

LIBRARY
STATE TECHNICAL INSTITUTE
AT MEMPHIS

OCTOBER 28, 1976

ANNUAL TECHNOLOGY UPDATE ISSUE

The microprocessor revolution continues unabated,
feeding the growing demand for electronics systems/74

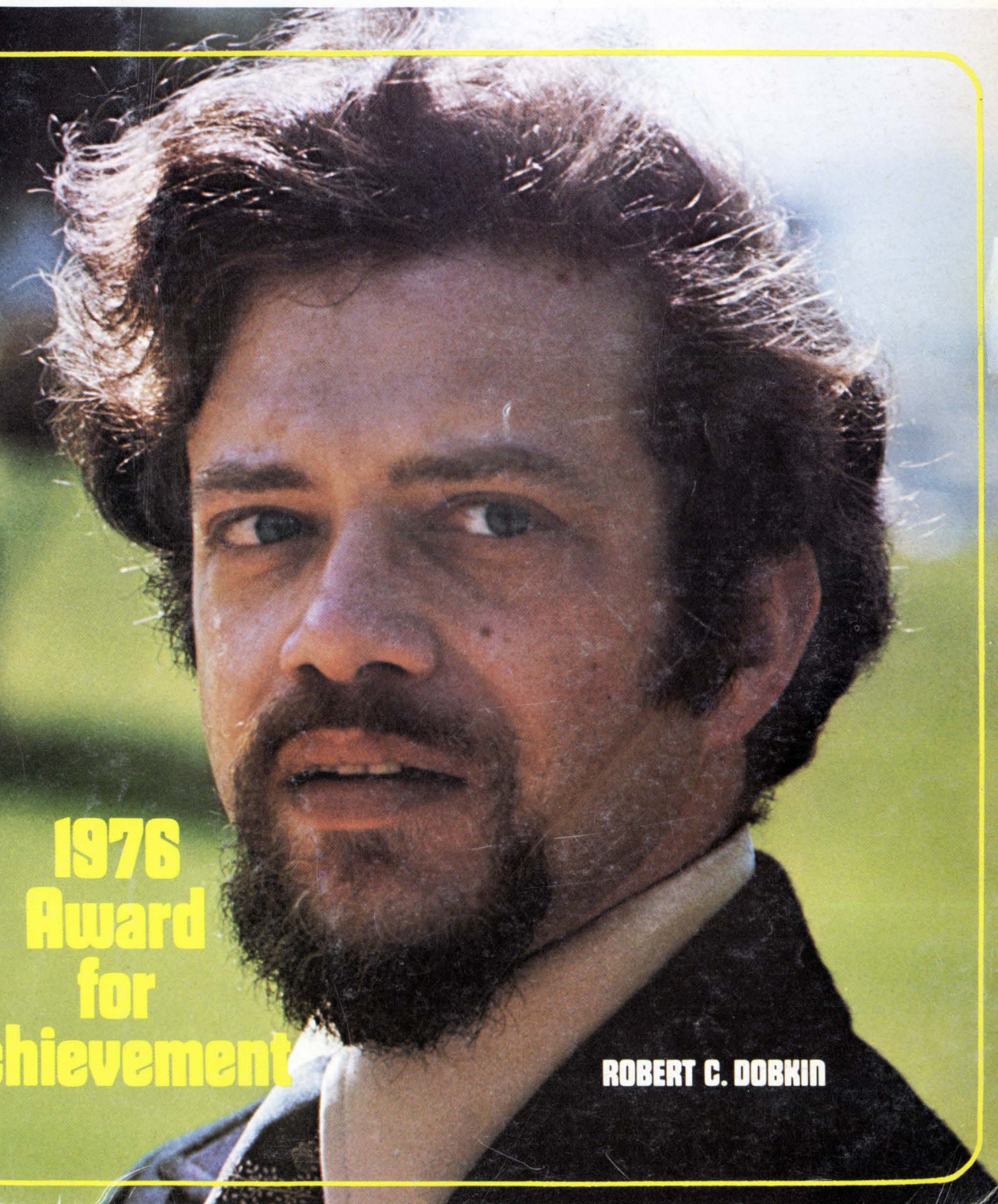
FOUR DOLLARS A MCGRAW-HILL PUBLICATION

Electronics®

STATE TECHNICAL INSTITUTE
STATE TECHNICAL INST
FREEMAN LIBRARY 017823
5983 MACON COVE
MEMPHIS TN
36134

**1976
Award
for
Achievement**

ROBERT C. DOBKIN

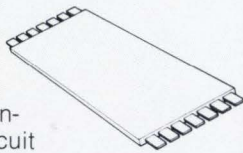


HOW DO YOU WANT YOUR FLAT CABLE?

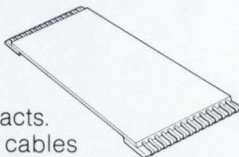
In Bulk. TAPE CABLE® for signal transmission, control and power distribution applications is available with 1 to 200 round or flat conductors of the same or different sizes; with any desired conductor spacing; with many types of insulation; unshielded or shielded on one or both sides.



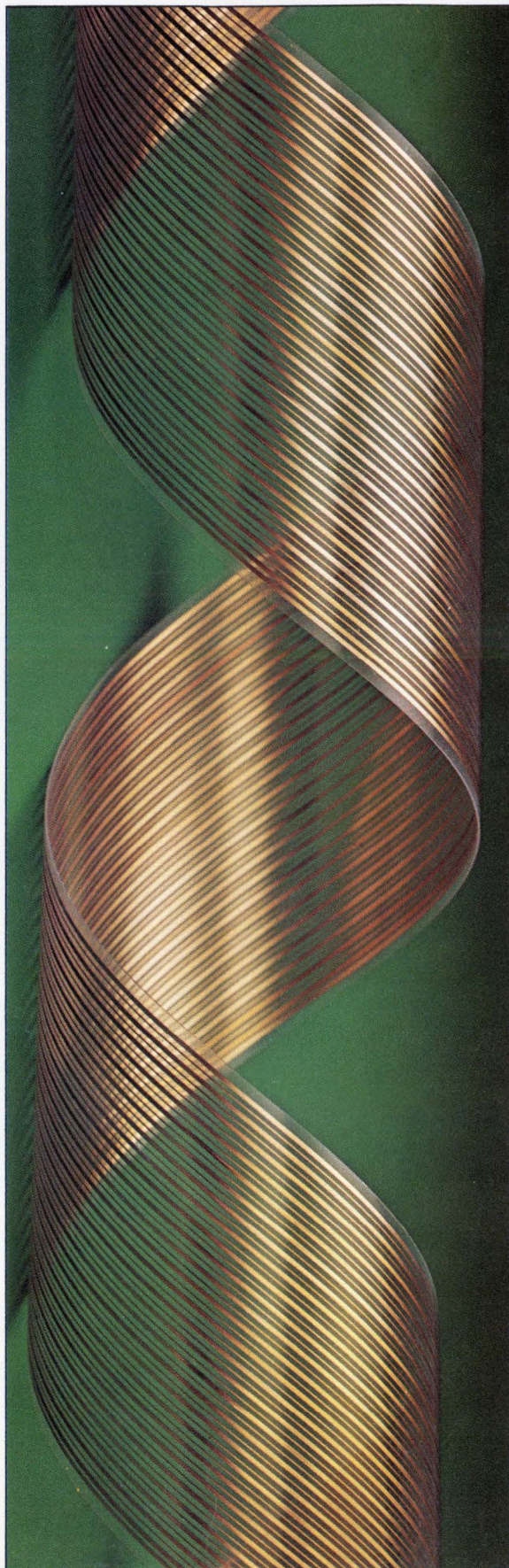
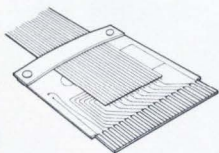
Jumper cables. We'll cut TAPE CABLE to any length you want and strip and tin it at both ends. Brand-Rex jumper cables are instantly ready to interconnect printed circuit boards, connectors, electrical circuits, etc. with reflow or wave soldering.



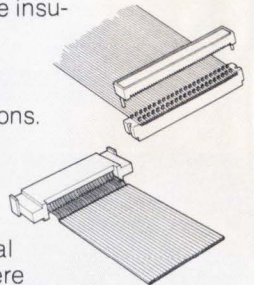
Plug-in jumper cables. We'll form the ends of our TAPE CABLE to mate with printed circuit connectors— with no external connectors or contacts. Plug-in jumper cables are minimum cost, flexible interconnectors for multiple circuits.



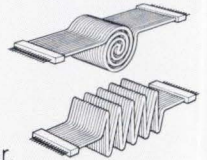
PC Board Harnesses. We can also bond TAPE CABLE to printed circuit boards. When you get it, the whole assembly is ready to go. All you have to do is plug it in.



Connector Harnesses. We can terminate TAPE CABLE with two types of connectors—the insulation piercing type or those requiring soldered connections. Using standard off-the-shelf hardware where appropriate, or special connectors where required. Brand-Rex can recommend suitable connectors for any application.



Self-retracting cables. We can form polyester insulated TAPE CABLE into spiral coils, helical coils or accordions. They're the perfect devices for interconnecting units that move in relation to each other.



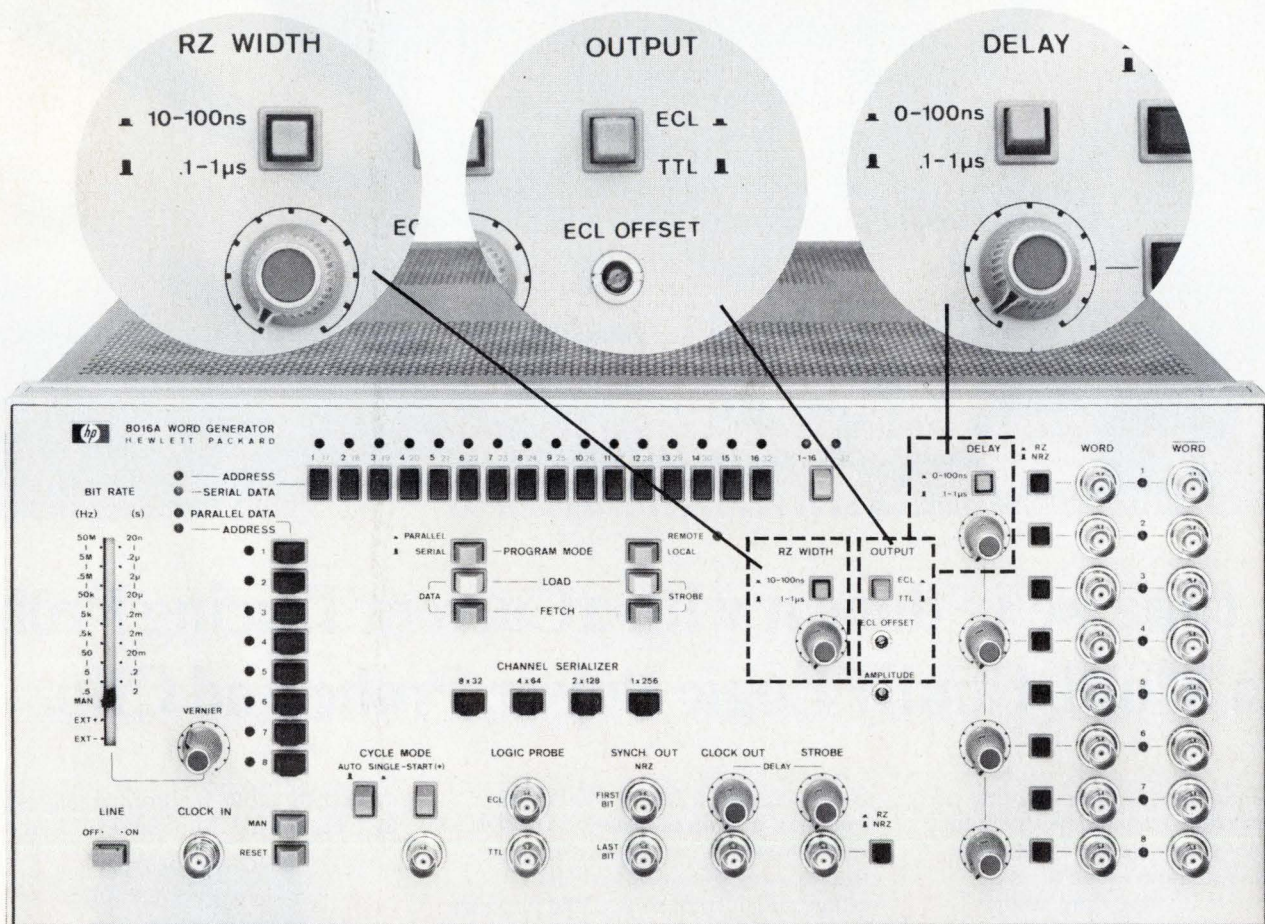
You can order Brand-Rex TAPE CABLE in any form—from bulk to custom assemblies—to solve your interconnect problems. No matter what your electrical, mechanical or termination requirements are, there's a Brand-Rex TAPE CABLE that's right for the job. For more information ask for Technical Bulletin BR-740. Or contact Brand-Rex directly or your nearest Brand-Rex sales engineer. Brand-Rex Company, Electronic & Industrial Cable Division, Willimantic, Connecticut 06226, Phone (203) 423-7771.

BRAND-REX

ELECTRONIC & INDUSTRIAL CABLE DIVISION

Other Brand-Rex Divisions:
 Abbott & Co., wiring harnesses
 Nonotuck Manufacturing Co., copper wire
 Pyle-National Co., electrical connectors
 Telecommunications Cable Division
 Teltronics, Inc., telephone equipment and components
 Brand-Rex, Ltd. (Scotland), wire and cable.

HP announces pulse-parameter control in a word generator



That means an end to building arrays of pulse and word generators to do complex digital testing in the lab or production. HP's new 8016A gives you the digital stimuli you need for IC development or testing, for digital circuit evaluation, for microprocessor system troubleshooting, and for interface evaluation — at data rates to 50 MHz.

Now you can vary pulse width, height, and delay for worst-case or parametric testing such as set-up and hold-time measurements, as well as functional testing. Add HP's new 1600A Logic State Analyzer to your system and you have the ideal combination for observing your logic circuits in action.

Parallel and serial data selection. In the parallel mode, output is 32 bytes, each 8-bits wide. In the serial mode you get up to eight 32-bit words. Or you can serialize outputs for word length up to 256 bits. You have complementary outputs and a selection of RZ/NRZ formats on each channel.

Programming options. Manual data loading is simple with the pushbutton matrix and LED indicators. And a remote programming option allows fast

loading with an HP Interface Bus compatible card reader, calculator, or minicomputer—a valuable option for on-line testing where speed and accuracy are important.

There's still more. The 8016A includes manual clocking for single step testing; a strobe channel to use as a ninth data channel or serial qualifier; clock and sync outputs; ECL and TTL logic-probe power outputs; and other features to provide flexibility and ease of use.

Your local HP field engineer can give you all the details on this powerful new word generator, which is priced at \$6,400*. Or, write for our 10-page data sheet. It gives all the specs, output timing diagrams, and includes application information.

*Domestic U.S.A. price only.

085/13

HEWLETT  PACKARD

Sales and service from 172 offices in 65 countries.
1507 Page Mill Road, Palo Alto, California 94304

We've just revolutionized digital troubleshooting. Again.



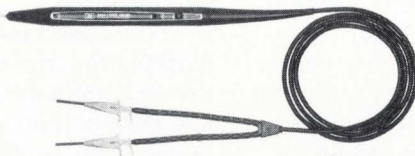
This time we've done it with a Current Tracing Probe and a Multi-Family Logic Pulser, Probe and Clip.

HP's hand-held logic troubleshooting instruments bring dramatic new capability, speed and convenience to locating logic faults. Use them alone or as a synergistic team to save time, money and frustration. They're the latest wave of the IC troubleshooting revolution we started when we introduced the first probe, logic clip and logic pulser.

A Probe that Traces Current! As shown above, the Model 547A Current Tracer's tip lights when on or near a conductor carrying digital current pulses from 1 mA to 1A — in any logic family. Now you know where the current's flowing so you can quickly fix stuck nodes without cutting circuit board traces or removing — and often damaging — good ICs or micro-processors when searching for bad ones. Now you can quickly find solder bridges and backplane shorts, troubleshoot wired AND/OR busses or three-state busses.

A Logic Pulser That Does More Than Just Give Single Pulses. The new 546A Programmable Logic Pulser (above)

gives one pulse, a 1,10 or 100 Hz pulse stream, or a burst of exactly 10 or 100 pulses. Now you can rapidly set your circuit to any state you wish. It's a voltage and current source that provides the controllable stimulus you need for troubleshooting. It'll drive TTL or CMOS high nodes low or low nodes high.



New Multi-Family Logic Probe. The HP 545A tests most positive families including TTL and CMOS. An unambiguous single lamp at probe's tip quickly indicates logic high, low, bad level, pulses, pulse trains. Its built-in pulse memory catches elusive transitions that occur when you're not looking.

New Multi-Family Logic Clip. The Model 548A's 16 LED's show logic states of 16 IC pins at once, revealing the cir-

cuit's truth table. It automatically adapts to TTL, RTL, CMOS and HTL and



automatically seeks Vcc and ground. It draws $<15 \mu\text{A}$ per pin, yet is overload protected to 30 Vdc.

Prices: HP545A \$125, HP546A \$150, HP547A \$350, HP548A \$105, Domestic U.S.A.

Get full details on how this new revolution can help you. Call your nearest HP field engineer today or write.

02604

HEWLETT  PACKARD

Sales and service from 172 offices in 65 countries.
1507 Page Mill Road, Palo Alto, California 94304

For assistance call: Washington (301) 948-6370, Chicago (312) 677-0400, Atlanta (404) 434-4000, Los Angeles (213) 877-1282, Toronto (416) 678-9430

Circle 2 on reader service card

31 Electronics Review

SOLID STATE: Four-level logic coming next year from Signetics, 31
MILITARY: Artillery computer uses Marconi microprocessor, 32
COMPUTERS: Burroughs plans 'super' system, 32
INDUSTRIAL: Microprocessors make progress in process control, 33
SOLID STATE: Fastest 16-k RAM available from Mostek, 33
IEEE: Professional program planning turns to grass roots, 34
COMMUNICATIONS: U.S. policy overhaul urged in Congress, 34
NEWS BRIEFS: 36
MILITARY: Loral adding to P-3C surveillance, 36
CONSUMER: Mosquito repellents sting only buyers, 38

51 Probing the News

COMPONENTS: Mixed-process chips mount linear challenge, 51
CONSUMER: Microcassette recorders awaken in Japan, 54
COMPANIES: Signetics warms in Philips' glow, 56

61 Electronics International

JAPAN: Ceramic filters handle video intermediate frequencies, 61
AROUND THE WORLD: 61

141 New Products

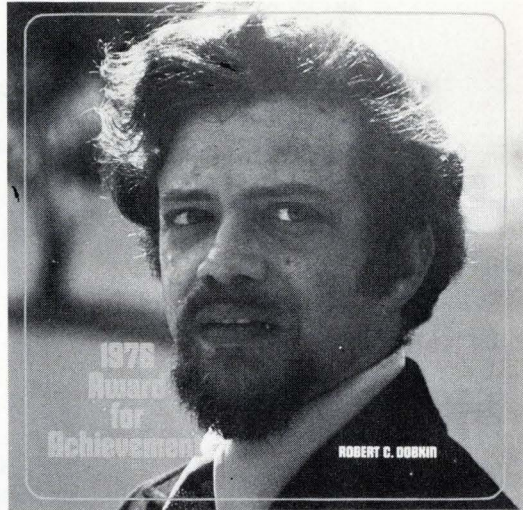
IN THE SPOTLIGHT: IC simulates matched transistor pairs, 141
Isolation amplifier includes integral supply, 144
SEMICONDUCTORS: ICs drive gas-discharge displays, 148
DATA HANDLING: Microcomputers shrink graphics terminal, 162
PACKAGING & PRODUCTION: Tester counts toroidal turns, 175
SUBASSEMBLIES: Modem filters include switches, 190
MATERIALS: 202

Departments

Publisher's letter, 4
Readers' comments, 6
News update, 8
Editorial, 12
People, 14
Meetings, 20
Electronics newsletter, 25
Washington newsletter, 59
International newsletter, 63
New literature, 212

Services

Employment opportunities, 214
Reader service card, 225



Cover: Award goes to linear wizard, 66

For significant advances in linear technology, including many devices that have become industry standards, *Electronics* salutes Robert C. Dobkin, the director of advanced-linear-product design at National Semiconductor Corp. in Santa Clara, Calif.

Cover photo is by Fred Kaplan.

TECHNOLOGY UPDATE, 74

Dramatic improvements in cost and performance achieved with large-scale integration are expanding capabilities in almost every area of electronics. The next 12 months promise to continue the strong technical advances.

Semiconductor, 76: Memory types multiply; microprocessor families grow.

Components, 86: Hybrid and monolithic units are displacing more discretes.

Computers, 90: Small systems move into the design spotlight.

Instruments, 100: Digital tasks spawn new tasks in measurement.

Communications, 108: All technologies aim at greater channel capacity.

Packaging & Production, 116: Process adaptation shrinks interconnection costs.

Industrial, 122: More tools and processes yield to microprocessor control.

Consumer, 128: LSI chips taking over more household chores.

The year in electronics: a chronology, 138

And in the next issue . . .

The growing activity in solar cells; a special report . . . distributed architectures come to control systems . . . the inexpensive way to design a three-pole filter.

EDITOR-IN-CHIEF: Kemp Anderson

EXECUTIVE EDITOR: Samuel Weber

MANAGING EDITOR: Arthur Erikson,
International

SENIOR EDITORS: Laurence Altman,
Ray Connolly, Lawrence Curran,
John Johnsrud, H. Thomas Maguire,
Stephen E. Scrupski

ART DIRECTOR: Fred Sklenar

ASSOCIATE EDITORS: Howard Wolff,
Gerald M. Walker, Alfred Rosenblatt

DEPARTMENT EDITORS
Aerospace/Military: Ray Connolly
Circuit Design: Don Blattner
Communications & Microwave:
Richard Gundlach
Components: Lucinda Mattera
Computers: Stephen E. Scrupski
Consumer: Gerald M. Walker
Industrial: Raymond P. Capece
Instrumentation: Andy Santoni
New Products: H. Thomas Maguire,
Michael J. Riezenman
Packaging & Production: Jerry Lyman
Solid State: Laurence Altman

CHIEF COPY EDITOR: Margaret Eastman

COPY EDITORS: Everett C. Terry, Ben Mason

ART: Charles D. Ciatto, *Associate Director*
Paula Piazza, *Assistant Director*

EDITORIAL SECRETARIES: Janet Noto,
Penny Roberts, Marilyn B. Rosoff

FIELD EDITORS
Boston: Lawrence Curran (Mgr.), Pamela Leven
Los Angeles: Larry Waller (Mgr.)
Midwest: Larry Armstrong (Mgr.)
New York: Bruce LeBoss (Mgr.)
San Francisco: Bernard Cole (Mgr.)
Judith Curtis
Washington: Ray Connolly (Mgr.)
Frankfurt: John Gosch
London: William F. Arnold
Paris: Arthur Erikson
Tokyo: Charles Cohen

McGRAW-HILL WORLD NEWS
Editor: Michael Johnson
Brussels: James Smith
Milan: Andrew Heath
Moscow: Peter Gall
Paris: Joel Stratte-McClure
Stockholm: Robert Skole
Tokyo: Colin Gibson

PUBLISHER: Dan McMillan

MARKETING ADMINISTRATION MANAGER:
Wallis Clarke

CIRCULATION MANAGER: Karl Peterson

MARKETING SERVICES MANAGER:
Tomlinson Howland

RESEARCH MANAGER: Margery D. Sholes

Our annual Technology Update issue, in which we review the major advances that have been made over the past year in electronics technology, is also the vehicle for announcing the winner of the *Electronics* Award for Achievement. The third annual award has been bestowed on Robert C. Dobkin, director of advanced linear-product design at National Semiconductor Corp., for his wide-ranging contributions to semiconductor technology. The award is given to those who, in the judgement of the editors of *Electronics*, best exemplify either leadership in electronics technology or, in the case of those in government, business, or the academic world, leadership in promoting the welfare of the electronics industry. Turn to page 66 for our profile of this year's winner.

One big factor contributing to the difficulty of deciding who will be our award winner is the fact that technology cuts across so many different fields and can take so many different paths. So, in addition to our

Dobkin profile, we have sprinkled profiles of noteworthy innovators throughout the Technology Update pages. The progress of electronics technology, in particular, requires people with imagination, drive, and vision, as well as basic technical skills. That, after all, is one of the things that makes electronics the dynamic field it is.

Even with the benefit of hindsight, putting together the Technology Update kind of story is no easy matter. Months of preparation by our entire New York staff, backed up by on-the-spot reporting by our extensive field staff, both in the United States and abroad, went into this issue, which we believe is one of the year's most rewarding efforts in terms of service to readers. You'll find Technology Update beginning on page 74.



We are looking for an editor

We have an exciting and rewarding career opportunity available for an engineer with writing skills who is interesting in applying those skills and his professional expertise to technical publishing. We have an opening on the New York staff of *Electronics* for circuit design editor. An applicant for the job must be adept at modern analog and digital circuit design and analysis and be able to evaluate circuits for accuracy and innovativeness. He will also write and edit technical articles in that field.

Candidates should have at least a BSEE and substantial engineering experience. If you are interested, send résumé and salary requirements to: Executive Editor, *Electronics*, 1221 Avenue of the Americas, New York, N. Y. 10020.

October 28, 1976 Volume 49, Number 22
96,489 copies of this issue printed

Published every other Thursday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 1221 Avenue of the Americas, N.Y., N.Y. 10020; second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: *Electronics*, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype 12-7960 TWX 710-581-4879. Cable address: MCGRAW HILL NEW YORK.

Subscriptions limited to professional persons with active responsibility in electronics technology. Publisher reserves the right to reject non-qualified requests. No subscriptions accepted without complete identification of subscriber name, title, or job function, company or organization, and product manufactured or services performed. Subscription rates: in the United States and possessions \$12.00 one year, \$30.00 three years; Canada and Mexico \$14.00 one year, \$32.00 three years; Europe \$35.00 one year, \$87.50 three years; Japan, Israel and Brazil \$60 per year; Australia and New Zealand \$80.00 per year, including air freight; all other countries \$40.000 per year. Limited quota of subscriptions available at higher-than-basic rate for persons outside of field served, as follows: U.S. and possessions and Canada \$25.00 per year; Europe \$40.00; Japan, Israel and Brazil \$85.00; all other countries \$50.00. Single copies: \$4.00. Please allow four to eight weeks for shipment.

Officers of McGraw-Hill Publications Company: Gordon L. Jones, President; Paul F. McPherson, Executive Vice President; Gene W. Simpson, Group Vice President; Senior Vice Presidents: Ralph Blackburn, Circulation; John B. Hoglund, Controller; Ralph R. Schultz, Editorial; David G. Jensen, Manufacturing; Vice Presidents: James E. Boddorf, Planning & Development; Edward E. Schirmer, Marketing Administration.

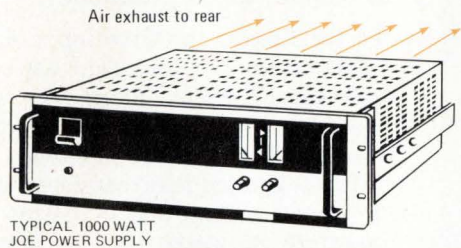
Officers of the Corporation: Harold W. McGraw, Jr., President, Chief Executive Officer, and Chairman of the Board; Robert N. Landes, Senior Vice President and Secretary; Ralph J. Webb, Treasurer.

Title registered in U.S. Patent Office; Copyright © 1976 by McGraw-Hill, Inc. All rights reserved. The contents of this publication may not be reproduced in whole or in part without the consent of copyright owner.

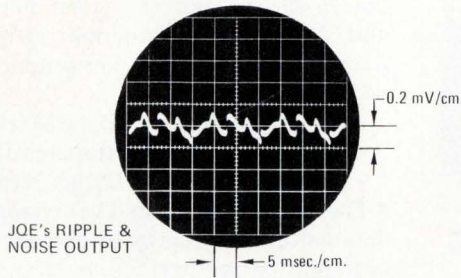
Subscribers: The publisher, upon written request to our New York office from any subscriber, agrees to refund that part of the subscription price applying to copies not yet mailed. Please send change-of-address notices or complaints to Fulfillment Manager; subscription orders to Circulation Manager, *Electronics*, at address below. Change-of-address notices should provide old as well as new address, including postal zip code number. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, *Electronics*, P.O. Box 430, Hightstown, N.J. 08520.

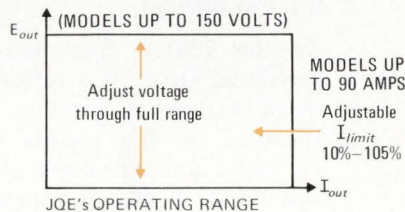
five important reasons to specify the **KEPCO JQE** power supply



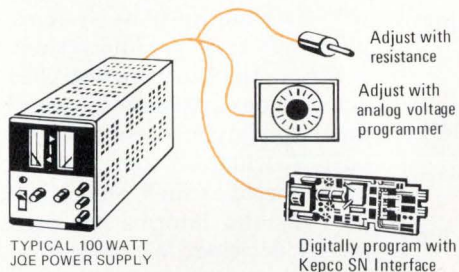
- **JQE deliver their rated output right up to +71°C without any derating whatever.** Moreover, they run cool! Internal blowers actually help circulate the air in your system to keep hot spots from developing.
YOUR MECHANICAL PEOPLE WILL APPRECIATE THIS.



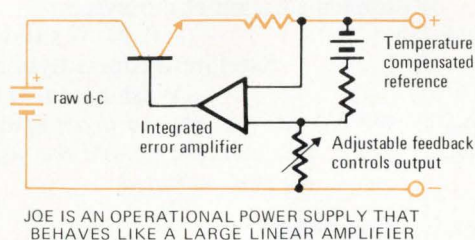
- **JQE produce clean d-c,** less than 0.2 mV rms ripple and noise (1.0 mV p-p including spikes up to 10 mHz). The output varies less than 0.0005% for the worst sort of line variation, and long-term drift is less than 0.01%.
YOUR LOAD WILL APPRECIATE THIS.



- **JQE are wide-range instruments.** Every JQE can be set from zero to its rated output. What's more, they all have one *additional* volt capacity so that wire drops do not subtract from the voltage available to your load. Buy a 0-15V model to cover the 5V, 6V, 8V, 10V, 12V and 15V loads. A 0-36V model to take care of 18, 24, 28, 32 and 36V jobs.
YOUR BUDGET WILL APPRECIATE THIS.



- **JQE are fully programmable**—by resistance (1000Ω/volt) or by voltage (any gain ratio you choose) or by parallel binary or BCD logic. That means you can easily interface your JQE with a computer control bus. (Use the Kepco SN Programmer)
YOUR SYSTEM WILL APPRECIATE THIS.



- **JQE are linear voltage stabilizers**—which means that JQE are a lot simpler and more reliable than switching machines. (You get a 5-year warranty.) A linear JQE will respond in microseconds to a load shift; will maintain its low output impedance into high frequency pulsed loads; produces no RFI/EMI and doesn't hack up the power line like SCR types.
YOUR NEIGHBORS WILL APPRECIATE THAT.

JQE

is a premium quality voltage stabilizer for the no-compromise job

Write Dept. V-14 for the new Kepco Catalog and Handbook.

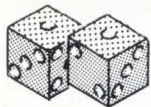
KEPCO®

131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352
(212) 461-7000 • TWX #710-582-2631

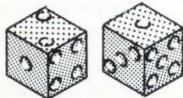


TAKE THE GAMBLE OUT OF SPECIFYING POWER SUPPLIES

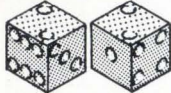
When you specify power supplies manufactured by Abbott Transistor Laboratories, you minimize your risks and maximize your return.



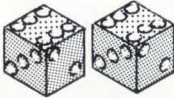
No "SNAKE EYES" with Abbott, only winning performance



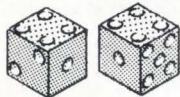
Abbott power supplies are reliable, they won't "CRAP OUT" on you



No "LITTLE JOE'S," Abbott units are big on performance



No "BOX CARS" either — Abbott units are compact



Don't go the "HARD WAY," specify Abbott, the easy way to solve your power supply requirements

Abbott makes a wide variety of industrial/commercial, OEM, military and aerospace power supplies. Each and every unit is subjected to rigorous quality control and electrical testing before shipment to insure that when you put it on the line, it will pass every time.

So when you want a reliable power supply, come to Abbott, the winner for price and performance.

Please see pages 1836-1848 of your 1976-77 EEM (ELECTRONIC ENGINEERS MASTER Catalog) or pages 672-682 Volume 2 of your 1976-77 GOLD BOOK for information on Abbott Modules.

Send for our new 60 page FREE catalog.

abbott transistor
LABORATORIES, INCORPORATED

GENERAL OFFICES
5200 W. Jefferson Blvd.
Los Angeles, CA 90016
(213) 936-8185
Telex 69-1398

EASTERN OFFICES
1224 Anderson Ave.
Fort Lee, NJ 07024
(201) 224-6900
Telex 13-5332

Readers' comments

A resistor gives practicality

To the Editor: In "Fiber-optic data transmission: a practical, low-cost technology" [Sept. 2, p. 94], the receiver in Fig. 5 needs some modification before it will be practical.

It is suggested that the zener diode be turned around and a resistor be inserted between the -12-volt power supply and the zener anode and 2N2905 base junction. Otherwise, the receiver is neither practical, nor is it low-cost.

Bela Marton
Texas Instruments Inc.
Dallas, Texas

■ **The author replies:** The changes detailed are necessary to correct an oversight on my part.

It's not official

To the Editor: The Washington newsletter item "FCC refuses bid to speed action on satellite review" [Sept. 2, p. 51] asserts that the Federal Communications Commission "will not drop a request for an evidentiary hearing" in connection with Satellite Business Systems' proposed domestic satellite system.

Since the commission has not acted on our applications, your headline is plainly erroneous. The text is pure speculation and should have been labeled as such. SBS believes the FCC has the information necessary for its decision. We hope for early commission approval to proceed with implementation of our system.

P. N. Whittaker
Satellite Business Systems
Washington, D.C.

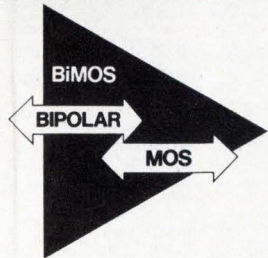
■ *While the FCC has not taken official action, it is expected to hold the hearing, as the item indicated.*

Correction

While the story on Texas Instruments Inc.'s plans to begin selling samples of 92,304-bit bubble memories [Sept. 30, p. 29] correctly gave the production prices for the packages as ranging from 40 to 50 millicents per bit, we erred in translating 50 millicents per bit into cents per bit for the deck of the headline. It should read "... volume-production goal is under 0.05 cent a bit."

What's new in solid state ...

RCA BiMOS op amps. They mix technologies to match circuit needs.



BiMOS was born with our CA3100. On a single chip we combined Bipolar with PMOS—for a more cost-effective wide-bandwidth op amp.

Next, the versatile 3130. With FET, Bipolar and CMOS, it can do a tremendous variety of jobs well.

Latest arrival: our 3140. The most useful op amp since the 741. Able to fill the great mass of op amp sockets, thanks to MOS/FET input and Bipolar output.

Low-cost, no-compromise circuits

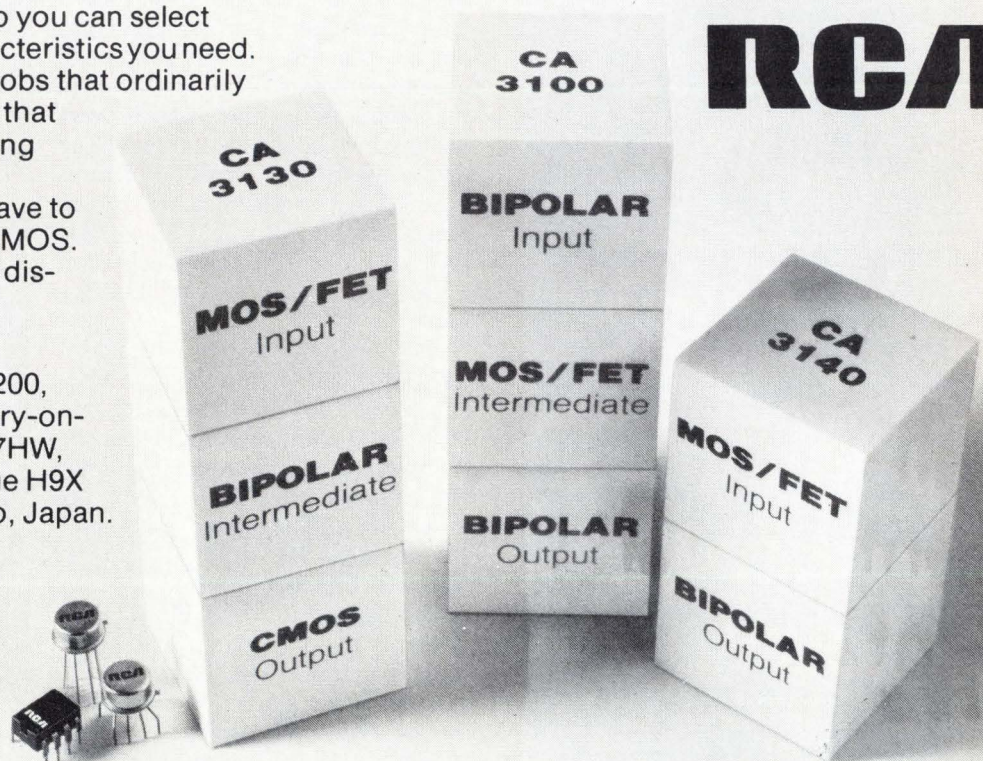
BiMOS gives you the best from each technology without the drawbacks. So you can select op amps with exactly the characteristics you need. A single op amp can often do jobs that ordinarily require many more parts. And that ability opens up new cost-saving ways to meet circuit needs.

Why pay more than you have to for your circuit? Check into BiMOS. Contact your RCA Solid State distributor. Or RCA.

Write: RCA Solid State, Box 3200, Somerville, N.J. 08876; Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste. Anne de Bellevue H9X 3L3, Canada; Fuji Bldg., Tokyo, Japan.

Op amp category	What BiMOS contributes	RCA device
General Purpose	Wide applicability. Low cost.	CA3140 CA3130
FET Input	Lower device cost. Reduced circuit cost. Large input voltage range: capability of swinging to 0.5 V below rail.	CA3140 CA3130
Wideband 4.5 to 70 MHz	High slew rate with low ringing.	CA3140 CA3130 CA3100
Micropower down to 1.5 mW	Strobability.	CA3130
High Current up to 22mA	Eliminates driver stage. Low device cost. Rail-to-rail output swing.	CA3130

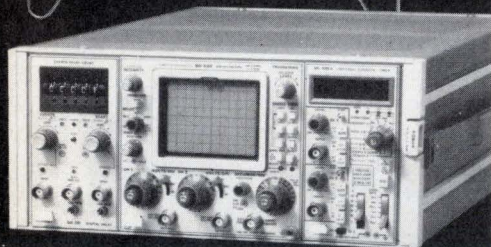
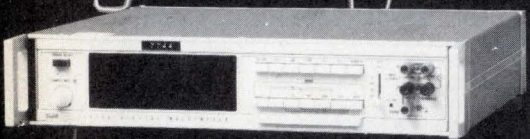
RCA



RCA. Full house in Linear ICs.

Circle 7 on reader service card

Want 90 DVM's for 90 days?



At 90 different places? For short-term, peak DVM needs, call the "Instrument Professionals". They can put the models you need, when and where you want them. Rental is the economic answer to training, field retro-fit or other short-term DVM needs.

Write or call for data on our other specialties: Instrument Leasing • Computer Peripherals • Equipment Sales • Instrument Service.

Circle 8 on reader service card

Call Get our FREE Catalog

Continental Rentals

Div. Continental Leasing Co., Inc.
175 Middlesex Turnpike, Bedford,
MA, 01730 (617) 275-0850

Metuchen, NJ (201) 549-8500;
Gaithersburg, MD (301) 948-4310; TX
(214) 357-1779; Elk Grove, IL (312)
439-4700; Costa Mesa, CA (714)
540-6566; Santa Clara, CA (408)
735-8300; Los Angeles, CA (213) 477-7521

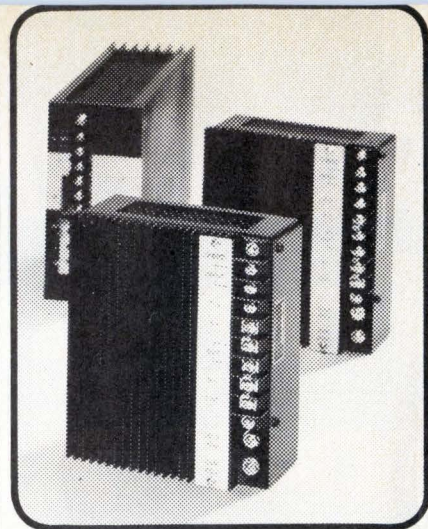
News update

■ The U.S. Army's Picatinny Arsenal in Dover, N.J., has scheduled another series of tests for miniature television cameras under development for battlefield surveillance systems. The TV systems, being developed by Fairchild Camera & Instrument Corp.'s Imaging Systems division in Syosset, N.Y., use a sturdy array of charge-coupled devices to replace the fragile vidicon tube [*Electronics*, Oct. 16, 1975, p. 31]. Tests of the full systems will be conducted next January or February with participation by the Army's Artillery School at Fort Sill, Okla.

The Army made its first deployment of the CCD-array TV systems on July 31 at the Yuma Proving Grounds in Arizona. Three systems were fired at high-G level environments, two at the maximum charge from a 155-millimeter howitzer, notes Ernest Ohloff, a project engineer with Picatinny's Precision Munitions Group. "All three systems functioned perfectly. We considered it a highly successful test," says Ohloff of the TV system that is carried inside a projectile over a target area and released at the right altitude by a timing fuze. Suspended by a parachute, the camera floats and sends pictures of the terrain and ground action to a command post. In the Yuma tests, the systems were deployed at 2,000 feet and picked up and relayed high-resolution pictures of all target symbols on the barren desert's terrain. It would be possible to install a self-destruct mechanism in the system to keep it out of enemy hands.


The Picatinny system is designed to be used with an illumination artillery projectile—the M485 for the 155-mm gun—that is already in the Army's catalog. In fact, the total system uses many of the components of the shell. The camera and associated electronics simply would replace the illuminating canister.

This is not the military's first attempt to put together such a camera system. The Navy experimented with a similar arrangement, using a Fairchild-developed 100-by-100-element CCD array, but dropped the work when it ran out of funds. □



SWITCHING POWER SUPPLIES

- **COMPACT AND LIGHT-WEIGHT!**
- **LOWER PRICE WITH HIGHER RELIABILITY!**
- **SIMPLER CIRCUITS BUT HIGHER EFFICIENCY!**

		MODEL NO.	OUTPUT VOLTAGE (V)	OUTPUT CURRENT (A)
		YP-0510A	5	10
		YP-0525A		25
		YP-0550A		50
		YP-1204A	12	4
		YP-1210A		10
		YP-1220A		20
		YP-1504A	15	4
		YP-1510A		10
		YP-1520A		20
		YP-2402A		2
		YP-2405A	24	5
		YP-2410A		10
		YP-3002A		2
		YP-3005A	30	5
		YP-3010A		10

Sole Distributor:
WAMCO Technical Sales, Inc.
705 W. 16th St. Costa Mesa
Calif. 92627, U.S.A.
Tel. No. (714)-833-9361 or
(714)-642-5100
TELEX No. 678-459.

YUTAKA ELECTRIC MFG. CO., LTD.

No. 228 KARIYADO NAKAHARA-KU, KAWASAKI
CITY KANAGAWA PREF-211 JAPAN
TELEX: J22890 CABLE: TLX-J22890 YUTACO

Circle 225 on reader service card



Faster than a speeding 741...

... more stable than a drifty FET!

Say hello to *Superslew*, generally known as PMI's Mild Mannered OP-01 general purpose bipolar monolithic op amp.

Finally OP-01 has been discovered for what he really is: a speed demon who slews at $18V/\mu\text{sec}$ in inverting configuration. His rise time of 150nsec. (with only 2% overshoot) puts him into competition with the Big Dollars op amps. But OP-01 works cheap—@ \$1.25 (100-999). His V_{OS} , as low as 0.3mV, and I_{OS} , as low as 2nA, make OP-01 the ideal op amp for DAC's. And he settles to 0.1% in 700ns (comparable to dielectric isolated op amps).

Bipolar monolithic, OP-01 fits most standard 741 sockets. Available in chips or package, *Superslew* can pass any MIL level; MIL-883B is instantly available from our distributors.

So if it's not a bird, not a plane, but a faster-than-a-741 op amp you need, call for *Superslew*—our OP-01. An exciting, dynamic data sheet is yours by writing *Shazam* at the address below.



Precision Monolithics, Inc.

1500 Space Park Drive, Santa Clara, CA 95050

(408) 246-9222. TWX: 910-338-0528.

© Cable MONO.

Circle 9 on reader service card

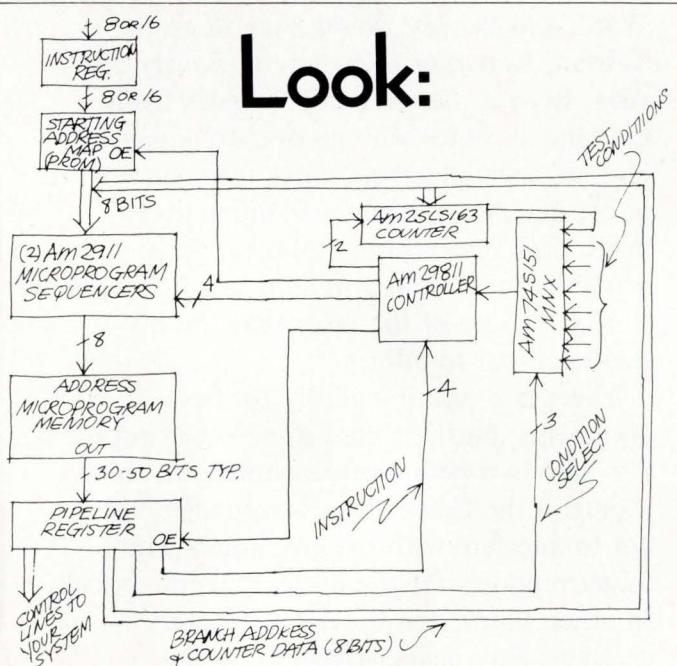
**The
microprogrammed
state machine:**

**Get an Am 29811
and you've
got it made.**

If you make state machines — and you're tired of gates and flops and hassles and headaches — we've just made your life a lot easier.

Get an Am29811, add some Am2911's and you get an amazingly powerful, efficient microprogram controller. Throw in a couple other 16- and 20-pin packages, and throw away your state machine problems. For good.

Look:



The Am2911 provides logic for sequential addressing, branching to any address, four levels of subroutines and looping.

The Am29811 is used to control the Am2911, as well as a loop counter and several branch address sources. The resulting system executes sixteen sequence control functions, most of which can be conditional. (With a 60ns microprogram memory, a typical system can run at 5MHz clock rate—even faster with some minor logic modifications. Wow!)

Two Am2911's can control up to 256 words of microprogram, enough for many state machines. (With three Am2911's, up to 4K words of microcode can be controlled.)

Look again:

Sequence Control Instructions

Jump to Zero

*Jump to Branch Address

Load Counter

*Repeat Jump if Counter \neq 0

*Push PC or Push PC and Load Counter

Jump to Map Address

*Loop

*Repeat Loop if Counter \neq 0

*Jump to Subroutine

*Return

*Jump to One-of-Two Subroutines

*Jump and Pop Stack

Jump to External Address

Jump to Branch Address

*Jump to One-of-Two Branch Addresses

Continue

*Conditional Instructions

Terrific. But how much?

Am2911, \$2.95 in volume.

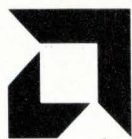
Am29811, \$2.60 in volume.

The entire controller shown, including 8-bits of loop counter and 8-input multiplexer is only \$11.64. That's right. \$11.64 total price.

If you want to know more about the Am2911 or the Am29811, just wire, write or phone. We'll send you a whole book about microprogrammed controllers. For free, of course.

Boy. Some guys really have it made.

Advanced Microprocessors



Advanced Micro Devices, Inc. • 901 Thompson Place, Sunnyvale, California 94086 • Telephone (408) 732-2400 • Distributed nationally by Hamilton/Avnet, Cramer and Schweber Electronics and regionally by Arrow, Bell and Century Electronics

Circle 265 on reader service card

Is dumping really dumping? . . . and other questions

The questions raised about whether Japanese TV manufacturers are dumping their wares on the U.S. market lead not to answers, but to more questions. A goodly number of them are raised by a report, recently prepared by the U.S. embassy in Tokyo and now circulating in Washington, which contains some interesting arguments in favor of unrestricted trade. Take its points on private-labeling, for example.

On the one hand, electronics technology in general and the growth of the electronics industries in the U.S. have always gone along with free trade. In addition, there are many U.S. enterprises, particularly in the consumer sector of calculators, watches, now even games, that depend on off-shore assembly and thus have a stake in fairly open borders. On the other side, however, there are industries like TV-set manufacturing that have been hit hardest by the exports, especially because the Japanese influx has centered around the all-important 19-inch size, the most popular in America.

That, in turn, leads to the question of where the sets are going—whether one should look closer to home for the source of the problems. Of the major mail-order houses, Sears Roebuck now has 80% of its TV sets made in Japan, and Montgomery Ward and J. C. Penney buy from Japanese makers, too.

For these big retailers, the Japanese connection makes sense. Sears, which is listed as having the third largest share of the U.S. color-TV market, wants to have a TV set for a low price, goes to Japan, and gets the right price. The Japanese supplier needs only sign the deal and ship as far as the port in Yokohama. Who could resist a deal like this, especially when hard times

hit Japan's market? The conclusion is that the Japanese are not pushing their sets on the U.S., it's the Americans who are pulling them in via Sears and the merchandisers.

Price is the key in private-labeling, the report continues. It's not exactly dumping, because the U.S. firm is responsible. If the U.S. were to stop Japanese imports next week, it would not end the problem. Sears, Ward, and Penney would have to go to Taiwan, Korea, or elsewhere in Southeast Asia. Even if the various governors from the United States who go over to Japan to lure industry into their states were successful in getting all the Japanese companies to make their receivers in America, there still would be more than a million sets imported, simply because of the price that the big retailers want to offer.

There is a certain validity to these arguments, but let's pose some other questions. For one: In a period of consumerism, isn't it part of the Government's responsibility not to interfere with the consumers' right to get products for the lowest possible price? In other words, consumerism in trade decisions may have arrived. Does the American citizen have a right to buy the cheapest TV set he can get? If so, it's up to those manufacturers to meet the competition through greater productivity. After all, the Japanese took steps two to three years ago to automate, reduce parts count, cut power requirements, and improve productivity in order to survive the 1974 oil crisis. It's now paying off, while American makers are still stuck with high costs.

If the U.S. companies are not truly competitive, no amount of Government support will help in the long run. If they are, no Government support is really needed.

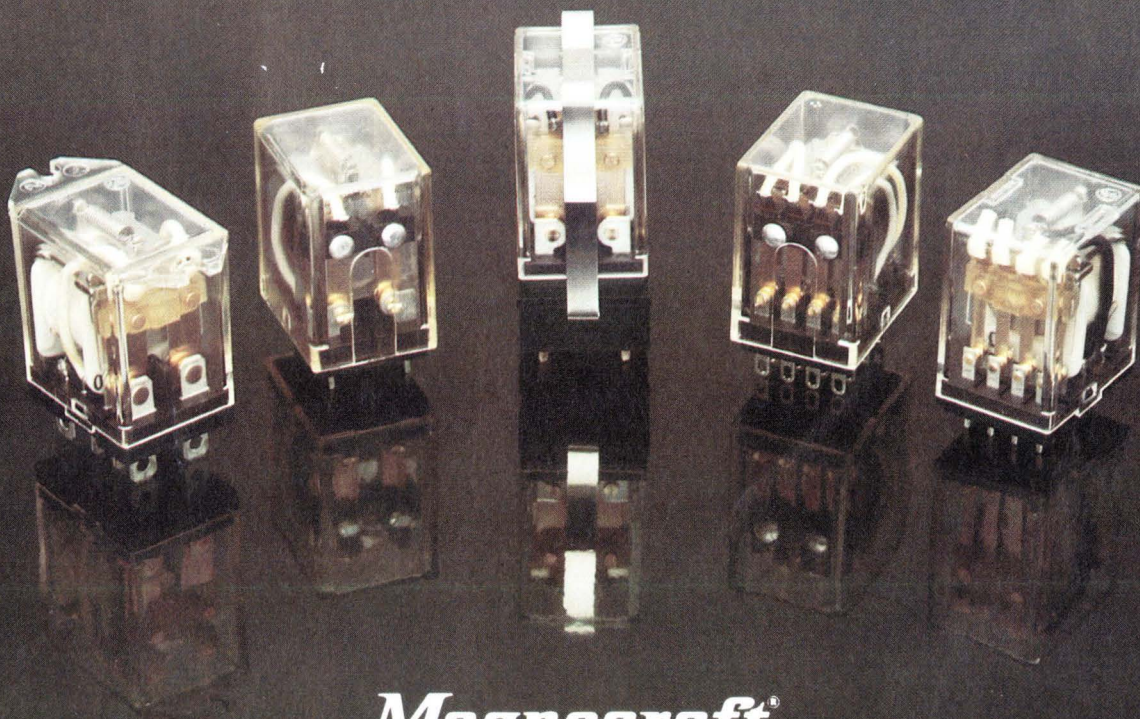
Magnecraft adds the Class 78 ... to make the most complete line of General Purpose Relays. Anywhere.

Class 78 type relays are widely used, general purpose relays. Slightly larger than one cubic inch, these relays provide the most switching capability per cubic inch that your money can buy. And they're interchangeable with all comparable types.

Designed with great flexibility, and in a wide range of AC and DC coil voltages, the Class 78 standard contact combinations are 4PDT for 1, 3 and 5 amps, and DPDT for 5 and 10 amp switching.

Barriered contacts available on some versions for opposite polarity switching. All relays are available with either solder, or P.C. terminals. The 4PDT version is also available with bifurcated contacts. A full range of sockets are also available. This includes screw terminals, solder and printed circuit types.

For complete information and specifications, WRITE FOR OUR CLASS 78 BULLETIN. Magnecraft Electric Company, 5575 N. Lynch Avenue, Chicago, Illinois 60630.



Magnecraft[®]
ELECTRIC COMPANY

RCL

Offers

"EXPRESS DELIVERY"

At Standard Pricing...

On Rotary & "PIP" Switches

Industry's Best Delivery at Non-Premium Prices.

PROTOTYPE OR PRODUCTION RUNS— ALL AT STANDARD PRICING

Send For New '76 Catalog Or Call our Hotline For Name Of Your Local Representative Or Stocking Distributor.

(201) 374-3311

AMF

RCL Electronics

General Sales Office:
700 So. 21st Street
Irvington, N. J. 07111

People

Van Deerlin: helping the law catch up with technology

Lionel Van Deerlin's justification for revising the Communications Act of 1934 is simple: technology has outpaced the law. Says the new chairman of the House Interstate and Foreign Commerce subcommittee on communications, "Yesterday's technology and yesterday's law covering that technology are as out of date as the Dead Sea scrolls."

Yet the 62-year-old California Democrat, a print and broadcast journalist in his home town of San Diego before his first election to Congress 14 years ago, gives the impression that his views of the changes that should be made may be different from those of AT&T and its allies sponsoring the Consumer Communications Reform Act of 1976 [*Electronics*, March 4, p. 33]. In opening three days of preliminary hearings at the end of September on "the Bell Bill," Van Deerlin warned the telephone industry "that those arguing for restraints on competition" must "accept the burden of proof."

In any event, the subcommittee will chart its own course in rewriting the law, beginning with a study next year that will look carefully at the Federal Communications Commission's spectrum allocations, as well as at communications alternatives that do not employ spectrum space.

Law man. Lionel Van Deerlin (D., Calif.) heads subcommittee studying the Bell Bill.



Beyond laws affecting domestic common carriers, the subcommittee is also responsible for legislation covering commercial and public broadcasting, cable television, communications satellites, and radio-frequency allocations including citizens' bands.

First view. The jam-packed hearing room on Capitol Hill provided the first view of Van Deerlin in his new role as subcommittee chairman since he succeeded the late Rep. Torbert MacDonald in April. A self-styled "early exponent of consumerism," Van Deerlin had chaired the commerce unit's subcommittee on consumer protection and finance.

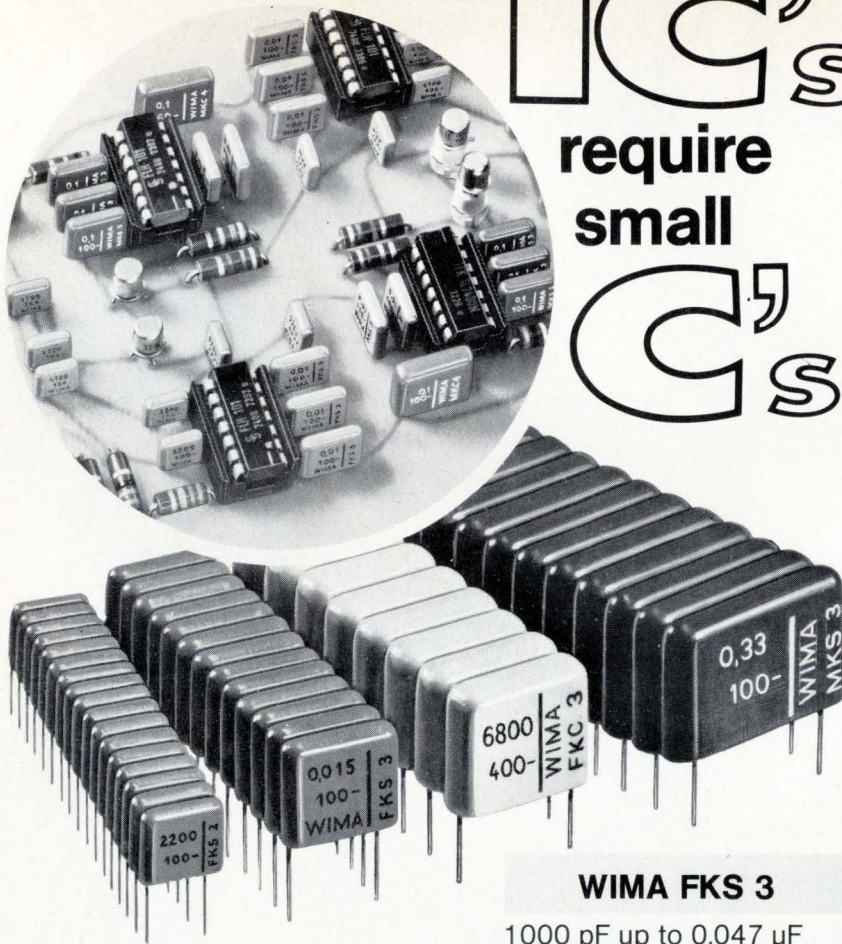
At the hearings, he challenged AT&T and other telephone company leaders to disprove the FCC's "exhaustive inquiry" which found "that any impact of competition on residential [telephone] rates will be limited, [and may even] have the effect of reducing rather than raising residential rates, and is, in any case, manageable by making certain policy adjustments." Yet the commission, Van Deerlin added quickly, is not infallible, and he called for a full airing of both sides of the issue.

Van Deerlin's visibility in his new assignment is sure to increase when the Bell Bill is reintroduced next year in the 95th Congress. The Californian, convinced of the importance of the legislation to the future of American telecommunications, is already making plans to keep his fellow legislators informed. Every new member of the House will receive a transcript of the initial hearings with a personal note from the chairman when the new Congress convenes in January.

GTE's Sacra has hopes for smaller earth-station terminals

The recent reorganization of General Telephone & Electronics Corp. elevated Glenn H. Sacra to the presidency of GTE International Systems Corp. in Waltham, Mass., which designs and builds communication-satellite earth stations and micro-

IC's
require
small
C's



WIMA FKS 3

1000 pF up to 0.047 μ F

WIMA FKC 3

100 pF and up

WIMA MKS 3

Up to 0.47 μ F

WIMA FKS 2 min

P.C.M. 5 mm
1000 pF to 0.047 μ F

Cast-moulded capacitors

are an excellent aid in designing your IC-equipped printed boards. Use the new plug-in WIMA® capacitors which are smaller and have regular dimensions.

Write for our new catalogue.



WILHELM WESTERMANN

Spezialvertrieb Elektronischer Bauelemente
D-68 Mannheim 1
Fed. Rep. of Germany
Augusta-Anlage 56
P. O. Box 2345
Tel.: (0621) 40 80 12

wave communications systems that have been installed worldwide. Most of the earth stations have antennas ranging in diameter from 30 to 32 meters, with an installation selling for \$4.5 million to \$5.5 million.

But the 45-year-old Sacra has his sights on a new market in smaller stations. These include the Intelsat consortium's "standard B" terminals with 10-13-m antennas for international telephone and television links that sell for \$1 million to \$2.2 million, and domestic stations for intra-country communications that range from \$500,000 to \$1 million and in antenna diameter from 4 to 8 meters.

Leadership. The firm recently won contracts for standard B stations in Upper Volta and Mali, and the low-keyed, affable new president has identified 20 to 30 other sales targets. "My goal for ISC is to establish the company in a solid world leadership position in satellite communications, which implies obtaining a significant portion of those standard B stations," Sacra declares.

He would also like to win "one or two more" intracountry programs like the Algerian domestic earth-station system, "where we would have the total national responsibility for a growing system."

Satellite terminals are about 70% of ISC's business, but Sacra also wants to expand in microwaves. "We want to expand beyond pure microwave communications to telephone switching systems and closed-circuit TV so that we're providing total systems service."

To help ISC grow, Sacra is counting on its own good reputation after completing "90% plus" of its projects on time and the leverage of being part of GTE.

But a weakness he hopes to overcome by mid-1977 is that GTE "hasn't been on the leading edge of technology" in developing the equipment needed for the standard B and domestic earth stations. "But we've been pressing very hard for these developments," Sacra points out, "because over the long run [we can't be] dependent on outside suppliers."

We've got 87 answers to your AC solid state relay needs.

Teledyne Relays can handle virtually any AC solid state relay switching application. The reason? A family of AC SSRs with 87 models — and more on the way. We offer a broad range of voltage ratings up to 600V peak, with current ratings from 0.5 to 40 Amps. Add to that a variety of packages for pc board, chassis, or heat sink mounting and you have the industry's most complete line of AC SSRs.

But hardware isn't the only answer. You need assurance of the best available applications engineering support.

And we've got it — backed by seven years as a pioneer and leader in SSR technology to enable you to use our SSRs to their maximum advantage.

That know-how, for example, is reflected in Teledyne's new 970 Series MOV transient suppressors designed specifically to protect our AC solid state relays against high voltage transients.

Contact your local Teledyne Relays people. You'll find we have the experience, technical support and products to meet your SSR needs.



- A. 601 Series***
5 and 10A (to 600V peak). Optically isolated, zero voltage turn-on. Screw terminals, quick disconnects, and pcb pin options.
- B. 611 Series***
10, 15, 25 and 40A (to 600V peak). Optically isolated, zero voltage turn-on. Dual purpose screw/quick disconnect terminals.
- C. 675 Series***
Low profile (0.5" max.) pc board SSRs. Output rating 3A, up to 600V peak. Optically isolated, zero voltage turn-on.
- D. 671 Series**
I/O Converter Modules. Special purpose SSRs for use in programmable controllers, machine tool controls, etc. Mounting panel available.
- E. SerenDIP® Series***
TO-116 DIP package. Output rating 1A/280VRMS. Logic compatible 3.8 to 10VDC input.
- F. 970 Series MOVs**
High voltage transient suppressors designed specifically for use with all Teledyne AC SSRs.

*UL recognized/CSA certified.

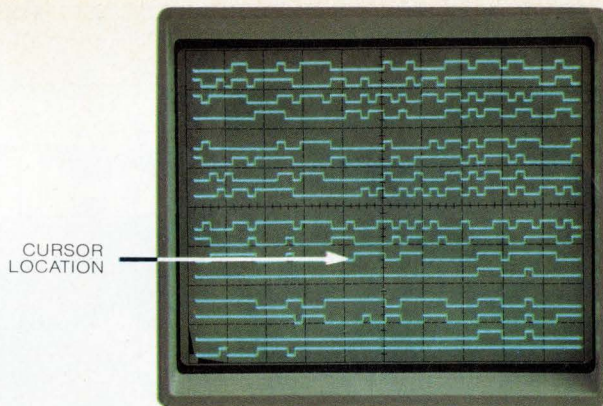
TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250
Telephone (213) 973-4545

time
domain.

data
domain.





Biomation's new 1650-D produces a repetitive display output reconstructing precisely 500 bits per line for a 16-line timing diagram on a conventional oscilloscope or CRT display. Separate selection of individual channel outputs allows viewing of 1, 2...16 channels at one time with automatic vertical expansion.

Biomation's new logic analyzers give you both.

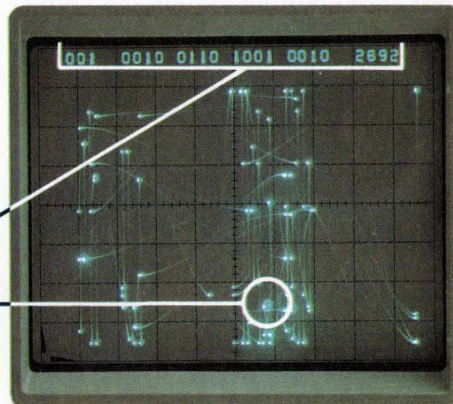
When your job is to interface, integrate and program a complex new digital logic system, you want as much information as you can get.

That's why we're providing a new set of tools which let you display timing information as well as logic word content—in the language of your choice.

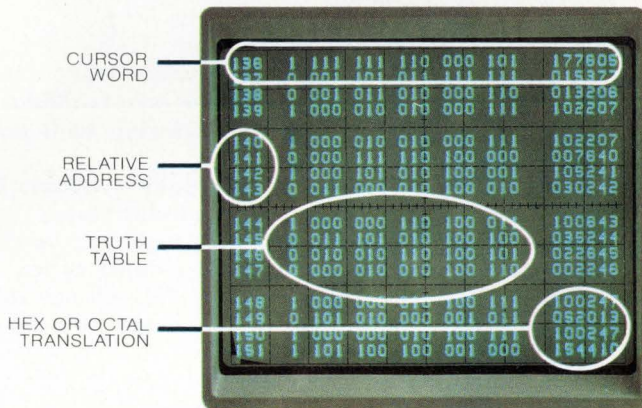
Our new 1650-D logic analyzer gives you 16 channels at 50MHz. Our 851-D gives you 8 channels at the same speed. Accessories can now give you a logic state (1's and 0's) display of any 16 stored words; hex or octal translation; and a vector map of memory contents. The 8 and 16-channel logic analyzers feature:

- Pretrigger and delayed trigger recording
- Trigger point can be easily identified
- Latch record mode for fast pulse capture
- Combinational triggering (true or false)
- Movable display cursor that stays with the data when you switch display modes
- Display expansion, mixed or full, X5, X10 or X20

These are complex instruments and we can't give you all significant details here. But please write, call, or use the reader service card. We want to get this useful information into your hands. Biomation, 10411 Bubb Road, Cupertino, CA 95014, (408) 255-9500. TWX: 910-338-0226.



Map—each word in memory is transformed via two DAC's to form a unique dot which characterizes that word. All 512 words of the 1650's memory can be accessed for mapping. The cursor word is circled in the map as well as displayed at the top of the screen in alphanumeric form. The cursor may be moved to any of the points in the map for positive identification of that word. In addition, a map of only 16 words may be selected.

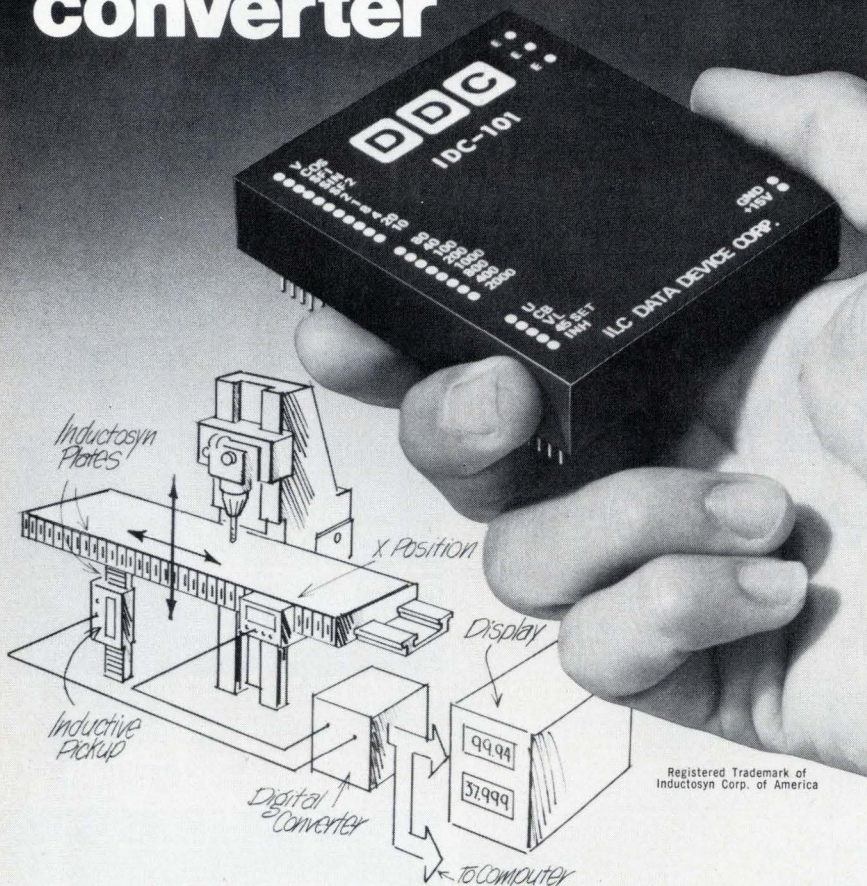


Logic state—provides memory address location, binary output of the 16 channels and selectable octal or hexadecimal translation. 16 words are displayed at one time with the cursor address location at the top of the screen. Movement of the cursor control allows accessing any 16 words of the entire 512 words stored in the 1650-D. The display control memory can store 16 words while a different set of 16 is selected from the 1650's main memory (or a new recording is made). These two sets of 16 words can then be overlaid on the CRT. Any differences will blink and be easily identified.

biomation
Creating tools for technology

Now in modular format!

Inductosyn[®] and resolver-to-digital converter



The first completely modular inductosyn-to-digital converter designed specifically for direct interfacing with both linear and rotary inductosyns.

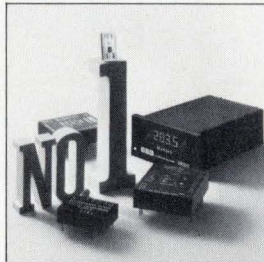
It is ideal for use with commercially available 0.1, 0.2 or 0.4 inch (or millimeter) pitch precision inductosyns.

Now, you can use the IDC-101's type II servo conversion technique which produces 4,000 pulses per pitch cycle . . . or the binary version, IDC-102 at 4,096 pulses. This all-new converter gives you both incremental and parallel output, an internal excitation source and a zero crossing pulse.

For high precision, the IDC-101 provides a worst-case accuracy of one part in 2,000 (or ± 0.00005 in. for a 1-in. pitch inductosyn).

Whenever you must convert inductosyn position information or your task is high-quality position measurement of tools or piecework on lathes, mills or boring machines, the IDC-101 is for you.

We're Number One in High Performance Data Conversions.



DDC

ILC DATA DEVICE CORPORATION

A Wholly Owned Subsidiary of ILC Industries, Inc.
AIRPORT INTERNATIONAL PLAZA, BOHEMIA, LONG ISLAND, N.Y. 11716 • (516) 567-5600
West Coast Office: 7337 Greenbush Avenue, N. Hollywood, California 91605 • (213) 982-6454
Interested engineers, write or call Harry Lewis or send for our 164-page product line catalog

Meetings

International Purdue Workshop on Industrial Computer Systems, Purdue University et al., West Lafayette, Ind., Nov. 8-11.

Joint Conference on Pattern Recognition, IEEE et al., Del Coronado Hotel, Coronado, Calif., Nov. 8-11.

1976 Gomac—Government Microcircuit Applications Conference, Dept. of Defense et al., Dutch Inn, Lake Buena Vista, Orlando, Fla., Nov. 9-11.

Fourth Computer-Aided—Design and Computer-Aided—Manufacturing Conference and Exposition, Society of Manufacturing Engineers (Dearborn, Mich.), Dallas Hilton Hotel, Dallas, Nov. 15-18.

Computer Networks: Trends and Applications, IEEE, National Bureau of Standards, Gaithersburg, Md., Nov. 17.

Electronica 76—7th International Trade Fair for Components and Production Facilities, Munich Fair Authority, Munich, West Germany, Nov. 25-Dec. 1.

National Telecommunications Conference, IEEE, Fairmont Hotel, Dallas, Nov. 29-Dec. 1.

Forum on Computer Technology, American Society of Mechanical Engineers, Statler Hilton Hotel, New York, Dec. 5-10.

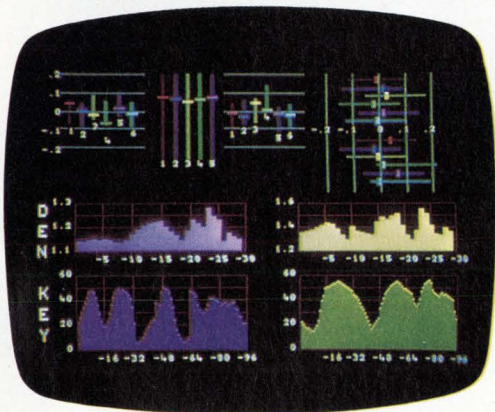
Chicago Fall Conference on Consumer Electronics, IEEE, Ramada Inn-O'Hare, Des Plaines, Ill., Dec. 6-7.

Distributed Data Processing Conference, American Institute of Industrial Engineers (Santa Monica, Calif.), Ramada Inn-O'Hare, Des Plaines, Ill., Dec. 7-10.

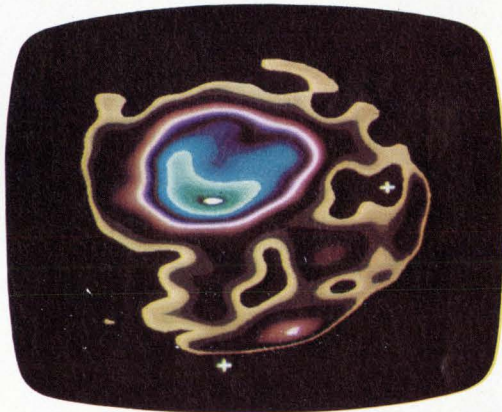
Solar Cooling and Heating: A National Forum, Energy Research and Development Administration, Fontainebleau Hotel, Miami Beach, Fla., Dec. 13-15.

What You Need Is What You Get.

Ramtek's new RM9000 modular graphics and imagery system gives you expandability, economy and flexibility.



Process Control: Color printing press.



Medical Imaging: Nuclear heart study.

Select The Performance You Need.

The RM9000's total modularity lets you select the exact performance you need to fill your particular application. You pay only for the performance you need. Nothing more. And that's like money in the bank.

Add On As You Have To.

As your needs change and grow, the RM9000's capability will grow right along with them. A comprehensive list of options such as expansion from black and white to grey scale or color—even a complete range of interactive peripherals and additional independent channels.

Microprocessor-Controlled Raster Scan.

The RM9000 is the first raster scan graphics and imagery system to be totally microprocessor

controlled. That means you can implement a higher-order user language to minimize programming costs without a sacrifice in system throughput.

Functional. Reliable. Maintainable.

High reliability is the direct result of intensive testing of components and systems prior to shipment. Solid state components and printed circuit construction are used exclusively. Result? No special preventive maintenance measures are required. In fact, the RM9000 can be pre-programmed with self-diagnostic capability.

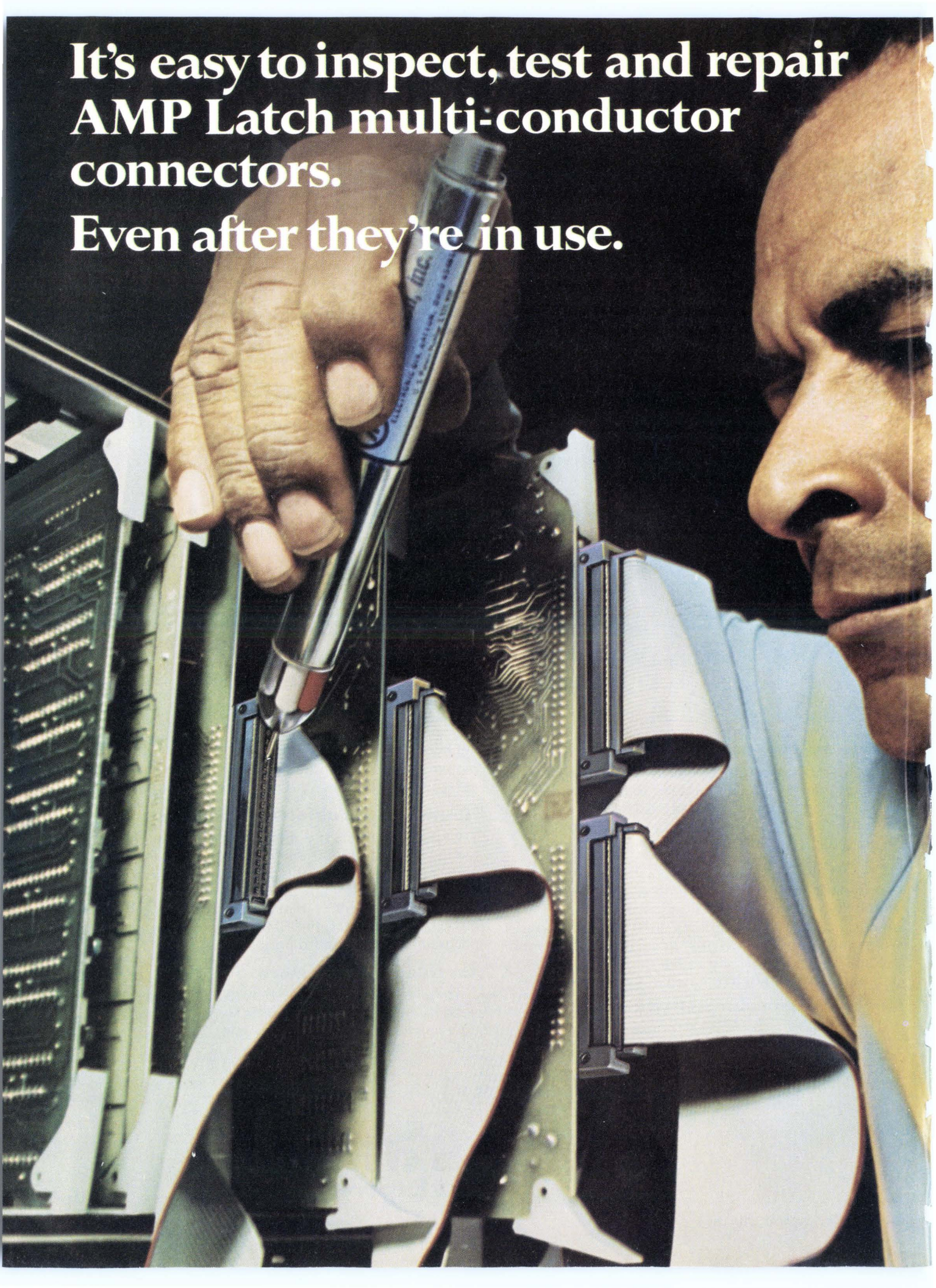
You Need To Know More.


To fully appreciate the RM9000's capability, you need more details. Call or write Ramtek Corporation, 585 N. Mary Ave., Sunnyvale, CA 94086. (408) 735-8400.

ramtek
Our Experience Shows

**It's easy to inspect, test and repair
AMP Latch multi-conductor
connectors.**

Even after they're in use.





We designed them that way. Because a mass termination connector should help you save time and effort before, during and after assembly.

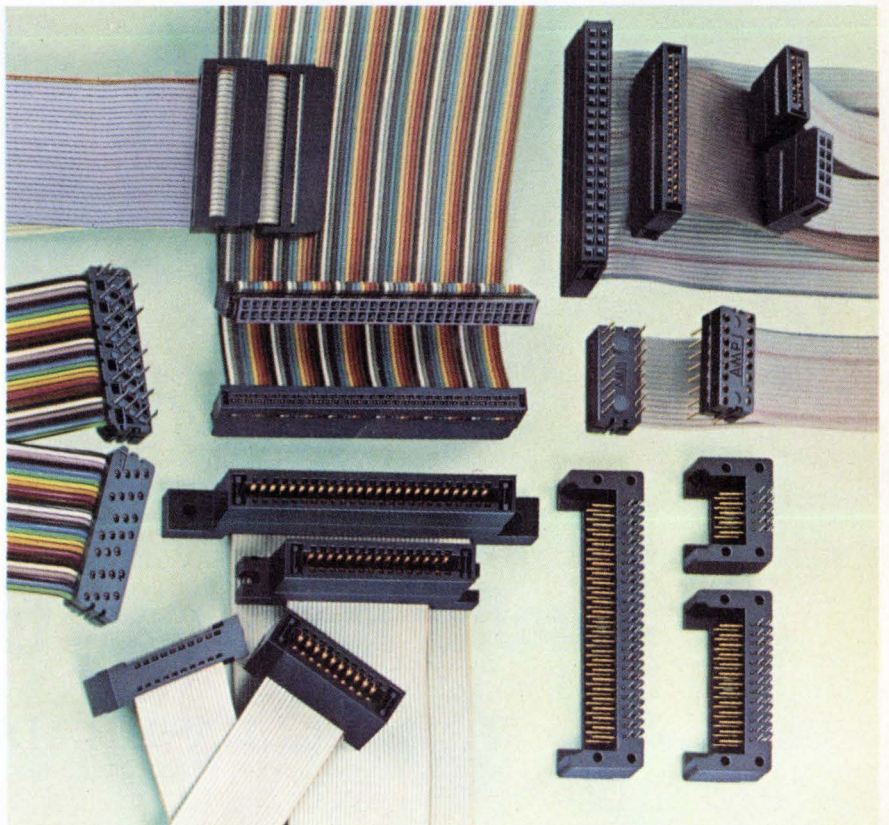
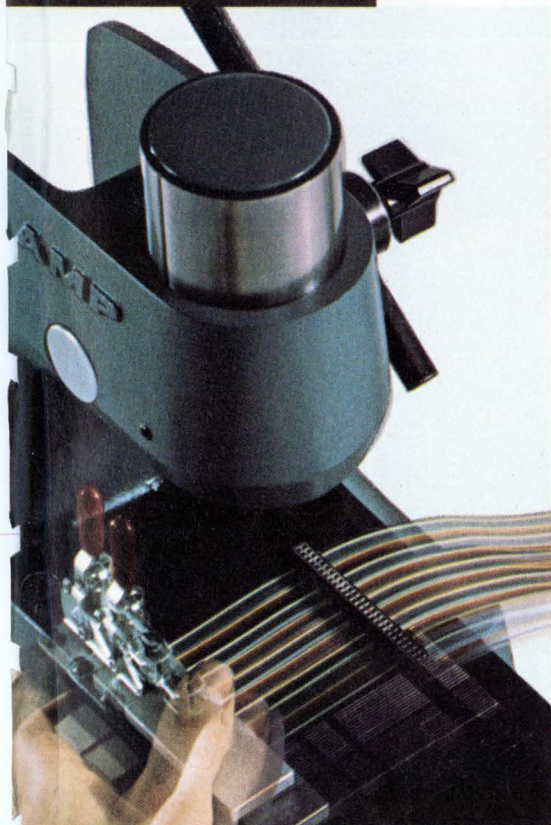
Their unique folded contact design, with dual camming and latching ears, assures you of four-point electrical contact and mechanical grip for each conductor. And that means superior overall reliability and protection. In addition, these fork-type contacts make it especially easy to visually inspect each termination before the cover is applied.

And even after the cover is on, each contact can still be visually checked for proper locking and latching. Because every AMP Latch cover has a built-in inspection port over each termination. This also permits electrical testing without cover removal, saving additional production time. And if repair ever is necessary, we've made that easier, too, by designing special hand and pen tools.

There are more reasons why you should choose AMP Latch connectors such as quick, easy terminating with the AMP shuttle tool, and the broad variety of pin headers and connectors. You also get AMP backup . . . expert design and production help that's yours for the asking from AMP connector engineers.

Why not contact Customer Service, at (717) 564-0100 for complete details on the AMP Latch connector line? Or write us direct. AMP Incorporated, Harrisburg, PA 17105.

AMP
INCORPORATED



AMP is a trademark of AMP Incorporated.

Circle 23 on reader service card

The one variable the world can standardize on.

