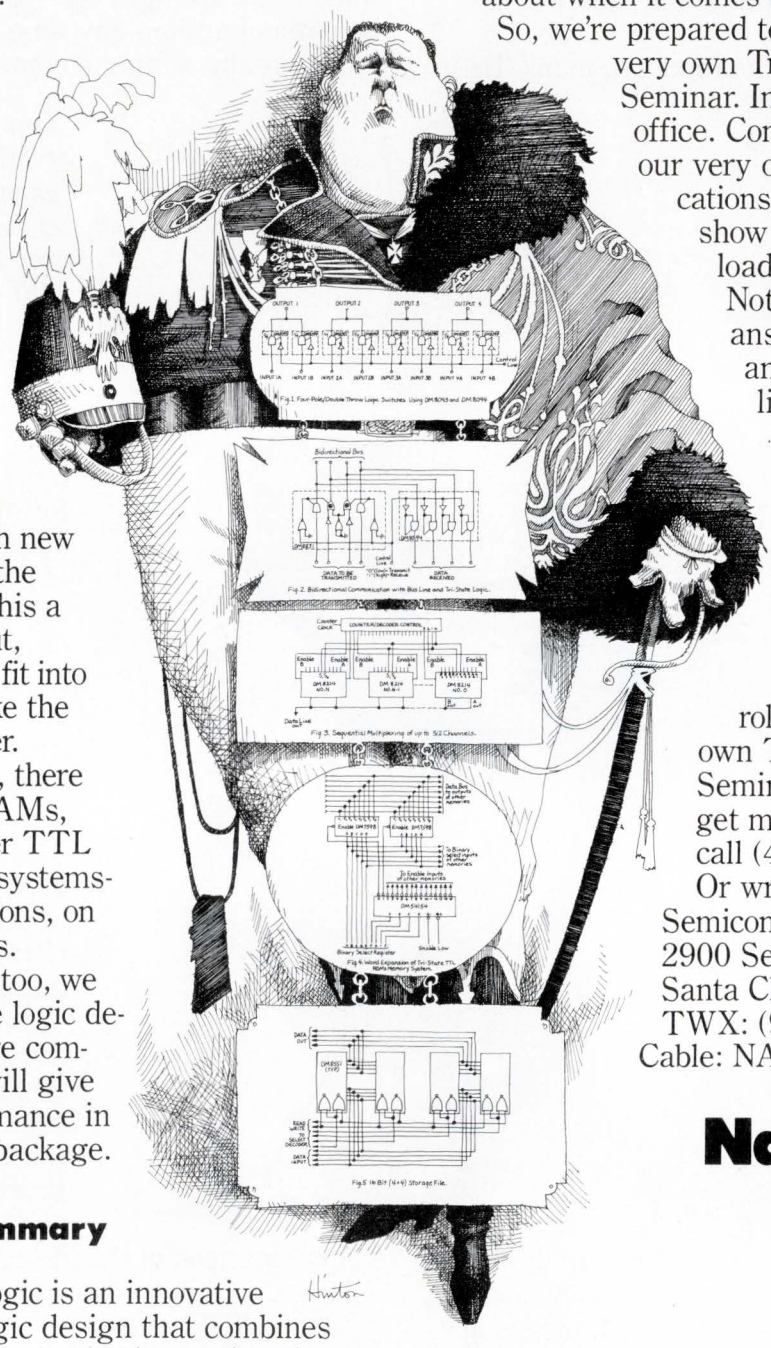
A Summary

Tri-State logic is an innovative new concept in logic design that combines the speed, power and noise immunity of TTL with the wire-OR'able flexibility required for real-life bus systems.

But even more importantly, Tri-State logic is a *systems-oriented* concept that not only simplifies the design and construction of bus-organized systems, but improves overall system performance by a factor of three-to-one.

How To Get Your Very Own Tri-State Logic Seminar

Obviously, there's a lot more to talk about when it comes to Tri-State logic. So, we're prepared to offer you your very own Tri-State Logic Seminar. In your very own office. Conducted by one of our very own Field Applications Engineers who'll show up with an armload of Applications Notes and a headful of answers to just about any question you're likely to come up with.



Our Operators Are Standing By For Your Calls

To get the ball rolling on your very own Tri-State Logic Seminar, or simply get more information, call (408) 732-5000. Or write National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, Calif. 95051. TWX: (910) 339-9240. Cable: NATSEMICON.

National

NEW PRODUCTS

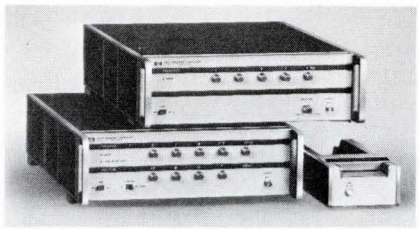
New frequency synthesizers offer high performance *and* low price

Frequency synthesizers find most of their application in radar and communication systems and other areas which require signals of high spectral purity. Traditionally, the user has been forced to tradeoff the better performance and higher cost of direct synthesizers versus the less attractive specs and lower prices of the indirect units. Well, all of a sudden indirect synthesizers are under siege in their own domain—low cost. And the attack is coming from, not one, but two directions, Hewlett-Packard Co. and Rockland Systems Corp.

The new offerings from HP are the Model 3320A and the Model 3320B. Both cover from 0.01 Hz to 13 MHz in seven ranges with two optional low ranges, 100 Hz and 10 Hz. Resolution is one part in 10^5 across the entire range.

Naturally enough, the spectral purity is of prime concern in any synthesizer and these new instruments are no slouches in this department. Harmonic content ranges from -60 to -40 dB depending on the frequency, and spurious content is more than 60 dB down.

The two models differ in that the B version has precision amplitude control, plus a remote amplitude programming capability. With the B model, you get



Circle Reader Service #298

± 0.05 dB from 10 Hz to 13 MHz while the 3320A offers ± 2 dB over the entire range. Base prices for the two units are $1900 for the 3320A and $2400 for the 3320B.

The other significant new synthesizer is from Rockland Systems, who up to now have been known for their solid background in digital filters (see **The Electronic Engineer,** October 1970, p. 68). This experience is very apparent in their latest product, the Model 5100 frequency synthesizer.

The 5100, like HP's new instruments, uses direct method synthesis, however, Rockland considers their technique as proprietary information. It requires no mixing or phase locking and provides very fast switching with no transients to worry about. They will reveal that they generate the signal digitally, perform the necessary functions on it, and then convert it to an analog output.

Circle Reader Service #299

If the 5100 has a shortcoming, it is the relatively narrow frequency range of 0.001 Hz to 2 MHz. If your application doesn't require anything higher than that, then the rest of the 5100's specs should prove very interesting.

Resolution is 0.001 Hz over the entire operating range, and you get less than 60 dB harmonic distortion and less than 70 dB spurious distortion in the output. The amplitude of the output is 10 V pk-pk max., and it's stable, ± 0.25 dB, over the frequency and temperature ranges. Prices for the 5100 start at $2450.

For more information, use the Reader Service Numbers provided.

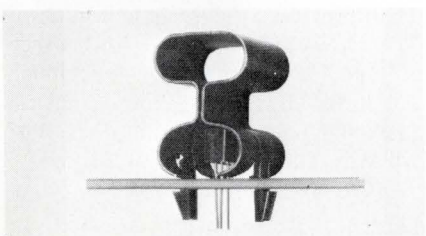
Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif.

Circle Reader Service #298

Rockland Systems Corp., 131 Erie St., Blauvelt, N.Y. 10913.

Circle Reader Service #299

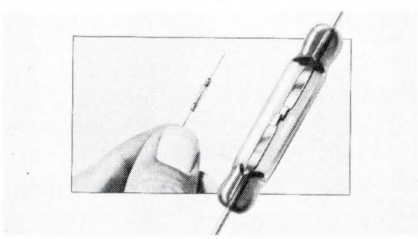
CIRCUIT CARD HEAT SINK



Three sizes of snap-in heat sinks cool and mechanically support plastic transistors on 1/16 to 3/32 in. thick cards. Types 293-3 and -2 may be used with two transistors side-by-side when common collectors are permitted. Wakefield Engineering, Inc., Audubon Rd., Wakefield, Mass. 01880.

Circle Reader Service #300

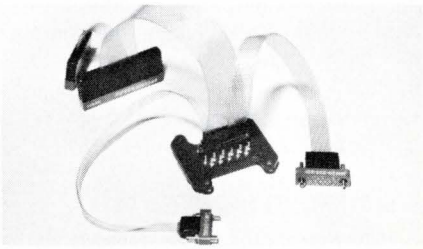
REED SWITCH



The RI-20 is for use by manufacturers of relays, keyboards and control systems. Failure rate is $<10^{-9}$ over more than ten million RI-20 operations at MOS and TTL load levels. Contact resistance is a max. of 500 mΩ. 20¢ or less in lots of 100,000. Amperex Electronic Corp., Hicksville, N.Y. 11802.

Circle Reader Service #301

FLAT RIBBON CABLE

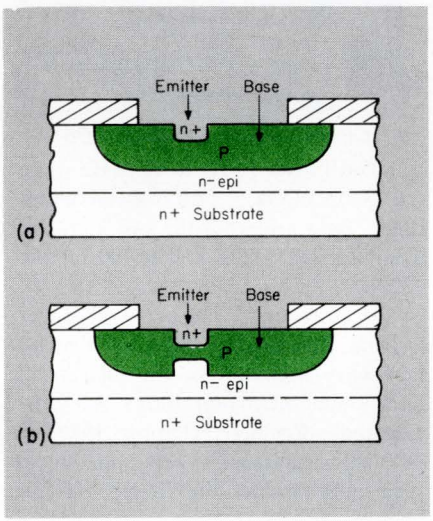


Hyper-Flex multi-conductor ribbon cables are specially molded with silicone rubber insulation. Flexibility of as many as 45 conductors per inch is assured even under operating temperatures as low as -100°F and as high as $+500$°F. Tri-Tech Electronic Corp., Orlando, Fla.

Circle Reader Service #302

New phototransistor reads or drives

Although the STPT 260, a 60 x 60 mil phototransistor, was developed to replace the standard 25 x 25 mil or 40 x 40 mil chips used in IBM System III card readers, it has much wider uses, as in relay or switching applications. The System III uses 96-column cards with 45-mil diameter round holes. Since the card and punch can misregister by as much as half of the hole's diameter, some holes are not sensed by standard sized chips. In addition, tolerances in chip package placement add to the problem. However, the new 60 x 60 mil size easily compensates for all misregistrations.