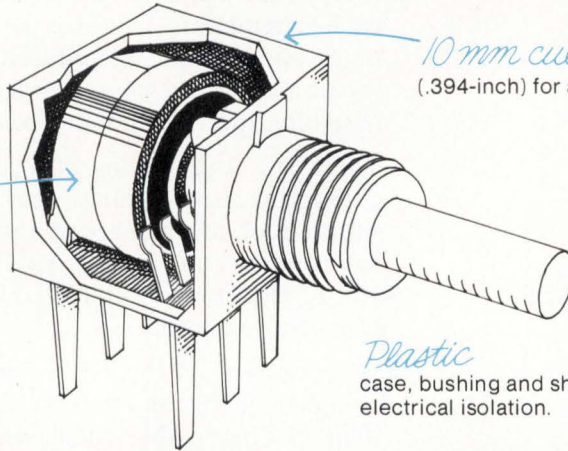
Our new Type M conductive plastic variable resistor is hard metric. A 10 mm cube that's tiny, flexible and rugged. The MINI-METRIC is the smallest dual pot available today. Manufactured in the United States, it's dimensioned the way the rest of the world thinks. Allen-Bradley has what you need; or, it can be ordered through our distributors. Ask for Publication 5239.

Choices

single or dual pot or
pot/switch combinations

100 ohms to 1 megohm

conductive plastic resistance
elements, $\pm 20\%$ tolerance,
standard resistance values
conform to IEC.

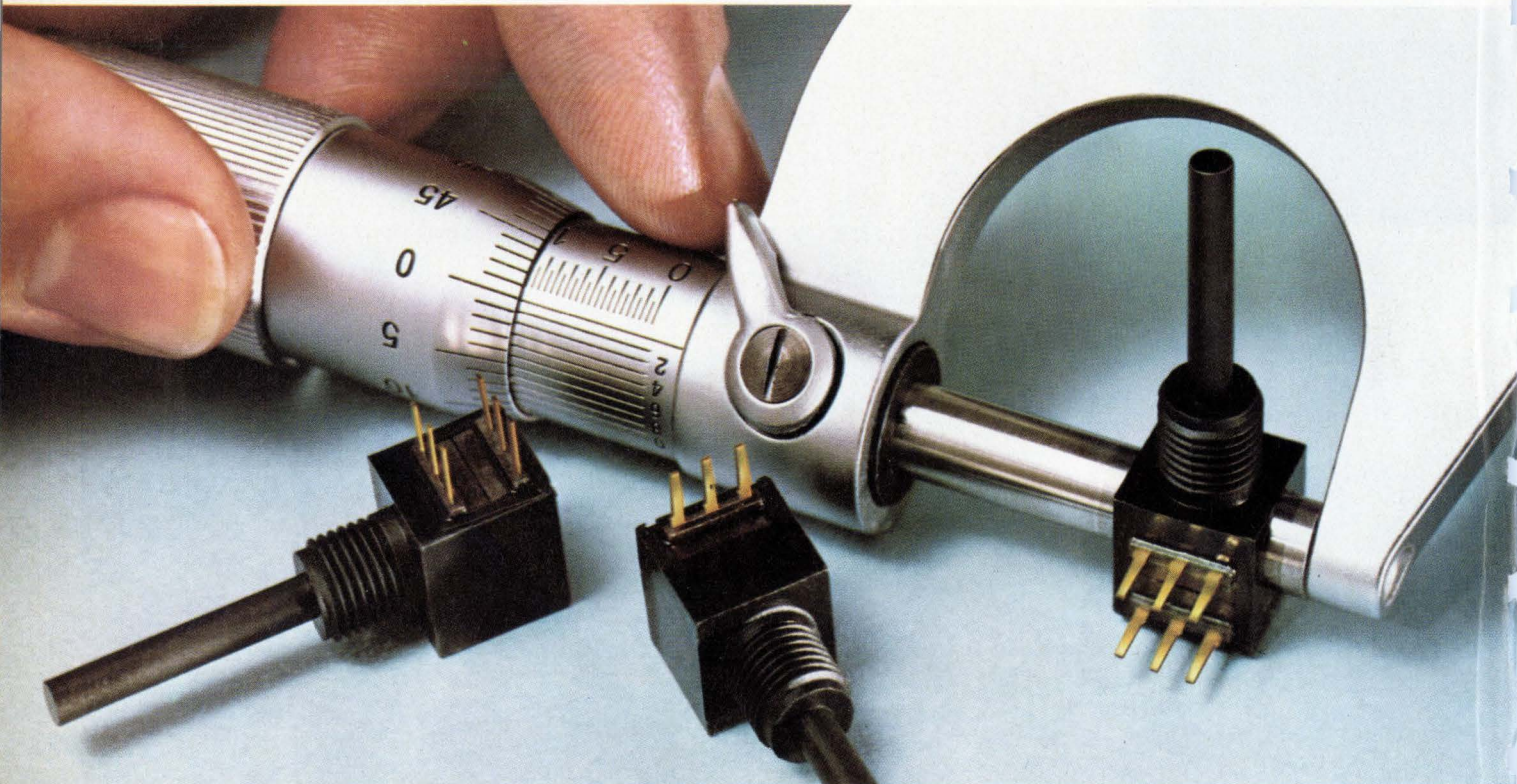


10 mm cube

(.394-inch) for all combinations.

Plastic

case, bushing and shaft for
electrical isolation.



Quality in the best tradition.



ALLEN-BRADLEY

Milwaukee, Wisconsin 53204

EC131

Intel to challenge IBM computers next year in Europe

San Francisco-based Intel Corp. plans to deliver its first Advanced System computers to Europe in the fourth quarter of 1977. The company expects to sell 25 to 30 of these large computers in Europe during the next 18 months. Intel says the Advanced System machines, which are being built by a subsidiary of National Semiconductor Corp., are compatible with IBM 370 models. **The Intel AS/5, which has the same operating speed as the 370/158 and uses similar software, is priced about 25% lower than the IBM system.** The smaller AS/4 will sell for about the same as the IBM 370/148 but has 1.4 times its performance. Intel says the lower power consumption and heat generation, as well as higher operating speed of its machines, should promote sales.

AMI making LSI chips for \$550 sewing machine

A \$550 home sewing machine, to be introduced in the U.S. next month by the Singer Co., will contain custom p-MOS metal-gate, ion-implanted LSI chips supplied by American Microsystems Inc. of Santa Clara, Calif.

The Singer-designed chip has a read-only memory for programmed pattern storage and input/output recognition circuitry that outputs to a servo amplifier to drive the needle for "feed and bite" functions. For cost reasons, the chip for the new machine, called the Diana, has fewer stored programs than the LSI devices also being supplied by AMI for Singer's first electronic sewing machine, the \$800 Athena 2000, introduced last year. **Singer is seeking multiple sources for the new chip.**

AMI also is supplying custom microprocessors for Singer's new industrial self-programmable sewing machine, the Centurion, whose "brain" is capable of remembering more than 100 different sewing tasks and reusing any one at any time. Intel Corp., also of Santa Clara, is supplying ROMs for the Centurion, which will be available in December and will cost up to \$3,000.

RCA developing microprocessor-based auto data system

RCA Laboratories in Princeton, N.J., is developing a microprocessor-controlled information system that will monitor the operating conditions of an automobile and even brake the car in an emergency. The work is being done under contract to Minicars Inc. of Goleta, Calif., for the research safety vehicle program sponsored by the National Highway Safety Administration. The system will present dashboard information and other data such as rate of fuel consumption and engine rpms in luminescent orange alphanumeric characters.

The system uses a standard, commercially available RCA Cosmac microprocessor to process information from sensors mounted throughout the vehicle. In determining the probability of a collision, the microprocessor **considers return signals from an RCA-developed microwave radar**, which shows the vehicle's direction and speed, as well as obstacles and the location, speed, and direction of other cars. If the lights or windshield wipers are on, indicating poor driving conditions, the microprocessor includes this information in continually calculating in thousandths of a second the probability of collision. The system can also be used with an automatic cruise-control system.

Air Force seeks long-range optical recon system

To augment its airborne radar and infrared day-and-night reconnaissance capability, the Air Force will probably award a development contract in December for a long-range electro-optical reconnaissance system that would **be able to discriminate between small targets at ranges of 20 to 30 miles**. The camera images would be relayed to the ground in real time via a data link, where processing and interpretation would be done.

The development contract from the avionics laboratory at Wright-Patterson Air Force Base, Dayton, Ohio, isn't expected to top \$3 million, but the production potential would be substantially greater. The system is supposed to be operational in the 1980s. Bidders for the development award include Actron Industries division of McDonnell Douglas Corp., Chicago Aerial Industries division of Bourns Inc., Fairchild Camera and Instrument Corp., Itek Corp., and Perkin-Elmer Corp.

Motorola first in U.S. with 3-leaded devices in SOT-23 packages

Motorola Semiconductor Products division is about to become the first U.S. producer of three-leaded devices in the popular SOT-23 package [*Electronics*, July 22, p. 99]. Prototype production is scheduled to start during the first quarter of 1977, **with full production due during the second quarter**. The package, now being used heavily in commercial hybrid circuits, will be dubbed MiniBloc by Motorola.

Vector shrinks airborne telemetry discriminators

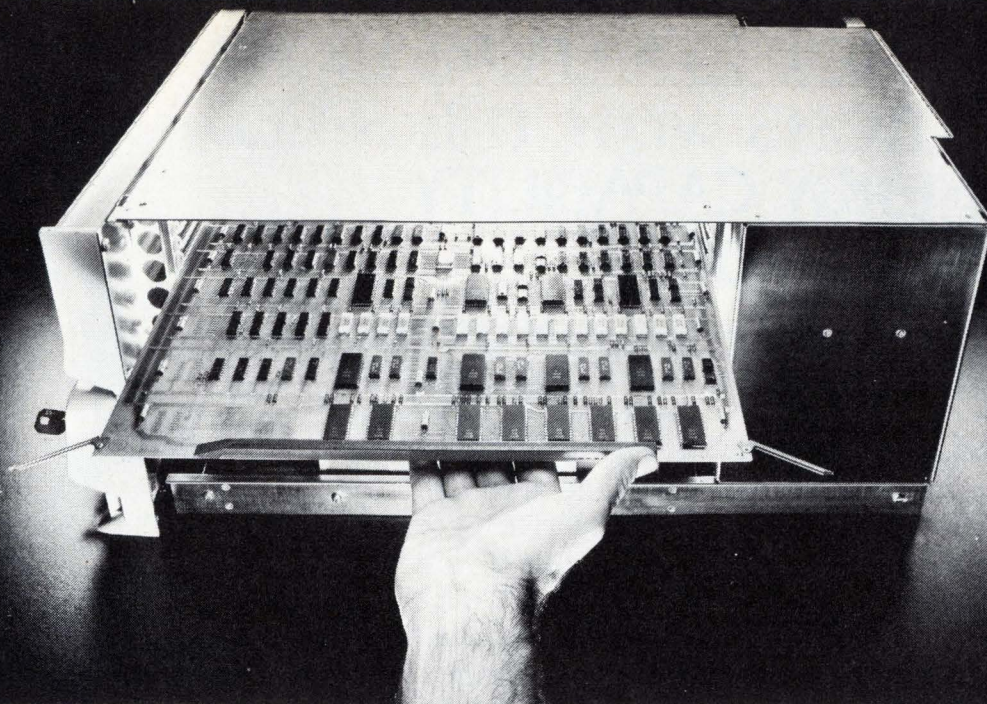
The Vector division of Aydin Corp. in Newtown, Pa., is marketing airborne telemetry receiving systems, beginning with a line of micro-miniature discriminators. Using the hybrid technology and packaging techniques developed for its voltage-controlled oscillators and other telemetry transmission equipment, Vector has come up with a discriminator that **consumes less than 1.5 watts per channel**. In its 1.42-by-1.38-by-2.18-inch package, the device is about one third the size of presently available units but, at \$600/channel, is also more costly. Each of three modules in the discriminators has two 1-in. hybrid substrates. The three-ounce discriminators, the ABD-111 series, are for airborne fm receiving systems such as those used in missiles, remotely piloted vehicles, and space vehicles with tight space, weight, and power-consumption constraints.

Sweda to market Data General's POS system

The Sweda International division of Litton Industries has purchased the **worldwide distribution rights to the supermarket point-of-sale system** announced by Data General Corp. In August 1974, legislation frustrating development of that market had the Southboro, Mass., discouraged the minicomputer maker from pursuing it. Under terms of the agreement, Sweda will buy some \$40 million in Data General products through 1980.

Addenda

Wema estimates worldwide semiconductor shipments by U.S. makers this year will total \$2.536 billion, **although the volume through August indicates the total could top that figure**. With shipments for that month hitting \$277 million, the first eight months of 1976 saw shipments soar to \$2.186 billion.



Give your data communications system a little goose and it'll put out ten times as much.

Open up the back of any Data General communications system, pop in our single-board DCU/50 Data Control Unit, run through a little step called COMGEN and stand back. Because that system can start pumping out ten times as much data. And possibly a good deal more.

What makes this all possible is a rather clever piece of engineering.

We've designed the DCU/50 as an intelligent programmable controller. So it takes over jobs the CPU used to do. Things like character handling and code conversion. Which frees up the CPU processing power and speeds up total systems throughput.

On the other hand, you may not need more throughput. Instead, you may need more lines or different types of lines. Both of which are just as easy to get. You just plug in some different boards.

We make modular synchronous and asynchronous multiplexors you can mix

in any proportion. They can handle anything from one to sixteen lines, are fully software supported and work equally well with or without the DCU/50.

Which brings up a rather significant point.

When you buy your communications equipment from Data General, you can get exactly what you need right now. And later, if you need more throughput, more lines or different types of lines, you won't have to throw out anything. All Data General communications hardware and software are completely compatible. So you can add on to what you already have.

Write for our free brochure, "The Sensible Way to Use Computers in Data Communications" and detailed information about the DCU/50 Data Control Unit.

And if that isn't enough information, we'll send a sales engineer who can also put out ten times as much.

DataGeneral

Data General, Route 9, Southboro, Mass. 01772 (617) 485-9100. Data General (Canada) Ltd., Ontario.
Data General Europe, 15 Rue Le Sueur, Paris 75116, France. Data General Australia, Melbourne (03) 82-1361

Circle 27 on reader service card

DELCO'S NEW 25-AMPERE HIGH VOLTAGE DARLINGTONS WITH THE SPEED AND ENERGY CAPABILITY YOU ASKED FOR.

Good news for motor speed control designers who have expressed a need to upgrade horsepower ratings. The 25-ampere gain of these new Darlington permits increased horsepower ratings of existing AC motor speed control systems and a reduction in paralleling in new designs. However, grouping of t_{off} is available for current sharing in designs

MAJOR PARAMETER LIMITS

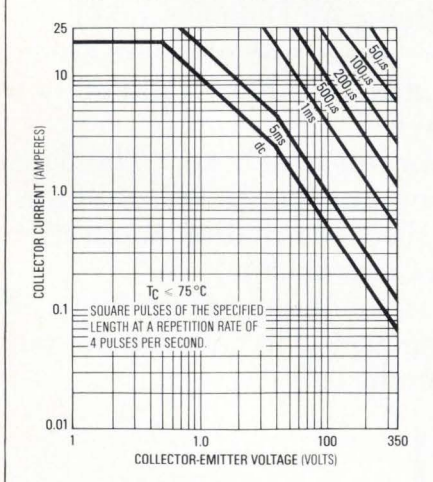
Type	hFE @ 25A	hFE @ 10A	VCEO (sus)	VCE (sat) @ 20A	ICEO @ 600V
DTS-4066	5	75	350V	3.5V	0.25mA
DTS-4067	10	150	350V	2.0V	0.25mA
DTS-4074	5	75	350V	3.5V	0.25mA
DTS-4075	10	150	350V	2.0V	0.25mA

TYPICAL SWITCHING

	DTS-4066 DTS-4067	DTS-4074 DTS-4075
t_r	0.5 μ s	0.5 μ s
t_s	5.0 μ s	3.2 μ s
t_f	4.5 μ s	1.0 μ s

NPN triple diffused silicon Darlingtons are packaged in solid copper cases conforming to JEDEC TO-3 outline dimensions.

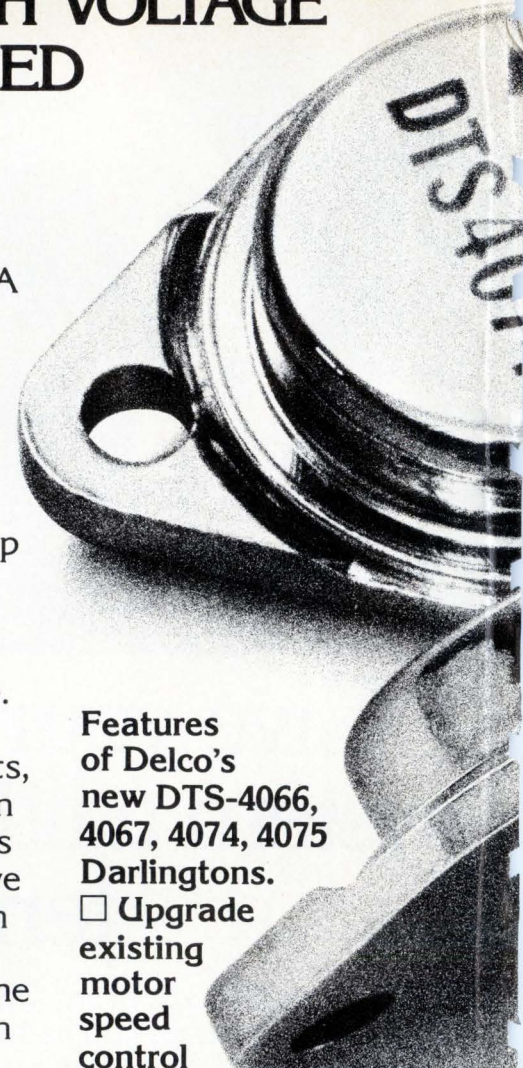
SAFE OPERATING CURVES



with parallel Darlingtons. A speed-up diode is built into the DTS-4074 and DTS-4075 permitting data sheet t_f typicals of 1.0 μ s. Drive circuit techniques involving $I_{B2} \geq 2$ A and a Baker clamp produce t_f typicals in the 0.4-0.6 μ s range for the DTS-4066, DTS-4067, DTS-4074, and DTS-4075.

Our experience with tolerances, faults, transients, and start-stall conditions in most systems convinces us that these Darlingtons have the right trade-off between speed and peak power handling capability. Note the greater than 10 kVA region of the reverse bias safe operating graph. All this, and you still get Delco's traditional solid copper TO-3 hermetic package that has a conservative 0.75°C/W thermal resistance.

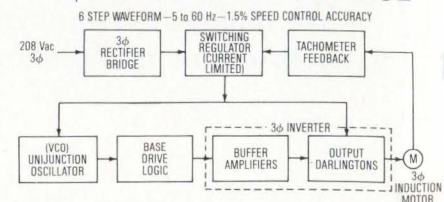
These Darlingtons are already in high volume production and are available on distributor shelves. Prices, applications literature, and data sheets from your nearest Delco sales office or Delco distributor can complete the story on these new Darlingtons.



Features of Delco's new DTS-4066, 4067, 4074, 4075 Darlingtons.

- Upgrade existing motor speed control horsepower ratings.
- Reduce need for paralleling in new systems.
- Offer switching speed improvements over our earlier types.
- Achieve greater than 10 kVA peak power dissipation.
- Available with t_{off} groupings
- Delco hermetic copper package with 0.75°C/W.
- Currently in high volume production.

208/220 Vac, 3 ϕ MOTOR SPEED CONTROL





NOW AVAILABLE FROM THESE DISTRIBUTORS IN PRODUCTION QUANTITIES.

ALABAMA

BIRMINGHAM
Forbes Distributing Co., Inc.
(205) 251-4104

HUNTSVILLE
Powell Electronics
(205) 539-2731

ARIZONA

PHOENIX
Sterling
Electronics, Inc.
(602) 258-4531

CALIFORNIA

GARDENA
Electronics
Distributors Div.
Bell Industries
(213) 321-5802

GOLETA
R.P.S. Electronics, Inc.
(805) 964-6823

LOS ANGELES
Kierulff Electronics, Inc.
(213) 685-5511

R.P.S. Electronics, Inc.
(714) 748-1271

PALO ALTO
Kierulff Electronics, Inc.
(415) 968-6292

SAN DIEGO
Kierulff Electronics, Inc.
(714) 278-2112

R.P.S. Electronics, Inc.
(714) 292-5611

SUNNYVALE
Bell Industries
(408) 734-8570

COLORADO

DENVER
Kierulff Electronics, Inc.
(303) 371-6500

CONNECTICUT

NORWALK
Harvey Electronics
(203) 853-1515

FLORIDA

CLEARWATER
Diplomat/Southland
(813) 443-4514

MIAMI SPRINGS
Powell Electronics/Florida
(305) 592-3260

ILLINOIS

ELK GROVE VILLAGE
Kierulff Electronics, Inc.
(312) 640-0200

SKOKIE
Bell Industries
Electronics Distributors Div.
(312) 282-5400

INDIANA

INDIANAPOLIS
Graham Electronics
Supply, Inc.
(317) 634-8202

MARYLAND

BALTIMORE
RESCO/Baltimore
(301) 823-0070

MASSACHUSETTS

BILLERICA
Kierulff Electronics, Inc.
(617) 935-5134
(617) 667-8331

NEWTON
The Greene-Shaw Co., Inc.
(617) 969-8900

MICHIGAN

LIVONIA
Pioneer/Michigan
(313) 525-1800

MINNESOTA

MINNEAPOLIS
Stark Electronics Supply Co.
(612) 332-1325

MISSOURI

KANSAS CITY
Walters Radio Supply, Inc.
(816) 531-7015

ST. LOUIS
LCOMP-St. Louis
(314) 647-5505

NEW JERSEY

CINNAMINSON
Wilshire Electronics/
Philadelphia
(609) 786-8990
(215) 627-1920

CLIFTON
Wilshire Electronics/
New Jersey
(201) 340-1900
(212) 244-8930

NEW MEXICO

ALBUQUERQUE
Sterling Electronics
(505) 345-6601

NEW YORK

BINGHAMTON
Harvey Electronics
(607) 748-8211

BUFFALO
Summit Distributors, Inc.
(716) 884-3450

FARMINGDALE
Wilshire Electronics/
Long Island
(516) 293-5775

FREEPORT
Milgray/New York
(516) 546-6000

WOODBURY
Harvey Electronics
(516) 921-8700
(212) 895-9260

OHIO

CINCINNATI
United Radio, Inc.
(513) 761-4030

CLEVELAND
Pattison Supply Co.
Industrial Electronics Div.
(216) 441-3000

DAYTON
Pioneer/Dayton
(513) 236-9900

OREGON

PORTLAND
Almac/Stroum Electronics
(503) 292-3534

PENNSYLVANIA

PHILADELPHIA
Almo Electronics
(215) 698-4000

PITTSBURGH
CAM/RPC Electronics
(412) 782-3770

SOUTH CAROLINA

COLUMBIA
Dixie Radio Supply Co., Inc.
(803) 779-5333

TEXAS

DALLAS
Sterling Electronics
(214) 357-9131

HOUSTON
Harrison Equipment
Co., Inc.
(713) 652-4700

Sterling Electronics
(713) 627-9800

WASHINGTON

SEATTLE
Almac/Stroum Electronics
(206) 763-2300

Kierulff Electronics, Inc.
(206) 763-1550

SPOKANE
Almac/Stroum Electronics
(509) 928-0679

IN CANADA:

Zenitronics Ltd.
Toronto (416) 787-1271
Ottawa (613) 238-6411
Montreal (514) 735-5361

OVERSEAS: EUROPEAN INQUIRIES:

European Parts &
Accessories Marketing
Group
General Motors Continental
Plant 2, Noorderlaan,
Postbus 9
B-2030, Antwerp, Belgium

ALL OTHER OVERSEAS INQUIRIES:

General Motors Overseas
Operations
Parts & Accessories Dept.
767 Fifth Avenue
New York, N.Y. 10022
(212) 486-4412

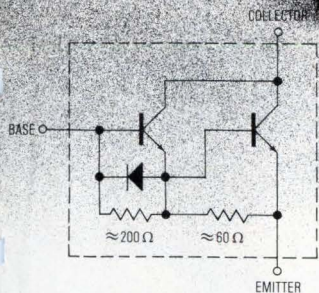
DELCO ELECTRONICS REGIONAL SALES OFFICES

Charlotte, North Carolina
28209
4600 Park Road
(704) 527-4444

Van Nuys, California 91404
Box 2968
(213) 988-7550

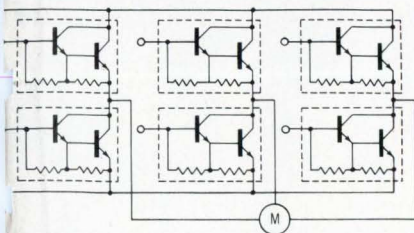
GENERAL SALES OFFICE

700 E. Firmin, Kokomo,
Ind. 46901
(317) 459-2175

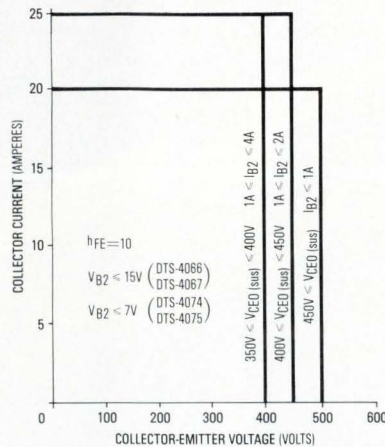


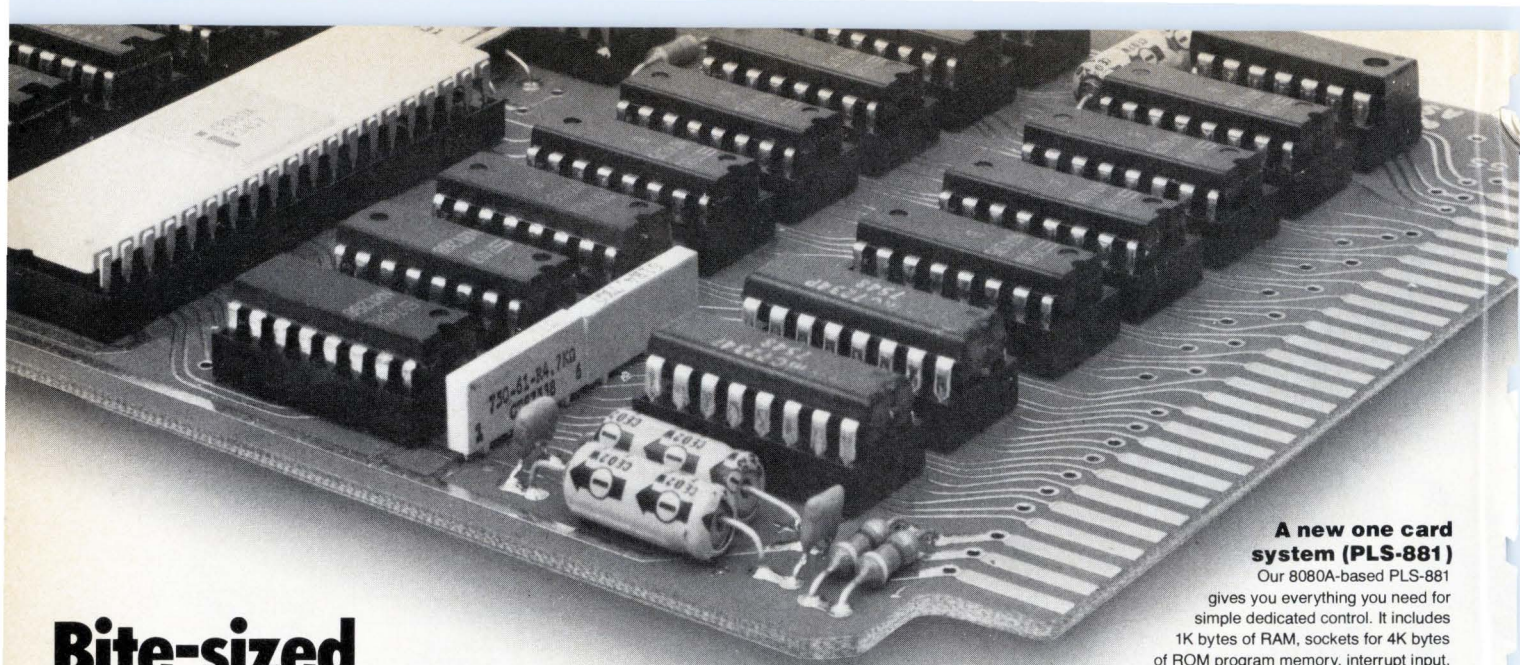
**SPEED-UP DIODE
USED ON DTS-4074/4075 ONLY**

3 ϕ DARLINGTON INVERTER DTS-4066-4067



CLAMPED INDUCTIVE SWITCHING PERFORMANCE





Bite-sized 8080A systems make big boards hard to swallow.

A new one card system (PLS-881)

Our 8080A-based PLS-881 gives you everything you need for simple dedicated control. It includes 1K bytes of RAM, sockets for 4K bytes of ROM program memory, interrupt input, crystal clock, power-on and external reset, three 8-bit output ports, and two 8-bit input ports. It costs only \$195 in 100 piece quantities.

Simple, flexible, standardized Pro-Log 8-bit microprocessor systems a best buy for OEM's.

We sell 8080A, 6800 and 9002 microprocessor cards two ways; as complete single or multicard systems, or as individual CPU and support cards so you can build a system of your own.

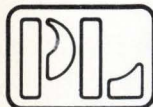
Our cards are all standard 4.5" by 6.5" with 56 pin edge connectors. They fit into standard card racks. To keep you from being tied to a specific semiconductor manufacturer for parts, delivery and pricing, our 8080A and 6800-based systems use only second-sourced parts.

Buy 250 of any particular card and we throw in free its manufacturing and assembly plans and non-exclusive rights to manufacture it, allowing you to build your own hardware, relying on us as an established and dependable second source.

We've got 4-bit systems, instruments, education and literature, too.

4-bit 4040 and 4004 systems; 4- and 8-bit microprocessor system analyzers; PROM programmers; a half-day economics seminar for decision makers; a three-day hands on design course for engineers; manuals and support documentation.

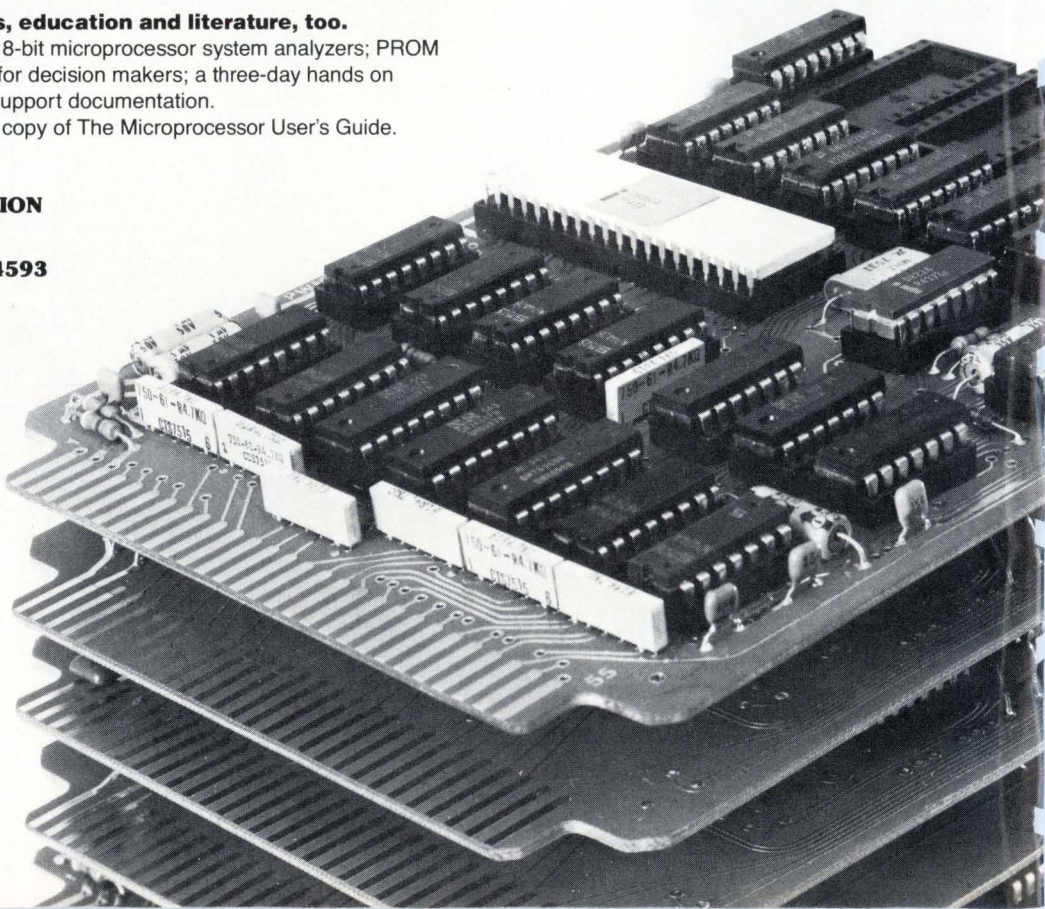
Call or write for data sheets or a free copy of The Microprocessor User's Guide.



PRO-LOG CORPORATION
2411 Garden Road
Monterey, CA 93940
Telephone (408) 372-4593
TWX 910-360-7082

A new, expandable plug-in CPU card (8821)

Our "buffered bus" 8821 processor card implements the 8080A as a fully TTL buffered microprocessor. Add one I/O card and it becomes a complete two-card system. Or expand it to use full 8080A memory and I/O capability—it's compatible with all the Pro-Log ROM, RAM and I/O modules shown here plus many more. The 8821 costs only \$190 in 100-piece quantities. We also have equivalent cards implementing the 6800 and 9002 microprocessors.



Four-level logic coming next year from Signetics

I²L process is applied to current-mode thresholding; circuit area reduced by 75% and pin counts cut in half

Practical nonbinary integrated circuits are about to elbow their way onto the digital logic scene. The Signetics Corp. breakthrough promises to increase the information-processing capability of bipolar large-scale-integrated devices 4 to 10 times—and in theory the increase could be 1,000 times.

The firm's first multivalued circuits use integrated injection logic and current-mode thresholding for a four-level logic (0, 1, 2, 3), according to David Kleitman, vice president of research and development at the Sunnyvale, Calif., subsidiary of Netherlands-based Philips (see p. 56). They are the precursors of a binary-compatible Quad Logic family of devices, which the company expects to sample in the second half of next year.

"In such circuits, metal conductors carry either 0, 1, 2, or 3 quantized units [levels] of current—double the number of information bits in a binary system—with the result that pin counts can be roughly halved," Kleitman says. "And circuits have been built that occupy one quarter the area needed in standard I²L with the same design rules and no extra processing steps."

With increased production experience, he says, there is no practical impediment to the development of ICs using octal (8-level) and decimal (10-level) logic systems.

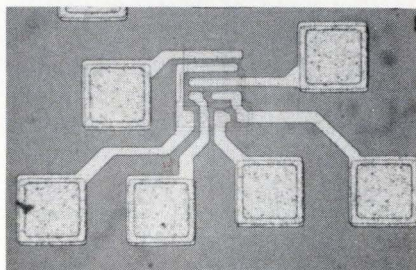
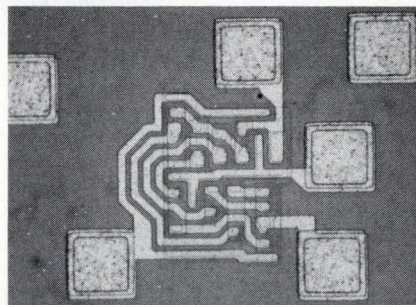
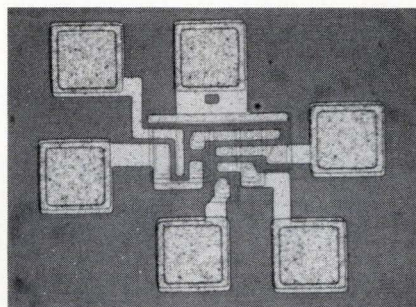
Multivalued, or multilevel, logic circuits until recently were considered interesting, but only a theoretical possibility. But it has been only with the development of high-density current-mode threshold techniques like emitter-coupled logic, and more recently I²L, that designers have begun to think about multilevel-logic ICs.

Signetics, however, has a significant jump on any competitors—two years of work on what it calls multi-threshold I²L, almost two dozen patents pending, prototype production runs on some of the basic circuits, and commercial production experience with a binary version it calls threshold-function I²L.

Building blocks. The Signetics developers found that by adapting other circuit techniques—such as emitter-coupled threshold detection, analog current mirrors, and input/output weighting, the basic I²L gate would perform threshold logic.

The ability to discriminate among several input thresholds is derived from binary-based ECL. It differs, however, because I²L, basically a current-mode rather than voltage-mode logic, requires a conversion from current to voltage at its output. This conversion is adapted from operational-amplifier circuits that use current-mirroring techniques to produce a current that varies linearly with the applied input voltage.

Input weighting is achieved by adjusting the size of the output collectors of the npn transistor in the I²L gate. Collectors of different sizes and different biases are connected together to form weighted sums. In addition, a current differential amplifier—another analog technique—is used to perform most of the



Quad world. Metalization is most striking feature in photos of multivalued logic. At top is a three-input max function (similar to a binary OR), next is a quantizer (a 4-bit a-d converter) and last a triple-complement circuit (like a binary triple inverter).

threshold detector functions.

To test the concept, Signetics built several commercial ICs that have threshold-function gates with binary inputs and outputs externally but multilevel weighted summing and detection schemes internally. Used in the input control logic of a de-

skew first-in, first-out memory, called the 8X04 [*Electronics*, Jan. 8, p. 129], such gates were used to determine if the memory was one-fourth, one-half, three-fourths, or completely full. If ordinary transistor-transistor-logic circuitry or even standard TTL had been used, at least 4,000 transistor devices would have been required. In this approach, there are only four.

Quad Logic. "Because of the wide array of weights and threshold combinations," says circuit research

manager Keith Russell, "it's a relatively simple matter to extend the technique to multi-valued circuits."

Using weighted outputs and inputs and a multilevel threshold detector, Signetics has built Quad Logic structures that perform functions roughly equivalent to binary functions such as "AND, OR, INVERT, as well as more complex ones such as multiplexing. In multilevel logic terminology these are, respectively, the "min", "max", "complement" and "T-gate" functions. □

Military

Norden uses microprocessor from Marconi in artillery computer for the U.S. Army

Generally, MPs aren't known for fighting the Army's front-line battles. But, when MP stands for microprocessor, the U.S. Army expects the computer-on-a-chip to make quite a name for itself as a battlefield hero. Out to see that happen is United Technologies Corp.'s Norden division in Norwalk, Conn.

Winner of a \$6.2 million contract to develop the battery computer system for the U.S. Army Electronics Command at Fort Monmouth, N.J. [*Electronics*, Oct. 14, p. 77], Norden is banking on microprocessor technology for its multirole central-computing system designed to perform general artillery computing tasks. The BCS, which will not enter production until late 1978 or early 1979, according to Norden president Peter Scott, is targeted for fire-control jobs by all active field artillery units of the Army as well as National Guard and Reserve units.

Surprise. Norden's winning proposal surprised some in industry who were expecting it to bid a system based on a military version of the PDP-11 computer from Digital Equipment Corp. in Maynard, Mass. Last year DEC licensed Norden to militarize its small, highly successful commercial computer, but Norden's initial PDP-11 entry won't be ready until later this year. For the battery computer, the firm teamed with Marconi Space

and Defence Systems Ltd. of England, a GEC-Marconi Electronics division that has been using microprocessors in advanced fire-control and gunnery-data systems it designs and builds for European armies.

It will use a new Marconi-designed microcomputer built around a standard, commercially-available 4-bit microprocessor slice, says Peter Lewis, assistant managing director of the Marconi division. And the memory of the rugged, portable system can be expanded with plug-in modules.

The microcomputer is one of a family employing similar architecture that Marconi used in earlier fire-control systems. "It emulates the earlier members of the family so that it can use a lot of the previously-developed software," he notes. "However, the BCS will be much more sophisticated than our earlier systems."

In its role as the primary subcontractor for the BCS' development, Marconi is responsible for the operational software and the gun display unit, a hand-held display with its own microprocessor to control "all of the information that a section chief requires to engage a target," says Lewis. Installed at each gun site, the display unit looks like a large calculator with push buttons for calling up specific data, such as azimuth

and elevation of targets, fuze lengths, and number of rounds left, to be shown on its light-emitting diode display.

Army Electronics Command project engineer Mike Simpson says the microprocessor-based battery computer system will be used "primarily as a replacement for Fadat [the current field-artillery digital automatic computer], which is fading out of the Army's inventory, as well as for the battery display unit [BDU] of the Tacfire [tactical fire direction] system," currently supplied by Litton Industries Inc.

"The capabilities of the BCS are well above those of the BDU," Simpson asserts. Pointing to its ability to simultaneously control up to 12 guns via direct data links to the gun sites, as opposed to the present network of voice links, he adds, "It provides for increased mobility and reduced manual error and response times."

In winning the prime contract, Norden bested Litton's Data Systems division in Van Nuys, Calif., and Teledyne Brown Engineering, Huntsville, Ala., the other finalists. Simpson notes Norden is to deliver five systems by October, 1977, for extensive Army testing. "We hope to award a production contract no later than February 1979," he says. "We have no commitments as to how large the production order will be, but right now we're thinking in terms of 1,000 units, including 150 for the Marine Corps." □

Computers

Burroughs plans 'super' machine

Burroughs Corp., whose last foray into large-scale scientific computing ended five years ago with Illiac IV, says it's developing "a new super computer designed to handle the largest problem-solving requirements of science, industry, and government." The computer, which won't be ready until the fourth quarter of 1978, will use "an array-

processor architecture, which will enable it to complete vector-oriented problems at speeds in excess of any system currently installed or believed to be under development," claims Burroughs chairman Ray W. Macdonald.

Presumably included in that statement are the Control Data Star 100, Texas Instruments' ASC, and today's biggest, fastest system, the Cray-1, from Cray Research Inc., Chippewa Falls, Wis., which also performs vector operations. The Cray-1 uses emitter-coupled logic and has a memory of 0.5 to 1 million 64-bit words, based on 1-kilobit bipolar random-access memories. In bursts, the computer can produce 250 million results per second.

Limits. The market for such large \$5 million-and-up machines, however, is limited. Cray, in its preliminary stock prospectus dated last Jan. 28, notes "the market for such large machines consists of approximately 100 governmental agencies, corporations, and educational institutions in the United States and abroad which are engaged primarily in scientific research." Burroughs delivered just one Illiac IV to the University of Illinois [*Electronics*, Oct. 11, 1971, p. 32].

The new Burroughs machine will use the company's own large-scale-integrated logic, called Burroughs current-mode logic. These circuits, which are similar to emitter-coupled logic, were previously used in the 800 family [*Electronics*, Dec. 25, 1975, p. 76]. The machine will be programmed exclusively in Fortran with a new "vectorizing" compiler that converts frequently used serial Fortran instructions into vector operations.

Manager. Being developed at the company's Great Valley, Pa., laboratories, the Burroughs machine will use the large-scale B7700 processor as its system manager, performing under the company's operating system called the master control program. The MCP has been used for some time in other Burroughs systems to provide automatic job scheduling and the management of system resources. □

Microprocessors appear to make progress in process control at Houston show

Though digital computers have been able to handle process control for 20 years, most users still prefer control systems that rely on electrical analog or pneumatic controllers. They're preferred for their inherent reliability—a failure shuts down only a single control loop rather than a complete plant.

But now microprocessor-based controllers are attempting to bridge the gap between single-loop controls that make local decisions and master minicomputers that run the entire process or plant from a central console. And record crowds at Houston's Astrohall this month for the Instrument Society of America's biennial international show witnessed an onrush of microprocessor products trying to gain part of a \$175 million market.

Many of the applications are still in the buzz-word stage, however. Design times for new process-control systems often range from three to five years, and many "microprocessors" were presented in cardboard systems mockups and non-functioning printed-circuit boards. Few firms put the device in the control loop, instead assigning it to such peripheral tasks as acquiring data for display, or multiplexing communications systems.

Bold move. One of the boldest steps toward microprocessors was taken by Honeywell's Process Control division, Fort Washington, Pa., earlier this year. Its TDC [total distributed control] system uses a 16-bit processor developed jointly with General Instrument Corp. The CP1600 is used, not only for data

Fastest 16-k RAM available from Mostek

Mostek Corp. has published the final data sheets for the first two versions of its 16,384-by-1-bit random-access memory, the MK4116. The parts have maximum access times of 150 and 200 nanoseconds and 375-ns cycle times, by far the fastest of any vendor that has shown parts. The Carrollton, Texas, memory firm, shipping through distributors, is charging \$100 each for the fast RAM and \$50 for the slower one, in quantities of 100.

Mostek's data sheet is explicit. "Our strategy is to draw a tight target for our competitors to meet," explains H. Berry Cash, vice president. "It's the most fully disclosed part we've ever made." Specifications are worst-case only; "typical" specs are relegated to the back of the document and displayed in graph form. In addition, Mostek includes parameters for device characterization and guarantees performance outside of specified operating conditions. Although the firm will ship fewer than 50,000 16-kilobit devices this year, Cash says it will sell about a million in 1977.

Competitors Texas Instruments Inc. and Intel Corp. are reportedly still redesigning their parts. TI has started shipping samples of a version of its IMS4070 that has the same pinout and timing as Mostek's, plus the Mostek early-write and noncritical clock features. And samples of TI's high-performance, double-level polysilicon design are expected early next year.

Others working on the Mostek configuration include National Semiconductor Corp., Motorola Inc.'s Semiconductor group, Fairchild Camera and Instrument, American Microsystems Inc., Fujitsu Ltd., and Nippon Electric Co. National is already shipping samples, and Intel is shipping as many parts as Mostek, but they're not socket-compatible. Intel will probably be joined by American Microsystems and Nippon Electric in producing its latched-output RAM.

handling and communications with the control room, but also for local process control: changing setpoints in up to eight loops under its control based on information coming from other loops. However, there is manual backup should the controller fail.

But an even bolder distributed control system was shown in Houston by Electronic Modules Corp., Timonium, Md. Its DSC-9700 system puts the decision power for up to 50 loops in a microprocessor with a host PDP-11 minicomputer downloading instructions. By including automatic process shutdown and manual override, the company believes it can eliminate the risk while spreading the microprocessor cost around many loops.

No risk. Others are more cautious. "We want to use the microprocessor where it doesn't ask the user to take a system risk," says William J. Kirk, program manager for electronic control systems at Bailey Meter Co., Wickliffe, Ohio. "Our controls today are single-loop analog or single-loop pneumatic. When the microprocessor is cheap enough that we can use one per loop, we'll do it." Nevertheless, the Babcock and Wilcox Co. subsidiary has designed about 30

digital modules aimed at data handling, computer interfaces, and communications applications that it will start shipping next year. "About a third of them use microprocessors," Kirk says.

Similarly, Taylor Instrument Process Control also plans microprocessor-based controls. "Our goal is to use microprocessors, but to maintain single-loop integrity," says Larry Fetterly, product engineer for the Rochester, N.Y., division of Sybron Corp. "Sure they're powerful and flexible, but they're very expensive for single-loop control." Taylor will first apply them, in mid-1977, to replace the transistor-transistor-logic console electronics on its new Mod III analog control, he says.

Beckman Instruments Inc., Fullerton, Calif., is using a single microprocessor per loop, but only in a new hierarchical system that's built around a central minicomputer. Jack J. Murray, senior applications engineer, explains, "Individual analog circuitry is used to compute the PID [proportional-integral-derivative] algorithm. Microprocessors can be plugged into only those controllers that require computer monitoring and control." □

have two responsibilities: to review the responses from the sections and to prepare detailed reports on the individual goals.

Written statements are due at the end of this month and will be aired by the full 16-member U.S. Activities Board at its November 12 meeting. Also at this meeting, a 1977 budget proposal will be drafted. Then, a second round of open meetings for members will take place to go over the modifications implemented from the first group of reports.

Shortcomings. However, there may be some shortcomings to this initial effort to solicit grass-roots opinion, the first of its kind. The opinions being sought must be gathered in a relatively short time—only about three weeks. And, only a dozen sections out of the IEEE's more than 250 U.S. sections are involved. But they represent the largest sections, with the most active professional-activities programs. And the leaders that have been chosen have been among the most critical of the IEEE's past professional activities efforts.

"I'm guardedly optimistic," says task-force leader Bruce. "USAB has made motions to involve the professional-activities committees and that's a step forward. But it's a vast program, and it will take time to discuss and formulate a response."

James H. Mulligan, Jr., IEEE's vice president for professional activities and chairman of the U.S. Activities Board, says: "My objective is to tighten the feedback loops. I have serious doubts that we've been getting good data on which to base our decisions and I want to find out exactly what's going on, what members really want." □

IEEE

Opinions from grass roots solicited for next year's professional-program plans

The U.S. Activities Board of the Institute of Electrical and Electronic Engineers has taken another important step toward opening the plans for next year's professional program to suggestions from its members. The new approach was put in motion at a weekend meeting earlier this month of board members and chairmen of professional-activities committees from local IEEE sections.

A dozen leaders were chosen to organize meetings of members in their sections that would review the board's draft of over 40 proposals for the 1977 program [*Electronics*, August 5, p. 32]. Budget for the program could exceed \$1 million.

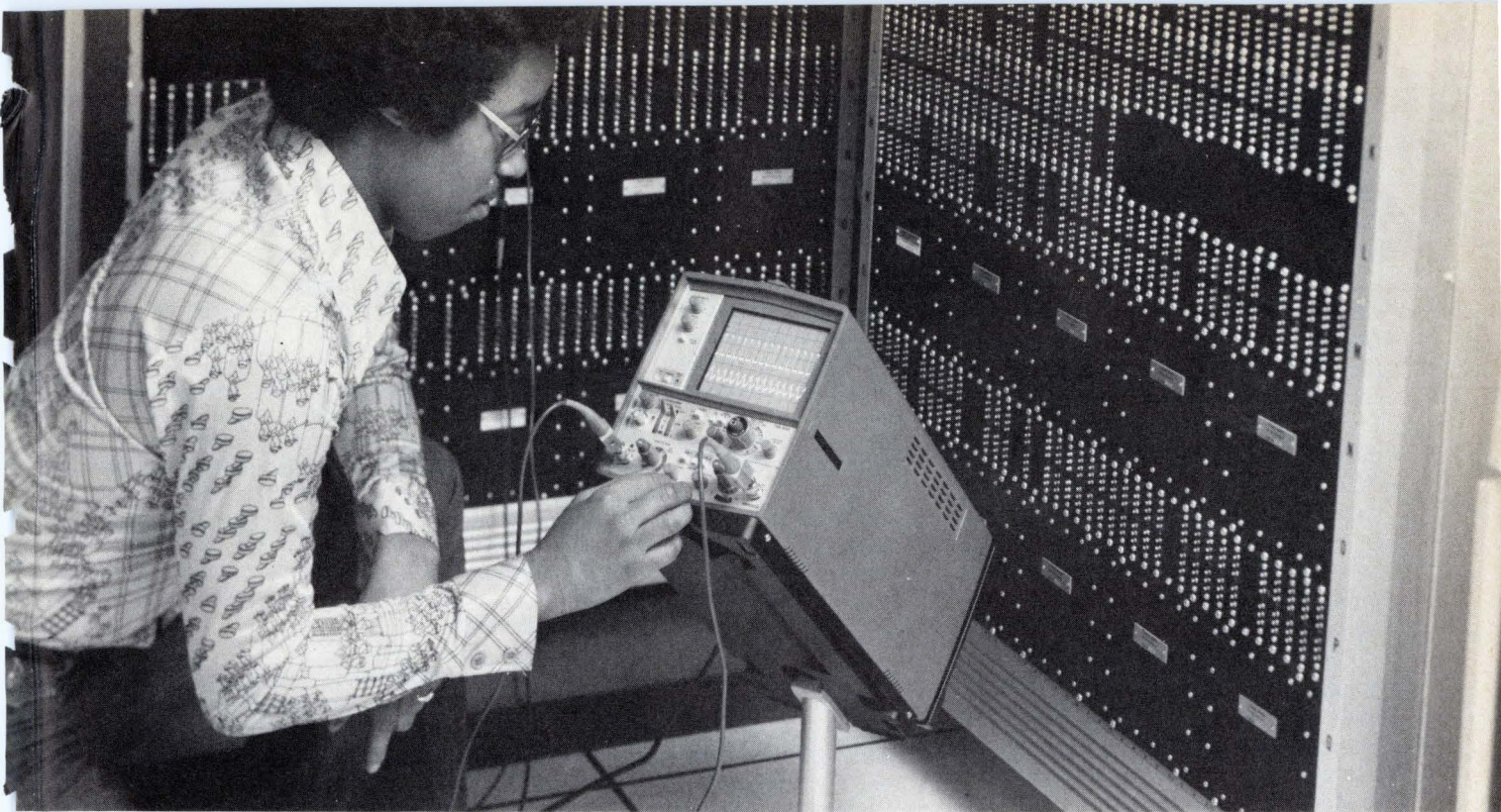
The idea is to establish priorities for the proposals, to identify crucial gaps in the proposals, and to find out from members how they feel about the directions the institute's professional activities should take.

Reviews. Grass-roots task forces have been set up that cover the three main goals of the activities board's plan: improvement in financial and economic benefits, headed by Alvin Reiner of Washington, D.C.; improvement in career conditions and opportunities, headed by Robert Bruce of Long Island, N.Y., and improvement in professional status, headed by Gerry M. Goldenstern of Los Angeles. These three men will

Communications

U.S. policy overhaul urged in Congress

A thorough rewrite of the Communications Act of 1934—and Federal policy with it—will top the agenda



Now you can service with a Tektronix Oscilloscope for as little as \$695*

Cost of service instruments is an important factor in any purchase. But so is reliability. Now T900 Oscilloscopes give you both Tektronix quality *and* reliability at prices *designed* for cost sensitive applications.

- T921—Dc to 15 MHz; single trace,
single time base\$695*
- T922—Dc to 15 MHz; dual trace,
single time base\$850*
- T932—Dc to 35 MHz; dual trace,
single time base\$1195*
- T935—Dc to 35 MHz; dual trace,
delayed sweep time base\$1395*
- T912—Dc to 10 MHz; bistable storage;
writing speed to 250 cm/ms; dual trace,
single time base\$1300*

Performance to Spare

All T900 scopes feature large (8 x 10 cm), bright crts; sensitivity

of 2 mV/div to 10 V/div in twelve calibrated steps; regulated power supplies and 3% accuracy. For convenience, T900 Oscilloscopes are equipped with beam finder, single knob triggering, automatic selection of chopped or alternate mode, and automatic selection of tv line or frame display (except T912 Storage model). T900 scopes are compact (7x9x18 in.) and lightweight (only 16 lb.). They are available with a full selection of accessories.

T900 Series— the *quality* low-cost oscilloscopes



For a demonstration of any T900 Oscilloscope or a free copy of the new T900 brochure, write to Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077. For immediate assistance, call (503) 644-0161, extension T900.

*All prices include 10X probes.
U.S. Sales Prices FOB Beaverton, Oregon



of the House Interstate and Foreign Commerce Committee's communications subcommittee when the 95th Congress convenes in January, according to chairman Lionel Van Deerlin. The California Democrat (see p. 14) was joined in this commitment by Rep. Lou Frey (R., Fla.), the subcommittee's ranking minority member, as the dust settled following three hectic days of controversy during preliminary hearings in late September on telephone-industry proposals to limit telecommunications competition in terminal equipment and special services.

Complex issues. Congressional recognition of the complexity of the issues was evident in both House and Senate at adjournment. Pro-competition interests were encouraged that leaders in both branches want to develop their own legislation from scratch next year, rather than rely on the various "Consumer Communications Reform Acts" being pushed by the American Telephone & Telegraph Co., its Bell System affiliates, and independent phone companies.

To guarantee "American consumers the best and most efficient access to modern communications technology," say the two subcommittee leaders, "we need to go back and take a look at the whole basis of regulation." Competition, they point out, is but one segment of the problem that will require revising present rules "from the basement to the attic."

At the same time, leaders of the communications subcommittee of the Senate's Commerce Committee, Vance Hartke (D., Ind.) and Howard Baker (R., Tenn.), reiterated earlier requests for a separate study.

IBM's threat. Rep. John M. Murphy (D., N.Y.) believes AT&T's anti-competition moves are directed at potential forays into the communications field by International Business Machines Corp., rather than at small specialized carriers. He wants a joint House-Senate study effort next session. Murphy's proposal calls for a five-man study group to be appointed by leaders of both houses.

News briefs

Data General picks North Carolina for software facility

Data General Corp., Southboro, Mass., says that because of the difficulty of attracting software professionals to its New England location, it is setting up an advanced research and development facility in the Raleigh-Durham Research Triangle in North Carolina. The company has been searching for the past six months for the best spot to locate the facility and settled on the Research Triangle area because of its "cordial business environment" and its proximity to Duke, North Carolina State, and University of North Carolina, all of which offer advanced computer science programs. The move was prompted by the threat of a graduated income tax in Massachusetts, plus a "business environment that is extremely depressing, to say the least." According to the company, its software R&D budget has doubled as a percentage of total R&D expenditures over the past two years; it is now running at 35% to 40% and is still climbing.

Datran assets going to Southern Pacific Communications

Southern Pacific Communications Co. has bought at auction the communications network and related equipment of defunct specialized common carrier Data Transmission Co. (Datran). Bidding began at \$2.5 million, and SPC's winning offer of \$4.9 million topped that of the only other bidder, Western Union Telegraph Co. Details of the sale should be completed by year's end. Proceeds are earmarked for yet-to-be-determined creditors of Datran, a subsidiary of University Computing Co. in Dallas [*Electronics*, Sept. 2, p. 32].

Raytheon gets rest of Pave Paws

The other shoe has been dropped in the Air Force's program to build its Pave Paws radars to detect sea-launched ballistic missiles approaching the U.S. coastlines [*Electronics*, Aug. 7, 1975, p. 43]. Raytheon Co.'s Equipment division, Sudbury, Mass., will build the West Coast installation at Beale Air Force Base, Calif., under terms of a \$28 million contract option exercised by the Air Force Electronic Systems division, Hanscom Air Force Base, Bedford, Mass. Raytheon had won an earlier \$46.5 million award for the East Coast radar, to be constructed at Otis Air Force Base, Mass. [*Electronics*, April 29, p. 36].

This group would include at least one communications engineer, an economist, a consumer advocate, as well as a businessman.

"What (the Bell System) is really worried about," Murphy contends, "is that somewhere down the road a company like IBM, with billions of dollars at its disposal, will take advantage of the blurred interface between data processing and data communications to provide services that the Bell System thinks belong to it." Yet, he points out, there is little or no mention of these questions so far in congressional consideration of legislative proposals. Murphy initially wanted the in-depth study to be performed by the Federal Communications Commission, but changed his mind because of FCC's "vested interest in its past decisions"

and a performance record "marked by a lack of interest, excessive delay, and a poverty of thought." □

Military

Loral adding to P-3C surveillance

The new electromagnetic threats presented by the Soviet Union's fleet pose problems for U.S. Navy patrol aircraft. However, the Navy hopes to attack these problems with a micro-computer-based electronic-surveillance system being developed at Loral Corp.'s Electronic Systems division in Yonkers, N.Y.

Under contract to the Naval Air Development Center, Johnsville, Pa.,

Now, Intel delivers memory for PDP-11/04 and PDP-11/34.

Intel is now shipping high speed, low cost memory for two of the hottest new minicomputers, DEC's PDP-11/04 and PDP-11/34.

That means you can get 30-day delivery and 30 to 50% savings by specifying Intel, the largest independent manufacturer of semiconductor memory.

We can give you add-in memory and add-on memory, both totally compatible with PDP-11 hardware and software. Our in-4711 is an add-in memory for the PDP-11 family and slides into an available memory slot, without modifications. For add-on memory capacity, simply attach the in-4011 memory system. You can add memory in 16K x 16 bit increments, up to 128K words.

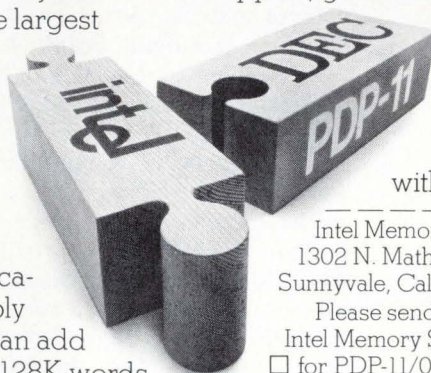
Built with the proven Intel 2107B 4K RAM, the in-4711 memory is fully transparent to the CPU, with greater processing speed. For maximum throughput you can interleave two memories.

The in-4711's lower power consumption permits wider operating margins on the main

frame power supply and results in a cooler running, more reliable system.

If you've picked DEC to be your computer supplier, go with the best for memory, too. Intel delivers a complete line of add-in and add-on memory for the entire PDP-11 family.

That puts two good names together. Add a third — yours — with the coupon.



Intel Memory Systems
1302 N. Mathilda Avenue
Sunnyvale, California 94086

Please send me information on the following Intel Memory Systems:

- for PDP-11/04, 11/34 for PDP-11/05, 11/35
 for PDP-11/_____

Name/Title _____
Company _____ Mail Station _____
Address _____ Phone _____
City/State/Zip _____

intel[®] memory systems
A DIVISION OF INTEL CORPORATION

NEW!

REVOLUTIONARY INSTRUMENT IN AC & DC CURRENT MEASUREMENT

No longer is it necessary to break the circuit to make an ac and dc current measurement! This time-saving feature is extremely useful in troubleshooting, maintenance, design and other fields. Now it is possible to obtain current measurements more easily and safely than voltage measurements by use of clamp-on probes.

Model 1776 features include digital readout, peak read and hold capability, resolution 10 mA on lowest range, wide dynamic range, portability with built-in recharging circuitry, three clamp-on probes, extremely low insertion impedance.

The 1776 is the only current meter of its type in the world!

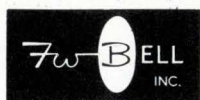


MODEL 1776 DIGITAL CURRENT METER

Current Ranges	10, 100, 1,000 amperes, FS.
Accuracy	
D.C.	±0.5%, FS.
A.C. (Sinusoidal)	±2.0%, FS.
Peak Detection (D.C. Accuracy)	± 0.2%, FS.
Frequency Response	D.C. to 10kHz
Readout	Digital (3½ digit)

The Gaussmeter People

F. W. Bell, Inc.
4949 Freeway Drive East
Columbus, Ohio 43229
614/888-7501
TWX: 810-337-2851



Electronics review

the system is part of a general update of the land-based P-3C Orion's electronics as the plane's mission is expanded. Loral hopes to begin delivering its ESM system in late 1978 for production-line aircraft and then retrofit about 200 P-3Cs with it.

In addition to its use as a patrol aircraft for antisubmarine warfare, the Lockheed-California Co. plane will also be used as a platform for launching the Harpoon missile against surface vessels. "But even if the P-3C wasn't getting the Harpoon, we would still have a requirement for the advanced ESM capability," says Comdr. Joe Kiel, deputy project manager for P-3C update programs at the Naval Air Systems Command in Washington, D.C.

Final R&D. Loral is performing final qualification and system integration tests on the first two ESM units, scheduled for flight tests early next year. Like the new radio-frequency surveillance/electronic-countermeasures system being built for the Air Force B-1 bomber by Cutler-Hammer Inc.'s AIL division in Deer Park, N.Y. [*Electronics*, Aug. 5, p. 36], the Loral system can use software to change parameters even during flight as new threats emerge.

The system can pick up and identify such threats as surface-to-air missiles, radar-controlled anti-aircraft missiles, and antimissile-defense systems, points out Loral's division president Frank Lanza. "We're going from analog to digital processing to increase the system's capacity and response time by several orders of magnitude," he adds.

The antennas and receivers in the present ESM system (part of the AN/ALQ-78 countermeasures set) will be expanded to cover the E through I (2-10-gigahertz) frequency bands. And the system's data-converter-control unit, which had used basically analog hardware to determine the direction and identity of enemy emitters, will now use a Loral-built 16-bit microcomputer to do the emitter-sorting and identification.

"With the analog hardware, we

could only measure one emitter at a time," says Lanza. "Typically, even with low enemy densities (10,000 to 15,000 pulses per second), it took seconds to sort and identify the pulses. Even after that, you still had high false-alarm rates."

More pulses. But with the computational and mathematical capability of the digital processor, Lanza continues, "you can sort and identify about 300,000 pulses per second in microseconds with very high reliability." Use of the microcomputer, Kiel adds, automates some of the things the operator has had to do and relieves the load on the computer.

To sort and identify emitters, the system notes their characteristics, such as direction, pulse amplitude, frequency, and time of arrival. After being digitized, this information goes to the central on-board computer, which will be either the current Sperry Univac CP901/ASQ-114 or a new standard Navy minicomputer, the AN/AYK-14. The emitter is identified by the threat library in the computer memory.

"Before, we had a limited library in analog circuitry that could be changed only with a change in circuitry. This was very costly and slow and considerably increased the size of the system," Lanza notes. "Now, the same computer can do all the computations and, if necessary, you just add memory." □

Consumer

Mosquito repellents sting only buyers

Buzz off. That's what the Environmental Protection Agency has told New York's Buzz-Off Products Co. and a dozen other makers of what EPA calls "electronic contraptions" sold as mosquito repellents. After extensive product testing in the mosquito-infested Chesapeake Bay area, the agency has declared the repellents "worthless" and is moving to prevent their sale as well as their importation.

So far the agency has stopped the

Program it or modulate it ...

RCA presents the variable op amp. As easy to use as a transistor.

The CA3080 variable op amp is the first differential-voltage input, current output op amp. Like a transistor it has a control input—one that lets you vary not just voltage but also power, bandwidth, slew rate, input current and output current. It can be programmed and/or signal modulated to select the optimum gain, speed, bandwidth and power. And the output can sink or source current.

It puts the designer in complete charge.

This wide range of operation gives you unusual design flexibility. You can create simplified versions of present designs ... or take unique approaches to new designs. You have linear gain over a 6-decade range to work with. A 50V/ μ s slew rate. Power levels adjustable from below 1 μ W up to 30 mW. And if you need more than 1 mA output, the CA3094 has integral Darlington's to provide 300 mA peak output.

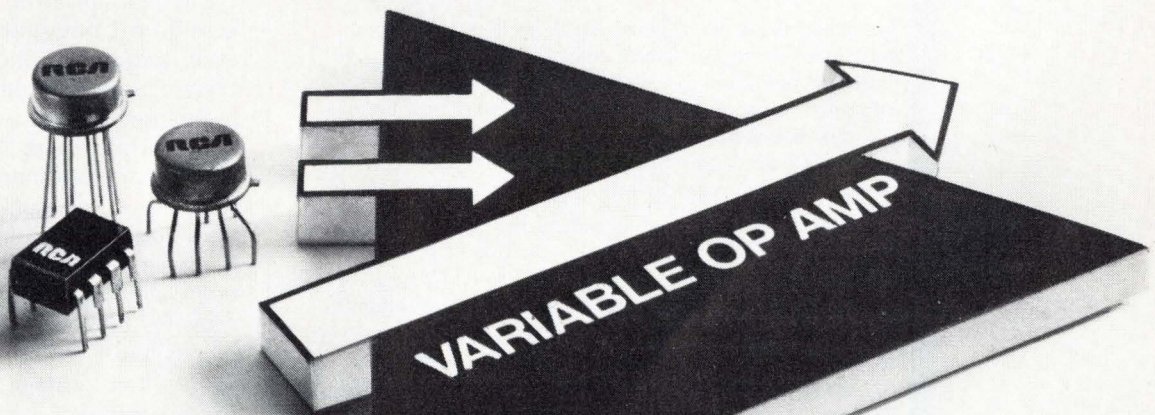
In short, you can "shape" the variable op amp to fit the job—and create big circuit savings.

How much does all this flexibility cost? Amazingly little: 55¢ for the 3080E and 65¢ for the 3094E, at the 1K level.

For data sheets and application notes on these op amps, contact your local RCA representative. Or RCA.

Write: RCA Solid State, Box 3200, Somerville, N.J. 08876; Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste. Anne de Bellevue H9X 3L3, Canada; Fuji Building, Tokyo, Japan.

RCA



plex Voltage follower Multiplier Co... ge protector Dual-tracking
y-range oscillator Analog timer L... n systems Ramp generator G
ample and hold Multiplex Voltage... multiplier Comparator Over-voltage p
pply Wide-frequency-range osc... analog timer Level detector Alarm system
Voltage tunable filter Sample an... Multiplex Voltage follower Multiplier Co
dual-tracking power supply Wid... frequency-range oscillator Analog timer Lev
erator Gain control Voltage tunable filter Sample and hold Multiplex Voltage

RCA. Full house in Linear ICs.

Circle 39 on reader service card



Some Delevan designs are very special...

THEY'RE NOT MADE YET

Applications for inductive devices are virtually unlimited . . . and not even Delevan's broad line of *standard* designs can fit every requirement. That's where Delevan's Application-Engineering capability comes in! No matter how unusual or highly-specialized your application may be . . . Delevan can provide a custom-engineered design to meet the most demanding specifications, the most unique applications.

At Delevan, the design of inductive devices is far more than an art . . . it is a highly-sophisticated science. State-of-the-art techniques in winding and molding; the instant availability of computerized data, and utilization of new materials and procedures . . . combined with the proven expertise of Delevan engineers . . . equals unmatched capabilities. If you have the application, Delevan can provide the design.

Delevan
Division



AMERICAN
PRECISION
INDUSTRIES INC.

270 QUAKER RD. / EAST AURORA, N. Y. 14052
TELEPHONE 716/652-3600 TELEX 091-293
OTHER DIVISIONS OF AMERICAN PRECISION INDUSTRIES INC.:
BASCO • DUSTEX

sale of a variety of repellents in Washington, D.C., New York, and Denver and ordered major distributors in Salt Lake City and New York to make no further sales or shipments, according to EPA's Stanley W. Legro, assistant administrator for enforcement. But the agency's most effective move to prevent consumers from being bitten is likely to come from its agreement with the Bureau of Customs, since nine of the 13 repellents it has tested are imports, mostly from Hong Kong.

Customs, which inspects incoming merchandise, has agreed to prohibit entry of ineffective devices and impound others at the dock or warehouse until they can be properly tested. EPA's authority stems from the 1972 Federal pesticides law, which prohibits false and misleading claims in device labeling. The repellents are pocket-sized, battery-powered boxes that emit sound waves supposedly repugnant to mosquitoes [*Electronics*, Oct. 2, 1975, p. 48]. They typically retail for about \$20, the agency says.

Batty. EPA cited one repeller's claim that "it repels the female mosquito (the one that does all the biting) by mimicking the sound of the bat, the mosquito's greatest enemy." Legro admits, "It's true that the female does the biting and that bats do eat mosquitoes, and there is even some scientific evidence that certain sounds could be offensive to some insects." But Legro stops there. Translating those principles into technology has flopped thus far, he says. "None of them works."

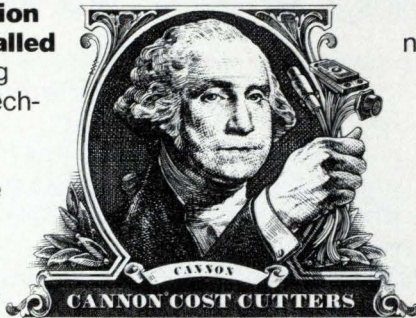
In addition to Buzz-Off Products, the agency's list of corporate gadgeteers hustling repellents includes Progressive Electronics Corp., Dallas, Norris and Co., Salt Lake City, and Trans International Corp., Chicago, which imports its repeller from Taiwan. Overseas makers include six from Hong Kong—Information Systems, Ltd., HBS International Ltd., Beuty Industrial Co., Mascotte Manufacturers Corp., Sonway Manufacturers Ltd., and Kelly & Co., plus Domac Industries Pty. Ltd., Melbourne, Australia. □

Mas/Ter INTERCONNECT SYSTEM INSULATION DISPLACEMENT CONNECTORS

High-speed mass termination that lowers your total installed cost! Here's the most exciting advancement in connector technology since Cannon introduced D Subminiatures—our new Mas/Ter-D Subminiature rectangular series of connectors and Mas/Ter-UND header series.

Designed to lower your total installed cost with a new level of reliability in mass terminating up to 50 conductors... quickly... error-free!

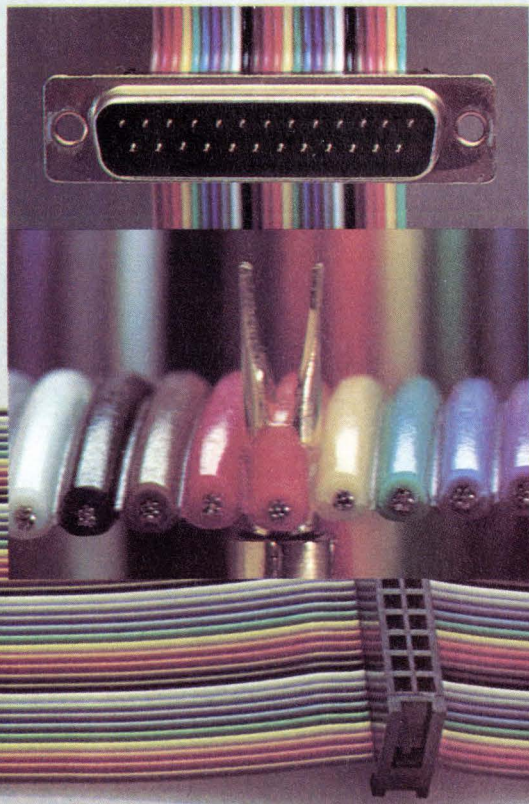
Look at these advantages: 25% more conductor surface contacted. Integral strain relief on the conductor insulator. Uniform contact force under extreme temperature, shock and vibration. Mas/Ter-UND accommodates 26 thru 28 AWG, while Mas/Ter-D offers two ranges of 22/24 and 26/28 AWG.



With the Mas/Ter Interconnect System, the entire connector is terminated at one time with no insulation stripping, no complex tooling... using standard round conductor flat cable or individual wires, solid or stranded. The contact penetrates and displaces the insulation without severing the conductor and still provides insulation support to the wire. Integral contact spring action wipes the conductor during termination to produce a high-force, low-resistance interface.

Mas/Ter-UND connectors and pin headers are intermateable and intermountable with other similar connectors, and Mas/Ter-D pin-and-socket connectors are fully intermateable and intermountable with Cannon's D Subminiature series. These are only the first of a growing family of insulation displacement connectors coming your way from Cannon.

Write or call today for new detailed literature! ITT Cannon Electric, 666 East Dyer Road, Santa Ana, California 92702. Call toll-free, 24 hr. (800) 854-3573. In California (800) 432-7063.



Six decades on the leading edge of interconnect technology.

CANNON ITT

Circle 41 on reader service card

The only microcomputer with the power of a PDP-11. The PDP-11/03.

If you've been looking for a microcomputer with minicomputer power at a micro price, join the hundreds of OEMs who've already found it with the DIGITAL microcomputer. The PDP-11/03.

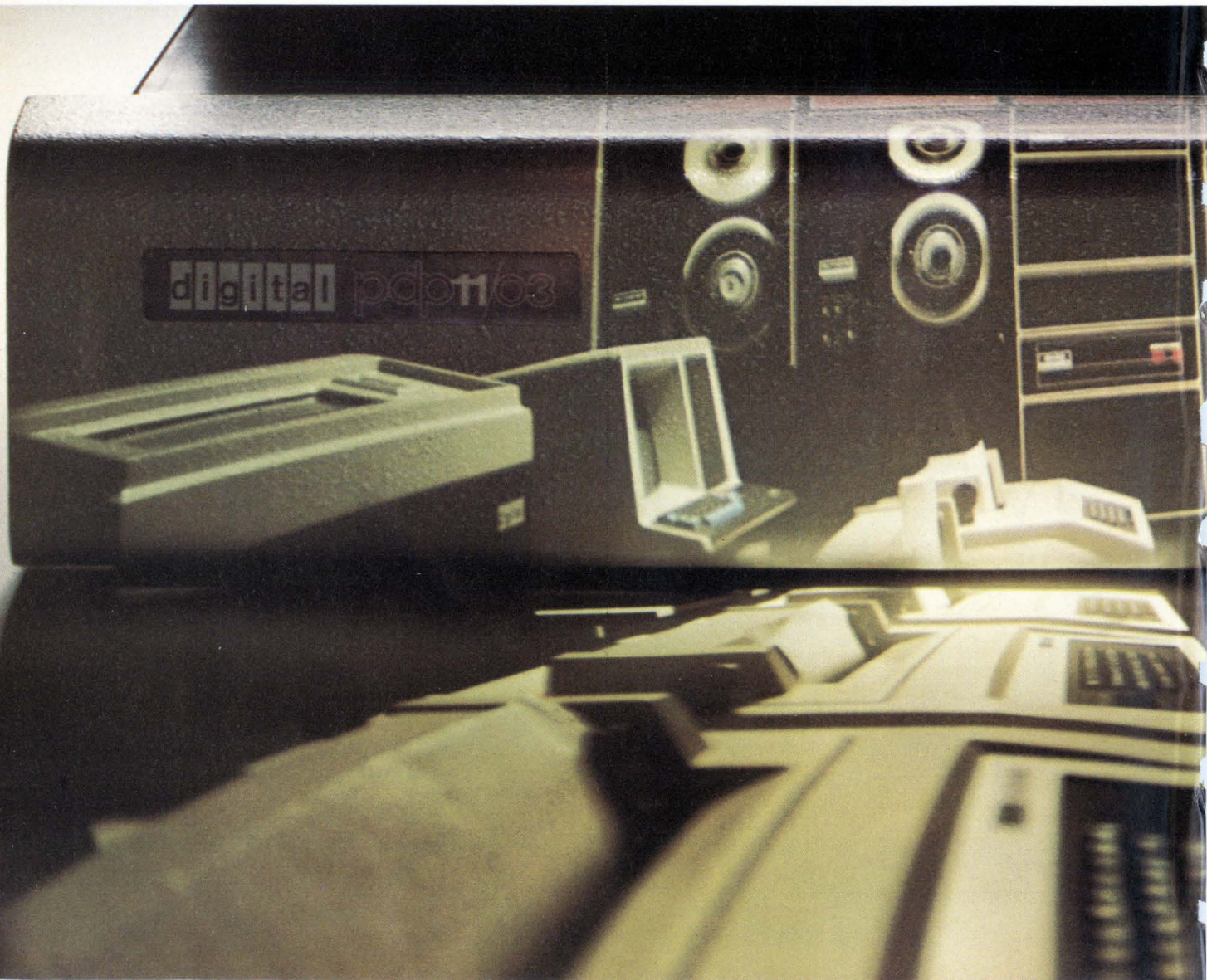
The 11/03 gives you everything you could ask for in a small computer. High performance. High reliability. And a low price — just \$1,357 in quantities of 50. And that micro price buys you mini features that quickly translate into benefits OEMs appreciate. Features like full PDP-11 instructions with eight general purpose

registers for fast program development. RAM (MOS or Core) and PROM memories that let you match the memory with the application. Hardware vectored interrupts with stack processing for real computer power. And multiple-sourced components for sure delivery.

Buying our 11/03 also buys you the chance to start small without staying small. Because you can add up to 32K words of memory, fast floating point instructions, and more. Whenever you and your customers are ready.

Besides growing bigger in size, the 11/03 lets you grow bigger in scope. It's software compatible with every other PDP-11 we offer. From our LSI-11 all the way up to our medium scale PDP-11/70. That means you can take full advantage of Digital PDP-11 software and services.

You can also take advantage of Digital's OEM Referral program — your chance to take on an international marketing and support team without hiring them. The OEM Referral program can help you locate new custom-



ers and new markets around town and around the world. And it can all start with the PDP-11/03.

So if you're looking for a

proven microcomputer with proven power and performance, get the micro with all the power and performance of a PDP-11.

Digital's PDP-11/03. Call your nearest Digital sales office. Or send the coupon to Digital Equipment Corporation, Maynard, Massachusetts 01754. (617) 897-5111. European headquarters: 81 Route de l'Aire, 1211 Geneva 26. In Canada: Digital Equipment of Canada, Ltd.

Digital Equipment Corporation, Maynard, Massachusetts

I'm interested. Please send information.

I'm more than interested. Please have your nearest Digital sales representative contact me.

Name _____ Title _____

Company _____

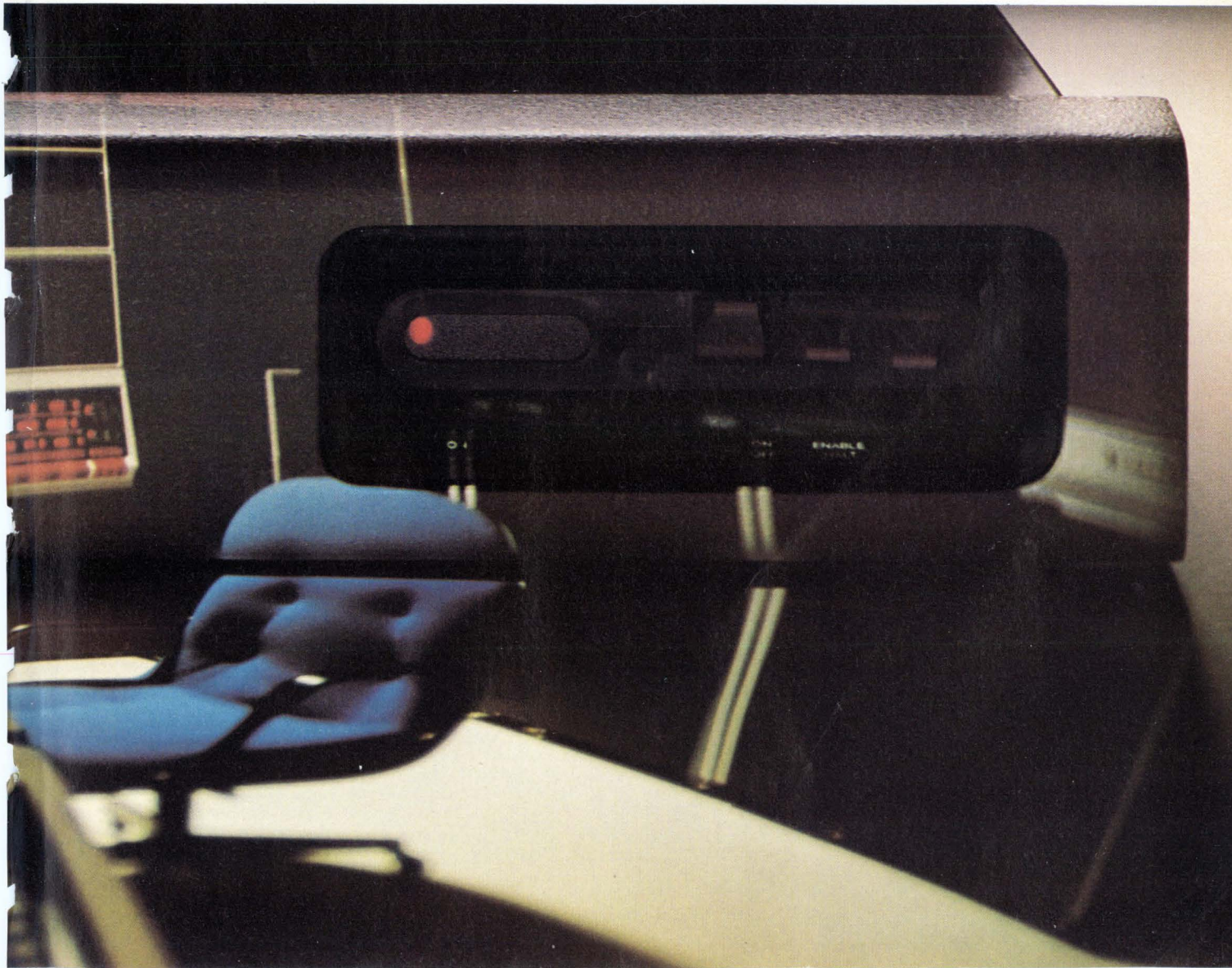
Address _____ Phone _____

City _____ State _____ Zip _____

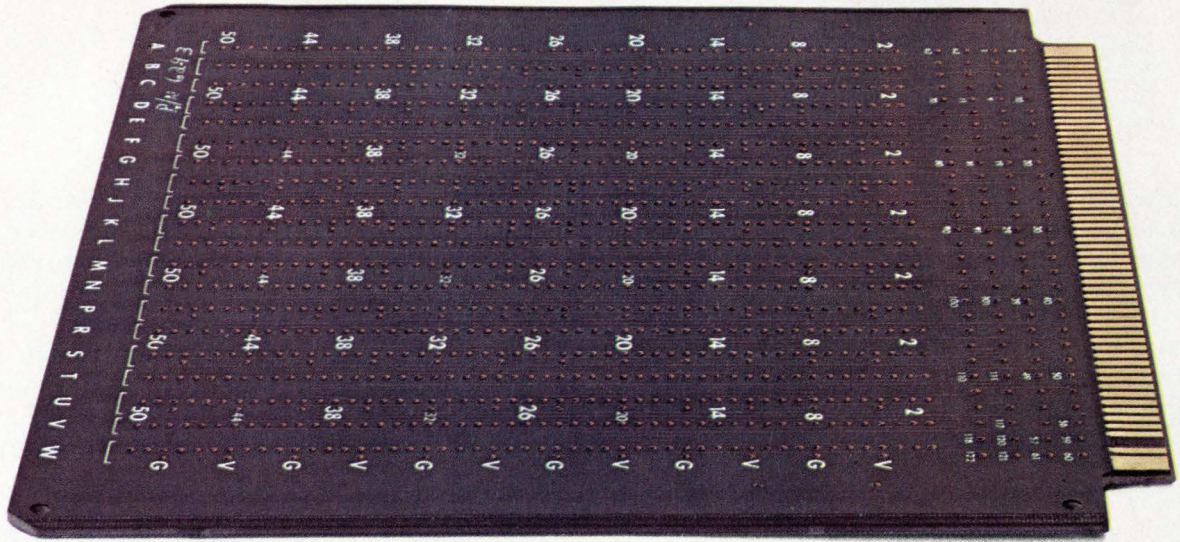
E106

digital

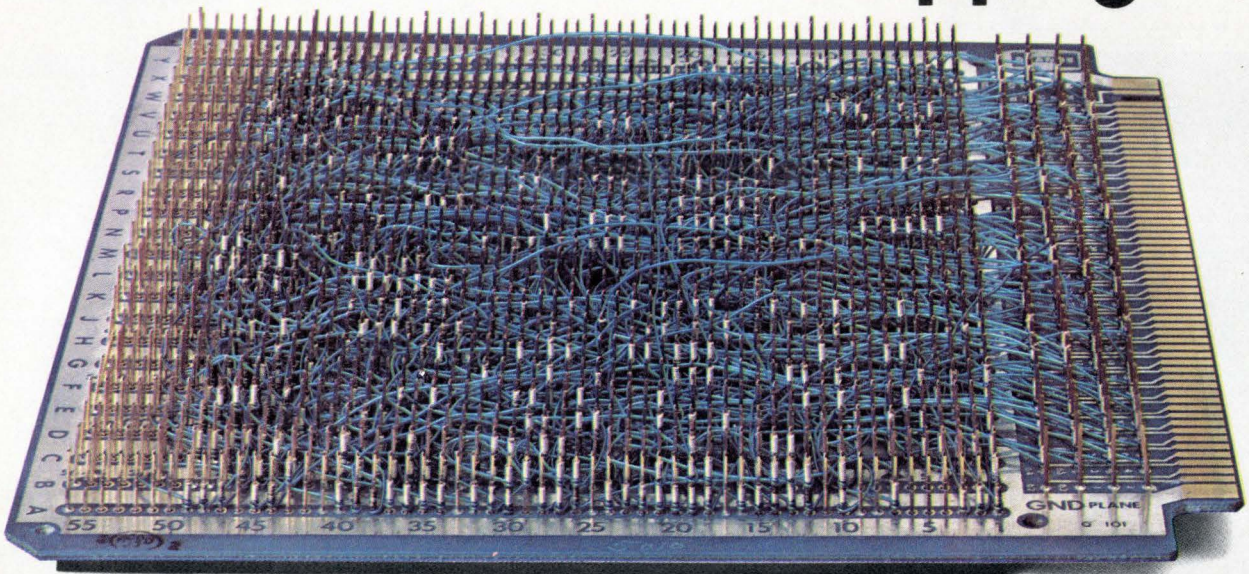
50,000 computers saving managers millions.



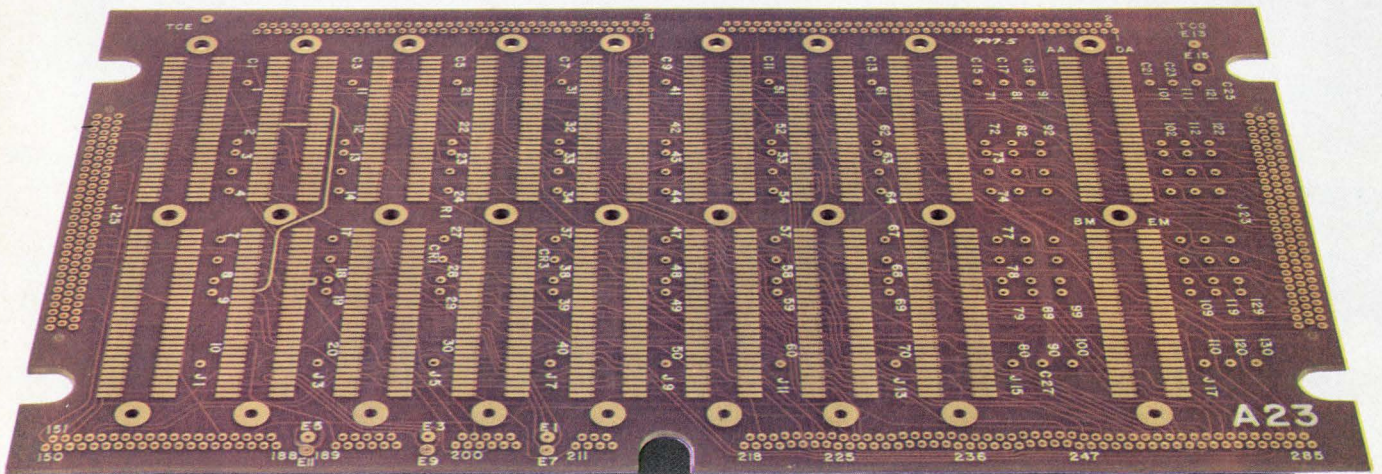
Compare Multiwire:™



costs less than wirewrapping...



works better than multilayering.



Two major systems—wirewrapping and multilayering—have been used for complex electronic interconnection in the last 15 years. Despite improvements and refinements, each still has inherent disadvantages. That's why Multiwire was created by Photocircuits. It overcomes the disadvantages of wirewrapping and multilayering.

A Multiwire board is basically a customized pattern of insulated wires laid down on an adhesive-coated substrate by a machine operating under numerical control.

Multiwire vs. wirewrapping.

Today, interconnection costs are more important than ever. So take a long, hard look at a key advantage of Multiwire panels. They cost much less than wirewrapping in small or production quantities.

Here's an example of how much less: a Multiwire replacement of a 60 DIP wrapped-wire panel. Total tooling costs were just \$750. In order quantities of 1000 pieces, the Multiwire boards at \$45 each were more than \$30 less than the wrapped-wire panel. (A 40% cost savings.) Multiwire prices also include a 100% continuity check.

But cost is not the only reason for the superiority of Multiwire over wirewrapping. There are also design advantages. For example, Multiwire offers two-dimensional packaging density equal to wirewrapping. But with Multiwire panels, you reduce board-to-board spacing. And Multiwire weighs much less too. So it can contribute substantially toward improving the envelope or three-dimensional package of your product.

Electrically, Multiwire is also superior. The extreme repeatability of the manufacturing process provides much higher electrical reliability as received—this is an important cost-saving factor. In addition, you get the controlled impedance characteristics required without variations.

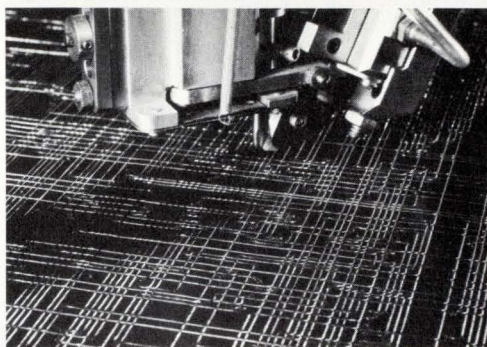
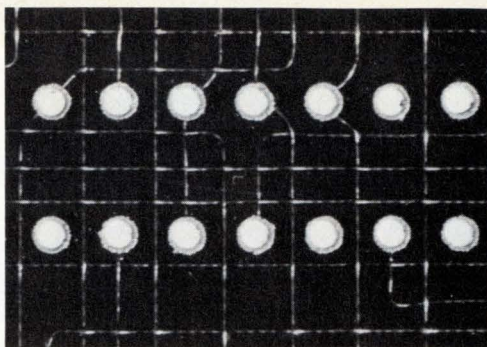
Multiwire vs. multilayering

With Multiwire, reliability goes up and inspection cost goes down. Multiwire doesn't need extensive inspection—like multilayering does—for nicks, pinholes, hairline cracks, spacing violations and bridging. Yet Multiwire regularly yields better than 99% reliability at incoming inspection.

Compared to multilayering, designing a new Multiwire board is a far simpler operation. Component locations and a wiring list are all we need. Our computer-aided system does the rest.

Since the computer also takes care of deletions and/or additions, engineering changes are simplified. What's more, Multiwire makes it easier to find paths for interconnections, because the insulated wires can cross one another. For these reasons we can deliver finished Multiwire boards to your door in weeks rather than months.

The advantages of Multiwire over wirewrapping and multilayering vary from case to case. We'd like to help you evaluate possible time, cost, design and reliability benefits. For information and price estimates, call the Multiwire Marketing Department at 516-448-1111.

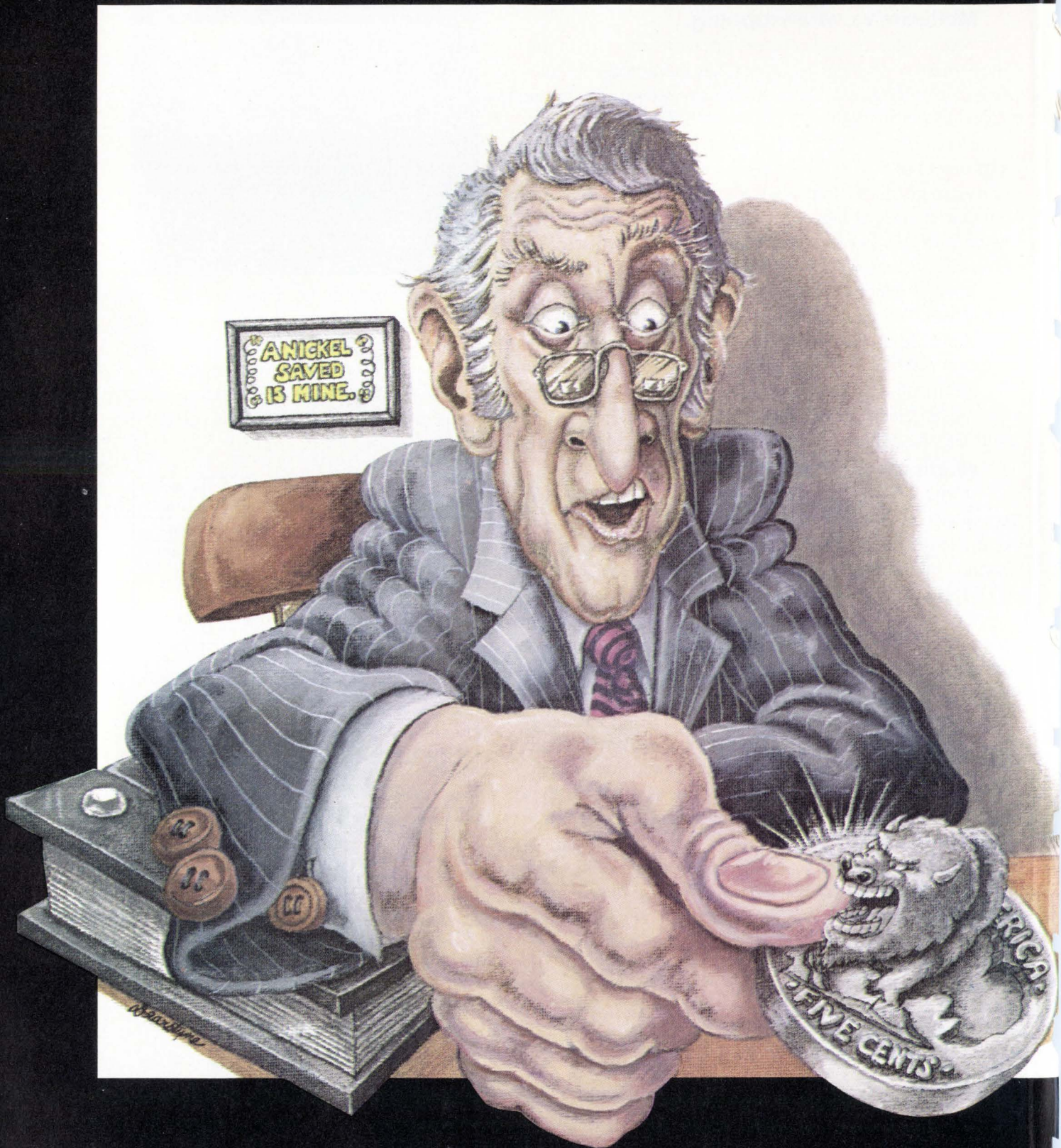


	Wrapped panels	Multi-layers	Multi-wire
Design & tooling cost	Low	Very High	Low
Design & tooling time	Short	Very Long	Short
1st piece delivery	Short to Very Short	Long	Short
Board cost in small quantities	High	High	Medium
Board cost in production quantities	High	Medium	Medium
2 dimensional packaging density	High	High	High
3 dimensional packaging density	Medium	High	High
Weight	High	Low	Low
Ease of changes	Excellent	Poor	Good
High speed electrical characteristics	Fair to Poor	Excellent	Excellent
Interchangeability with other techniques	Fair	Excellent	Excellent
Repairability	Excellent	Poor	Good
Controlled impedance	Poor	Good	Good
Electrical reliability as received	Fair	Good	Excellent

Multiwire from Photocircuits

Division of Kollmorgen Corporation, Glen Cove, New York 11542

“Itchy Palms” to buy all his mini



Palmer used peripherals on price

Ebenezer "Itchy Palms" Palmer.

Born prematurely in the bargain basement of a discount department store.

Shortened his first name to "Eb" to save writing time.

Once used a borrowed tea bag for 126 consecutive days.

Prided himself on always buying his minicomputer peripherals on price: rock-bottom.

But "Itchy Palms" Palmer's penchant for parsimonious peripheral purchasing was beginning to cost him a lot in returned devices, repairs, headaches and lost customers.

Until one day, while eating his way through a bag of day-old fortune cookies, "Itchy Palms" came across the following message:

"The truly wise man pays for his mini peripherals only once. Plessey Microsystems can expand your minicomputer systems with a complete line of highly-reliable, hard-working mini peripherals that won't come back to haunt you. And Plessey Microsystems is part of an international billion dollar corporation which prides itself on providing complete and comprehensive product support services."

"Pay only once," smiled Palmer.

"Won't come back to haunt me. Comprehensive product support."

They were talking *his* language.

So from that day on, Eb Palmer bought all his mini peripherals from Plessey Microsystems.

He ended up spending much less in the long run.

And he rewarded himself with a cup of well-aged tea.

If you'd like to find out how Plessey add-on core memories, single and dual disc drives and punched tape readers can expand your mini without depleting your resources, just call us today.

Miser's Delight

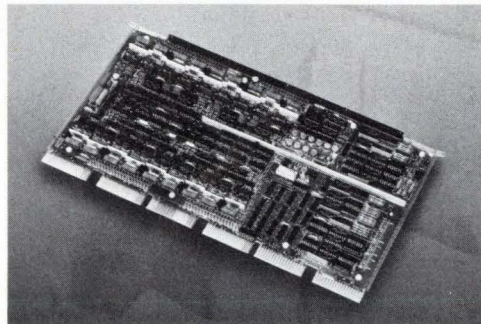
Plessey has delivered thousands of reliable low-cost memories which are being used in a variety of applications around the world.

Our latest offering is more of the same: 32K words on a single plug compatible card.

The PM-1132 core memory has an access time of 350 ns, is available with or without parity, and occupies just two slots in your PDP-11 series mainframe. The PM-1132 is plug compatible in either the standard or new modified unibus backplane, and can be selected on any 4K address boundary. Also available is the new PM-S1132, an NMOS semiconductor memory which is plug compatible with the DEC MS11-EP, FP, and JP M05 modules. The PM S1132 contains up to 32K x 18 on a single hex board with a 400 ns access time and a 500 ns cycle time.

Or if 32K is more than you need, try one of our 8K or 16K modules with your DEC, Data General, and Interdata minis. They're all plug compatible and can be mixed and matched with memories from the mini manufacturers.

It's a new high in mini memory performance. And a new low in minicomputer data storage costs.



Plessey Microsystems

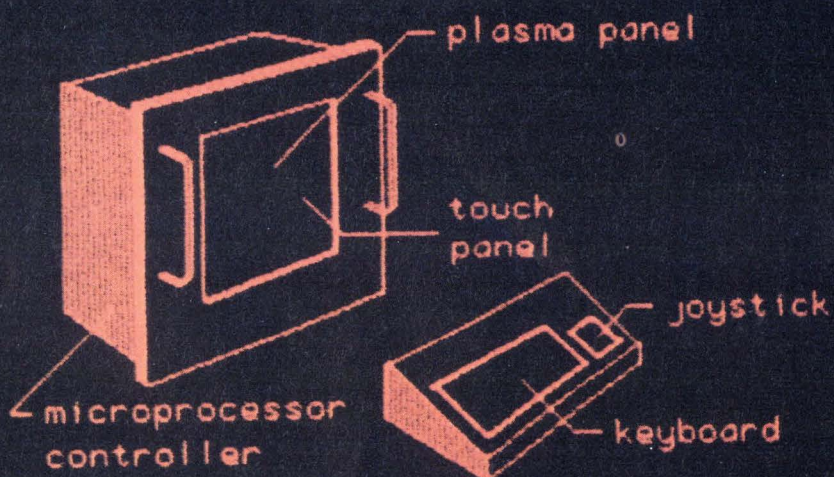
(714) 540-9945

Circle 47 on reader service card

Look at the latest in plasma display.

alpha/graphic terminals

- MILITARY ENVIRONMENTS
- 10 YEAR OPERATING LIFE
- LOW LIFE CYCLE COST
- HIGH BRIGHTNESS
- HIGH RESOLUTION
- HIGH CONTRAST
- REDUCED SIZE
- INTERACTIVE



Now look at the source.

Interstate Electronics—veteran supplier of military computer-based electronic equipment.

For over 20 years, we've designed and delivered hardware for a range of environments, from laboratory to full Mil-Spec conditions. Today, we're among the leading 100 defense contractors in America.

Now we're producing plasma display terminals under multiple military contracts. Our products range from standard off-the-shelf models to special configurations, with display features like joy-stick interactive editing and microprocessor control. All have the inherent advantages of plasma display—plus Mil-Spec capability.

Your new military display source—Interstate Electronics—a dynamic part of the Electronics Group of A-T-O, Inc.

Give us an opportunity to discuss your operational environment and performance requirements.

Write Sid Wing, Military Products Manager, Interstate Electronics Corp., Marketing Department, 707 E. Vermont Ave., Anaheim, CA 92802. Better yet, call him at (714) 772-2811.

**INTERSTATE
ELECTRONICS
CORPORATION**

SUBSIDIARY OF **ATO**

From the first connector to the last termination, we can put connector back panel assemblies together to your exact specifications.

We make our own connectors, stamp our own metal, make our own circuit boards and program our own automatic wiring machines. Since we control every step of the process, we can promise you

zero electrical defects on delivery.

You can minimize your capital investment by letting us do the complete job. But, if you have your own assembly or semiautomatic wiring capability we'll stop at any point you want. We'll even sell you just the connectors, on 0.100, 0.125, 0.156 or 0.200-in. centerline spacing, if that's your need.

So, if you're wrapping up the details of a new product design, it's time to start rapping with us. For complete details, contact GTE Sylvania, Connector Products Operation, Titusville, Pa. 16354. Phone 814-589-7071 TWX 510-692-6763.

GTE SYLVANIA

**Our package deal:
with
or without wrapping.**



Mixed-process devices gain ground

Bi-FET and bi-MOS linear chips invade area that was exclusively bipolar with input bias currents that are 1,000 times lower

by Lucinda Mattera, Components Editor

Mixed-process chips are moving in on what has been the traditionally bipolar domain of linear integrated circuits.

Popularly dubbed either bi-FET or bi-MOS, most mixed-process chips have bipolar outputs and matched field-effect transistors at their inputs. And because of their FET front ends, mixed-process devices can operate with input bias currents that are 1,000 times lower than those of bipolar chips. Additionally, they respond more than 10 times faster, offer broader bandwidths, and exhibit lower noise and better stability.

In bi-FET devices, ion implantation is used to fabricate the input p-channel junction FETs. With high-energy ion beams, the low-concentration dopant profile needed for building good JFETs can be obtained easily. On the other hand, as a rule, the bi-MOS process involves only diffusion, but requires an extra masking step to define the gates for the input p-channel MOSFETs.

Bi-FET and bi-MOS device performance is fairly evenly matched, with perhaps a slight edge going to bi-FET products for somewhat lower noise and less offset-voltage drift. On the other hand, input MOSFETs can accommodate signals over the full range of the supply voltage. Finally, MOSFET inputs generally require protection diodes to guard against damage from electrostatic charge.

Most of today's mixed-process linears are operational amplifiers, but other types of devices are beginning to appear. By the end of the year, more than half a dozen major semiconductor firms will have their

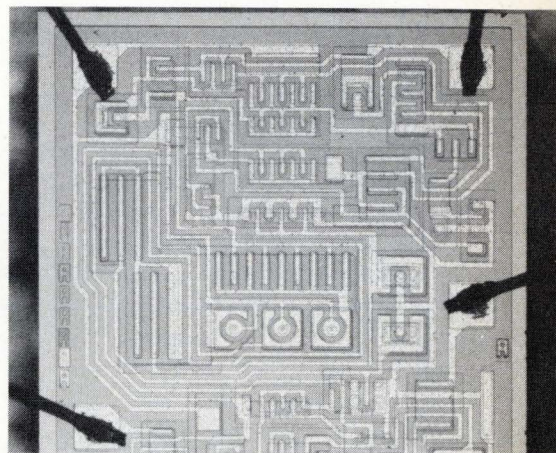
own bi-FET processes. And bi-MOS is by no means standing still, with leaders in the field planning exciting introductions in the near future.

At this time, National Semiconductor Corp., Santa Clara, Calif., has already announced the greatest variety of bi-FET products, including op amps, instrumentation amplifiers, comparators, analog switches, and sample-and-hold circuits. Moreover, the firm, which will shortly introduce a bi-FET quad op amp, is also investigating bi-FET data converters and products for telecommunications applications.

According to James Soloman, manager of linear design at National, bi-FET processing, besides being more complex than straight bipolar technology, requires 5 to 10 times more die area than the equivalent bipolar function. As a result, he says, bi-FET devices will always cost about 15% more. However, he believes that bi-FET technology will have a significant impact on hybrids, replacing most of them with monolithics within a few years.

Drawback. High input offset voltage is probably the biggest drawback of present bi-FET technology. "The dimensional control of channel width has to be about 10 times better than for bipolar to obtain the equivalent offset voltages," notes Soloman. But even with the improved dimensional control permitted by ion implantation, a JFET pair can be matched to within only about 3 millivolts, whereas bipolar transistors can be matched as closely as 0.8 mV, he points out.

Because of the obvious performance advantages of bi-FET devices, a number of other semiconductor



Dual technologies. This op amp from National is a bi-FET device. It has JFETs on the same chip as bipolar transistors.

houses are perfecting their own bi-FET processes. Both Intersil Inc. of Cupertino, Calif., and Fairchild Camera and Instrument Corp. of Mountain View, Calif., will soon announce their versions of National's op amps, followed by a series of analog switches and multiplexers. And Signetics Corp., Sunnyvale, Calif., a pioneer in the development of ion implantation as a production process, is also planning a family of bi-FET products, scheduled for introduction during the first quarter of 1977.

Texas Instruments in Dallas already has a family of bi-FET op amps, encompassing quad, dual, and single versions, and is now second-sourcing National's op amps. The company is also offering a line of bi-FET analog switches and plans to follow with related products, like comparators. What's more, within a few weeks, TI will make available selected versions of its bi-FET quads—input offset voltage of the devices will be approx-

Probing the news

imately half as large, down around 6 to 7 mV.

And early next year, Precision Monolithics Inc., Santa Clara, Calif., will announce an improved version of National's bi-FET op amp. "For one thing, we've developed a different circuit technique to optimize the JFET matching, as well as get rid of some unwanted effects," says Dan Dooley, the company's vice president of engineering. Instead of input bias current doubling every 10°C, as is the case in the National device, it will increase 1% to 2% every 10°C.

In December, Motorola Semiconductor Products, Phoenix, Ariz., intends to introduce its first bi-FET

device—a quad op amp. Each amplifier in the package will have a 10-megahertz bandwidth. While specific price is not yet determined, it is expected to be in the \$5 range for 100-and-up quantities. After the bi-FET quad, the company will second-source National Semiconductor's line of op-amps.

TI occupies a unique market position, since it has both bi-FET and bi-MOS processes. Mixed technologies open tremendous possibilities, says John Spencer, applications engineer for linears. "We've busted a dam, and it's really difficult to pick out what specific direction we're going in," he adds. Future mixed-process op amps will not be just simple amplifier circuits, but systems components like programmable gain blocks or op amps with multiplexed

front ends that can handle a number of different input signals, he foresees.

Besides applying its bi-MOS process to amplifiers and analog switches, Siliconix Inc., Santa Clara, Calif., has a bi-MOS IC that is half of a chip set for a 3½-digit analog-to-digital converter. But probably the most intriguing mixtures are coming from RCA's Solid State division in Somerville, N.J.

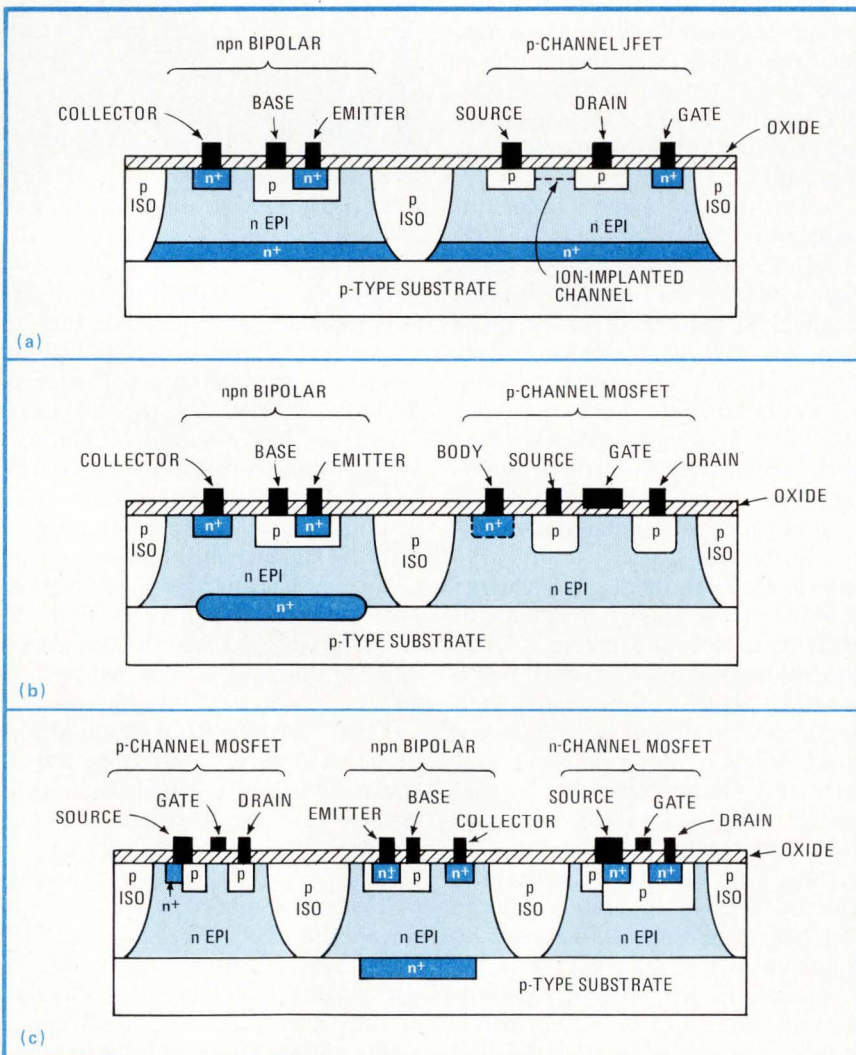
The firm already has three unusual mixed-process devices on the market, among them an op amp combining bipolar and complementary-MOS technologies, and is planning to complete some custom circuits for consumer applications sometime next year. Mixed processing is ideal for putting both digital functions such as frequency division and control logic on the same chip as linear functions, notes the Solid State division's Merle Hoover, a member of the bipolar integrated-circuit group.

Performer. The newest mixed-process chip from RCA is a bi-MOS op amp having a p-MOS front end and a bipolar output. It's an all-around better performer than the industry-standard 741 bipolar op amp, says Hoover, and even input offset voltage is comparable. What's more, he points out, the device can be operated from a single-polarity supply without the loss of common-mode-voltage integrity. And the price is good, too—the device sells for only 69¢ each in hundreds.

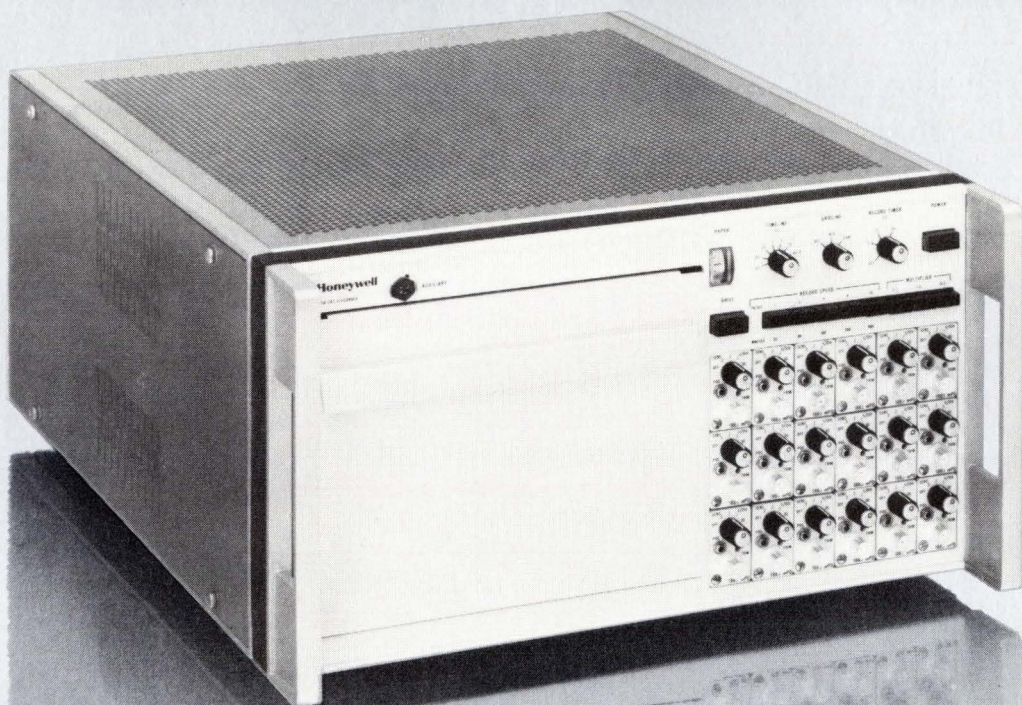
Dielectric isolation can also be used to fabricate mixed-process devices. Harris Semiconductor, Melbourne, Fla., the chief proponent of dielectric isolation, has successfully combined bipolar and n-MOS transistors on the same chip for a wide-band inverting op amp, a current amplifier, and a chopper-stabilized op amp.

As might be expected, now that mixed processing has started to roll, new variations are beginning to crop up. For example, at National, designers are investigating n-channel bi-FET devices that outperform their p-channel counterparts. Among other things, they offer five to six times higher gain at one-fourth the noise, as well as faster slew rates and lower on-resistance. □

Integrated neighbors. Mixed-process chips may consist of bipolar and JFET devices (a), bipolar and p-MOS transistors (b), or a combination of bipolar and C-MOS structures (c).



The smallest graphic recording system is also the biggest in flexibility and convenience.



Honeywell Model 1858 Data Acquisition System

Most compact.

The Honeywell Model 1858 Oscillograph is an unbelievable 8¾ inches short, including plug-in signal conditioning and internal paper take-up. The 65-pound-light 1858 is easy to take anywhere as well; it can be used in a rack, on a table, on the seat of a car or plane.

Most flexible.

You get up to 18 channels (expandable to 32), each with dc to 5,000 Hz response, and a choice of 42 discrete paper speeds . . . up to 120 inch/sec. You also get a choice of seven plug-in signal conditioning modules, each of which was designed to perform a specific function. Taken together, these modules cover a wide range of input signals, including those from transducer sources. Its new 14-channel add-on housing permits up to 32-channel capacity, but adds only 5¼ inches to height. And our new 1887 plug-in signal conditioning module (one of seven)

provides simultaneous input signal conditioning for magnetic tape recording and the Model 1858, or serial record and playback from tape to the Model 1858.

Most convenient.

Because the Model 1858 uses a cathode ray tube and plug-in signal conditioning modules, it is easier to use and set up than any other graphic recorder. You never have to waste time with pens . . . there are no inks, chemicals or toners to worry about. Also, our signal conditioning is calibrated in volts/division and have both trace position and trace-off controls, so that you can position any trace at any point across the record. The trace, if desired, may traverse the full record width even at maximum frequency. All these features add up to making the 1858 the most in graphic recording.

**For complete technical specifications, call or write
Lloyd Moyer, Honeywell Test Instruments Division,
P.O. Box 5227, Denver, CO 80217, (303) 771-4700.**

Honeywell

Consumer electronics

Japanese press microcassettes

On the market since 1969, ultrasmall tape recorders finally are ready to gain niche in market as sales and competition pick up

by Gerald M. Walker, Consumer Editor, and Charles L. Cohen, Tokyo bureau manager

The microcassette tape recorder, a machine that has been struggling to gain consumer acceptance since it hit the market in 1969, is a product whose time has finally come in Japan. And, based on the history of other Japanese consumer electronics products, America can't be far behind.

One of the drawbacks of the transistor-radio-sized recorder, aside from its initial selling price of \$150 to \$280 depending on options, was that it was developed by a camera company, Olympus. That firm has had great success with tiny cameras, but was not known for its skill in tape recorders. But the picture has changed in the last 18 months, as two well-known consumer-electronics companies have joined the competition. Now other firms are getting set to enter. The net effect is that the microcassette recorder has become a viable product.

According to Olympus, total sales in Japan by all manufacturers last year amounted to 150,000 to 170,000 units, a drop in the bucket in a 4-million-plus portable-tape-recorder market. This year sales will probably total 240,000 to 250,000 units and in 1977 could climb to almost 310,000 units domestically. There is very little export so far, because the Japanese companies have been concentrating on the larger minicassette machines for overseas which use standard Philips-tape cassettes (see table).

The microcassette reels and housing, about a quarter the size of the standard type, was also developed by Olympus using tape supplied by TDK Electronics Co. Tape speed is 15/16 inch per second, exactly one-half

HAND-HELD TAPE PLAYERS			
	Microcassettes		Minicassette
	Olympus, Sony, Matsushita RQ 160	Matsushita RQ 170	
Dimensions (mm)	64.5 x 132.6 x 28.2	67 x 31.5 x 138	141 x 92 x 40 to 166 x 45 x 100
Weight (grams)	340	345	640 to 830
Price	\$156 to \$171	\$122	\$97 to \$139

that of the standard Philips cassette. Tape width is 3.81 millimeters, frequency response is 200 to 4,000 hertz, and running time is 30 minutes per side for one-hour total playing time. The cassette itself measures only 33.5 by 50.2 by 8.1 mm.

The first to join Olympus in the market was Matsushita Electric Industrial Co. which started selling the R 160 last year for about \$163. It is made for Matsushita by Olympus, but has different options. Then, in March of this year, Sony Corp. got into the act with two models priced at around \$160 and \$156. They are available in the U.S. through office-equipment outlets. In July, Olympus brought out a new Pearlrecorder-SD for \$156 with a-m and fm radio options at \$17 and \$22, respectively.

New models. Last month, Matsushita started selling a new model, RQ 170, priced around \$120. Early next year, Toshiba Electric Co. Ltd. expects to introduce one of its own at the same price, but also is aiming for a unit under \$75, which is the Japanese commodity-tax breakpoint. Sanyo Electric Co. Ltd. will probably join the field as well.

The new Matsushita recorder measures 138 by 67 by 31.5 mm and with batteries weighs 345 grams, slightly bigger and heavier than the first model. Production economies and use of standard components made by Matsushita account for the lower price, explains M. Shingai, manager of the Audio Tape Recorder department. In addition, the new model has a plastic case rather than metal.

Akiyoshi Tshitani, manager of radio and tape-recorder sales-planning department for Sanyo, says, "The microcassette offers a good opportunity because there are fewer competitors compared to the minicassettes. But the problem is the high price, which means fewer potential customers at first."

Studying. In the United States, the hand-held tape players have been sold primarily to businessmen, but the prime target in Japan is the student. Therefore, it's important for all the competitors to get prices down. However, working in the manufacturers' favor is the fact that conscientious Japanese parents can be counted on to buy the microcassettes to help their children get ahead in school. □

Multifunction Voltage-to-Frequency Converter

The Raytheon 4151 is more than a voltage-to-frequency converter. It consists of a comparator, a one-shot, a precise gated current-source-output, an internal reference and an open-collector output... all on one chip.

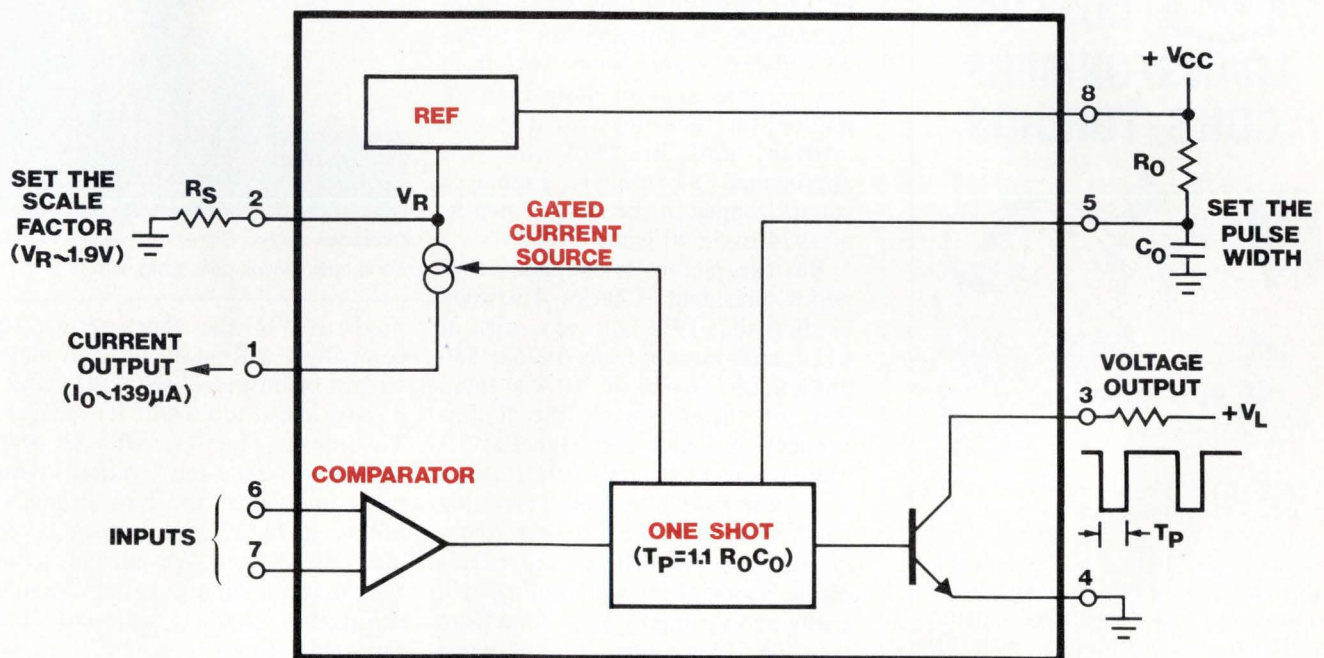
Make what you need. It's all in the way you connect it up. You can make a voltage-to-frequency converter, a frequency-to-voltage converter or a voltage-controlled pulse generator. It's up to you.

The versatility of the unique device is truly amazing. You can externally set the output pulse width by varying an impedance or voltage level. The amplitude of the gated current source is easily set with only one resistor. The open-collector transistor output makes it

easy to interface with any logic family. You can design high-performance data conversion and signal generating circuits at the lowest possible cost.

Combine the 4151 with a little external logic, an op amp or two, possibly a 555 timer, and you can make integrating analog-to-digital converters, long-term analog integrators, signal isolators, FSK demodulators, frequency scalars and many, many more special functions.

For complete details on this unique multifunction VFC, contact your local distributor or Raytheon Company, Semiconductor Division, Dept. 4151, 350 Ellis Street, Mountain View, CA 94042, (415) 968-9211.

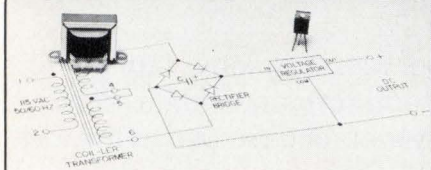


RAYTHEON

SEMICONDUCTOR DIVISION



COIL-LER

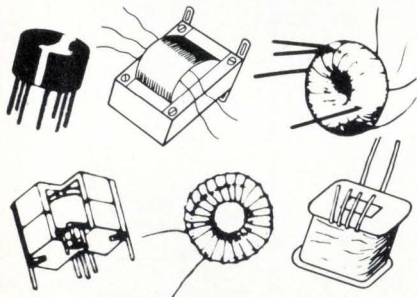


STOCK P.C. POWER TRANSFORMERS

- For use with 3-terminal IC voltage regulators
 - Printed circuit mounting
 - For power supplies for most integrated circuit families
- TTL LOGIC ECL LOGIC
CMOS LINEAR-OP AMPS
- 36 models in stock

Write or phone for complete data sheet.

CUSTOM TRANSFORMERS, COILS, TOROIDS



Our precision manufacturing facility produces a full range of medium, miniature or ultra-miniature size transformers and coils — bobbin or toroidal wound. We can meet both your specs and your delivery dates whether for prototype, small or large production runs. Our experienced engineers are at your service.

Write or phone for information or quotes.



COIL-LER MANUFACTURING, INC.

2-E Town Line Circle Rochester, N.Y. 14623
716/442-6630
Representatives in Principal Cities

Probing the news

Companies

Signetics warms in Philips' glow

Acquisition by Dutch giant fuels optimism as IC maker prepares 80% proprietary, 20% standard product mix

by Judith Curtis, San Francisco bureau

How would you like to run a \$120 million company with a \$200 million R&D budget? That, in effect, is what has happened to Signetics Corp. since it was acquired last year by Philips Gloeilampenfabrieken N.V., the Dutch giant whose R&D and financial resources could go a long way toward thrusting Signetics out of the doldrums.

And since the Sunnyvale, Calif., semiconductor maker slid into them in 1970, those doldrums have at times been deep. In that year, the company suffered a net income loss from the previous year of more than \$8 million; the following year it was \$6 million, and in 1974 the loss approached \$4 million. Employee count dropped in the last six months of 1974 to 5,500 from 12,000.

But the picture is changing. Signetics president Charles Harwood predicts that 1976 will see a gross of \$120 million, up from 1975's \$80 million and equal to 1974's total. Part of the reason is the Philips connection, which cost Signetics 5.5 million shares of its stock at \$8 a share but, says Harwood, "certainly has helped us in the last year" technologically. He believes the effects of the association with Philips will really be showing by 1977 "and from then on." In return, Philips gains Signetics' bipolar and MOS expertise plus an American base from which to expand worldwide markets.

But still, Signetics' main strength—and the basis for its strong sales outlook for 1976—lies in its line of standard transistor-transistor-logic products. James Reilly, who was Signetics' president until 1970,



Overseas help. Signetics president Harwood calls Philips deal a big help.

predicts, "In the short term, [the company] will stay in the mainstream of business" with TTL, which he says constitutes half its business. The market for TTL will be \$800 million in 1980. Jon Gruber, investment analyst at the San Francisco brokerage house of Robertson, Coleman, Siebel, and Weisel, notes that "Signetics is doing better because commodity products, especially TTL, are harder to get."

Cycling. Harwood admits that the company has relied on standard products for its strength and has not been the technological innovator it could be. But he plans to change that image. Now, he says, a third cycle is starting: "We've gone from a proprietary position to industry standard back to proprietary." By

"proprietary," Harwood means new technologies developed in house—and he predicts Signetics will be 80% proprietary within the next few years, compared to 20% now. For instance, the company is building I^2L circuits using multi-level logic (see p. 31).

The transition from follower to leader will be lengthy and will require a product mix far different from Signetics' present one: TTL first, and analog and bipolar memory products following. The other markets Harwood is aiming at include MOS, microprocessors, bipolar system logic, and integrated injection logic, and to reach these, "different things have to be done," admits Jack Halter, director of marketing. First, he says, the company must "increase its applications support, particularly in the microprocessor area."

Bipolar push. The thrust will be in bipolar LSI products, using I^2L , a technology that Signetics helped pioneer. In fact, one industry insider believes the company will produce more new proprietary products in the next year than in its entire history, most of them I^2L . The company also plans to become a major supplier of I^2L watch modules and circuits.

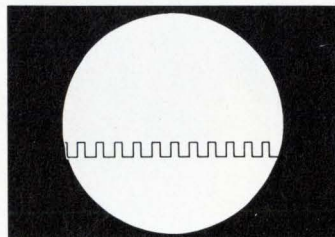
One of Signetics' first steps into more proprietary products on the MOS side was the introduction of its 2650 microprocessor, designed to compete with Intel's 8080. Although Harwood acknowledges that "our microprocessor effort last year was small," he predicts that over the next five years, "a larger proportion of our business will be in MOS and microprocessors." With the addition of n- and p-channel silicon-gate MOS, Schottky emitter-coupled phase-locked loops, and timing circuits, Harwood expects the company to place fifth or sixth in IC sales.

Signetics is in a strong position to build, unlike the down year of 1974 when distributors cashed in on escape clauses and sent back \$40 million worth of inventory. The company has "substantially reduced" that stock, says Harwood. As further evidence that it is coming on strong, he points to a 40% increase in shipments during the first half of 1976. □

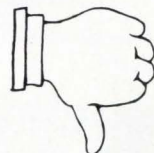
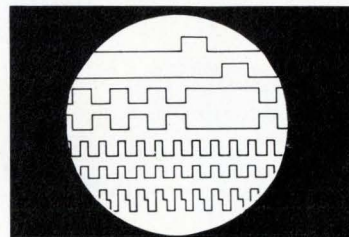
A NEW GENERATION OF IMAGE SENSORS

SIMPLICITY OF USE

Requiring less than a dollars worth of circuitry to drive—and barely more than that for video processing—is just one of the key features of our new "G" series image sensors. Compare the non-critical single TTL clock needed for the "G" device to the complex multi-phase clocks prescribed by others.



You need only this for Reticon



You need all these for others

HALF THE PRICE

Or even less will bring you 256, 512, 768, or 1024 sensor elements on 25μ centers or up to 1728 elements on 15μ centers in our "H" series.

SUPERIOR PERFORMANCE

Low dark current allowing low light level operation, on-chip noise cancellation, and smooth spectral response from visible through infrared makes this new generation the unquestionable choice.

APPLICATIONS

Page readers, facsimile, OCR, point of sale readers, non-contact measurements and inspection and many others.

RETICON®

910 Benicia Avenue, Sunnyvale, California 94086
PHONE: (408) 738-4266 TWX: 910-339-9343



**To be a social success
in Wabash, Indiana it helps to be
good at playing basketball and designing coils.
Some of us are still working on the basketball.**

If you're from these parts, people expect you to be good at one or the other. Our engineers are 'bout the best there is when it comes to designing coils. In fact, that's the reason why Wabash coils are famous and why Wabash makes the most molded coils in the United States, including epoxy, nylon, and engineered thermo-plastic and thermoset materials.

But their basketball game... is awful. So on Saturday afternoons you can expect to find them over at Don Fisher's trying to pick up a few pointers from the kids. But it really doesn't bother them as much as they'd let you think. As Dick Kosiarek, our Coil Engineering Vice President put it, "George McGinnis never designed a coil in his life".



Shown: custom engineered thermoplastic and thermoset molded coils for automotive applications.

Coils, Relays & Transformers

wabash
of
Wabash, Indiana

and Huntington, Indiana; Farmington, Missouri;
Tipton, Iowa and South Boston, Virginia

For information and quotes write or call:

Wabash, Inc., Dept. CA-1, 810 N. Cass St., Wabash, Ind. 46992 Tel: 219/563-3111 TWX 810-290-2724
Circle 58 on reader service card

Enterprise to keep assemblies with counterfeit devices . . .

The six electric-load controllers in Rockwell International's space shuttle, the Enterprise, **won't have to be replaced.** That's NASA's decision, even though Rockwell has discovered that the units may contain as many as 673 transistors misrepresented as JANTX 2N2222A from Transitron Electronic Corp.

The \$150,000 assemblies "check out fine" in tests, says NASA's Office of Space Flight, despite the fact that some of the transistors were 2222A devices from International Telephone and Telegraph Corp. and Teledyne Inc. inside the Transitron can. None of the device makers is suspect in what NASA's James J. Cummings, chief of inspections and security, says may be "fraud against the Government." An investigation is continuing.

Rockwell's Autonetics operation, which supplied the six power-controller assemblies for the Enterprise, says it has pulled the suspect batch of transistors from its inventory. Tests on the lot show, Rockwell says, "**a failure rate of less than 0.2%**"—within specifications—and no field failures. Moreover, Rockwell points out that the assemblies have triple redundancy built in, are intended for use only in Enterprise approach and landing tests, and were never planned for use in orbital flights.

. . . that Rockwell, NASA say came from N.Y. distributor

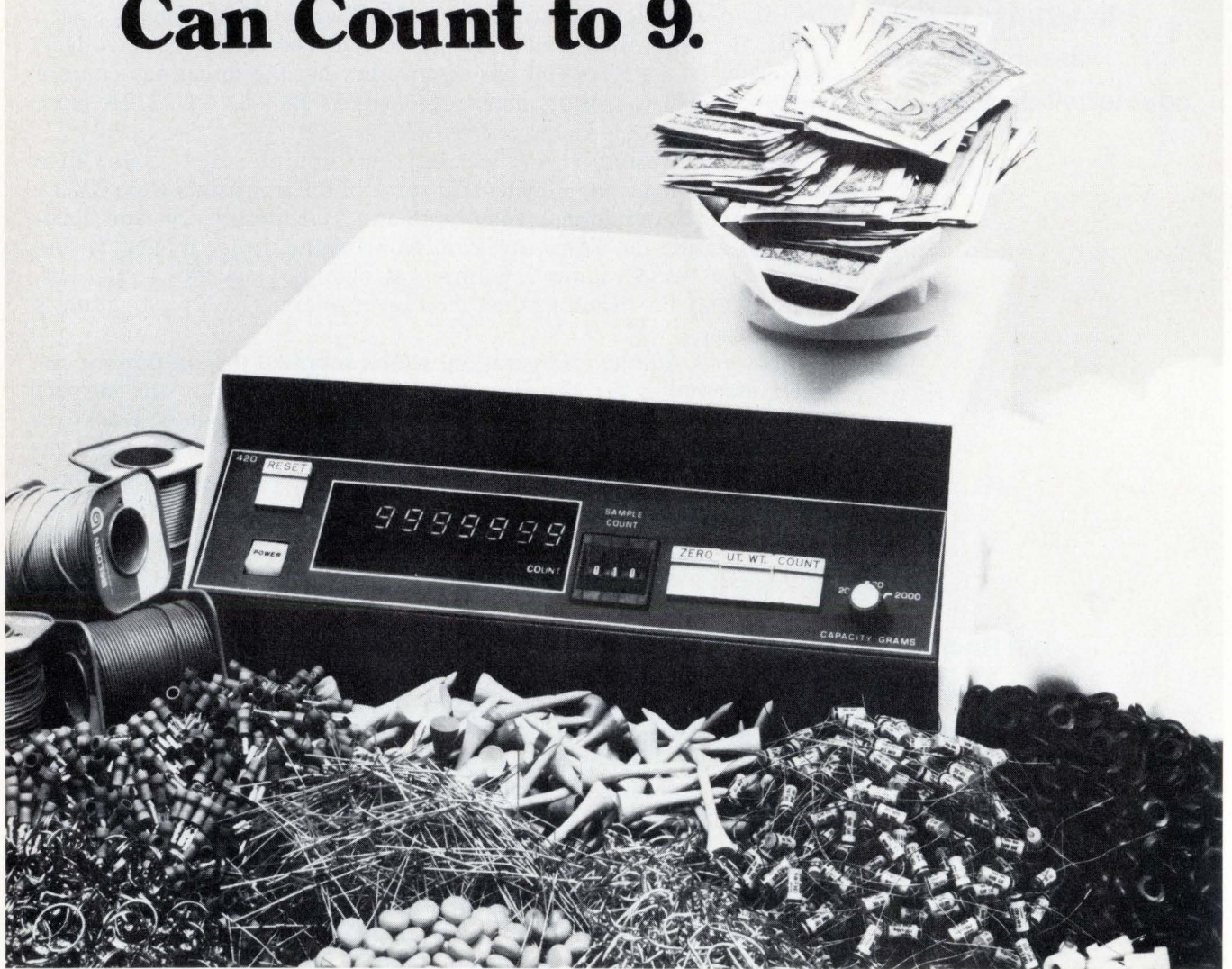
The counterfeit transistors turned up in a lot of 14,000 acquired in 1974 by Rockwell's Autonetics operation, supplier of the Enterprise load controllers, **from Time Electronics, a Hauppauge, N.Y., distributor** owned by Avnet Inc., explain NASA and Rockwell spokesmen. They say Time, which is not a franchised Transitron distributor, told Rockwell that it acquired the Transitron transistors from another source. Time has named those sources but won't identify them publicly.

EIA uncovers seven cases in 53-firm survey

The Electronic Industries Association has turned up seven cases of semiconductor counterfeiting—all involving discrete devices—in a survey of 20 producers and 33 device users. In five cases another maker's name had been put on the device, while three cases showed a commercial product from the same maker had been upgraded by marking with a JAN or JANTX mil-spec part number. In four cases, the part was procured through a single distributor.

EIA's new Semiconductor Counterfeiting Task Group, coordinated by staff vice president and engineering director Allen M. Wilson, held its first meeting at the end of September. Eleven companies representing both producers and users attended, as did five distributors, the National Electronic Distributors Association, and the Defense Electronic Supply Center's Col. Floyd E. Heinzig. The group doubted that industry could mount any coordinated effort against the problem. However, individual users and military buyers like Rockwell International lean toward **buying semiconductors only from manufacturers or franchised distributors.** The EIA group is trying to develop consensus recommendations for government to cope with the problem.

Digimetric Counts or Measures from 1 to 9,999,999 Before You Can Count to 9.



Digimetric is a name you can count on if you distribute electronic parts or manufacture electronic parts or equipment. They are machines that mean business when it comes to counting—high accuracy electronic counting scales that are capable of counting one part to 9,999,999 parts in seconds.

Digimetric counting scales lend speed, accuracy, and efficiency to shipping/receiving, stock room, and production/staging operations, while simplifying inventory control problems. Packing and distributing operations also find Digimetric counting scales ideal for breaking bulk and repacking.

Hand counting items is time consuming and often inaccurate. The Series 400 Counting Scales take the total weight of a large number of like-items and instantaneously convert their mass to a quantity, which is then displayed electronically on the easy to read display panel. It's the fast, easy, accurate way of counting connectors, transistors, semi-conductors, resistors, diodes, grommets, or for measuring wire lengths.

If you require the collecting, storing and print-out of count or other data, there's a Digimetric Counting System that can be tailored to your specific needs.

Digimetric... The Machine That Business Counts On.

SYBRON | Digimetric

Digimetric Company, 730 Kalamath Street, Denver, Colorado 80204, (303) 534-1190, Telex 45-712

Matsushita's ceramic filter handles video i-f in color-television sets

With the development of a multi-mode bulk ceramic filter for video intermediate-frequency amplifiers, video i-f filter design should catch up with such color-television advances as integrated circuits and in-line picture tubes. Although the inductance-capacitance filter now used requires a large handful of parts, the single IC will provide adequate gain. And it comes along just in time, too, because, with the advent of in-line picture tubes, the video i-f filter has the greatest concentration of adjustments in the TV set.

The Matsushita Electric Industrial Co. Materials Research Laboratory developed a ceramic with the desired characteristics, and its Wireless Research Laboratory developed the filter. The ceramic, made of lead zirconate, lead titanate, and lead magnesium niobate, has a high Poisson ratio, which aids in eliminating spurious response, and a high coupling coefficient that makes possible the required bandwidth of about 5% with negligible ripple in the passband. The new material is also suitable for fabrication into the 40-micrometer-thick sheets for operation at about 60 megahertz in Japanese color-TV sets.

Similar technology is also being used to make filters with a bandwidth of about 1 MHz at the 27-MHz citizens' band frequency. Using this filter between two low-level stages of the transmitter greatly attenuates out-of-band spurious signals generated by the frequency synthesizer.

IC processing. Many filters are formed on a single sheet of ceramic by deposition of chrome-gold electrodes through a metal mask. The wafer is then scribed and broken into individual chips. Each filter's active portion is 1 millimeter square by 40 micrometers thick. Two parallel electrodes on one side of the chip overlay a perpendicular electrode on other side. The thickness vibration,

or symmetrical mode, of the ceramic sets the upper frequency pole of the filter, while the symmetrical-mode vibration sets the lower pole. Bandwidth is primarily determined by ceramic characteristics.

In operation, a small inductance between the common electrode and ground decreases the frequency of the low-frequency pole, thereby increasing filter bandwidth, and also permitting adjustment of the low-frequency pole. Required inductance is inconveniently small, though, and

a capacitor is connected in series with the inductor to permit a practical value of inductance to be used.

Both one- and two-section ceramic filters have been used. A single-section filter does not sufficiently attenuate adjacent-channel audio and video signals, and piezomotor traps—narrow-bandwidth ceramic filters—are used for additional attenuation at these frequencies. A third piezomotor in series with a resistor produces the shelf for the same-channel sound carrier. □

Around the world

Process puts MOS or bipolar circuits on CCD chip

A single process may be used to integrate either metal-oxide-semiconductor or bipolar driving circuits on the same chips with charge-coupled devices. At the recent Third International Conference on the Technology and Applications of Charge-Coupled Devices at the University of Edinburgh, Scotland, the Plessey Co.'s narrow-gap shadow-etch process was advocated for both types of circuits.

The performance of the popular 741 operational amplifier was matched by a CCD chip containing an n-channel MOS amplifier built by researchers at the university's Department of Electrical Engineering. However, the chip's gain is limited to 100, and it must be used at frequencies below 10 megahertz because of MOS-technology limitations. But for frequencies between 5 and 25 MHz, bipolar circuits were advocated by designers at Plessey's Allen Clark Research Centre. For the MOS circuits, the shadow-etch process effectively adds one layer of aluminum in two depositions. However, to get the bipolar circuits, photoengraving and ion-implantation stages are added.

For high-gain and large-bandwidth amplifiers, bipolar drivers are better than MOS, the researchers say.

Digital thermometer gives probe choice

A digital electronic fever thermometer introduced by the West German firm ETW GmbH is one of the smallest and fastest being marketed. Powered by a 5-volt rechargeable battery, the Digimed H01 thermometer set will be sold in Germany, the U.S., and elsewhere for about \$250, including a battery charger and a number of probes. The Digimed H01 weighs only 300 grams.

It comes with three types of probes—a "throwaway" version intended for use primarily in hospitals and infirmaries, a standard type, and one for taking the temperature of the skin surface. The probes are attached to the thermometer by a plug-in cable so that many temperatures can be taken quickly in a hospital ward. The throwaway type is priced at about \$2.50, but the price is expected to drop to less than \$1.

A temperature reading, accurate within 0.1°C, is registered in only 2 to 3 seconds, thanks to the tiny negative-temperature-coefficient sensor made by Siemens AG. This disk-shaped sensor is mounted at the tip of the thin probe.

CORTRON IS WRITING THE SOLID STATE KEYBOARD SUCCESS STORY

A new name in keyboards, CORTRON actually has a history dating back to 1968, when Illinois Tool Works Inc. made news with the introduction of its first solid state keyboard through its Licon Division. ITW has emerged as a major producer of solid state keyboard products and has supplied thousands upon thousands of custom-designed keyboards to meet specific customer requirements.

CORTRON DIVISION FORMED BY ITW

With a strong market demand and a promising future for keyboard products, ITW formed a new division, CORTRON, to handle full responsibilities for electronic keyboards and key switches. Following a proven ITW strategy, CORTRON concentrates a special division team of experienced Licon design, manufacturing and marketing people on this new major business opportunity.

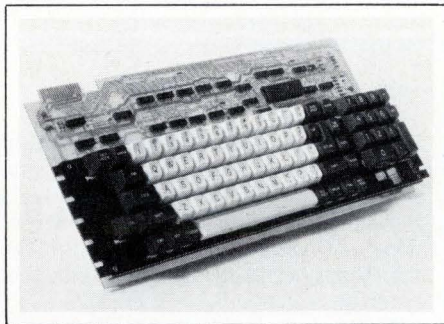
KEYBOARD MARKET DIVERSIFIED

Typical applications for CORTRON™ Keyboards include data and word processing, computerized accounting, production and inventory control systems, retail point-of-sale and remote banking terminals, airline reservation and seat assignment stations, typesetting and text editing systems. And new applications are continually surfacing.

PROVEN PRODUCT RELIABILITY

The CORTRON Division offers proven keyboard products with an

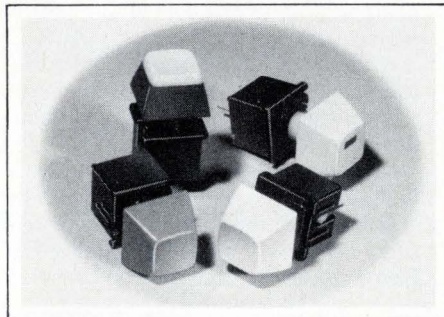
established reputation for excellence and reliability. The



CORTRON Series 555 Solid State Keyboard is a sophisticated electronic device. Its high reliability protects against costly service calls and the hardship of downtime. The low profile alpha numeric keyboard has the human engineered "feel" required by your marketplace. This promotes speed, accuracy and greater operator productivity.

CORTRON KEY SWITCH MAKES THE DIFFERENCE

The CORTRON Contactless Key Switch is the heart of the solid state keyboard. The CORTRON



Key Switch is respected throughout the industry for its ultra reliable 100 million cycle life rating. Utilizing a ferrite core switching technology, the key switch is mechanically simple with only four basic parts.

CORTRON RESPONDS TO CUSTOMER NEEDS

Since keyboard products are CORTRON's only business, the ITW Division is highly responsive to individual customer needs and requirements. CORTRON offers expert application engineering assistance, and has the high volume keyboard production capability so essential to large customer demands. Further, the division is backed by the resources of ITW, a worldwide corporation. Whether you want to buy keyboards or build them, CORTRON can supply the key elements necessary to success. For complete details, contact CORTRON, A Division of Illinois Tool Works Inc., 6601 West Irving Park Road, Chicago, Illinois 60634. Phone: (312) 282-4040. TWX: 910-221-0275.

CORTRON is writing the solid state keyboard success story.

TO BE CONTINUED...



CORTRON
A DIVISION OF ILLINOIS TOOL WORKS INC.

**THE KEYBOARD
PROFESSIONALS**

International newsletter

Bankruptcy sought by Japan's leading calculator exporter

Systek Corp., which had led all Japanese manufacturers in calculator exports and was second only to Casio Computer Co. in production, has applied for bankruptcy under the Stock Company Reorganization and Rehabilitation Act. Systek's debts are estimated at about \$40 million, a new record for failing calculator companies. **The failure is blamed on increased competition in low-price calculators from Taiwan and Hong Kong and the surplus of calculators in principal markets**, which led to a decrease in new orders, cancellation of orders, and a pile-up of components in Systek's plants. The company also had large stock of components for television games.

Systek, which was started in November 1968, last year had sales in excess of \$100 million, and at its peak monthly production was more than 1.1 million units, mostly for export. The rapid downturn came in August. In September, both components manufacturer Kyoto Ceramic Co. and Tokai Bank Ltd. agreed to help Systek. However, they pulled out on Oct. 12 after examining the company's books.

British firm bags \$57 million pact for F-16 diplays

Marconi-Elliott Avionic Systems Ltd. of the UK will supply the heads-up display/weapons-aiming system for the U.S. Air Force's F-16 fighter under a \$57 million contract with prime contractor General Dynamics Corp. The pact covers 650 F-16s for the U.S. and 348 for four NATO countries—Belgium, Denmark, Norway, and the Netherlands—in the so-called arms deal of the century.

Each system includes a pilot's display unit, a digital-electronics unit, and a rate-sensor unit. The latter two products for 430 heads-up displays will be made by Norway's Kongsberg-Vapenfabrik in a \$17.5 million deal with Marconi, which also will negotiate with a second European firm for the pilot's display unit. Marconi's U.S. subsidiary, E-A Industrial Corp., Atlanta, Ga., will make several full systems.

CCD circuit wipes out video 'ghosts'

"Ghosts" on television screens caused by multipath echoes will be eliminated if Philips' research laboratories in Eindhoven, the Netherlands, has its way. The remedy is a recursive filter that is based on a p-channel charge-coupled device. But Philips says a commercial product will be delayed about a year.

The circuit, which provides automatic gain and polarity control, **adds a synthetically generated ghost signal to the incoming real one to wipe out the interference caused by signal delay of 0.6 to 8.5 microseconds** over the full 5-megahertz PAL video bandwidth. Besides the four-phase, buried-channel, 128-bit CCD, the circuit will have off-chip video drivers and one chip for the timing, comparator, up-down counter and digital-to-analog circuits.

Gold use halved by plating process from German firm

West Germany's Glaswerk Schott has developed a pure gold-plating process that uses 50% less gold than conventional gold-plating methods. Applicable to electronic components, even those of complex shapes, the technique makes gold layers only 0.5 to 0.8 micrometer thick, about half that of gold layers made by other plating processes. **The proprietary technique provides smooth, poreless, pure gold layers that are well suited for further processing steps** such as resistance welding, alloying, and bonding, the company says.

Talk to the 32,329 decision-makers in Japan's electronics industry.

翻訳

We'll furnish the language.

If you want to reach the most influential group of management and professional electronics engineers in Japan, we're certain you couldn't choose a more important medium than Nikkei Electronics. Or a more helpful one, either.

When you're thinking about selling to our 32,329 decision-makers, we offer you our full communications resources.

For instance, we'll translate your advertising message from English into the kind of Japanese that we know gets results from our readers. Then we'll set type for you. Also lay out the entire ad for you. And, wonder of wonders, there's no extra charge for these services.

Speaking the precise language of our very important readership is just one of the ways Nikkei Electronics gets more value for your yen in Japan.

As the bi-weekly product of Japan's largest business-economic newspaper and McGraw-Hill, Inc., we're by far the most-respected magazine in our field. (About 30% of our material is a translation of specialized contents from U.S. *Electronics*.)

As the only Japanese electronics magazine that's a member of the Japan Audit Bureau of Circulation, we can guarantee exclusivity as well as readability.

Our reader profiles are computer-controlled. The better to provide you with up-to-the-minute information on purchasing patterns, reader

analysis studies and proper market approaches.

And our Reader Information Service is a masterpiece of effectiveness. As many as 3,388 responses per issue, with 57.4% of the respondents acknowledging that they participate in or influence the purchasing decision of their companies.

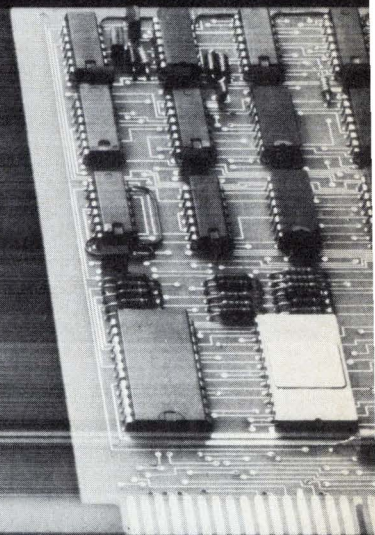
Talk to the electronics decision-makers of Japan in our pages. We'll even furnish the language. Contact Mr. H.T. Howland (in English), Marketing Services Manager, Electronics, McGraw-Hill Publications Company, 1221 Avenue of the Americas,

New York, N.Y. 10020. Telephone: (212) 997-6642. Or talk to any member of McGraw-Hill's advertising sales staff in the U.S. or Europe, or contact us directly in Japan.



Nikkei Electronics: Ask anybody who can read us.

The fastest microcomputer known to man



Want to see it again?

Just call Plessey and ask to see the 16-bit MIPROC 16, the first microcomputer fast enough for your real-time systems.

We'll show you three models, with throughputs of 2, 2.85 and 4 million instructions per second. An optional 10 megaword per second direct memory access channel. 82 powerful instructions that eliminate costly, time consuming microprogramming and hardware design and debugging. And an architecture that achieves this ultra-high speed with less expensive MOS memories.

To round out your systems, we've got a full range of software and hardware support. Everything you need for signal processing and Fast Fourier Transforms,

process control and data acquisition, real-time telemetry and data communications. Even an extended temperature range and/or ruggedized version for your military systems.

The Plessey MIPROC 16 is yours for as little as \$500 in quantity, so if you're still paying the price of hardwired logic just to get speed, ask for the details.

We've just brought microcomputing up to speed.



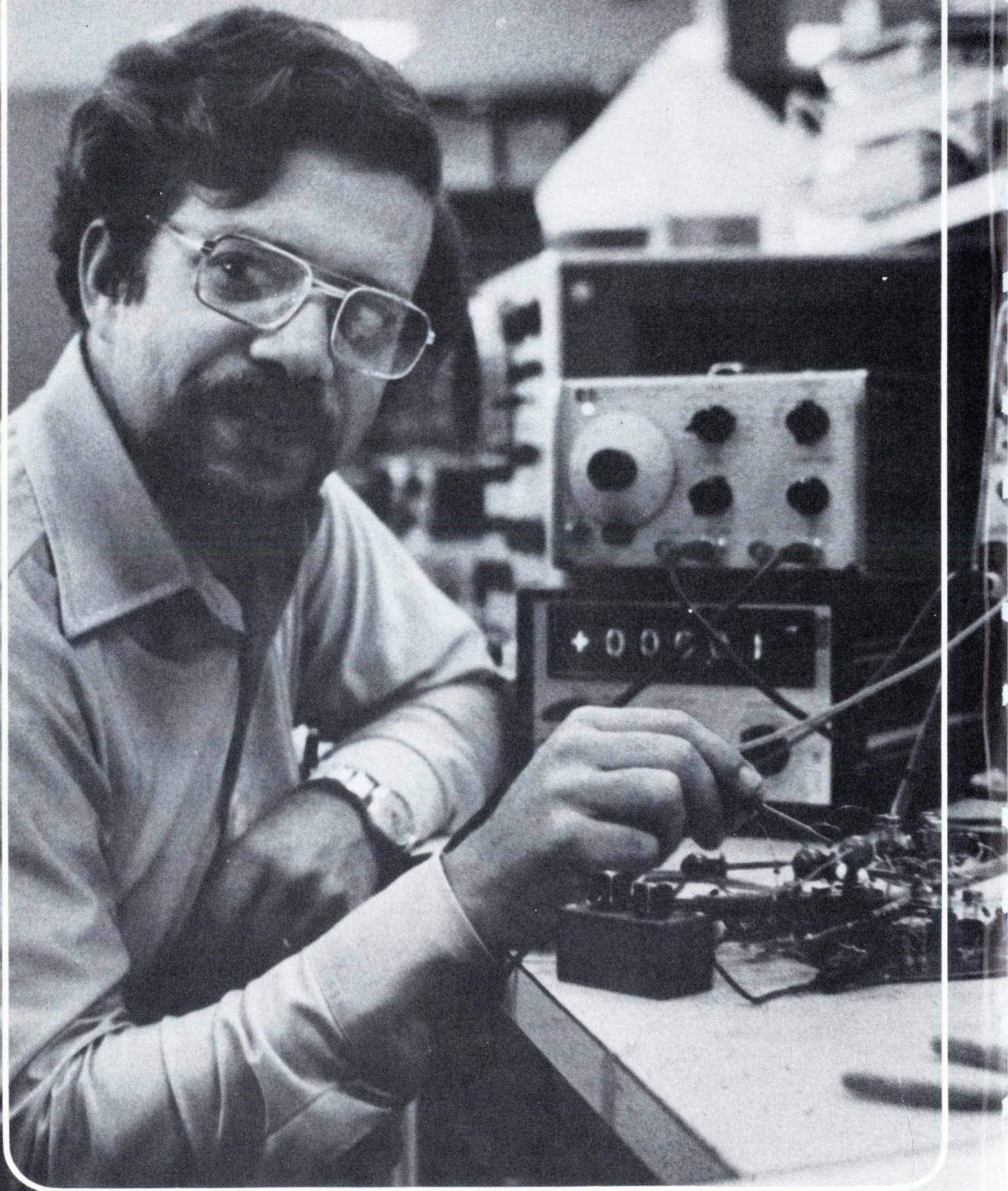
Plessey Microsystems

U.S.A.: Irvine, CA (714) 540-9945
Wheaton, MD (310) 949-1664

United Kingdom: Towcester (0327) 50312

Circle 65 on reader service card

1976 Award for Achievement



National's Dobkin cited for his linear wizardry

In a world increasingly dominated by microprocessors and other digital large-scale-integrated circuits, it takes an exceptionally creative designer to make waves in the less glamorous linear domain. Yet, over the past ten years, just such waves have come from Robert C. Dobkin, a self-taught 33-year-old engineer and circuit designer who dropped out of the Massachusetts Institute of Technology because he was bored.

He is now director of advanced-linear-product design at National Semiconductor Corp. in Santa Clara, Calif. His 20 patents and patent applications cover circuits and processes fundamental to monolithic linear-circuit design, as well as such diverse areas as transistor-transistor logic circuits, digital-watch testing, pressure- and temperature-transducer design, and vertical-channel field-effect-transistor fabrication. In concert with his predecessor at National, Robert Widlar, he is responsible for the design of some of the industry's first operational amplifiers and linear circuits incorporating band-gap-referencing techniques.

Dobkin, who has the look of a slight-

ly mellow revolutionary, is of the generation of design engineers who grew up with semiconductor technology. Its intricacies and idiosyncracies have become almost second nature to him. "Bob is more than just a clever linear-circuit designer," says Widlar, now a consultant to National. "He's a damn smart one with an asset a lot of designers lack—a detailed knowledge of the terrain he's working: the silicon."

This knowledge comes quite naturally, for "I've been playing around with electronics since I was six or eight years old," Dobkin says. But after he got his hands on one of his first semiconductor devices in his early teens ("a germanium pnp transistor: the CK722, I think"), he would have nothing more to do with vacuum tubes.

It was not simply a hobbyist's interest in what could be built with these components. It was a fascination with the devices themselves—how they did what they did and how far they could be pushed beyond the capabilities listed on data sheets. "There seemed something almost magical about those chunks of material," he says. "It just amazed the hell out of me that they could do what they did. Of course there was no magic at all after I pushed and poked at them enough."

But his approach to a problem is more than just a push and a poke, according to National's converter-products manager, Brent Welling. "Bob has an almost uncanny capacity to absorb information quickly, digest it, and come up with the essentials needed to solve a particular problem. If he can't get the information he needs from tests on the work table, he'll read everything he can get his hands on. If that's not enough, he'll corner anyone he thinks has information he needs. Then he'll go back to pushing and poking at the problem until he has an answer—the answer."

While this ag-

The 1976 Achievement Award

For significant contributions to linear-circuit development, the editors of *Electronics* have voted Robert C. Dobkin, head of advanced linear design at National Semiconductor Corp., the recipient of the magazine's 1976 Achievement Award. At National, he has guided a small group of designers to an impressive string of successful linear-product designs that encompass both circuit and process innovations. Their achievements include the LM120, the industry's first three-terminal voltage regulator; the LM123, the industry's first high-current-output three-terminal regulator; the LM117, the industry's first adjustable three-terminal regulator, and the LM195, the industry's first integrated-circuit power-transistor amplifier. Previous winners of the award were Gordon E. Moore, Intel Corp., in 1974, and for 1975, Arie Slob and Cornelius Hart of Philips Gloeilampenfabrieken, along with Horst Berger and Siegfried Wiedmann of IBM.

gressively obstinate approach to solving problems is a key element in Dobkin's present success, it was not conducive to an academic career. In fact, his attitude probably contributed to his departure from MIT in 1963 at the end of his sophomore year. "I left because I was bored," he says. "I was climbing the walls. They just expected me to sit there, take notes, and take tests. I need a productive situation to do my best. So I got out."

After a series of technician jobs he landed a job in 1966 at General Electric Co. in Philadelphia, where he was responsible for evaluating and building test equipment for semiconductor components in space applications. It wasn't exactly either a technician's or a designer's job. "It was sort of in between," he recalls, "amorphous enough to be anything I wanted it to be."

About this time there began to appear some of the first linear IC work by, among others, Widlar at Fairchild Semiconductor and later at National. "The feeling I got about the technology—and that I still have—is that it is wide open," Dobkin says. "There are no hard and fast rules, except the laws of physics. And, if you know those well enough, you can find the loophole in any given situation to allow you to do almost anything you want to. It's completely eclectic. Nothing is ruled out as long as it works."

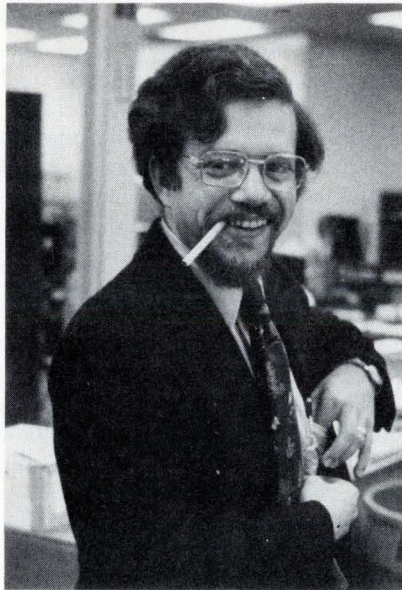
He was especially interested in operational amplifiers. After tearing up several made by a pioneer in the field, Teledyne Philbrick, Dedham, Mass., he called engineers there and began asking a lot of penetrating questions. After several weeks they stopped answering. "I think they thought he was from a competitor," says Robert Pease, who was a Philbrick engineer then and is now a member of Dobkin's design group. But to his last question in late 1967—"can I have a job?"—the firm said yes, and he went to work as a linear-circuit designer.

"But after a year it was clear that the real action in linear design was elsewhere," he says. About the same time as this realization came a job offer from Widlar at National. It was the culmination of two years of irritating phone calls, Widlar says.

"Every now and then I would get these calls from a wild-sounding freak. He was always asking questions. Finally I hired him and told him to go answer his own damned questions."

Starting in 1969, Widlar and Dobkin worked together on a number of linear circuits including the LM111 comparator. They were joint authors of a patent describing the first use of band-gap-referencing techniques in op amps and other linear devices.

Since taking over the advanced-linear-product-development group in 1970, he has kept it "lean and mean," at first working with just one other designer, Carl Nelson. Later he added Peter Lefferts and Pease.



And what has resulted from this small group of designers in the past five years is at least 15 new linear IC families, more than half of which were industry firsts. Many others have become industry standards. At the same time, the small group has kept up a continuous stream of redesigns on older products with ten- to one-hundred-fold improvements in performance. It also has produced process and fabrication improvements that have allowed National to remain the pricing pacesetter in high-volume linear ICs.

"Dobkin is not only one of the most brilliant designers I've worked with, he also has an amazing feel for exactly what the marketplace needs and wants," says his boss, Robert

Swanson, director of linear-circuit operations. "On a number of products he's suggested, my marketing people have told me the volume just didn't justify it. Usually I just take a deep breath and tell him to go ahead. So far, his batting average has been pretty good, and I haven't regretted it."

According to Brian Hollins, director of processing for the advanced-linear-products group, Dobkin "has a gut-level understanding for processing and for the limits and capabilities of the silicon," unusually so for a circuit designer. "He'd make a pretty good process guy, if he weren't a circuit designer," he says.

His participation in the various projects ranges from complete engineering responsibility, such as on the LX5600, to working as a coinvestigator as on the zener IC project with Nelson. Just as often his contribution is the right insight at just the right time. "Just when my brain is turning to mush trying to work through a particular problem," Pease says, "Dobkin says something that makes everything crystal-clear."

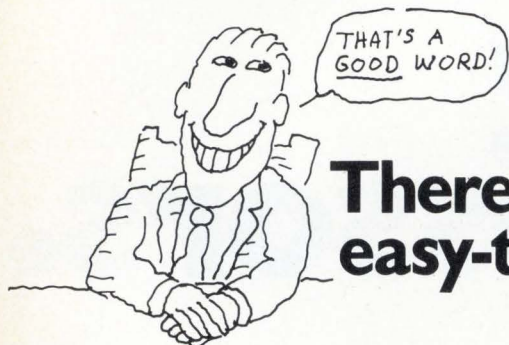
This ability extends beyond his own group, according to Siegel who says a number of linear hybrid products came from "a few conversations over coffee." Similar conversations with digital-logic designers led to a patent on a Schottky-TTL-clamped circuit using a linear biasing technique—pnp current sources—instead of resistors. On the digital-watch production line, a calibration technique he invented, based on an optical pickup from the light-emitting-diode display, is used to test modules. And an interest in improvements to the power-handling capabilities of field-effect transistors led to a patent on a vertical-channel FET technique.

With his wife Carrie and two dogs, Dobkin makes his home in Hillsborough, Calif., in a slightly run-down, two-story, 9,000-square-foot frame house built in 1884, which the two of them are restoring. From there they embark on their other favorite pastime, collecting antiques. It's more profitable than house restoration, he says. "It's pretty easy once you know more than the experts." □

A word to the wise for those considering microprocessors.



ea



There is one, and only one, easy-to-use microprocessor.

The early μ Ps were bears.

Cute, but cantankerous. And difficult to work with. All kinds of special interfaces, difficult to debug, their own language, expensive to program, ponderous and not terribly efficient. Strange animals indeed. But they held great promise, so a lot of companies spent a lot of money working around their limitations.

Pity the pioneers.

Sad, but true. Many of those early applications just have to work for those who invested in them. Too much development cost. Too much invested in programming. In training. In hardware. In design. In prototypes. Incredible.

The early birds in micro-processor applications got more than their share of worms. There ought to be an easier way. And there is.



Easy does it.

The 8 bit NMOS 2650 microprocessor uses standard memory, standard TTL logic, is easy to use, easy to operate, easy to learn, easy to program, and easy to de-bug. By design. With fewer chips doing the whole job, its costs are significantly lower. It requires less real estate. And it was designed to require far less memory in its own operations. It's the smart way to get ahead of the competition who beat you into microprocessors. And save a bundle doing it.



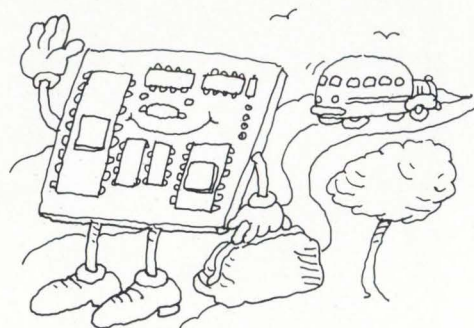
Stop the clock.

Because the 2650 is totally static, you can single step the clock or even turn it off at will. It makes for the easiest debugging in microprocessorland, and it's a single phase TTL clock at that. No two-phase clock required.

The easiest interface.

Where the other microprocessors require custom interface devices (extra circuits, more chips, more board room) for every peripheral and for memory, the 2650 requires interface only to its single 5V

power supply (simple again) and naturally for data bus buffering. In interface requirements, none is best and the 2650 is as close as you can get. All I/O levels are TTL compatible and all outputs are three state.

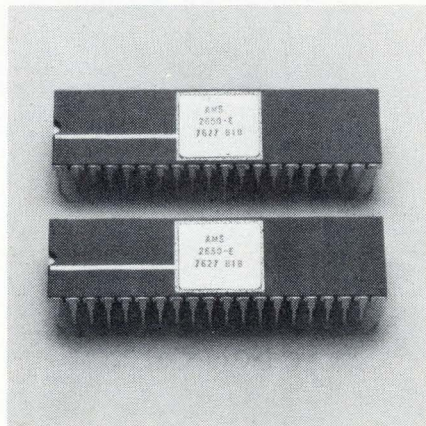


Off the bus.

The 2650 features serial I/O operations separated from the data bus. This means UART type simple functions with no separate chips required. Hook up a teletype direct, for instance.

Easy to program.

With 75 instructions, the 2650 looks very much like the mini-computers you're used to working with. Both the instruction set and architecture are what you've found in working with minis. Seven general purpose registers on chip. Vectored rather than polled interrupt. Much more flexible. Information goes straight in. With variable length instructions, 8 16 and 24 bit instructions do not



SYO

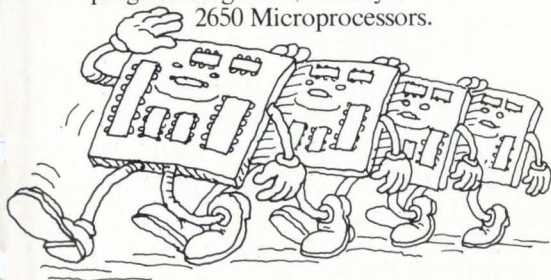
waste program memory. Fewer chips and less RAM requirement; save memory space and save costs. And the 2650 has a wide variety of addressing modes, many of which can be combined for optimum usage.

Easy I/O.

One instruction will switch the general purpose registers which saves register contents without a special store/retrieve routine. Again, you save time, you save memory, you save money. Nothing easier.

More to come.