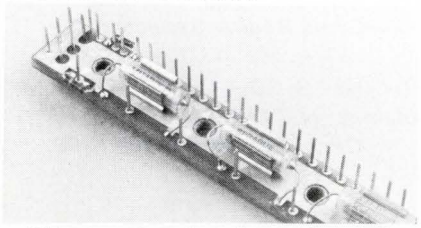
Processing is the key to satisfactory yields of large area Quantistor phototransistors. Normal processing (a.) creates a planar structure with properties that depend heavily on the proper doping level in the emitter-base region to produce good injection efficiency. Sensor Technology controls doping of the emitter-base region and the rest of the base independently (b.). Relatively light doping can be maintained in the emitter-base region, while high doping is used elsewhere. Characteristics such as drift field gradient, doping level, depth, blocking voltage, and sensitivity can be controlled.

It takes about 1.6 mA at 0.4 V to work into a TTL load in a logic or switching circuit application. The STPT 260 can power about four TTL devices at an illumination of 1 mW/cm^2. The STPT 260 can be mounted in moderate density arrays or as a single device.

The high output version of the STPT 260, known as the Quantistor^{PP}, can be used directly as a photoelectric relay or for optoelectronic switching of power SCRs. In a hermetically sealed TO-5 can with a lens, the Quantistor has a 70 mA output at an irradiance of 5 mW/cm^2 (100 ft-candle) or 11 mA at 1 mW/cm^2 (20 ft-candle). Switching time remains in the 6-11 μs range. Low collector-emitter bias permits operation with 5-15 V power supplies. Maximum power dissipation is 600 mW at 25°C ambient. STPT 260 prices range from $5.00 to $1.00. Sensor Technology, 7118 Gerald Ave., Van Nuys, Calif. 91406.

Circle Reader Service #303

DISTRIBUTION BAR



This bus bar has four 13Ω timing pulse distribution paths in addition to a ground and three voltage distribution lines. Less than 1 in. wide, it is 17 in. long. Capitron Div., of AMP Inc., Elizabethtown, Pa. 17022.

Circle Reader Service #304

CERAMIC RESONATOR

The Piezonator solves the selectivity problem of video i-f response in color TV receivers. Replacing the present day tuned i-f transformer and trap coils, it occupies less space and needs no adjustments. It operates in the vhf region (30-200 MHz). Matsushita Electric Corp. of America, 200 Park Ave., N.Y., N.Y. 10017.

Circle Reader Service #305

PANEL ADAPTER FOR LED'S

This panel mount adapter is for the company's FLV100, FLV101, and FLV102 light emitting diodes. Designated FVC001, it may be used for panel thicknesses ranging from 0.03 to 0.25 in. 10c (100 to 999). Fairchild Camera & Instrument Corp., MOD, 3500 Deer Creek Rd., Palo Alto, Calif. 94304.

Circle Reader Service #306

TCX CRYSTAL

Here is a new temp. compensated crystal which provides good freq. control without an oven. With a freq. range of 6 to 25 MHz, it provides a stability of $\pm 5 \times 10^{-6}$ over an amb. temp. range of $-30°$ to $+60°$C. CTS Knights, Inc., 400 Reimann St., Sandwich, Ill. 60548.

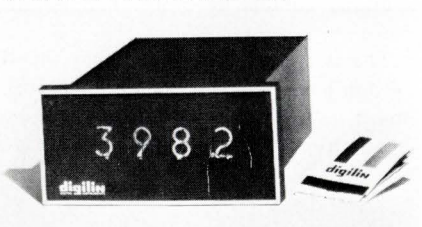
Circle Reader Service #307

2½ DIGIT PANEL METER

The VT-50 meter has a full scale range of 1.99 dc and a resolution of 10mV with an accuracy of ±1 digit. Dixson Instruments, Box 1449, Grand Junction, Col. 81501.

Circle Reader Service #308

DIGITAL PANEL METER



This extended range meter (Type 2430) provides a full scale indication of 3999. It is said to fill the gap between 3½ and 4½ digit meters while retaining the lower cost of 3½ digit meters. $199.00 in unit quan. Digilin, Inc., 1007 Air Way, Glendale, Calif. 91201.

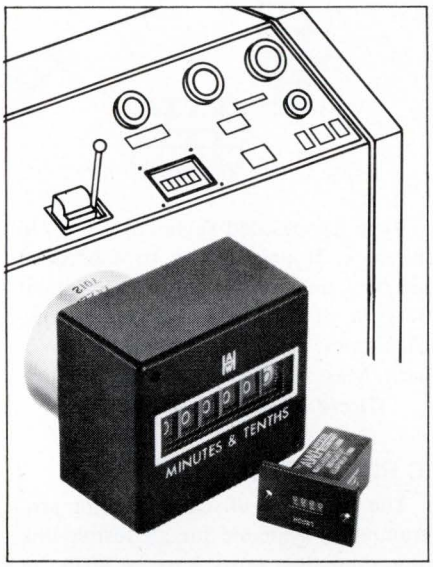
Circle Reader Service #309

LOW TC RESISTORS

These Series M negative TC resistors (−10 ppm/°C) have a power rating of 1 W at 25°C, stab. of 30 ppm/yr., are non-inductive, and have non-measurable noise. They are direct replacements for RB53 type wirewounds. Vishay Resistor Products, 63 Lincoln Highway, Malvern, Pa. 19355.

Circle Reader Service #310

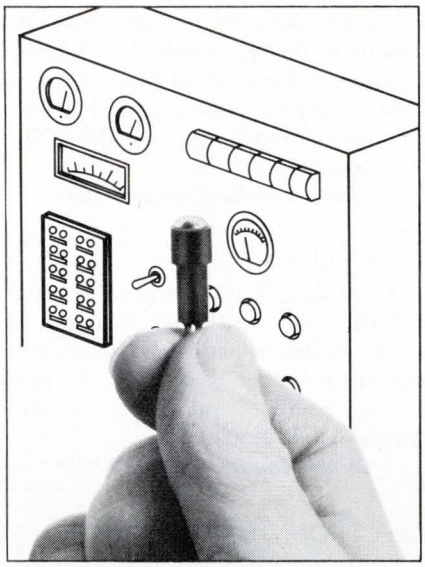
Compact design ideas for monitoring things.



TIME-BILLING MAINTENANCE

You can keep track of a lot of hours, minutes or seconds utilizing very little space with The A.W. Haydon Company's Elapsed Time Indicators. Choose from 21 standard size low-cost models or from a wide range of smaller units down to microminiature devices measuring only 37/64" square. Accurate digital readout is assured by precision Geneva gearing. These indicators operate from a wide range of power sources, both AC and DC, and are available in many mounting configurations. When you must monitor time for billing purposes, or maintenance programs such as lubrication, overhaul or recalibration, our indicators will do the job using a minimum amount of space. Write for complete technical information.

Circle Reader Service #36

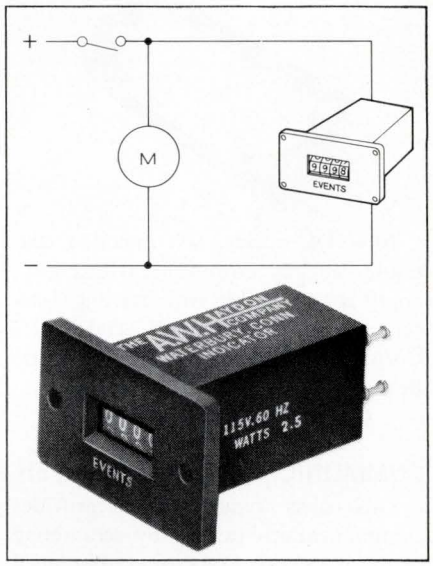


FAULT ISOLATION

These microminiature Fault Indicators not only signal a malfunction, but they "remember" that it happened, too. The electrically actuated display latches magnetically until reset. This "latch memory" assures positive isolation and indication of both transient and continuous malfunctions. The The A. W. Haydon Company's BITE (Built-In-Test-Equipment) Indicators are low power devices that operate on pulses of milliseconds duration and can be mounted directly on PC boards or grouped on remote panels. Their cost is unusually low for the function they perform.

You can design these BITE Indicators into your circuitry, or let our engineers design a complete fault isolation system for you. Write for literature, today.

Circle Reader Service #37



EVENTS-BILLING MAINTENANCE

If monitoring how many times anything has happened is a big problem, you don't need a big counter to solve it. This Events Counter, illustrated, is only 37/64" square x 1.250" deep. Yet, small as it is, it provides a 4-digit readout of up to 9999 events before recycling. Non-resettable, it is ideal for both billing and preventive maintenance programs because it is tamper-proof and provides a fast (1,200 cpm) accurate count of everything that has happened. It requires minimum power, too — only 2.5 watts max. at 115 VAC 60Hz. If you need high speed totalizing for data processing equipment, business machines, vending machines or production line machinery and operations find out about these miniature Events Counters. Write for literature.

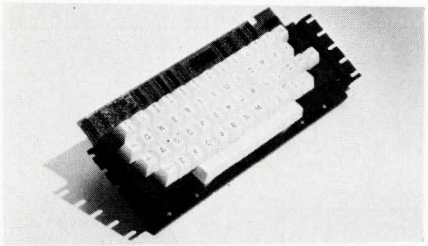
Circle Reader Service #38

THE A. W. HAYDON COMPANY

NORTH AMERICAN PHILIPS COMPANY

232 North Elm Street, Waterbury, Conn. 06720 Tel. (203) 756-4481 TWX: 710-477-3141
In Europe: Polymotor International · Brussels 1, Belgium

LOW-PROFILE KEYBOARD



New DC series, MSI encoded, tri-mode, 48-key communications keyboard is compatible with existing Teletype Model 33 terminals. Datanetics Corp., 2828 Spreckels Lane, Redondo Beach, Calif. 90278. (213) 542-4355.

Circle Reader Service #352

COMMUNICATIONS SCRAMBLER

This voice privacy modem provides communications privacy by scrambling two-way radio conversations. Equipped with more than 8,000 different codes, it is insensitive to normal detection and decoding devices. The Boeing Co., Seattle, Wash. 98124.