Between now and January 1977 we'll be introducing in rapid-fire succession a series of LSI I/O devices designed to make use of the 2650 even easier still: the 2651 PCI Programmable Communications Interface; 2652 SDLC Synchronous Data Link Control for IBM line protocol; 2655 PPI Programmable Peripheral Interface; 2656 SMI System Memory Interface; and 2657 DMA Direct Memory Access. Fewer chips, less memory requirement, better use of memory, lower hardware costs, lower programming costs, all easy with 2650 Microprocessors.



Easy to learn.

TED, our dynamite microprocessor trainer, makes it easy. Equipped with hex keyboard, lights and switches, it lets you enter instructions and simulate performance with actual I/O operation. Used with our programmed learning manual, it lets you teach yourself.

Prototypes: easy as ABC.

Our Adaptable Board Computer is a neat little package with its own microprocessor, ROM, RAM, serial and parallel I/O ports and clock. It gets you to prototype fast, easily and inexpensively. Easy as ABC.

TWIN is twice as good.

TWIN is our full blown software development system, equipped with CRT, Dual floppy disc, and supervisory system. It reduces large software development projects to manageable proportions. Sound easy? It's part of the total "easy does it" approach to building low cost, super efficient microprocessors into an ever broader range of products and systems.

Easy to get, too.

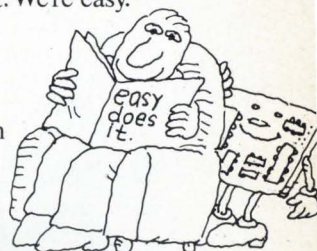
As one of the largest producers of NMOS RAMs in the world, we've got major production facilities to handle ample supplies of the 2650 microprocessor. And the same masks are in production at

Signetics and Phillips, too. It doesn't make sense to be easy on the pocketbook but hard to get. We're easy.

Easy reading.

We've got the documentation (programming manual, support hardware and software manuals) and a rapidly growing library of application notes, to boot.

We're ready when you are. Advanced Memory Systems, 1275 Hammerwood Avenue, Sunnyvale, California 94086. (408) 734-4330. Ask for Semiconductor Marketing.



Advanced Memory Systems
1275 Hammerwood Ave.
Sunnyvale, CA. 94086

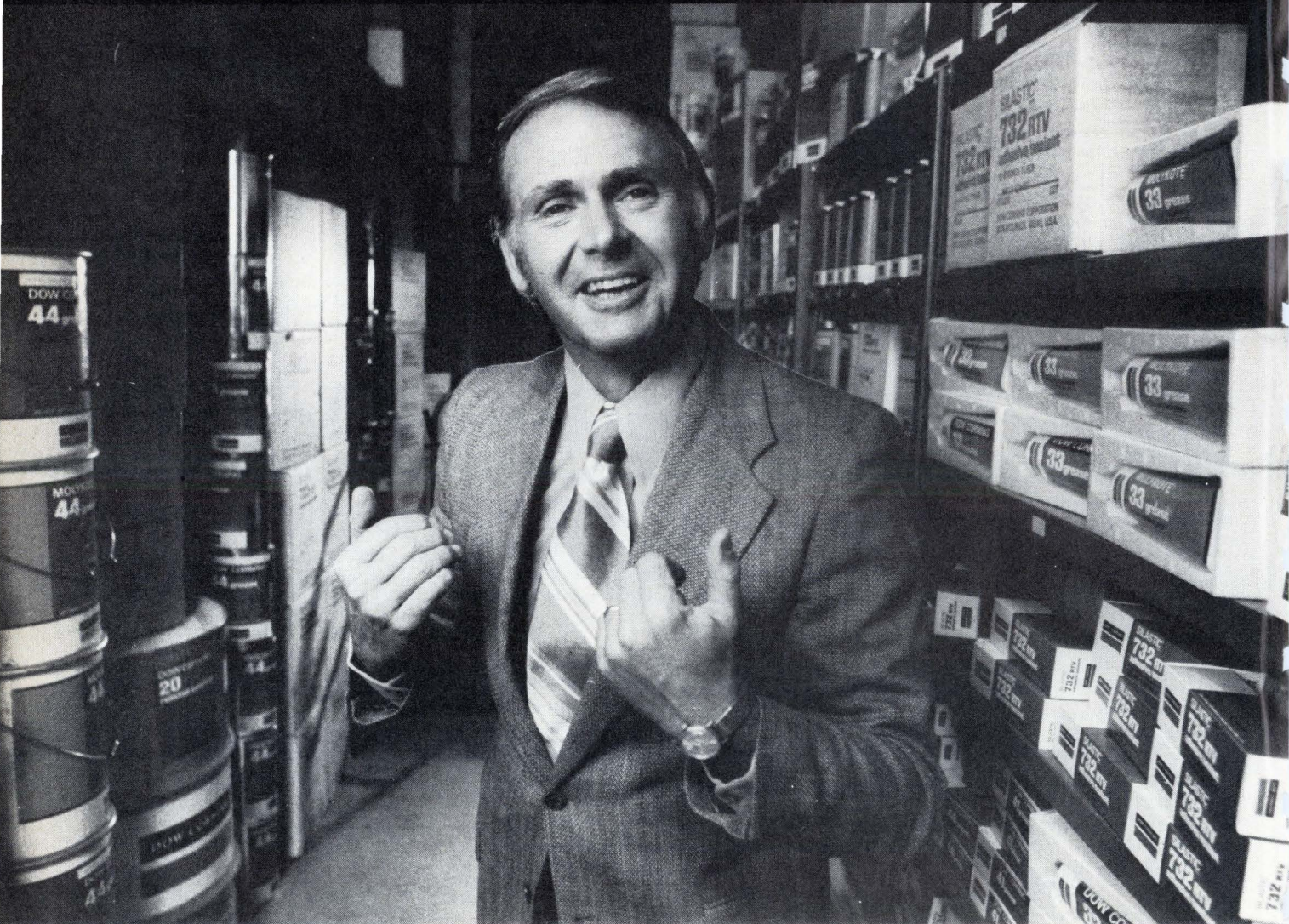
If it's as easy as you say, it's hard to resist.

- Tell me more about the 2650.
- I'm interested in TED.
- Tell me more about TWIN.

Name _____
Title _____
Company _____
Street _____
City _____
State/Zip _____
Phone () _____

AMS Advanced Memory Systems.
We make it easy.

If you're looking for safety and reliability in electronics, see me.



I'm a distributor for Dow Corning silicones. And, like the other Dow Corning distributors throughout the United States, I have the silicone materials you need for today's demanding electronic applications.

Increased safety, reliability, reduced manufacturing costs, longer service life, protection against harsh environments, and reduced service and replacement costs are just some of the reasons why silicone insulating materials

are replacing organic materials.

Because silicones come in almost limitless variations of physical, electrical, and chemical properties, they can perform many functions.

They protect, insulate, support. They cool, lubricate, seal, and bond. They do many jobs and do them well because of the unusual properties of silicones as a class of materials. I'm sure you'll find several of them ideal for the manufacture or repair of

electronic devices.

If you'd like to know more about Dow Corning silicones, see me; I'm listed on the right-hand side of this advertisement. Write or call for more information and for your application/product needs. I'll recommend the safe, reliable Dow Corning silicones to match your requirements.

DOW CORNING

DOW CORNING

Silicone Protectors

Silicone encapsulating, insulating, sealing, coating and dielectric materials are stocked by Dow Corning distributors at the following **warehouse locations:**

Electrical / electronic materials
from

DOW CORNING

DOW CORNING

A-6407

ALABAMA

Birmingham

Electrical Insulation
Suppliers, Inc.
205 252-9046

Mobile

Brownell Electro, Inc.
205 479-5405

ARIZONA

Phoenix

Essex International, Inc.—
Magnet Wire & Insulation Div.
602 258-4589

CALIFORNIA

Berkeley

C. D. LaMoree Co.
415 841-0601

Culver City

E. V. Roberts & Associates,
Div. EVRA, Inc.
213 870-9561

Long Beach

K. R. Anderson Company, Inc.
213 367-1411

Los Angeles

Brownell Electro, Inc.
213 532-1150

C. D. LaMoree Co.
213 225-5666

Essex International, Inc.—
Magnet & Wire Insulation Div.
213 264-7000

Mountain View

K. R. Anderson Company, Inc.
415 961-6007

San Diego

A. E. Yale Enterprises
714 299-7710

San Francisco

Essex International, Inc.—
Magnet Wire & Insulation Div.
415 626-5351

COLORADO

Denver

Waco Electronics, Inc.
303 371-4370

FLORIDA

Orlando

Brownell Electro, Inc.
305 843-6770

Electrical Insulation
Suppliers, Inc.
305 855-7100

Tampa

Essex International, Inc.—
Magnet Wire & Insulation Div.
813 621-5554

GEORGIA

Atlanta

Brownell Electro, Inc.
404 762-5181

Electric Insulation
Suppliers, Inc.
404 355-1651

Essex International, Inc.—
Magnet Wire & Insulation Div.
404 691-8520

Chamblee

Prehler Electrical Insulation
404 451-4266

ILLINOIS

Chicago

Essex International, Inc.—
Magnet Wire & Insulation Div.
312 254-8787

Prehler Electrical Insulation
312 384-6100

Mt. Prospect

Magnuson Electronics, Inc.
312 956-0700

INDIANA

Fort Wayne

Essex International, Inc.—
Magnet Wire & Insulation Div.
219 461-4000

Hammond

Electric Supply Corp.
219 932-8840;
312 374-6000 (Chicago)

IOWA

Marion

Ensco Distributing Corporation
319 377-6313; 800 325-3232

KANSAS

Overland Park

Ensco Distributing Corporation
913 381-7557; 800 325-3232

KENTUCKY

Louisville

E & H Electric Supply
502 587-0991

LOUISIANA

Baton Rouge

Essex International, Inc.—
Magnet Wire & Insulation Div.
504 927-2686

New Orleans

Williamson Distributing Corp.
504 486-5584

Shreveport

Williamson Distributing Corp.
318 424-6638

MARYLAND

Baltimore

Essex International, Inc.—
Magnet Wire & Insulation Div.
301 644-0140

Baltimore/Washington

Pyttronic Industries, Inc.
301 792-7000; 301 953-3000

Columbia

Brownell Electro, Inc.
301 997-5660

MASSACHUSETTS

Cambridge

Brownell Electro, Inc.
617 864-7500

Peabody

Essex International, Inc.—
Magnet Wire & Insulation Div.
617 531-7100

MICHIGAN

Detroit

Essex International, Inc.—
Magnet Wire & Insulation Div.
313 925-6000

Farmington

Sheridan Sales Co.
313 477-3800

Madison Heights

McNaughton-McKay Electric
313 399-7500

MINNESOTA

St. Paul

Prehler Electrical Insulation
612 452-2470

MISSOURI

Kansas City

Glazer Chemical
816 842-2092

N. Kansas City

Essex International, Inc.—
Magnet Wire & Insulation Div.
816 842-1613

St. Louis

Ensco Distributing Corp.
314 567-3935;
TWX 910 764-0856

Essex International, Inc.—
Magnet Wire & Insulation Div.
314 371-2616

NEW JERSEY

Livingston

Robert McKeown Co.
201 992-0700;
212 267-9264 (NYC);
516 248-2525 (L.I.)

Moonachie

Essex International, Inc.—
Magnet Wire & Insulation Div.
201 641-4400;
212 695-7840 (NYC)

North Bergen

EISCO Plus, Inc.
201 589-2929; 800 631-8642

South Plainfield

Brownell Electro, Inc.
201 753-4600

NEW MEXICO

Albuquerque

Waco Electronics, Inc.
505 268-2409

NEW YORK

Buffalo

Summit Distributors, Inc.
716 884-3450

New York City

Brownell Electro, Inc.
212 691-7900

Rochester

Summit Electronics of
Rochester, Inc.
716 334-8110

NORTH CAROLINA

Charlotte

Brownell Electro, Inc.
704 399-9791

Electrical Insulation
Suppliers, Inc.
704 394-4341

Essex International, Inc.—
Magnet Wire & Insulation Div.
704 394-1315

OHIO

Cincinnati

Electrical Insulation
Suppliers, Inc.
513 771-4073

Essex International, Inc.—
Magnet Wire & Insulation Div.
513 771-6500

Sheridan Sales Co.
513 761-5432

Cleveland

Essex International, Inc.—
Magnet Wire & Insulation Div.
216 781-2310

Prehler Electrical Insulation
216 267-2650

Columbus

McGraw-Edison Co.
National Electric Coil Division
614 488-1151

OKLAHOMA

Oklahoma City

Essex International, Inc.—
Magnet Wire & Insulation Div.
405 236-5411

OREGON

Portland

Essex International, Inc.—
Magnet Wire & Insulation Div.
503 665-0138
C. E. Riggs, Inc.
503 226-3286

PENNSYLVANIA

Philadelphia

Brownell Electro, Inc.
215 632-3030

Essex International, Inc.—
Magnet Wire & Insulation Div.
215 236-7100

Prehler Electrical Insulation
215 725-5914; 215 725-5913

Pyttronic Industries, Inc.
215 643-2850; 215 242-6700

Pittsburgh

Essex International, Inc.—
Magnet Wire & Insulation Div.
412 242-5560

TENNESSEE

Memphis

Brownell Electro, Inc.
901 332-9254

Electrical Insulation
Suppliers, Inc.
901 947-4176

Nashville

Brownell Electro, Inc.
615 835-1302

TEXAS

Dallas

Essex International, Inc.—
Magnet Wire & Insulation Div.
214 339-8346

Lubri-Kote
214 630-6007

Specialized Products Company
214 358-4663; 713 771-7227

Williamson Distributing Corp.
214 741-5831

Houston

Essex International, Inc.—
Magnet Wire & Insulation Div.
713 869-3667

Lubri-Kote
713 771-7227

Williamson Distributing Corp.
713 672-1715

UTAH

Salt Lake City

Standard Supply Co.
801 355-2971

WASHINGTON

Seattle

Atlas Packing & Rubber Co.
206 623-4697

Essex International, Inc.—
Magnet Wire & Insulation Div.
206 763-8650

C. E. Riggs, Inc.
206 623-5707

WISCONSIN

Milwaukee

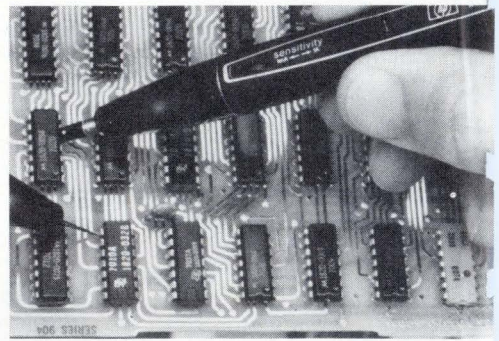
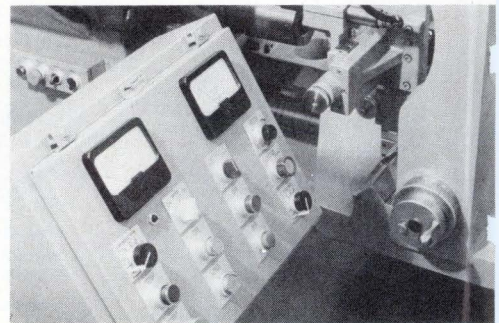
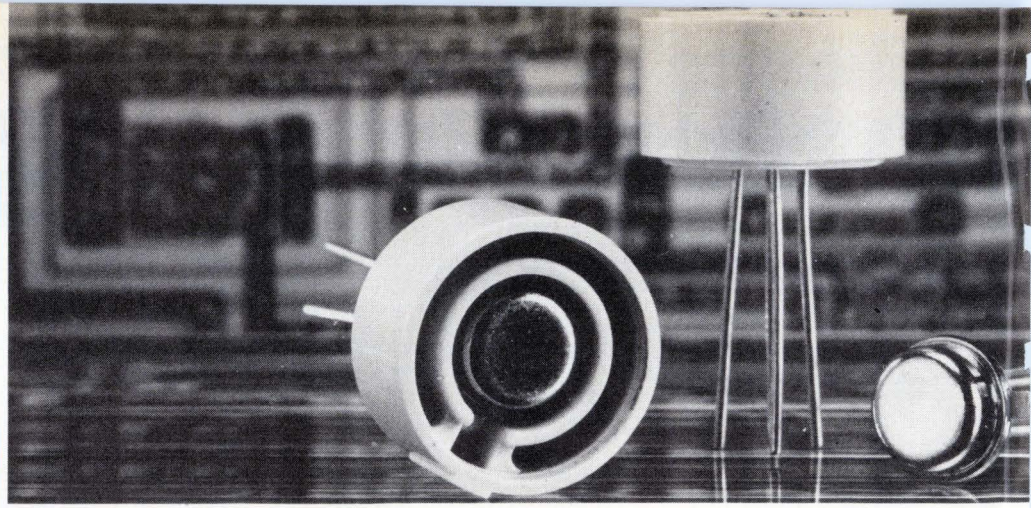
Essex International, Inc.—
Magnet Wire & Insulation Div.
414 475-6188

almost every segment of electronics is benefiting from the dramatic improvements in cost and performance being attained with large-scale integration. Microprocessors are spearheading this dynamic expansion of electronic capabilities, as they find their way into instruments, communications systems, consumer products, computers, and industrial controls.

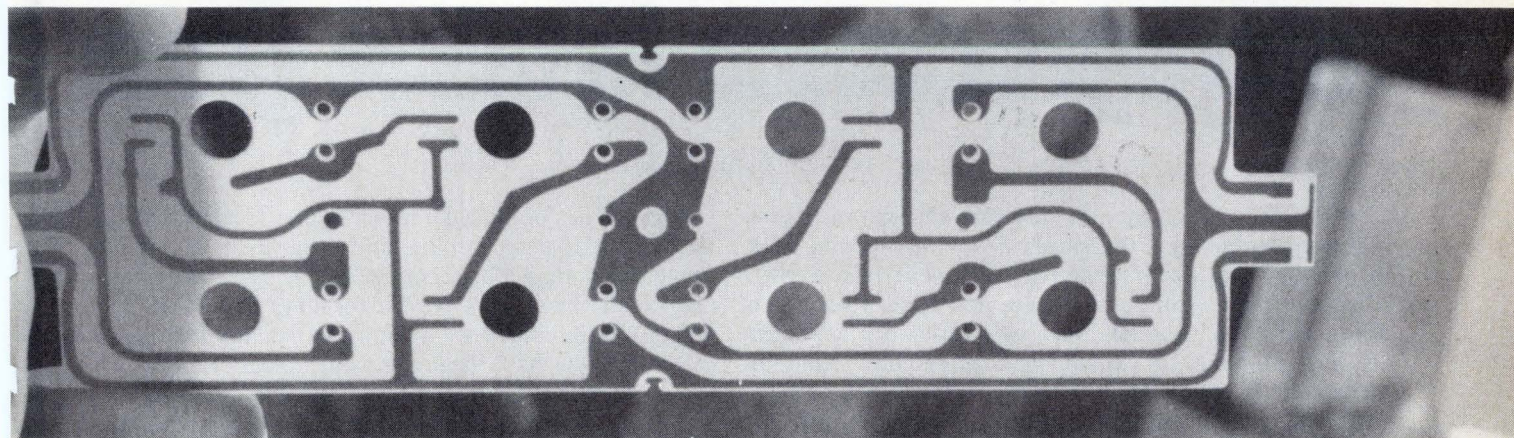
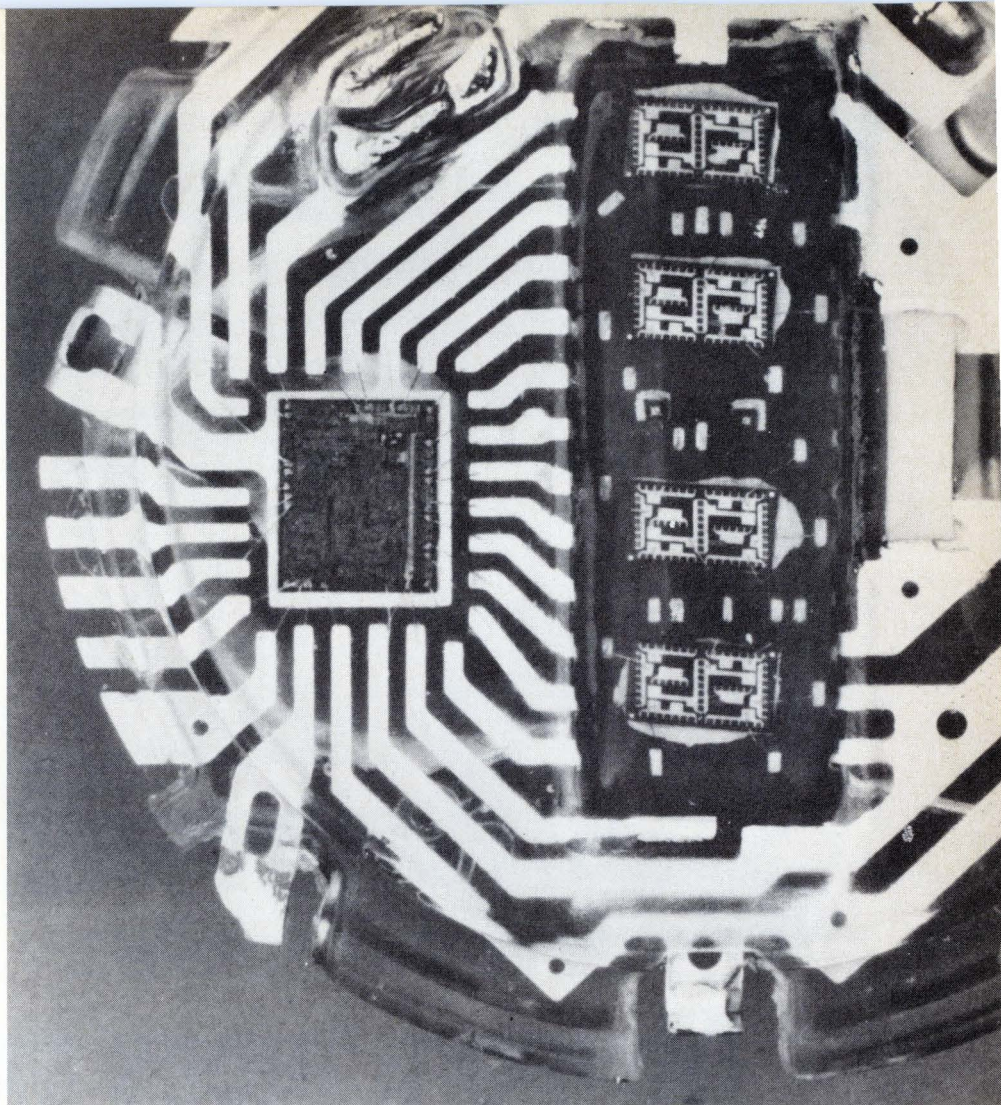
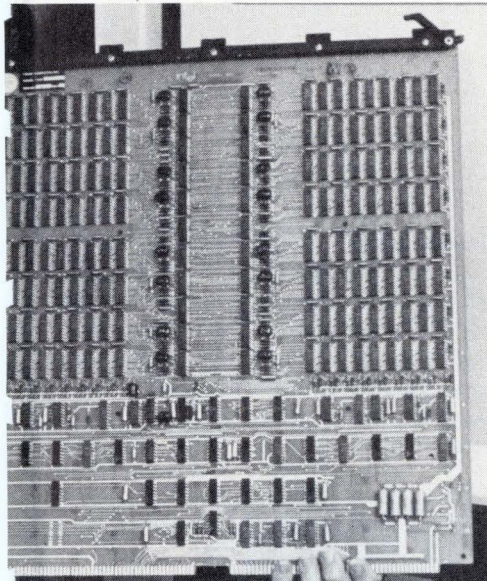
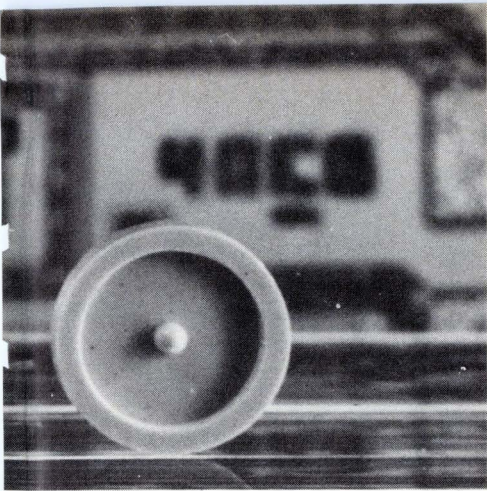
But important as they are, microprocessors aren't the whole story in 1976 technology developments. Memories are experiencing dramatic changes in form, density, and speed as newer processes, materials, and chip organizations are applied. In communications, optical fibers performed nobly in field trials.

Linear technology, too, has kept pace. It has adapted monolithic techniques in devices that rival their older hybrid forms in performance. Improved thick- and thin-film techniques are providing dramatic reductions in the size of high-performance systems.

All in all, it was a normal year for electronics technology in 1976; that is, a decade's worth of progress.

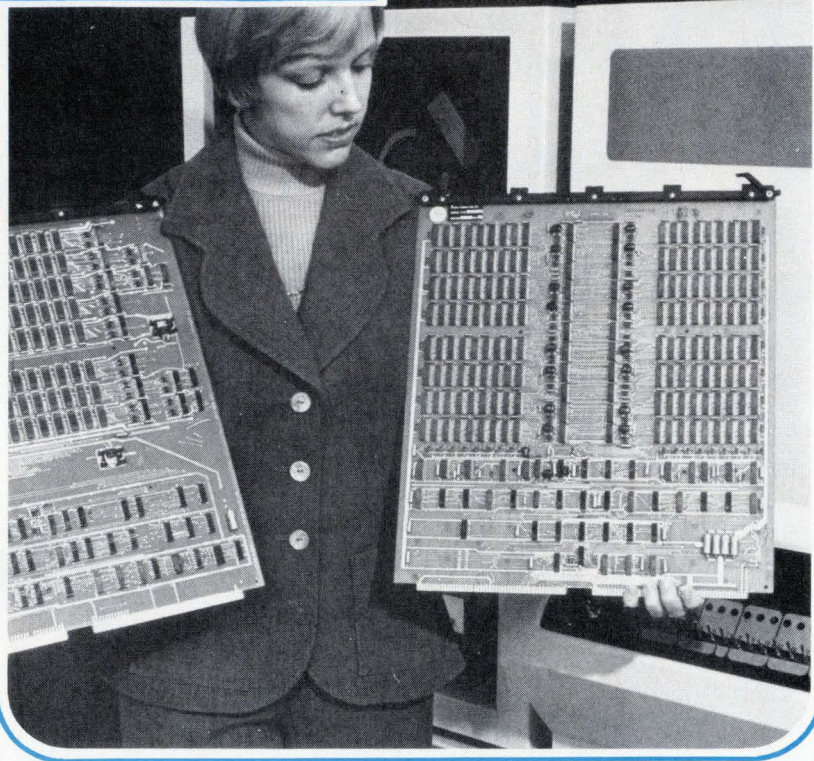


Technology



Update

- Semiconductor / 76
- Components / 86
- Computers / 90
- Instruments / 100
- Communications / 108
- Packaging & Production / 116
- Industrial / 122
- Consumer / 128
- Chronology / 138



Density grows. 16-kilobit RAMs are invading equipment throughout the computer industry. This 256-kilobyte memory board from Prime Computer Inc., which measures only 16 inches by 18 inches, contains 128 packages of RAM, or four times fewer than would be needed if it were fabricated with 4-kilobit chips.

Memory types multiply, microprocessor families grow

by Laurence Altman, *Solid-State Editor*

□ While the last 18 months saw the big push in microprocessor technology, the emphasis is now shifting back to memory and linear-circuit development (see p. 86). Most microprocessor suppliers are now concentrating on filling out their product lines, while memory suppliers are just starting to exploit new technology, such as integrated injection logic, charge-pumped metal-oxide-semiconductor, double-level MOS, charge-coupled-device, silicon-on-sapphire, and nonvolatile storage techniques. For instance:

- I²L and SOS random-access memories are challenging conventional MOS in two areas—dynamic types in some high-speed mainframe applications, and static types in some peripheral memory jobs.

- Conversely, a new static n-channel MOS technique has been built into a 70-nanosecond 1,024-bit RAM that is now intruding on some buffer and cache memory designs formerly dominated by bipolar technology.

- In the more traditional 4-k and 16-k mainframe, peripheral and microprocessor area, a double-level poly-

silicon cell has produced a much higher level of MOS chip integration that is forcing down the cost of memory usage to less than a 0.1 cent per bit for dynamic memory and to less than 1 cent per bit for static memory.

- Nonvolatile read-only memories that are also electrically alterable have begun moving ahead rapidly with two competing technologies: a nitride-storage MNOS technique and a modified avalanche MOS technique, both of which have led to impressive 8,192-bit devices.

- Finally, charge-coupled devices are now reaching the economically feasible 65,536-bit level, and magnetic-bubble memories are making it finally into production with impressive 92,304-bit chips. Both technologies are ready to attack the bulk storage memory—the last major stronghold of nonsemiconductor memories.

Meanwhile, on the microprocessor front, suppliers are moving in two directions:

- They are adding peripheral chips to their established families to include almost every circuit block needed in most computer designs.

■ They are extending their product lines downward with single-chip controllers and upwards with powerful mini-computer-like-chip sets.

The MOS-bipolar battleground

The changing state of memory technology is illustrated in Table 1, where competing MOS and bipolar devices are shown fighting for the same sockets. Notice that 4-k and 16-k MOS RAMs still dominate in large mainframe systems, where low cost is the prime consideration. They are also still preferred by most system designers in microprocessor dynamic memory applications, where their compatibility with the MOS processor logic is an asset.

But bipolars are gaining in the smaller mainframe applications that need fast access times of under 100 nanoseconds, as in military computers; in auxiliary memory that can provide fast access to subroutines in large mainframe computers, and in minicomputer-controlled high-speed data-processing systems that are being built with bipolar bit-slice techniques. Here, the sudden influx of I²L devices into the mainstream of MOS applications is causing a major rethinking of the traditional wisdom, which favored MOS for low cost and bipolar for high speed.

Leading the way into this new cost-performance middle ground is a RAM with an access time of less than 100 nanoseconds. Built by Fairchild Semiconductor of Mountain View, Calif., the 93481 is the first bipolar dynamic memory. It uses an Isoplanar version of the I²L process, which Fairchild dubs I³L. Not only is it twice as fast as n-MOS 4,096-bit dynamic designs, but it requires a chip less than 14,000 mils square, so that it fits into the

same 0.3-inch-wide dual in-line package that's used in most high-density-board MOS designs.

Texas Instruments Inc.'s 4,096-bit static RAM also uses I²L and also outperforms 4-k MOS static devices. The TI part, of which samples are now available, has a maximum access time of less than 100 ns, half to a third that of any other proposed n-channel 4-k static memory. Moreover, besides being fully static, dissipating only 500 milliwatts, and fitting in a 18-pin package, the S400 is a 5-volt device. This fact makes it a useful high-speed replacement for the widely used 2102 static RAM, as well as a good alternate to the new 4-k MOS static devices.

As for cost, the Dallas company's use of I²L results in an extremely compact chip. Its area of around 20,000 mil² is much than that of MOS 4-k static chips. In the IC business, of course, the smaller the chip, the higher the yields, and the lower the costs, so TI planners see this higher-performing memory as potentially no more expensive than MOS 4-k static devices.

MOS fights back

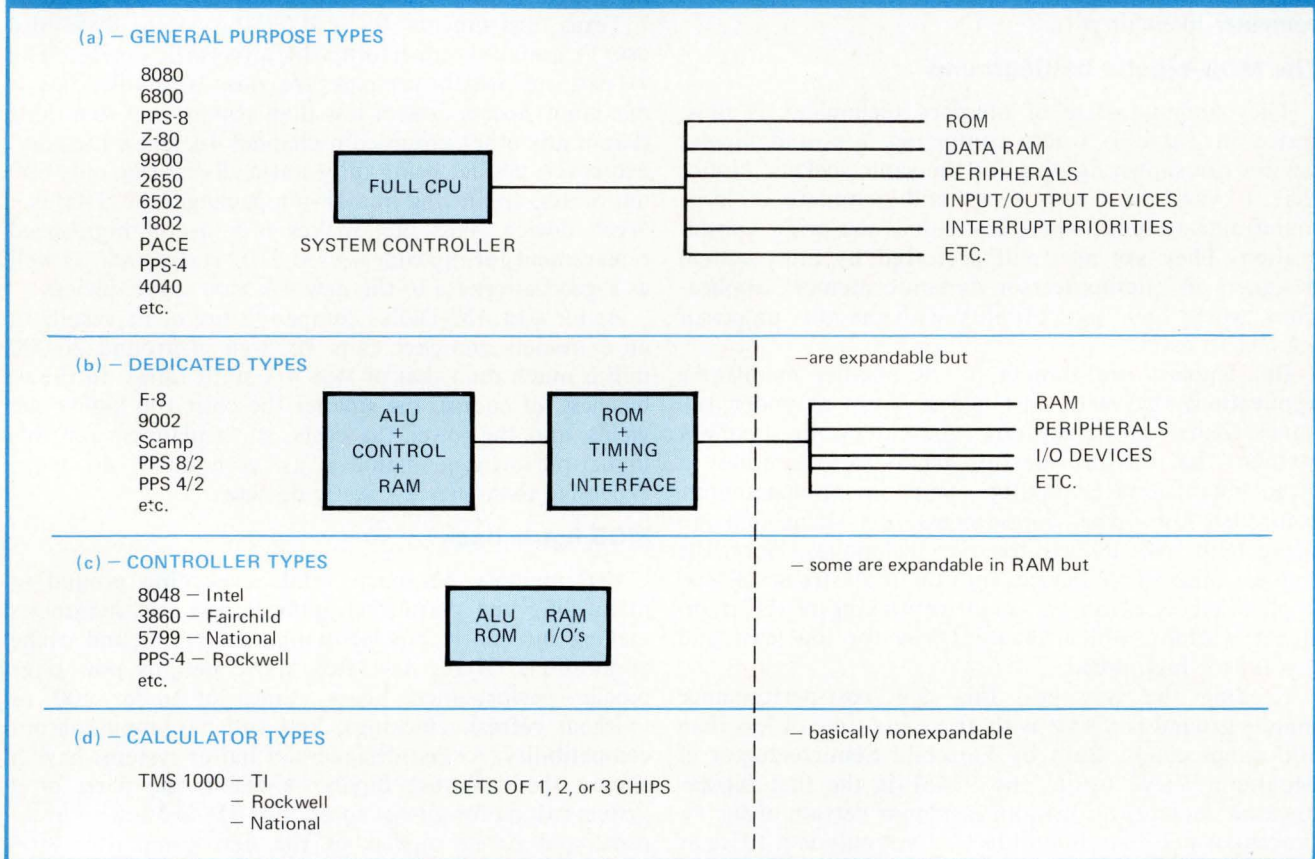
MOS memory designers, while conceding ground in mainframe and peripheral applications, are themselves making inroads in bipolar-dominated buffer and cache applications. Here, new MOS static designs now offer bipolar performance: access times of under 100 ns (without refresh clocking), and full TTL input/output compatibility. At last designers of buffer systems have a choice: they can use bipolar RAMs in the parts of a system calling for all-out speed, like 25- to 50-ns scratchpads, and either bipolar or the new compatible MOS statics for the 50- to 100-ns systems.

Heading up the new fast statics is the 2115-2 from

TABLE 1: COMPARISON OF READ/WRITE MEMORY DEVICES

Application	Device types	Access time (ns)	Active power dissipation per chip	1977 cost per bit (cents)
Large mainframe	4-k n-MOS dynamic	150 - 350	450	0.15
	16-k n-MOS dynamic	200 - 350	500 - 700	0.08
Small mainframe microprocessor-based	4-k to 16-k n-MOS dynamic	150 - 350	450 - 700	0.15
	4-k I ² L dynamic	90	500	0.25
	4-k I ² L static	70 - 100	500	0.25
	4-k n-MOS static	150 - 550	350 - 500	0.20
	1-k SOS/C-MOS static (5 V)	150	4	1.5
Buffer, cache, etc.	1-k TTL static	40 - 100	600 - 800	1.5
	1-k n-MOS fast static	70	600 - 800	1.0
	4-k I ² L static	75 - 100	400	0.25
Peripheral	1-k n-MOS static	150 - 500	300	0.3
	4-k n-MOS static	150 - 550	350 - 500	0.2
	4-k I ² L static	90	500	0.25
	4-k n-MOS dynamic	150 - 350	450	0.15
	16-k n-MOS dynamic	200 - 350	500 - 750	0.08
Small storage (1 - 5 Mb)	CCD memory	100 μs		0.03
	disk	100 ms		0.01
Large storage (5 Mb)	bubbles	10,000		0.02
	disk	10,000		0.01

TABLE 2: AVAILABLE MICROPROCESSOR TYPES



Intel Corp. of Santa Clara, Calif., which has a maximum access time of 70 ns. The chip is a single 5-volt 18-pin part that is fully decoded, and it comes in either an open-collector or a three-state-output version. It can also drive TTL packages directly, without buffers, at TTL voltage levels. These virtues for the first time allow MOS RAMs to plug directly into bipolar RAM sockets. That's important, since enhanced static MOS RAMs will probably drop steadily in price like other MOS memories.

Manufacturers are also going for increased density in static 5-v parts, as new 4-k designs enter production. These big statics, which operate in the 150-500-ns range, are intended as high-density replacements for the popular 1,024-bit 2102 RAM as well or serve as an alternate to dynamic 4-k RAMs in microprocessor designs. System designers would use the static memories in small-capacity systems, say under 4 kilowords, where their slightly higher cost per bit over dynamic RAMs would be offset by the elimination of clocking circuits needed in dynamic systems.

The first fully static 4-k arrivals come from Advanced Micro Devices with two devices in production. (Intel, Semi, Phoenix, Ariz., and National Semiconductor are at the sampling stage with their devices.) AMD's memories are 4,096-by-1-bit and 1,024-by-4-bit configurations and operate in the 150-to-250-ns speed range. Both parts, the AM9130 and 9140, come in 22-pin packages

and dissipate about 350 milliwatts. Since their specifications almost duplicate those of many 4-k dynamics, the Sunnyvale, Calif., company can promise nearly complete interchangeability.

Further enriching the options in static memories are the silicon-on-sapphire RAMs that are now available from RCA's Solid State division, Somerville, N.J. RCA presently offers four 1,024-bit configurations and is working on a 4-k design as well. Operating in the 90-ns range at 10 volts and 150 ns at 56 v, these static parts can be used in buffer memories as bipolar replacements, in high-speed peripheral systems that require very low power dissipation (the 5-v part dissipates only 4 mw), or in microprocessor-based systems where a small, high-speed static memory can serve as a scratchpad buffer or interrupt store.

Apart from RCA, which continues to make headway in SOS product development, no other commercial supplier is working with the process. Solid-State Scientific Inc. has all but dropped out of commercial SOS, and while Hewlett-Packard Co.'s announced SOS program is for its own computer products. The biggest objection to SOS is the expense of its starting material: sapphire costs almost seven times more than bulk silicon. According to RCA developers, however, silicon-on-sapphire processing is actually easier, more forgiving, and produces higher yields than bulk silicon processing and thus compensates

You don't go to an amateur for product design, or corporate financing, then why use amateurs to try to sell your products.

Talk with a Manufacturer's Representative. He is a professional—He knows how to get results.

A manufacturer's representative has a broad base of product and market knowledge because of multiple-line selling. Each call for each product helps uncover new applications, new market opportunities.

His objective—his **only** objective—is to develop his **chosen** territory into the best marketplace possible.

The manufacturer's representative is more than a commissioned salesman. He's a territory manager . . . A personnel manager . . . A customer service manager . . . A sales manager . . . A product manager . . . A merchandising manager. **And an independent business man!**

For more information on how a manufacturer's representative can help you market **your** products, write or call the Electronic Representatives Association. We can help you set up the finest representatives in the world!

Electronic Representatives Association
233 E. Erie Street, Suite 1002
Chicago, Illinois 60611
(312) 649-1333



—Manufacturers' Representatives make good business sense, at a time when we really need it most—

Yes, send me information on how I can use representatives.

Name _____

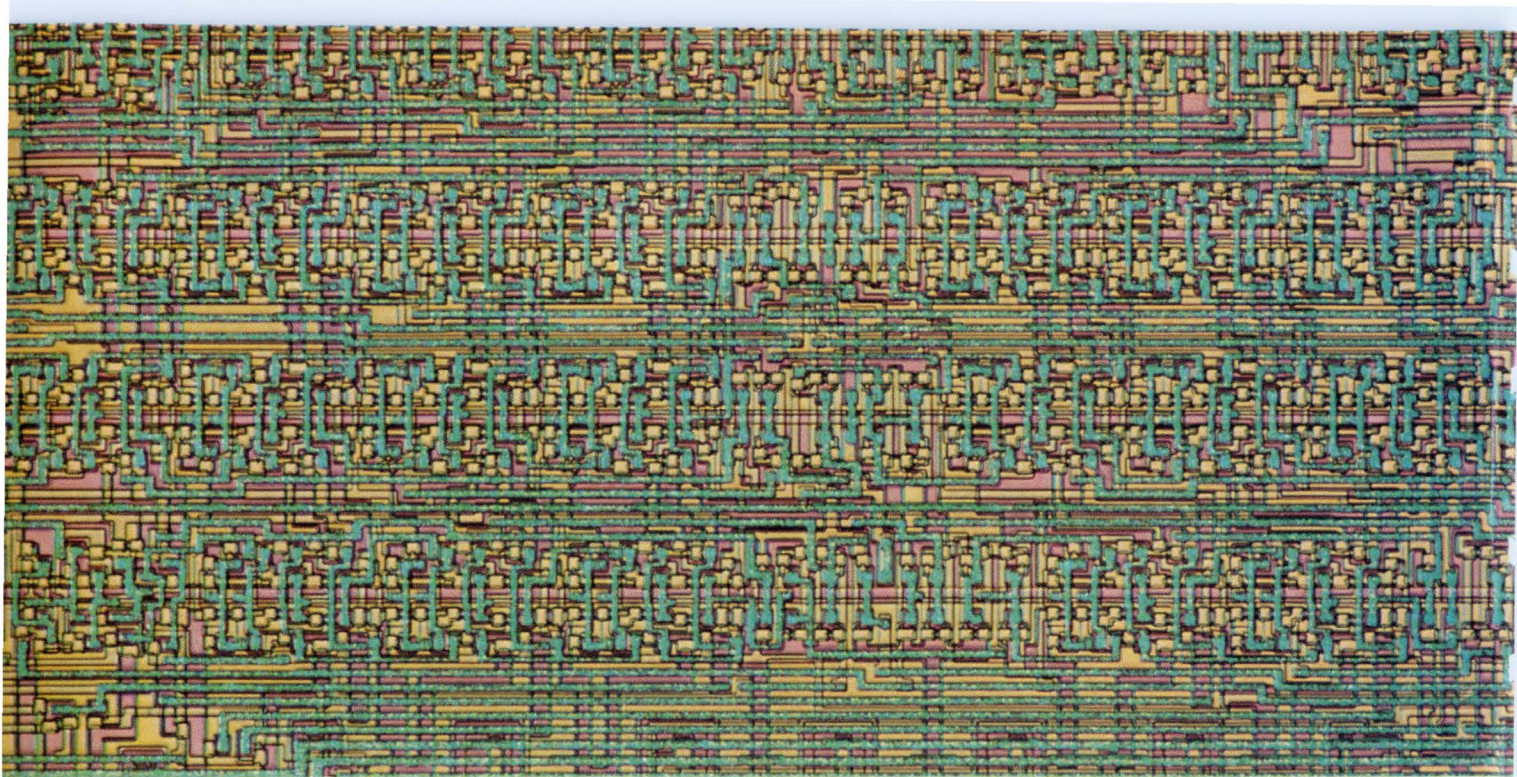
Company _____

Address _____

City _____

State _____

Clip out and send to
Electronic Representatives Association
233 E. Erie Street, Suite 1002
Chicago, Illinois 60611



LAST YEAR THIS PROPRIETARY LSI CIRCUIT WAS ONLY AN IDEA. This year it made a good idea into an outstanding product.

Our business is helping original equipment manufacturers exploit the advanced semiconductor technologies to improve performance and reduce costs. We do it by developing proprietary LSI circuits for our customers' exclusive use. Maybe we should be doing it for you.



If you're trying to stay competitive with a new product—or by improving an existing product—now is the time to consider a custom development program. We can help you fully understand the very significant benefits of custom LSI.

Performance Bonuses That Cost You Nothing! The real beauty of LSI is the way it gives you product design options. Once you've made the decision to develop a custom circuit,

there's usually plenty of silicon real estate to use in new and different ways. You can add performance features to the product at virtually no incremental cost. In short, your product can be much better than a competitor's non-LSI equivalent.

High Yields Mean Lower Costs. Our LSI processes are production-proven. We get high yields. Which means you get lower chip costs. Plus, LSI reduces product assembly costs. Your product should have a competitive edge in price.

Low Power Consumption. LSI circuits conserve power. Their low current requirements often permit portability which would otherwise not be possible. Energy conservation in itself is a product advantage these days.

Small Size is Only Part of the Story. Product miniaturization is the most obvious advantage of LSI. Even if small size seems unnecessary for your application, don't overlook the numerous other benefits that we've been talking about.



Our knowledge of the custom LSI approach can help you to evaluate these potential benefits in your own terms. LSI may be exactly what you need. If it isn't, we'll be the first to tell you. Contact us today for some of the answers.



We sell more than circuits. We sell solutions.

3100 Alfred Street, Santa Clara, CA 95050
Telephone: (408) 247-5350
Cable: Micropower
Telex: 910-338-0154 MICROPWR SNTA

for the higher initial starting costs experienced.

A surge of activity is occurring in electrically alterable memories. Because they are also nonvolatile and retain their data when the power is off, they are in great demand for many television, calculator, and microprocessor-based applications. Examples are point-of-sale systems and telecommunications terminals.

Only three memory suppliers in the world offer electrically alterable ROMs: General Instruments Corp., Hicksville, N.Y., McDonnell Douglas Corp.'s Nitron division, Cupertino, Calif., and Japan's Nippon Electric Co., which also plans to market its devices in this country. Recently GI and NEC developed 8,192-bit electrically alterable ROMs, a level of complexity that is extremely useful from many applications. GI uses a standard nitride or MNOS technique, and NEC uses a modified avalanche MOS process.

Freedom to change

Electrically alterable memories, of course, allow a system's capabilities to be continuously updated simply by applying voltages to the package pins. The only other field-alterable ROMs are Intel-developed ultraviolet-erasable ROMs. But while extremely popular, they are used primarily in prototyping since to erase them the user must remove them from the circuit.

GI's alterable ROMs, including its new ER 2800 8,192-bit part, have performance typical of today's MNOS technology: fairly slow read times of 2 microseconds at about 15 v (standard p-channel MOS levels) and quite slow write and erase times, in the tens of milliseconds, at 28 v. Because of their slowness, the new devices will not be made extensively for large ROM programs in fast microprocessor or computer systems. Nor will they impinge heavily on the major RAM markets, where 200-300 ns and very low cost are needed. But faster versions are on the way—GI will soon begin distributing samples of a 4-k device that has a read time of 650 ns.

In microprocessors, chip suppliers are filling out their established product lines with new and more powerful peripheral chips, such as data links, memory controllers, and keyboard and CRT chips. They are also broadening their application range with very basic single-chip central processors for low-end control applications and with chip sets containing greater processing power for high-end minicomputer applications.

Pushing the limits in microprocessors

The oldest general-purpose 8-bit families, such as the 8080, 6800, PPS-8, are rapidly being extended with chip versions of large subsystems that formerly required hundreds of TTL packages. At least a dozen such peripheral chips are on their way from Intel. Already available are interface and communication controllers, interval timers, direct-memory-access chips and interrupt controllers. Soon to come are even higher-level subsystems—Intel's 70 series, which includes a synchronous data-link controller as well as controller chips for a floppy disk, cathode-ray tube, and keyboard.

Also busy in the peripheral area is Rockwell International Corp.'s Microelectronics group. It has already equipped its PPS-8 microprocessor family with programable peripheral and communication controllers on chips, and floppy-disk and synchronous data-link chips are soon to come.

These high-level peripheral chips are impressive achievements, being complete subsystems in themselves that require two to three times the complexity of processor chips. Moreover, they all plug into the main system bus and so are controlled by signals from the central processing unit. And since the CPU treats them as input/output, in effect they are controlled directly by program data residing in RAM. This means that a designer wishing to expand his system with these peripherals need only increase his or her RAM capacity and add the appropriate instructions. No hardware interfacing or

TABLE 3: MICROPROCESSOR CAPABILITY

	TTL equivalent	Most comfortable address capability (kilowords)	Program size	Interrupt capability	Maximum execution time (μs)	Number of packages
General purpose (low volume)	100 and up	4 - 64	30 - 150	5 - 10	4 - 8	10 - 50
Dedicated types	100 and down	2 - 4	50	up to 5	5 - 10	5 - 10
Controller types	50 and down	1 - 2	50 and down	2 or so	5 - 10	below 5
Calculator types custom (high volume)	25	none (with a few exceptions)	25 and down	1 or 2	100 or so	1 or 2
Bit slices	100 - 200 and up	64		5 - 10	5	50 - 100

special program implementations are required.

As for new major CPU entries, Texas Instruments came in with its 9900 chip—a 16-bit n-channel microprocessor that is powerful enough to replace the microcomputer in many real-time control and data processing systems. It joins General Instrument's 1600 and National Semiconductor's PACE families in the 16-bit camp, and some observers expect them to gain at the expense of 8-bit systems over the next few years.

Of course, 8-bit suppliers are fighting back with high-performance units. First to reach production are the Z-80 from Zilog Inc., Los Altos, Calif., which takes the 8080 instruction repertory and expands it to about 158, and RCA's 1802 single-chip version of its COSMAC C-MOS system. Intel itself is planning to augment its 8-bit family with a higher-performance 8085 chip that promises five times greater throughput—and to follow that up with a full 16-bit chip. Motorola Semiconductor, too, is rumored to be developing an 8-bit CPU with ten times the performance of the 6800.

Equally important is the activity on the low end, where chip suppliers are readying single- and two-chip microprocessor families for high-volume low-cost applications. Intel's soon-to-be-announced single-chip 8040 and 8748 each contain CPU, ROM, RAM and I/O, while its 8041/8741 is a stripped-down version intended to serve as a peripheral controller in 8080-based systems. They

will be supplied in a version containing an 8,192-bit ultraviolet-erasable ROM on the chip, a feature that significantly adds to the flexibility of the device. Similarly, Motorola is readying the 6802-single-chip controller for its 6800 family (Motorola is reported to be working with Nitron Corp. on an electrically alterable ROM version), Rockwell has samples out of a two-chip PPS 8/2, and Fairchild is readying a single-chip F-8.

What all this device activity means to the user is shown in Table 2, which distinguishes between four types of microprocessors: general-purpose, dedicated, single-chip controller, and calculator types.

From this, it is clear that, to make the most out of their powerful CPUs, the general-purpose microprocessors are intended for full system expansion, including a large instruction ROM, 32 to 64 bytes of data RAM, and a large number of I/Os and peripherals. On the other hand, the dedicated and single-chip controllers serve the requirements of much smaller systems that can be handled with one, two or three chips.

Table 3 shows the rough capability of each processor type and roughly the number of TTL packages they replace. It can come as a surprise, though, to the new microcomputer designer to realize that a system built around general-purpose microprocessor also requires a good many other LSI packages—maybe 50 excluding memory for, say, a real-time control application. □

Profile

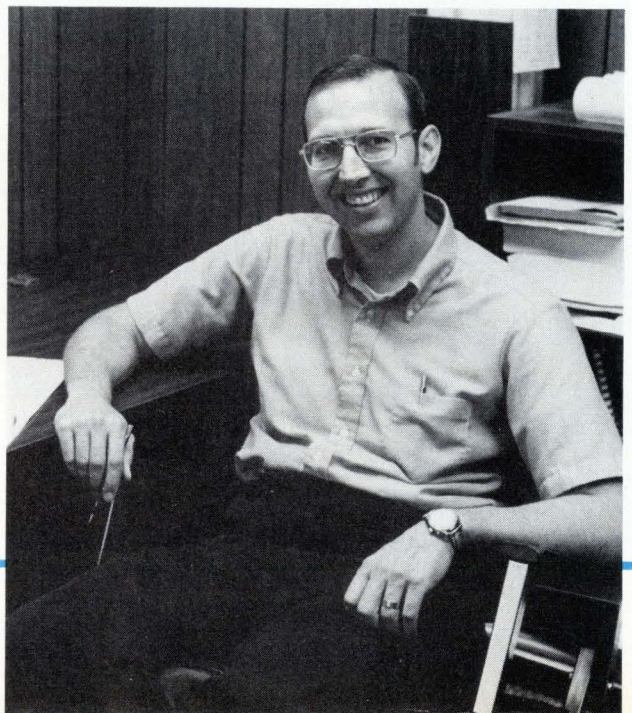
Few other designers can have done as much as Mostek Corp.'s Bob Proebsting to advance the state of circuit design. He conceived of the 16-pin multiplexed 4,096-bit memory circuit that not only put a fledgling Mostek on the map in 1972 but is now copied throughout the industry. He was the first to use dynamic sense amplifiers in RAM designs, a power-saving innovation that's now also being widely copied by his colleagues. He also invented the programmable logic array and pushed the use of depletion-load circuitry in MOS designs—achievements that by their own would cap the career of many engineers.

People who have worked with Proebsting have often been fooled by his mild manner, only to be brought up short by his aggressive, audacious approach to circuit design. Take his radically different 4-k RAM design. "You must remember," says Proebsting, "that when I proposed my approach we were small fish indeed, and going against the tide required a lot of confidence from the people around here. The rest of the industry, the big guys like TI and Intel, were all developing a straightforward 22-pin chip, and here I was talking about a completely different multiplexed circuit, with a totally different pinout. But in this business you've got to have guts and a feeling about your design; so I was able to convince my management to back the project."

Proebsting has acquired 10 major patents in the course of a career that has been as speculative as his designs. After leaving Wisconsin with a Ph.D. in 1967, he went to Texas Instruments, working for L. J. Sevin, now president of Mostek, who was then TI's director of MOS design.

When Sevin left to raise money for a startup company, TI managers appointed Proebsting head of the department, even though he was 32 years old and almost fresh out of school. That might have been enough for other designers. But when Sevin got the money together in June 1969 and founded Mostek, Proebsting didn't hesitate to jump over and start designing circuits for him again.

Why? "I'm a designer," says Proebsting, "and that's what they let me do around here."



New from Centralab...

CERBON™ TRIMMER RESISTORS

Affordable Stability...
300% More
Stable Than Carbon...
at a Carbon
Trimmer Price!



Why pay more? With Centralab's new CERBON trimmers you get stability approaching cermet and at carbon prices... As little as 28¢ in distributor 1,000 quantities; as low as 10¢ in high volume orders.

The secret of CERBON superior performance? A totally new thick film resistor element, which combines both potentiometer and conventional thick film technologies, *plus* a heat stable ceramic substrate, *plus* a dual-tine contact spring, *plus* "Fluxgard" protection from dust and wave soldering contaminants. In short, a totally balanced electromechanical system.

Look at these benefits:

- TCR less than -400 ppm/°C.
- CRV less than 2% of maximum resistance.
- Rotational life exceeds 500 cycles.
- Adjustability (typical)—0.05% of total voltage.
- High overload capability—

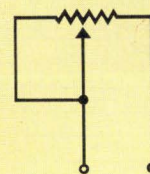
1 watt at 25°C ambient for 1,000 hours exhibits less than 2% cumulative resistance change. • Maximum stability in humid environment — Resistors exposed to an atmosphere of 40°C at 95% relative humidity for 300 hours return within four hours to +2.5% of their initial readings.

CERBON trimmers are offered in a resistance range of 1 K ohm to 1 megohm with a choice of standard PC terminal configurations. They fit universally accepted circuit board mounting patterns. And they're ready now for fast delivery in any quantity.

Write for complete technical data on Centralab's new CERBON trimmer resistors. Or call (915) 779-3961 for a free evaluation sample. Move up to CERBON and save!

AVAILABLE CIRCUIT OPTIONS

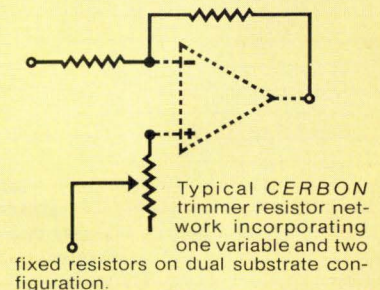
Thanks to their ceramic substrate, Centralab CERBON trimmers permit a variety of screen printed circuit options. Here are three typical circuits:



TERMINAL SHORTING

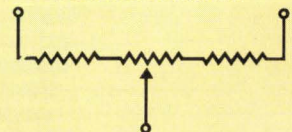
One of five electrical termination options available.

OPERATIONAL AMPLIFIER NETWORK

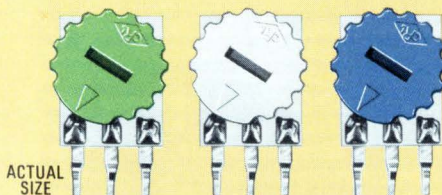


Typical CERBON trimmer resistor network incorporating one variable and two fixed resistors on dual substrate configuration.

VOLTAGE DIVIDER



Fixed and variable resistors can be ratio matched for precise values and to insure temperature tracking. Eliminates need for costly discrete resistor selection.



Knob colors available in white, blue, red and green for ease in assembly operations.



CENTRALAB

Electronics Division

GLOBE-UNION INC.

7158 MERCHANT AVENUE
EL PASO, TEXAS 79915

MEMORY AT WORK

Process Control

Loss of power on

a computer-controlled processing system is real trouble. Get back on line fast—or risk losing an entire batch or run. EMM's reliable MICROMEMORY core memories take care of that. Just push your restart button and you're up and operating. No program reloading. No back-up batteries to worry about. We have designs for 4-bit, 8-bit and 16-bit microprocessors—even larger systems with capacities to 32K x 18. We make semiconductor memories, too. But for process control you need reliable MICROMEMORY core memory.

EMM

COMMERCIAL MEMORY PRODUCTS

A Division of

Electronic Memories & Magnetics Corp.

12621 Chadron Ave., Hawthorne, Calif. 90250

(213) 644-9881



MEMORY AT WORK

Diagnostics

Memory for medical

diagnostic equipment must be reliable. Human lives are involved. It must be fast; dynamic imaging calls for high speed CRT refresh. Those are two reasons our MICRORAM static RAM memory systems are chosen so often. Cycle speeds are sufficient for CRT refresh. Our metal-gate technology is inherently reliable. And the support circuitry needed by static RAMS is very simple. That adds up to an overall system reliability you just can't beat.

You can't beat our 15-year experience in the memory business, either. Give us a call today and tell us what you need.

EMM

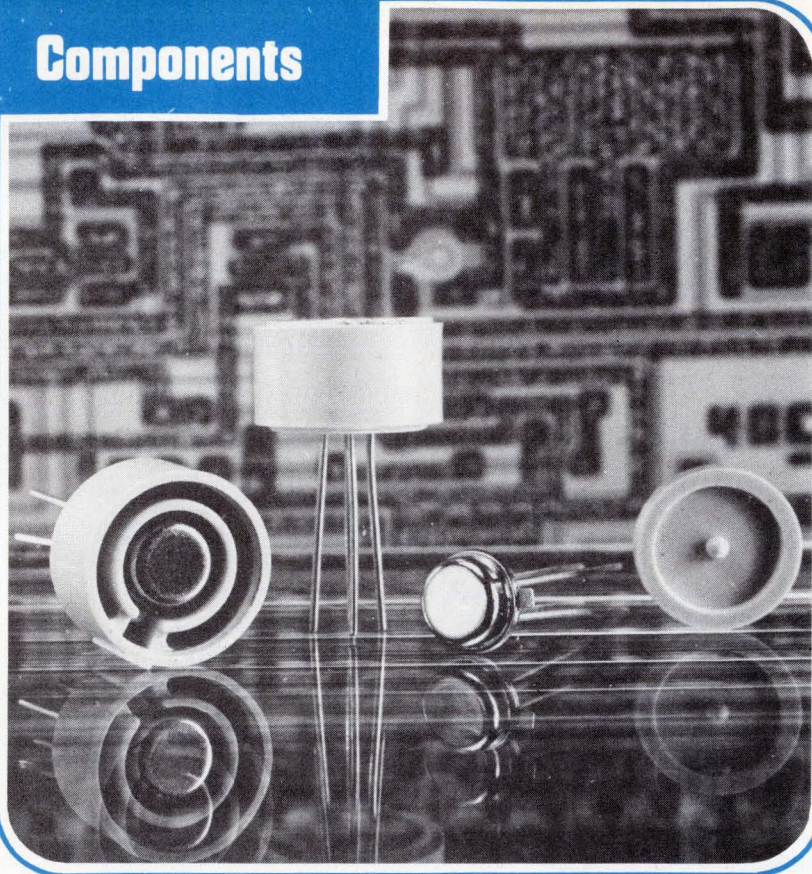
COMMERCIAL MEMORY PRODUCTS

A Division of Electronic Memories & Magnetics Corp.

12621 Chadron Ave., Hawthorne, Calif. 90250

(213) 644-9881





Linears lead the field. In components, advances in linear-IC technology are outstripping all other areas. The performance of monolithic data converters and mixed-process amplifiers is coming closer to that of hybrids. Special-purpose linears, like temperature transducers and motor controls, are proliferating, as are bipolar linears for power supplies and voltage references. Depicted here is a temperature-stabilized IC zener from National Semiconductor.

Hybrid, monolithic units displacing more discretes

by Lucinda Mattera, *Components Editor*

□ The latest active and passive components are sparking new markets and stimulating ever more sophisticated equipment design, besides fueling the continuing drive to ever simpler, smaller, and cheaper electronic products. Examples abound.

- Monolithic data converters and mixed-process amplifiers are performing nearly as well as comparable hybrid units, but at lower costs.
- A new class of bipolar large-scale-integrated circuits has dramatically simplified power-supply design.
- Special-purpose linears for sensing and control are replacing a host of discrete components.
- Vertically integrated field-effect transistors are threatening the pre-eminence of bipolar power transistors.
- With thick-film hybrid technology, isolation amplifiers are being reduced to miniature components in dual in-line packages.
- Simplified designs for rotary switches are displacing conventional labor-intensive assemblies.
- Finally, in passive-component technology, revamped

element designs and computer-controlled laser trimming are creating a new class of potentiometers for semiprecision applications, as packaged resistor networks continue to encroach on the domain of discrete devices.

Accuracy improving for IC converters

The growth of microprocessor-based data systems depends on the availability of low-cost but fast and accurate data converters. Although hybrid devices perform well enough, low enough prices can be achieved only with monolithic analog-to-digital and digital-to-analog converters.

In successive-approximation a-d converters, TRW Systems Group, Redondo Beach, Calif., has developed a 10-bit high-speed high-accuracy bipolar LSI chip. It processes signals at the rate of 5 million samples per second, quantizing them into 10 bits within $\pm 1/4$ least significant bit. Accuracy is also getting better for monolithic integrating a-d converters, which generally end up in instruments. From Analog Devices Inc. of Norwood,

Mass., comes a 13-bit complementary-MOS chip that is self-calibrating—it employs a novel circuit technique called quad slope in which internal gain and offset errors are compensated for automatically.

Improved processing techniques are helping to tighten the accuracy of monolithic d-a converters, too. Motorola Semiconductor Products in Phoenix, Ariz., is using automatic laser trimming at the wafer-prove stage to produce a 10-bit d-a chip that is accurate to within 0.05%. An unusual monolithic d-a converter comes from Precision Monolithics Inc., Santa Clara, Calif.—it's a companding device, principally aimed at telecommunications.

The FET-input fashion in linears

Mixed processing—be it bi-fet or BiMOS—is becoming the name of the game in monolithic amplifiers. Mixed-process amplifiers have FET inputs and bipolar outputs—the former for low input bias current with high input impedance and the latter for good linearity. A bi-fet device provides p-channel junction-FETs up front, whereas a BiMOS device instead incorporates p-channel MOSFETs up front.

National Semiconductor Corp., Santa Clara, Calif., now offers a bi-fet instrumentation amplifier that holds gain nonlinearity to within 0.02% to 0.05%. The company is also making a bi-fet version of the industry-standard 741-type op amp—its input bias current ranges from only 50 to 200 picoamperes. In addition, National is applying its bi-fet process to other product lines, including analog switches, comparators, and sample-and-hold circuits.

Among the bi-fet products from Texas Instruments, Dallas, are a quad op amp and a line of analog switches. Each amplifier of the quad device has an input bias current of 4 nanoamperes and a unity-gain bandwidth of 3 megahertz. What's more, with its BiMOS technology, TI is fabricating a low-cost chopper-stabilized op amp that's priced at only \$14.50 in hundreds.

Another important mixed-process development comes from RCA's Solid State division in Somerville, N.J., which is offering a BiMOS op amp that may prove to be as useful as the workhorse 741. It's internally compensated and has input bipolar diodes to guard against damaging electrostatic charges.

In hybrid amplifiers, Burr-Brown Research Corp., Tucson, Ariz., has introduced the first isolation amplifiers to be made as thick-film hybrid circuits. They are a fraction of the size and cost of their modular counterparts. Also, instead of the more usual transformer coupling, a set of linearized optoelectronic semiconductors isolate input and output stages in the new devices. The table shows the varying performance available from monolithic, hybrid, and modular amplifiers.

Switching regulators go monolithic

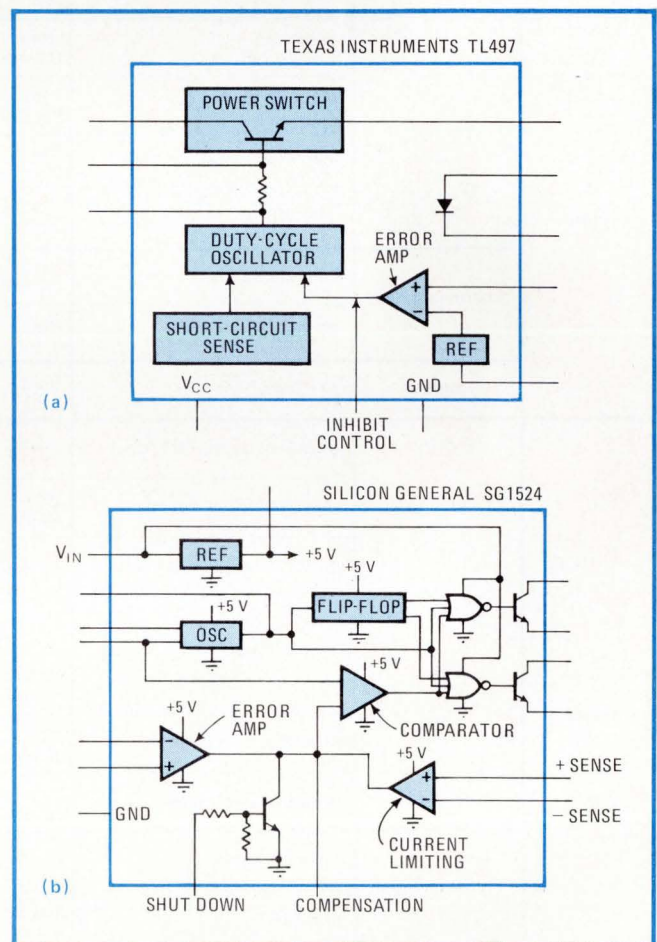
Within only a few years, power linear ICs have become standard components in power supplies, and now there's a new generation of these devices—monolithic switching regulators that replace 20 or more discrete components.

These bipolar LSI chips (see Fig. 1) include a voltage reference, an error amplifier, an oscillator, pulse-width-modulating circuitry, short-circuit protection, and switching transistors.

To obtain the small geometries needed for such a circuit, TI is using ion implantation to fabricate its IC switching regulator, which contains a single output power switch. For push-pull or double-ended operation, both Silicon General of Westminster, Calif., and Plessey Semiconductors of Santa Ana, Calif., have chips that fill the bill.

Conveniently, too, IC voltage regulators are now available in adjustable versions. A National family of 1.5-ampere three-terminal devices has an adjustment range of 1.2 to 37 volts. A Precision Monolithics line of 10-v references has an output that can be varied by $\pm 3\%$ from nominal, while the firm's 5-v models have $\pm 6\%$ adjustability. Both positive- and negative-output adjustable regulators rated at up to 1.5 A can be obtained from Lambda Electronics Corp., Melville, N.Y.

Other types of monolithic regulators are also coming on the market. For example, TI has an adjustable three-



1. For power suppliers. These monolithic switching regulators include all the circuitry needed to control switching-mode power supplies. Texas Instruments has a chip (a) for single-ended operation, while Silicon General offers a device (b) for push-pull control.

PERFORMANCE SURVEY OF COMPONENT AMPLIFIERS									
Technology	Type of amplifier		Input offset voltage	Offset voltage drift ($\mu\text{V}/^\circ\text{C}$)	Input bias current	Open-loop gain (V/V) or nonlinearity (%)	Unity-gain bandwidth (Hz)	Output slew rate (V/ μs)	Approximate price (commercial grade)
	Family	Classification							
Monolithic	operational	general-purpose	2 mV typ	15 typ	20 – 50 nA	50 k – 100 k	500 k – 3 M	0.5 – 2	40¢ – 60¢*
		wideband	2 mV typ	15 typ	20 – 200 nA	25 k – 100 k	8 M – 25 M	10 – 150	\$1 – \$7*
		low bias, FET input	2 – 6 mV	5 – 50	10 – 100 pA	50 k – 100 k	1 M – 10 M	3 – 15	\$1 – \$4*
		precision, low offset, low drift	50 μV – 0.5 mV	0.5 – 5	1 – 10 nA	100 k – 1 M	400 k – 1 M	0.1 typ	\$1 – \$4*
		precision, low bias	0.5 – 6 mV	5 – 50	50 pA – 2 nA	100 k typ	500 k – 1 M	0.1 typ	\$1 – \$4*
		chopper-stabilized	50 – 80 μV	0.4 – 0.6	150 pA typ	500 M typ	3 M typ	2.5 typ	\$25* typ
	instrumentation	bipolar input	1 – 5 mV	2 – 20	20 nA typ	0.02% – 0.1%	100 k – 1 M	1 – 5	\$4 – \$15*
		FET input	15 mV typ	10 – 15	20 pA typ	0.02% – 0.1%	100 k – 1 M	1 – 5	\$4 – \$15*
Hybrid	operational	wideband	from 0.5 mV	from 15	from 12 pA	up to 1 M	up to 60 M	up to 1,000	from \$70*
		low bias, FET input	from 0.4 mV	from 25	from 75 fA	up to 50 k	up to 1 M	up to 1	from \$18*
		low offset, low drift	from 8 μV	from 0.1	from 10 pA	up to 10 M	up to 1.5 M	up to 0.6	from \$7*
		high voltage, high current***	from 2 mV	from 25	from 20 pA	up to 100 k	up to 5 M	up to 30	from \$42*
	instrumentation	bipolar input	from 0.2 mV	from 2	from 40 nA	0.03% – 0.1%	up to 2 M	up to 10	from \$12*
		FET input	from 5 mV	from 25	from 10 nA	0.05% – 0.1%	up to 600 k	up to 2	from \$20*
	isolation	all classes ****	from 1 mV	from 20	50 pA – 40 nA	0.1% – 0.2%	15 k typ	1 typ	\$40 – \$62**
Modular	operational	general-purpose, FET input	1 – 5 mV	5 – 25	25 – 100 pA	50 k – 1 M	500 k – 5 M	0.25 – 1,000	\$15 – \$40**
		general-purpose, chopper	25 – 50 μV	0.1 – 1	300 pA typ	5 M typ	100 typ	0.0001 typ	\$50** typ
		general-purpose, electrometer	1 – 5 mV	15 – 50	75 – 350 fA	100 k – 500 k	500 k – 1 M	0.1 – 0.3	\$30** typ
		wideband	1 – 3 mV	15 – 50	100 pA – 5 nA	25 k – 100 k	60 M – 120 M	300 – 1,000	\$75 – \$100**
		precision, FET input	200 μV – 1 mV	1 – 5	0.1 – 25 pA	50 k – 100 k	500 k – 5 M	0.25 – 1,000	\$40 – \$100**
		precision, chopper	10 – 25 μV	0.1 – 1	50 – 150 pA	10 M – 100 M	100 typ	0.2 – 100	\$50 – \$115**
		precision, electrometer	1 – 10 mV	10 – 30	10 fA typ	100 k typ	2 k typ	0.0004 typ	\$60** typ
	instrumentation	general-purpose	1 – 5 mV	0.5 – 3	10 pA – 5 nA	0.02% – 0.2%	500 k – 1 M	0.1 – 1	\$40 – \$60**
		precision	200 μV – 1 mV	0.2 – 2	10 pA – 5 nA	0.002% – 0.01%	500 k – 1 M	0.5 – 3	\$60 – \$150**
	isolation	all classes*****	0.5 – 150 mV	from 1	10 pA – 50 nA	0.002% – 1%	1 k – 2.5 k	0.1 typ	\$60 – \$180**

*in quantities of 100

**in quantities of 1 – 9

***output current up to 7 A pk ac

****CMRR = 110 dB typ

*****CMRR = from 60 – 140 dB

terminal shunt regulator that can be used like a temperature-compensated zener diode. Output voltage can be set from 2.75 to 30 v, with output current ranging from 600 microamperes to 100 milliamperes.

Special-purpose linear ICs are beginning to open up many new applications in consumer and industrial electronics. Particularly active in these linears is National, which this year announced a monolithic temperature transducer selling for less than \$1, monolithic tachometer/switches for automotive and industrial applications, and a monolithic ultrasonic sonar system that includes a transmitter, a receiver, and a display driver.

Even motor control has gone monolithic. Micro Components Corp., Cranston, R.I., is offering a dual control that can regulate motor speed to within $\pm 0.1\%$ for consumer products like cassette recorders and movie cameras.

The big news in power semiconductors is vertical FETs. They can provide very high current gains and extremely fast switching speeds and are not susceptible to secondary breakdown, which can lead to thermal runaway in bipolar transistors. Vertical-channel power MOSFETs from Siliconix, Santa Clara, Calif., are capable of switching 1 ampere in only 4 nanoseconds.

New designs and automated production techniques are also upgrading such traditional components as switches, relays, resistors, and capacitors.

Rotary switches have been multiple-deck clip-laden units, assembled by hand from a myriad of tiny parts. But designs are getting simpler. For example, in one approach, Oak Industries' Switch division, Crystal Lake, Ill., is stamping all conducting paths and terminals for a switch from a single piece of metal. Similarly, the new rotaries for citizens' band radio provide 40 or more BCD-encoded positions with only a single deck. Inside the switches, a disk-shaped printed-circuit card containing the conducting paths rotates past stationary wipers that are mounted in the switch housing.

As for passive components, packaged resistor networks are continuing to replace discrete units in applications requiring localized clusters of resistors. More networks are going into single in-line packages these days, but DIPs are still the predominant package form. As in other areas, the use of simplified designs, lower-cost materials, and higher degrees of automation is cutting costs of variable resistors that still deliver on performance.

In potentiometers, for example, the Trimpot Products division of Bourns Inc., Riverside, Calif., now makes a line of single-turn semiprecision units that sell for only \$2 to \$2.50 in quantity. Zero-based linearity is 2% for cermet versions, 3% for conductive-plastic models. To obtain this kind of performance at low cost, Bourns divides the resistive elements into 10 equal segments for fast, accurate, automatic laser trimming. □

Profile

Ivar Wold is one of the new breed of chip designers who are putting not just circuits but entire systems on tiny pieces of silicon. Now with Analog Devices Inc., Norwood, Mass., he's the man behind the firm's monolithic quad-slope analog-to-digital converter. Presently, as director of systems development, he manages a group that is developing microprocessor-related hardware, software, and subsystems.

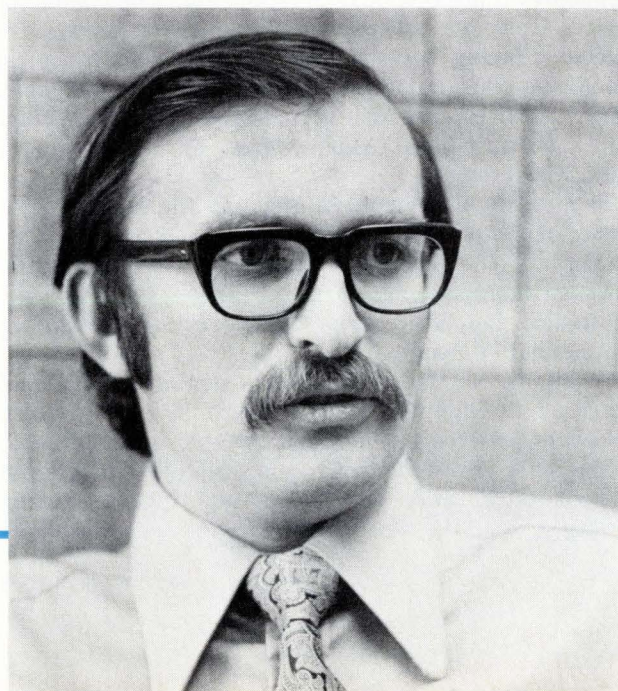
Wold, who joined the Massachusetts company about four and one-half years ago, came to it as an experienced equipment designer. While working in his native Norway, he designed minicomputer-based point-of-sale terminals—the sort used at airports for exchanging currency. Previously in England, he designed dynamic-analysis instrumentation, of the kind that is needed for vector measurement.

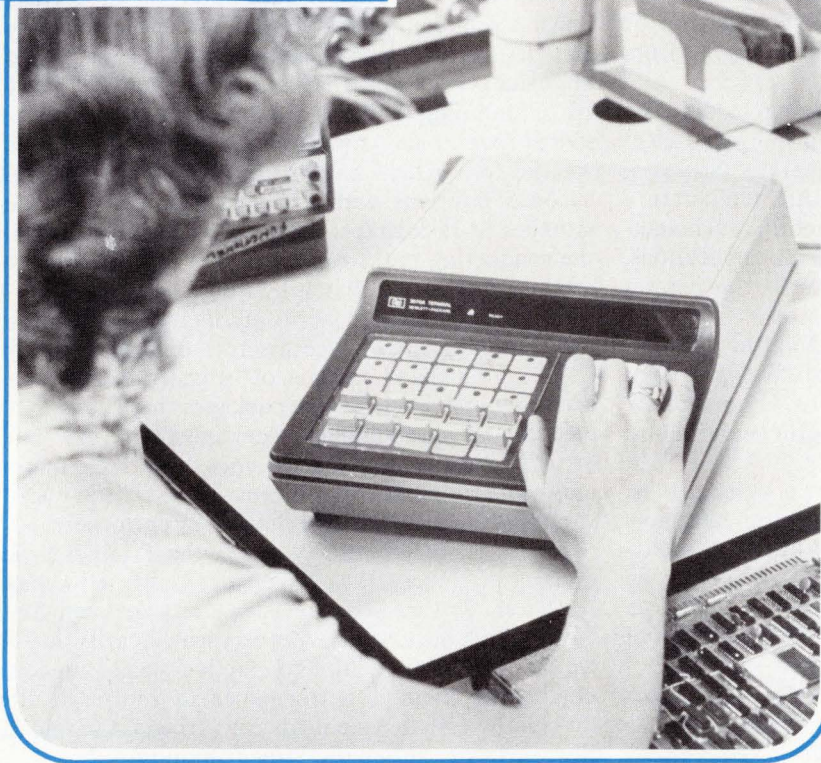
At Analog, Wold has been involved with widely varying projects—ranging from digital panel meters to data converters to modules for serial data transmission. The DPMs are small $3\frac{1}{2}$ -digit units that can operate from a 5-volt power supply, while the data converters are 10-bit microprocessor-compatible complementary-MOS chips. Called Serdex, the modules enable parallel-output devices, like data converters and DPMs, to communicate with serial-input equipment, like teletypewriters and minicomputers.

The quad-slope a-d converter designed by Wold is an integrating 13-bit C-MOS chip. But, instead of the usual two-phase integration period, it has four phases, in addition to a reset phase. The extra two phases are put to

good use, making up a digitally corrected auto-zero cycle. With this self-calibration scheme, gain and offset temperature drifts are held to less than 1 part per million per degree celsius.

More recently, Wold has been working on programable microprocessor-related subsystems for acquiring, manipulating, and processing data. "They are not just hardware, but involve a significant amount of software," he explains. According to Wold, Analog is now test-marketing the new family of products.





At the input. Hewlett-Packard's HP 3070A numerical data-entry terminal, designed for use with the company's HP 2100, 21MX, and 1000 computers, is intended for inexperienced operators, as in the production testing shown here. The terminal also interfaces to instruments via the Hewlett-Packard interface bus, allowing a computer to control instruments up to 1.24 miles away.

Small systems move into the design spotlight

by Stephen E. Scrupski, *Computers Editor*

□ Right on the cutting edge of advances in computer technology is large-scale integration—but semiconductor devices aren't the full story of 1976. New LSI devices are indeed reducing the size and cost of low-end central processing units, but developments in software, magnetic storage devices, and distributed-processor architecture will have an almost equal impact on the design of computer systems.

The year's developments that highlight the major trends in computer technology are:

- One-board 8- and 16-bit computers offer substantial power in small systems.
- Bit-slice bipolar microprocessors are appearing in commercial minicomputers.
- 16-kilobit RAMs offer lower memory costs and increased throughputs, both achieved by cutting down the swaps between memory and external mass storage.
- Magnetic cores, however, are still alive. Improved versions offer lower cost-per-bit and higher packing density.

■ Mass storage for small systems is being increased in capacity with such developments as higher bit densities on tape cartridges and double-density floppy disks.

■ Multiple processors are being used in large mainframe computers to give higher throughputs.

■ Software tools greatly ease the writing of programs for microprocessor-based systems.

One-board computers arrive

Semiconductor LSI technology has advanced to the point that a full computer—a central processing unit, memory, and input/output controls—can be built on one board. Minicomputer and microprocessor makers and other manufacturers announced a host of such computers in 1976. Generally 8- or 16-bit units, they offer an intermediate choice—and intermediate performance—between a microprocessor-based system built from scratch and a full-blown minicomputer.

Two major advantages of one-board computers is that the supplier performs much of the testing, and the

software is likely to be more extensive when the unit is part of an established minicomputer family. For example, the LSI-11 from Digital Equipment Corp., Maynard, Mass., can handle most PDP-11 software and undergoes extensive testing in the company's Puerto Rico plant. Boards are automatically tested for logic faults, temperature-cycled, then tested again. With the manufacturer responsible for such testing, the user can spend more time in solving the application problem. He also can save the capital investment required for test equipment.

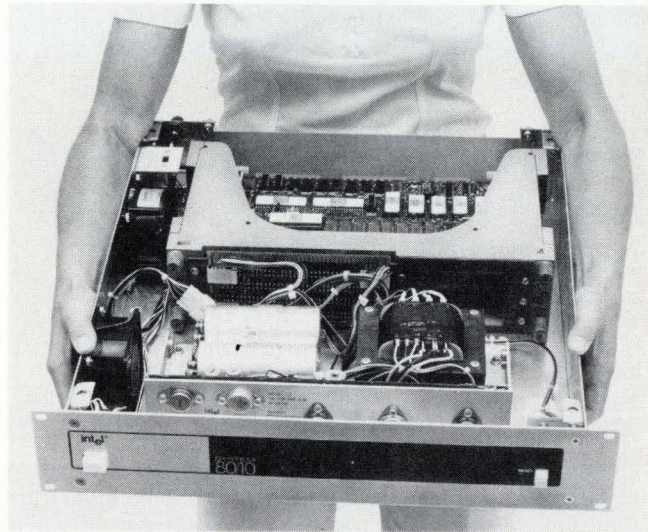
Minicomputer and semiconductor manufacturers that have introduced one-board computers include:

- DEC: The LSI-11, a 16-bit unit with 8 kilobytes of memory on an 8.5-by-10-inch board.
- Data General Corp., Southboro, Mass.: the micro-Nova, a 16-bit unit based on the company's own metal-oxide-semiconductor microprocessor chip. The 7½-by-9½-in. board holds up to 8 kilobytes of RAM and handles the Nova-family development software.
- Texas Instruments Inc., Dallas, Texas: the 990/4, a 16-bit unit based on TI's 9900 MOS microprocessor chip. The 14.25-by-10.8-in. board holds up to 8 kilobytes of RAM and 2 kilobytes of read-only memory.
- Intel Corp., Santa Clara, Calif.: the SBC 80/20, an 8-bit unit based on the 8080A MOS microprocessor chip. The 6¾-by-12-in. board holds 2 kilobytes of RAM and 4 kilobytes of ROM and has programable input/output lines. The company also moved up to the packaged minicomputer level by adding a power supply and front panel to the SBC 80/10 one-board computer (Fig. 1).
- Motorola Semiconductor Products group, Phoenix, Ariz.: The M68MM01, an 8-bit unit based on the 6800 MOS microprocessor chip. The 9.75-by-6-in. board holds 1 kilobyte of RAM and 4 kilobytes of ROM.

Bipolar bit-slice microprocessors offer the cost advantages of LSI with the speed of bipolar technology, and computer manufacturers are starting to cash in on it:

- Honeywell Inc., Minneapolis, Minn.: the series 60 level 6 minicomputers, announced in January, use the 5700 family of 4-bit devices from Monolithic Memories Inc., Sunnyvale, Calif.
- Interdata Inc., Oceanport, N.J.: its 6/16 and 5/16 computers use the 2900 family from Advanced Micro Devices Inc., Sunnyvale, Calif.
- Harris Corp. Computer Systems division, Fort Lauderdale, Fla.: its Slash/6 system uses the AMD parts.
- Hughes Aircraft Co. Microelectronics Products division, Newport Beach, Calif.: the military computer UYK-30 uses Intel's 3000 series of 2-bit slices.
- Itek Corp.'s Applied Technology division, Sunnyvale, Calif.: the recently introduced ATAC 16M avionics processor uses the AMD 2900 devices.

Although 16,384-bit RAMs are beginning to filter into the development laboratories for evaluation, by no means will they replace 4,096-bit RAMs soon. In fact, the 1,024-bit devices haven't given way completely to 4-k units in production versions of many main memories.



1. Packaged micro. Intel Corp. expanded its microcomputer line upward by packaging the SBC 80/10 single-board computer in an enclosure and adding power supply, cooling, and front-panel. Up to three memory or input/output boards can be added.

Honeywell, for example, recently announced that 4-k devices would henceforth be the standard in large-system main memories. Earlier this year, Burroughs Corp., Detroit, Mich., announced its B80 series of small systems with 1-k RAMs.

One system manufacturer preceded the semiconductor makers with a 16-k RAM. Four-Phase Systems, Cupertino, Calif. announced its NP-80 network processor last December with the company's own 16-k RAMs, which were designed and are being produced in house. With the devices, 256 kilobytes can be placed on one printed-circuit board. Early models of the processor were shipped with 4-k RAM memories, but the company says the larger systems are being readied for shipment. Prime Computer Inc., Framingham, Mass., also says it will be shipping 16-k RAM boards totaling 256 kilobytes late this year.

Despite the advances in semiconductor memories, manufacturers of core memories still are advancing their technology. Ampex Corp.'s Memory Products division, Marina del Rey, Calif., for example, says it will produce all cores with a new tape process, which raises yields to about 99%. The process, called Unibit, produces cores stamped out of a tape material and then fired. The 13-mil-size cores have better uniformity than those produced with the older powder-press techniques. Ampex, in fact, says it will be increasing its total bit production by 50% next year.

Solid-state mass storage systems—based on charge-coupled devices, magnetic bubbles, or both—will almost certainly be announced in 1977, but they won't be used in any quantity until 1978. System prices are likely to be in the 0.1-to-0.2-cent-per-bit range. Intel's memory systems division has been shipping a 1-megabit board based on 16-k CCD devices, but, with the appearance of the 16-k RAM, CCDs will have to hit 65,536 bits per chip

REPRESENTATIVE GENERAL-PURPOSE ONE-BOARD COMPUTERS				
Manufacturer	Model	Bits	CPU technology	Memory on board
Intel	SBC 80/20	8	MOS (8080A)	2-k RAM, 4-k ROM
Motorola	M68MM01A	8	MOS (M6800)	1-k RAM, 4-k ROM
National	Super-Pace	16	bipolar MSI	4-k ROM
Computer Automation	LSI 3/05 (Naked Millii)	16	bipolar MSI	(CPU only)
Data General	microNova	16	MOS custom chip	4-k RAM
Digital Equipment Corp.	LSI-11	16	MOS custom chip	4-k RAM
General Automation	GA-16/110	16	MOS custom chip	512-word RAM, 2-k ROM
Interdata	5/16	16	bipolar LSI (AMD 2900)	16-k RAM
Microdata	Micro-One	16	bipolar MSI	(CPU only)
Texas Instruments	990/4	16	MOS (TMS 9900)	4-k RAM, 1-k ROM

before they begin to appear as an attractive alternative to disk and tape mass storage. Fairchild Semiconductor, Mountain View, Calif., is offering samples of such devices, while Texas Instruments and Intel are close behind.

Texas Instruments has started production on a 92-kilobit bubble device. When full systems using such devices are announced, it's likely that total capacities will be in the range now offered by large disk drives—32 to 64 megabytes, with increments of 4 or 8 megabytes.

Tapes, disks carry more

Higher bit densities are coming for magnetic tapes. Microdata Corp., Irvine, Calif., increased the bit density on 3M-type cartridges from the customary 1,600 bits per inch to 6,400 bits, thus raising the total capacity from about 2.7 megabytes to more than 10 megabytes. And, in the large reel-to-reel tape drives, Control Data Corp., Minneapolis, Minn., joined IBM and Storage Technology Corp., Louisville, Col., as suppliers of 6,250-bit-per-in. tape systems. Today's maximum density on large drives is 6,250 b/in. because of the skew problems involved

with recording and recovering nine tracks across the tape. The cartridge records a serial bit stream in one track and so can achieve much greater densities.

Magnetic floppy disks also are being improved with higher-capacity recording. This is being attained, first of all, by writing on both sides of the disk, as in IBM's 3602 programable communications controllers and in the Burroughs B80 system. IBM's unit stores a total of 560 kilobytes, while Burroughs, by increasing recording density and using both sides of the disk, hits a capacity of 1 megabyte.

So-called double-density floppy-disk drives were introduced by such manufacturers as Remex, Santa Ana, Calif., General Systems International Inc., Anaheim, Calif., and Shugart Associates, Sunnyvale, Calif. These drives simply double the bit-recording density on one side of the disk to reach a capacity of 800 kilobytes.

Miniature floppy-disk drives—handling disks 5 1/4 in. in diameter compared to the 8-in. standard diameter—were introduced for lower-cost, less demanding applications. Shugart's SA400 drive, for example, stores 89.6 kilobytes, but costs about half of a standard drive. Figure 2 compares the various kinds of magnetic storages.

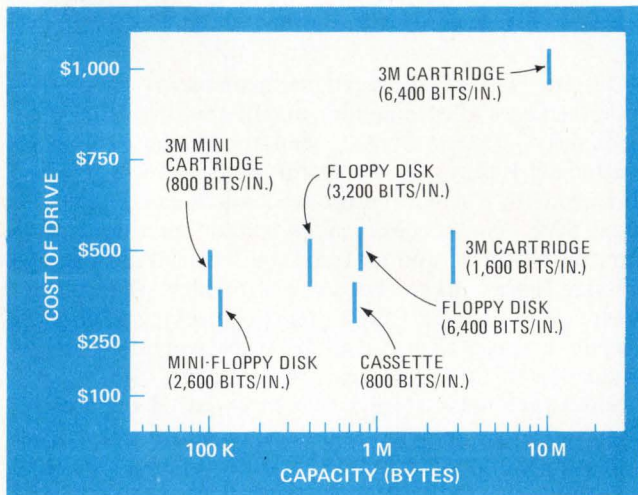
One device that may help recording densities on magnetic disks in the future are thin-film heads. Burroughs introduced a disk file using one such head for each track, while Applied Magnetics Corp., Goleta, Calif., also is developing them. With the AMC head, bit densities could soon reach 8,000 or 10,000 bits per inch, whereas today's disks generally record at 6,400 b/in. Track density, too, would be increased—from today's 600 or 700 tracks/in. to 1,000 tracks/in. The AMC heads are being evaluated by system manufacturers, and commercial systems using them could hit the market in late 1977 or early 1978.

Hitching up processors

Large mainframe machines are becoming an interconnection of small, modular processors that communicate with one another over a wideband bus. The best example of this architecture is Criterion, introduced by NCR Corp., Dayton, Ohio, this year. The system, which uses emitter-coupled logic, 4-k RAMs and a pipeline processor cycling as fast as 56 ns, comprises several processors. In addition to a central unit, others include a manager for control and diagnostics, another to interface with the disk memory, and still others to serve as low-cost communication interfaces.

Similarly, the new 90/80, the largest member of the series 90 family from Sperry-Univac, Blue Bell, Pa., uses two processors—one as the central instruction processor and the other to control peripherals. These, too, use emitter-coupled logic. The instruction processor has a 98-ns cycle time.

In giant mainframes, Control Data claimed a new world speed record for computers with a Star-100 (see Fig. 3), which produced nearly 100 million results per second, breaking the mark of 36 million operations per



2. Low-cost storage. Various means of low-cost storage are shown in terms of their capacity and approximate costs of the drive in quantities of about 100. The newest types are the mini floppy disk drives and the high-density 6,400-bit/in. drive for the 3M cartridge.

Not New...Just the Best



ERIE RED CAP

Miniature Ceramic Capacitors

WIDEST SELECTION OF MINIATURIZED CERAMIC CAPACITORS IN THE INDUSTRY!

Erie is in the Red Cap winner's circle because of a well engineered component that's backed by a unique process control system. Combine this with talented, motivated people and you have Erie as the leader in its field. These tiny high quality capacitors are not new... but they are the best. Our customers attest to it. Our test laboratories prove it.

Red Cap dielectrics are manufactured by Erie's exclusive Monobloc Process®... a modern, time-proven ceramic film technology. And tough environmental extremes routinely are endured by our own Jet-Seal, a hard, bright red polymeric protective coating. (The superior aesthetic appearance of Jet-Seal comes to you at no charge.)

Erie Red Caps have it all. 21 temperature characteristics. 1pF to 10uF capacitance range. Ratings from 25 to 500 Vdc. You name the application... we've got a Red Cap for the job. All this is due to Erie's total in-house capability... from exclusive ceramic formulations to unique packaging. So on your very next buy of ceramic capacitors, do it the easy way... specify Erie Red Caps.

Write TODAY for Red Cap brochure 8000... or call our nearby factory representative.

CAPACITANCE RANGE
1pF to 10uF

21 TEMPERATURE Characteristics

Voltage Range
25 to 500 Vdc

Encapsulated by "JET-SEAL"

Meet or Exceed Requirements of MIL-C-20 MIL-C-11015 As applicable

ERIE TECHNOLOGICAL PRODUCTS, INC.
Erie, Pennsylvania 16512

Circle 93 on reader service card

The Great



SEND FOR THE NEW CELCO YOKE GUIDE LISTING OVER 175 TYPES. SELECT THE ONE YOKE FOR YOUR SPECIAL DISPLAY APPLICATION.

American YOKE Company

CONSTANTINE ENGINEERING LABORATORIES COMPANY

1150 E. Eighth Street, Upland, CA 91786

70 Constantine Drive, Mahwah, N J 07430





3. Big disks. Control Data's new Star service center uses 10 type 819 disk drives to provide more than 2.5 billion bytes of on-line data storage. The Star computer itself recently performed more than 100 million operations per second, claimed as a new world's record.

4. Upgrades. IBM upgraded its system 370 models 135 and 145 to the 138, shown here, and 148. Performance was increased 28 to 43 percent, while purchase prices decreased by about 45%. The systems use MOS main memories based on 2-kilobit RAMs.



second held since 1969 by the CDC 7600. The computer will be the center of a new data service announced by the company.

Amdahl Corp., Sunnyvale, Calif., has been shipping its 470 V/6 systems at the rate of about one a week, and by the end of the year it will have around 30 systems installed. The system's performance topped IBM's top-of-the-line system 370 model 168, but IBM is getting ready to leapfrog Amdahl. Although no details of the enhanced 168 have been disclosed, chances are it will contain many of the improvements of the 138 and 148.

The first model of the largest scientific computing system ever built, the Cray-1, by Cray Research Inc., Chippewa Falls, Wisc., has been shipped to the Atomic Energy Commission's Laboratory in Los Alamos, N. Mex. The company says it plans to ship another this year and perhaps four more next year. The first Cray-1 had a memory of half a million words, of 64 bits each.

IBM upgraded its system 370 models 135 and 145 to the 138 and 148 (Fig. 4). Although the company did not disclose much about the hardware improvements, it did note that the new systems make greater use of firmware in the form of a reloadable control store of 131,072 characters. Software had been used to control operation sequences and emulation and diagnostic routines.

Processors also are being geographically distributed to bring computer power closer to where the information is gathered and results are needed. The basis for such system architectures is the increasing ability to build small, low-cost terminals. Intelligent terminals are steadily hiking their IQ by taking advantage of the advances in small processors and peripherals—memory, with 4-k and, soon, 16-k RAMs, higher-capacity mass storage with floppy disks or tape cartridges, and lower-cost, more

capable printers, which often use microprocessors to control the printing formats.

Since Intel's 1975 announcement of its Intellec micro-computer-development system, the byword in such equipment has been in-circuit emulation. Intellec's operation is typical of such systems. The designer can write, edit, and partially debug his program and, using in-circuit emulation, can run the program in his actual prototype hardware. The Intellec replaces the 8080A microprocessor in the prototype.

In-circuit emulators

In the past year, many development systems from other manufacturers have come out with in-circuit emulation. Motorola, for example, added the feature to its Exorciser, which is used to develop 6800-based systems, and called it USE, for user system evaluator. An independent, Millenium Information Systems Inc., Santa Clara, Calif., designed the development system for the 2650 microprocessor from Signetics Corp., Sunnyvale, Calif. Then it announced its own version, calling it the Universal One, with two processors, master and slave. It can be used for any processor type for which Millenium has developed the slave unit.

It was also a banner year for microprocessor-development software. Many high-level-language compilers were introduced for versions of PL/1, Basic, and Fortran. Such high-level languages can substantially ease programing, compared with the more detailed assembly-language statements. Intel's PL/M was the first language based on PL/1, and many others are now available. Motorola has its MPL for the 6800; Signetics has PL μ S for the 2650; National Semiconductor Corp., Santa Clara, Calif., has SMPL for the IMP-16, PACE, and other

Profile

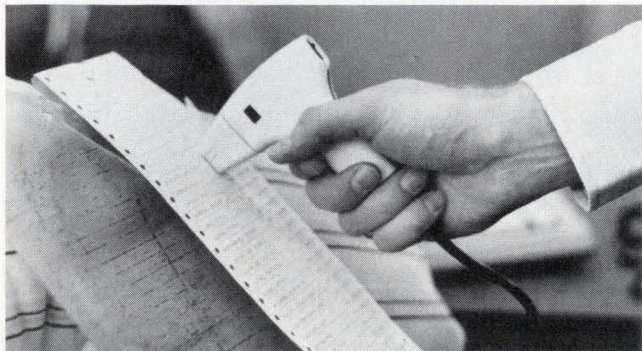
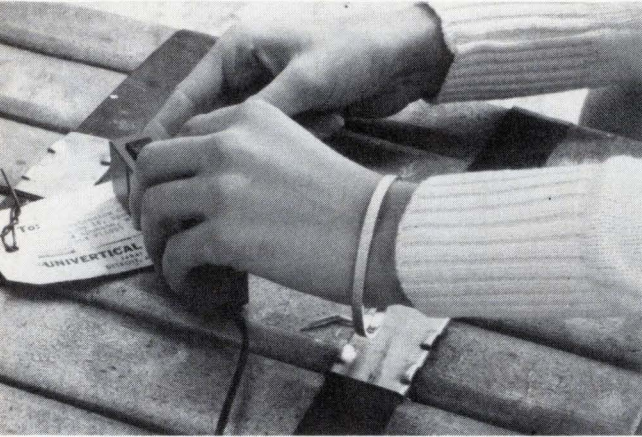
Diskette, flexible disk, floppy disk, call it what you will, this data-storage medium has had a tremendous impact on small computer systems since it was developed by IBM at its San Jose, Calif., plant in the late 1960s. And two of the leaders of the project are still in the business, further refining today's floppy-disk drives. Don Wartner, left, is chief engineer at Shugart Associates, Sunnyvale, Calif., while Warren Dalziel is a senior engineer at Shugart. Along the way, they worked at Memorex Corp., Santa Clara, Calif.

Each joined IBM in San Jose upon graduation from college—Wartner in 1958 from the University of Colorado and Dalziel in 1962 from Oregon State University. Each left in 1969 to join Memorex, along with Al Shugart, who became vice president for development at Memorex, and others. At that time, the IBM system was well on its way, having passed the final tests before manufacturing.

The first drive, however, was a read-only device intended to load a microprogram into a larger disk drive upon startup. The project, called Minnow, went through some difficult times at IBM as the engineers tried to come up with the right flexible medium. One ill-fated idea was to bond thin magnetic sheets of Mylar to the two sides of a plastic foam disk and allow the read head to press into the Mylar while the foam acted as a backing. Problems in maintaining production tolerances on the foam, however, forced them to discard this idea and eventually adopt the jacketed, flexible medium as it is known today.

"The requirements of the project were fairly easy by today's standards, but at the time they seemed hard," Wartner says. "The bit density was 1,594 bits per inch, whereas today we typically operate at 3,200 bits/in. Track density was 32 per inch, and today it's 48 per inch. And rotational speed was 90 rpm, while today we spin the disk at 360 rpm."

Did the two engineers foresee the eventual impact of their Minnow? "I have to admit that I didn't have the foresight to see there would be a big market for floppies," Dalziel says. Wartner notes that it wasn't until IBM announced in Europe the 3741 keypunch replacement system based on a read-write floppy disk that he realized that the company had continued to develop the device.



5. Optical magic. The Key Tronic OCR wand (top) uses a wheel moving across the paper to generate pulses that cause the photodiode array to take readings every 1/200 in., while the Recognition Products wand need not be in contact with the paper.

devices; Zilog Inc., Los Altos, Calif., has PL/Z for the Z-80, and many independent software houses introduced compilers for the PL/1 derivatives.

Most of the compilers, however, are cross-compilers, which means that they must be run on a large computer. The next push is to develop compilers that will be resident in the semiconductor firm's own microprocessor-development system. Intel recently announced PL/M as resident in the Intellec, and Motorola has installed a resident version of Fortran in the Exorciser.

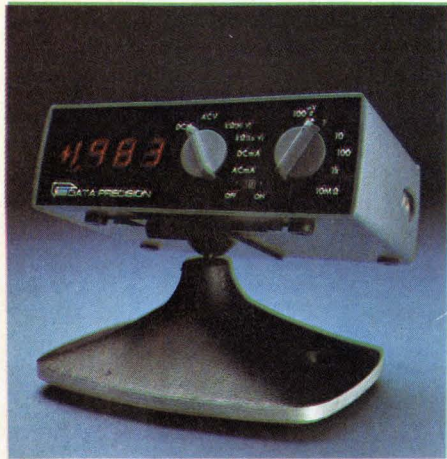
Among the more unusual developments in data-entry technology was a pair of wands that perform optical-character recognition (Fig. 5). They are found in such applications as point-of-sale systems, inventory control, and recording manufacturing data. A wand from Recognition Products Inc., Dallas, Texas, can read 26 OCR-A-coded characters while being moved left to right or vice versa. The associated electronics module is built around an F8 microprocessor. Another wand, from Key Tronic Corp., Spokane, Wash., has a displacement wheel that turns as the wand is moved across the paper. The wheel, in turn, generates a series of marker pulses that trigger the photosensor array to read a different slice of the character every 1/200 inch. This wand reads all OCR-A letters and numerals, some other fonts, and even hand-printed numbers and a few letters.

extraordinary...



even for Data Precision.

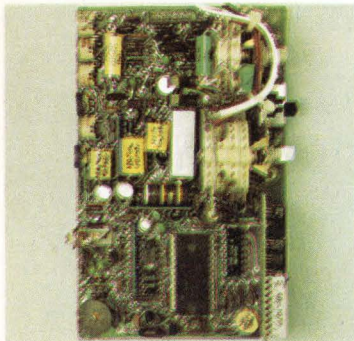
Here's a miniature 3½ digit portable multimeter that delivers extraordinary performance and value for only \$189.



Data Precision proudly presents a 0.1% accuracy multimeter that brings the same high performance and value to 3½ digit portable instruments that our Model 245 brought to 4½ digit multimeters. The same levels of reliability, the same small size, the same great convenience and flexibility. The Model 175 has it all... and more for just \$189.00.*

High performance

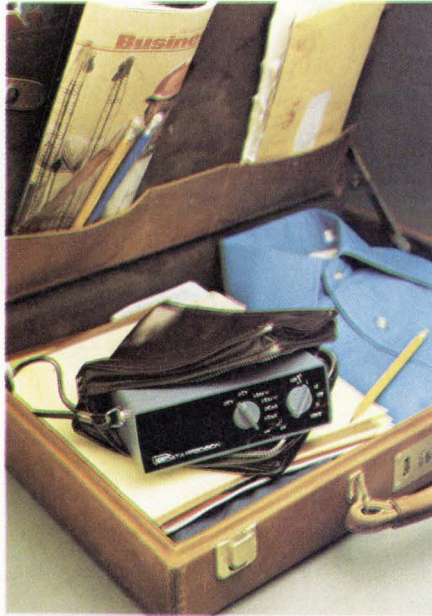
The Model 175 gives you 32 ranges of measurement capability, six functions, 0.1% DCV accuracy guaranteed for one year, and 100 microvolts resolution. You can measure DCV from ±100 microvolts to ±1000V, ACV from 100 microvolts to 500V with a frequency response of 30Hz to 50kHz, DC Current from ±100 nanoAmps to ±2A, AC Current from 100 nanoAmps to 2A with a frequency response of 30Hz to 50kHz, Resistance from 100 milliohms to 20 Megohms in two excitation voltages.



*Price U.S.A.

Real miniature portability

Here is true miniature portability that delivers lab performance wherever you take it. And you can take it anywhere. The 175 operates from AC line, or rechargeable NiCad batteries for 6 hours of in-spec operation. Add this to the remarkably small size 1¾"H x 5½"W x 3½"D, 34 cu. in., weight 22 oz. (4.45 x 13.97 x 8.89cm, 552cc, .63kg.) exceptional operating temperature characteristics, rugged construction... and you can see that this is real portability.

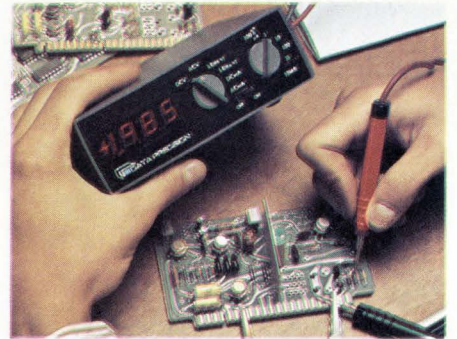


Right at home in the lab

Connect the 175 to an AC line and you have a great bench instrument. It's always recharging when line connected and ready to go into the field whenever you need it.

And the Model 175 gives you a lot more.

• **Easy to Read, Big, Bright Display:** 0.43" LED display for easy reading in dim light or bright light.



• **Hi/Lo Resistance Measurement:** Measure resistance in two modes. Hi excitation 2.5V (exceeds semiconductor forward threshold) and Lo excitation 300mV (below silicon junction threshold), for in-circuit resistance measurement without turning on semiconductor junction. No need to unsolder resistor.

• **Automatic Zero:** TriPhasic™ conversion eliminates need for any front panel zero control.

• **Tells You When To Recharge:** Blinking decimal point advises up to 10 minutes in-spec battery operation remaining.

• **Overload Protected:** It's forgiving. All DCV ranges can take ±1000V, all ACV ranges to 500V, all resistance ranges up to 250V... continuously—without loss of calibration or damage to the instrument. Current ranges are protected by 2A fuse easily accessible in a test lead.



Actual size, front view.

And Much More: Auto Polarity, 100% Overrange, Overload Indication, Internal DC and AC Current Shunts, LSI/CMOS Reliability, Exceptional Common and Normal Mode Rejection, Complete Documentation including NBS traceability and **individually** calibrated data sheet. Simple and precise calibration.

You get a complete package.



Everything you need to use the 175 is supplied with the instrument. Nothing else to buy. No extra costs. Standard accessories include the rechargeable NiCad battery module, line cord with recharger, a pair of fused test leads, alligator clips, carrying case and documentation.

Optional accessories that make the Model 175 even more versatile.



High voltage probe, AC current clamp, pedestal stand, rack mount, deluxe leather case and mini- to-standard banana adaptor.

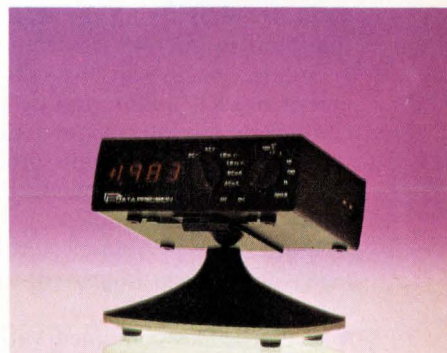
The competition just isn't competitive.

The Model 175 is an extraordinary value offering the performance, size and price you want. Judge for yourself. The following is a comparison based upon manufacturers' data.

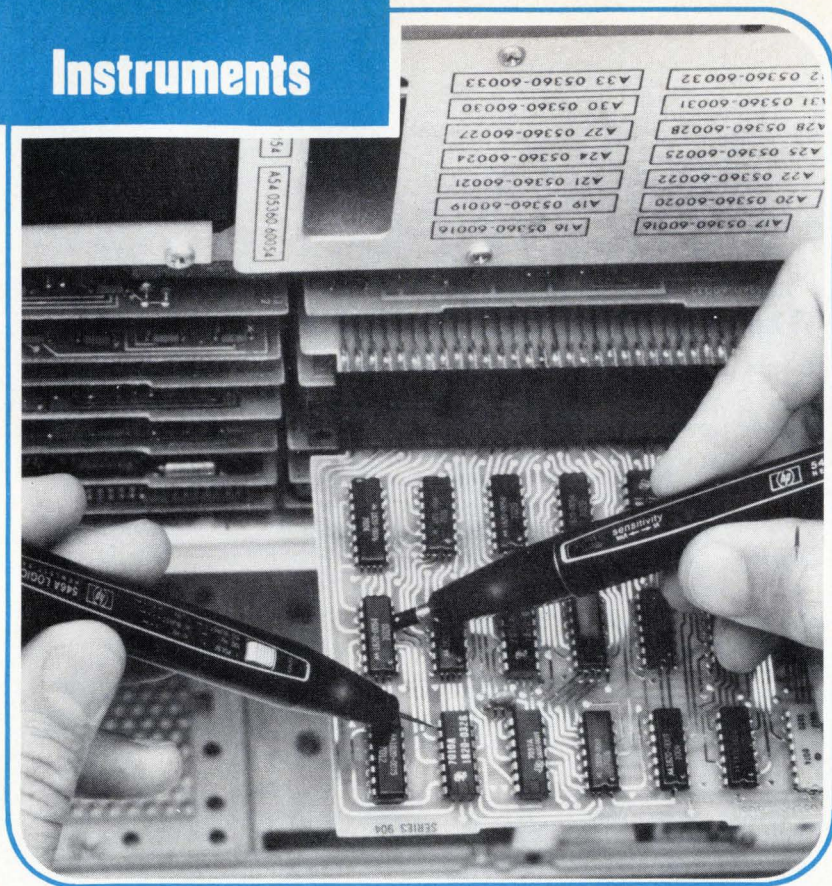
	Data Precision Model 175	HP 3435	HP 3176B	Fluke 8000 A
Digits	3½	3½	3½	3½
Size	34 cu. in.	395 cu. in.	123 cu. in.	212.5 cu. in.
Display Size	0.43" LED	0.30" LED	0.25" LED	0.25" LED
Basic Accuracy for 1 Year ±1 Digit	0.1%	0.1%	0.3%	0.1%
DCV Sensitivity	100µV	100µV	100µV	100µV
AC Frequency Response	30Hz-50kHz	30Hz-100kHz	45Hz-10kHz	45Hz-20kHz
Functions	6	5	5	5
Ranges	32	27	19	26
Hi/Lo Excitation	Yes	No	No	No
Calibration Accuracy Guaranteed	1 year	1 year	1 year	1 year
Overrange	100%	100%	10%	100%
Ranging	Manual	Manual & Auto (except current)	Auto	Manual
Rechargeable Batteries	Yes	Yes	Yes	Optional (\$50.00)
Recharges Batteries While Operating	Yes	Yes	No	Optional
Full Scale Voltage Drop Measuring Current	100 millivolts (EIA STANDARD)	220-400 millivolts	100 millivolts	100 millivolts
Price With Batteries	\$189.00	\$400.00	\$275.00	\$349.00

All Model 175 specifications are covered by a one year warranty. Service is available from our worldwide service centers.

For complete information or a demonstration, contact your local Data Precision representative or Data Precision Corporation, Audubon Road, Wakefield, MA. 01880, (617) 246-1600. TELEX (0650) 949341.



DATA PRECISION®
...years ahead



Finding failures. The emphasis in digital testing hardware is on gear that can trace a fault directly to the errant integrated circuit, solder splash, or other cause, thus avoiding slow, costly, and inefficient hit-or-miss techniques like mass IC replacement. Troubleshooters like this Hewlett-Packard pulser and probe help make the right fix first time.

Digital systems spawn new tasks in measurement

by Andy Santoni, *Instrumentation Editor*

Improvements in circuit design and the increased use of large-scale-integrated circuits—especially microprocessors—are making instruments faster, less expensive, and more convenient to use. Equally important, new kinds of testers and variations of older types of equipment are simplifying the testing and troubleshooting of the latest in microprocessors and other digital circuits.

- In the past year, microprocessor analyzers have emerged as a major product line, aimed at the needs created by microprocessor-based circuits (Fig. 1).

- New versions of logic probes and other hand-held troubleshooting instruments have made tracking faults in digital circuits simpler.

- Testers for printed-circuit boards containing digital logic have been improved to permit faster and less expensive repairs.

- Oscilloscopes combined with digital multimeters and time-interval counters offer more capability in one instrument.

- Digital voltmeters and multimeters are heading in two

directions: higher reading rates and lower prices.

- Frequency counters are measuring pulsed signals in the gigahertz range to simplify tests of communications and radar systems.

- Calculator-based measurement systems are supplanting minicomputer-based systems at lower costs.

Testing microprocessors

Microprocessors have created new markets for test-instrument manufacturers. With 24 lines of addresses and data on an 8-bit microprocessor, logic analyzers with more than the maximum of 16 lines of older instruments are required. To meet the need, almost a dozen instrument makers are offering analyzers with as many as 32 input channels and with features aimed at microprocessor circuit designers, such as hexadecimal readouts and one-clip interfaces. Enough equipment of this kind has hit the market to establish a new category of instruments—microprocessor analyzers.

No two microprocessor analyzers are alike. They

range in price from under \$1,000 for units from Pro-Log Corp., Monterey, Calif., and Systron-Donner Corp., Concord, Calif., to \$5,000 and more for the complex analyzers built by Hewlett-Packard Co., Palo Alto, Calif., and Biomation Corp., Cupertino, Calif. Yet all types simplify trouble-shooting circuits that contain microprocessors.

Displaying data

By wiring the analyzer's test probes differently for different microprocessors, the manufacturer can guarantee that the signals coming from the microprocessor buses go to the right point on the display of the analyzer. That display can be a row of light-emitting diodes corresponding to one program or instruction step. Another display approach is to offer hexadecimal readouts on a built-in cathode-ray-tube screen or an external oscilloscope. Hexadecimal readout is preferred by software programmers, who use it to compare actual circuit operation to documented programs.

By far the most complex microprocessor analyzer displays are offered by HP's model 1611A and Biomation's model 168-D. The HP unit, in addition to hexadecimal readout, can display system activity on its CRT in the alphanumeric mnemonics of the microprocessor's instruction set, thus even further simplifying interpretation. The CRT on Biomation's analyzer can display a 16-by-16-position map of the instrument's 256-word memory so that similar instructions and the program loops they identify can be located.

With a microprocessor analyzer, an engineer can determine that a failure has occurred and can often trace the fault to a software error. The analyzer can some-

times even determine where a hardware problem exists. But it usually cannot track a fault far enough to determine which integrated circuit must be replaced or where a solder splash exists on the system's pc board.

Hand-held digital troubleshooting instruments such as logic probes, pulsers, and test clips come into play for tracking such faults. These low-cost instruments are gaining greater popularity now that prices are falling. The latest such gear can handle the demands of mixed logic types on a single board. But they cost less than their predecessors, which could only handle one logic family at a time.

One logic probe that indicates logic level and pulse activity at a node under test in either complementary-metal-oxide-semiconductor or transistor-transistor-logic



1. Microprocessor monitor. Analyzers like this Systron-Donner unit simplify microprocessor-program generation and debugging by displaying the activity on address and data buses.

LOGIC ANALYZER APPLICATIONS		
Number of channels	Memory bits per channel	Applications
1 - 2 4 8 16 32		analyzing serial data transmissions comparing control signals comparing complex control signals and analyzing data lines in peripherals analyzing transactions on microprocessor and other buses, and tracing programs examining total processor operations, including addresses, data, and control signals
	1 16 256 ≥1024	storing status information recording sequences of logic states analyzing timing relationships and long sequences of logic states making high-resolution timing analyses and analyzing serial data transmissions

Analyzing analyzers. The memory capacity of a logic analyzer determines the range of applications it can cover, says Murlan Kaufman, project manager at Tektronix. Units with almost any combination of memory width and depth are available.

systems is available from Continental Specialties Corp. of New Haven, Conn. Its \$44.95 price is less than half that of many earlier logic probes that could handle only one family. For systems with an even greater mix of logic types, Hewlett-Packard's model 545A, which can test resistor-transistor, high-threshold, and MOS logic in addition to TTL and C-MOS, is priced at \$125.

Unfortunately, these instruments cannot readily determine which IC has failed. All they can tell is whether a line is stuck at a logic high or a logic low, not whether

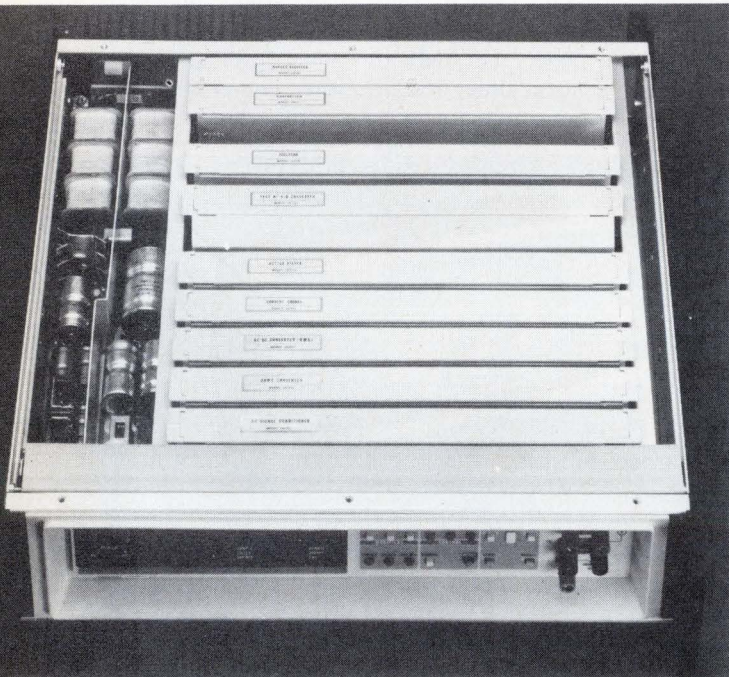
it's the driver or receiver that is at fault. Nor can they determine which driver has failed when the outputs of a number of gates are tied into a single wired-OR bus.

To solve these problems, instrument makers have introduced logic troubleshooters that trace signals through pc paths, instead of checking a line's voltage level with respect to system ground. For example, the current-path indicator from Storage Technology Corp., Broomfield, Colo., is a microvoltmeter with a zero-center scale that indicates the direction of current flow between two points on a pc path and can thus locate a solder splash or the IC pin that's shorted to the power-supply voltage or to ground. The Short-Trak from Digital Facilities Inc., Dallas, performs a similar function and includes a third probe that can act as a current-pulse source.

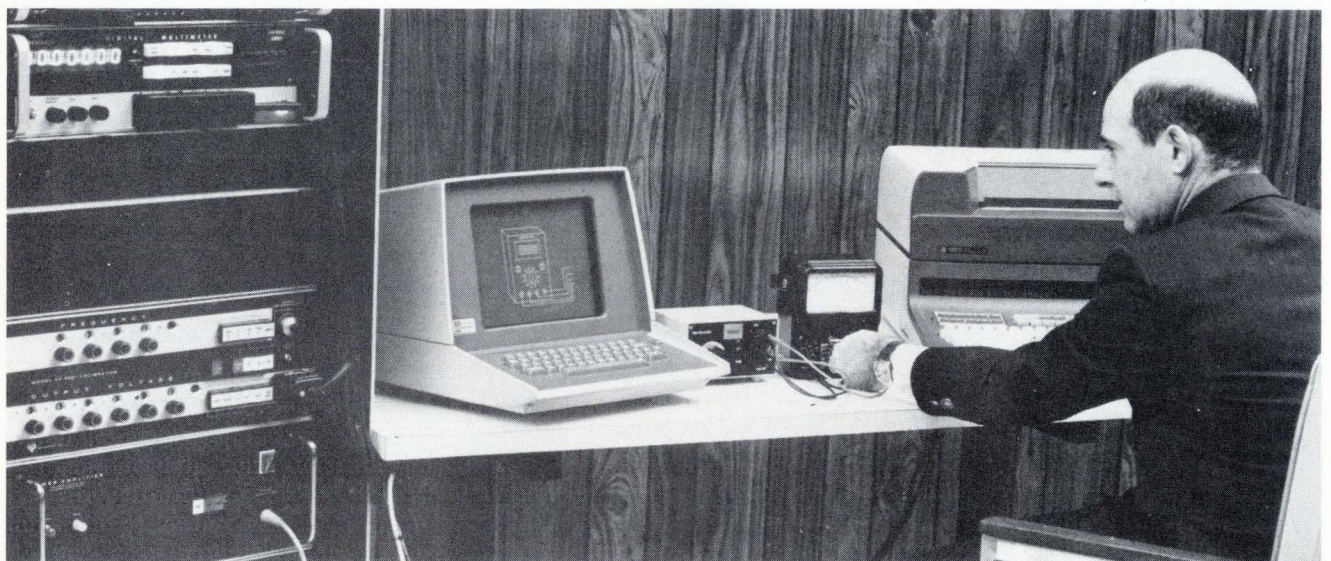
Another approach to current sensing is to look for the fields surrounding the paths through which current flows. This approach is taken by HP in its model 547A current tracer, a \$350 instrument that has a pickup coil at its tip and a wideband, variable-sensitivity amplifier that turns on a lamp when current is present. A similar technique is used by Testline Instruments Inc., Titusville, Fla., in its wired-OR probe, which also includes a pulse source.

Testing boards

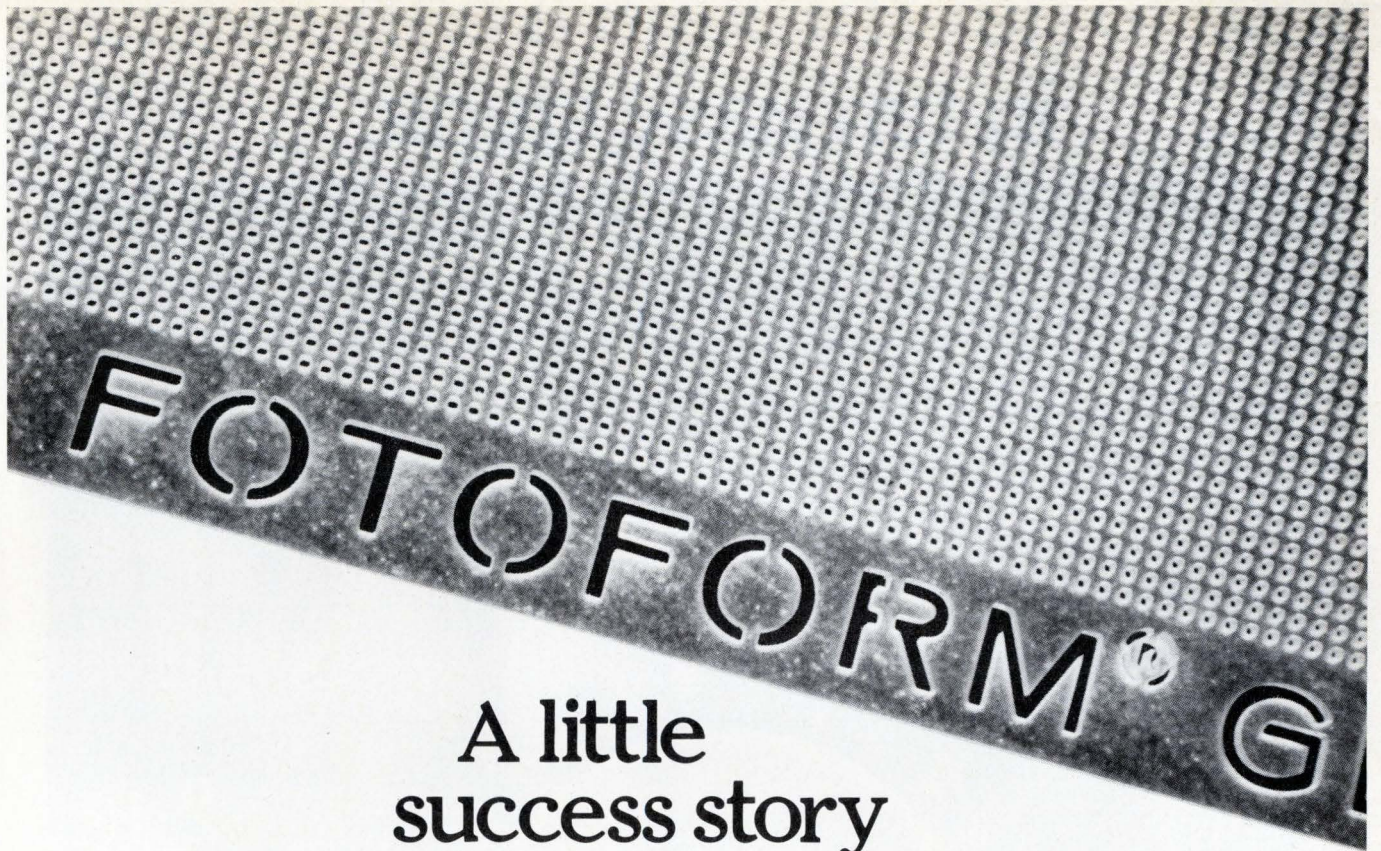
Testline has expanded its relatively simple wired-OR probe into a complete board-test system that fits into a suitcase and gives a clear go/no-go indication of the board's performance. Called the AFIT 1000, the tester drives an IC's pins with a signal from a 2-ohm source impedance. This low impedance is critical, says Roger Boatman, Testline's president, because the impedance at a failed device's pin is about 3 Ω , while the highest impedance exhibited by a common board problem such



2. Speed system. The converter in Fluke's 8500A digital multimeter can take 500 readings per second at 5½ digits of resolution.



3. Calculator control. As the speed and flexibility of desktop programmable calculators increase, more of these devices are applied in automatic test systems such as this Julie Research calibration console. The tester can generate images of the unit under test on a graphics terminal, thereby simplifying the location of test points and controls.



A little success story with holes in it...

Holes of almost any shape and size. Up to 10,000 holes per square inch, in pieces as thin as 0.010 inch. Holes, slots, and channels, as small as 0.005 inch. And with tolerances as close as ± 0.001 inch.

We're talking about Corning FOTOFORM® and FOTOCERAM® materials. Unique, photosensitive materials that can be precision-etched, machined, cut, milled, chamfered, ground, lapped, polished, sealed to glasses or ferrites. And even metalized.

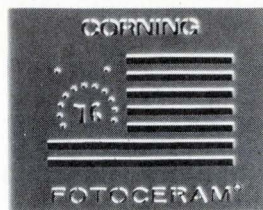
The real beauty of FOTOFORM and FOTOCERAM materials is they offer you engineering flexibility—the flexibility to do it your way.

And at Corning, your way is the only way. That's why we developed FOTOFORM and FOTOCERAM materials. They may help you write your own success story. We'll help. We're the Fotoform Products Group, Corning Glass Works, Corning, New York.

You ought to get to know us better. Find out more about FOTOFORM and FOTOCERAM materials. Write, under your letterhead, for a free sample depicting the 1776 Bennington Flag and complete specifications to:

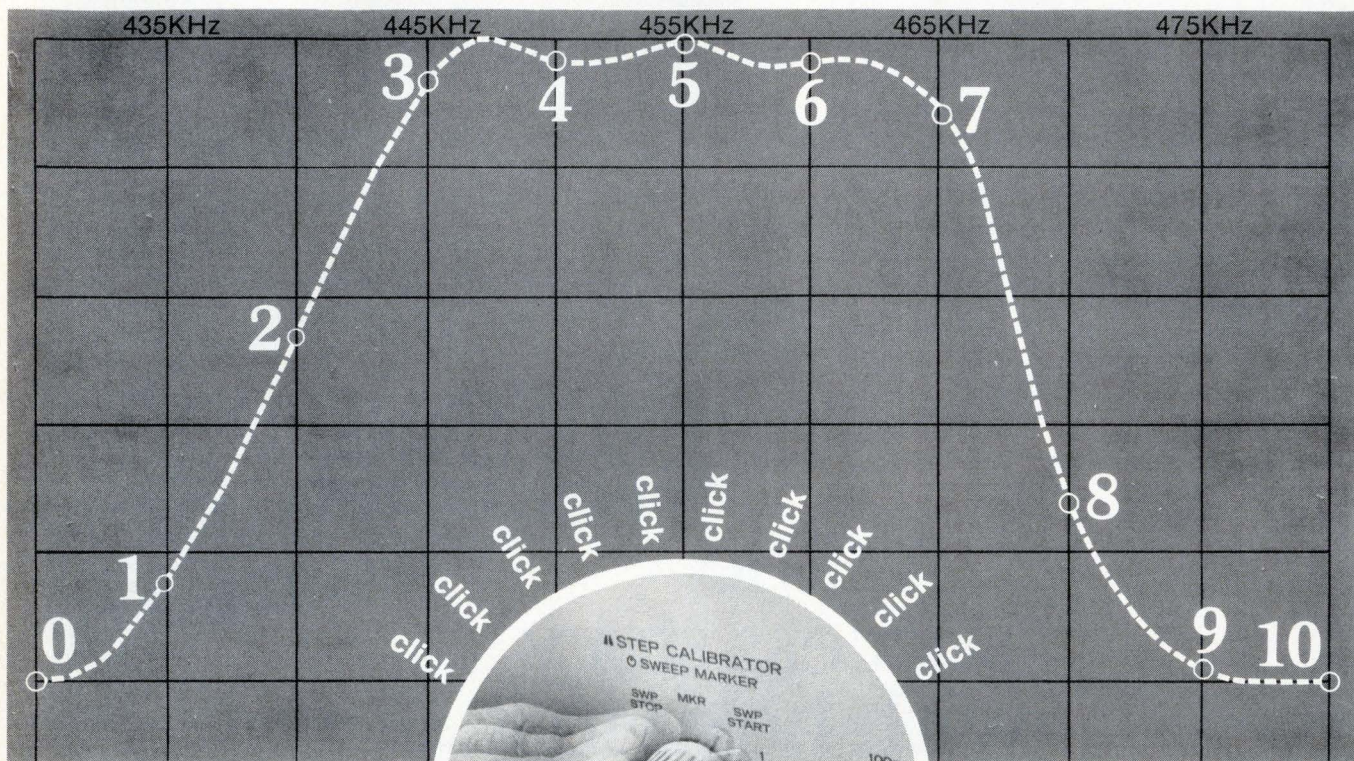
FOTOFORM Products Group Dept. E-1028
Corning Glass Works, Corning, New York 14830
(607) 974-8583

CORNING
CORNING GLASS WORKS



Write for free sample today!

How to get through a bandwidth in ten easy steps.



SERIES 40's Step Calibrator measures frequency response with the click of a switch.

Set SERIES 40's main dial *once*, and you'll get eleven precise frequencies in ten equal steps by simply clicking the Step Calibrator switch from zero to ten. With 1000:1 frequency change in the log mode, each step is equivalent to approximately one octave, which is particularly useful in audio testing. And unlike other function generators, SERIES 40 allows you to step up or down without having to cycle through the entire ten steps.

So — when you're testing frequency response, just set up the band edges and click through the ten steps, measuring amplitude at each step...it's that easy.

SERIES 40 Function Generators — New from INTERSTATE

SERIES 40 gives you plenty of amplitude — 40 V peak-to-peak (open circuit) — and takes the guesswork out of pinpointing response with its continuously variable Frequency Marker. SERIES 40 also offers you INTERSTATE's exclusive direct-reading sweep limit control and full spectrum of function generator capabilities in five models from \$475 to \$695. For additional SERIES 40 specifications, call Product Marketing at (714) 549-8282, or write Interstate Electronics, Dept. 7000, Box 3117, Anaheim, CA 92803.

INTERSTATE
ELECTRONICS CORPORATION
Subsidiary of A-T-O Inc.



as a solder splash is less than 0.1 Ω . If a 2- Ω source impedance can drive the IC, the failure is in the chip, since a board failure would short out the signal.

While much emphasis in instrumentation has been on solving problems in digital circuits, analog-oriented instruments such as oscilloscopes, voltmeters, and frequency counters have not been ignored. In fact, these three types of instruments are more often being provided within a single cabinet.

Vu-Data Corp. of San Diego, for example, is offering its model PS915/975, which contains a digital multimeter, a frequency counter, and an oscilloscope in a 10-pound package. Priced at \$1,250, the unit permits measuring the voltage and frequency of a signal while displaying the waveform on the scope screen.

Tektronix Inc., Beaverton, Ore., offers its model DM44, a digital multimeter and time-interval counter that rides piggyback on many of the firm's portable oscilloscopes. To measure a time interval on screen, the scope is set for sweep A intensified by sweep B, and two intensified spots are positioned at the beginning and end of the interval to be measured. The time is read out on a 3½-digit display that's part of the DM44. For greater precision, the DM44 can measure a time interval (and its inverse) with accuracies to within 1% by switching the scope into the sweep-B-intensified-by-sweep-A mode, in which detailed views of the interval's beginning and end are displayed. Using the delta-time control, the end of the interval is superimposed on the beginning to produce a readout.

Measuring volts faster

Improvements are also being made in stand-alone digital voltmeters and multimeters. In meters designed for applications in systems, the trend is toward higher conversion rates and, therefore, shorter overall test times. The model 8500A systems multimeter from John Fluke Manufacturing Co. of Mountlake Terrace, Wash., for example, can take up to 500 readings per second while achieving 5½ digits of resolution (Fig. 2). The instrument employs an analog-to-digital converter that can make less precise approximations to the unknown voltage at each stage of the conversion. It makes the approximations more quickly because it can correct the error, whether positive or negative, on the next conversion step.

Data Precision Corp., Wakefield, Mass., took a different approach. In its model 7500 voltmeter, the unknown input is integrated for 200 microseconds so that 1,000 conversions per second are possible. The instrument integrates a large reference input for as long as is required to get within 1% of full scale. Then a comparator sends a signal that changes the reference current and the clock rate each by a factor of 100, reducing the load on the comparator for the final, brief integration period.

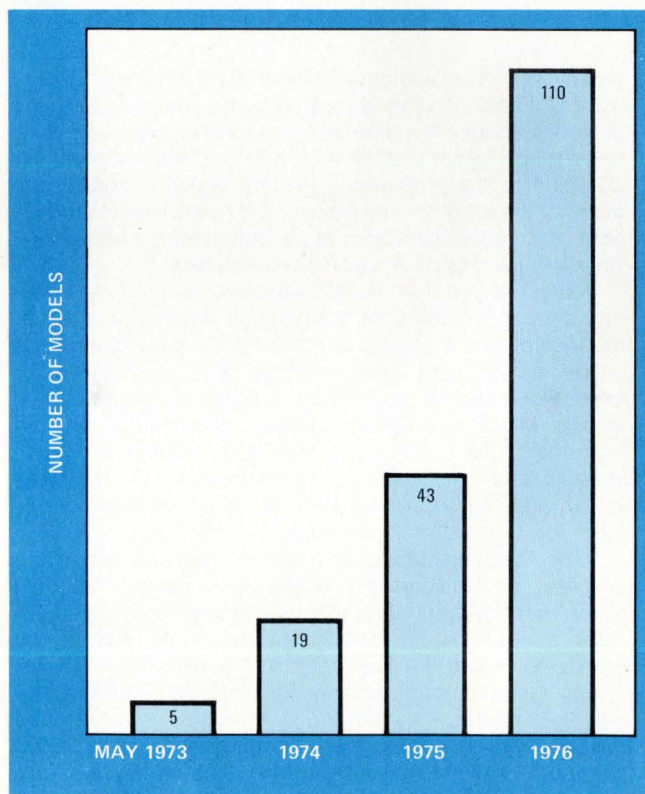
An even faster system voltmeter is Hewlett-Packard's model 3437A. It can measure dc voltages at better than 5,000 readings per second with a resolution of 3½ digits,

which is often enough in data-acquisition systems. By combining high measurement speed with an internal sample-and-hold circuit, the 3437A can analyze transient signals. Repetitive waveforms with frequency components up to 1 megahertz and low-frequency transients with components up to 1 kilohertz are quickly digitized and analyzed, so that parameters such as residual dc, harmonic content, peak values, and root-mean-square values can be determined.

The ability to measure rms values is becoming more important as engineers begin to realize the benefits of making these measurements in a wide variety of power-dissipating circuitry. At the same time, prices for rms-responding digital multimeters are falling, so that such instruments are now available for large-scale use in field service or on the production line.

Two digital multimeters from Fluke offer rms response in low-cost instruments whose small size and light weight are designed for field service as well as bench use. The \$235 3½-digit model 8030A and the \$425 4½-digit model 8040A both have 26 ranges and five major functions (ac and dc voltage, ac and dc current, and resistance). In addition to five ranges for each function, the 8040A has an additional resistance range, and the 8030A has a diode-test position.

In Data Precision's latest entry, the \$345 4½-digit model 248, the rms-to-dc conversion is performed by a



4. Bus bonanza. More than 35 manufacturers are supplying systems, instruments, or components that are compatible with the standard interface bus.

linear, bipolar integrated circuit made by Analog Devices Inc.'s Semiconductor division in Wilmington, Mass. The IC is capable of less than 1% error in measuring signals with crest factors up to seven and is responsible, at least in part, for the DMM's low price.

Counting in bursts

Just as voltmeters are improving in performance, so, too, are frequency counters. The latest instruments from Systron-Donner, EIP Inc. of Santa Clara, Calif., and Eldorado Instruments Co. of Pleasant Hill, Calif., can measure frequencies in the gigahertz range, even when the signal under test is pulsed, not continuous. For example, a radar system under test does not have to be put into a standby, continuous-wave mode, but can continue in normal operation.

Eldorado's model 9899 is a heterodyne counter with a range from 925 MHz to 18 GHz. It is similar to the firm's continuous-mode model 989 except for the addition of pulsed-radio-frequency measurement circuits. The model 451 from EIP uses the same heterodyne technique and features fully automatic pulsed-rf counting capability over a range from 300 MHz to 10 GHz. Systron-Donner's model 6063, planned as the first in a series of pulsed rf counters, covers the range from 20 Hz to 6.5 GHz, with 1-Hz resolution.

Along with single-function instruments like these

counters, instrumentation makers are looking toward more complete systems for testing communications gear. In telecommunications, as well as other testing applications, calculator-based systems have moved into the spotlight because they give engineers or production-line personnel a great deal of information quickly, yet are less expensive than computer-controlled systems (Fig. 3).

Control by calculator

Although most calculator-based testers are built by users, some are commercial products. For example, the SMPU radiophone tester from West Germany's Rohde and Schwarz uses a microprocessor to control instrument modules and monitor their operation, along with a TEK 31 desk-top calculator to make a fully automatic system complete with datalogging. This system also reflects the trend toward compatibility with the IEEE-488-standard instrument-interface bus (Fig. 4).

More such systems will be required because of the demands for more sophisticated instrumentation to lower labor costs, says Norman Christianson, director of engineering at W & G Instruments Inc., Livingston, N.J. "We have to give the user the information he wants in the parameters he desires, so we need smart instruments to do the jobs faster and provide whatever data reduction is necessary." □

Profile

When Chuck House's development team at Hewlett-Packard's Colorado Springs division ran into snags while trying to troubleshoot the serial-data bus in what was supposed to be a new generation of oscilloscopes, they turned their attention to the problems of testing digital circuits. As a result of the insights they gained, the new products turned out not to be oscilloscopes at all, but instead a whole new class of instruments—logic state analyzers.

House realized that digital transmissions are fundamentally different in character from analog signals. As a result, test equipment designed to measure the parameters that define an analog signal—voltage and frequency, for example—may be totally inappropriate for digital-circuit testing. What was needed, House determined, was an instrument that abstracted the data flowing in digital streams and presented only the essential information—logic states that existed at the time the circuit made use of them, on the system clock edge.

Like most ingenious ideas, the concept of the "data domain," as House calls it, seems rather simple. Yet, until a few months ago, HP was alone in implementing logic-state analysis in commercial products. All but a few engineers used oscilloscopes to troubleshoot digital systems, even though scopes—including multi-trace and multi-beam units—do not display enough signals to make the necessary comparisons among the many lines common in digital systems. Logic state analyzers and microprocessor analyzers trade off the ability to display precise voltage and timing relationships to increase the number of data lines displayed.

House's varied experiences all contributed to his present position as logic-analyzer department manager. He joined HP in 1962 upon graduation from the California Institute of Technology, where he studied solid-state physics. He was anxious to take a job in Colorado Springs because nearby Denver is his wife's home town. ("We've been happily married for almost half my life," the 36-year-old House says.)

"I was going to turn myself into a circuit designer," says House, who spent the next four years designing what he calls "moderately successful" oscilloscopes. He then became involved in a project to design a large-screen cathode-ray-tube monitor for the Federal Aviation Administration, which led to an assignment researching other possible applications for the device—"and I got hooked on product planning."

Meanwhile, he was appointed to the Air Pollution Control Commission by the governor of Colorado and there gained an appreciation for systems engineering, in which there is more emphasis on solving a problem and less on circuit design.

At HP, he realized that "another scope is nothing to write about. It didn't make any fundamental measurements you couldn't make before." Late in 1971, he made a proposal to John Young, now executive vice-president of the firm, and Barney Oliver, vice-president for research and development, to spend \$5 million over five years to develop the state analyzer. He didn't get that much money or that much time, but he and his team developed the product nonetheless.

TRW/Cinch Ribbon Connector System

a lot to cheer about!



- Dependable solderless termination.
- Handles stranded or solid wire.
- Single wires can be removed and replaced repeatedly.
- Interchangeable with over 300 million ribbon connectors now in the field.
- PLUS—the most versatile and broadest range of terminating equipment of any line of solderless ribbon connectors. Automatic, semi-automatic and hand tools that will terminate competitor's connectors as well as TRW/Cinch Connectors. They are more adaptable and more convenient to use than any other equipment you can buy or lease.

Certi-Clinch, illustrated above; measures only 6" x 14" x 7" high. It is rugged enough for production use, light enough for portable applications and terminates a 50 contact connector in less than 4 minutes. (For faster assembly, the Auto-Clinch requires only 1-1/2 minutes). Interchangeable jaws adapt it to any size connector of any manufacturer.

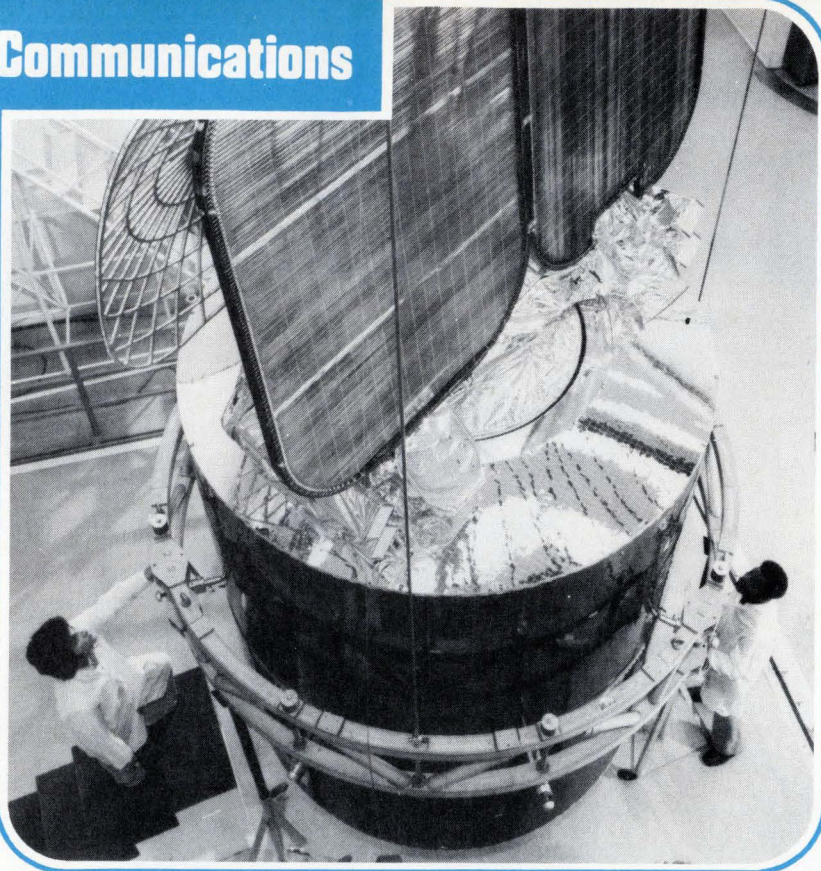
For information on the complete line of Cinch Ribbon Connectors, including solder tab terminal types, call Al Consiglio at 312/439-8800 or write to him at TRW/Cinch Connectors, An Electronic Components Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, Illinois 60007.

CC-7602

TRW/CINCH CONNECTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

Circle 107 on reader service card



Orbiting switching center. At 22,300 miles in space, Comstar, a geosynchronous-orbit communications satellite will be used jointly by AT&T and GTE to relay the myriad telephone calls across the 48 contiguous states as well as Hawaii, Alaska, and Puerto Rico.

All technologies aim at greater channel capacity

by Richard Gundlach, *Communications & Microwave Editor*

□ Communications technology was the father of the electronics revolution that is reshaping our lives, and the developments of the past year show there's plenty of life left in the old man. The demand for more and faster information transfer is spurring the adoption of new technology, notably in the development of optical-fiber communications. There also were solid advances in satellites and the adaption of large-scale integration.

- This year optical-fiber communications came out of the laboratory into operating environments.
- Higher-power satellites, some operating at higher frequencies with increased channel capacity, were launched, with others to follow soon.
- Microprocessor technology found increased use in radar, microwave receivers, and navigational equipment, and it was being tapped for telephony tasks as well.

Large-scale integration is playing a major role in reshaping communications products (Fig. 1). Acceptance had been slow in telecommunications, because most companies have large investments in existing plants. But

many semiconductor makers see LSI technology making inroads into all phases of communications as users demand improvements in performance, versatility, reliability, and economy. It is already found in a good range of products from several companies.

Fiber optics come on strong

The advance of fiber-optic technology was demonstrated dramatically by Bell Telephone Laboratories Inc. engineers in an experimental telephone link started last January. Not only did it show a fiber-optic system working successfully with existing telephone equipment, but it proved the mass producibility of fibers by demonstrating that cables of 144 single fibers could be produced and mass-spliced without individual handling of fibers. These cables, only half an inch in diameter, are capable of carrying almost 50,000 simultaneous telephone conversations.

Another fiber-optic system, designed to carry television signals over several fibers to a cable-TV headend

some 800 feet away, was established in New York City in July by TelePrompter Manhattan Cable Television. The Japanese will start testing a fiber-optic interactive network to provide two-way residential video information to households in Japan. An in-building prototype system will determine technical feasibility this November. Later, an expanded video information system will be tested by 300 subscribers in the Higashi Ikoma area, a model city near Osaka. And General Telephone and Electronics Corp. is readying a fiber-optic link to handle telephone messages between central offices.

Several advances in fiber-optic component technology have surfaced this year as well. Practical single-fiber connectors were developed by several companies, and a new generation of fiber cables was announced by Corning Glass Works, Corning, N.Y., which doubles source-to-fiber coupling efficiency over that of standard graded-index cables. The cables have 400-megahertz bandwidth capability with losses as low as 6 decibels per kilometer.

Still in the laboratory stage is an ultra-low-loss step-index fiber developed by the Fujikura Cable Works Ltd. of Japan. By eliminating almost all water ions from the glass, researchers there reduced fiber loss to only 0.47 dB/km at a wavelength of 1.2 micrometers. (For more on fiber-optic developments, see the special report in *Electronics* Aug. 5, pp. 81-104, and related articles in subsequent issues.)

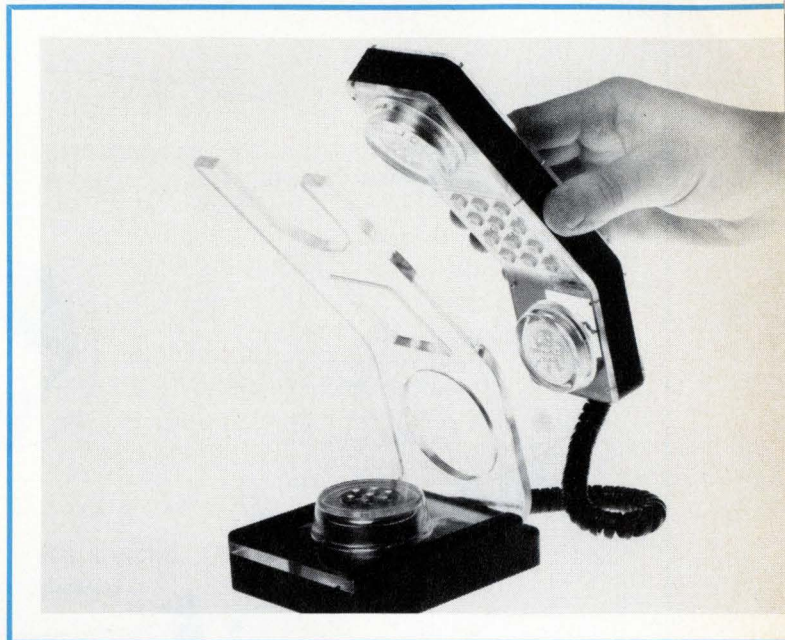
Going up

Satellite communications for international and domestic applications have jumped almost exponentially since 1974. One cause of the growth is the shift from costly ground systems to lower-cost earth stations. And with this year's launch of Marisat, satellite communications are serving ships at sea.

Satellite networks can bring communications directly to a user without access to telephone or telegraph networks. They meet the growing demand for domestic and international telephone channels, as well as distribution of data, direct connection of computers, television broadcasting, and high-speed facsimile distribution. In addition, satellites teamed with radar technology are being used for automatic vehicle locators, mapping the terrain on distant planets, and planning flood control and management of crop, forest, and water resources.

In the past, satellite technology centered on low-power satellite transponders that required large earth-station terminals removed from metropolitan areas to avoid interference with terrestrial microwave networks operating on the same 4- and 6-gigahertz bands. Higher-power satellite transmitters operating at higher frequencies will avoid terrestrial congestion and make it possible to use much smaller antennas right on the customer's property, even on urban rooftops.

This year's blessing by the Federal Communications Commission of what's called a standard B earth station lets users participate in Intelsat, the biggest international satellite network, with a 10-meter antenna with band-



1. First of a kind. Bell Northern Research has developed an all-electronic telephone using LSI circuitry to replace the electromechanical parts of conventional telephones. One result is that future phones could take many shapes, as the model shown suggests.

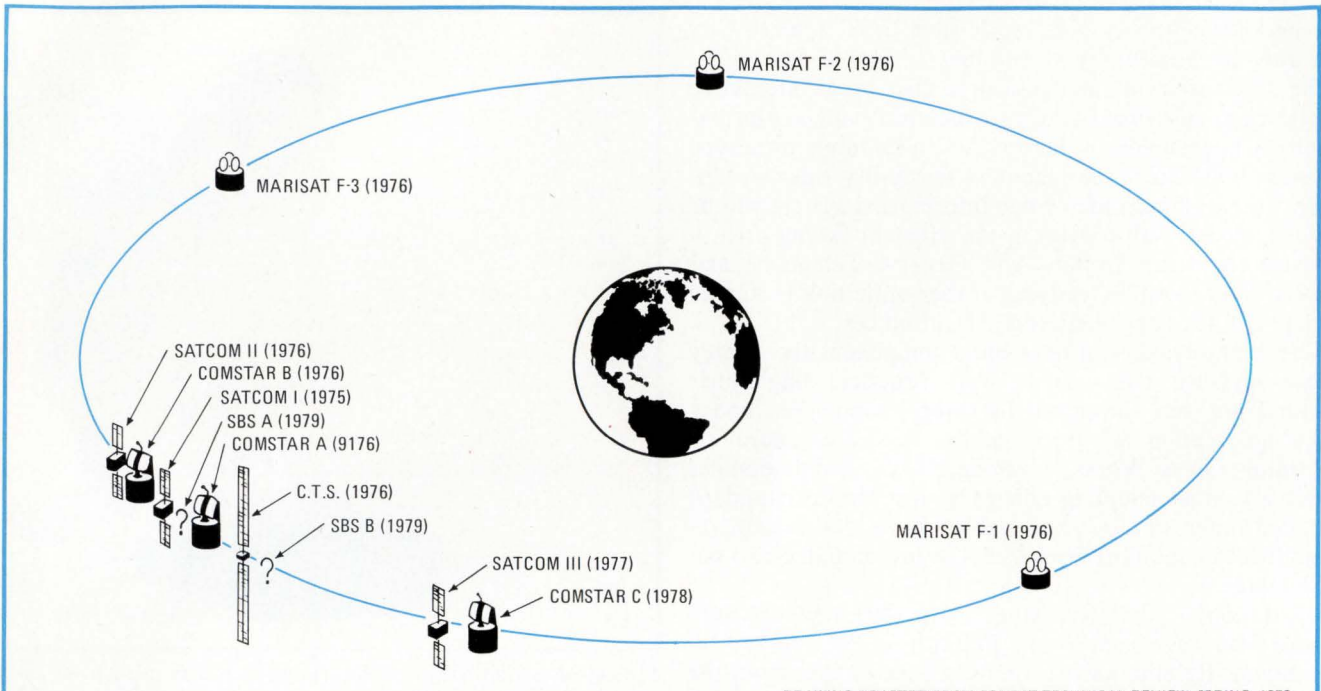
width-efficient single-channel-per-carrier techniques. No longer is a 30-meter antenna on a \$6 million earth station needed.

Modulation schemes for satellite networks, such as single-channel-per-carrier and time-division-multiple-access, can efficiently accommodate single-voice channels or receive-only terminals and handle the complex and varied demands of a network of users. Originally, Intelsat network stations used wideband frequency modulation with frequency-division multiplexing, but with this technique only one station could gain access to a satellite transponder at any given time.

Single-channel-per-carrier systems have been a boon for small earth-terminal users. Such systems offer low startup costs and allow for the later addition of extra channels. They are especially advantageous in low-demand situations if combined with demand-assignment multiple access, which allows each earth station use of a channel only as required, under control of a master ground station.

Satellite departures

This year saw the launch of several domestic satellites (Fig. 2), such as Satcom I and II from RCA Corp. With the FCC's permission, American Telephone & Telegraph Inc. and GTE have combined their planned domestic communications satellites into a single system. Two Comstars were launched this year with a third planned for launch in 1978. Initially they will operate in the 4- and 6-GHz bands, using 24 transponders to handle 28,800 simultaneous telephone conversations. The total system will provide enough video and data distribution



DRAWING ADAPTED FROM COMSAT TECHNICAL REVIEW, SPRING, 1976

Satellite	Launch date	Application	Operator
Satcom I	Dec. 12, 1975	Commercial communications for Alaska, Hawaii and contiguous 48 states	RCA
C.T.S.	Jan. 17, 1976	Broadcast satellite experiments — shared by Canada and U.S.	Canadian government
Marisat F-1	Feb. 19, 1976	Ship to shore (Atlantic)	Comsat General
Satcom II	Mar. 26, 1976	Second RCA satellite	RCA
Comstar A	May 13, 1976	First AT&T and GTE satellite to serve Alaska, Hawaii, Puerto Rico and contiguous 48 states	Comsat General
Marisat F-3	June 9, 1976	Ship to shore (Pacific)	Comsat General
Comstar B	July 22, 1976	Second AT&T and GTE satellite	Comsat General
Marisat F-2	Oct. 14, 1976	Ship to shore (Indian Ocean)	Comsat General

2. Heavy traffic. Satellites placed in a geosynchronous orbit, a circular path around the earth some 22,300 miles high, appear stationary with respect to a point on earth. Shown are several such communications satellites launched recently to serve the Americas.

and telephone service for Alaska, Hawaii, and the other 48 states. Later, higher-frequency bands are certain to be used to provide additional capacity and to avoid the congestion on the lower bands.

Rivaling the size of the new Comstar system is a satellite system planned by Satellite Business Systems, a combined venture of International Business Machine Corp., Aetna Life and Casualty Co., and Comsat General Corp. Since it will operate in the 12- and 14-GHz bands, its terminals can be in metropolitan areas without interfering with terrestrial microwave systems.

The system will use two satellites and will include dedicated full-period and on-demand capacity, along with time-division-multiple-access techniques. It will feature all-digital techniques for the transmission of voice, facsimile, and data and will provide point-to-point and multipoint service directly to the user in a switched,

private-line network, thus bypassing common-carrier land lines completely.

The next decade will witness continuing growth of domestic satellite systems to handle the expected increases in telephony, data, and television transmission. And an aeronautical satellite service will join the maritime service just launched. Satellite systems in the development and planning stages worldwide will continue to use the congested 4- and 6-GHz bands, but eventually will come to use higher frequencies, even well above today's 12- and 14-GHz limit.

What may well be the harbinger of a new breed of high-power, high-frequency satellites was launched last January. A U.S.-Canadian effort, the communications technology satellite will test technology, applications, and the social impact of satellites offering expanded services through smaller, cheaper earth stations. Many observers look upon the project as the forerunner of the direct-broadcasting satellite.

With an output of 200 watts—10 to 20 times higher than any of today's communications satellites—CTS will provide data on propagation in space and prove out the feasibility of using TDMA synchronization schemes in transmitting high-speed data via satellites. Also, it will determine if frequency-division-multiple-access techniques can adequately provide telephone channel-sharing for remote locations.

Also to be evaluated is reception of high-powered 12-GHz TV signals from satellite to 2-m antennas in metropolitan areas and the practicality of TV reception with a

Save power. Save money.

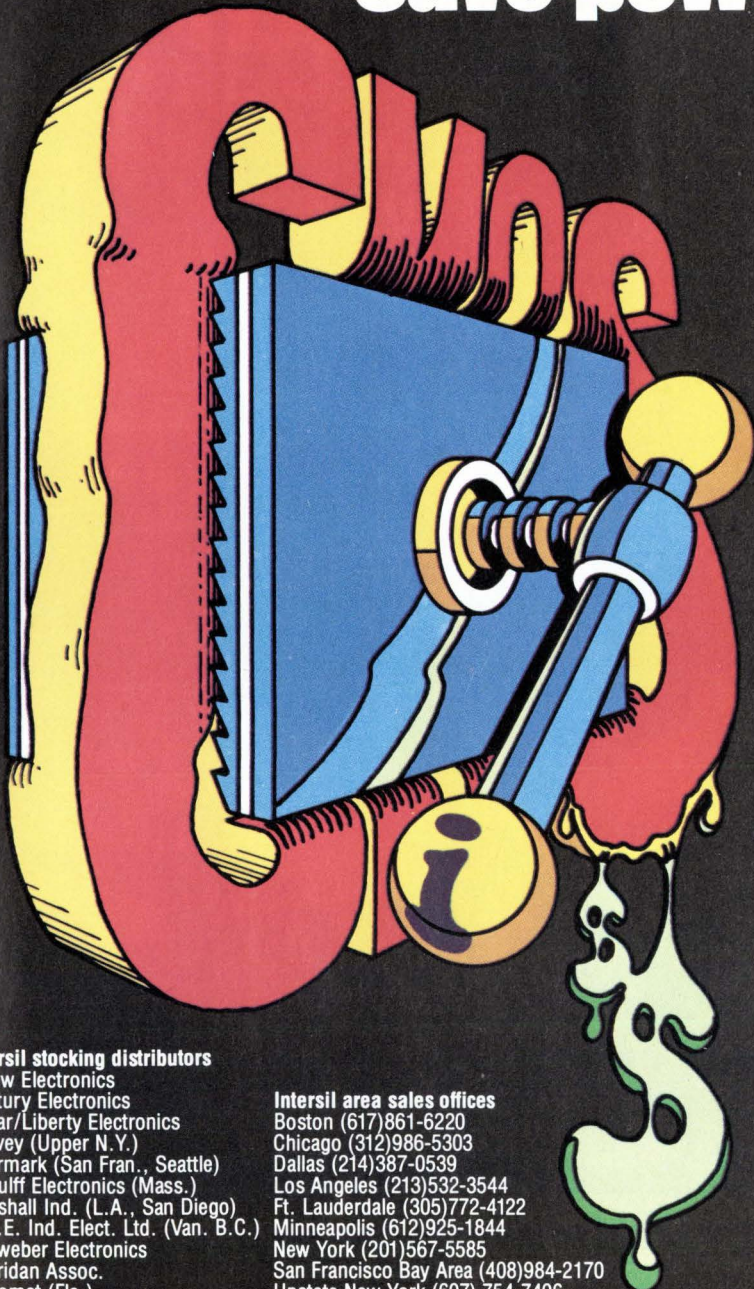
Our CMOS is not costly.

For instance here's a
1K CMOS RAM for only \$5.

Intersil's putting a lot of pressure on the myth that CMOS is always expensive. The IM6508C is a 1024 x 1 CMOS static RAM, for example, with all the benefits you want from CMOS: micro-power, simple supplies, great noise immunity and reliability... but you can buy it now in 16 pin plastic DIPs for only \$5.00 in 100+ quantities.

Now check the low cost Intersil CMOS line.

We're in volume production with an entire family of CMOS microcomputing devices which work together to simplify your design problems while giving you real system advantages. Intersil, 10900 North Tantau Ave., Cupertino, CA 95014.



Intersil stocking distributors

Arrow Electronics
Century Electronics
Elmar/Liberty Electronics
Harvey (Upper N.Y.)
Intermark (San Fran., Seattle)
Kierulff Electronics (Mass.)
Marshall Ind. (L.A., San Diego)
R.A.E. Ind. Elect. Ltd. (Van. B.C.)
Schweber Electronics
Sheridan Assoc.
Diplomat (Fla.)
Weatherford
Zentronics (Canada)

Intersil area sales offices

Boston (617)861-6220
Chicago (312)986-5303
Dallas (214)387-0539
Los Angeles (213)532-3544
Ft. Lauderdale (305)772-4122
Minneapolis (612)925-1844
New York (201)567-5585
San Francisco Bay Area (408)984-2170
Upstate New York (607) 754-7406
Canada (416)842-0411

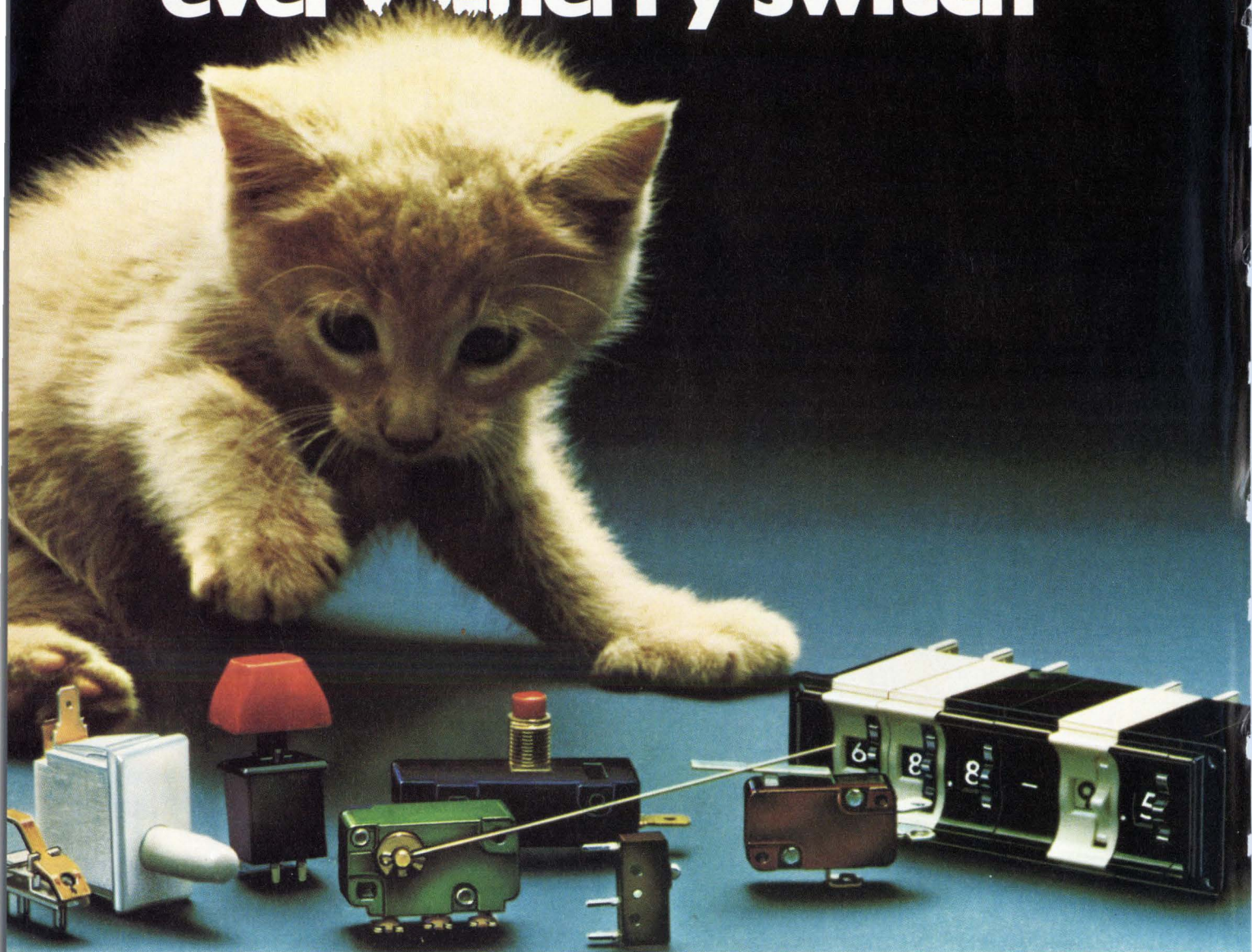
Representatives in all major cities.

Part	Description	100+
IM6100	CMOS 12 bit μ P	\$25.20
IM6101	CMOS Parallel I/O	8.65
IM6312	CMOS 1024 x 12 ROM	27.90
IM6402	CMOS UART	4.00
IM6508	CMOS 1024 x 1 RAM	5.00
IM6561	CMOS 256 x 4 RAM	5.00

Intersil



There's a little tiger in every Cherry switch



...but we're pussycats to do business with

Our products are tough, but our people aren't... and that's the beauty of dealing with Cherry.

You see, we can control the quality of our switches because we fabricate most of our own parts (moldings, stampings, springs, printed circuits, etc.) And we can keep the price down because we're loaded with automatic equipment to handle high volume.

But the real difference is in the *people* you work with at Cherry...from your first contact with a technically trained sales representative...through careful analysis and recommendations by engineers

who are really concerned about *your* problem... to production scheduling and customer service men who follow-up and expedite to make sure we keep our delivery promise to you.

Of course we're proud of our modern facilities and equipment...but what we're proudest of is our reputation for customer service. Try some.



Test a free sample "tiger" from the pussycats at Cherry.

Ask for our latest catalog which contains complete information on all our switches and keyboards, and we'll include a free sample switch. Just TWX 910-235-1572...or PHONE 312-689-7700...

or circle the reader service number below.

CHERRY

CHERRY ELECTRICAL PRODUCTS CORP. • 3608 Sunset Avenue, Waukegan, Illinois 60085
SWITCHES • KEYBOARDS • DISPLAYS—Available locally from authorized distributors.

dish antenna as small as 30 inches in diameter. The results could have a tremendous impact on planning of future TV-distribution systems and worldwide satellite communications systems.

CB adopts phase-locked loop

Makers of citizens' band equipment, busily trying to keep up with the exploding demand, are turning to phase-locked-loop technology, long a staple in more sophisticated frequency-control equipment. Its principal attraction is that it reduces the number of crystals needed to accurately generate the assigned frequencies. The January 1977 increase in channel allocation from 23 to 40 makes PPL frequency synthesizers even more attractive for CB radios.

But along with the FCC's granting of additional channels come more stringent restrictions on close-in spurious radiation from both transmitter and receiver sections of the CB sets.

New answers for phones

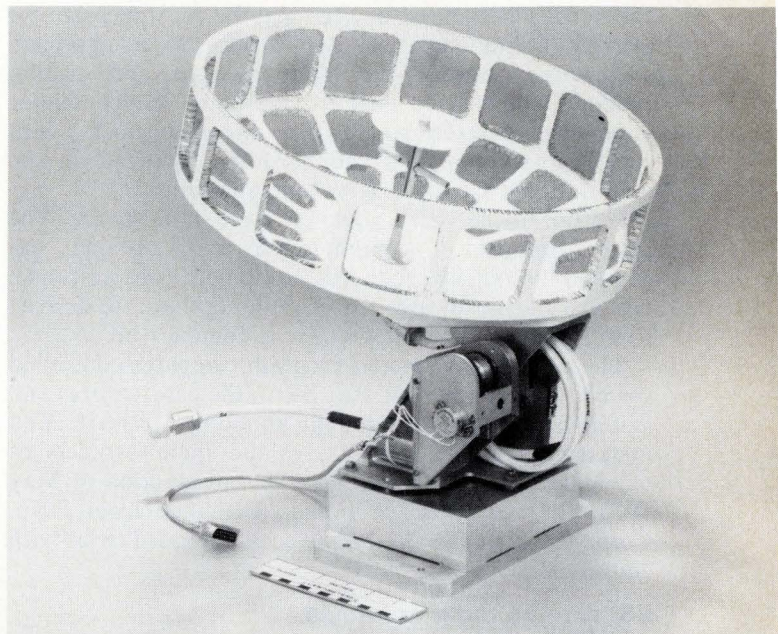
Advances in technology will help both operating telephone companies and outside firms to bring innovations in integrated circuits into the total network and into the telephone itself. The one part of the telephone system that really hasn't changed in over a hundred years, the telephone itself, is even getting a new look.