Circle Reader Service #353

HIGH-DENSITY MEMORY

Model 3600 series core memory uses high-density core packaging methods to accommodate more than 1,000 bits of data in 1 $in.^3$ of space. It costs < 2¢/bit in quantity. Ampex Corp., 9937 W. Jefferson Blvd., Culver City, Calif. 90230.

Circle Reader Service #354

SAMPLE AND HOLD MODULE

Model 5881 high speed sample and hold analog memory is compatible with DTL, TTL and COSMOS logic systems. It provides you with a 1% sample and hold unit having a 300 ns aperture time and 3 μs max. acquisition time. Optical Electronics, Inc., Box 11140, Tucson, Ariz. 85706.

Circle Reader Service #355

ADD-ON MEMORY

The NM-8000 series, specifically for DEC's PDP-11, is available with either 4k or 8k modules, and is field-expandable to 64k x 16. You can use a portion of the memory as read-only, and retain the balance as random-access. The PDP-11's full-cycle time is about 850 ns; 500 ns is possible with this memory. Nemonic Data Systems, 1301 W. Third Ave., Denver, Col. 80223.

Circle Reader Service #356

DIGITAL SCANNING DEVICE

Solidscan® is a totally ss electro-optical device which converts optical inputs directly to digital outputs. It is for use in place of the electron beam vacuum tube in digital electro-optical applications. Optonetics, Inc., 32 Henry St. Teterboro, N.J. 07608.

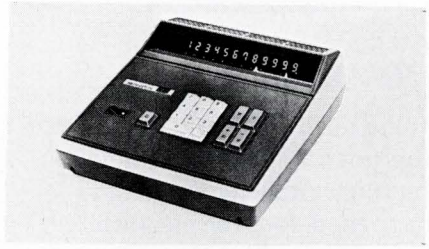
Circle Reader Service #357

DELAY LINES

These delay lines, designed to meet the high quality performance standards of the broadcast and studio equipment (BASE) industry, feature wide BW and low noise level. Corning Glass Works, Raleigh, N.C. 27602.

Circle Reader Service #358

ELECTRONIC CALCULATORS



Models 1201 and 1201C offer mixed sequential calculations, constant multiplication, constant division, square and power calculations. Each is equipped with floating decimals and shut-off clearing. Models 1203 and 1603 also have grand totals and extra storage, a fixed and floating decimal point, and round-off. Sperry Rand Corp., Remington Rand Div., Box 999, Blue Bell, Pa. 19422.

Circle Reader Service #359

CUSTOM-BUILT KEYBOARDS

Custom-built keyboards offer complete TTL/DTL interface capability, sealed reed switches, and a wide range of design options. The Bunker-Ramo Corp., 2855 S. 25th Ave., Broadview, Ill. 60153.

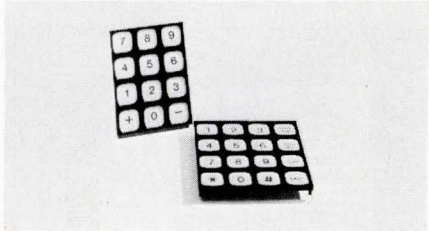
Circle Reader Service #360

VOICE RESPONSE SYSTEM

With the Digitalk 4000 voice response system you can call directly into a computer using a touch tone telephone or touch tone telephone pad only. You receive an answer to your call with a human voice. Cubic Corp., San Diego, Calif. 92123.

Circle Reader Service #361

ENCODED KEYBOARDS



Type EF encoded keyboard is < 3/16 in. thick. It provides up to 4 encoded bits/key, and contact closure with about 0.005 in. of motion. As low as 25¢/key. Chomerics, Inc., 77 Dragon Ct., Woburn, Mass. 01801.

Circle Reader Service #362

IC ROM PROGRAMMER

The 300 series of semiconductor programmers, available for all fusible-link programmable ROMS have a 4096 bit (512 words x 8 bits) capacity. Programs recorded on truth table cards are easily generated and verified to ROM patterns by depressing program switches. Spectrum Dynamics, Inc., 2300 E. Oakland Park Blvd., Ft. Lauderdale, Fla. 33306.

Circle Reader Service #363

MAGNETIC TAPE TRANSPORTS

Mod 310 and 311 transports are for use with mini-computers as well as data communications systems, key-to-tape, data terminals, data storing and forwarding applications and in data conversion systems. Uni Comp, Inc., 18219 Parthenia St., Northridge, Calif. 91324. (213) 886-7722.

Circle Reader Service #364

MEMORY PROGRAMMER

This table-top programmer (PR-23) for the Signetics 8223 256-bit Field-programmable ROM sells for under $200. It permits fast, error free programming of custom TTL ROM patterns by unskilled personnel in only five minutes. Curtis Electro Devices, Box 4090, Mountain View, Calif. 94040.

Circle Reader Service #365

TAPE READER

Slo-syn photoelectric tape reader type TRP500 has a reading rate of 0 to 500 char./s and is well suited for applications having TTL, DTL, or RTL compatible signals. The Superior Electric Co., Bristol, Conn. 06010.

Circle Reader Service #366

Grow with RCA's COS/MOS IC line and make your logic systems even more cost-effective

RCA expands its broad line of COS/MOS IC's again to bring the circuit designer nine new opportunities to save space, weight, power, as well as cost, in his new and existing logic circuit designs. The nine new types shown here now widen the number of COS/MOS functions to a total of 43.

- Dual-in-line ceramic and flat-pack packaged COS/MOS IC's (AD and AK series) enable the designer to plan cost-effectiveness into demanding military and aerospace systems. Operating temperature range of these devices is -55^{o} to $+125^{o}$C.
- Dual-in-line plastic packaged COS/MOS IC's (AE series) that open up many new application areas in industrial and commercial logic systems. Their operating temperature range is -40^{o} to $+85^{o}$C.

Designers prefer RCA COS/MOS for these significant design advantages: extremely low power dissipation — Gates, P_T = 10 nW (typ) at V_{DD} = 10 V (50 nW for AE series); MSI circuits, P_T = 10 μW (typ) at V_{DD} = 10 V. Noise immunity is 45% of the applied voltage over the entire 3 to 15 volts operating range.

See your local RCA Representative or RCA Distributor for price and delivery information on RCA's full line of COS/MOS Product Guide COS-278A write: RCA, Commercial Engineering, Section 591 /CDC65, Harrison, N.J. 07029. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong or, RCA Limited, St. Anne de Bellevue, 810 Quebec, Canada.

RCA Solid State

Formerly Dev. No.	Circuit Description	Commercial Type No.	Package	Price 1000-unit level
TA5385C	7 Stage Ripple Carry Binary Counter w/Buffered Reset (CD4004A Replacement)	CD4024AD CD4024AE CD4024AK CD4024AT	14 pin DIC 14 pin DIP 14 pin F.P. 12 pin TO-5	$ 7.50 3.35 8.20 7.50
TA6018W	Decade Counter/ Divider with 7 Segment Display Outputs (Display Enable Input)	CD4026AD CD4026AE CD4026AK	16 pin DIC 16 pin DIP 16 pin F.P.	12.50 5.95 13.15
TA5872W	Dual J/K F-F with Set/Reset	CD4027AD CD4027AE CD4027AK	16 pin DIC 16 pin DIP 16 pin F.P.	5.50 2.65 6.15
TA5873W	BCD to Decimal Decoder	CD4028AD CD4028AE CD4028AK	16 pin DIC 16 pin DIP 16 pin F.P.	8.25 4.10 8.90

Formerly Dev. No.	Circuit Description	Commercial Type No.	Package	Price 1000-unit level
TA5925W	Presettable, up/down Counter, Binary or BCD Decade	CD4029AD CD4029AE CD4029AK	16 pin DIC 16 pin DIP 16 pin F.P.	$11.95 5.75 12.60
TA5940W	Quad Exclusive OR Gate	CD4030AD CD4030AE CD4030AK	14 pin DIC 14 pin DIP 14 pin F.P.	3.95 1.55 4.60
TA5963W	Triple Serial Adder (Positive Logic Version)	CD4032AD CD4032AE CD4032AK	16 pin DIC 16 pin DIP 16 pin F.P.	7.20 4.25 7.85
TA5677W	Decade Counter/ Divider with 7 Segment Display Outputs (Ripple Blanking)	CD4033AD CD4033AE CD4033AK	16 pin DIC 16 pin DIP 16 pin F.P.	12.50 5.95 13.15
TA5951	Triple Serial Adder (Negative Logic Version)	CD4038AD CD4038AE CD4038AK	16 pin DIC 16 pin DIP 16 pin F.P.	7.20 4.25 7.85

An easy way to check logic ICs

Hewlett-Packard's Model 10529A logic comparator is simple to use, powered from the IC under test, and adjustment-free.

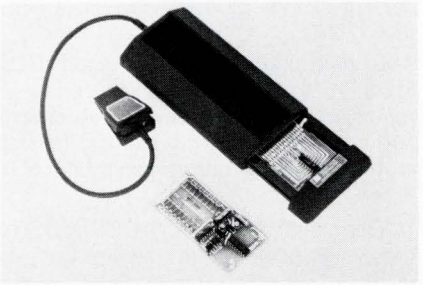
A probe-head simply clips onto powered TTL, DTL, or RTL ICs, and the instrument's LED display identifies any pins where the logic states don't match those at the corresponding pins of a known good IC.

A lighted diode shows a logic difference at the corresponding pin, and thus a faulty logic package. The comparator has one LED for each pin of a 14- or 16-pin DIP.

The user needs no knowledge of the operation of the circuit under test. He simply identifies the IC to be tested and inserts a reference board, loaded with a known good IC of the same type, into the comparator.

When the comparator is clipped onto the test IC, it first connects the inputs of the two ICs in parallel. Then it compares outputs. A difference in logic states lasting more than 100 ns causes a diode to light.

The user programs the reference



board, which slips into a drawer in the comparator, by breaking one PC trace for each output pin.

Hewlett-Packard Co. lent us one of these comparators for evaluation by anyone we wanted to have try it out. We passed our 10529A on to Vidar, Inc., a Mountain View, Calif. manufacturer of a wide range of data acquisition and recording systems, telecommunications products, instrumentation, and so on. In short, Vidar uses lots of ICs each month.

After several days of using the comparator, a Vidar test department spokesman commented that the 10529A does what it's supposed to do, is useful, and is readily used to run down and troubleshoot a matrix of ICs.

But the Vidar man also pointed out two problems. The first cannot be charged to the comparator: it's the problem that you have when one IC drives a number of other gates or functions. The tester doesn't know whether the driver or the loads are bad.

The second problem that the Vidar man pointed out is definitely chargeable to the comparator. The clip-on test head is too large to use in close quarters. For instance, your boards may have discrete components close-in to the IC package, or the ICs themselves may be tightly packed. In such situations, you may not be able to clip the test head to the IC.

And so it's up to you. The 10529A logic comparator costs only $295. There's also an IC test kit—Model 5010A—that includes the comparator, a Model 10528A logic clip, and a Model 10525A logic probe, all for $495. For more information, contact Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304. (415) 493-1501.

Circle Reader Service #315

DUAL 50-BIT REGISTER

This MOS static shift register, the UC7355, features DTL/TTL compatibility on input, clock, data and output lines without external circuitry. The register is completely static for either state of the clock. Solitron Devices, Inc., 8808 Balboa Ave., San Diego, Calif. 92123.

Circle Reader Service #316

DYNAMIC MOS RAM

This 1024 x 1 RAM operates over the full −55 to 125°C range. The device is fully decoded and features static-charge protection on all inputs. Access time is 250 ns and power dissipation averages 320 mW. Unisem Corp., Box 11569, Phila., Pa. 19116.

Circle Reader Service #317

12 BIT D/A

You can get the MP1812A and AN1812M high speed D/A's in all standard unipolar and bipolar 12 bit or 3 BCD digit configurations. Typical settling time to ½ bit accuracy is 5 μs. Typical TC of range and offset is 10 ppm/°C and 50 μV/°C respectively. Analogic Corp., Wakefield, Mass. 01880.

Circle Reader Service #318

COUNTER/DISPLAY CIRCUIT

The MK 5002P is a low-power MOS/LSI device which provides about 80% of the functions of a standard digital voltmeter. It also includes all the logic necessary to drive a four-digit multiplexed seven-segment display. The chip includes four decade counters, four quad latches, 2 four-bit multiplexers, a seven-segment decoder and control logic. Mostek Corp., 1400 Upfield Drive, Carrollton, Texas 75006.

Circle Reader Service #319

FAST PRECISION COMPARATOR

The mono CMP-01 overcomes the traditional tradeoff between fast response and good input characteristics by using Schottky barrier diodes to optimize circuit speed. A combination of high input slew rate, fast small-signal response and high fanout make the device attractive in 13- to 15-bit high speed D/A's and similiar applications. Precision Monolithics, Inc., 1500 Space Park Drive, Santa Clara, Calif. 95050.

Circle Reader Service #320

INSTRUMENTATION AMPS

Models ZA702M1 and 703A1 feature 500-1000 MΩ differential input impedance (both channels) and a gain range of 1-1000. Input impedance remains high regardless of the gain selected for the amplifier. Zeltex, Inc., 1000 Chalomar Road, Concord, Calif. 94520.

Circle Reader Service #321

FREQUENCY DIVIDER

This MOS resettable frequency divider features TTL drive capability. The GEM 501 gives you six stages of frequency division in a 16-lead plastic DIP. Integrated Circuit Products Dept., General Electric Co., Electronics Park, Syracuse, N.Y. 13201.

Circle Reader Service #322

BCD TO DECADE DECODER

The 382 is a high noise immunity logic decoder which decodes BCD 1248 code and drives gas filled cold cathode indicator tubes. It has over 4-V typical noise immunity, and a guaranteed 70-V output. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040.

Circle Reader Service #323

Sperry explodes the LED myth

There has been a lot said in recent months about LED's representing the most significant advance in display technology and how they are destined to dominate the digital display market. We feel it's time to explode the myth and set the record straight. So, here's a direct, point-by-point, comparison of Sperry seven segment gas discharge planar displays† vs LED displays.

COST

For the price of a single ¼" LED digit you can buy three ½" or three ⅓" Sperry display digits*. And, in the future, the Sperry displays should continue to be less expensive than LED displays. Gives you something to think about, doesn't it?

SIZE Let the size speak for itself.

READABILITY

Have you tried to read a ⅛" or even a ¼" LED display at 20'? On the other hand, the Sperry ⅓" display is easy to read at that distance and the ½" model can be read at up to 40'. See the difference?

COLOR

With LED's, you have the choice of red, red or red. Not so with Sperry. They come in an eye appealing orange — with amber and red available with filters. If you like red, why pay more for a LED?

APPEARANCE

Which do you prefer — looking at individual red dots on LED devices or at continuous unbroken Sperry figures. The choice is yours.

BRIGHTNESS

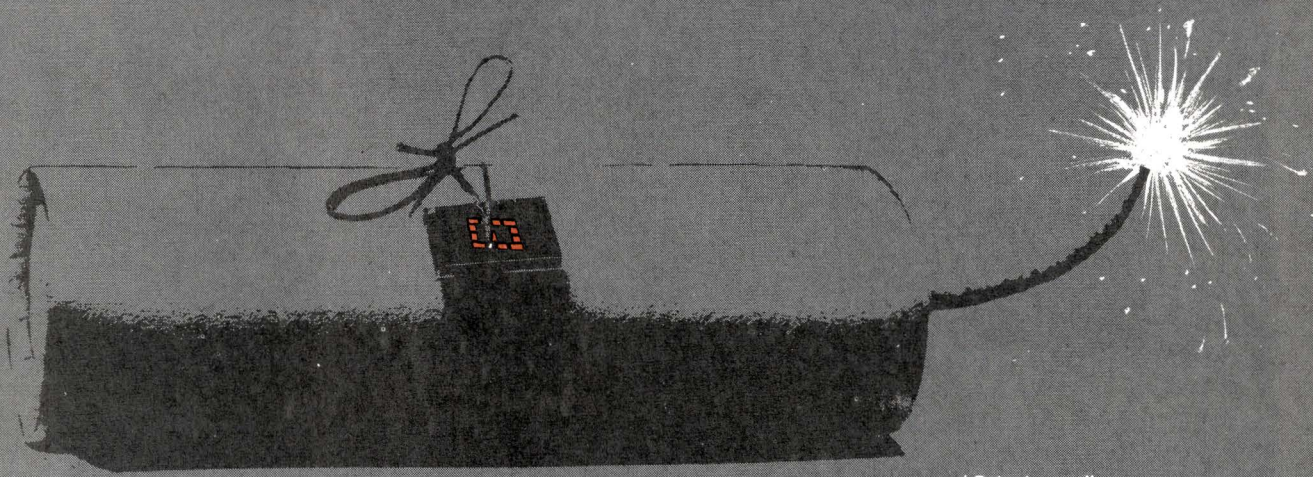
Sure you can read LED's indoors, but how about in bright light or direct sunlight? LED's fade fast while Sperry displays stay clearly legible with no appreciable loss in brightness. And, Sperry devices won't poop out when it gets hot!

Sperry advantages don't stop here either. The small Sperry package is only a shade larger than a LED and nearly as thin. Sperry power dissipation is also significantly lower. And, Sperry reliability is so good that they have proven fail-safe in stringent, high performance aircraft applications including the Boeing 747. There are no wire bonds to go bad, either. Don't just take our word for it. Arrange for a comparison demonstration and see for yourself what the difference will mean to your particular application.

For complete technical information on Sperry displays, use this publication's reader service card or phone or write:
Sperry Information Displays Division
P.O. Box 3579, Scottsdale, Arizona 85257
Telephone (602) 947-8371

SPERRY
INFORMATION DISPLAYS

It's a whole new ball game in display devices!



† Patents pending

*based on 1,000 digit quantity, and above. Sperry displays are available in 3 digit, 2 digit, and 1½ (7 segment character and a 1 with + and —) digit models in both ⅓" and ½" sizes.

SPERRY RAND

Circle Reader Service #46

MICROWORLD

HIGH GAIN OP AMPS

These units combine the outstanding features of the 741 into a close parameter matching and tracking dual, high gain op amp. The devices, the RM4558 and RC4558, feature offset null capability, no latch-up, continuous short circuit protection, low power consumption and internal frequency compensation. Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040.

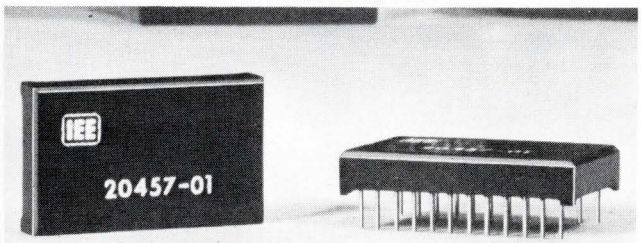
Circle Reader Service #367

COLOR PROCESSOR IC

You get a chroma i-f amplifier with automatic chroma control, color killer, and injection lock reference system in one 14-pin package with this device. The MC1398P features an injection lock reference system that generates the required sub-carrier reference signal by pulling an crystal oscillator into phase with the reference burst. Another noteworthy feature is the use of dc control circuitry for hue and chroma amplitude adjustments. This avoids the necessity of higher signal levels and shielded cables from the front panel to the circuit board. $1.98 ea., 1000-4999. Technical Information Center, Motorola Semiconductor Products, Box 20924, Phoenix, Ariz. 85036.

Circle Reader Service #368

HIGH CURRENT DECODER/DRIVER



The 20457 Series of hybrid circuits decodes standard 8421 BCD data into 12 outputs. Or, if only 10 outputs are needed, two may be used as lamp buffers. Intended primarily, as display drivers, the circuits have a drive capability of 300 mA at 30 V. The circuits are DTL/TTL compatible and you can get them with or without memory. Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, Calif. 91405.

Circle Reader Service #369

SYSTEMS ORIENTED 4096-BIT ROM

The 8205 is a 512 x 8 organized ROM with a typical access time of 35 ns. The memory features an integrated output data register which, in addition to eliminating the need for eight external latches, also improves system performance by about 10 ns. You can also use the device in a conventional mode by holding the output latch strobe high. In 100 lot quantities, the price is $29.50. The 8204, a 256 x 8 version, is also available for $16. 40 in 100's. Signetics Memory Systems, 740 Kifer Road, Sunnyvale, Calif. 94086.