Bell Northern Research, the research arm of Bell Canada, has developed an exploratory all-electronic telephone (Fig. 1). Two hundred of them are undergoing user trials in the Canadian telephone system. The heart of the new equipment is an IC package that replaces the ringer, transformer-coupled speech network, and dial-pad assembly. It's built with bipolar integrated-injection logic technology that enables the stringent telephone-system specifications to be met with ICs for the first time.

These telephones are extremely cost-effective, according to BNR, since the highly labor-intensive electromechanical components are replaced with LSI circuitry that keeps dropping in price. The resulting reduction in component size also makes new receiver shapes possible. If field trials uncover no problem areas, these telephones will be used exclusively in the future.

Solid response

The FCC decisions to allow nontelephone equipment from outside companies to be connected to the telephone system have evoked a response from many semiconductor companies. Various products already or soon to be available use double-diffused-metal-oxide-semiconductor, complementary-MOS, I²L, and standard bipolar technologies. Devices under development include cross-point switches, PCM coder/decoders, tone encoders with a variety of output codes and control functions, dial pulsers, repertory dialers, electronic ringers with added features, companders, and filters. Some companies are even considering developing \$20-to-\$30 all-electronic telephones with memory for repertory dialing and last-



3. Radar mapper. The antenna assembly being built for NASA Ames Research Center by Hughes Aircraft Co. will be part of the Venus-Pioneer radar mapper. Based on a high-efficiency configuration called the short-backfire reflector antenna, it uses a parabolic dish.

number-dialed options, as well as controlled tone ringing and display of number dialed.

Digital technology and the telephone

The digital telephone interests semiconductor manufacturers because of the potential high-volume market. But it is still too early to decide which is the best technology—I²L or standard bipolar, n-channel MOS or C-MOS, one chip or two.

Companies are investing in various technologies to develop a coder/decoder that's cheap enough to install on each telephone line (about \$10). Precision Monolithics Inc., Santa Clara, Calif., and Exar Integrated Systems Inc., Sunnyvale, Calif., are two companies that have already announced the availability of a companded digital-to-analog converter, the most difficult component in the codec. National Semiconductor Corp. is working on a bipolar C-MOS codec for the telephone handset—the last component needed for a completely digital system. Signetics is using I²L technology because it lends itself to combining analog and digital circuitry on one chip, and American Microsystems Inc. is working on an MOS codec, using a charge-redistribution approach. A single chip, all-digital codec from Intel Corp., Santa Clara, Calif., will use n-channel MOS technology.

For home telephones, there's much interest in using tone-key signaling to control functions remote from the telephone and to transmit and receive data after the call is completed. A tone encoder with controller equipment could control devices in the home, using a phone call to turn on the lights, for example.

General-purpose microprocessor architecture with all

the needed peripheral devices may be too expensive for many telecommunications applications, so an approach somewhere between the microprocessor and custom random logic may be what evolves. Some semiconductor companies foresee single-chip microprocessors with special instruction sets and hardware included on the chip to tailor it to such telephone applications.

Not all of the year's advances were in hardware. The major promise of computerized private-branch exchanges is vastly reduced equipment obsolescence, because additional user features and options are derived from software. And the promise is coming true.

The power of the stored-program computer-controlled switches introduced last year lies in the new features and system improvements brought about by software. Bell updated its Dimension PBX, as did manufacturers of other PBXs. For example, since its introduction in May 1975, the computerized branch exchange from Rolm Corp., Cupertino, Calif., it has been upgraded twice with additional software.

LSI shrinks radar antennas

Thanks to high-speed digital processing and low-cost memories, synthetic-aperture radar now appears very attractive for real-time, high-resolution applications. In fact, both range and azimuth resolution under 10 feet is possible. The SARs have very small antennas, but use digital processing to synthesize the performance of a very large one. The antenna and scan mechanism for the Pioneer-Venus radar mapper is shown in Fig. 3.

What was needed was upwards of 100 megabits of memory, high-speed arithmetic (up to 100 million multiplications per second), and high-speed analog-to-digital converters to handle at least as many samples per second. With low-cost mass memories, fast Fourier transform circuits, a-d converters, low-cost high-resolution radar is being considered for commercial aeronautical use, as well as in such areas as satellite mapping, crash location, and flood control.

As with telecommunications, microprocessor architecture isn't optimum for SAR. But the devices are finding their way into other communications equipment. For instance, they are taking over chores originally relegated to minicomputers in some navigational receivers. Substituting microprocessor technology along with several radio-frequency redesigns, Navigation Communication Systems, Inc. of Chatsworth, Calif. has sliced the cost of satellite navigational-receiver systems almost in half. An Intel SBC 80/10 microprocessor provides a fixed resident program to eliminate a big user problem: loading the program into core-type minicomputers.

And GTE Sylvania Inc. has developed a microwave receiving system controlled by a 8080A processor. Intended for reconnaissance, it operates in the 0.5-40-GHz region. The software provides flexibility for control, display, and switching functions. And, with microprocessor capability, the system can test itself and can select an optimum intermediate-frequency filter and scan rate when in automatic scan mode. □

Profile

Although the concept of communicating over light has been around for many years, what really made it practical was a low-loss glass fiber developed at Corning Glass Works in 1970. The scientists responsible for reducing fiber loss from more than 1,000 decibels per kilometer to 16 dB/km, agree that the key to that breakthrough was developing a pure enough glass composition that could be processed into hair-thin fibers.

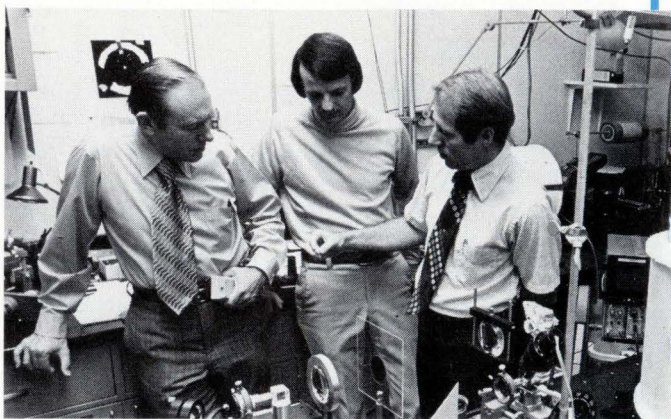
Providing the pure glass was only half of that battle, for it had to be fabricated so as to maintain the low-loss characteristics. Previously the thrust was to purify the more conventional glass ingredients before melting them. But the problem really boiled down to one of glass chemistry and unconventional processing techniques.

Peter C. Schultz (center), the chemist on the Corning team that developed the fiber, remembers being just a bit surprised that it had come so far in only a few years. "Until that time no one even knew if low-loss glass could be made," reflects the 33-year-old researcher. "It was a combination of chemical-vapor-deposition techniques and processing the high-purity glass compositions that made low-loss fibers a reality."

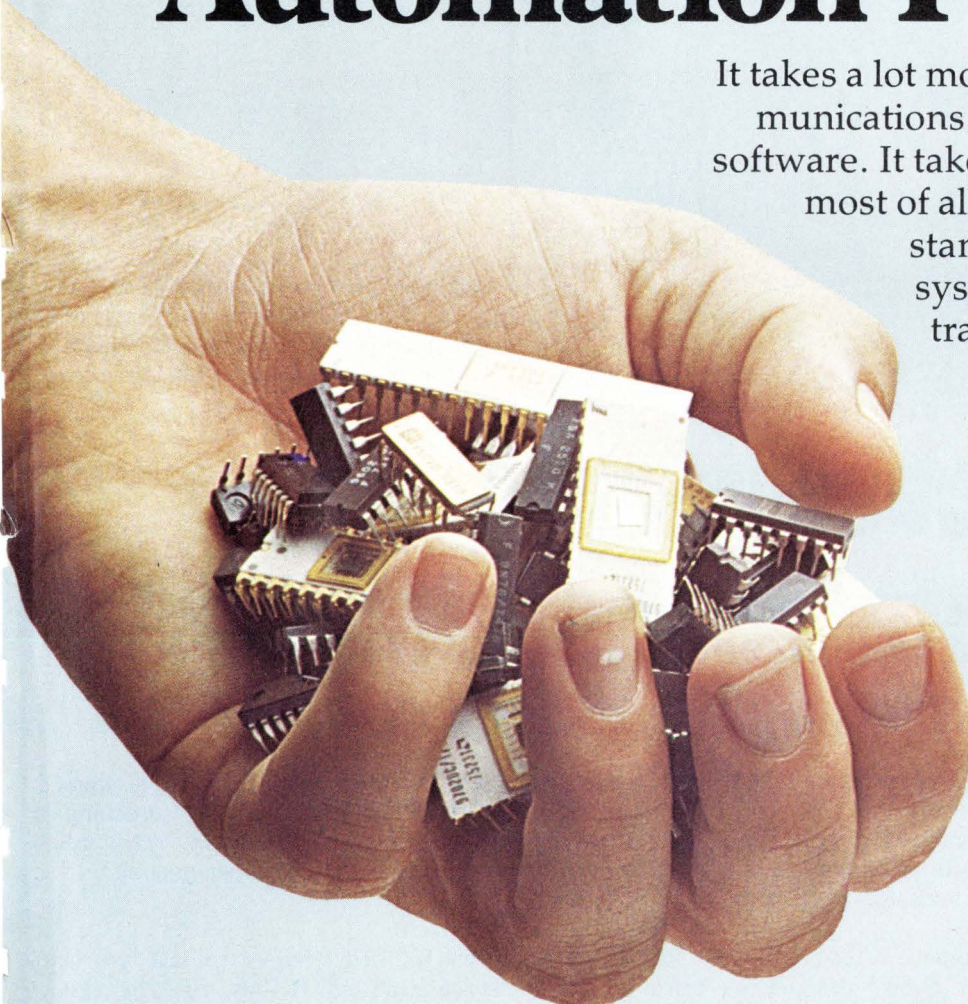
Donald Keck, a 35-year-old research physicist (right), viewed the breakthrough with guarded optimism. "When it happened, I carefully rechecked the measurements before I could believe that we really had produced a fiber with only 16-dB/km loss." Robert D. Maurer, the leader of the project, was elated at the breakthrough, but what he remembers best is the reaction to the paper that announced the existence of the fiber. "I was amazed at the quickness with which the audience grasped the potential of the fibers we had just developed," the 52-year-old Corning veteran recollects.

All three are still very much involved in the firm's continuing commitment to fiber-optics technology. Maurer is now manager of applied-physics research, Keck is a senior research scientist, and Schultz is manager of glass synthesis research.

The researchers predict a bright future for fiber-optic technology. "Optical fibers will find use in communications links that now use coaxial cable or copper wires," Maurer says, "areas such as computer and instrumentation links, CATV or 'wired-city' networks, and applications in power utilities and electric railways, as well as various government and military areas."



It Takes More Than A Handful of Chips To Solve An Industrial Automation Problem



It takes a lot more. It takes I/O. It takes communications. It takes peripherals. It takes software. It takes service and support. And, most of all, it takes people who understand the needs of the industrial system builder. People who can translate those needs into cost-effective solutions.

That's what PCS is all about. And that's why we make more industrial microcomputers than anyone else. Find out how we can help you solve your industrial automation problem. Send for a free brochure that describes the PCS Hard Hat line of industrial microcomputer products and services.

Please send me more information about PCS single-board microcomputers PCS packaged systems PCS customer support capabilities.

Please have a salesman call.

Name _____ Title _____

Company _____

Street _____

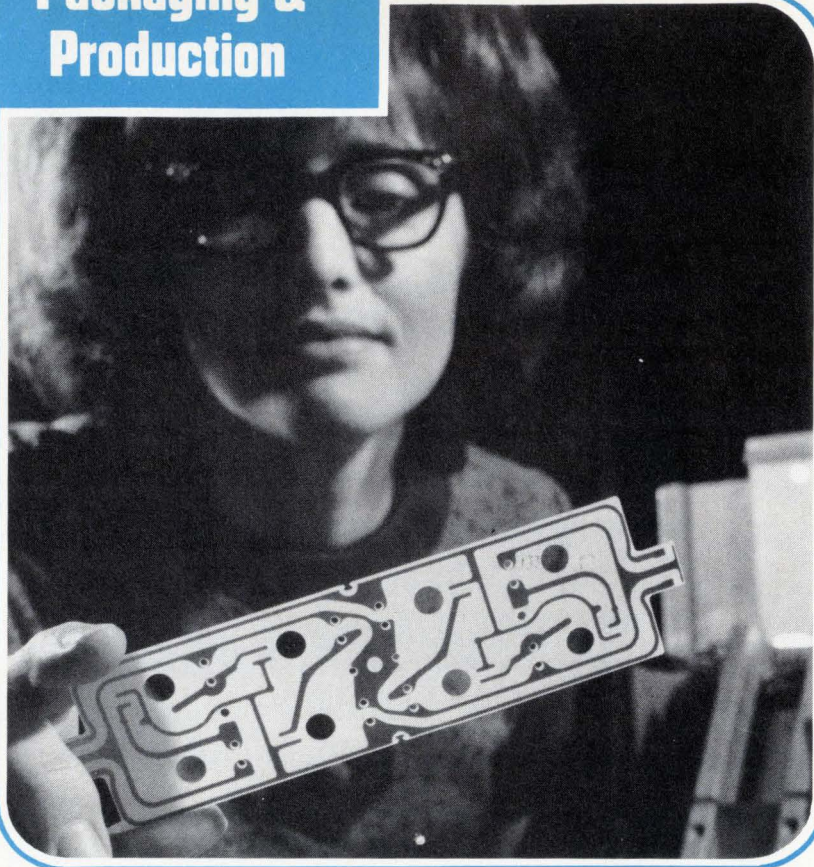
City _____ State _____

Telephone _____ Zip _____

pcs

Process Computer Systems
5467 Hill 23 Drive, Flint, Michigan 48507
313-767-8920 TWX 810-235-8667

Circle 115 on reader service card



Screened pc. A low-cost porcelainized steel circuit board developed at General Electric uses a screenable, low-temperature-fired, polymer-based silver ink for the conductive patterns of a flashbulb array.

Process adaptation shrinks interconnection costs

by Jerry Lyman, *Packaging & Production Editor*

□ In the never-ending battle for lower packaging and production costs, several skirmishes were won this year. Cheaper methods of building printed-circuit boards arrived, lower-cost (and better-performing) hybrid techniques were adopted, and new methods for packaging large-scale integration are appearing.

■ The year's most important development is the adaptation of thick-film inks intended for hybrid designs to printed-circuit boards.

■ A low-cost screenable copper-ink system emerged that is applicable to thick-film hybrids in every kind of circuit, from low-frequency to microwave.

■ A gradual adaptation of film-carrier technology to hybrids is appearing.

■ Also significant is the introduction of a tiny discrete-device package, several new LSI carriers, and two automatic-wiring methods.

Manufacturers of pc boards have long wished they could adapt the simple screen-and-fire process of thick-film hybrids, because labor, material, and machinery

costs are low compared to additive or subtractive plating. However, the 800–1,000°C firing of the screening process is well above the temperature limits of standard pc substrates such as epoxy glass and paper phenolic.

The silver screen

The wish has been fulfilled, thanks to last year's introduction of screenable inks that fire in the 65–150°C range. Methode Development Co., Chicago, is using them to produce on-board silver conductors, carbon resistors, and dielectrics. These inks, also available from Electro Science Laboratories, Pennsauken, N.J., and Electro-Materials Corp. of America, Mamaroneck, N.Y., can be screened onto a wide range of materials, from thermosetting plastics to conventional pc substrates. They are being used on pc boards for TVs, security systems, smoke detectors, and test equipment.

Most of the conductors are composed of polymer-based binders and silver. Resistor materials are based on carbon plus polymer binders and are available with

resistivity values between 10 ohms per square and 1 megohm per square.

While the resistors may be screened onto copper-plated pc boards, the real cost savings comes from screening both conductors and resistors onto bare substrates. "Resistor screening gives a pc manufacturer the equivalent of automatic resistor insertion without investing in expensive equipment," says Wayne Martin, Methode's chief engineer. "The resistors are simply designed into the pc pattern."

Aside from saving the cost of inserting discrete resistors or potentiometers, the cost of components is drastically cut. Martin cites the case of a customer who had 32 discrete potentiometers on a pc board. Each component cost 17 cents. Screened-on elements cost only 1-2 cents.

Another tack has been taken by General Electric Co. and GTE-Sylvania, who last year began producing screened-on pc boards for flash-bulb arrays. The boards, composed only of conductors, use a porcelainized steel substrate, which has an inherently high temperature limit, and a special resin-based silver conductor ink. Production time for GE's boards from screen printing through curing is only a few minutes, compared to up to 60 minutes for plated boards.

A related development is the introduction of polymer-based conductive inks by Electro-Materials Corp. and Engelhard Industries, East Newark, N.J. The inks can be fired onto porcelainized steel in the 550-650°C range. Since they are available commercially, they open up the possibility of using the coated steel for other electronics applications, such as less expensive hybrids.

Copper inks cut hybrid costs

This year's big story in hybrid thick-film technology is also an ink development. Cheap, screenable nitrogen-fired copper conductive inks have surfaced along with nitrogen-fired dielectrics and resistive inks. Practically all the air-fired conductive inks for thick films are precious metals—gold, palladium, silver, platinum, or compounds of them. They have two disadvantages: they are expensive, and they aren't easily soldered.

The new copper inks are relatively inexpensive compared to those based on precious metals. They are excellent conductors and can be soldered and wire-bonded. What's more, they have good adhesion, good solder-leach resistance, and excellent low-frequency and microwave properties.

Almost all the major hybrid-ink companies are supplying nitrogen-fired copper inks and dielectrics. While most of them have nitrogen-fired resistor materials in the laboratory, only Cermalloy, a division of Bala Electronics Corp., West Conshohocken, Pa., supplies a resistance ink compatible with the copper ink. The firm's NPS 7000 inks have a resistivity range from 100 to 100,000 ohms per square and a temperature coefficient of ±500 parts per million.

Copper inks are already in use as conductors in multilayer hybrids, microstrip conductors, high-power

diode conductors on alumina and beryllia substrates, and as a termination material for certain types of capacitors. All major hybrid companies are evaluating them. For example, a comparative cost study by CII-Honeywell Bull in France of copper and gold multilayer substrates shows that the copper lowers substrate cost from \$1.80 to 16 cents (Table I). The comparison is between 2-by-1-inch substrates with two conductor layers separated by a double-printed dielectric.

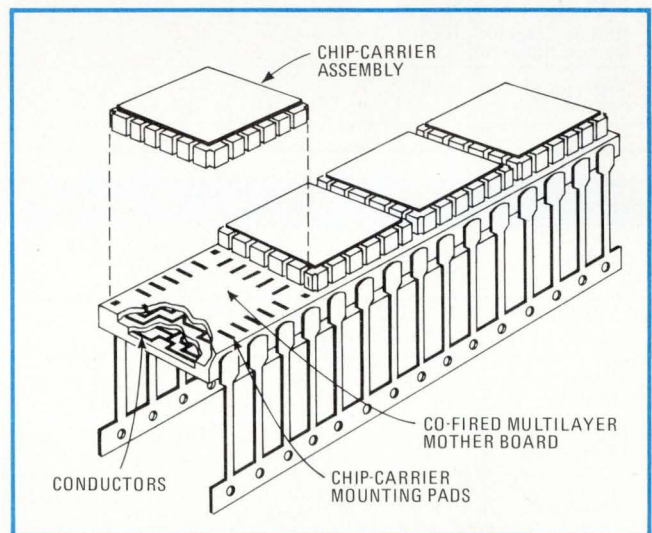
Another field where copper inks are finding immediate use is microstrip circuit applications at microwave frequencies. They require a full ground plane on one side and well-defined conductor patterns on the circuit side, so the ink must be capable of printing large areas and fine lines, as well as providing low direct-current resistance and low radio-frequency loss. Copper inks easily meet all these requirements, in contrast to the costly thick-film gold that requires expensive indium-bearing solders for chip bonding. These circuits can also be made by thin-film processes, but only with a large investment in sputtering or evaporation equipment.

Film carriers fit hybrid needs

Another hybrid development, as important as the new inks, is the adoption of film carriers for chip mounting. It is a solution to the yield problems for hybrid packages caused by the loss of chips during optical inspection, probe testing, and handling.

The film-carrier system uses a sprocketed, nonconductive film with a copper surface etched into the integrated-circuit interconnections. Specially bumped chips are automatically gang-bonded to the inner leads of the interconnections. (The bumps are raised, metalized interconnect pads.) The completed film can easily be moved for on-tape testing or outer-lead bonding.

Two factors have kept hybrid makers away from film-



1. Chip carrier / mother board. By combining four square, leadless ceramic chip carriers with a co-fired ceramic multilayered substrate, it is possible to put four LSI chips in the pc-board space that one chip in a standard dual in-line package would take.

carrier techniques. The major IC firms weren't willing to sell chips on tape; instead they were putting most of their output into dual in-line packages. And the hybrid manufacturer who decided to do their film-carrier work in house ran up against the lack of suppliers of either the bumped chips or of low-cost tape-bonding equipment.

Recently matters began to look up. Pactel Corp., Westlake Village, Calif., came out with a tape that has the copper interconnect pattern on one side connected through the tape to bumps on the other side. This should eliminate the need for specially bumped chips.

This year also brought some good news for those firms unwilling to go the in-house route. Motorola Semiconductor Products Group, Phoenix, Ariz., is prepared to supply standard chips (mostly digital logic) on all-copper-tape carriers.

Semiconductor packages shrink

"Think small" was the watchword for semiconductor packaging in 1976. Discrete components became available in a tiny reflow-solderable plastic package, and smaller alternatives to the DIP started appearing. In addition, some firms are beginning to use multilayer hybrid techniques to jam even more chips onto the LSI carriers usually occupied by standard DIPs.

This year saw the U.S. introduction of the 3-by-3-by-0.85-millimeter SOT-23 plastic packages for transistors,

diodes, optical couplers, and field-effect transistors and also of a companion unit, the 4.6-by-2.6-by-1.6-mm SOT-89 for 1-ampere switching transistors. These small semiconductors, made in Japan and Europe, can take rough handling and are suited to automatic insertion.

Consumer and industrial users of thick-film hybrids are the chief beneficiaries, because these packages are amenable to low-cost reflow soldering. For instance, SOT-23 transistors are being applied as display drivers for light-emitting diodes in digital wrist watches. Next, linear ICs will be put into this small package.

Saving precious pc-board space is the impetus behind the trend toward square LSI packages. One of the newest is the MiniPak from General Instruments Corp.'s Semiconductor Products division in Hicksville, N.Y. This glass-epoxy carrier is about 1/2 in. on a side, a third the size of a DIP. On this carrier, an LSI chip is wire-bonded to plated conductors linked to an array of solder bumps on the underside of the package.

After the chip is covered with a protective drop of epoxy, the solder bumps are reflowed to a pc board or substrate. At present the package is only being used for the firm's 28-pin ICs, but there are plans for adapting it to all of its custom and standard ICs.

Another new approach to maximum LSI packaging density is the chip-carrier/motherboard design from Minnesota Mining and Manufacturing Co. (Fig. 1). In this technique, a rectangular, multilayered, cofired ceramic substrate with a lead frame attached acts as the motherboard for four LSI chips sealed in small, square ceramic chip carriers. The carriers are reflow-soldered to mounting pads on the motherboard and are easily removed for repairs. The entire assembly occupies the space of a standard DIP carrying one of the LSI chips.

As well as easing removal, the carriers facilitate chip pretesting. The motherboard substrate offers extremely short lead lengths that allow full-rated IC switching speeds. Since most interconnection is on the motherboard, the system pc can be a simple double-sided type, rather than a multilayer type.

The Wire-Wrap process has dominated the automatic-wiring field because of its readily available machines and

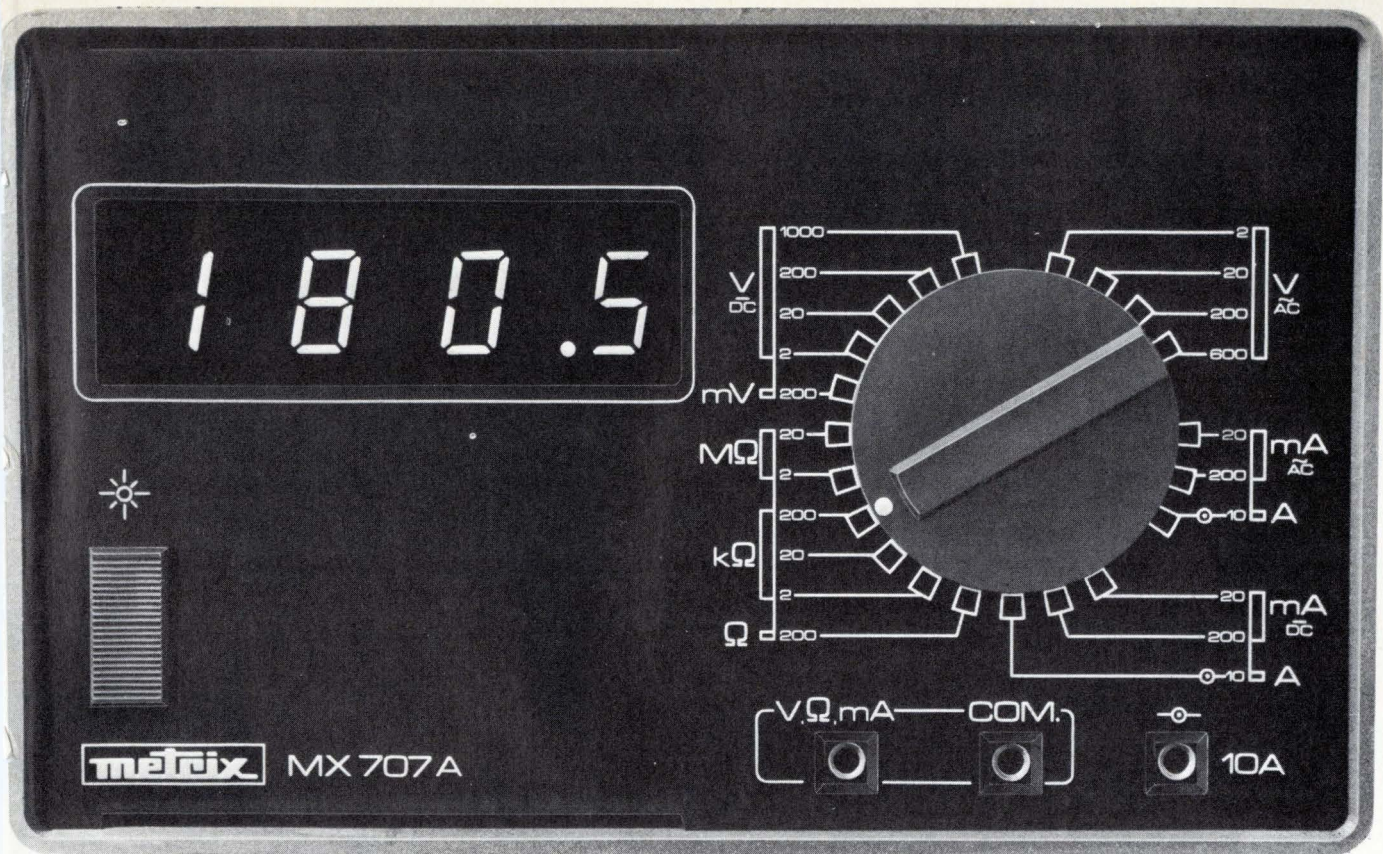
TABLE 1: PASTE COST OF GOLD AND COPPER HYBRID-SYSTEMS

	Gold system		Copper system	
	Conductor layer	Dielectric layers	Conductor layer	Dielectric layers
Quantity of paste (mg)	258	170	134	170
Paste price* (\$/g)	6.70	0.43	0.45	0.43
Cost of used paste (\$)	1.73	0.073	0.060	0.073
Nitrogen: cost of separate firings (\$)			0.018	0.01
Total cost of substrate (\$)	1.80		0.16	

*June 1975

TABLE 2: COMPARISON OF INTERCONNECT PROCESSES

Process	Requires artwork	Engineer design	Engineer changes	Density (surface/cubic)	Production cost	Field-changeable	Prototype process	Schottky logic
Two-sided boards	yes	long (6 - 10 wk)	artwork changes	low / high	low	poor	very poor	poor
Multi-layer boards	yes	long (10 - 12 wk)	artwork changes	high / high	high	very poor	very poor	good
Wire-wrap	no	short (2 - 4 wk)	no artwork	high / low	high	good	good	fair
Stitch-weld	no	short (2 - 4 wk)	no artwork	high / fair	medium to high	fair	good	fair
Single-sided solder-wrap	no	short (2 - 4 wk)	no artwork	high / high	low	good	good	fair
Two-sided solder-wrap	no	short (2 - 4 wk)	no artwork	high / high	low to medium	good	good	good



No strain on your eyes with the new MX 707A Multimeter ... even less strain on your budget

First look at that 3½ digit, daylight bright 16 mm read out. Then look at the simplicity of operation from one dial selector. Then realise that it's a complete, five-function, line-operated digital multimeter with a 2000 count and a 10A input that will measure on 20A for 30 seconds.

Now, add the fact that you can count on worst-case accuracies of 0.5% for dc voltage and 1.0% for dc current. And that you get full overload protection on all modes. Then, look at our mini-spec and calculate what you expect to pay (or have been paying) for the equivalent.

We can surprise you by coming in at around the \$200 mark. Circle the page number below on the reader service card at the rear of the journal. We'll come back to you with an illustrated data sheet and a firm price indication that will make your budget look bigger overnight.

Five functions

V _{DC}	± 100 μV to ± 1,000 V 10 MΩ
V _{AC}	5 mV to 600 V 40 Hz - 25 kHz 1 MΩ // 100 pF
I _{DC}	± 10 μA to ± 10 A
I _{AC}	10 μA to 10 A 50 - 400 Hz
Ω	100 mΩ to 20 MΩ

Protection

1,000 V p. to p. on all V ranges
220 V rms on all Ω ranges
0.3 A on all mA ranges
20 A can be measured during 30 s on the 10 A input.

Dimensions

W 210 mm. H 130 mm. D 75 mm.

METRIX
Division Instrumentation de la SPI-ITT
Chemin de la Croix-Rouge - B.P. 30 -
74010 Annecy, France
Tel. (50) 52.81.02 - Telex: 300 722
Sales and service in 90 countries

metrix

Instruments and Components

ITT

Way out in front!

A great new line of RF-heating triodes from THOMSON-CSF:

- Output power from 100 to 800 kW.
 - Superior PYROBLOC[®] grids and HYPERVAPOTRON[®] anode cooling - the latest word in power-grid tube technology. Specially designed for industrial thermal treatment and built using rugged metal/ceramic technology.
- Get the latest advance in the power-grid tube state of the art from the RF-heating leader: THOMSON-CSF!
Contact us today.



THOMSON-CSF

THOMSON-CSF ELECTRON TUBES / 750 BLOOMFIELD AVENUE / CLIFTON NJ 07015 / TEL. : (201) 779 1004 / TWX : 710 989.7149

France - THOMSON-CSF Division Tubes Electroniques / 38, rue Vauthier / 92100 BOULOGNE-BILLANCOURT / Tél. : (1) 604 81.75

Germany - THOMSON-CSF Elektronenröhren GmbH / Leerbachstr. 58 / 6000 FRANKFURT am MAIN 1 / Tel. : (0611) 71.72.81

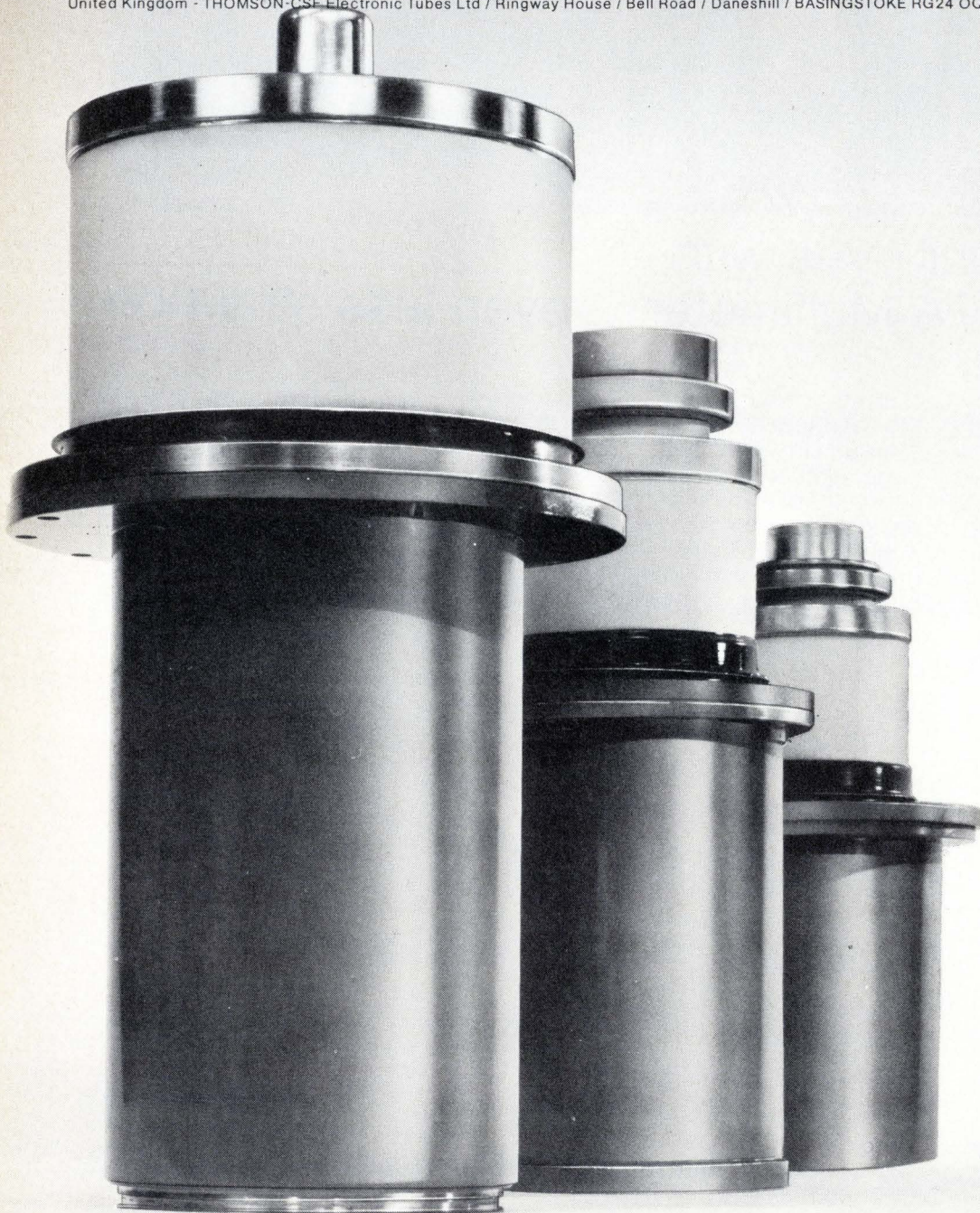
Italy - THOMSON-CSF Tubi Elettronici SRL / Viale degli Ammiragli 71 / I - 00136 ROMA / Tel. : (6) 638 14.58

Japan - THOMSON-CSF Japan K.K. / TBR Building / Kojimachi 5-7 / Chiyoda-Ku / TOKYO / 〒 102 / Tel. : (03) 264 6341

Spain - THOMSON-CSF Tubos Electronicos S.A. / Alcalá 87 / 7^o Dcha / MADRID 9 / Tel. : (1) 226 76.09

Sweden - THOMSON-CSF Elektronrör AB / Box 27080 / S 10251 STOCKHOLM 27 / Tel. : (08) 22 58 15

United Kingdom - THOMSON-CSF Electronic Tubes Ltd / Ringway House / Bell Road / Daneshill / BASINGSTOKE RG24 0QG / Tel. : (0256) 29155 / Telex : 858865



Circle 120 on reader service card

special IC socket panels with pin matrices. Now two new contenders are entering the arena: Solder-Wrap, from United Wiring and Manufacturing Co., Garland, Texas, and Bell Laboratory Inc.'s Quick Connect.

Solder-Wrap is already in use by Texas Instruments Inc. and Control Data Corp. The Bell Labs system, on the other hand, is still confined to in-house use.

Alternatives in automated wiring

The United Wiring process forms interconnects at speeds two to three times as fast as Wire Wrap—as much as 2,400 connections per hour on automatic equipment. It routes a fine insulated wire to the protruding pins of components previously inserted in a specially patterned pc board. The individual wires and component leads are soldered to the pc pads by a soldering probe, which simultaneously melts away the wire insulation at the solder area.

Solder-Wrap has completely automatic equipment with a self-checking feature that makes sure of each connection. The process will not proceed if an error in wiring has occurred. Wiring costs are said to be 20–30% lower than for competitive methods. So far Solder-Wrap has been used extensively for transistor-

transistor logic, as well as for emitter-coupled logic where it is possible to put down twisted pairs to eliminate cross-coupling and reflections. Table 2 (furnished by United Wiring and Manufacturing) compares Solder-Wrap to its major competitors in this field.

Quick Connect, the second new automatic-wiring method, was developed at Bell Labs, Holmdel, N.J., by Charles Von Roesgen, supervisor of optical systems. It began as a breadboarding technique that had insulation-piercing terminals on one side and special pins to accept IC leads on the other. Arrays of these pins were mounted on special epoxy-glass boards with plated-on ground and power planes. The boards were wired by pressing insulated wires into the terminals, making a gas-tight connection. The system's low profile (about 420 mils including DIPS) permits use of high-speed logic.

With the addition of a semi-automatic, self-checking wiring machine that accepts Wire-Wrap software, Quick Connect has become a full-fledged automatic-wiring system. Von Roesgen says it is at least twice as fast as Wire-Wrap. Hundreds of boards have been wired at three branches of Bell Labs, most of them with TTL and TTL-Schottky logic. This system is not commercially available, but the firm will probably license it. □

Profile

In late 1971, market researchers at Owens-Illinois Inc., Toledo, Ohio, decided that the rising cost of precious metals made the time right for research on non-noble conductors for thick-film microelectronics. A young chemist, John D. Grier, who had been with the firm for five years, was assigned as program manager.

Grier decided to concentrate on creating a workable nitrogen-fired copper paste. There had been earlier research on copper pastes, but these compositions used 100-micrometer copper particles to produce conductors with poor peel strength and low conductivity.

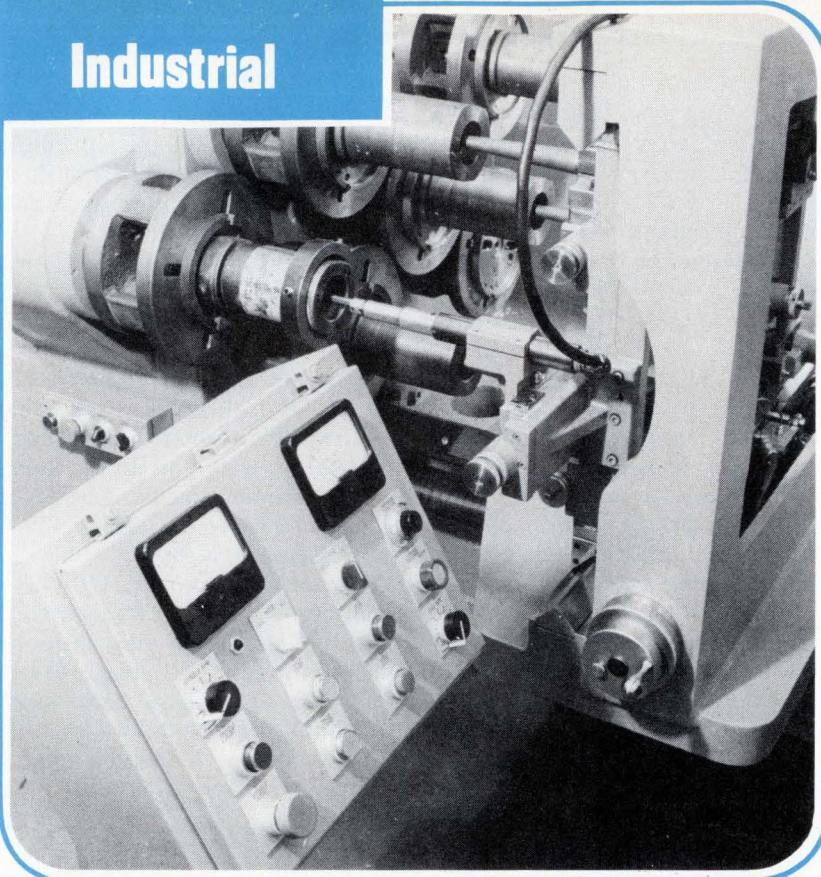
He went to 3-to-5- μ m copper particles for the functional phase of the ink and found both a glass binder and vehicle that could survive firing at about 800°C. The late 1972 result was a patented, practical, screenable copper paste that had good peel strength and conductivity. At that point Grier correctly predicted that the new copper paste would be suitable for microstrip and thick-film hybrid applications.

After leaving Owens-Illinois in January 1973 and spending a short time at Dynasil Corp. of America, he came to the Cermalloy division of Bala Electronics Corp., West Conshohocken, Pa., as director of new-product development. It was there that he continued his original work on base-metal inks and developed a full copper system of conductor, resistor, and dielectric inks. In addition, he created a low-firing-temperature (580°C) nickel ink suitable for gas displays fabricated on black alumina substrates. He has also done extensive work on other base-metal inks such as zinc and aluminum, which is radiation-resistant.

"Base-metal technology, and copper in particular, will take advantage of all the experience hybrid manufacturers

have already gained in air-fired systems to cut the time lag for the full use of these new inks," Grier says. "Large numbers of microstrip circuits using copper inks will appear this year followed in about a year by multilayered thick-film hybrids with copper conductors."





Mold maker. Six-spindle bottle-mold machine with Honeywell controls can produce five molds in approximately 6½ hours.

More tools, processes yield to microprocessor control

by Michael J. Riezenman, *New Products Editor*

- Activity has been lively in three areas:
- Microcomputer-controlled machine tools.
- Microprocessor-based process-control systems.
- The development of semiconductors for the generation of electricity, and the control of its consumption.

Microprocessors are finally getting into the mainstream of industrial new-product development. Although only a year or two ago they were regarded merely as promising devices, they are now routinely used in a variety of applications—principally in the machine shop, in process control, and in energy-management systems.

Some progress has been made in the use of photovoltaic cells to generate electricity. But the day on which they become serious competition for oil is still in the unforeseeable future.

Controlling the machine shop

Electronic control, of course, has carved out its niche in the machine shop. But this year, some changes have been made in the size of that niche, as well as in what's

filling it. As the doors closed on last month's giant International Machine Tool Show, attendees, who are accustomed to the increasing price of iron, were amazed by the falling price of silicon. More new machine tools have numerical controls instead of manual ones, more numerical-control systems include computers, and more of those computers are microcomputers rather than more expensive minicomputers.

Although two years ago only one computer numerical control was being built around a microprocessor, a half-dozen controls manufacturers are now offering CNCs built around microprocessors instead of minicomputers [*Electronics*, Sept. 16, p. 44]. General Electric Co., Waynesboro, Va., by far the largest control maker, has filled out its line with several new controls, including a low-cost family with limited capabilities that is built around Toshiba 12-bit processors and programable read-only memories. Its pioneering 1974 entry, the Mark Century 1050, used a five-chip IMP-16 from National Semiconductor Corp. and more than a score of dedicated

arithmetic processors. McDonnell Douglas Corp. hopes to become an important controls manufacturer through its Actron division in Monrovia, Calif., while Germany's Siemens AG and Japan's Fujitsu Fanuc Ltd. are pursuing the U.S. market through a joint venture, General Numerics Corp., in Elk Grove Village, Ill. Actron is building its control around a microprocessor from Nitron, a division of McDonnell Douglas, while General Numerics is using an Intel unit.

Divide and rule

The microprocessor has presented manufacturers of process-control systems with the combined opportunity and problem of distributing intelligence around the plant, rather than concentrating it in one central computer or a small number of computers. The advantages include increased reliability—especially minimizing the effects of failure of any single computer, reducing communications requirements, and reducing system costs. The major problem now is to figure out the best way to distribute intelligence around a plant.

One approach, that of Beckman Instruments Inc., Fullerton, Calif., is to use one microprocessor for each control loop in a system. The Beckman series 8000 ASCII computer interface system, which was unveiled earlier this month at the Instrumentation Society of America show in Houston, doesn't so much distribute intelligence as reduce communications costs. It allows a single five-wire data bus to connect a maximum of 36 controllers to one computer port. Most other techniques require that each controller have its own set of wires going to and from the computer. At an estimated cost of \$5 to \$10 per connection in the field, plus the cost of wire and ductwork, it is clear that this so-called data-highway approach can produce large savings.

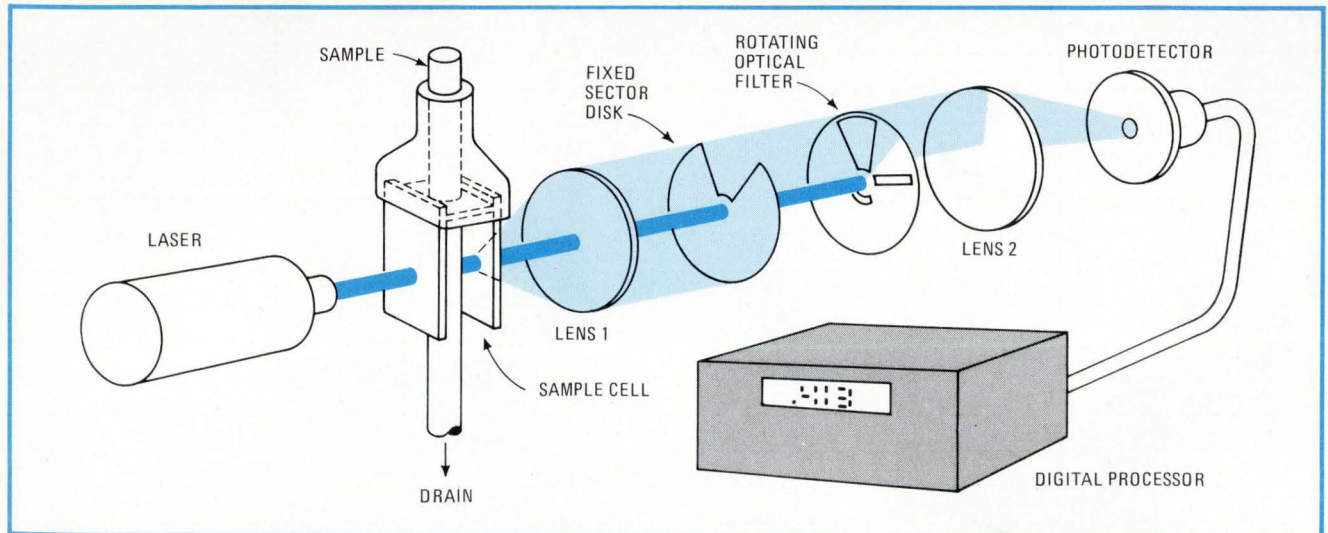
A somewhat different method is being applied by Honeywell's Process Control division, Fort Washington, Pa. Its TDC 2000 system also communicates over a data

highway, but a single microcomputer controls up to eight loops. The microcomputer acts not only as a communications controller but also as a local process controller. It can make changes in the setpoints of some of the loops under its control as they are affected by changes in other loops. This not only allows for more efficient operation of the system if the central computer fails, it also relieves the central machine of much of its simple, but time-consuming and repetitive work.

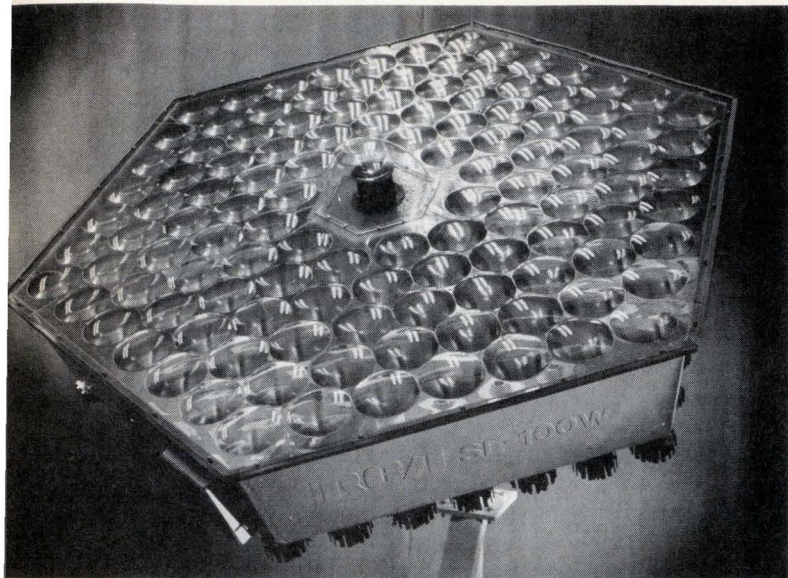
While microprocessors are cutting costs and increasing the reliability of minicomputer-based process-control systems, at the individual-instrument level microprocessors make possible devices that were economically impossible before. "Smart" recorders and plotters, for example, are being offered by several companies. One measuring device that combines two recent technologies—microprocessors and lasers—is the Microtrac particle-size analyzer recently developed by Leeds & Northrup Co., North Wales, Pa. Useful for measuring particle-size distributions in such varied applications as ore-grinding, pottery-manufacturing, flour-milling, and the preparation of pharmaceutical powders for compression into pills, the Microtrac device can handle particles measuring anywhere from about 1 to 200 micrometers.

The analyzer (Fig. 1) works by passing a laser beam through a sample of the material being studied and then measuring the characteristics of the light scattered by the particles. (The laser is used not for its monochromatic or coherent properties, but because it is an inexpensive, reliable source of well collimated light.) After the scattered light emerges from the sample cell, it is collected by lens 1 and projected through a fixed sector disk and a computer-generated rotating optical filter to the photodetector.

The photodetector output is sent to the digital processor where it is digitized by an analog-to-digital converter and processed by a microcomputer built around an Intel 8008 microprocessor. The microcom-



1. Particle sizer. Small particles scatter laser light further from its axis than do large particles. Exploiting this phenomenon, Leeds & Northrup's Microtrac analyzer uses a rotating optical filter to determine mean particle size and standard deviation.



2. Keeping cool. Although operated under concentrating lenses, this RCA silicon-cell array keeps its temperature rise to only 10°C by using small cells spaced relatively far apart on a heat sink. At 1,000 suns, the array has an efficiency of 10%.

puter correlates the photodetector output with the angular position of the rotating filter. Data displayed by the digital processor includes mean particle size and standard deviation of particle-size distribution.

Solar cells dawdle

The economical generation of electricity by photovoltaics still faces a chicken-and-egg dilemma: the price of solar generators is too high to make them competitive

with alternate sources of electricity for most applications, and demand is not yet sufficient to attract enough suppliers to drive the cost down. However, that situation is changing slowly. The Federal Government's Energy Research and Development Administration has recently announced that the cost of using solar cells to generate 1 watt of peak power has been halved from about \$30 to a little more than \$15 in only 18 months. Meanwhile, the conversion efficiency of silicon cells in volume production has crept up from about 10% two years ago to 12% today, and 15% is being promised two years hence.

But when the ERDA price goal of 50 cents per peak watt by 1986 is considered, it's clear that U.S. producers still have a long way to go. ERDA officials say that's the price at which solar generators can readily compete with other energy sources across the board, not merely at remote sites where it's too costly to install land lines.

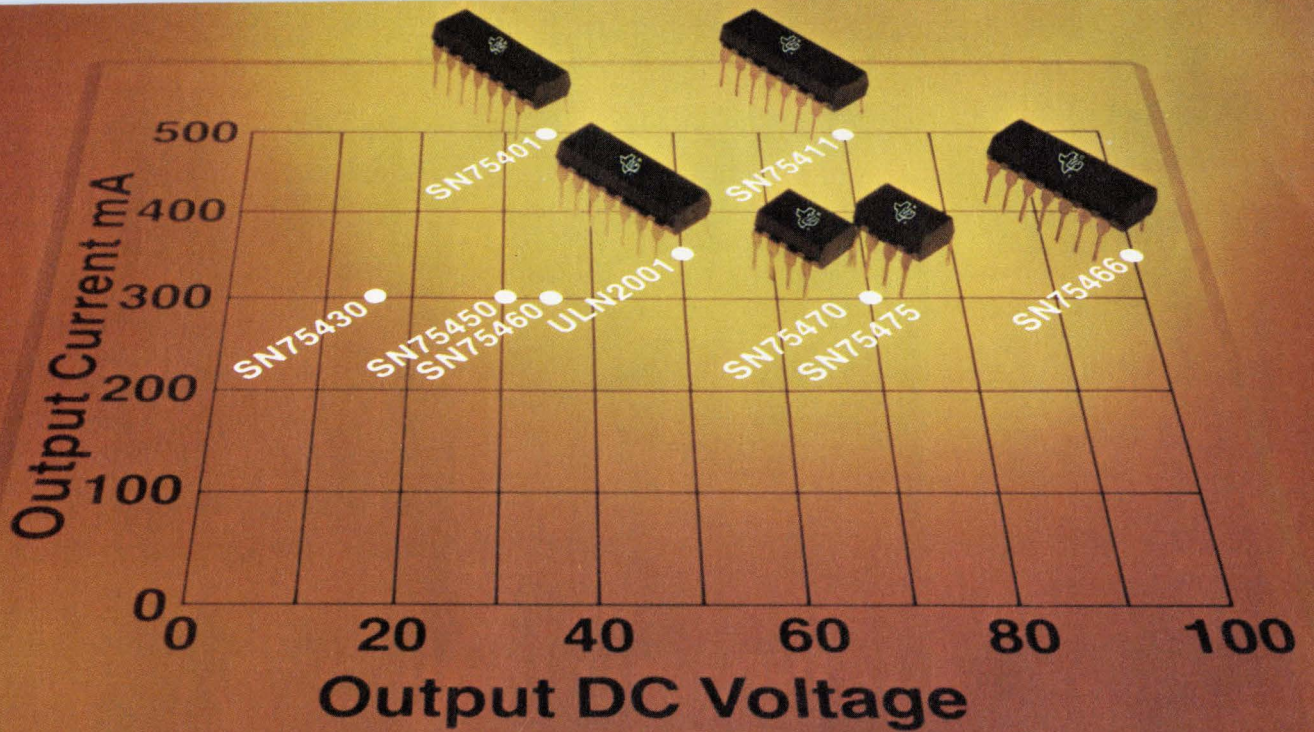
Further, there's some indication that silicon may have fundamental limitations that won't allow much more than 18% to 20% conversion efficiencies. That's one reason silicon-cell makers are looking more and more at sunlight concentrators—lenses that intensify the light focused on their arrays (Fig. 2).

Of more immediate value than its potential as a source of electricity is the capability of electronics to conserve energy through careful control of its usage. This idea is being implemented at present mainly in the control of the heating, ventilating, and air-conditioning (HVAC) systems of large commercial and industrial buildings. This may not solve the energy crisis, but it is a good first step, and it can be done now. □

EFFECT OF COMPUTER CONTROL IN VARIOUS PROCESSES

Process	Major importance	Relatively important	Relatively unimportant	Minor importance
Drilling				
Milling				
Jig-boring				
Grinding				
Gear cutting				
Turning				
Welding				
Die-sinking				
Cold forming				
Hot forming				
Hot rolling				
Cold rolling				
Powder metallurgy				
Pressure die-casting				
Precision casting				
Injection moulding				
Extrusion				
Wood-working				

SOURCE: NUMERICAL CONTROL SOCIETY, INC.



INTERFACE ICs

Broadest choice. Highest output power. New TI peripheral drivers.

Thirty-seven devices including the industry leaders, TI's SN75450 and SN75460 Series. Twenty-one are brand new. The highest output power capability available. With a spread of 300-500 mA and 15-100 V, you'll now have fewer problems matching current/voltage combinations to design requirements.

Being single package, monolithic devices, these new linear ICs save assembly time. Improve reliability. Cut component costs. Rid p.c. boards of unnecessary clutter.

And no problem with driving inductive loads. TI's new SN75475 and

SN75466/67/68/69 have output clamp diodes built-in on the chip. No externals required.

TI PERIPHERAL DRIVER FAMILY					
	No. per Package	Latch-up Voltage	Typical Speed	Logic Type	Package
SN75430-SN75434	2	15V	13ns	All	N/J/P/JG
SN75450-SN75454	2	20V	20ns	All	N/J/P/JG
SN75460-SN75464	2	30V	42ns	All	N/J/P/JG
SN75470-SN75474	2	55V	42ns	All	N/J/P/JG
SN75401-SN75404	2	30V	42ns	All	NE
SN75411-SN75414	2	55V	42ns	All	NE
SN75475	2	55V	42ns	NAND	P/JG
ULN2001-ULN2004	7	50V	1 μ s	Inverter	N/J
SN75466-SN75469	7	60V	1 μ s	Inverter	N/J

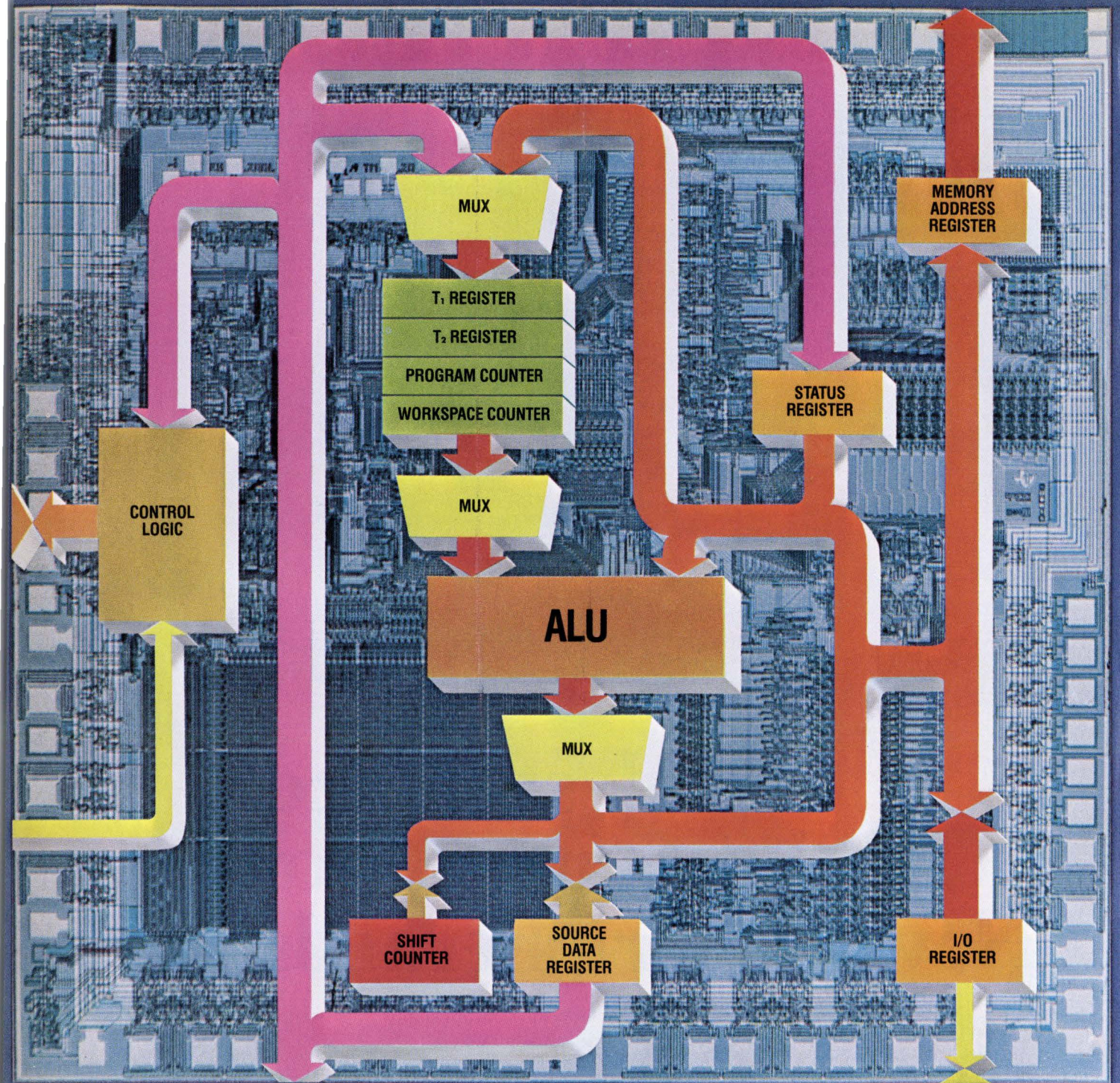
N=14-pin plastic DIP; J=14-pin ceramic DIP; P=8-pin plastic DIP; JG=8-pin ceramic DIP; NE=Heat sink 14-pin plastic DIP.

Another new wrinkle: the SN75401 and SN75411 Series come in a special low thermal impedance (NE) package with copper-clad silver-plated leads. You have a choice of logic functions—AND, NAND, NOR, OR—as well as packages. Excellent availability; competitive prices.

New Data Book: For your personal copy of TI's hot-off-the-press Peripheral Driver Data Book, write Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.



TEXAS INSTRUMENTS
INCORPORATED



FIRST FAMILY

TI's new single-chip, 16-bit TMS9900 microprocessor is the frontrunner of a revolutionary new family. The first family of software-compatible microprocessors, support circuits, microcomputers and minicomputers, support circuits, microcomputers and minicomputers. To give you unlimited design flexibility. A technological milestone achievable only by a leader in both integrated circuits and minicomputers.

Now, minicomputer performance from a 16-bit microprocessor: TI's new TMS9900. ...And it's only the beginning.

Unmatched. In word size. Instruction set. Addressing capabilities. TI's 16-bit TMS9900 microprocessor.

Powerful enough to be the heart of a minicomputer. Ideal for terminals. Instrumentation. Machine control. Scores of OEM applications. Destined to become today's and tomorrow's design standard.

Because the TMS9900 microprocessor represents more than just a single device. It introduces a new family concept allowing full design flexibility. Enabling you to move freely and easily over your entire range of applications. Now. And in the future. With less redesign. Less software reinvestment. Less re-learning. Less obsolescence.

Improved System Cost/Performance
Compared to 8-bit μ Ps, TI's TMS9900 microprocessor provides these unmatched savings:

- 30% faster execution time
- 50% saving in program coding
- 50% saving on system interface costs
- 50% more efficient interrupt handling
- 20% reduction in memory bit requirements

These benefits stem from the TMS9900's advanced features:

16-bit instruction word with full 16-bit data precision.

Operation at 3.3 MHz clock rate.

Full minicomputer instruction set including hardware multiply and divide.

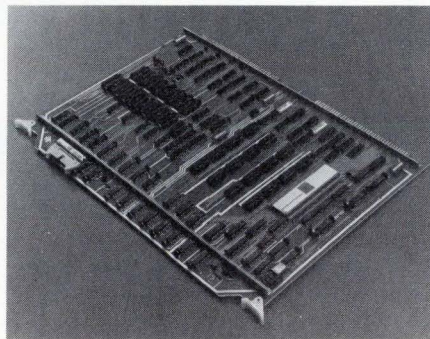
Advanced memory-to-memory architecture that locates general-purpose register files in memory.

Separate address, data, I/O and interrupt buses.

Complete Design Support

Hardware and software development tools are available to help you utilize the 9900. For evaluation and development work, there's the 990/4 board level microcomputer. In a desk-top chassis, the 990/4 serves as a fully supported prototyping system. And for larger software development, there's the 990/10 TTL minicomputer. All available now.

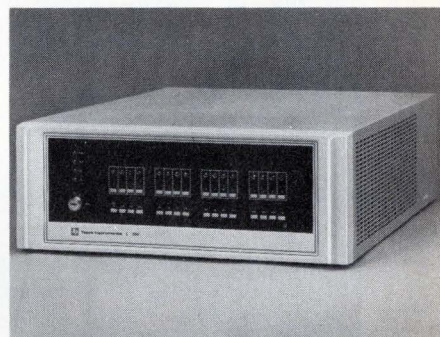
For design assistance, TI microprocessor applications specialists are located in 12 TI field sales offices.



990/4 Board System

Fully Compatible Software

The 9900/990 software has been tested and proven in more than 1000 systems. Any software you develop for the TMS9900 can be used with the 990/4 and 990/10 minicomputers—or the SBP9900 and TMS9980 microprocessors. In fact, any software developed for the TMS9900 can be used with any other family member—at present and in the future.



990/4 Prototyping System

More 9900 Family Soon

The TMS9900 is just the beginning. Future family circuits, all software compatible: SBP9900, an I²L microprocessor designed to handle military temperature ranges. TMS9980, an N-channel μ P with an 8-bit data bus for smaller systems.

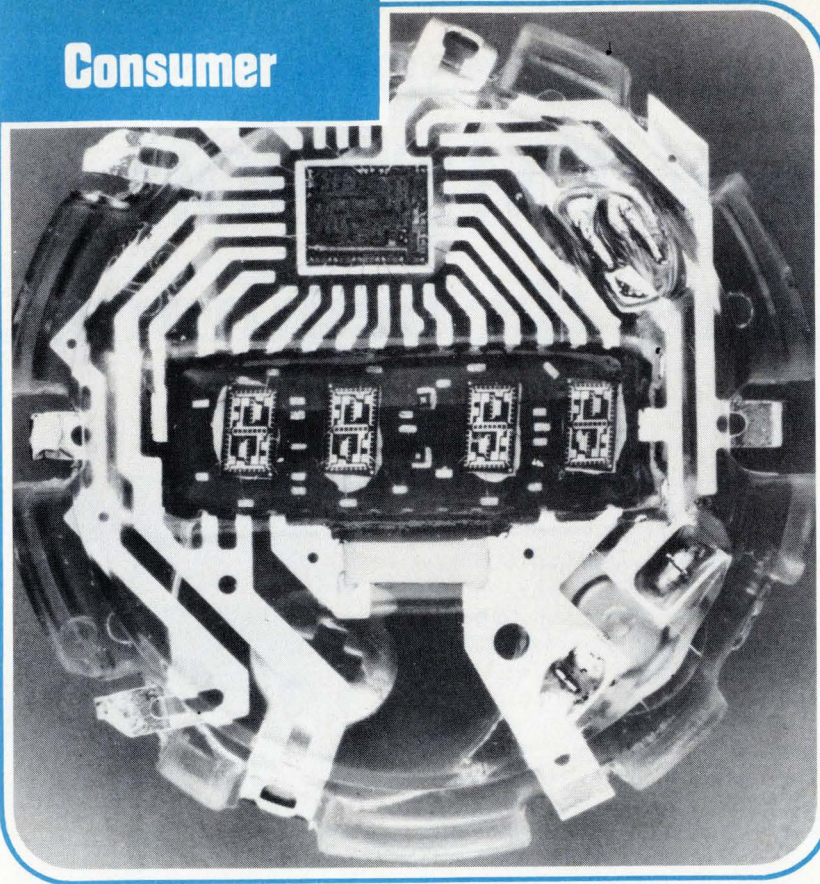
Also coming are 9900 peripheral support circuits: TMS9901 programmable systems interface. TMS9902 asynchronous communication controller. TMS9903 synchronous communications controller. And the TIM9904 low power Schottky TTL 4-phase clock generator.

Applications Workshops

TI distributors are sponsoring applications workshops in 36 locations across the nation beginning in November. For more information about the workshops, the 9900 First Family, or price and availability, contact your TI field sales office. Or write Texas Instruments Incorporated, P. O. Box 1443, M/S 669, Houston, Texas 77001.



TEXAS INSTRUMENTS
INCORPORATED



Trend setter. A good example of the rapid application of LSI technology in low-cost consumer products is the Texas Instruments plastic case watch that retails for \$19.95. The module (left) is a chip and lead frame encapsulated in plastic (opaque in actuality) similar to other standard IC packages. It makes automated production possible for large-volume output at low total cost.

LSI chips taking over more household chores

by Gerald M. Walker, *Consumer Editor*

□ Cooks, commuters, competitive types, and clock-watchers may not be aware of it, but microprocessors are about to enter their lives. Already established in such commercial products as point-of-sale devices and text editors for the office, the devices will soon be titillating the consumer's fancy in video games, microwave ovens, automobiles, and even some digital watches.

- Using other LSI circuits, TV makers are equipping their sets with remote electronic tuning and automatic color control as well as rigging them for video games.
- Further ahead, some imaginative entrepreneurs hope to team the TV set with a Touch-Tone telephone keyboard and a microprocessor for data processing.
- In digital watches, I²L and C-MOS chips are competing, and so are LED and LCD displays.
- Although the calculator must have nearly reached the maximum performance for the lowest possible price, nonvolatile memories are being installed for the first time in scientific models.
- An expensive video offshoot, projection television, has

begun to move into American homes. But development of video-disk players has slowed, though Japanese manufacturers of video-tape recorders are jockeying to establish their products as the VTR player/recorder standard for home systems [*Electronics*, Oct. 14, p. 68].

- Home appliances are rapidly getting solid-state controls to conserve electricity as well as for timing precision.
- After a couple of years of idling, automobile electronics is being shifted into high by the Environmental Protection Agency's tightening of emission standards, the public's demand for fuel economy, and the likelihood of renewed Government interest in mandatory air bags. The first digital microprocessor will be installed in a 1977 car, and more—many more—are sure to follow.

Games score with microprocessors

In the past year, the most successful video games have been adaptations of the popular paddle-type games originally developed for arcades. Home games are becoming

so popular that a couple of dozen companies are trying to get a piece of the action. More variations and increased difficulty have been added by the entry of the first microprocessor in a game.

The microprocessor has brought about programs for additional games stored in digital tape cassettes. Some of these games, such as blackjack, enable the player to compete against the microprocessor. Most of the first-generation games have been based on MOS chips that generate images of the paddle, the ball, and playing field, as well as store the logic necessary to control movements of the players and ball.

Although the simple paddle-type games have barely reached the market, the TV industry is excited over next-generation programable games based on microprocessors, such as Fairchild's Video Entertainment System (VES), built around an F-8 microprocessor set. The reason for the excitement is obvious: the games using hard-wired LSI chips are no match for microprocessor-controlled systems in variety of challenges and sheer playability. Some programable games aimed for high-volume production will probably contain dedicated custom processors rather than standard units like the four-chip F-8.

The Fairchild VES, which uses additional random-access memory and video modulator circuits, will probably be converted to a dedicated microprocessor later. The present model, priced at \$150, consists of a set-top console that contains two preprogramed games and a pair of joystick controls. The VES is programed by a library of digital tape cartridges, called Videocarts, which are inserted into the console. By the end of the year, Fairchild hopes to have five Videocarts offering 10 games and four types of arithmetic quizzes.

Although building game chips into the TV set is an efficient way to use them, the resulting sets may become obsolete so that fewer people will buy them than if the consoles are connected to the antenna terminals of

existing home receivers. German manufacturers are leaning toward the built-in approach, but in the U.S., only Magnavox has elected to do so. That company, which in 1972 offered Odyssey as the first video game, will have a \$499 19-inch model that contains a three-game chip supplied by General Instrument Corp.'s Microelectronics division in Hicksville, N.Y. Texas Instruments has been supplying PL chips for Magnavox's other Odyssey models.

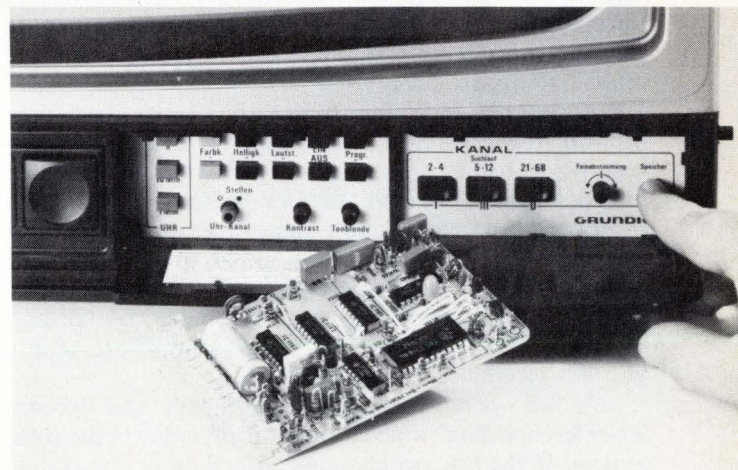
The leading supplier of multigame chips this year has been General Instrument Corp. Later, National Semiconductor Corp. of Santa Clara, Calif., introduced a chip for three games in full color that will be used in a game to be marketed by National's Consumer Products division.

For the set owner who wishes to spend less money, Texas Instruments, Dallas, has introduced a two-game monochrome chip. In contrast to the \$60 to \$120 for most units, games using the TI entry could retail for \$30 to \$40. And ITT's West German subsidiary, Intermetall, is introducing a chip for the European market.

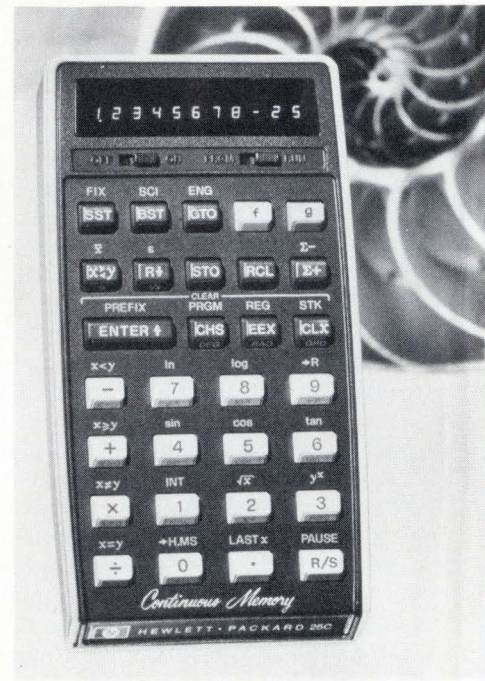
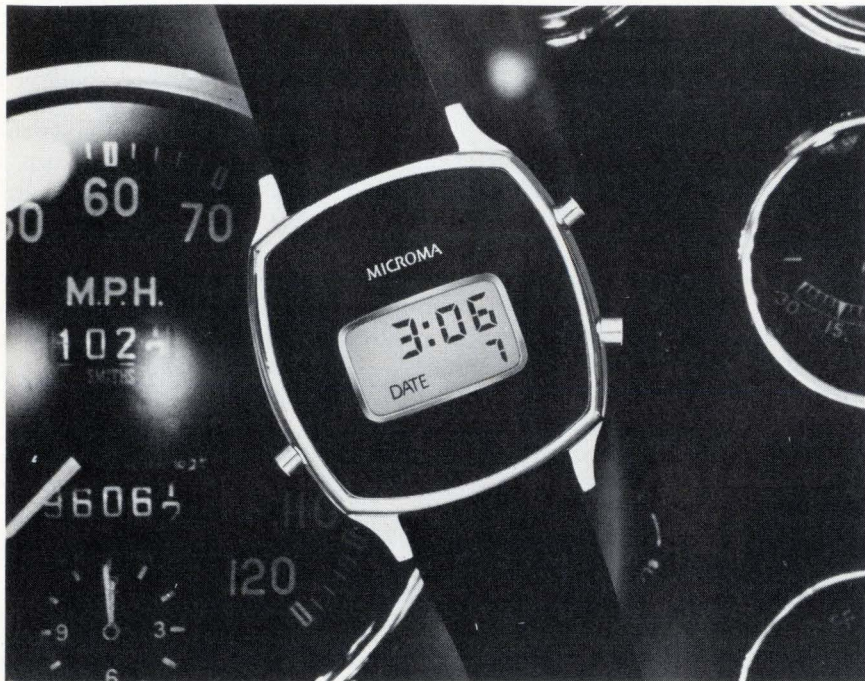
By the end of the year, General Instrument will be offering three more games. One design, built around a microprocessor, provides blackjack and slot-machine games of chance. Another will be the second-generation chip for a paddle-and-ball game, and the third will be a battle game on one or two chips.

GI's n-channel MOS chip enables an original-equipment manufacturer to build a game fairly easily. In addition to the chip, the only components required are an oscillator-modulator, a couple of potentiometers, a power supply, a switch to decouple the game console from the TV antenna, and a case to hold the circuit boards. For manufacturers of add-on games, however, a formidable technical hurdle—the Federal Communications Commission—must be cleared. Type approval must be obtained for these Class I TV devices, which must conform to specifications in part 15 of the FCC rules

1977 ELECTRONIC GAME PRODUCTS		
	Selection	Retail price
Arcade (high end)	dedicated arcade games reprogrammable pinball machines reprogrammable arcade games	\$1,000 to \$3,000
Recreation room	free-standing (cassette programable) pinball card games	\$200 to \$500
TV add-on	ball and paddle (second generation) battle race cards/gambling/doodle (programable) educational (interactive)	\$25 to \$100
Non-TV	boxes hand-held	\$10 to \$50



1. Selection. All-electronic tuning has been advancing rapidly in West Germany. For example, this Grundig channel-selection system designed jointly with TI, features scan and select frequency search. When user finds correct frequency, he enters it into memory.



2. Watch memories. Microma's LCD chronograph watch (left), which sells for under \$100, is based on a mask-programmable MOS circuit from Intel. Hewlett Packard's HP-25C programmable scientific calculator has a C-MOS continuous memory that retains input when turned off.

which cover interference regulations.

The television receiver itself has been undergoing considerable changes in the last few years. The 1977 line is chock-full of innovations that range from digital electronic-tuner address systems and automatic color controls to the picture tube itself.

TV sets get revamped

The rapid improvement of electronic tuners with LSI digital address systems has made it possible to design truly efficient remote controllers, some of which can change contrast, brightness, color intensity, channel, and volume, as well as switching the set on and off. In Europe, which is ahead of the U.S. and Japan in acceptance of remote tuning, both infrared and ultrasonic systems are being used.

U.S. set designers for the last few years have been working toward automatic control of contrast, brightness, color saturation, and tint. There are now two ways to go—either internal factory-preset controls and circuits that correct picture appearance to match these settings or external decoding of the vertical-interval reference (VIR) transmitted by some broadcasters on the 19th line for each frame. Thus far, only the General Electric Television Business department, Portsmouth, Va., has elected to go the VIR route.

GE's VIR system identifies the 19th line and decodes the reference data, which automatically adjusts the color control. If the VIR switch is not turned on or the station being received is not transmitting the VIR signal on the 19th line, the receiver must be operated by manual controls. Circuitry to detect and process the VIR consists of five off-the-shelf TTL integrated circuits and 30 tran-

sistors. However, these components may be integrated into one or two LSI chips in future models.

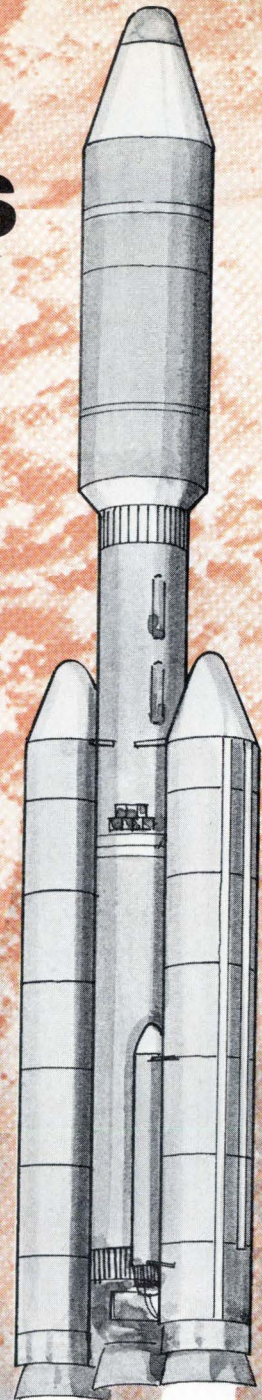
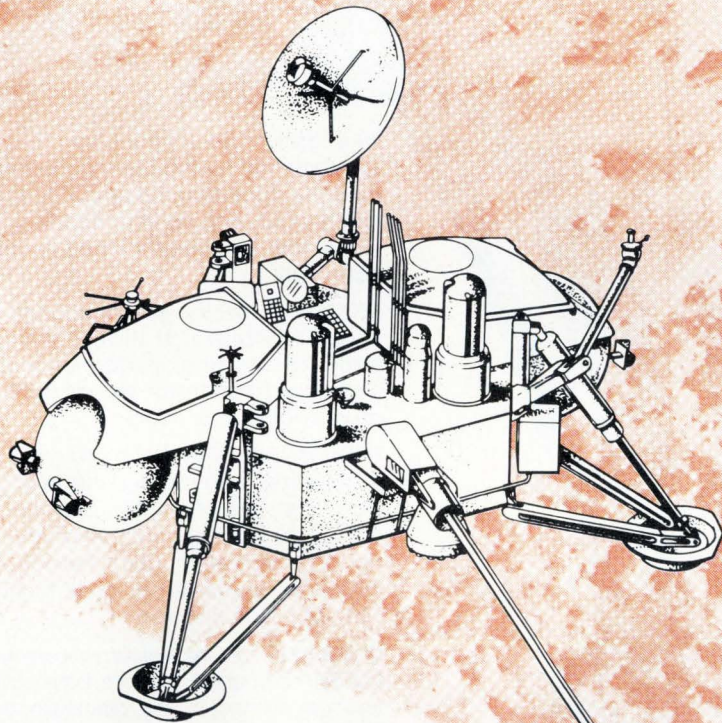
Infrared remote control, installed on most sets in the new line from Grundig of West Germany, is implemented with a photodiode on the set and a small hand-held IR transmitter. For each of five control functions, the transmitter produces a specially coded ultrasound signal, modulates that signal into the 950-nanometer IR beam, and sends it to the photodiode at the TV set. After demodulation, the signal performs control functions.

The RCA Consumer Electronics division, Indianapolis, Ind., also has an elaborate remote controller that operates by ultrasound. The RCA ColorTrak model with remote control displays the channel number and time on the screen. In addition, the hand-held remote unit has buttons for channel-selection, as well as to control volume, color, and tint. When the set is in the color-control mode, the channel display is recalled in red, and the buttons used for volume then control the color. When the set is in the tint-control mode, the channel display is in green. The up button then changes flesh tones in increments toward magenta, while the down button changes it in increments toward green.

Not only have digital-address systems made remote controllers more elaborate, they have made remotes easier to install. Magnavox Consumer Electronics Co., Fort Wayne, Ind., and Rockwell's Admiral group in Schaumburg, Ill., have both introduced remote-control kits for retrofit after the set is purchased.

The Magnavox kit, consisting of a microphone and amplifier that interfaces with the digital address package, must be installed in the cabinet by the dealer. The set owner can plug in the Admiral unit, which has a

Teledyne Hybrids Arrive on MARS



Hybrid microcircuits manufactured by Teledyne Microelectronics played an important role in the Viking Missions—from initial launch, thru descent on Mars and the on-going scientific experiments.

- Inertial Reference
- Guidance Control Computer
- Data Acquisition & Processing
- Biology Experiments
- Camera Circuits
- Meteorology
- Upper Atmosphere Mass Spectrometer
- Launch Vehicle Atlas-Centaur Guidance Computer

573 hybrids **137** hybrids **645** hybrids

FOR YOUR HI-REL HYBRID MICROCIRCUIT REQUIREMENTS, CALL:

 **TELEDYNE MICROELECTRONICS**

12964 Panama St., Los Angeles, Calif. 90066 • Phone (213) 822-8229

Coming through...

with people, ideas, products—
whatever it takes to get the job done



Wire, cable and cord sets usually cost less to buy than install. And poor performance can cut into your product's profitability deeper than potential savings on an initial buy. Belden is ready with whatever it takes to get the job done right.

BROAD LINE: Belden comes through with thousands of standards that fit your toughest environmental and application needs. And if a standard won't work, we will custom design an answer to your need.

ENGINEERING HELP: When you have problems in stripping, terminating, installing, fabricating, safety engineering, ordering, quality control, or want information on the codes or design parameters, ask a Belden specialist. "Hot-line" assistance is as near as 317-966-6681. Call and see.

UNIQUE PUT-UP CAPABILITY: Ask about Belden's UNREEL® dispensing system. Pays out wire continuously without snarls, backlash, or tensioning devices. One company cut processing time by 30%.*

And Belden is coming through with a lot more. A design kit that covers performance characteristics, costs, material capabilities. And we've increased production capability for shorter lead times, great delivery.

Quality wire, cable and cord—whatever it takes to protect your bottom line performance every day. Belden Corporation, Electronic Division, P.O. Box 1327, Richmond, IN 47374, 317-966-6661.

8-6-B

*Information available upon request.

BELDEN 

Circle 132 on reader service card

Coming through...
with new ideas for moving electrical energy

Copyright © 1976 by Belden Corporation

combination microphone/amplifier, through the front of the set. Each kit includes a battery-powered, hand-held controller for on/off, volume, and channel selection, plus mute. A major advantage in having field-installable remote tuners is that receiver inventories can be reduced for both the manufacturer and the dealer. A single receiver model can be equipped with a remote control if the customer desires it. In addition, more people may be inclined to buy the remote control some time after purchasing the set when the additional cost of \$99.95 does not seem as formidable.