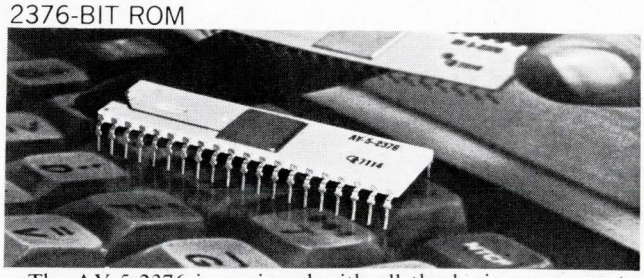
Circle Reader Service #370

FIRST JFET IC

The AM1000, a precision, high-frequency analog switch is the first JFET integrated circuit to go into production. The device virtually eliminates switching transients in the signal output by routing the transients into drive and bias supply lines where they are disposed of by conventional bypass capacitors. You can use the device to switch signals of ± 10 V at toggle frequencies up to 4 MHz. A slightly more expensive version, the AM1001, will handle ± 15 V with mV resolution at toggle frequencies up to 2 MHz. Prices start at $5.50 ea in 100 and up quantities. National Semiconductor Corp., 2900 Semiconductor Drive., Santa Clara, Calif. 95051.

Circle Reader Service #371

2376-BIT ROM



The AY-5-2376 is equipped with all the logic necessary to encode SPST keyboard closures into a useable 9-bit code. Data and strobe outputs are directly compatible with TTL/DTL or MOS logic arrays. This device features increased system flexibility by providing external control for output polarity selection; for selection of odd or even parity, two key rollover operation, N-key lockout capability, and programmable coding with a single mask change. Price, $27.50 in 100 unit lots. General Instrument Corp., 600 W. John St., Hicksville, N.Y.

Circle Reader Service #372

ULTRA FAST OP AMP

This FET-input, differential op amp offers the unique combination of high slew rate, fast settling and ± 100 mA output. The Model 46 uses a novel input stage that gives $1000 V/\mu s$ slew rate and settling times of 100 ns to 0.1% and 300 ns to 0.01% in the inverting mode. In the unity gain, noninverting mode, the device will settle to 0.05% in 150 ns. The price is $62 in quantities of 100. Analog Devices, Inc., Route 1 Industrial Park, Norwood, Mass. 02062.

Circle Reader Service #373

IC ZERO-VOLTAGE SWITCHES

The CA3058 and CA3079 are two new zero-voltage switches that you will find useful in thyristor control applications such as electric heating, motor on/off controls, one-shot controls and light flashing systems. Each of the devices includes a limiter power supply that permits direct operation from the ac line; a differential on/off sensing amplifier; a zero crossing detector; and a triac gating circuit. RCA Commercial Engineering, Harrison, N.J. 07029.

Circle Reader Service #374

Great 'Standards' by the Power Professionals

We set out to engineer standardized power modules with some pretty high standards to meet. Yours. We had two things going for us. Nearly four decades of *custom* power experience . . . and, the determination to make an off-the-shelf line that was not merely good . . . but great! It paid off.

North's standard power units offer you real cost economy plus the utmost in reliability. May we suggest you look over our catalog . . . then take your *own measure* with a test unit.

Call 419/468-8244 or TWX 419/468-4860.

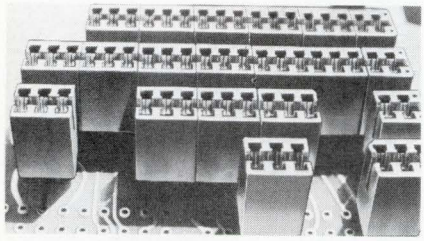
North Electric Company • Electronetics Division / Galion, Ohio • A subsidiary of United Utilities, Incorporated

NORTH ELECTRIC

NSP-8

NEW PRODUCTS

PRESS-FIT CONNECTOR



Series 6318 modular card edge connector provides a means to update connection systems without having to redesign existing PC cards with their 0.156 in. center contact traces. It comes in modules of four and six contacts. Elco Corp., Maryland Rd. at Computer Ave., Willow Grove, Pa. 19090.

Circle Reader Service #329

SS READOUT ASSEMBLY

Series 749 readout contains groups of Diode-lite readouts, decoder-drivers and a bezel assembly that makes it easy to install in a panel. The readout is a 6 x 8 dot matrix connected for 7-segment driving. Dialight Corp., 60 Stewart Ave., Brooklyn N.Y. 11237.

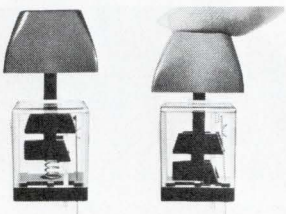
Circle Reader Service #330

SIGNALLING DEVICE

Cybertone provides selectable, programmable sounds that are easily discerned in the presence of high-background noise. It emits signals of up to 90 dB (max) sound power level and operates on 12 Vdc with a current drain of about 30 mA. C.A. Briggs Co., Box 151, Glenside, Pa. 19038.

Circle Reader Service #331

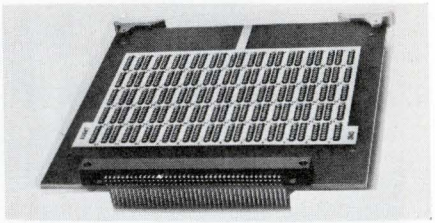
KEY SWITCH



Contacts in this key are made of WE Alloy #1 (69% Gold, 25% Silver and 6% Platinum). Result is low contact resistance (typ. 25 mΩ). Also, contacts are normally held apart, eliminating bounce or microphonics. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085.

Circle Reader Service #332

DIP SOCKET PANEL



New standard panel is for 60 or 72 DIPS, 14 or 16 lead. Series 8136-W panels come with male connectors (120 contacts, 3 rows of 40 with 0.100 in. spacing between pins and rows). Mating female connectors are available. Panel is ⅛ in. glass epoxy with electro-tin plated VCC and Gnd. planes. About 7.350 x 6.950 in. Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703.

Circle Reader Service #333

GLASS-CERAMIC CAPACITORS

Available in four sizes and three purchase tolerances, these new CGC capacitors are well suited for computer, calculator and other by-pass or power supply decoupling applications. Corning Glass Works, Corning, N.Y. 14830.

Circle Reader Service #334

RAYTHEON SEMICONDUCTOR. OUR 64-BIT RAM WON'T QUIT. EVEN AT 125°C.

Some people claim their bipolar 64-bit RAM will work over the entire MIL temperature range. Others keep silent. We guarantee our RR5100 will operate within specs from −55°C to 125°C ambient.

The RR5100 and its commercial version, the RR5102, are available in dual-in-lines, flat paks, and Raytheon Semiconductor's own beam lead configuration. Of course both of these 64-bit RAM's are compatible with our RAY III TTL and other DTL/TTL.

And don't forget our other memory products. We've delivered thousands of our reliable RL80 series 16-bit scratch pad memories. And when it comes to custom devices we're second to none. Our custom 256-bit RAM doesn't know when to quit.

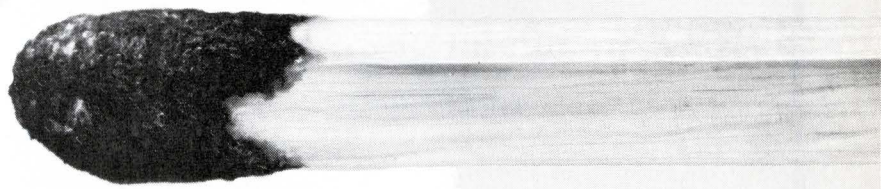
And we have plenty of new things in the mill. Denser bipolar chips with faster cycle times and a MOS-type power dissipation are on the way. Thanks to our new revolutionary V-ATE bipolar process.

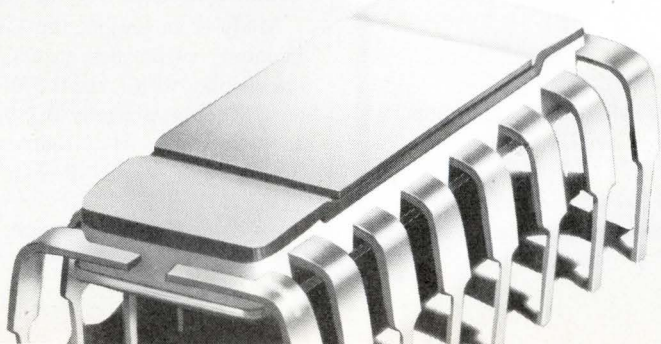
Don't get burned on your present projects. Get immediate delivery on our 16-bit and 64-bit memories from our local sales office or your nearest franchised Raytheon Semiconductor distributor. And call us direct for custom memories.

Raytheon Semiconductor, 350 Ellis Street, Mountain View, California, 94040. 415/968-9211.

RAYTHEON

GUARANTEED.

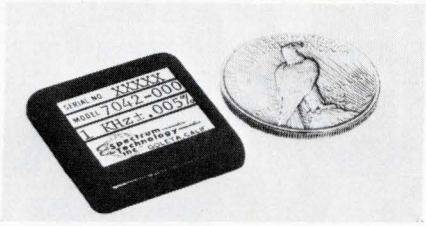




Circle Reader Service #52

NEW PRODUCTS

OSCILLATOR/LOGIC CLOCK



Series 7042 is a thin (¼ in. seated height) crystal oscillator/IC logic clock that features low power consumption and hf stability. Spectrum Technology, Inc., Box 948, Goleta, Calif. 93017.

Circle Reader Service #335

THERMAL CONTROL UNITS

Series LV thermal control units are for power burn in, HTRB, life testing or product evaluation, using liquid/vapor heat transfer methods. They take up to 2000 W of power dissipation by semiconductors mounted on heat sinks which are clamped to a temperature controlled pipe. Wakefield Engineering, Inc., Audubon Rd., Wakefield, Mass. 01880.

Circle Reader Service #336

SEVEN SEGMENT DISPLAYS

SP-750 series ½ in. gas discharge displays can be easily read as far as 40 ft. within a 150° viewing angle. The series includes three, two, and one and 1.2 digit models featuring the same 1.2 in. char. height. The one and 1.2 digit is a full seven segment character with plus/minus symbols, an over-range numeral "1" and an extra decimal point. Sperry Information Displays Div., Box 3579, Scottsdale, Ariz. 85257.

Circle Reader Service #337

TANTALUM CAPACITORS

These tantalum capacitors are no longer than std. bare chip (uncased) tantalum capacitors. Type 182D and 183D units are voltage aged and tested for all parameters prior to shipment. Sprague Electric Co., 615 Marshall St., North Adams, Mass. 01247.