Watch technologies compete

Even though the digital watch has become entrenched in the world market, two technologies are still in dispute: integrated-injection-logic versus complementary metal-oxide-semiconductor electronics and light-emitting-diode versus liquid-crystal displays. A single PL chip and a plastic case enabled TI to deliver in April the \$19.95 watch it had promised in January. Competitors have countered by mounting display logic and timing logic on the single C-MOS chip. National Semiconductor ran into highly publicized yield problems with its C-MOS chip, but these have apparently been overcome.

PL has the inherent advantage because the LED-display drivers can easily be mounted on the same chip as the control logic. Such a configuration is more difficult with C-MOS technology, but the necessary packing density has been made possible by silicon-gate processing.

At the high end of the market, the development of so-called programable MOS chips has been a key factor in the design of economical multifunctional watches. Intel's processor-type watch chip, which has been customized for use by the company's Microma watch subsidiary in Cupertino, Calif., has programmed-logic arrays to control timesetting, and a ROM and a RAM are used for time counting and related functions. This chip is programmed at the mask level for 4-, 6-, and 8-digit displays, as many as eight timing functions, including chronograph, and a choice of several styles of alphanumeric characters.

Watch-display technology has not been settled yet either. Even though LEDs dominate the low end of the market, LCDs have made a strong comeback in the medium-to-high-end watches, thanks to improvements in reliability, viewability, and the addition of command back-lights for visibility in the dark.

Memory extended for calculators

Manufacturers have started a new major trend, the use of nonvolatile memories in calculators. Due out this year is a range of scientific calculators, some with metal-nitride-oxide-semiconductor (MNOS) memories, a relatively untried semiconductor technology. A more conventional approach is use of clocked static C-MOS random-access memories that require only a few microamperes of current to maintain the stored input.

New clocked static 1,024-bit C-MOS RAMs from National, Intersil, and American Microsystems Inc. dissipate in the standby mode only 75 to 100 microwatts,

which is within the self-discharge rate of nickel-cadmium batteries—2% to 3% a week.

The MNOS memory is truly nonvolatile. It consumes no power to store data, the data can be changed electrically, and the readout is nondestructive. Unfortunately, the adoption of MNOS has been retarded by its high cost and uncertain reliability. The nitride storage medium has a tendency to take charge into the substrate so that the memory loses data.

Microprocessors travel to Detroit

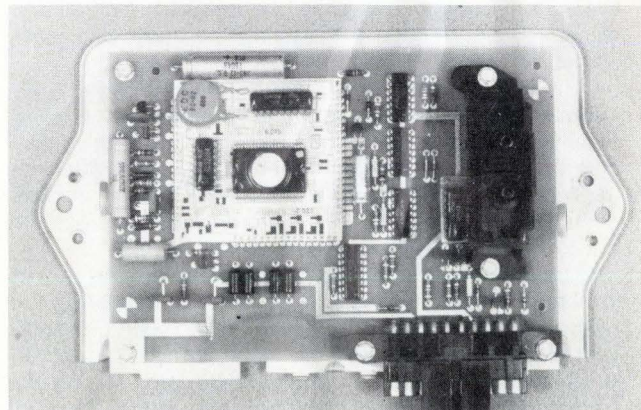
When General Motors Corp. announced that it will use a 10-bit digital microprocessor to control ignition in the 1977 Oldsmobile Toronados, some of the suspense over Detroit's intentions in processors was relieved. The custom two-chip microprocessor was designed by GM's Delco-Remy and Oldsmobile divisions, and it was developed by Rockwell International. GM will second-source the manufacturer chosen to produce it.

This processor, which times the ignition and regulates the spark, is expected to increase the Toronado's fuel economy by 1.2 miles per gallon. Called Misar, for microprocessor sensing and automatic regulation, the system processes inputs from three sensors—coolant temperature, manifold vacuum, and crankshaft position, which also provides engine speed.

Misar, which is programmed to interpolate speed and vacuum information and look up in memory the optimum ignition timing, also controls the dwell and either advances or retards the firing according to the temperature of the coolant. The microprocessor's programability is expected to pay off handsomely as it is matched eventually to the various types of GM engines.

Meanwhile, Chrysler Corp. engineers are planning to use customized automotive microprocessors to succeed the discrete electronic spark computer used on the lean-burn engine. Taking another tack, Ford Motor Co. is seeking to develop a custom microprocessor to control several functions.

The long-range prospects for consumer electronics are



3. Custom job. GM's 10-bit microprocessor-controlled spark timing system, designed by Delco-Remy for the 1977 Olds Toronados, uses inputs from three sensors and computes spark advance based on engine speed, vacuum, and coolant temperature.

also tied to the microprocessor. The way it will invade the television receiver is suggested by the Admiral Videospond, a proposed system that uses the TV set to display several non-broadcast services. Designed around the PPS-8 microprocessor from Rockwell International Microelectronics group in Anaheim, Calif. Videospond is an interactive system, programed by digital-tape cassettes and has joysticks to control on-screen cursors. Though Videospond has been put on the back burner at Admiral, it's been demonstrated in four distinct modes: programed instruction, information storage with text editing, calculations such as determining the optimum diet and exercise to reach an individual's ideal weight, and highly sophisticated games and entertainment.

Other services will be performed around the house by

microprocessor-controlled appliances, as well. A robot that cleans the house is entirely possible, for example. Systems are also being considered to provide heating and cooling precisely to demand. Additional plans for consumer application of microprocessors depend on the further rapid decline in hardware prices. In the last 10 years processing intelligence has dropped by three orders of magnitude in cost to today's microprocessors, while IC complexity has increased by four orders of magnitude.

Over the long run, consumer-electronics hardware is headed toward virtually free processing, and software will eventually represent the only important cost. With this kind of economics at work, there is no end to the electronic products that probably will become available to consumers in the next decade. □

Profile

One of the most significant developments this year in the consumer market was Texas Instruments' introduction in April of the first digital watch to retail at less than \$20. Its arrival opened up a large new market much sooner than had been predicted.

The engineers responsible for meeting the April deadline with the \$19.95 five-function watch agree that at every step of the design and production cycle they were dealing from TI's strengths in semiconductor technology. From the chip to the module to the unique plastic case, there was a minimum of technical tightrope walking because the team was applying technologies mastered in previous products.

Nevertheless, particular challenges had to be overcome. "If this were some other company, we probably would have approached the problem from a different direction," comments Hector Cardenas, 39-year-old engineering manager for the Time Products division and technical director for the low-cost watch project. "But we took advantage of our leadership in ICs, calculator displays, and molding techniques to reach our own solution."

Cardenas, who in 15 years at TI has helped develop diode-transistor and emitter-coupled logic, points out that the original goal was to develop a watch to sell for more than \$100. But in doing so, he realized that all the elements were in hand for entering the under-\$25 mass market, where 70-80% of all watches are sold.

At the chip level, the fundamental decision was to use integrated injection logic rather than complementary-MOS technology. This decision eventually led to a small dense chip that was easy to integrate and was compatible with the light-emitting-diode display. "Using a bipolar process, one of TI's strongest suits, we were also able to place the driver on the same chip," Cardenas explains.

Clark Williams, a graduate of Arizona State College, was in charge of the chip design, including investigating the relative merits of I^2L and C-MOS technologies. The 31-year-old Williams and his IC-development team added an isolation process to a conventional nonisolated I^2L process so that the display drivers could be integrated on the chip. "It was not a major extension of technology, but it was different from TI's other I^2L products," Williams says.

James Harper, a veteran design engineer, handled the

module effort. A key decision was to use the firm's advanced automated-assembly line to turn out the modules, packaged in plastic. "The TI watch module is, in effect, a plastic-packaged IC with a round, rather than rectangular, shape," remarks Harper.

The automated bonding process put the watch module under tight production control. In addition, TI had the advantage of being vertically integrated in key components.

The final step in making the \$20 watch practical was using polysulfone plastic in the case. "The molding technology already in place at TI allowed us to solve the problems inherent in new product startup, just as semiconductor-production expertise enabled the molded module, and bipolar leadership made the single chip with on-board driver possible," states Cardenas.

Like the company, the design team relied on its strengths—Cardenas (below, left) in integrated circuits, Williams (right) in bipolar ICs, and Harper in advanced assembly—to get the \$20 watch out on time.



Got artwork, need parts? Got masks, need parts? Got a deadline, need parts?

Call

We do all kinds of custom work. Always have. And we're glad to interface with your people at whatever stage suits your need, from concept to working plates to finished parts. We'll deliver your design, wafers, dice, or tested, packaged parts on time and within budget. Call for specifics: Synertek, 3050 Coronado Drive, Santa Clara, CA 95051, (408) 241-4300. TWX 910-338-0135.



Synertek.

MOS and CMOS processes now on stream

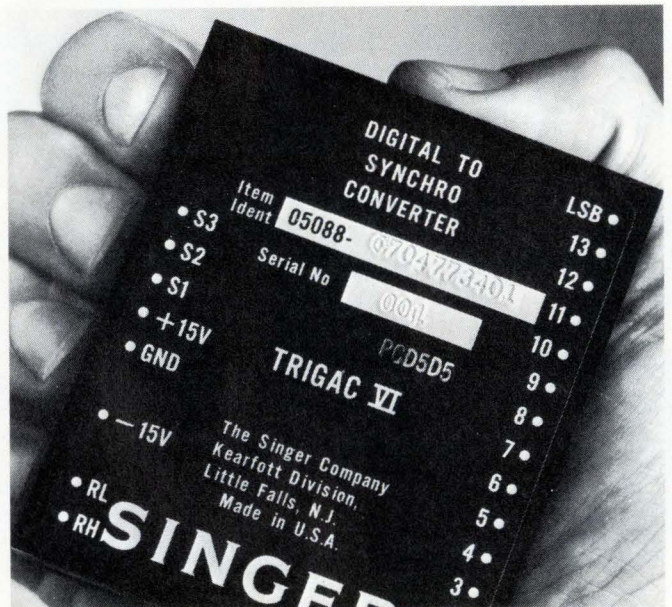
	With Ion Implant	Without Ion Implant
P-Channel Si Gate	x	x
N-Channel Si Gate (Low V_t)	x	x
N-Channel Si Gate (High V_t)	x	x
CMOS Si Gate (Low V_t)	x	
CMOS Si Gate (High V_t)	x	



Trigac VI digital-to-synchro converter gives you accuracy and power without raising your temperature.

The closest thing yet to a Solid State Synchro, Kearfott's Trigac VI Modular Digital-to-Synchro/Resolver Converters provide the accuracy and power you need, with a bonus. In addition to standard 4 arc minutes of accuracy at 1 volt ampere, the transformation ratio remains constant within $\pm 0.25\%$. We also have units constant within $\pm 0.1\%$. That can make the difference between delivering power or just throwing it away.

Let us help you be cost effective. Standard options range from industrial grades thru hi-reliability units, from accuracies of ± 20 arc minutes to ± 1 arc minute and, in addition, special designs and packaging as you require.



Need more power? Try our line of compatible synchro amplifiers.

Our 3185 Series is designed to perform the synchro power buffering or resolver to synchro (Scott-T) function. They provide matched power amplifier channels and transformer coupled outputs capable of driving torque repeaters or multiple control transformers up to 5 va. These fully potted units feature overload protection, low-quiescent currents and transformer-isolated outputs. Models available range from industrial to full MIL-SPEC high-reliability grades.

NEED ADDITIONAL POWER? We have units available with power outputs to 50 va, 60 or 400 Hz operation, and options of built in digital converters and/or power supplies.

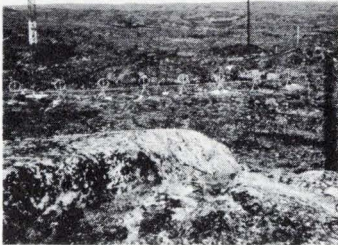
For details on our converters and amplifiers, contact The Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, New Jersey 07424.

SINGER
AEROSPACE & MARINE SYSTEMS

HERMES LOOP ANTENNA

THREE SAMPLE SITES
ON THE NORTH AMERICAN
CONTINENT —

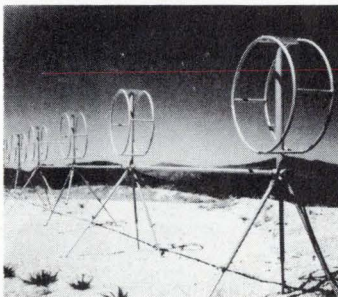
DIFFERENT LATITUDES
DIFFERENT CLIMATE



64°N



42.5°N



32.5°N



Good Listeners maintain a low profile

Even in the solitude of the forest depths, from rooftops, arctic tundra, swamps to sweltering tropics, 'neath snow, sand or ice,

the Hermes Loop antenna keeps an ear to the sky.

The amazing aperiodic antenna does away with vast log periodic and rhombic arrays - those towering antenna farms.

In rosette configuration, the Hermes loop antenna provides an omnidirectional broadband receiving array in space merely 1/100th that of the traditional antenna farm.

More than 53 government agencies around the world have pressed the loop antenna into service.

A new, even more compact version is available.

Only Hermes Electronics makes it.

**2-32MHz
BROADBAND**



ASK US Send for our Brochure

Hermes Electronics Limited

Suite 315

2020 F Street NW

Washington, DC 20006 USA

202-296 2978

TWX 710 822 1106

Chronology

- OCTOBER 1975**
- First low-cost monolithic temperature transducer, which includes a sensor, a zener reference, and an op amp, is announced by National Semiconductor. *Oct. 16, p. 148*
 - Automatic continuity tester for thick-film hybrid substrates, developed by Westinghouse, slashes testing time from 2 hrs to 2 min. *Oct. 30, p. 30*
 - Stitch-wireable microprocessor boards, produced by the Apac division of Varian Data Machines, facilitate low-profile microprocessor packaging for military. *Oct. 30, p. 125*
 - Microprocessor-based programable controllers introduced by Eagle Signal offer many features of minicomputer-based systems. *Oct. 30, p. 137*
- NOVEMBER 1975**
- ERDA's photovoltaic-cell effort reaches contract-award stage with orders for \$1 million worth of solar cells. *Nov. 13, p. 40*
 - First use of 16-k RAM chips in a commercial computer system is announced by Four-Phase Systems Inc., Cupertino, Calif. *Nov. 27, p. 36*
 - Quick Connect wiring system developed at Bell Labs, Holmdel, N.J. is faster than wire wrapping and easier to modify or repair. *Nov. 27, p. 48*
- DECEMBER 1975**
- Laser-based photorepeater from D.W. Mann division of GCA Corp. has a resolution of 1 μ meter and exposable area of 36 in.² *Dec. 25, p. 96*
 - Fail-safe computer based on multiple redundant processors and standard operating-system software is announced by Tandem Computers Inc. *Dec. 25, p. 97*
- JANUARY 1976**
- Varactor VHF television tuner developed by Zenith provides reliable performance at low cost. *Jan. 8, p. 36*
 - Satellite Business Systems (IBM, Comsat General Corp. and Aetna Life and Casualty Co.) plan a new end-to-end domestic communications satellite system to become operational by August 1979. AT&T and GTE receive FCC approval to develop a satellite system for long-distance voice service; first Comstar launched in May. *Jan. 8, p. 38*
 - Texas Instruments Inc. announces a \$19.95 five-function, LED, plastic-case watch using a single I²L chip. *Jan. 22, p. 44*
- FEBRUARY 1976**
- Utilizing a new quad-slope technique, a 13-bit integrating C-MOS a-d converter from Analog Devices compensates for drift errors. *Feb. 5, p. 25*
 - Magazine-style information services via TV tested in Britain using digital information transmitted on two lines of each blanking period and displayed through a home decoder. *Feb. 5, p. 68*
 - Commercially available glass fiber for optical communications is sold by Corning Glass Works for \$1 a meter. It is unjacketed, provides 20-MHz bandwidth, and has attenuation of 10 dB per kilometer. *Feb. 19, p. 36*
 - First samples of the long-awaited 16-k RAMs enter market; Intel and TI lead the way, followed closely by Mostek. *Feb. 19, p. 119*
- MARCH 1976**
- Low-temperature nitride process that permits hermetic sealing of silicon wafers is developed by LFE Corp. *March 4, p. 40*
 - First commercial ROM to hit 32-k level is marketed by Electronic Arrays Inc. *March 4, p. 40*
 - First maritime communications satellite (Marisat), providing ships with full-time quality communications, goes up. A second Marisat is launched in June. *March 4, p. 42*
 - RCA's new 8-bit 1802 microprocessor is built with a faster, smaller C-MOS process called closed C-MOS logic (C²L). *March 18, pp. 35 and 129*
 - Zenith unveils an in-line 19-in. color-TV picture tube featuring a tripotential gun, 100° deflection, and new glass envelope. *March 18, p. 39*
 - First commercially-available wand for optical-character recognition is announced by Key Tronic Corp. It can read the standard OCR font, several numeric fonts, hand-printed numerals, and five hand-printed letters. *March 18, 1976, p. 46*
 - First commercial power MOSFET, a vertical-channel MOS device that switches 1 ampere in 5 nanoseconds, is developed by Siliconix. *March 18, p. 124*

Significant advances in electronics technology reported over the past year in *Electronics*

APRIL 1976

- Switching regulators for power supplies go monolithic with advent of a bipolar chip from Texas Instruments. *April 15, p. 25* (Silicon General later introduces a version with push-pull capability. *Aug. 5, p. 133*)
- New dedicated microprocessors appear aimed at the low-end controller market: Intel begins sampling the first one-chip microcontroller containing a field-erasable 8-k ROM; TI broadens its TMS 1000 line with an array of new devices; Rockwell starts production on a 4-bit chip, and National builds a line of calculator chips for control applications. *April 15, p. 74*
- Calculator firms aim at nonvolatile memory with MNOS and clocked static C-MOS designs. *April 29, p. 75*

MAY 1976

- First of the enhanced 8-bit general-purpose microprocessors appears as Exxon-backed Zilog Corp. readies its Z-80 device. TI breaks ground with its TMS 900 full-performance 16-bit n-channel MOS unit. *May 13, p. 25*
- Industry's first RAMs built with PL burst on the scene. Fairchild is developing a 4-k dynamic RAM, TI slates a 4-k static device, and National readies 1-k 35-ns static units. *May 13, p. 25*
- All-electronic phones, developed by Bell Northern Research, begin user trials in the Bell Canada system. *May 27, p. 36*
- Hardware and software package interfaces Hewlett-Packard minicomputers to the IEEE-488-standard instrumentation-interface bus. *May 27, p. 145*

JUNE 1976

- Three different memory types—C-MOS, MNOS, and p-channel MOS—are used for nonvolatile performance in National's 7100 all-semiconductor-memory programmable scientific calculator. *June 10, p. 29* (The nonvolatile memory in Hewlett-Packard's HP-25C programmable calculator relies on C-MOS chips. *June 24, p. 26*)
- Japanese develop an ultra-low-loss fiber-optic cable with attenuation of only 0.47 dB/km at a wavelength of 1.2 μ meters. *June 10, p. 55*
- First monolithic instrumentation amp with a J-FET front end is made by National with its bi-fet process. *June 10, p. 143* (RCA offers bi-mos op amp. *p. 193*)
- Thick-film-hybrid isolation amplifier from Burr-Brown is the first to employ optoelectronic semiconductors for coupling input and output stages. *June 24, p. 144*

JULY 1976

- Fairchild starts production on the industry's first 65-k CCD memory, giving users a semiconductor alternative to disks in storage application; TI readies a similar prototype. *July 8, p. 32*
- FCC issues the first standard specification for plugs and jacks to allow interconnection to telephone networks. *July 22, p. 36*
- Bell System finishes six months of successful testing on an experimental fiber-optic phone link in Atlanta; Teleprompter uses an 800-ft fiber-optic link for CATV in New York. *July 22, p. 43*
- Using a bi-fet linear process, National Semiconductor introduces the first single-chip sample-and-hold circuit, breaking the \$5 barrier. *July 22, p. 44*

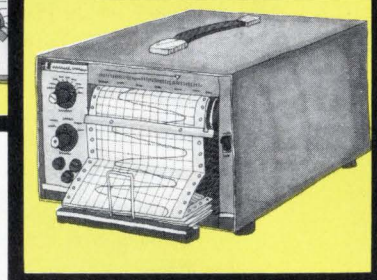
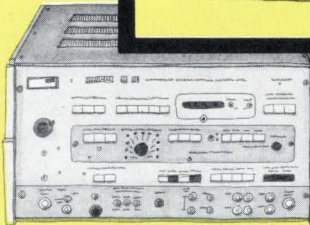
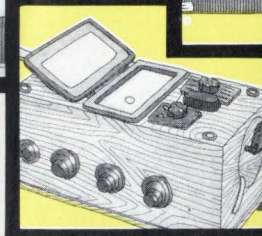
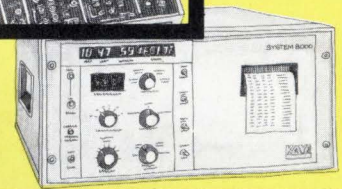
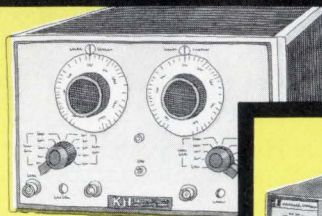
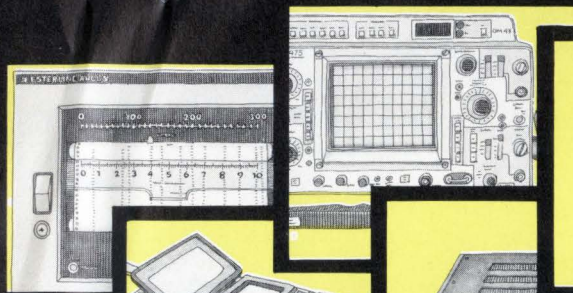
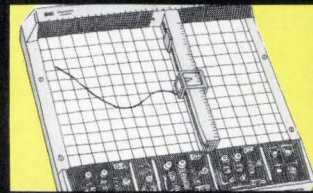
AUGUST 1976

- FCC expands class D citizens' band radio service from 23 to 40 channels, effective Jan. 1, 1977. *Aug. 5, p. 49*
- General Motors Corp. announces that 1977 Oldsmobile Toronados will use custom 10-bit microprocessors from Rockwell for ignition timing. Gas mileage is expected to improve 8%. *Aug. 19, p. 43*

SEPTEMBER 1976

- Resident PL/M compiler on Intel Corp.'s Intellec system gives microcomputer designers access to powerful software techniques. *Sept. 2, p. 34*
- General Instruments' new 8-k electrically-alterable read-only memory answers users' needs for erasable, nonvolatile semiconductor memories. *Sept. 16, p. 40*
- A 350-ns, 16-k ROM from Mostek, the industry's fastest MOS ROM, boosts throughput of microprocessor systems. *Sept. 16, p. 42*
- Texas Instruments starts the first commercial bubble-memory production with a 92-k device aimed at disk and drum storage memory systems. *Sept. 30, p. 29*

You Don't Have To Beg, Borrow Or Buy...



Rent'em From GE

Short or long-term instrument rentals give you flexibility and economy.

GE has over 9,000 instruments available for immediate shipment: □ Tek Scopes □ Biddle Megger Insulation Testers □ H-P Signal Generators □ Honeywell Oscillographs □ Complete Data Systems □ Esterline Angus Recorders □ GE Chart Recorders □ Modems □ Communication Terminals . . . all calibrated to the manufacturer's specs.

We have over 100 Sales/Service Centers,

and one of them is near you. In addition to maintaining our Rental Inventory, they can also repair and calibrate your own equipment.

Don't borrow someone else's GE Rental Catalog. **Call collect (518) 372-9900** or your nearest Sales/Service Center.

**Quick-rental[®]
instruments**

GENERAL  **ELECTRIC**

ALA. BIRMINGHAM (205) 925-3101 • **ARIZ.** PHOENIX (602) 278-8515 or 8516, TUSCON (602) 294-3139 • **CAL.** LOS ANGELES (213) 674-7900, SAN FRANCISCO (415) 436-9260 • **COL.** DENVER (303) 371-1260 • **CONN.** SOUTHINGTON (203) 261-4059 • **FLA.** JACKSONVILLE (904) 751-0610 • **GA.** ATLANTA (404) 458-2231 • **ILL.** CHICAGO (219) 933-4500 • **IND.** INDIANAPOLIS (317) 639-1565 • **KY.** LOUISVILLE (502) 452-3311 • **LA.** NEW ORLEANS (504) 367-6528 • **MD.** BALTIMORE (301) 837-4500 • **MASS.** BOSTON (617) 396-9600 Ext. 160, SPRINGFIELD (413) 781-1111 • **MICH.** DETROIT (313) 285-6700 Ext. 212 or 209 • **MINN.** MINNEAPOLIS (612) 522-4396 • **MO.** KANSAS CITY (816) 231-4377, ST. LOUIS (314) 342-7835 • **N.J.** CLIFTON (201) 471-6556 • **N.Y.** BUFFALO (716) 876-1200, SCHENECTADY (518) 385-2195 • **N.Y.C.** CLIFTON, N.J. (201) 471-6556 • **N.C.** CHARLOTTE (704) 525-0311 • **OH.** CINCINNATI (513) 874-8512, CLEVELAND (216) 523-6382, TOLEDO (419) 691-3501 • **OR.** PORTLAND (503) 221-5101 • **PA.** PHILADELPHIA (609) 424-4450, PITTSBURGH (412) 462-7400 • **TEX.** DALLAS (214) 357-7341, HOUSTON (713) 672-3569 • **VA.** RICHMOND (804) 232-6733 • **WASH.** SEATTLE (206) 854-0211 • **W.V.** CHARLESTON (304) 346-9421 • **WISC.** MILWAUKEE (414) 744-0110 • **PUERTO RICO** PONCE (809) 843-4225.

IC simulates matched transistor pairs

100 units on die are randomly paired for statistical matching; technique said to yield improved amplifiers, loggers, multipliers

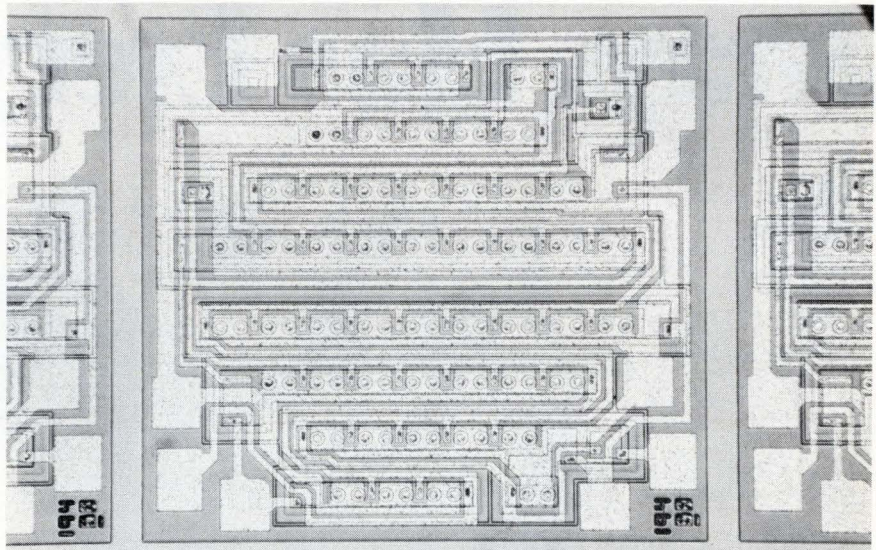
by Bernard Cole, San Francisco bureau manager

In a departure from traditional techniques, National Semiconductor Corp. has built what is essentially an integrated circuit that simulates the function of a matched transistor pair. The matching that results from the device—designated the LM194/394—is 10 to 60 times better than present transistor pairs, according to the company.

An unsung workhorse of the electronics industries, matched transistor pairs are used in many dc biasing jobs such as in instrumentation and power supplies, as well as in rf applications. They are usually made by fabricating two monolithic npn transistors on the same 600-to-800-square-mil die and trying to match their offsets. This approach has yielded transistor pairs matched within 0.5 to 3 millivolts.

What National has done with the LM194/394, says Carl Nelson, advanced-linear designer, is fabricate 100 npn monolithic transistors onto a die that is about 2,500 square mils in area and connect 25 pairs in parallel with the other 25. "But rather than attempting to match offsets," he says, "the attempt is made to randomly interconnect the 50 pairs of transistors to take advantage of statistical variations and random cancellation of offsets."

Even though any one pair may have offsets whose match varies between 0.5 and 3 millivolts, the net effect for all the 50 pairs is an offset matching to within 50 microvolts. "The matching gets closer to zero as the number of pairs in parallel goes up," he says. "More accurately, matching improves as a direct ratio of the square root of the number of transistors." A 100-transistor



matched-pair simulation, Nelson says, therefore offers a ten-fold improvement in performance over standard matched pairs on a die that is only two to four times larger.

Electrical characteristics of the LM194/394, such as drift versus initial offset voltage, noise, and the exponential relationship of the emitter-base voltage to the collector current, he says, "closely approach those of a theoretical transistor." On top of the 50- μV matching, offset voltage drift in dc amplifiers is held to 0.1 $\mu\text{V}/^\circ\text{C}$ (versus 2 μV for most transistor pairs). The IC circuit has a minimum current gain of 500, a current-gain match within 2%, and a common-mode rejection ratio of 120 to 130 decibels, compared with the 100 db of conventional matched pairs.

Another product of the statistical matching of transistor pairs, he adds, "is a device with virtually only theoretical noise, enhancing its useful-

ness in ac amplifiers and nonlinear circuitry." Most of the parameters are guaranteed over a current range of 1 to 10 microamperes and a collector-base voltage from 0 to 40 v.

To guarantee long-term stability of matching parameters, internal clamp diodes have been added across the emitter-base junction of each transistor. These prevent degradation from reverse-biased emitter current, the most common cause of field failures in matched devices, Nelson says. "The parasitic isolation junction formed by the diodes also ensures isolation between devices," the designer adds.

Available in an isolated-header, six-lead TO-5 package, the LM194/394 is priced at \$2.75 each for devices specified for operation from 0°C to 70°C.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [338]

Get Everything You Always Wanted For Switchers From A Source That Always Has Everything. Us.



Everything for control...



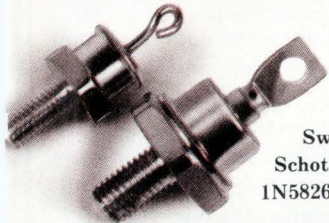
Switchmode*linear
IC regulator MC3420

For the first time, there's a unique control circuit available with everything you need to regulate the simplest to the most complex constant frequency switching supply: reference... oscillator... PWM... phase-splitter... dual alternating outputs... and unique 0-100% dead time comparator.

Just plug it in and your design work's done!

Specs include 10-30 V supply range, 2-100 KHz operation, 0.5 V-at-40 mA output sat voltage and 40 V blocking capability. Best of all, the MC3420 is priced at just \$5.75 (100 up).

Everything for efficiency...



Switchmode*
Schottky rectifiers
1N5826-34 15A-40A

Efficiency like you've never seen is yours with Motorola Schottky rectifiers — at least 80% or more in most high frequency designs. In a 500 W switching supply this can mean a saving of 625 W of power!

Switchmode Schottkys offer performance and price advantage — lowest VF at rated current... guard rings that protect barrier junctions from spikes... thermal resistance that doesn't... speed you can't even measure... super dv/dt... and, believe it or not, lower cost.

And they're reliable. Mil-type testing of *standard* units has shown excellent results. Nobody else passed initial screening.

Everything for power...



Switchmode* silicon power
2N6542-47, MJ10000/MJE13000
discretes & Darlingtons, 1.5-20 A, 300-400 V

These are the only devices around designed and spec'd to bring you *into* the switcher design cycle instead of keeping you *out*!

Designers* Data Sheets completely spell out all essential parameters for high-frequency, 100°C inductive use — RBSOA volt-ampere capability... high-temperature, clamped inductive load switching specs... switching times as functions of collector current and temperature... spec'd limits for active region SOA. No more "typicals" or empiricals!

Because no other source has taken time and effort to completely define necessary performance data of this state-of-the-power art.

Switchmode specs are presented with important applications info to aid you in device selection and use under *actual operating conditions*.

Put 'em all together...

They spell SWITCHER. With a capital state-of-the-art.

The 20 KHz revolution in power supplies has taken hold of the designer's imagination and Motorola is the *only* semiconductor source able to supply you with *all* the devices you want to put your design skills to work... from IC to zener.

Nobody else can make that statement. Check it out.

And we can add an edge or two to your particular switching supply design through applications engineers who work on nothing but. Call us.

Everything else for everything else...



72 Rectifier Bridges
from 1 A to 35 A

85 Fast Recovery Rectifiers
from 1 A to 40 A

132 Rectifiers from 1 A to 50 A

198 Triacs from 0.45 A to 40 A

377 SCRs from 0.5 A to 80 A

556 Small Signal Transistors
from 10mW to 1 W

764 Voltage Reference Diodes
from 6.2 V to 200 V

1,191 Zener Diodes
from 1.8 V to 200 V

... and one sensational, new unique crowbar IC — MC3423 — that protects against transients or regulator failure with adjustable threshold voltage and programmable overvoltage duration for just a buck-and-a-half!**

Free Design Pack



Designers Data Sheets, application notes and engineering bulletins — including our new, "Showcase" switching supply — are available through any franchised distributor or Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036.

Get it.

Then get *everything* you want for your switcher from us.



MOTOROLA Semiconductors

**100-999 *Trademark of Motorola Inc.

Isolation amplifier includes supply

Selling for \$41 in hundreds, module for medical, industrial uses provides internal isolated source, measures 1.5 by 1.5 by 0.62 inches

by Lucinda Mattera, Components Editor

As they become smaller in size and lower in price, isolation amplifiers are being more widely used in medical and industrial applications. But to provide true isolation, these devices must be operated from an isolated power supply.

Now Analog Devices is offering a modular isolation amplifier that contains its own isolated supply—within a package that measures merely 1.5 by 1.5 by 0.62 inches. What's more, in quantities of 100, the model 284J is priced at just \$41 each. "OEMs can now cost-effectively buy a complete isolation amplifier, instead of investing engineering time in building their own," says Fred Pouliot, product marketing manager for Systems Components.

Besides powering the 284J's guarded floating front end, the internal dual-output supply can provide power for external circuitry, like transducers and signal-conditioning devices, he notes. It delivers an isolated output of ± 8.5 volts dc at ± 5 milliamperes. Furthermore, the 284J itself requires just a single-polarity supply of +8 to +15.5 v, enabling it to operate directly from a

single battery. The unit, therefore, is suitable for portable-equipment applications, and power consumption is only 85 milliwatts at 12 v, Pouliot says.

The 284J can withstand common-mode voltages of 2,500 v continuous or 5,000 v pulsed. Additionally, its common-mode rejection is guaranteed at 110 decibels minimum, even under a worst-case source imbalance of 5 kilohms. With a single resistor, gain can be adjusted from 1 to 10 v/v. This means that the unit can operate over a wide dynamic range, handling low-level signals as small as 8 microvolts peak to peak as well as large signals of up to 10 v pk-pk.

A transformer-isolated unit, the new module meets the patient-safety requirements of Underwriters Laboratories' Standard 544. In fact, leakage current is only 1.2 microamperes root-mean-square at 115 v ac and 60 hertz, Pouliot points out.

Over the entire gain range, linearity error is held to within $\pm 0.3\%$, while gain drift is just $\pm 0.025\%/^{\circ}\text{C}$ over a temperature range of 0°C to 70°C . From 0.05 to 100 Hz, input noise voltage is a low $8 \mu\text{v}$ pk-pk,

increasing slightly to $10 \mu\text{v}$ rms at frequencies of 10 Hz to 1 kilohertz. The 3-dB small-signal bandwidth is 1.1 kHz for gains from 1 to 10 v/v.

Applications are numerous, Pouliot observes, including biomedical instrumentation, patient-monitoring equipment, industrial process-control systems, interfacing with remote transducers, eliminating ground loops, and measuring off-ground signals.

In medical applications, such as multilead electrocardiography recorders and diagnostic equipment, the 284J provides protection from ground-fault currents and from 5-kilovolt defibrillator pulse inputs. In industrial applications, the 284J is suitable for computer interface systems, process-signal isolators, and sensitive instrumentation. It offers complete galvanic isolation and protection from high-voltage transients or fault surges.

The new amplifier, which is priced at \$59 in single quantities, is available from stock.

Analog Devices Inc., P.O. Box 280, Route 1 Industrial Park, Norwood, Mass. 02062. Phone: (617) 329-4700 [339]



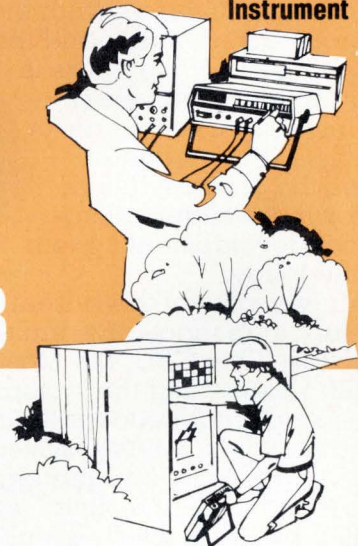
Simpson®

NEW PORTABLE DIGITAL MULTIMETER



460-3

- 0.1% DC V Accuracy
- 3½ Digits • 32 Pushbutton Ranges
- IC reliability
- All in a Compact State-of-the-Art Instrument



Lab quality in a portable instrument for general electronic servicing and industrial testing.

- High accuracy \pm (0.1% of reading + 1 digit) on all DC voltage ranges
- Large bright 0.43" LED readout
- 32 ranges: 5 DC voltage ranges to 1000V
5 AC voltage ranges to 600V
5 Lo-power ohms ranges to $2M\Omega$
5 Standard ohms ranges to $20M\Omega$
6 DC current ranges to 10 amps
6 AC current ranges to 10 amps
- Rugged, high-impact case with adjustable tilt-view handle
- Calibrated analog meter included for nulling and peaking as well as scanning trends
- Choice of battery and AC line operation or AC line operation only

460-3A for 120/240 VAC (50-400 Hz) power line operation; with test leads, line cord, and operator's manual \$285.00

460-3D for battery operation (batteries not included) and 120/240 VAC (50-400 Hz) power line operation; with test leads, line cord, operator's manual \$322.00

ACCESSORIES

RF Probe, Catalog No. 00433 \$25.00

40kV High Voltage Probe, Catalog No. 00432 \$35.00

AC Amp-Clamp Adapter, Model 154 \$29.50

Rugged Carrying Case, Catalog No. 01617 \$25.00

In stock at your local electronics distributor

Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY

853 Dundee Avenue, Elgin, Illinois 60120 • (312)697-2260

CABLE: SIMELCO • Telex: 72-2416

KATY INDUSTRIES



INDUSTRIAL EQUIPMENT GROUP

Universal One

The Microprocessor Development System for the 8080, 2650, and 6800.

It's universal. Millennium's Universal One System interfaces to the most commonly used microprocessors today and others in the near future.

And, it's universally accepted. It's so well accepted that design engineers call it a hardware development aid. It's so powerful, application programmers call it a complete software development system. And project managers? They know it as a great time and money saver and don't worry about what it's called.

Can the project manager be right?

The ability to interface with the different microprocessors of today and the new microprocessors of the future is the key benefit of Universal One. Universal One will never be obsolete and therefore provides the greatest *Return On Investment* of any microprocessor development system available today.

The universality of the system is based on Universal One's innovative multiple CPU architecture. One CPU, the Master CPU, is the controlling element of the system and executes all application *independent* functions; file management, text editing, system utilities, system I/O and software debugging.

The second CPU, the slave, which is controlled by the master, executes those functions that are application *dependent*; the microprocessor Assembler, in-circuit testing, user application programs, and user I/O. Additional microprocessor slaves are readily added by interfacing the new slave to the system bus and integrating it into the system software.

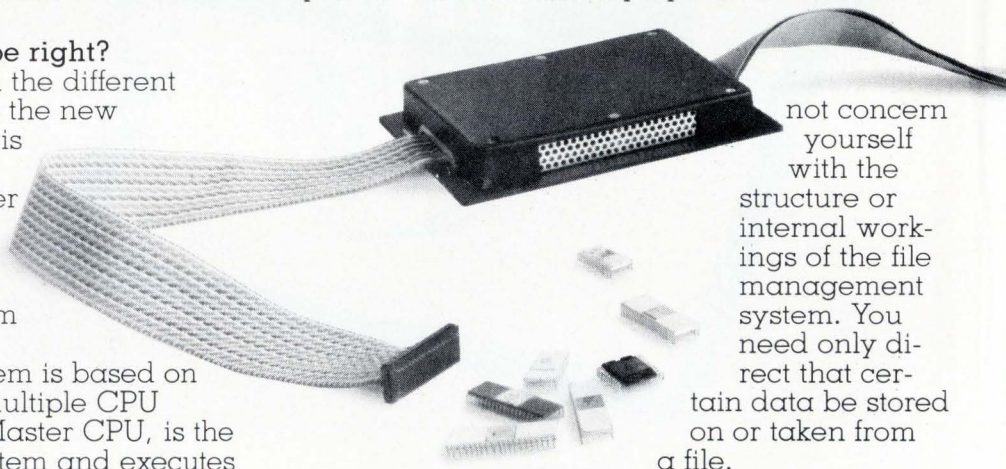
By meeting all the staff's needs, Universal One cuts costs. It's not necessary to have special test fixtures for design engineers and software development systems for programmers. Universal One saves on personnel training expenses since only one system interface need be learned.

Can the programmer be right?

Universal One's software capabilities rival those found on many powerful minicomputer systems. Universal Disk Operating System (UDOS) was developed specifically for and tailored to the multiple CPU architecture. The

operating system is executed by the Master CPU in its own totally protected Master memory to prevent disruptions by application programs.

UDOS is floppy disk file oriented. The system was designed specifically for the characteristics and peculiarities of a floppy disk and as such makes maximum use of its benefits. Many file management functions, normally required to be performed by the user, are performed automatically by UDOS. You need



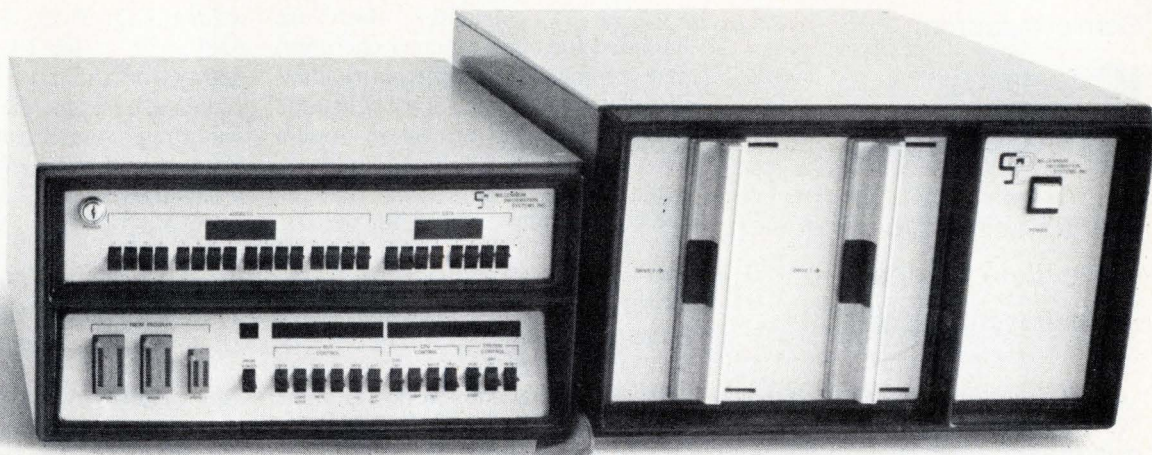
not concern yourself with the structure or internal workings of the file management system. You need only direct that certain data be stored on or taken from a file.

μ BASIC™, Millennium's proprietary high level compiler, is a flexible version of BASIC tailored for microprocessor development applications. Unlike interpretive systems the final output of μ BASIC is the object code for the microprocessor. μ BASIC can also be intermixed with Assembly for memory space reduction and faster program execution.

With Universal One's dynamic trace capability, the activity of a program is traced, instruction by instruction. For break-point analysis two hardware registers provide a break and display of the breakpoint address and contents on memory fetch only, memory write only or on memory read/write access.

Universal One contains a powerful text editor which is file oriented and has macro and iteration capabilities for combining commands.

Millennium provides comprehensive diagnostics which not only test the system's processors, memory & I/O but also check peripheral devices and interrupt logic.



Can the design engineer be right?

Universal One provides two modes of development system emulation for saving time during initial hardware debug and during hardware/software integration. In the first mode, Universal One emulates the prototype's microprocessor and its memory, while I/O functions are controlled by the user hardware. In the second mode, the prototype uses its own memory and I/O. Universal One's two-stage emulation eases the transition from initial test to full prototype implementation.

The front panel PROM sockets accommodate the most commonly used PROMs, the *2708, the 1702A MOS erasable and 82S115 family of bipolar PROMs. Others will be added in the future.

Can they all be right?

Obviously yes! Universal One has the capabilities to get development projects completed on time and within budget. And, Universal One will be just as valuable in the future as it is today. The universal architecture assures the product will never be obsolete.

Universal One's powerful operating system is easy to use so personnel get the most out of it whether they are inexperienced or advanced programmers. μ BASIC saves vast amounts of software development and maintenance time.

Last but not least, development system emulation simplifies hardware and software integration. Put it all together, it's the Universal One for 8080s, 2650s, *6800s, application programmers and design engineers.

* Available January, 1977

A better hardware solution

If you already have good techniques for assembling and debugging your programs but need hardware and PROM programming capabilities, Millennium has a solution. It's Universal Emulator, an advanced product that provides all the hardware emulation and PROM programming capabilities of Universal One at a lower price. And, it can be upgraded to the Universal One in the field at any time.

You can be right, too!

Universal One and Universal Emulator are available for immediate delivery. A complete Universal One System with a single slave and dual flexible disc is \$8,900. Additional slaves are \$1,250. A single slave Universal Emulator is \$4,500. For a prompt direct reply, return the coupon.

I'm tired of doing it the hard way. Show me a better way. My need is — Immediate — Within the next six months — for information only.

Name _____

Title _____

Company _____

Address _____

City/State/Zip _____

Application _____

Phone _____

MILLENNIUM

420 Mathew Street
Santa Clara, CA 95050
(408) 243-6652

New products

Semiconductors

ICs drive gas displays

Interface circuits

deliver high voltages to gas-discharge units

Gas-discharge displays are enjoying healthy growth in such markets as point-of-sale equipment, calculators, instruments, electronic games, computer terminals, and industrial-process monitoring. But these displays require fairly high operating voltages, compared to the relatively low voltages available from the logic circuitry that controls them.

However, Dionics Inc. of Westbury, N.Y., now has three new families of monolithic drivers for gas-discharge displays that deliver high-voltage outputs from low-voltage logic inputs. The new lines include the series DI-300 segment drivers, the series DI-500 digit drivers, and the series DI-5100/5200 drivers for ac plasma displays. All the chips are dielectrically isolated integrated circuits.

The DI-300 and the DI-302 segment drivers are designed to operate from signals developed in

MOS or TTL circuitry. Both are intended for eight-channel operation and are housed in 18-pin plastic dual in-line packages. Their constant-current outputs are programmable over a range of 0.1 to 2.5 milliamperes. Supply voltage is -200 v for the DI-300, and -125 v for the DI-302. In quantities of 1,000, the DI-300 sells for \$2.45 each, while the DI-302 is priced at \$2.06 each in the same quantities.

Available in 4-, 6-, and 8-line versions, the DI-500 series of digit drivers is also compatible with either MOS or TTL circuitry. Each section of these devices is made up of a switched constant-current level shifter and a complementary-transistor driver pair. The DI-500, -505, and -510 devices offer 200-v level-shift capability, while the DI-502, -507, and -512 provide 125-v level shifting.

They are packaged in 14-, 16-, or 18-pin plastic DIPs. Prices range from \$1.50 to \$3.97 each in 1,000-unit lots.

The drivers for ac plasma displays are designed to deliver switched, high-voltage, square-wave signals to either multisegment or dot-matrix panels. Each driver provides five outputs that have integral diodes for pullup of off segments. Output current is as high as 5 mA per line, yet required input voltage is typically only 3 v. Output voltage is 140

v for the DI-5140, 180 v for the DI-5180, 240 v for the DI-5240, and 280 v for the DI-5280. The units come in 14-pin plastic DIPs, and operating temperatures can range from -15°C to $+70^{\circ}\text{C}$. They are priced at from \$1.41 to \$3.09 each in quantities of 1,000. All are available from stock.

Dionics Inc., 65 Rushmore St., Westbury, N.Y. 11590. Phone (516) 997-7474 (411)

Uhf power transistors

are broadband, rugged

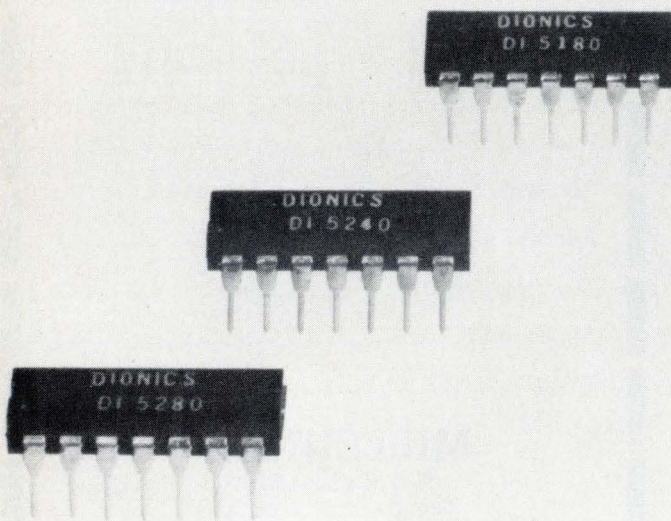
Operating in the range from 450 to 512 megahertz, a line of ultra-high-frequency power transistors is designed for broadband performance and unusual ruggedness. Made by Communications Transistor Corp., the devices are upgraded versions of CTC units widely used in land-mobile communications equipment. Offering maximum reliability because of their single-chip construction, they can withstand infinite voltage standing-wave ratio at all phase angles at 15.5 volts dc and rated output power. The transistors, all 12.5-v units in low-inductance stripline flange packages, consist of the 10-watt CM10-12A, priced at \$12.45 each in 100-piece quantities; the 20-w CM20-12A, \$16; the 30-w CM30-12A, \$20; the 45-w CM45-12A, \$24.50, and the 60-w CM60-12A, \$34.20. All are available from stock.

Communications Transistor Corporation, subsidiary of Varian Associates, 301 Industrial Way, San Carlos, Calif. 94070. Phone (415) 592-9390. [416]

Timer IC functions

as stable controller

Selling for less than 50 cents each in OEM volumes, a timer integrated circuit from Micro Components Corporation functions as a highly stable controller. The MCC-555 timer circuit, housed in a standard eight-lead dual in-line package, can be used for accurate time delays (monostable mode) and as an oscil-



Designing with Ferrites?

Here
comes
help



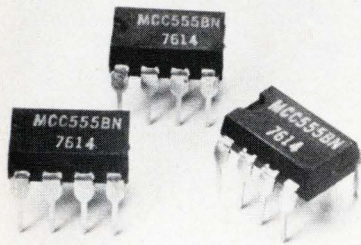
DESIGN — Get a complete design package with circuits that work, electrical specs that make sense and graphs to speed up the arithmetic. Ask about ferrites for inverters (in three temperature ranges), broad band devices, attenuators, filters or pulse transformers.

PERFORMANCE — Get the best specs available because our ferrites are manufactured and tested for specific circuit applications. Ask for the lowest loss and get 30 MW/CC, highest perm and get up to 16,000, no rejects and get 100% pulse testing, maximum noise attenuation and get 20 DB at 100 kHz, high temp operation and get maximum efficiency at 125°C.

ECONOMY — Starting with our Series 18 components at \$4.00 per M, we have a range of ferrite products priced to meet your most critical OEM cost targets. Call (201) 826-5100 or write Indiana General, Keasbey, NJ 08832.

EMM indiana general
a division of Electronic Memories & Magnetics Corp.
Keasbey, N.J. 08832 • (201) 826-5100

New products



lator (astable mode). All input-output terminals are compatible with direct transistor-transistor-logic/diode-transistor-logic interfaces. Resettable time delays ranging from microseconds to hours can be obtained over the single power supply range from 5 to 15 volts. Output of the MC-555 can either sink or source up to 200 milliamperes.

Micro Components Corporation, 99 Bald Hill Rd., Cranston, R.I. 02920. Phone (401) 463-6000. [415]

Transistors offer ratings to 1,000 volts, 500 watts

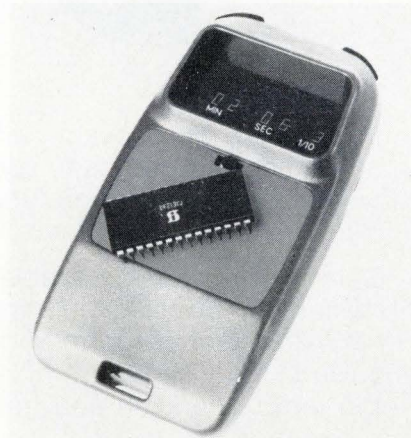
Aimed at applications in high-voltage dc regulators, high-voltage switching power supplies, and switching regulators, a series of npn power transistors made by International Rectifier, have ratings up to 1,000 volts and 50 watts. Designated the series IR721, the transistors are rated for a continuous collector current of 3 amperes. Maximum dc gain for the devices is 60 at 150 milliamperes and 5 v. All are glass-passivated to provide stability at high junction temperatures and are made with triple-diffused processing to allow operation at exceptionally high voltages with a wide safe-operating region. The IR721 high-voltage transistors are among a group of 15 power transistors and Darlingtons being introduced by IR. Price of the IR721 devices is \$6.10 each in quantities from 100 to 999. Delivery is from stock.

Semiconductor Division, International Rectifier, 233 Kansas St., El Segundo, Calif. 90245. Phone (213) 322-3331. [417]

One-chip stopwatch circuits are multifunctional

Through use of digital stopwatch circuits that operate as dual timing systems, a single electronic stopwatch can replace two timepieces in sports, engineering and scientific applications. Also the metal-oxide-semiconductor large-scale-integrated devices from Siliconix provide single-chip replacements for 20 or more conventional logic circuits in precision timing systems. This is expected to lead to widespread use of digital-stopwatch technology in a variety of industrial applications.

The new integrated circuits are the DF213 minutes-seconds sports stopwatch and an interchangeable version, the DF214 decimal-minutes industrial stopwatch. The DF214 provides a readout format that simplifies tabulation and calculation of timing in process control, test timing, time and motion studies, laboratory instrumentation, and aircraft navigation. Each device con-



tains two independent timers that can operate in two readout modes. One timer accumulates total elapsed time, and the other accumulates lap time. The technique allows the ICs to perform timing functions that usually require the skilled manipulation of two separate stopwatches or use of a complex timing-logic system. Outputs are delivered in a binary-coded-



Zilog products are available now. Contact:

ALABAMA HUNTSVILLE
Technology Marketing Assoc. (205) 883-7893

ARIZONA MESA
Nakoma (602) 834-6549

CALIFORNIA GOLETA
The Thorson Company (805) 964-8751

CALIFORNIA LOS ANGELES
The Thorson Company (213) 476-1241

CALIFORNIA MOUNTAIN VIEW
The Thorson Company (415) 964-9300

CALIFORNIA SAN DIEGO
Littlefield & Smith Assoc. (714) 455-0065

CALIFORNIA TUSTIN
The Thorson Company (714) 544-5121

COLORADO BOULDER
RG Enterprises, Inc. (303) 447-9211

FLORIDA ORLANDO
Technology Marketing Assoc. (305) 857-3760

FLORIDA POMPANO BEACH
Technology Marketing Assoc. (305) 942-0774

ILLINOIS CHICAGO
Mar-Con Associates, Inc. (312) 675-6450

INDIANA CARMEL
S.A.I. Marketing Corp. (317) 844-7196

MASSACHUSETTS WALTHAM
Impact Sales (617) 893-2850

MICHIGAN BRIGHTON
S.A.I. Marketing Corp. (313) 227-1786

MICHIGAN GRAND RAPIDS
S.A.I. Marketing Corp. (616) 942-2504

MINNESOTA MINNEAPOLIS
Quantum Sales, Inc. (612) 831-8583

MISSOURI FLORISSANT
S.A.I. Marketing Corp. (314) 837-5200

NEW JERSEY WALL TOWNSHIP
Quay Corporation (201) 681-8700

NORTH CAROLINA RALEIGH
Bob Dean, Inc. (919) 851-2065

OHIO BEACHWOOD
S.A.I. Marketing Corp. (216) 292-2982

OHIO CINCINNATI
S.A.I. Marketing Corp. (513) 761-5432

OHIO DAYTON
S.A.I. Marketing Corp. (513) 277-8911

PENNSYLVANIA PITTSBURGH
S.A.I. Marketing Corp. (412) 782-5120

TEXAS DALLAS
The Thorson Company (214) 233-5744

TEXAS HOUSTON
The Thorson Company (713) 771-3504

VIRGINIA ALEXANDRIA
Dyna Rep Company (703) 354-1222

WASHINGTON BELLEVUE
SDR² Products & Sales (206) 747-9424

CANADA
CALGARY, ALBERTA
Westronic Engineering (403) 253-5585

OTTAWA, ONTARIO
Datagraphics (613) 225-0411

TORONTO, ONTARIO
Datagraphics (416) 622-6752

DENMARK
SC Metric A/S 02/80 42 00

ENGLAND LONDON
Cramer Electronics 01/579 3001

FINLAND
FINN Metric OY 90/46 08 44

FRANCE BOULOGNE
AZM 603-66-40

GERMANY MUNCHEN
Kontron Elektronik GMBH 08165/771

ITALY MILAN
Ezimar SPA 3493539

NETHERLANDS AMSTERDAM
Ikelec Airtronic 020-92 87 66

NORWAY
Metric A.S. 02/28 26 24

SWEDEN SOLNA
Scandia Metric AB 08/82 04 00



The Battle of the 80's continues:

With the introduction of Zilog's Z-80 microcomputer products the tide is turning in the battle for supremacy.

Features:	8080A	Z80-CPU	Features:	8080A	Z80-CPU
Power Supplies	+5,-5,+12	+5	Addressing Modes	7	11
Clock	2 Φ , +12 Volt	1 Φ , 5 Volt	Working Registers	8	17
Standard Clock Speed	500 ns	DC to 400 ns	Static Operation	No	Yes
Interface	Requires 8222, 8228 & 8224	Requires no other logic and includes dynamic RAM Refresh	Non-maskable Interrupt	No	Yes
			Full TTL Compatibility	No	Yes
Interrupt	1 mode	3 modes; up to 6X faster	Throughput	Up to 5 times greater than the 8080A	
Instructions	78	158*	Program Memory	Generally 50% less than the 8080A	
OP Codes	244	696	*Including all of the 8080A's instructions.		

The Z-80 is a third generation LSI component set including CPU and I/O Controllers with full software support and second sourcing available now.

A single chip, N-channel processor arms you with a super-set of 158 instructions that include all of the 8080A's 78 instructions with total software compatibility. The new instructions include 1, 4, 8 and 16-bit operations. That means less programming time, less program storage and less end costs. And you get memory-to-memory or memory-to-I/O

block transfers, nine types of rotates and shifts, bit manipulation, a legion of addressing modes and a standard instruction speed of 1.6 μ sec. The Z-80 CPU and peripheral circuits require only a single 5V power supply and a single phase clock. With these circuits you can interface directly to a wide range of both parallel and serial interface peripherals and even dynamic memories without other external logic. With all these features you'll require approximately 50% less memory space for program storage and you'll get up to 500% more throughput than the 8080A.

The Zilog Battalion includes a development system with: Z-80 CPU Card with 4K Bytes of ROM/RAM Monitor software • 16K Bytes of RAM memory, expandable to 60K Bytes • Real Time Debug Module and In-Circuit Emulation



Module • Dual Floppy Disc System • Software Package including Z-80 Assembler, Editor, Disc Operating System, File Maintenance and Debug.

We'll support this with resident microcomputer software, time sharing programs, software libraries and high-level languages such as PL/Z.

A reserve of reinforcements is ready. The Zilog Z-80 brings to the battlefield new levels of performance and ease of programming not available in second generation systems.

And while all the others busy themselves with overtaking the Z-80, we're busy on the next generation—continuing to demonstrate our pledge to stay a generation ahead.

The Z-80's troops are the specialists who were directly responsible for the development of the most successful first and second generation microprocessors. Nowhere in the field is there a corps of seasoned veterans with such a distinguished record of victory.

Think of your next microcomputer as a weapon against horrendous inefficiencies, outrageous costs and antiquated speeds.



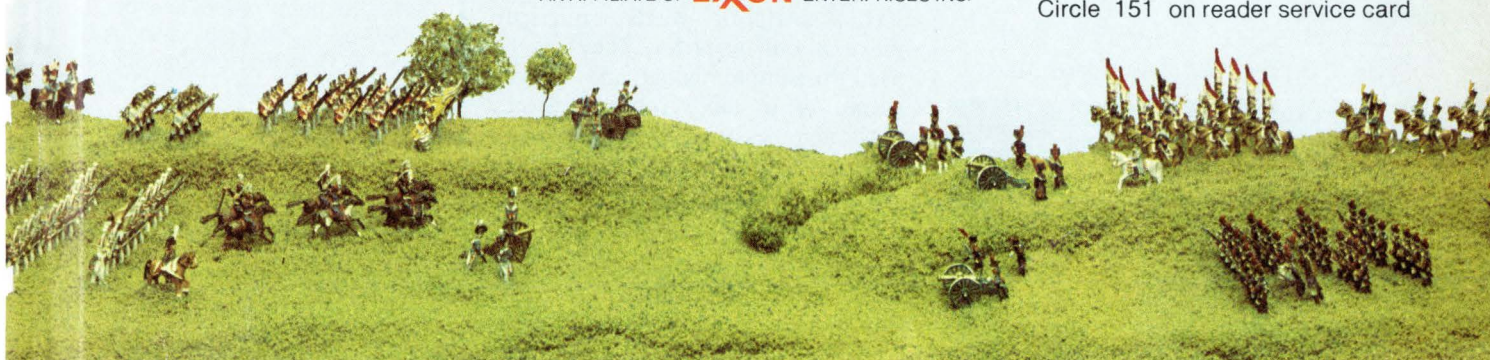
Zilog MICROCOMPUTERS

170 State Street, Los Altos, California 94022
(415) 941-5055/TWX 910-370-7955

AN AFFILIATE OF **EXXON** ENTERPRISES INC.

See ZILOG in Munich
at Electronica '76—
Hall 14, Booth 14104

Circle 151 on reader service card



Now there's a universal computer-based in-circuit/functional test system with extensive digital test capability.



FAULTFINDER[®] FF303

The new FF303 provides two separate in-circuit test approaches. Analog testing procedures use guarding techniques for straightforward component fault isolation. Pulse techniques are used for digital testing of all combinatorial and sequential logic independent of the surrounding circuitry. The FF303 can be configured with up to 928 analog test points and 1216 digital test points.

In-circuit test programming is done with a Faultfinder extension of BASIC which permits on-line editing and simplified, high-level language programming with user nomenclature.

The FF303 is a complete, flexible in-circuit test system for your production floor with low-cost software generation and unique capabilities for testing hybrid boards. We'd like to show you what it can do for you. Write or call for complete information.

Circle 152 on reader service card

FF FAULTFINDERS Inc.
15 AVIS DRIVE, LATHAM, NY 12110 (518) 783-7786

Irvine, CA
Sunnyvale,
Park Ridge, IL
Faultfinders GmbH, Eschborn, Germany

Cicero, IN
Waltham, MA

New products

decimal, digit-multiplexed format that is compatible with light-emitting-diode and gas-discharge display drivers. Housed in plastic dual in-line packages, both chips are priced at \$9.80 each in quantities of 100 to 999.

Siliconix, 2201 Laurelwood Rd., Santa Clara, Calif. 95054 [414]

Dual line-driver meets EIA data interface standard

Satisfying the interface requirements between data terminals and communications equipment as defined by EIA Standard RS-232-C, a dual line-driver from Fairchild permits 20,000 bits per second to be transmitted with a full 2,500-pico-farad load. The logic input is compatible with most transistor-transistor logic and diode-transistor logic families. Operation is from power supplies of $\pm 12v$.

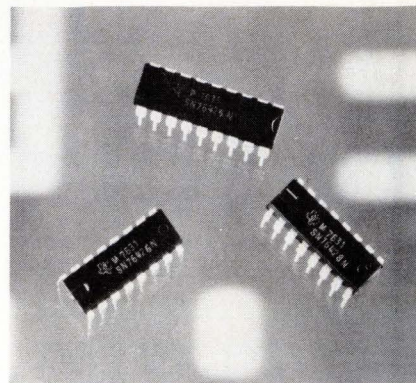
The 75150 is a pin-for-pin replacement for the SN75150. It is available from stock in a ceramic dual in-line package, priced at \$2.07 in quantities of 100; a plastic DIP at \$1.72; a ceramic mini-DIP at \$2, and a plastic mini-DIP at \$1.67.

Linear Integrated Circuits Division, Fairchild Camera and Instrument Corporation, 464 Ellis St., Mountain View, Calif. 94042 [418]

Video-game circuits offer wide flexibility

First group in a line of universal game circuits planned for applications in video games, six circuits developed by Texas Instruments Inc. offer a wide range of games with easily changeable features and game rules. Combinations of the six circuits allow games with multiple balls, multiple walls, multiple players, and obstacles. They can be used in simple tennis and hockey games or in more complex games such as races, battles, soccer, pool, and pinball. All are compatible with joystick operation.

The first six circuits are the



SN76423, game logic with automatic random English priced at \$1.25 in 100-unit quantities; SN76425, a horizontal and vertical synchronization generator priced at \$1.89; SN76426, a character generator, \$1.53; SN76427, a wall and ball generator, \$1.53; SN76428, game logic with manual English, \$1.25, and SN76460, O to W (Win) digital-scoring circuit, \$4.54.

Texas Instruments Incorporated, Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: Video Game ICs), Dallas, Texas 75222. Phone John Stich at (806) 747-3737, Ext. 246 [413]

TOPICS

Semiconductors

Motorola Semiconductor Products Inc., Phoenix, Ariz.,

has slashed the price of its MRF901 microwave transistor nearly 50%—from \$7.80 to \$3.75 (in hundreds). The small-signal device is commonly used in land-mobile and paging applications.

Fairchild Camera and Instrument Corp., Mountain View, Calif.,

has added six new device types to its Isoplanar 4000 series complementary-MOS family. Included are an 18-stage shift register, a quad buffer, two three-state latches, and two up/down counters.

Texas Instruments Inc., Dallas, has announced price reductions on its 1,024-by-1, 64-by-8, and 256-by-4 MOS static random-access memories. Prices for the 450-nanosecond versions of each of the memories, in hundreds, are \$2.10, \$3.80, and \$3.80, respectively.

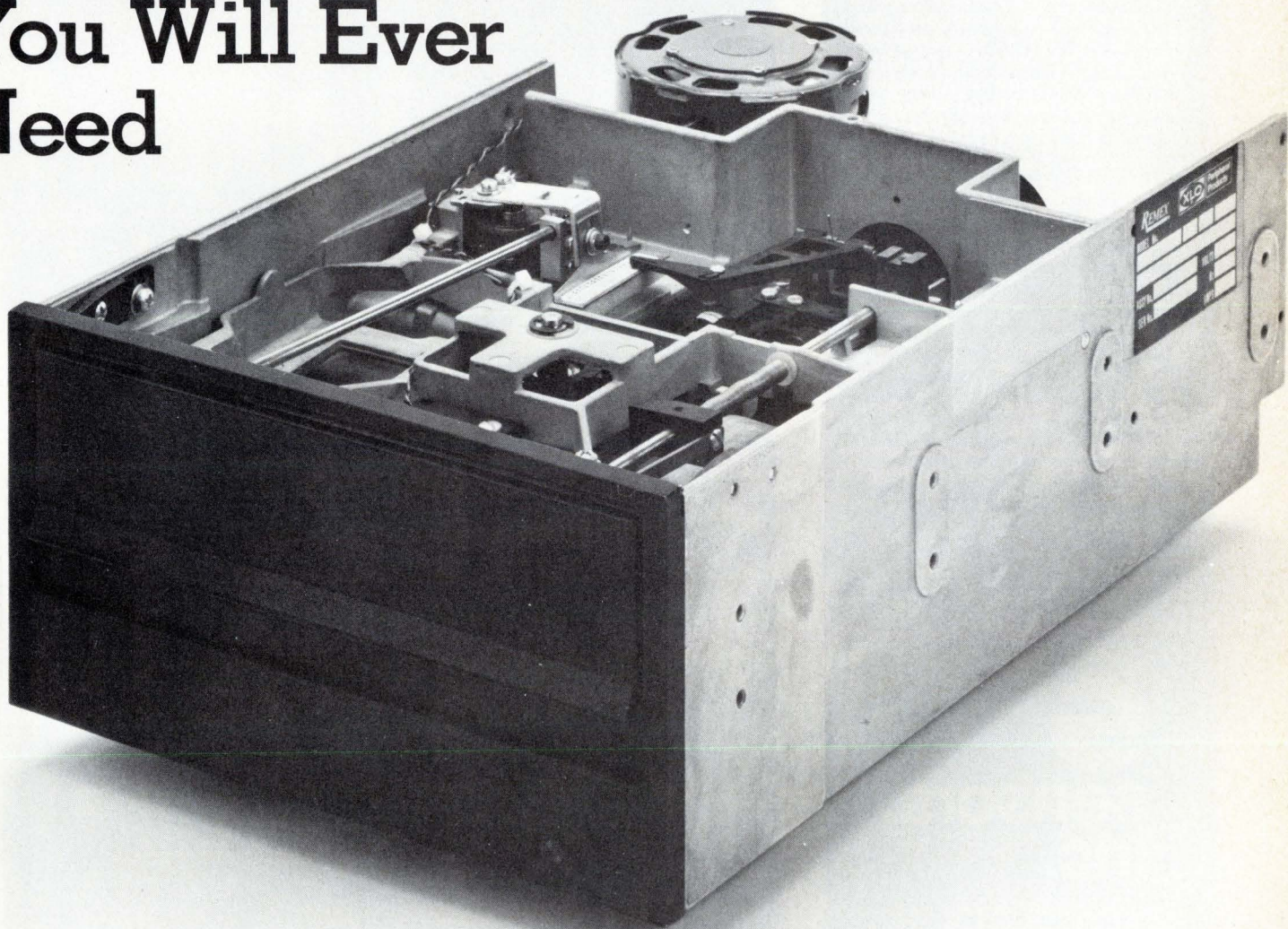
Circle 154 on reader service card →

The REMEX RFD 1000 — Because It's Versatile. Double or single density with capacity up to 6.4 Mbits... IBM standard or 32 hole hard sectored media without drive modification... IBM compatible or expanded hard and soft sectored formats for application flexibility... Unit select daisy chain capability for maximum controller efficiency... Selectable DC negative voltage for system compatibility... Individual drive housing or two drives horizontally side by side in a 19 inch rack configuration.

The REMEX RFD 1000 — Because It's Reliable. Ceramic head for extended life... Precision machined, die-cast construction... Operator interlock and expandable clutch for media protection... Front panel "head in contact" indicator and optional "head in contact" door lock... Optical write protect to assure data security... Stylus ball lead screw positioning system for long-lived accuracy... Optical track 00 sensing for drive carriage protection.

The Remex RFD 1000 is the RIGHT peripheral from Remex.

This Is The Only Flexible Disk Drive You Will Ever Need

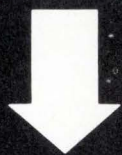


Ex-Cell-O Corporation

REMEX DIVISION

1733 E. Alton Street, P.O. Box C19533, Irvine, California 92713
(714) 557-6860, TWX (910) 595-1715. In Europe and the U.K.: SpA, Microtechnica
Via Madama Christina 147, Torino, Italy 10126. Circle 161 on reader service card

\$10 Thermopile Detector is here



Its initially high cost limited the thermopile to defense and space applications. Sensors patented production process lowered the price of the thermopile, permitting its use in gas analyzers, non-contact temperature monitors and fire detection systems. Our latest price milestone places the Sensors thermopile in a new realm of applications.

The thin film thermopile detector has long been the choice infrared detector in many instruments and systems. It is rugged, stable, and is especially suited for DC measurements. It is a low noise, low impedance device that has a flat response from the UV to 40 microns.

If your application does not require 5000 detectors yearly to take advantage of our \$10 price, we offer similar price advantages in lower quantities.

Could Sensors thermopile detectors lower your component cost? Find out how. Call today for quick answers or circle our reader service number.



**sensors,
inc.**

3908 Varsity Drive
Ann Arbor, MI 48104
Telephone: 313/973-1400

New products

Data handling

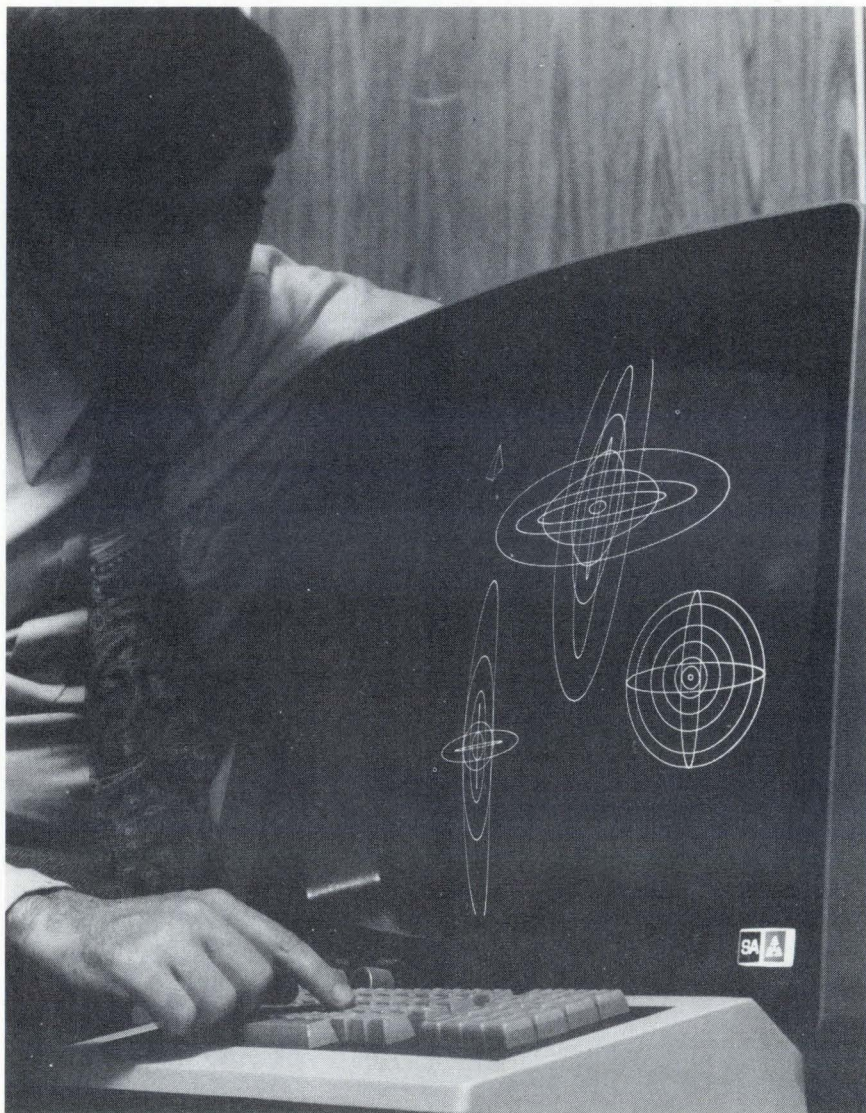
Microcomputers shrink terminal

Bipolar microprocessors
used in graphics unit
aid speed and flexibility

The incorporation of two microcomputers in the Graphic 7 interactive graphics terminal has allowed engineers in the Computer Graphics division of Sanders Associates to substantially reduce the size and price of the cathode-ray-tube terminal

[*Electronics*, Oct. 14, p. 26]. The microcomputers are based on bipolar bit-slice microprocessors.

Sanders engineers chose the 4-bit MMI 6701 microprocessor from Monolithic Memories Inc. to get bipolar speed and because it allowed them to write their own instruction set. One of the two microcomputer boards in the Graphic 7 has been programed as the display processor, replacing a minicomputer used in the earlier Sanders SA 500 system. Elimination of that separate box is the big contributor to size reduction, allowing the Graphic 7 to fit most desk tops. The other microcomputer is the graphics controller, which controls and refreshes the images presented on the screen. This micro-



ChipStrates™ cost up to 40% less than other power SCRs and Triacs.

And that's only the beginning.

ChipStrates are glassivated power SCR or Triac chips mounted on solderable ceramic substrates. Since they eliminate the need for expensive metal packages, they cost up to 40% less than other power SCRs or Triacs.

For example, our 55A, 400V, ChipStrate goes for just \$3.80 in quantities of 5,000. The electrically equivalent press fit Triac will run you \$5.00 in the same quantity.

But that's not all.

ChipStrates are available in ratings from 3 to 55A and up to 800V



and come in a rugged, electrically insulated package.

Their exceptionally good form factor will simplify the packaging of your system.

And their reliability is unmatched.

ChipStrate. The new concept in SCRs and Triacs that gives you more. And costs you less.

For the full story, just call or write: Carl Uretsky,
Unitrode Corporation,
580 Pleasant St., Watertown,
MA 02172. 617-926-0404.



™ChipStrate is a trademark of Unitrode Corporation.

sealed high density miniature switching

ENVIRONMENTALLY SEALED

Tbar[®]
SERIES 832/932

for 12 PDT to 108 PDT
with MIL-R-5757

protection against
humidity ...

sand ...

dust ...

moisture ...

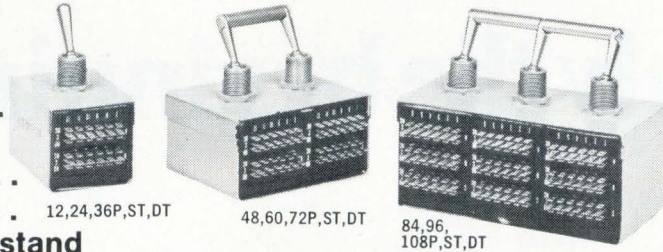
splash ...

explosion ...

corrosion ...

built to withstand

shock/vibration!



Toggle switches with contacts epoxy sealed in backfilled metal enclosures. Lever operates through diaphragm. Dust boot supplied to exclude salt and sand from mechanical actuator. Simple crimp snap-in contacts fit into single block for easy wiring. 108 circuits switched in a space as small as 2 5/8" x 4" x 1 7/8".

Interested? Write or
phone T-Bar today for
complete facts, prices,
quantity discounts.

Tbar[®] INCORPORATED

SWITCHING COMPONENTS DIVISION

141 Danbury Road, Wilton, CT 06897 • Telephone: 203/762-8351 • TWX: 710/479-3216

Circle 164 on reader service card

Line Isolated Standard

To eliminate ground loops, power line interruptions
and aberrations, EDC's new Calibrator/Source offers:

- $\pm 0.1 \mu\text{V}$ to 10V output • Accuracy $\pm 0.003\%$
- 10MA output current • Noise $1 \mu\text{V}$
- Internal battery-run 8 hrs., rechg. 4 hrs.
- Ext power - 115 Vac, 12 Vdc or 28 Vdc
- Absolute line isolation
- Model MV216A - \$1195.

Write or phone Bob Ross
for details. 11 Hamlin St.

Boston, MA 02127 (617) 268-9696



**ELECTRONIC
DEVELOPMENT
CORPORATION**



164 Circle 228 on reader service card

New products

computer contains 40 Sanders-developed instructions that are compatible with the earlier SA 500.

The display processor is a general-purpose unit that operates with 16-bit words or 8-bit bytes. The graphic controller is a 16-bit parallel micro-computer with the 40 display instructions, 13 display registers, and four general registers. It provides refresh rates of 30, 40, and 60 hertz.

The Graphic 7 can be connected to any standard local or remote computer. Roy Williams of the division's New Product Development department says a typical system, consisting of the terminal controller, 21-inch CRT display and keyboard, and 8,192 words of semiconductor memory, will sell for \$32,800. But the controller can drive several displays, and additional memory is available in 8-k increments.

Williams looks for the terminal to expand Sanders' penetration of the computer-aided design market for a variety of products from auto tire treads to aircraft parts. A.A. Hastbacka, manager of systems marketing in the Military Data Systems division, looks for the terminal to find widespread use in the military simulation and training market in which Sanders is already established. A version of the unit is being bid for a variety of Air Force aircraft simulation programs.

Interface options for the Graphic 7 include 16-bit parallel or RS-232C serial interfaces. Deliveries will begin in March.

Computer Graphics Division, Sanders Associates Inc., Daniel Webster Highway (South), Nashua, N. H. 03061. Phone (603) 885-5280. [361]

CRT display terminal
costs less, does more

Selling for \$2,600—13% less than its predecessor, the 2640A—the model 2640B interactive CRT terminal sports an improved keyboard and cursor sensing and positioning. The B version terminal gives the user a choice of either main-channel proto-

Electronics/October 28, 1976

17 days from now this trace will look the same as it does today. Now that's storage!

The Gould OS-4000 Digital Storage Oscilloscope . . .

will store any signal up to 450 kHz for as long as you need, while providing the performance of a conventional 10 MHz scope as well. The OS-4000 opens the door for entirely new viewing possibilities involving low frequency measurements. It is ideal for displaying and recording transient waveforms for medical, electrical, vibration, dynamic testing and pulse testing applications.

The digital storage capability provides a non-flickering, full trace at low frequencies and a unique "Dot Joining" technique.

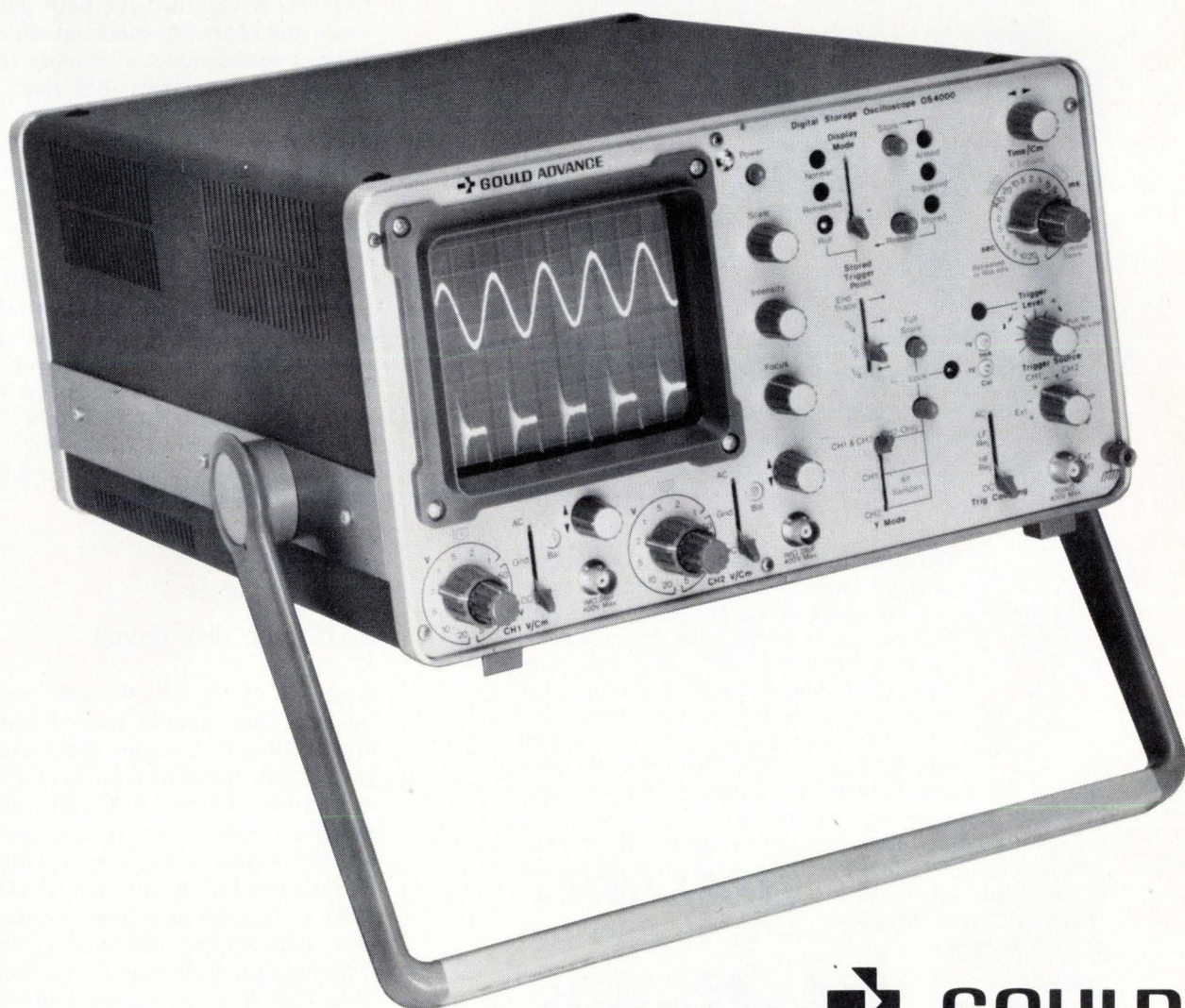
The OS-4000 will allow you to simultaneously view stored and real time signals. These may even be superimposed to reveal small changes.

The OS-4000 also allows you to examine a single event trace prior to, as well as after, a trigger point; and it's stored indefinitely as long as power is supplied to the unit.