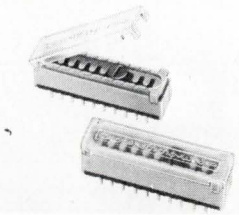
Circle Reader Service #338

INDUSTRIAL PUTs

Three new series of Programmable Unijunction Transistors—2N6119-2N6120, U13T3-U13T4 for industrial applications and 2N6137-2N6138 for military requirements, are all packaged in hermetically sealed TO-18's. Unitrode Corp., 37 Newbury St., Boston, Mass. 02116.

Circle Reader Service #339

PROGRAMMING SWITCH



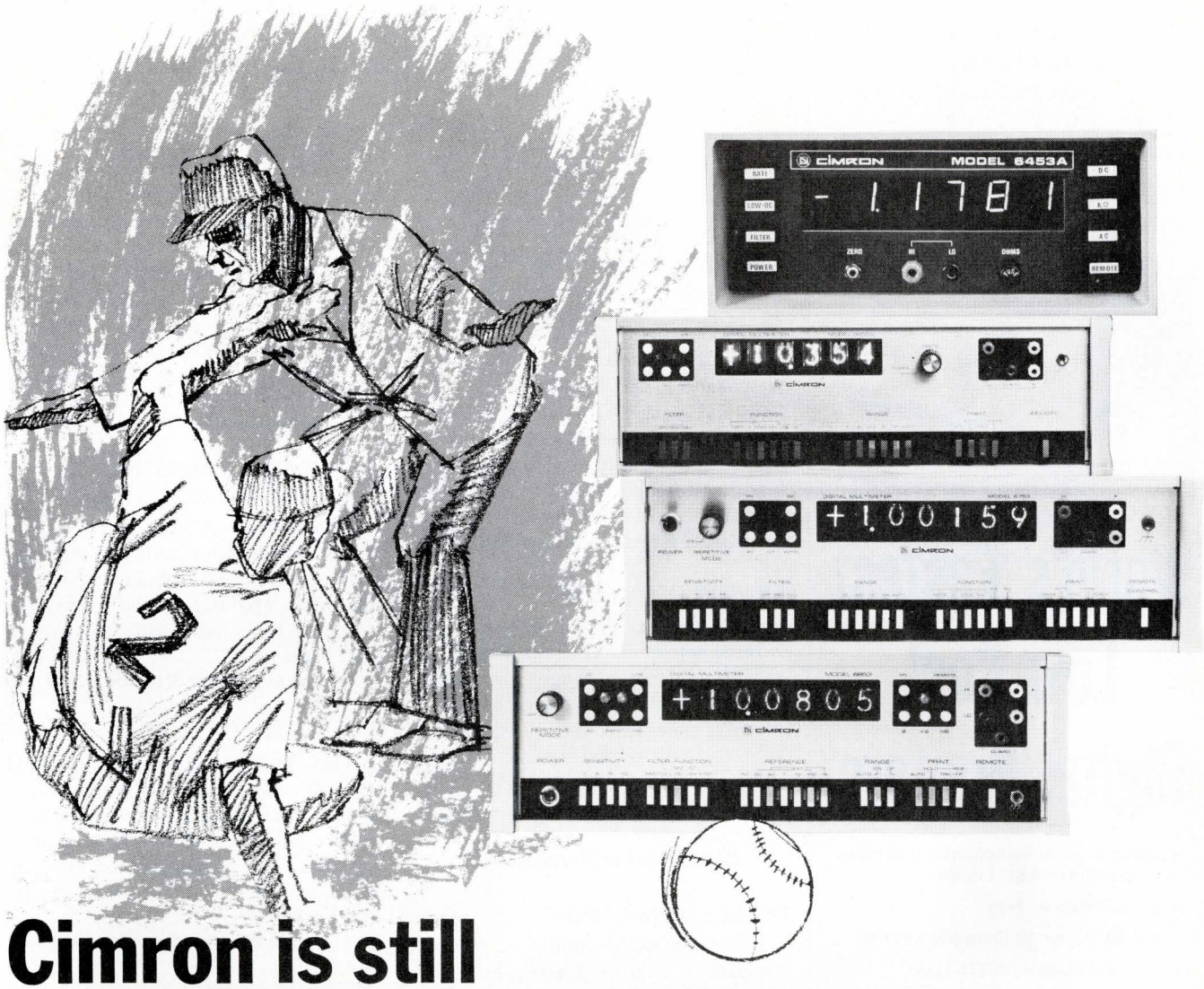
New miniature 10-position rotary slide switch for PC board applications has non-shorting contacts, comes in two mounting styles and takes <0.350 in.^{2}. You merely twist a small screwdriver to change programs and set up new operating conditions. Siemens Corp., 186 Wood Ave. S., Iselin, N.J. 08830.

Circle Reader Service #340

THUMBWHEEL SWITCH

Modular in design, the Series 29000 Economy switch has an easily-read in-line display with large 0.200 in. characters. Modules are only 0.350 in. wide x 1.200 in. high. The Digitran Co., 855 So. Arroyo Pkwy, Pasadena, Calif. 91105.

Circle Reader Service #341



Cimron is still the winner in any league!

Here's the line-up for the winning team of Cimron DVM'S you can depend on to stay ahead of the rest. A few of the bonus features that can be added to your new or present Cimron DVM'S are: true RMS converter plug-in; optical (high speed) coupler with 1000 volt isolation; 100 volt ratio operation of the 6653A, 6753 and 6853; front and rear input isolation.

Something else... Cimron has reevaluated their instruments and found the specifications to be significantly better than stated in the fine print. For example, our short-term accuracy is now 90 days instead of 30 days.

Let Cimron show you how to replace your old DVM with a new, high performance model without changing your interface cables.

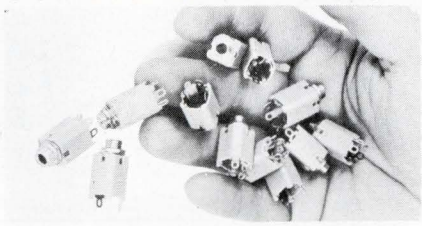
As an added convenience, we are establishing local service facilities throughout the nation for warranty or out-of-warranty repairs. Ask us for the location of your service facility.

When you have a requirement for DVM'S, AC Power Sources, Line Regulators, Pulse Generators or Data Acquisition Systems or Components, buy the best in the league... write or call Lear Siegler, Inc./Cimron Instruments, 714 N. Brookhurst St., Anaheim, California 92803. Phone 714-774-1010.

LEAR SIEGLER, INC. / *CIMRON INSTRUMENTS*

NEW PRODUCTS

3-CONDUCTOR PHONE JACKS



This 3-conductor miniature phone jack mates with miniature plugs. The "Unijax" series also includes 2-conductor types. Terminals can be bent over to provide a hard mount on a PC board. Switchcraft, 5555 N. Elston Ave., Chicago, Ill. 60630.

Circle Reader Service #342

SILICON RECTIFIERS

Type numbers 44001 to 44007, are diffused-junction silicon rectifiers in an axial-lead plastic package. Electrically identical to JEDEC Types 1N4001-1N4007, they have voltage ratings of 50, 100, 200, 400, 600, 800 and 1000 V, and an average forward current rating of 1A. RCA Solid State Div., Somerville, N.J. 08876.

Circle Reader Service #343

PLATED WIRE EAROM

The OmniROM family of "plug-compatible" EAROMS (Electrically Alterable Read Only Memories) is especially configured for popular minicomputers. Memory Systems. Inc., 3341 W. El Segundo Blvd., Hawthorne, Calif. 90250. (213) 772-4220.

Circle Reader Service #344

POWER TRANSISTORS

Six new uhf communication power transistors are for use at 12.5 V and 28 V at 400 and 470 MHz. All are designed with a ballasted emitter for extreme ruggedness under load mismatch. Solid State Scientific Inc., Montgomeryville, Pa. 18936. (215) 855-8400.

Circle Reader Service #345

SHIELDED INDUCTOR

A new shielded inductor, the "Pee Wee Ductor," has only about 1/8th of an in. between its leads. L and Q, in relation to volume, are high. Minimum Q ranges from 34 to 55 at rf frequencies. Inductance values run from 0.10 to 1000 μH, $\pm$10%. Essex Electronic Products/Darlington Div., Nytronics, Inc., Darlington, S.C. 29532.

Circle Reader Service #346

ACCELEROMETER

Series INA-50 piezoelectric accelerometer provides a voltage output proportional to vibration and shock in rough environments of dirt, oil, heat, or cold. It is self-amplifying and completely self-contained requiring no auxiliary signal conditioning amplifiers. Columbia Research Labs, Mac Dade Blvd. & Bullens La., Woodlyn, Pa. 19094.

Circle Reader Service #347

16-BIT MINICOMPUTER

A 16-bit, 800 ns minicomputer—the MODCOMP I—is designed as a dedicated controller for real-time measurement, control, and communications applications. Modular Computer Systems, 2709 N. Dixie Hwy., Ft. Lauderdale, Fla. 33308.

Circle Reader Service #348

SOLID STATE RELAY

These computer-compatible all solid state SPST ac relays can switch 2, 10, and 25 A at 120 and 240 V. Normally-open types, they operate from a min. 1.5 mA, 3 Vdc signal. Crydom Div., International Rectifier Corp., El Segundo, Calif. 90245.

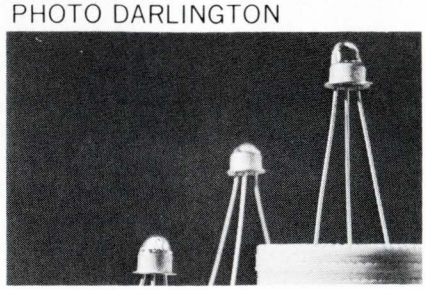
Circle Reader Service #349

TIME DELAY RELAY

Model TDP panel mounted, ss hybrid relay is a delay on make unit. It is only 2 in. wide and is rear mounted with 4 screws. Vanguard Relay Corp., 225 Cortland St., Lindenhurst, N.Y.

Circle Reader Service #350

PHOTO DARLINGTON



Type QS-507 is for general purpose computer and industrial applications that require light sensitivities 10 to 20 times those of normal photo transistors. It provides light current of 5.0 mA with irradiance of only 2.0 mW/cm^2. Is sensitive to both visible and near I-R illumination. 45¢ (1,000 quan.). Quantum Sensing, Inc., 1650 Locust Ave., Bohemia, N.Y. 11716.

Circle Reader Service #351

A screwdriver is all you need to hook up to most P&B relays

The new Potter & Brumfield socket system with screw terminals gives you a whole new world of relays to choose from.

How?

By converting octal and quick-disconnect tab termination relays to screw terminals.

Quickly. Simply.

Our system comes complete with mounting channel. Brackets. Retainers. Spacers. And sockets made of virtually indestructible Lexan.

Think of it!

Now you can use newer, more sophisticated relays.

Just as compatible as the ones you've been using. And every bit as reliable.

But they cost less. And take up less space.

(You probably can save as much as 75 percent of the space you're now using.)

This is just part of what's possible with P&B's new socket system.

To find out more, write or call Potter & Brumfield Division, AMF Incorporated. Princeton, Indiana 47670, (812) 385-5251.

Or talk to your local P&B distributor or representative.

AMF
POTTER & BRUMFIELD

LITERATURE

Data acquisition system

A modular data acquisition system designed to interface with most minicomputers is discussed in a short form brochure. A general description of the system is provided, as are applications, modes of operation, and mechanical and electrical specs. Varadyne Systems, 1020 Turnpike St., Canton, Mass. 02021.

Circle Reader Service #391

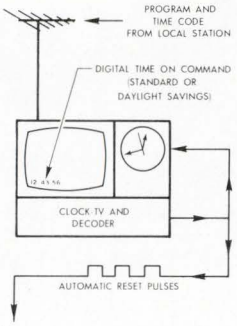
Linear ICs

Lots of "firsts" are featured in this catalog from Analog Devices on its new family of high performance IC FET op amps. The first complete IC multiplier, the AD530; the first IC instrumentation amplifier, the AD520; the AD810 series monolithic dual npn transistor; μDAC IC D/A and A/D converter building blocks,—they're all included with specs provided for each. Analog Devices, Route 1 Industrial Park, Box 280, Norwood, Mass. 02062.

Circle Reader Service #392

TV time and frequency system

Proposed to distribute accurate time and frequency over the nation's commercial TV networks, this system is described for you in a 12-page bulletin. Features of the system you'll find detailed are the clock-reset pulse circuit,



hours-minutes-seconds code, precise-time code, the 1-MHz frequency standard, the alphanumeric message channel, and message-processor control functions. U.S. Department of Commerce, National Bureau of Standards, Time & Frequency Div., Boulder, Colo. 80302.

Circle Reader Service #393

The Nuclear Data processor

Nuclear Data invites you to compare the features of its new ND812 minicomputer with those of other models. Like price, instruction and arithmetic power, addressing capability, I/O capability, and serviceability. In their 18-page catalog they give you an instruction set for many functions; they show you word formats; and they include a block diagram of the computer's logic. Nuclear Data Inc., 100 W. Golf Rd., Box 451, Palatine, Ill. 60067.

Circle Reader Service #394

Product reference guide

A compendium of applications bulletins describe the versatility and simplicity of putting together a custom analog computational system. Various systems are discussed with applications for a variety of industries included. Bell & Howell Co., Control Products Div., 706 Bostwick Ave., Bridgeport, Conn. 06605.

Circle Reader Service #395

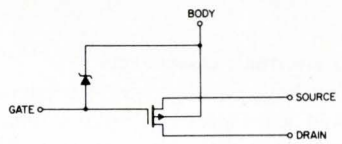
Interface modules

This newly formed company already has more than 50 functional-circuit modules on the market. Designed to interface between realtime, physical processes and digital equipment, the product line includes DACs, ADCs, and instrumentation amplifiers. For a full package of information, including data sheets and pricing, write Cycon, Inc., 1080E Duane Ave., Sunnyvale, Calif. 94086.

Circle Reader Service #396

Discretes and ICs

Featuring a broad line of FETs and ICs, this 16-page catalog puts special emphasis on MOS and JFET switches, analog devices, gates, and CMOS multiplexers and switches. Technical data is included on digital and linear ICs, current and voltage limiters, and high-frequency products. Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054.



Zener gate protection

Circle Reader Service #397

Data communications

A line of standard modems for the data communications industry is the subject of an 8-page brochure. The products discussed operate at speeds of 2000, 2400, 3600, 7200, 9600, and up to 1 million b/s. Descriptions and specs for multipliers, transmission test equipment, and specialized modems for OEM users are included. International Communications Corp., 7620 N.W. 36th Ave., Miami, Fla. 33147.

Circle Reader Service #398

Microprogramming handbook

A 532-page handbook tells you how to microprogram, why the concept is effective, and when it is most appropriate. Six sections include a primer with glossary on data processing terms, applications examples, a Micro 800 user's manual, a firmware manual, tutorial text on systems design, and a brief product catalog. For your copy, write on company letterhead to Microdata Corp., 644 E. Young St., Santa Ana, Calif. 92705.

LITERATURE

Alphanumeric devices

Alphanumeric tubes and details on digital display applications are covered in 12-pager ETD-6051. The low cost tubes feature low drive and power levels, solid-state compatibility, and rigid structure. Basic circuits that can be used to operate the alphanumeric tubes in

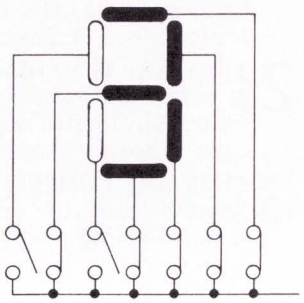


Figure 3 display

display applications are described and general characteristics of the tubes are provided. Technical data is presented in tabular and graphical form and good schematics are included. General Electric Co., 309 Nolan Bldg., 2100 Gardiner La., Louisville, Ky. 40205.

Circle Reader Service #399

Semiconductor memories

Looking for information on memories? Try this 20-page catalog which describes 21 silicon-gate and Schottky-bipolar memories. Highlighted are a 1024-bit MOS RAM, a 256-bit bipolar RAM, a 2048-bit MOS ROM, and a 512-bit recirculating register. Also included are decoders, drivers, and latches designed for use with the memories. The data, arranged for quick reference, includes major specs, block diagrams, timing diagrams, pin configurations, and characteristic curves. Intel Corporation, 3065 Bowers Ave., Santa Clara, Calif. 95051.

Circle Reader Service #400

Rotary switches

In addition to just technical data on their products, this 64-page catalog becomes a handy reference guide. It discusses materials, contact resistance, life test data, and gives switch mounting details. Plus it features enlarged product photos so you can see details on features such as switch assembly, indexing and stop controls, the stator, and part construction. Options are pictured, too. ASM Corp., Box 860, 525 Truck La., Smithfield, N.C. 27577.

Circle Reader Service #401

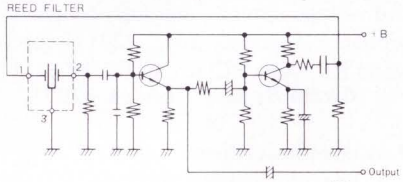
Diode and microwave components

This 16-page brochure describes rf and microwave mixers, detectors, switches, attenuators, limiters, multiplexers, oscillators, and amplifiers. Included are components in chip form for hybrids, beam-lead and stripline items, discrete products, and packaged modules. Organized from the circuit designer's point of view, the brochure lists components first by primary product line (rf and microwave conversion and switching, rf and microwave control, multiplication and pulse generation, etc.), then by application. Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304.

Circle Reader Service #402

1971 electronic components

This huge catalog (over 400 pages) is packed with specs, schematics, photos, dimensional drawings, and data charts for literally hundreds of products. To name a few, you'll find resistors, varistors, thermistors, hybrid thick-film ICs,



Application of reed filter in oscillator

capacitors, piezoelectric ceramic components, tuners, switches, inductors, af transformers, speakers, and custom printed-wiring boards. For your copy write on company letterhead to Matsushita Electric Corp., Pan Am Bldg., 200 Park Ave., New York, N.Y. 10017.

Self scan subsystems

"Self-Scan™ Panel Display Subsystems—Theory of Operation," an 18-page application note, provides Burrough's subsystem users with the details necessary to incorporate the system into new or existing display devices. The subsystem's theory of operation includes interfacing timing and pin-out data, operating sequences, and loading requirements. Mechanical characteristics showing outline dimensions of assemblies and connectors are included as are mounting provisions. Burroughs Corp., Electronic Components Div., Plainfield, N.J. 07061.

Circle Reader Service #403

Market data for 1970

You wouldn't guess from reading the EIA's *Electronic Market Data Book* (with info through 1970) that the industry went (and still may be going) through a recession. It calls 1970 the "electronic industry's second highest sales year at $24.3 billion," without mentioning that this is the first time in 20 years that sales have declined. If you want to draw your own conclusions, however, this is a valuable data reference. The Electronic Industries Association, 2001 Eye St. N.W., Washington, D.C., sells it for $15.

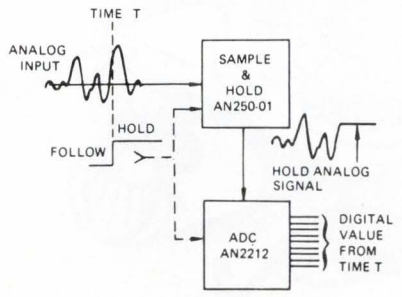
Active filters

A new supply of a popular booklet is now available. "Universal Active Filter—Theory and Application," outlines the operating characteristics and performance advantages of active filters. (The company's product is a multiloop feedback structure that synthesizes a second-order transfer characteristic.) The 54-page book has extensive information on the use of such filters in telemetry systems, avionics gear, vocoders, touch-tone equipment, etc. Two appendices review network synthesis and graphically describe a number of common transfer functions. Kinetic Technology, Inc., 3393 De La Cruz Blvd., Santa Clara, Calif. 95050.

Circle Reader Service #404

Analog/digital/analog conversion

A new short form catalog summarizes a line of A/D/A conversion, signal conditioning, and digital display products. Basic specs and descriptive data on card-mounted and modular devices,



power supplies, digital panel meters, and displays are included in the 16-pager, as is a list of available technical literature and application data. Analogic, Audubon Rd., Wakefield, Mass. 01880.

Circle Reader Service #405

LITERATURE

PC contacts and terminals

Varicon™ contacts and how they are staked and dip-soldered to PC boards are discussed in this 12-page catalog. Contact variations for parallel, perpendicular, or tandem PC board connections are illustrated. Because the contacts for these connection systems are standard, the cost of special connector designs is eliminated. Elco Corp., Willow Grove, Pa. 19090.

Circle Reader Service #406

Optoelectronic components

Here's an information package useful to anyone working with LEDs and solid-state displays. The manufacturer has put together a complete set of data sheets, an OEM price list, and several application notes. The package also includes a cross-reference guide correlating this manufacturer's displays to those made by others. The displays are seven-segment, GaAsP alphanumeric indicators, while the discrete emitters are for visible-red and IR applications. Litronix, Inc., 19000 Homestead Rd., Vallco Park, Cupertino, Calif. 95014.

Circle Reader Service #407

Digital computer

Designed for a wide range of small computer applications, the 2100A features extended arithmetic instructions, power fail interrupt with automatic restart, memory parity check with interrupt, and memory protect. This 16-page booklet discusses its simple but functional design, peripherals, input/output interface, operating systems and software modules, and provides an instruction repertoire. Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle Reader Service #408

Switches and termination hardware

Here's a 90-page catalog packed with information on electronic switches and termination hardware. The first few pages are devoted to engineering data and are followed by sections on push button switches, hardware, and rotary switches. Factor charts, diagrams, and outlined techincal data provide you with all the information you need to choose the switch best suited to your application. Grayhill Inc., 561 Hillgrove Ave., Box 373, La Grange, Ill. 60525.

Circle Reader Service #409

Process instrumentation publication

Foxboro has recently issued a revised edition of its annotated bibliography of article reprints, textbooks, and engineering aids, most of which are available without charge. The 24-page booklet covers publications in the process control, analog instrumentation, computer control, and pollution control fields. Foxboro Co., Dept. 120, Foxboro, Mass. 02035.

Circle Reader Service #410

Electronic instruments

This 60-page catalog gives you complete details on a wide variety of instrumentation. Divided into three sections, you will find the largest portion devoted to Monsanto's very broad range of counter-timers. But there is also a generous amount of information on their line of signal sources as well as auxiliary equipment. This section includes such instruments as DVMS, D/A converters, digital printers, and the like. Monsanto Electronic Instruments, 620 Passaic Ave., West Caldwell, N.J. 07006.

Circle Reader Service #411

THE ELECTRONIC ENGINEER

Advertisers—September 1971

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New semiconductors

A 12-page catalog brings you up to date on semiconductors. It gives you technical data and application information. Outstanding features of the various models are listed separately, and detailed data sheets for each type are available upon request. Photos, charts, and diagrams are included. AEG-Telefunken, Fachbereich Halbleiter, D 71 Heilbronn, Postfach 1042, Germany.

Circle Reader Service #412

Video display terminal

Here is a video display terminal with comprehensive editing facilities that enable off-line editing of messages before transmission to the computer. It's already found a proposed application in helping the British police forces fight crime. The computer network system makes information available within seconds of asking the computer. SE Laboratories Ltd., Feltham, Middlesex, England.

Circle Reader Service #413

Digital BCD encoder

Since the switching circuits in this digital BCD encoder are contained within the encoder, you get a much more clearly reproduced signal. Another advantage of this instrument is its backlash-free coupling. A corrugated expansion joint absorbs all displacement and ensures error-free transmission. Jena Optical Works, DDR 69 Jena, Carl-Zeiss-Strasse 1, Germany.

Circle Reader Service #414

Data processing

In a standard configuration this system includes a Laben 70 computer (with 8k memory, 16-input analog miltiplexer, and built-in A/D converter), a teletype machine, and an oscilloscope display unit. The standard configuration may be extended with the addition of 4k memory increments up to 32k. You can get computer programs for on-line data processing operations called RASP (random analog signal processor). Montedel, Laben Div., Via E. Bassini, 15, 20133 Milano, Italy.

Circle Reader Service #415

Static shift registers

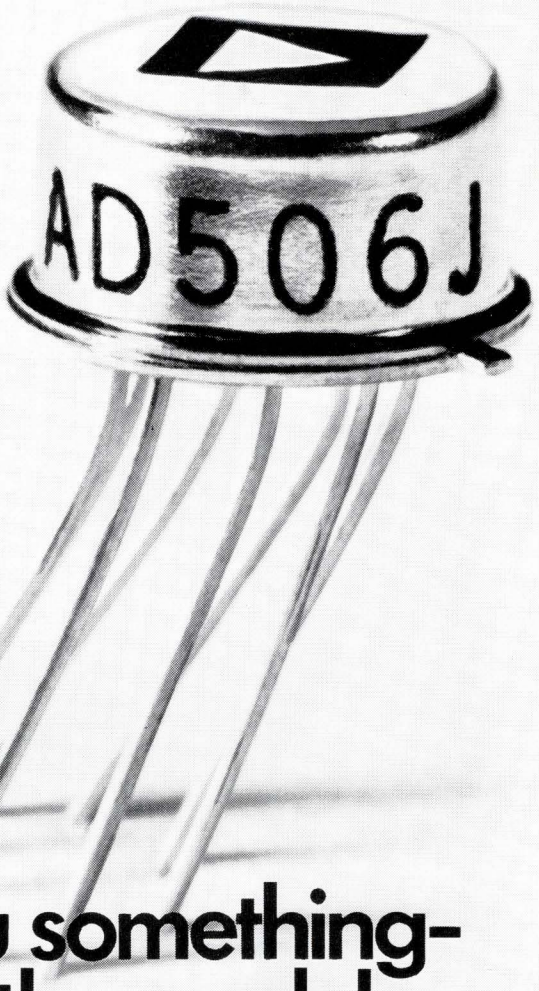
This silicon gate 100/128-bit static shift register operates within the frequency range of 0 to > 3 MHz. All inputs and outputs are TTL compatible and the register operates on standard voltage levels. Registers may be operated sequentially to provide a single 200/256-bit function. The device is available in a TO-5 package. GEC Semiconductors Ltd., Freebournes Rd., Witham Essex, England.

Circle Reader Service #416

Solid state displays

Here is a solid-state numeric display that can be custom designed to your requirements both in terms of numerals displayed and of packaging. Each numeral is a 7-segment monolithic display affixed directly to a master PC board for compact size. Numerals also come individually in a flat-pack configuration for PC mounting. Bowmar Canada Ltd., 1257 Algoma Rd., Ottawa 15, Ontario, Canada.

Circle Reader Service #417



I'll tell you something- we're really out to get the modules (even our own).

Our family of linear IC FET op amps is definitely not going to market as just another low priced substitute for something-or-other. Instead they're going as highest performance, in many cases unique, circuits. Some of them are so good they're replacing some of our discrete modules. Other IC's simply can't compete.

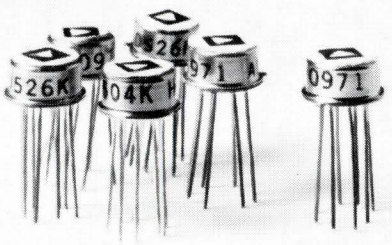
Look at the AD-506: Internally compensated; max I_b 10pA; max V_{os} (internally laser-trimmed) 1mV; guaranteed V_{os} drift 25uV/°C; min gain 50K; typical slew rate 5V/usec.

And the AD-516: Single capacitor externally compensated; slew rate to 20V/usec; settling time 3usec to 0.1%; 5MHz gain bandwidth; (with feed-forward compensation: slew rate to 50V/usec, gain bandwidth to 30MHz); max I_b 20pA; max V_{os} (internally laser-trimmed) 1mV.

There are seven FET op amps in the basic family, all high performance, all functionally complete with little or no need for outboard components, all manufactured and tested under our complete control using the most advanced techniques and equipment. Same is true of our other new IC's: multipliers, converters, instrumentation amplifiers, and dual transistors.

Get our 20-page facilities brochure and detailed catalog of products, free for the asking. Analog Devices, Inc., Norwood, Mass. 02062 (617) 329-4700.

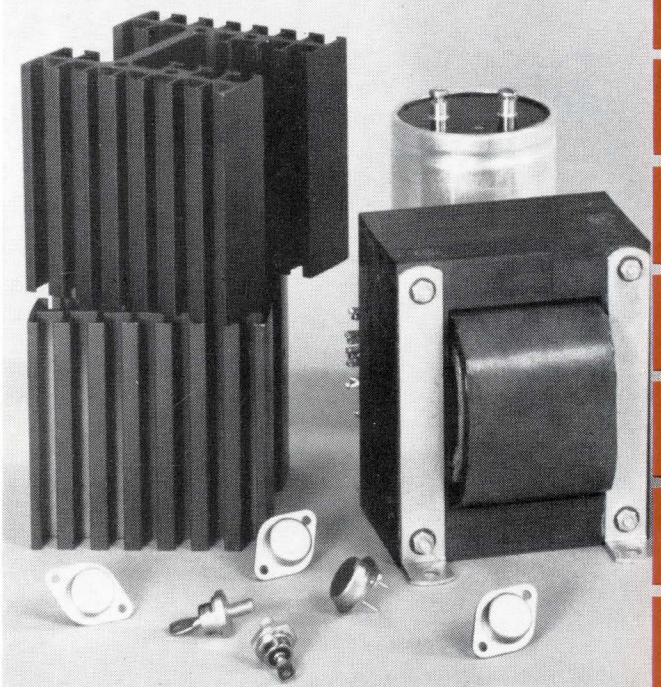
ANALOG DEVICES



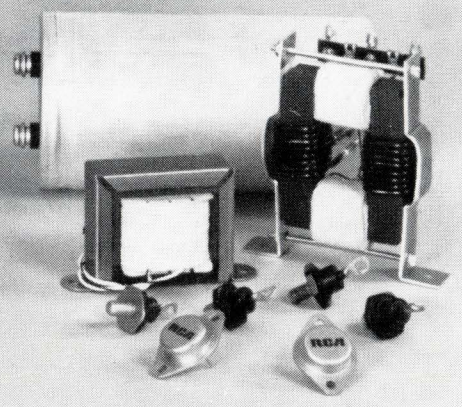
Circle Reader Service #66

Cut the Size of Your Power Supply in Half with Fast, High-Voltage Transistors from RCA.

TRANSISTOR TYPE	POWER SUPPLY OUTPUT (W)
40850	125
40851	250
40852	250
40853	500
40854	1000



Conventional 5 V, 25 A Supply



New 5 V, 50 A Supply

RCA

For details and application note, write: RCA, Commercial Engineering, Section 59I/UT23, Harrison, N.J. 07029

Circle Reader Service #67