If you'd like a hard copy of a stored trace, you can record it in either analog or digital form on your recorder by using the Gould 4001 Output Unit.

Find out how the unique Gould OS-4000 Digital Storage Oscilloscope and the companion 4001 Output Unit can make your work more efficient and easier. Call your nearest Gould Sales Engineer for details. Or write Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114.

PHONE TOLL FREE FOR BROCHURE (800) 325-6400.
(In Missouri (800) 342-6600)

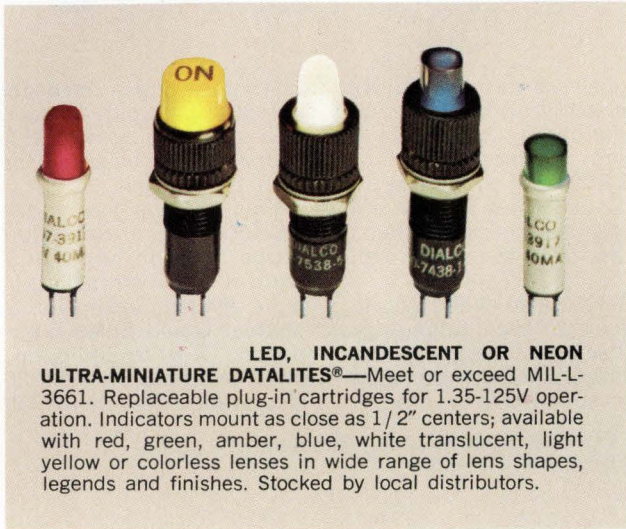


 **GOULD**

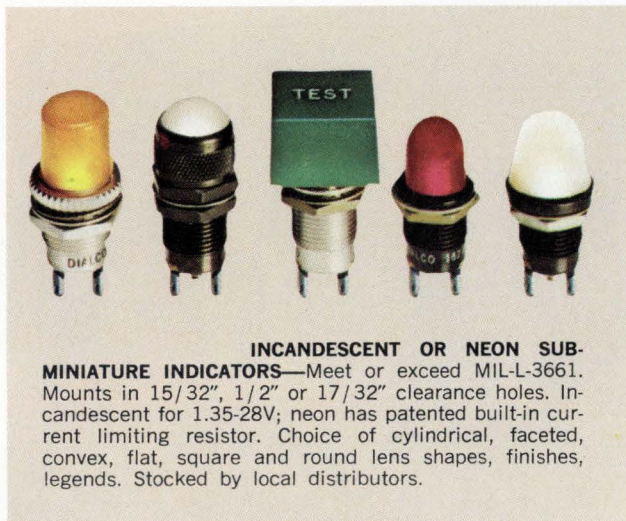
Dialight

INDICATOR LIGHTS

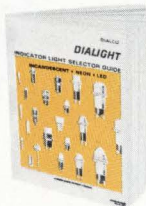
The widest choice for your every application.



LED, INCANDESCENT OR NEON ULTRA-MINIATURE DATALITES®—Meet or exceed MIL-L-3661. Replaceable plug-in cartridges for 1.35-125V operation. Indicators mount as close as 1/2" centers; available with red, green, amber, blue, white translucent, light yellow or colorless lenses in wide range of lens shapes, legends and finishes. Stocked by local distributors.



INCANDESCENT OR NEON SUB-MINIATURE INDICATORS—Meet or exceed MIL-L-3661. Mounts in 15/32", 1/2" or 17/32" clearance holes. Incandescent for 1.35-28V; neon has patented built-in current limiting resistor. Choice of cylindrical, faceted, convex, flat, square and round lens shapes, finishes, legends. Stocked by local distributors.



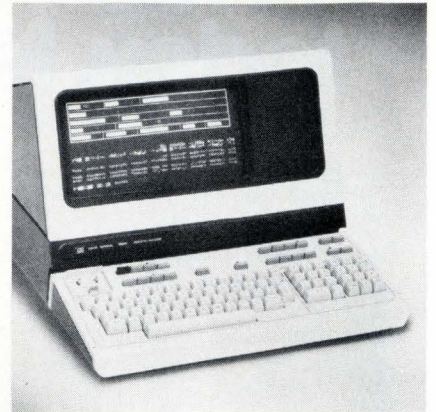
Dialight, the company with the widest choice in switches, LEDs, indicator lights and readouts, looks for needs . . . your needs . . . and then they develop solutions for your every application. No other company offers you one-stop shopping in all these product areas. And no other company has more experience in the visual display field. Dialight helps you do more with these products than any other company in the business, because we are specialists that have done more with them. Talk to the specialists at Dialight first. You won't have to talk to anyone else. Send for your free new copy of Dialight's current catalog.

DIALIGHT

Dialight, A North American Philips Company
203 Harrison Place, Brooklyn, N. Y. 11237
(212) 497-7600

See Dialight.

New products



col or standard reverse-channel protocol for half-duplex modem operation. And its additional firmware allows connection of most serial printers via an EIA RS-232-C interface. Like its predecessor, the new terminal is designed for both page-mode and character-mode operation. It has a semiconductor memory that can store more than 400 lines of data, which the user can view 24 lines at a time. Other standard features are off-line data preparation and editing, built-in self-testing, and modular construction for easy maintenance and expansion.

Two units based on the 2640B—the 2640N and the 2640S—offer keyboard layouts and character sets conforming to Danish/Norwegian and Swedish/Finnish language requirements, respectively. The N and S versions are priced at \$2,750.

Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304 [363]

Exerciser tests

2315-type disk drives

A series of switch-selectable tests ranging from simple restore operations through complex data exercises can be performed on 2315-type disk drives by the DX-1000 disk exerciser. Able to test drives made by such manufacturers as Wangco, Pertec, and Diablo, the model DX-1000 tests such functions as seek, seek incrementing, decrement seek, increment or decrement up or down disk, and random incrementing. A digital readout of seek time, rota-

FLUKE PROVES AN INEXPENSIVE, HANDHELD DMM CAN BE BUILT WITHOUT LEAVING EVERYTHING OUT.

Let's face it.

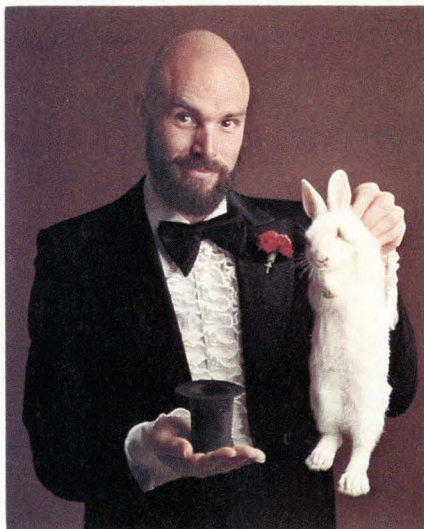
Before now, if you bought an inexpensive, handheld digital multimeter you didn't get much—they just left most everything out.

We knew that was no answer.

So we built the 8030A 3½-digit DMM. It's a small, portable, inexpensive, handheld DMM, but it performs like our benchtop units.

With one basic difference. The 8030A was designed, built and tested to a size and shape proven best for field service and laboratory technicians. There's a built-in hood that can be slipped forward to shade the readout in sunshine. It has rms capability. The best overload protection. Diode test. It weighs 2.2 pounds, and will take a beating without failing. Finally, we guarantee accuracy specifications for one year.

And it only costs \$235*.



"Fluke does the impossible again."

There is extensive overload protection. It has been tested with transients up to 6000V peak across the input terminals.

Options include two battery operations: a rechargeable NiCad for 8 hours operation and throw-away alkaline cells. Accessories include probes for measure-

ment of rf voltages, high current ac, high voltage dc and temperature.

80T-150 Temperature Probe
Sensitivity: 1 mV/°C or 1 mV/°F

Accuracy:
+15°C to +35°C ambient: ±2°C (3.6°F) -25°C to +125°C ±3°C (5.8°F)
-50°C to -25°C and +125°C to +150°C
0°C to 15°C, 35°C to 50°C ambient: Add 1°C (1.8°F) to above

You can also get temperature measuring capabilities with the 8030A.

And because the 8030A gives you so much in performance, let us remind you once more of the price.

Only \$235*.

For the first handheld DMM that's small in size, small in price, but huge in performance.

For data out today, dial our toll-free hotline, 800-426-0361.

John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043

Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands.

Phone: (013) 673-973 Telex: 52237

*U.S. price only.

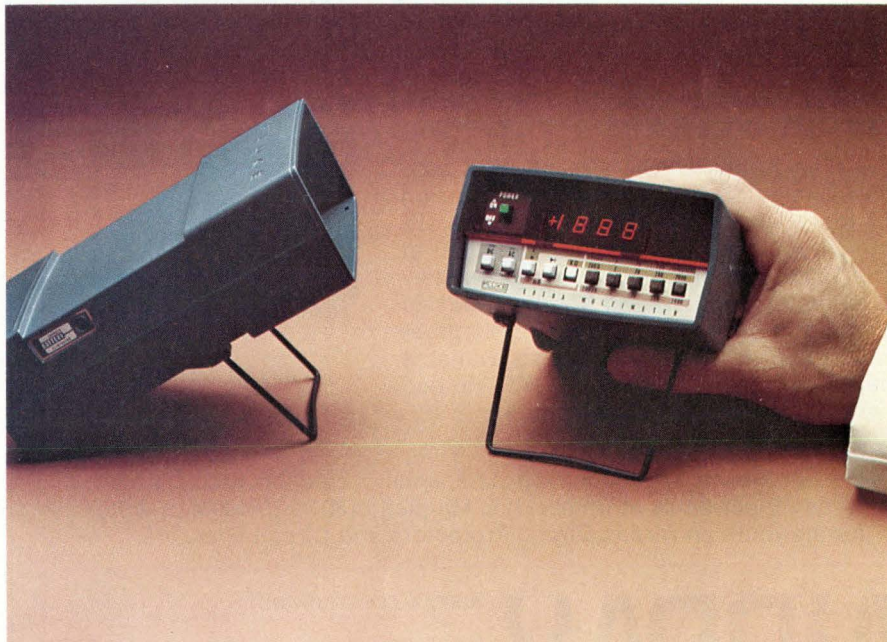
True rms.	Fluke
1-year accuracy specs.	Fluke
High voltage protection.	Fluke
Diode test.	Fluke

A full line of accessories offering rf voltage, high current ac, high voltage dc, and temperature measurement probes. Fluke

There's only one place to go for all the performance you need in a handheld DMM.

There are measurement functions in five selectable ranges for dc volts, ac volts (true rms), dc current, ac current (true rms), and resistance. DC voltage measurement is from 100 μV to 1100V with basic accuracy of ±0.1%, ac measurement is from 100 μV to 750V rms with basic accuracy of ±0.5%. DC and ac current is from 100 nanoamps to 1.999 amps with basic dc accuracy of ±0.35% and basic ac accuracy of ±1%. Resistance measurement is from 100 milliohms to 2 megohms with a basic accuracy of ±0.4%.

We added true rms response for ac measurements. Specified accuracy is still attainable when the measured waveform is distorted.



A NEW ADVANCE. 8030A DMM. **FLUKE**®

AIRPAX™



UPG Delay 66 Circuit Protector

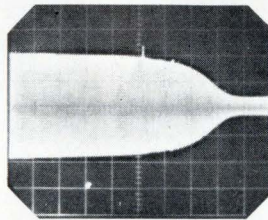


Problem Solver!

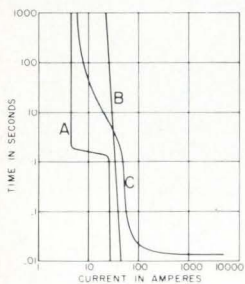
Problem:

Customer had a 1/3 hp, 115 volt single phase capacitor-run 3450 rpm motor. Running current was 4.6 amperes and starting current was 28 amperes with a start-up time of 1.6 seconds.

He needed overload protection that was faster than that supplied by the internal sensors and a fairly quick dropout in case of a jammed load or stalled rotor.



Start-up Current Envelope
Vertical 7.5 amps rms/div.
Horizontal .2 sec./div.

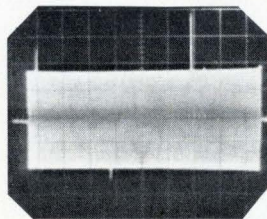


Time vs Current
A — Motor Characteristics
B — 15A Fuse
C — UPG Delay 66, 5A

In order to start the motor without blowing a fuse, he was forced to use a 15 ampere rating. This gave him stalled rotor protection at about 10 seconds, but no overload protection. The standard long delay magnetic protector required a 7½ amp rating to be able to turn his motor on reliably. This gave him his stalled rotor protection at about 5 seconds, and overload protection at 200%. Still not good enough.

Solution:

The Airpax UPG Delay 66, at 5 amp rating eliminated this problem with turn on . . . locked rotor protection at about 4½ seconds . . . and overload protection at about 150% on nameplate in approximately 400 seconds. This allowed short periods of overload without nuisance tripping. His problem was solved. (Delay 66 is also available in larger Airpax Type 219 and 229 Molded Case units up through 100 amperes.)



Stalled Rotor Trip Out
Vertical 7.5 amps rms/div.
Horizontal .5 sec./div.

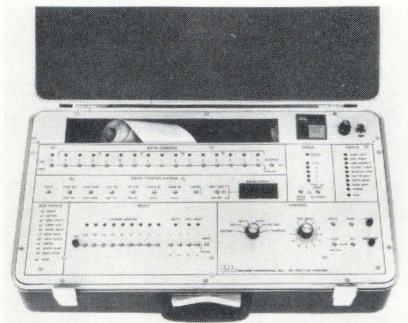
If you have an application with a special protection problem, call Airpax Electronics at Cambridge, Maryland (301-228-4600) or write for literature on Airpax Circuit Protectors and Circuit Breakers.

AIRPAX™

**AIRPAX ELECTRONICS
CAMBRIDGE DIVISION**
Cambridge, Maryland 21613 • Telex 8-7715 • TWX: 710-865-9655
Other Airpax Divisions:
CONTROLS DIVISION, Ft. Lauderdale, Florida
Instruments for Industry
AMERICAN DATA, Huntsville, Alabama
TV Products

New products

tional speed, and sector count allows the user to determine if the drive is within factory specifications.



The exerciser offers three basic data patterns: 16 bits of fixed track address data, 16 bits of incrementing data, and 16 bits of random data. Switches allow the user to choose various standard bit packing densities, track packing densities, disk speeds, and read/write formats. The DX-1000 is equipped with 16 bits of error counting with overflow, and has a stop-on-error feature for overnight testing for bit dropouts.

The portable, 20-pound unit sells for \$1,995.

Wilson Laboratories Inc., 2536-D East Fender Ave., Fullerton, Calif. 92631 [364]

Impact printers run at up to 240 lines/minute

Two rotating-belt impact printers have maximum printing speeds for upper- and lower-case text of 240



LOGIC BOARD TESTING DOES NOT DEMAND SOFTWARE PROGRAMMERS, AND LOTS OF MONEY.

There is a foolish notion in logic board test circles that says, "Plan on spending all the budget you have, plus a lot more, to get logic board testing results."

What nonsense.

Why, that's as bad as the arguments for testing in the end product. Is there no middle ground? You know, a good testing system for a fair price.

Of course there is. And we built it.

It's our 3000 Series Logic Testers. The 3020A is a console for high-volume production applications. It comes complete with 128 pins for under \$30,000*. The 3010A is a compact version for field service and low-volume production at less than half the price.

O.K. So why no high cost?

Most testers share one major shortcoming: the cost and complexity of programming. As logic boards become larger and more complex, test engineers anxiously reach for more computer power and more software.

It just isn't necessary.

The fact is that tediously developed, bit-by-bit sequences are now past history. Instead, we provide powerful groups of general-purpose sequences with various duty cycles and frequencies. Boards respond to them. Their mathematical qualities honor the constraints of your circuits and the laws of logic.

Specifically, the 3000 Series Testers have seven classes of signals. Over 350 unique bit streams and their complements are available to exercise the most complex boards.

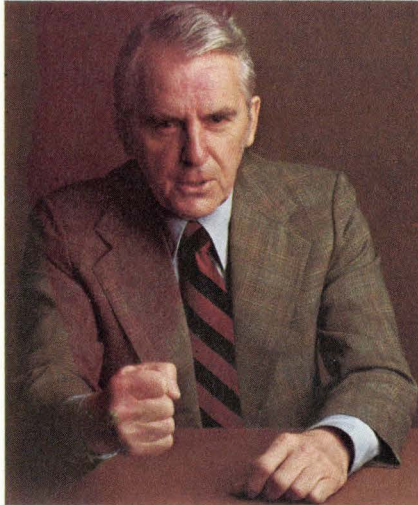
And, where a specific sequence is needed, it is easily added.

The test engineer doesn't program in the conventional sense. He simply develops a test plan which consists of selecting the appropriate stimulus algorithm for each input.

We've pre-programmed the CPU, simplified the peripherals, and eliminated 80% of the programming. That's what keeps the cost down.

The beautiful part is that test confidence ends up higher.

And fault isolation is just as practical as the price. It's hard to imagine



"Prove it."

any other tester making more common sense.

Test program assignments and editing are made on-line by pushbutton. Program debugging is simple. Whenever a pin number is entered, the sequence assignment is displayed. Sequences can be changed simply by depressing the appropriate pushbutton.

Again, there are no assemblers or compilers to fuss with. Highly compre-

hensive programs are completed in hours, not days or weeks.

And once the test program is entered into memory, you can record it easily on a handy little magnetic credit card that looks exactly like those credit cards in your wallet. The programmed card will function interchangeably with the production Model 3020A, or the field service 3010A.

Maybe we've made our point.

You can get a tester that offers four million tests per second, test sequences to 40 million words, and programmable logic levels without subsidizing a computer center and staff of programmers.

We'll prove it to you in dollars and cents.

Write and ask for "The Economics of Logic Board Testing." Everything you need is there to get you into logic board testing. Economically, for a change.

For data out today, dial (415) 965-0350. Fluke Trendar, a subsidiary of John Fluke Mfg. Co., Inc., 500 Clyde Avenue, Mountain View, CA 94043

Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Phone: (013) 673-973 Telex: 52237

*U.S. price only



COMMON SENSE 3010A/3020A TESTERS. **FLUKE**[®]

HP's Small Wonders

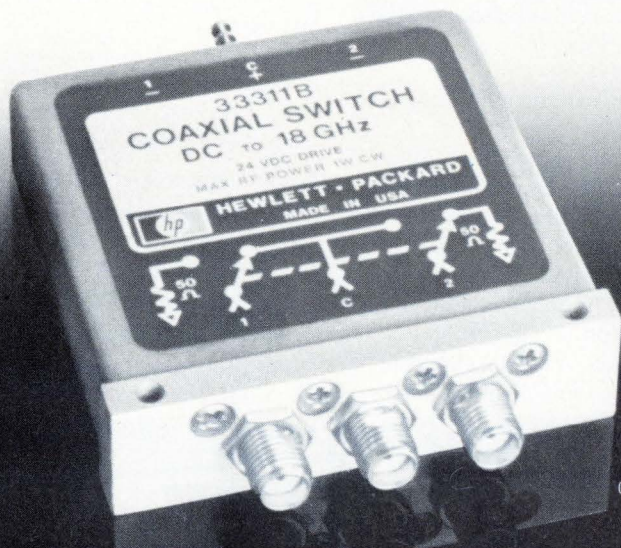
The 33311B OEM Microwave Switch

- DC to 18 GHz with 1.4 SWR, 0.8 dB loss and useable to 24 GHz.
- 90 dB isolation, $\pm .03$ dB repeatability at 10^6 switchings, ungated port terminated in 50 ohms.
- 30 ms switching time, zero-power magnetic latch, 5V or 24V coils.
- Small, rugged with a compact design that fits easily into microwave equipment. SMA connectors. Price is \$395* with quantity discounts available.

These and more than 300 other microwave measurement items are described in our 80 page coaxial and waveguide catalog. You can get a copy from your nearby HP field office, or write. *Domestic US prices only.



Sales and service from 172 offices in 65 countries.
1507 Page Mill Road, Palo Alto, California 94304



04607

For assistance call:
Washington (301) 948-6370, Chicago (312) 677-0400, Atlanta (404) 434-4000, Los Angeles (213) 877-1282

Circle 170 on reader service card

HOPE

in a word is what we are.

Project HOPE exists because there are people with hope—people who have given 3.5 million men, women, and children on four continents the chance for happier, more productive lives through improved health care.



Give to
Department A
Washington, D. C. 20007

New products

lines per minute. Depending upon the number of characters per line, the model 9212 prints from 120 to 240 lines/min, while the model 9214 puts out 230 to 240 lines/min. Both 132-column printers may be ordered with an option that restricts them to upper-case characters; in that case, maximum speed is raised to 340 lines/min.

Packed with sound-absorbing material to make them suitable for use in business offices, the 9212 and 9214 have prices of \$8,640 and \$11,880, respectively. Their respective monthly leasing charges are \$312 and \$395.

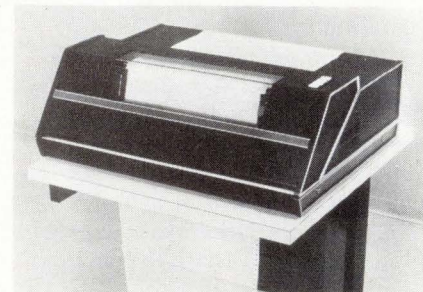
Marketing Dept., Datapoint Corp., 9725 Datapoint Dr., San Antonio, Texas 78284 [365]

Low-cost printer bangs out 300 to 500 lines/minute

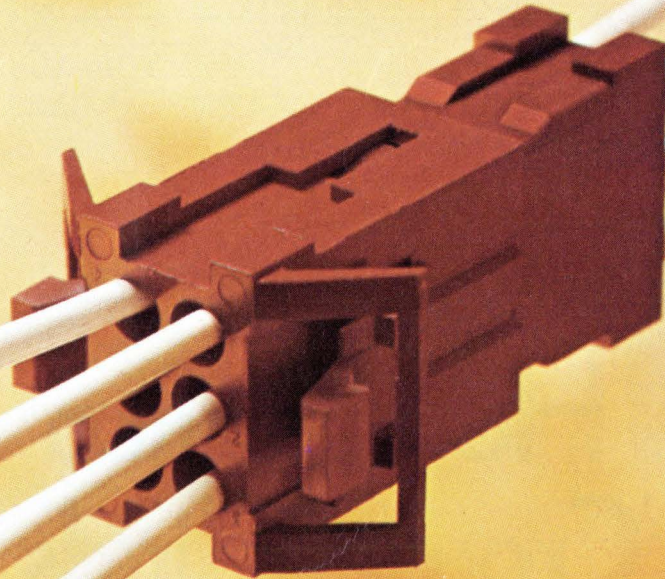
Offered in both 80- and 132-column widths, the Data Test 300 line printer operates at 300 and 500 lines per minute. Vertical spacing is 6 lines per inch at 50 lines per second (8.3 inches per second).

The printer uses a fully formed character font on a horizontal type carrier, which is removable and replaceable for changing type styles. It employs one hammer per position and can produce an original and up to five copies. The printer is available with 48-, 64-, and 96-character ASCII sets. A wide variety of interfaces is offered: Centronics, Data Products, Intellec 8, Incoterm, and RS-232-C up to 9,600 baud in an asynchronous mode.

In quantities of 100 printers, the 80-column unit sells for \$4,295 each, and the 132-column version of the



Our FIRE-PLUG™
connectors already
meet UL 94V-0
flammability tests.



And you can't beat our price.

These new Amphenol® connectors are classified 94V-0 for flame resistance by Underwriters Laboratories. That's the most stringent test of plastic material flammability conducted by UL. And these connectors are also listed by CSA.

What's more, FIRE-PLUG connectors exceed UL's upgraded standards for thermoplastic materials scheduled to go into effect July 1, 1977. So you can upgrade your products now.

They cost no more than what you're buying now. FIRE-PLUG connectors are priced no higher than commercial connectors sold under the less stringent UL 94V-2 rating.

Interchangeable, too. FIRE-PLUG connectors are interchangeable, intermatable, and intermountable with the most popular types of commercial connectors.

Save time and labor with faster panel mounting. The FIRE-PLUG has mounting latches that flex easily. Only fingertip pressure is needed to push and lock the housing into a panel. Cable-to-cable styles are also available.

You can get them now — in quantity. Just call your Amphenol Industrial Distributor for fast delivery. Or write or call: Ray Hayer, Amphenol Connector Systems, Bunker Ramo Corporation, 900 Commerce Drive, Oak Brook, Illinois 60521. (312) 986-3749.



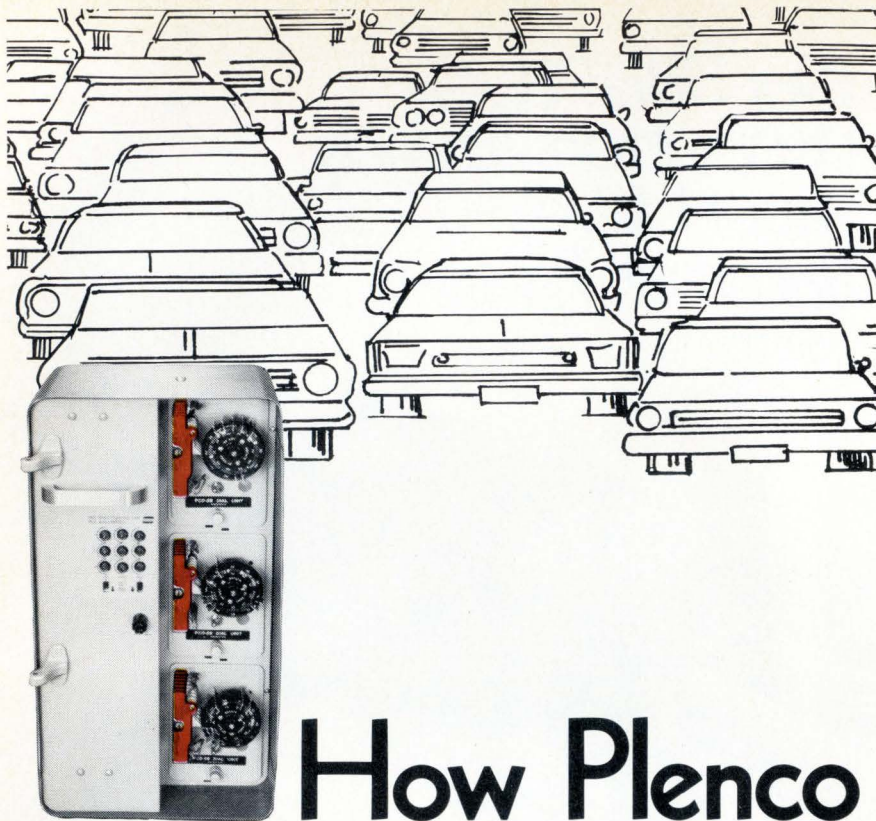
Semi-automatic crimping machine.
Hand tools also available.



The right idea
at the right time.

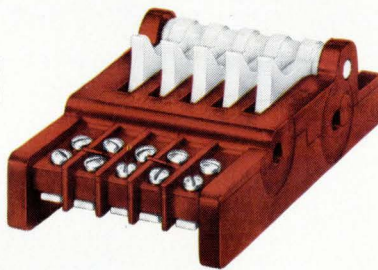
AMPHENOL Connector Systems **BUNKER RAMO**®

Circle 171 on reader service card



How Plenco helps Crouse-Hinds keep the police off the streets:

Plenco 317 Red. This dial contact block is molded of it.



Manufactured by Crouse-Hinds Company, Traffic Control Products Division, Syracuse, N.Y., thermoset-molded contact blocks like this are used in motor-driven dial timing devices.

These dial units in turn are used in Crouse-Hinds pre-timed traffic controllers, coordinating units and synchronizers. Measuring only 1.9" in height, the controller shown is part of a close-working traffic team that's been called a policeman's best friend.

Clearly the components used in Crouse-Hinds traffic control equipment must have a long service life and a high degree of

reliability. We're pleased that our Plenco 317 Red General-Purpose Phenolic Molding Compound was chosen to help.

Next time you have to specify compound, signal your needs.

Chances are you'll give Plenco the go-ahead.

PLENCO
THERMOSET PLASTICS

PLASTICS ENGINEERING COMPANY
Sheboygan, WI 53081

Through Plenco research... a wide range of ready-made or custom-formulated phenolic, melamine-phenolic and alkyd thermoset molding compounds, and industrial resins.

New products

new machine is priced at \$3,490. Data Test Corp., 2450 Whitman Rd., Concord, Calif. 94518 [367]

Core memory designed for PDP-11/70 computers

A plug-compatible magnetic-core memory for PDP-11/70 computers is offered by Ampex Corp. at what the company says is a savings of up to 40% over the price of the MJ11 memories used in those machines. The Ampex ARM-1170 is available in 128-kilobyte increments (32 kilowords of 36 bits each) and is capable of expanding PDP-11/70 computers to their maximum of 4 megabytes. All the equipment needed for expansion to the full 4-megabyte capacity can be contained within the two PDP-11 cabinets, according to Max Bennett, Ampex vice president.

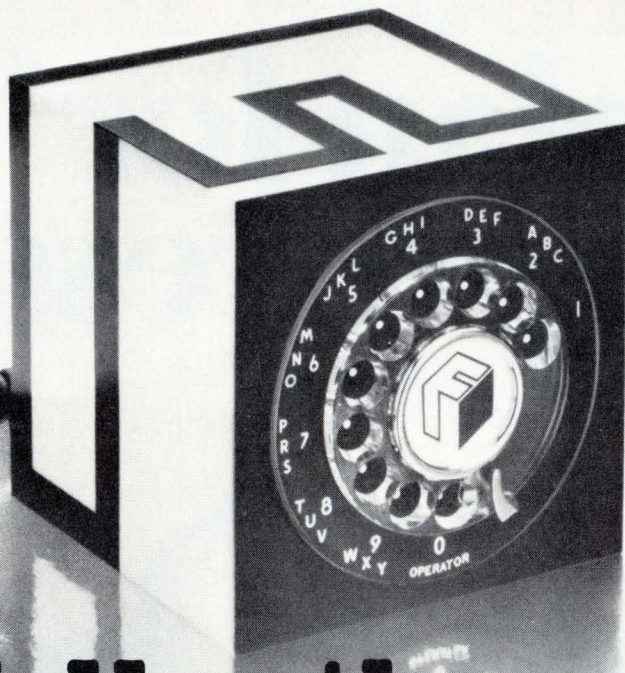
One megabyte of ARM-1170 memory sells for \$48,500 in small quantities and has a delivery time of 45 days.

Ampex Corp., 200 N. Nash St., El Segundo, Calif. 90245 [368]

Low-priced terminals built for distributed processing

Two low-priced intelligent batch-terminals from General Terminal Systems are designed to serve the field of distributed data processing. Built around General Electric Company's TermiNet 9600 communications controller and including a TermiNet 320 line printer and a 300-card-per-minute reader, the first terminal—called the GTS 5030—is suited for line speeds of 2,000 and 2,400 bits per second. The terminal, which includes an IBM 2780 emulator, is priced at \$12,900. The other new unit, the GTS 5040, is capable of a line speed of 4,800 bits per second. A TermiNet 340 line printer is included in the terminal, which is priced at \$14,900.

General Terminal Systems Inc., Suite 416, 13777 North Central Expressway, Dallas, Texas 75243. Phone (214) 234-3346 [369]



Call on the cube...

With 7 distribution centers and 36 sales offices, it's easy!

From Vancouver, British Columbia to Waltham, Massachusetts, you'll find Ferroxcube representatives eager to help. After a quarter of a century as the leading supplier of ferrite materials, we've gained experience you can rely on. So pick up the phone. Tell us your troubles, your applications, your needs.

Call one of the distribution centers listed below. Or, write or call for your free copy of the new Ferroxcube Linear Ferrite catalog and a directory of our sales offices and stocking points.

Ferroxcube Distribution Centers

Ferroxcube Corporation
Waltham, Mass.
(617) 899-7100

Elna Ferrite Labs
Woodstock, N.Y.
(914) 246-5861

Kahgan Sales Corporation
Hempstead, N.Y.
(516) 538-2300

Eastern Components, Inc.
Flourtown, Pa.
(215) 836-1616

Ferroxcube Corporation
Elk Grove Village, Ill.
(312) 437-8050

Ferroxcube Corporation
Canoga Park, Calif.
(213) 998-7311

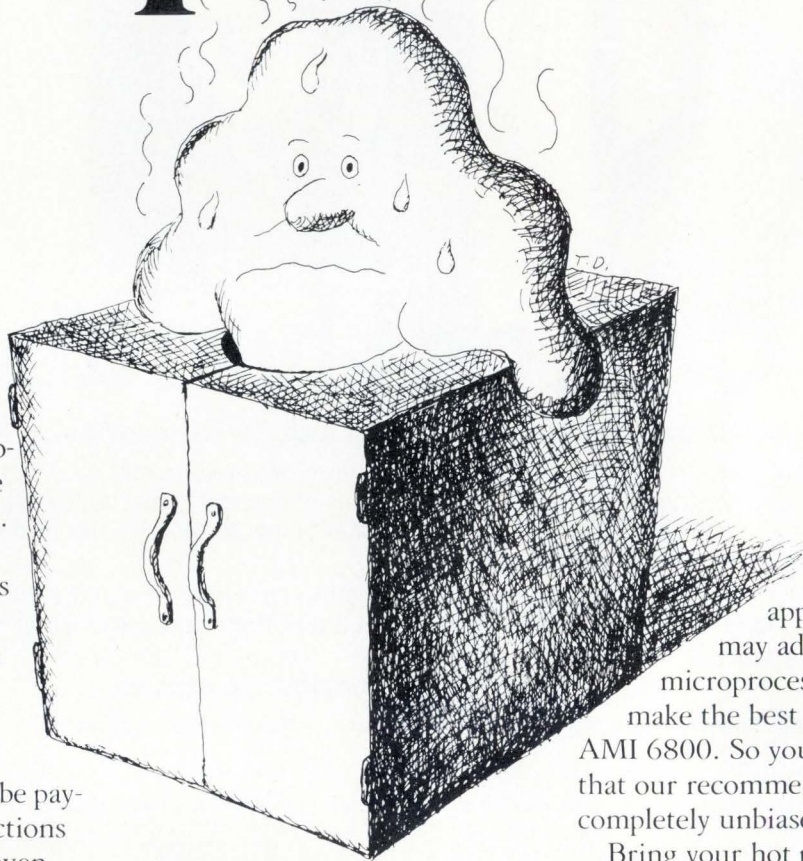
**Philips Electronic
Industries, Ltd.**
Scarborough, Ont.
(416) 292-5161

FERROXCUBE CORPORATION
Saugerties, New York 12477 Tel: (914) 246-2811

FERROXCUBE 
A North American Philips Company

Circle 173 on reader service card

A reducing plan for microprocessors.

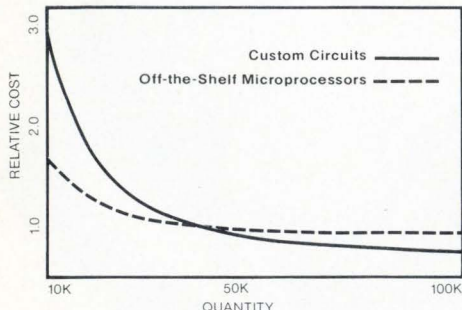


Here's a way to get a micro-computer that's *exactly* the right size for your product.

It's a custom microprocessor. We've made millions of them since 1966. And we're selling more of them today than ever.

The reason is simple. When you buy a standard microprocessor, you could be paying for a lot of built-in functions that you don't need. And, even though the standard part is cheaper going in, you can tell by the chart that custom comes out ahead in high volume runs.

If you're not sure which way to



go, come to us. Nobody can match our experience in custom MOS, with our full-time staff of engineers, technicians and marketing specialists. We've recently developed a totally new method of design that cuts about 25 percent off the development cycle time. And our production lines in Santa Clara and Pocatello are geared to produce all the CMOS, N-Channel or P-Channel circuits you want.

After we've assessed your

application, we may advise a standard microprocessor—ours! We make the best one going, the AMI 6800. So you can be sure that our recommendation will be completely unbiased.

Bring your hot new idea to your nearest AMI sales office. Or write for our brochure on Custom MOS to: AMI, 3800 Homestead Road, Santa Clara CA 95051. One way or another, we'll help you cut out the fat.

Long Beach CA (213) 595-4768 • San Jose CA (408) 249-4550 • Altamonte Springs FL (305) 830-8889 • Elk Grove Village IL (312) 437-6496 • Norwood MA (617) 762-0726
Livonia MI (313) 478-9339 • Minneapolis MN (612) 559-9004 • Monsey NY (914) 352-5333 • Cleveland OH (216) 292-6850 • Ampler PA (215) 643-0217 • Richardson TX (214) 231-5721

**tailor-made MOS
from AMI**

AMERICAN MICROSYSTEMS, INC.

New products

Packaging & production

Tester counts toroidal turns

Easy-to-use instrument displays winding's turns on 3½-digit LED readout

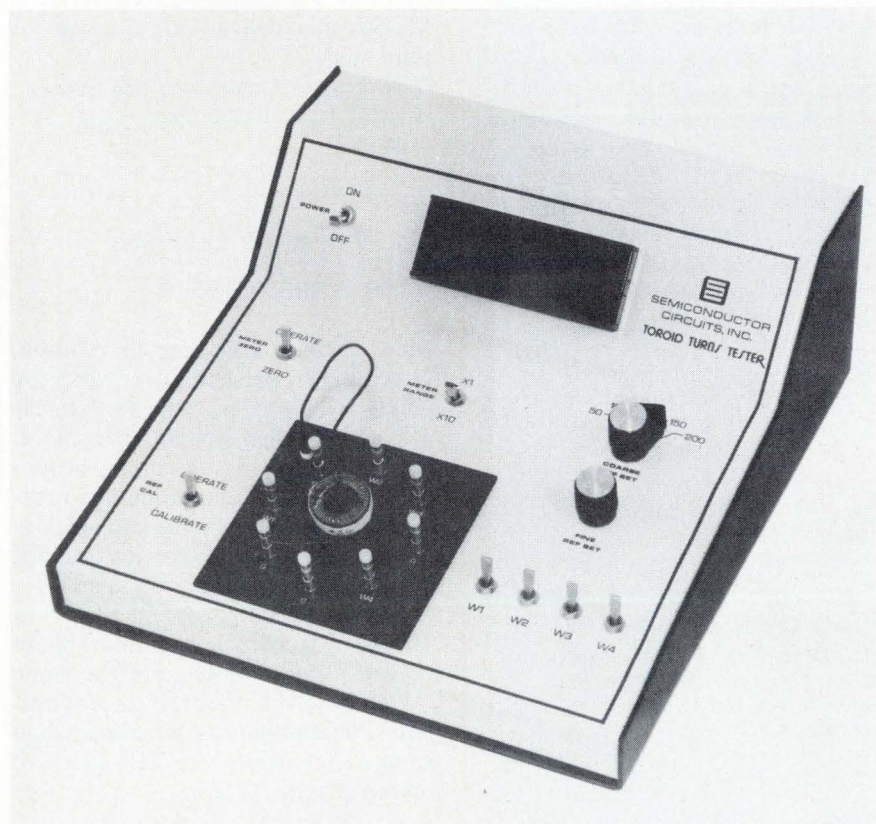
Engineers using wound toroidal inductors and transformers customarily use three parameters to specify them: turns per winding, wire size, and core material. Turns per winding is perhaps the most critical—and the hardest to check. A new instrument from Semiconductor Circuits Inc., the model 2000, allows non-technical test personnel to quickly measure the number of turns in toroids having single, multiple, and tapped windings. Turns are read out directly on a 3½-digit light-emitting-diode display.

Many companies inspecting toroids have been measuring their

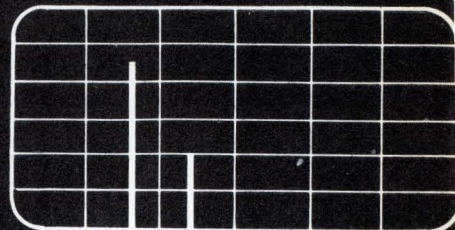
inductance and calculating the number of turns or, alternately, attempting to measure turns ratios by nulling the winding under test against a precision ac ratio box. Both of these methods required skilled operators and long setup and test times. In addition, each method had some inherent inaccuracies.

The model 2000, on the other hand, is said to be extremely accurate. A front panel turns-test-range switch allows an operator to scale the digital readout for best resolution. For instance, an operator can use the 0–200 turns range with an accuracy of one turn out of 200 or the 0–2,000 turns range with an accuracy of 20 turns out of 2000. Scaling of the readout permits measurements of up to 19,999 turns. Interpolation and estimation normally used on analog panel meters is eliminated. Four front-panel switches permit independent measurements of up to four windings that share the same core.

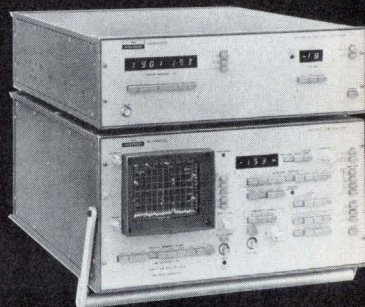
Don Delanger, president of the firm, says the new tester was originally developed to meet an in-house



Q. How do you resolve two signals spaced 1 Hz apart at 2 MHz?



A. With EMR's new Model 1520 Digital Spectrum Translator and Model 1510-03 Digital Real-Time Spectrum Analyzer.



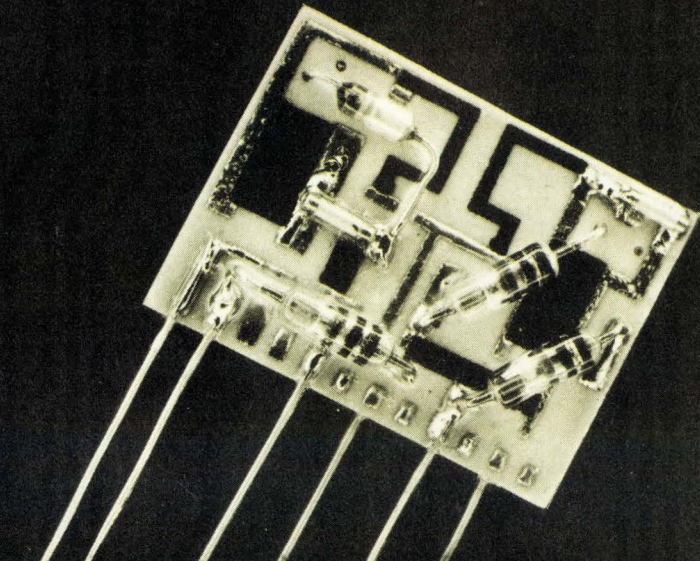
Why go partway in analyzing data? Get the resolution/performance edge of our Model 1510-03 Digital Real-Time Spectrum Analyzer, then go it one better. Enhance frequency resolution still more by adding the Model 1520 Digital Spectrum Translator to concentrate the full resolution of the Analyzer about a selectable point of interest in the spectrum. For that matter, why stop there? Step up from 25.6 kHz to a full 2 MHz upper frequency limit by adding the optional Model 1521 Range Extension Module, too!

Other features of the unequalled 1520 Translator: nine translatable frequency ranges from 25.6 Hz to 10.24 kHz; center frequency selectable in 1-Hz steps and automatic gain ranging — each with an easy-to-read LED display; plus, an automatic frequency sweep. Full-scale out-of-band signal to minimum-detectable in-band signal exceeds 100 dB.

EMR EMR
Schlumberger

EMR Telemetry
Weston Instruments, Inc.
Box 3041, Sarasota, Florida 33578
(813) 371-0811

Circle 194 on reader service card



Conap Conformal Coatings for Printed Circuits

• Proven Reliability • High Performance

Expect Conap's conformal coatings to be different. Each product in this family of polyurethane and epoxy coatings was developed specifically for protecting printed circuit boards and electrical/electronic parts from adverse environments.

They are not intended for use as general purpose protective coatings or for other purposes. This accounts for their high quality performance in circuit board applications. Reliable performance attested to by years of successful on-the-job service and backed with a full staff of customer service specialists.

Broad Selection of Coatings

Conap's economical, easy-to-process printed circuit coatings include both single component and two part systems conforming to MIL-I-46058C, Type UR requirements. There are formulations for dipping, spraying, or brushing. Coatings that cure at room temperature or elevated temperatures. Available in quart, gallon, 5-gallon and 55-gallon containers as well as convenient, easy-to-use, aerosols.

High Performance Properties

Films are available to provide excellent resistance to reversion, abrasion, impact, chemicals and solvents, fungus, thermal shock. Good electrical properties are a common denominator.

These coatings will protect assemblies from water, high humidity, contamination, and other severe environmental conditions. At the same time, they can ruggedize units against shock and vibration.

Excellent adhesion, uniform coating thickness, and easy repairability are other important features.

Free Bulletin, Low Cost Evaluation Kits.

Send for Conformal Coatings Brochure C-110 containing complete specifications and information on inexpensive evaluation kits.

Conap Means Many Things

• Epoxy and Urethane Resins • Chemical Specialties • Adhesives, Sealants and Coatings • Potting and Casting Systems • Fabricated Elastomer Components. For an over view of Conap's complete capabilities, write on letterhead for copy of Brochure FB-1.

CONAP

Conap, Inc. / Olean, N.Y. 14760 / 716-372-9650
Conap (Canada) Ltd. / Mississauga, Ont. 416/625-2520

New products

need to speed up toroid inspection. Circuitry of the model 2000 is surprisingly simple. The heart of the tester is a single-turn reference probe that is placed within the inner diameter of the device under test. With an internally generated 20-kilohertz signal exciting the toroid, voltages across the reference and any of the toroidal windings are compared. The factor by which the toroid winding voltage exceeds the single-turn reference winding voltage is a direct measure of the turns ratio of the toroidal turns to the single turn.

The in-house version of the tester has cut production time on products using toroids, Delanger says. In addition, the firm's engineers have found that the added accuracy of the new tester has eliminated many low-line input voltage rejects on the inverter line. The turns ratios that were slightly on the low side had slipped through previous in-house inspections.

The tester operates from 105 to 125 volts ac at 10 watts and weighs 8 pounds. Its dimensions are 4 by 10 by 11 inches. Single-quantity price is \$1,495, and delivery time is two to four weeks.

Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830. Phone (617) 373-9104 [391]

Vacuum gage identifies three types of leaks

Most vacuum-leak detectors simply indicate the presence of a leak. A gage developed by Varian Associates—and called smart—does more. Besides detecting vacuum system leaks and giving a readout of pressure, it can tell what type of leak is present: air, water vapor, or internal outgassing from contaminants.

Range of the instrument is 10^{-8} to 10^{-4} torr. Accuracy is comparable to that of a nude ion gage of the same range; however, the new gage eliminates the ambiguity that exists when carbon monoxide and nitrogen are present in the system.

For detecting leaks, the gage

Ask Control Data for the first horizontal font 300-600-900 lpm family of OEM printers with the print band any operator can change in 30 seconds.

We have it.

GET 1130 LPM FOR LESS THAN \$10,000 IN 48-CHARACTER SET APPLICATIONS, OEM QUANTITIES.

Here now: CDC horizontal font Band Printers with truly operator-interchangeable bands—plus exclusive choice of 10 and 15 cpi bands! Just look at their advantages:

Users can switch bands in 30 seconds! Single-piece band weighs less than an ounce! Stores conveniently in cabinet. No need to lift out the ribbon! Insert a new band—the printer automatically adjusts for pitch and character set (adjustment between 64/96 characters standard; 48/64/96 or 64/96/128 optional). Eleven bands now available.

Paper-saving condensed pitch! Prints 132-character lines either on 14⁷/₈" or 11" paper! Unique 15 cpi bands cut user paper costs and storage needs by reducing paper volume 40%!

Three look-alike models. Only six differences between units; identical spare parts kits. Offer a choice of speeds—without tying up capital in spare parts inventories!

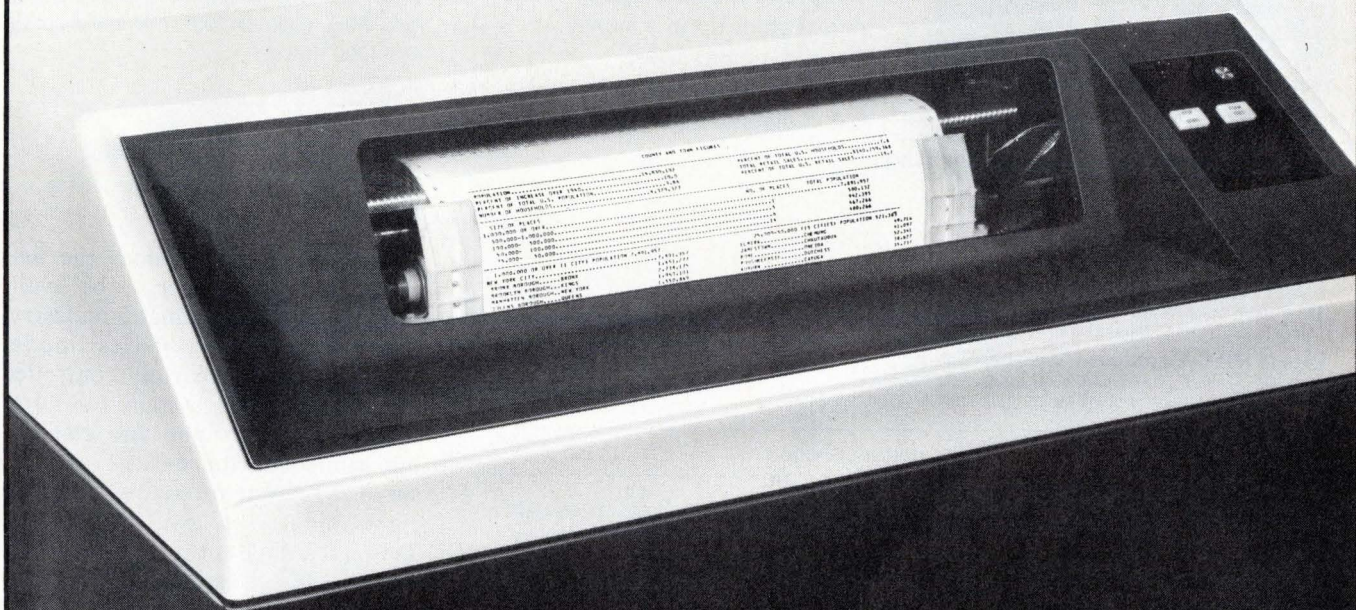
Minimum operator attention. Exclusive patented control permits use of double-length 48-yard ribbon, cuts ribbon changes 50%! Electric eye automatically reacts to any paper feed jam-up, permits use of lighter-weight paper.

Superior readability. These CDC Band Printers deliver full, solid strokes—top to bottom—even on super- and sub-scripts.

Make these advantages your advantages!

Write for complete information plus sample printout. Compare our sample with copy from any printer. See how CDC Band Printers offer print quality and printer features never before available in a medium-to-high-speed printer under \$10,000!

New compact 34" width. Takes a minimum of precious floor space; produces up to 900 lpm (using 64-character sets).



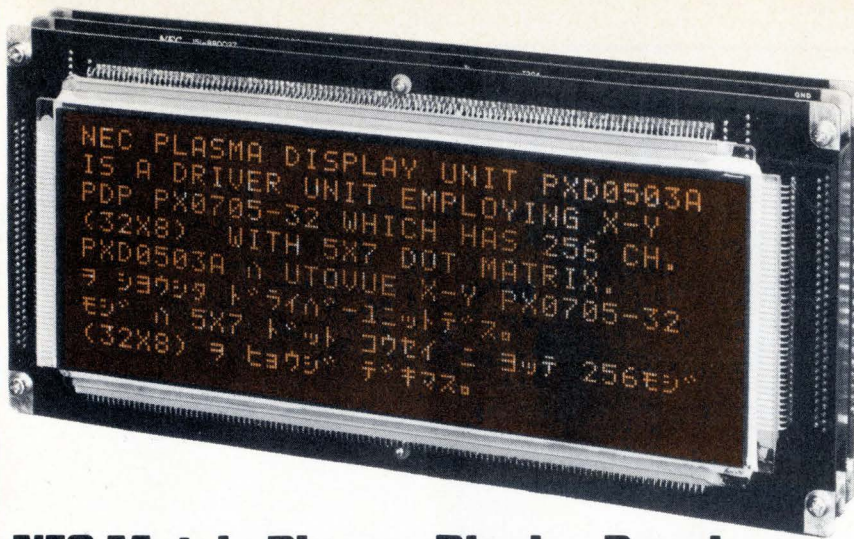
Phone (313) 651-8810 or write: Harrison Craig, Peripheral Products Sales Manager, Control Data Corporation, 1480 N. Rochester Road, Rochester, Michigan 48063. Ask a CDC Sales Representative to bring me a Band Printer evaluation unit. Send more information and sample print-out.

NAME _____ TITLE _____
FIRM _____ ADDRESS _____
CITY _____ STATE _____ ZIP _____ AREA CODE _____ PHONE _____

Ask the CDC OEM people

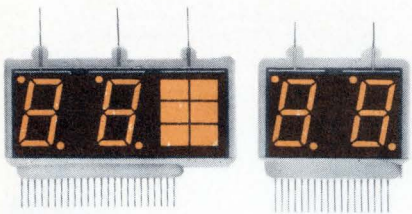
CD CONTROL DATA CORPORATION

New products



NEC Matrix Plasma Display Panel — compact, complete with driver circuits. TTL compatible.

Type PXD0503A displays 256 characters (32 x 8 lines) in 5 x 7 dot matrix form. The 0.26-inch high characters are high contrast neon orange. No glare, distortion, flicker or fuzziness. NEC's unique transparent electrodes enhance inherent high readability. TTL level interface. Measures 5.5 x 12.6 x 2.1 inches including connectors. Ideal for terminal display applications.



Type PO2504T-02 Type PH2524T-02

AC-coupled Plasma Display Panels

- Inch-high or up to 4 inches.
- Static/dynamic drive.
- Usable up side down.
- Noble display appearance.

U.S.A. Sole Agent: World Products, Inc.
7625 Bush Lake Road, P.O. Box 35263, Minneapolis, Minn. 55435
Tel: (612) 835-2117 Telex: 29-0181 WORLD PROD EDNA

Europe NEC Electronics (Europe) GmbH
4000 Düsseldorf, Immermannstrasse 22, F.R. Germany
Tel: Düsseldorf 357088, 357089, 357080 Telex: NECD 8587419

NEC
Nippon Electric Co., Ltd.
P.O. Box 1, Takanawa, Tokyo, Japan

Circle 178 on reader service card

makes use of the established ratio of nitrogen to total gas present in a normal leak-free vacuum system at any given pressure. An optical filter, tuned to the spectral line of nitrogen, enables measurement of the partial pressure of nitrogen in the system. The gage compares that partial pressure with the total system pressure to determine the nitrogen percentage that is present.

An abnormally high nitrogen percentage indicates an air leak in the system. An abnormally low percentage indicates the presence of an unwanted gas, such as water vapor. If the gage indicates an abnormally high system pressure with the correct percentage of nitrogen, internal contaminants are outgassing.

A three-position switch controls the meter to cover system pressure, nitrogen percentage, and leak checks. For recording and automated process-control purposes, total pressure and percent nitrogen outputs are provided at the rear panel.

Varian Vacuum Division, 611 Hansen Way, Palo Alto, Calif. 94303. Telephone: (415) 493-4000. [392]

High-speed chip prober operates automatically

Described by its maker as the first automatic chip prober to be available to the semiconductor industry, the Electroglas/Xynetics model 146X is an electronically controlled electromechanical system for automatically test-probing and classifying semiconductor devices at high speed. The system requires less than eight minutes to test 100 devices. This, according to the manufacturer, makes 100% testing economically



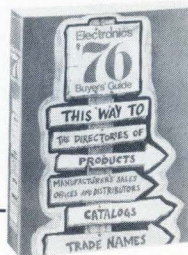
The Answer Book. It makes your job easier. \$25.

Who makes what? Over 4000 products, 6000 manufacturers with their local contacts, directory of trade names and catalogs, inquiry "bingo" card for 5-second ordering of current catalogs.

Electronics Buyers' Guide
1221 Ave. of the Americas
New York, N.Y. 10020

Yes, send me a copy of The Answer Book. I've enclosed \$25 (USA and Canada only, elsewhere send \$35). Full money back guarantee if returned within 10 days.

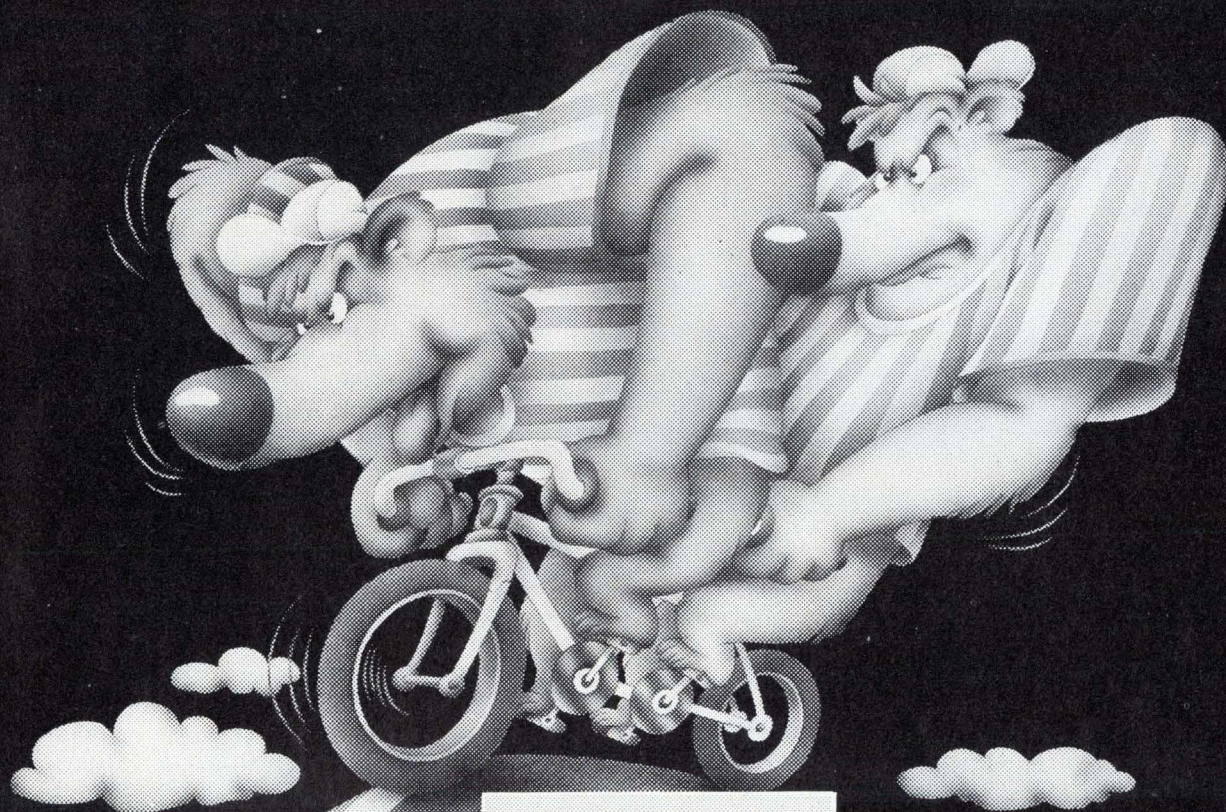
Name _____
Company _____
Street _____
City _____ State _____ Zip _____



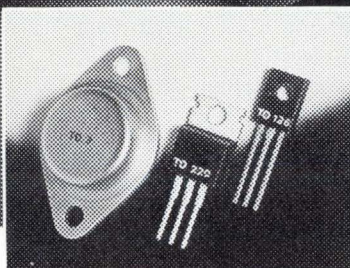
RIGHT ON TARGET AGAIN



Bearing it well!



NEW
FROM
SGS-ATES



Complementary power Darlington pairs

4 Amperes - TO 126 package

NGN	PNP
2N 6037	2N 6034
2N 6038	2N 6035
2N 6039	2N 6036
SJE 800	SJE 700
SJE 801	SJE 701
SJE 802	SJE 702
SJE 803	SJE 703

8 Amperes - TO 220 package

BDX 53/A/B/C	BDX 54/A/B/C
--------------	--------------

8 Amperes - TO 3 package

NPN	PNP
SJ 1000	SJ 900
SJ 1001	SJ 901
2N 6055	2N 6053
2N 6056	2N 6054

10 Amperes - TO 3 package

SJ 3000	SJ 2500
SJ 3001	SJ 2501

12 Amperes - TO 3 package

2N 6057	2N 6050
2N 6058	2N 6051
2N 6059	2N 6052

SGS-ATES Semiconductor Corporation - Newtonville, MA, 02160 - 435 Newtonville Avenue - Tel: 617-9691610 - Telex: 922482.
Stocking Distributors: Edmar Electronics Co., Des Plaines, IL, (312) 298-8580 - Energy Electronic Products, Los Angeles, CA, (213) 670-7880 - Esco Inc., Dayton, OH, (513) 226-1133 - KA Electronics Sales, Dallas, TX, (214) 634-7870 - Radar Electric Co., Seattle, WA, (206) 282-2511 - Re-Coil Electronics Inc., Santa Clara, CA, (408) 984-0400 - Rical Electronic, Santa Ana, CA, (714) 557-6543 - Semtex, Wakefield, MA, (617) 245-9050 - Wilshire Electronics, Burlington, MA, (617) 272-8200 - Zeus Components Inc., Elmsford, NY, (914) 592-4120 - Burlington, MA, (617) 273-0750 - Pompano Beach, FL, (305) 942-4312 - Zeus/West Inc., San Dimas, CA, (714) 599-8374 - Mexel, Mexico 12, DF, (905) 575-7868 - Prelco Electronics Ltd., Montreal 357, Quebec, (514) 389-8051.

The cool one from Tecnetics



55% efficiency in a 25 watt DC to DC Converter

Why pay for useless heat when you want power? That's the philosophy behind the new high efficiency 1200 Series 25 volt regulated converter from Tecnetics.

With efficiency as high as 55% at full load under normal conditions, an integral heat sink, improved circuitry and a black anodized aluminum case, this converter operates within a range of -20°C ambient to +100°C case temperature.

Available with a single output, this series features full input-output isolation to 500VDC allowing the user to change polarity and prevent ground loops. Compact size and sturdy barrier strip terminals make this the perfect converter for a wide

variety of military, industrial, aerospace and telecommunication applications.

For more information on the 1200, and hundreds of other power supplies, write for our 26 page catalog.

SPECIFICATIONS: 1200 Series 25 watt DC to DC converter

Inputs: 12 ± 2VDC to 48 ± 6VDC

Outputs: 12, 24, 28 and 48VDC

Dimensions: 5" x 4.1" x 1.25" (typ)

Weight: 16 oz.

Price: Single Output—\$198.00

tecnetics® The Power Conversion Specialists P.O. Box 910,
1625 Range Street, Boulder, Colorado 80302 (303) 442-3837 TWX 910-940-3246

Circle 180 on reader service card

HOPE

in a word is what we are.

Project HOPE exists because there are people with hope—people who have given 3.5 million men, women, and children on four continents the chance for happier, more productive lives through improved health care.

Give to

PROJECT HOPE

Department A
Washington, D. C. 20007

New products

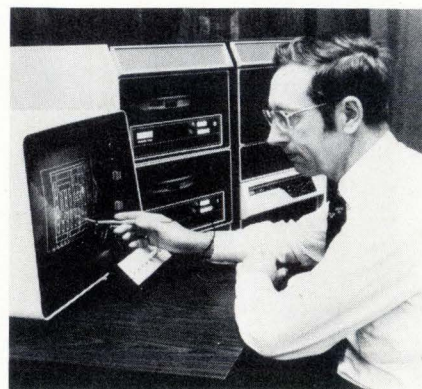
practical for the manufacturers of hybrid circuits.

In conjunction with an external IC tester, the model 146X automatically indexes to each chip cavity on the carrier, optically aligns the chip, makes probe-to-chip contact and subsequent separation on command from the tester, and returns to the load position at the end of the cycle. Provision is made for no-chip and position-error signals to prevent time loss in false alignment searches. The system can also classify devices by inking bad and improperly positioned chips, and it can accommodate up to three different categories of the same device type.

Electrogas Inc., 2901 Coronado Dr., Santa Clara, Calif. 95051. Phone Al Harmon at (408) 246-6500 [393]

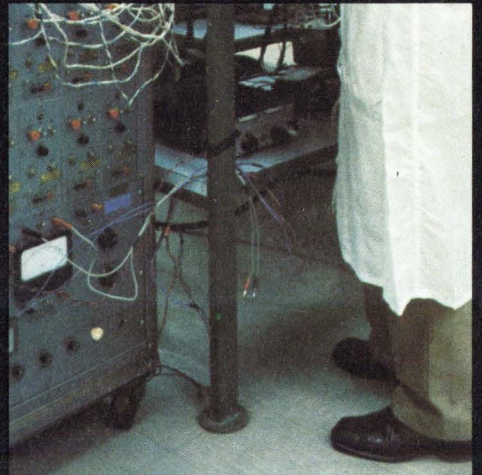
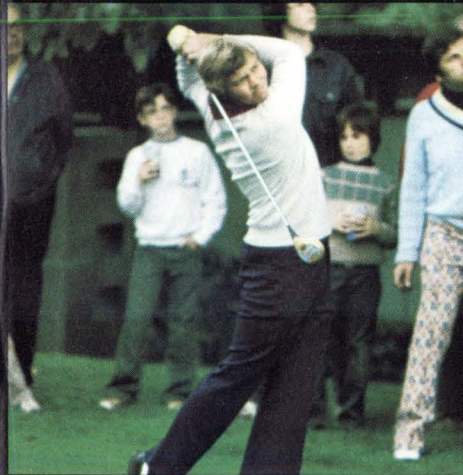
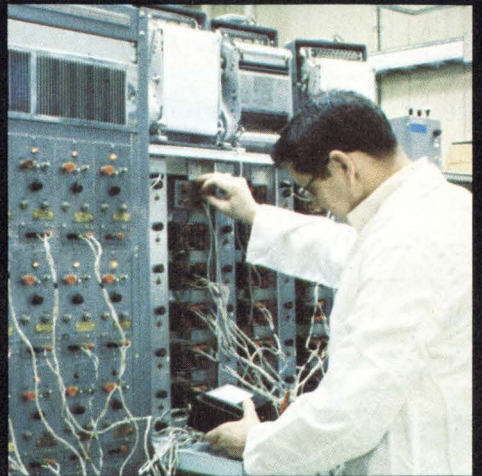
Computerized board-design system sells for \$90,000

With such standard features as automatic component placement, auto-routing, design-rules checking, and multilayer capability, the Redac Mini PCB Designer combines interactive capabilities and a system price tag of only \$90,000. At this price, companies that previously could not afford a computer-aided design system can obtain the benefits of such a system for less than the price of a traditional manual-digitizer-type system. The Redac Mini is built around a Digital Equipment Corp. PDP-11/34 computer system with a 17-inch refresh graphics terminal for interaction with the designer. Options include a Gerber photoplotter



PRECISION.

The mark of a Pro. Like P&B.
Time delay relays with up to $\pm .05\%$ repeatability.
And delay times to a year or more.



That's the kind of precision you get with Potter & Brumfield **CG Series** relays. And there are many more P&B time delay relays to meet virtually any requirement. Including . . .

R12, R13, R14, R15 Series. Sophisticated circuitry usually found in more expensive relays. Repeatabilities to $\pm 3\%$; time delays to 600 sec.

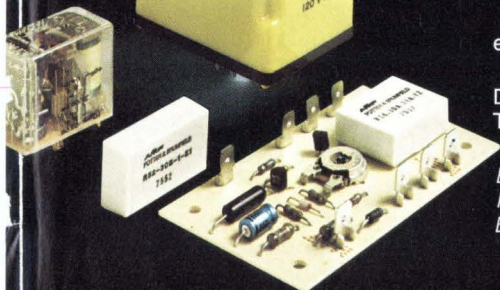
Low cost R16 Series. Easily mounted p.c. board module. Delay on operate ranges: 0.2 to 2, 2.0 to 30, 5.0 to 100 sec. Potentiometer or resistor adjustable.

R52 modules. Inexpensive way to make all but a few 6, 12 or 24 VDC P&B relays into time delays. Resistor adjustable timing ranges from 0.2 to 100 sec.

Also low profile, solid state hybrid, adjustable and non-adjustable—even dry reed. With every type of termination, too!

Design for precision. Specify P&B. See your P&B sales representative, or P&B Pro Shop Distributor. Or, contact Potter & Brumfield Division AMF Incorporated, Princeton, IN 47671. Telephone: 812-386-1000.

European address: Electrical Products Group, AMF International Limited, AMF House, Whitby Road, Bristol BS4 4AZ, England. Telephone: (0272) 778383, Telex: 449481, AMMAFOCO, BRSTL.



Go with the Pros and you can't go wrong.



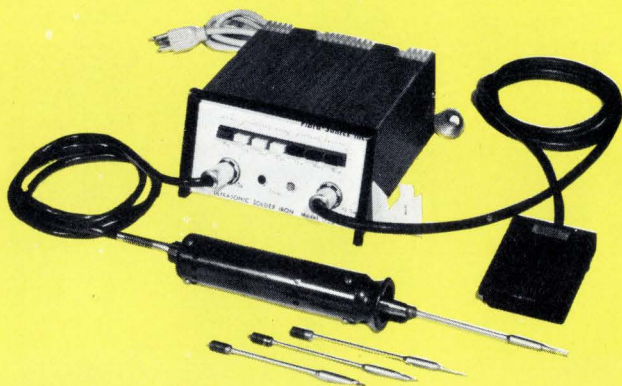
They've been around...



These Top 500 companies got there by using only products and services of the highest quality. That's one of the reasons they use Fibra-Sonics. They recognize the distinct advantages of using our ultrasonic fluxless soldering system for soldering metals, exotics, glass and ceramics.

The G-35 generator shown here delivers 35 watts of ultrasonic heated power into the soldering iron, and features push button controlled power levels of heat and sound energy.

Solid state circuitry assures you of worry-free durable performance. And auto-feedback and power tracking leads to perfect production every time.



To find out how we can help you, send samples of your materials and a description of your requirements to Fibra-Sonics. We'll return them to you without cost or obligation.

FIBRA-SONICS®, INC.

4626 N. Lamon Avenue • Chicago, Illinois 60630 / (312) 286-7377

Circle 182 on reader service card

The Answer Book. It makes your job easier. \$25.

Who makes what? Over 4000 products, 6000 manufacturers with their local contacts, directory of trade names and catalogs, inquiry "bingo" card for 5-second ordering of current catalogs.



Electronics Buyers' Guide
1221 Ave. of the Americas
New York, N.Y. 10020

Yes, send me a copy of The Answer Book. I've enclosed \$25 (USA and Canada only, elsewhere send \$35). Full money back guarantee if returned within 10 days.

Name _____
Company _____
Street _____
City _____ State _____ Zip _____

New products

table for the generation of master-board and silk-screen artwork, provisions for generating numerical-control drilling tapes, and interfaces to other artwork tables.

Redac Interactive Graphics Inc., 225 Great Rd., Littleton, Mass. 01460. Phone H.G. Marsh at (617) 486-8751 [394]

Modular system tests memories at up to 20 MHz

The model 203 semiconductor-memory tester is a modular system that operates with up to 16 multichannel clock-pulse generators to achieve a resolution of 1 nanosecond at a maximum clock frequency of 20 megahertz. Used mainly for memory-oriented and problem-oriented tests, the system allows judgments to be made of the function and behavior of such memory devices as random-access memories, read-only memories, and shift registers.

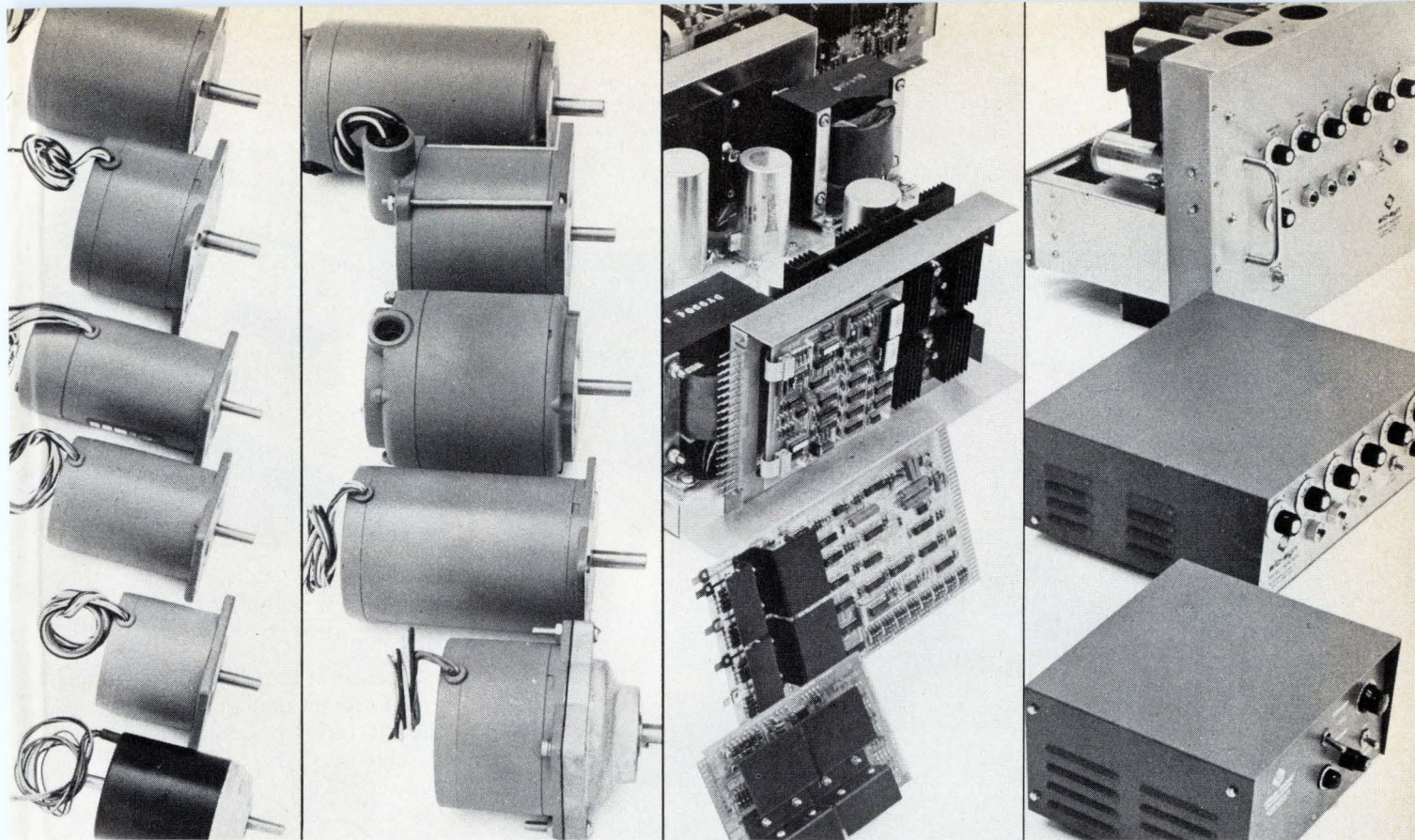
Because the system is modular, various programable stimulus and measurement instruments can be added to it for determining such parameters as short-circuit, interruption, discharge, and loading currents. The computer-controlled system can handle up to four manual or automatic-feed test stations.

Siemens Corp., 186 Wood Ave. South, Iselin, N.J. 08830. Phone (201) 494-1000.

Siemens AG, Zentralstelle für Information, Postfach 3240, D-8520 Erlangen 2, Federal Republic of Germany. Phone Joachim Ullmann at (09131) 7-3394 [396]

Low-cost system programs Signetics logic array

A field programmer for the Signetics 82S100/101 field-programable logic array allows data entry, either manually or automatically, from a master FPLA. Called the PR-100, the FPLA programmer contains an internal random-access memory, which can be loaded automatically in about 1 second or manually in about 30 minutes. (The Signetics 82S100/101 FPLA accommodates 16 input varia-



Stepping just came of age.

Fifteen years ago, we introduced the first stepper. SLO-SYN.[®] But in a real sense, the stepping motor has been waiting for today's technology to match circuitry with motor capability. Converting electronic input into mechanical output.

For starters. From 0 to 2,000 steps per second in 4 msec with our M060 series (up to 150 oz-in of static torque).

Mid-range. From rest, 12 steps in 12 msec, damped; or 12 steps in 15 msec start — stop — damped, with 100 oz-in of frictional load and 1.2 lb-in² inertia.

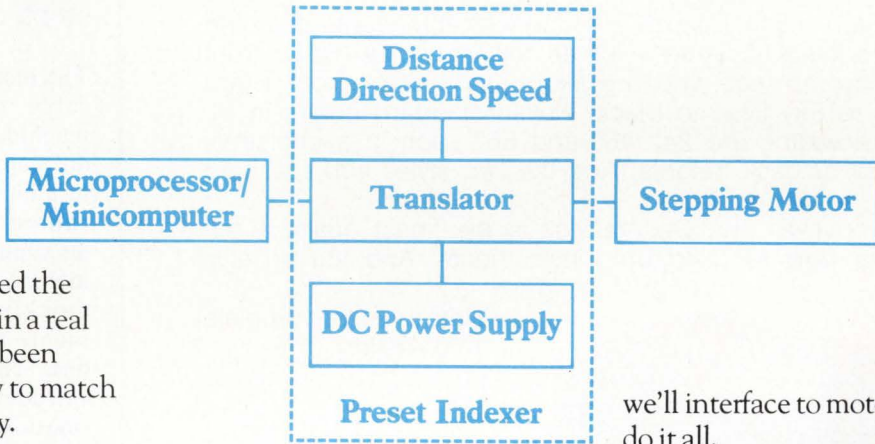
High Performance. At 10,000 steps/sec (3,000 rpm), output torque of 525 oz-in, shaft power 1,165 watts (1.65 hp).

The stepper's logical companion is the Slo-Syn translator or preset indexer. The power for moving loads, controlling distance, speed, direction. Velocity control means motion/time efficiency for a wide range of inertial loads.

Drives interface with microprocessors and minicomputers. Design modularity prevents over-design. You control the options: 1) Modular or packaged drives. 2) If you want to provide the logic,

we'll interface to motor. 3) Or we can do it all.

Whatever the manufacturing move, see the company that's in the best position to help. Write The Superior Electric Company, Bristol, CT 06010. Or call us direct (203) 582-9561.



A step ahead in positioning.

 **Superior Electric**

New products



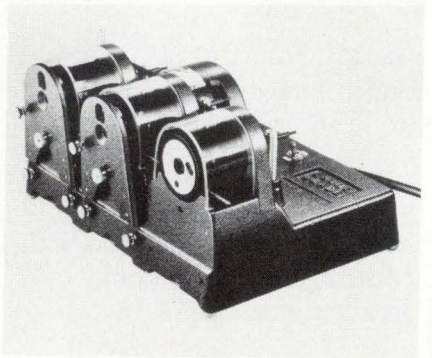
bles, allows a minimum of 48 product terms, and provides 8 outputs.)

Housed in a 16-by-10-by-4.5-inch metal cabinet that weighs 10 pounds, the PR-100 is powered by 115 v ac. It sells for \$1,299.

Curtis Electro Devices Inc., Box 4090, Mountain View, Calif. 94040. Phone (415) 964-3136 [395]

Swing-blade unit strips coax cable

The model 74A swing-blade coaxial-cable stripper is a three-in-one machine that can strip wires of three different gages to individually predetermined lengths. Miniature coaxial cables and hook-up wires to a maximum outer diameter of 0.265 inch (6.7 millimeters) are stripped quickly, leaving the insulation square-shouldered and free of residue. The stripper can handle most extruded, built-up, or wrapped insulations including Teflon, Kapton, and Neoprene. The model 74A is



Electronics/October 28, 1976



**OptimaDesk...
the data console
with the one thing you've
been waiting for.**

Everything.

Every feature you'll ever conceivably want, including the ones that cost extra in other data consoles (rolled front edge, chrome legs and the like.) Every color from Burnt Orange to Sky Blue to Black; eleven standard colors in all. Standard widths are 24", 45" and 66" each in a choice of keyboard or desk heights. And the two styles you see here are just the beginning.

Above all, the OptimaDesk is the finest quality furniture ever built for electronic instruments. And the price is right.

Write to us for complete information.



OPTIMA®

Optima Enclosures, a division of Scientific-Atlanta, Inc. 2166 Mountain Industrial Blvd., Tucker, Georgia 30084 or call (404) 939-6340

Circle 184 on reader service card

Data Converters Can Be Easy To Use

We think it's our job to make your job simpler. That's why our data conversion products come with the fullest guaranteed specifications in the industry. That's why we use functional laser trimming to eliminate the need for zero and gain adjustments. That's why we test every Micro Networks converter at 25°C and at both specified temperature extremes. That's why we'll continue to develop the most advanced conversion products available anywhere. Products like our MN7100 8-bit, 8-channel hybrid data acquisition system — only \$140* and the industry's first in a DIP package.

Let's face it. No designer's job is child's play. And that's why designers look to Micro Networks for rugged converters that are simple to use. High performance converters at competitive prices. Over 150 standard types to meet your varied requirements. Call or write us today for specs on our full converter line. Specs that mean what they say.

Circle 185 on reader service card

* in 100s



**MICRO NETWORKS
CORPORATION**

324 Clark St., Worcester, MA 01606 617 852-5400



CUSTOM MICA CAPACITORS for Specialized Form Factors and Extremes of Environmental Resistance



CEM type mica capacitors are epoxy molded, using pour-mold under high vacuum to produce a void free assembly capable of operation in most severe environments.

The pour-mold technique also allows incorporation of curved surfaces, special mounting arrangements, and non-uniform shapes, for greater utilization of available system space, and usually, lighter weight assemblies.

Designers . . . Look:

- Moisture proof
- Shock proof
- High Corona resistance
- Unbreakable

To see how Custom Electronics can fill your requirements, write for FREE descriptive CEM Techni Tip, and general Techni Tip including sample of mica dielectric.

Send for FREE Product Brochures



CUSTOM ELECTRONICS, Inc.

12 Browne Street, Oneonta, N.Y. 13820
PH: (607) 432-3880 TWX: 510-241-8292

Circle 186 on reader service card



New MCL power generators feature flexibility, high output, minimum distortion.

Main frames for 115 VAC and for 208/220/240 VAC operation. Six standard front panel plug-ins provide frequency range from 10 MHz to 2500 MHz with a minimum output of 65 watts. Two optional plug-in modules are available which produce 100 watts narrow-banded.

Single knob tuning for each plug-in provides exact frequency selection. Front panel, direct frequency readout is accurate to ± 1 percent.

Solid-state mainframe designed for minimum components, optimum reliability. Residual AM held to .1 percent, eliminating nearly all AM distortion in output waveform. Generates continuous or 1 KHz square wave pulsed output. External AM signal generator can be added with single plug-in connection. External pulse circuit is TTL compatible. Automatic VSWR protection.

Write or call for your 4-page power generator brochure: Tom Rys, MCL, Inc., 10 N. Beach, LaGrange, IL 60525. (312) 354-4350.



186 Circle 223 on reader service card

New products

supplied with two twin-blade and one single-blade face-place assemblies. It measures 6-by-10.75-by-9 inches and weighs 11.25 pounds.

Carpenter Mfg. Co., Fairgrounds Drive, Manlius, N.Y. 13104. [399]

Heat gun produces a spot only 0.25 inch in diameter

By adding a model A-206-HG pinpoint adapter to a model HG-301 flameless heat gun, one obtains a heat gun that can deliver a spot of heat a quarter-inch in diameter. This



small heat spot can be used to selectively heat single components in crowded chassis or on printed-circuit boards. The heat gun itself, without the adapter, can be used for such routine functions as activating adhesives, shrinking tubing, and drying components.

Master Appliance Corp., 2420 18th St., Racine, Wis. 53403. Phone (414) 633-7791 [397]

Terminal blocks

. . . by the roll

A dispenser system of tape-mounted nylon modules produces terminal blocks with an unlimited number of 6-32 screw pairs. Once cut to desired length, the flexible tape is slid into a track and mounted by snap-on end stops. The design permits mounting to curved as well as flat surfaces, and the rolls are packaged complete with screws.

Amp Inc., Harrisburg, Pa. 17105. Phone (717) 564-0101 [398]

Electronics/October 28, 1976

If you're designing hard-copy systems, here's the laser breakthrough you've been waiting for:



The new CR135 WriteLite™ Modulated Laser from Coherent Radiation

You've been waiting for a laser-writing system that was easy to design with. And a graphics capability at a price that was easy to live with.

The new WriteLite Modulated Laser from Coherent Radiation is the first *complete* laser-writing sub-system. All the components are put together for you: the laser, the modulator, and the electronics.

Now you don't have to be a laser expert to be a laser user. The laser and modulator are integrated and pre-aligned in one small package. The 2mW output power and 150 ns rise time are guaranteed.

All you have to do is plug in your TTL input. And the WriteLite is ready to write.

You might think that having the whole package systems-engineered and pre-aligned beforehand would run up the price. Quite the contrary: \$395.00 in OEM quantities.

So now laser-writing capabilities are within your reach and within your budget.

And what capabilities!

The WriteLite is the heart of a laser graphics system: It's a point-to-point writing system similar to video CRTs. Resolution is from 500 to 10,000 TV lines. Speed? An 8 1/2" x 11"

hard copy page in one second or faster.

Think of the possibilities. For facsimile systems. Non-impact printing systems. CRT hard-copy recorders. Direct writing oscillographic recorders. COM systems. Telecopiers.

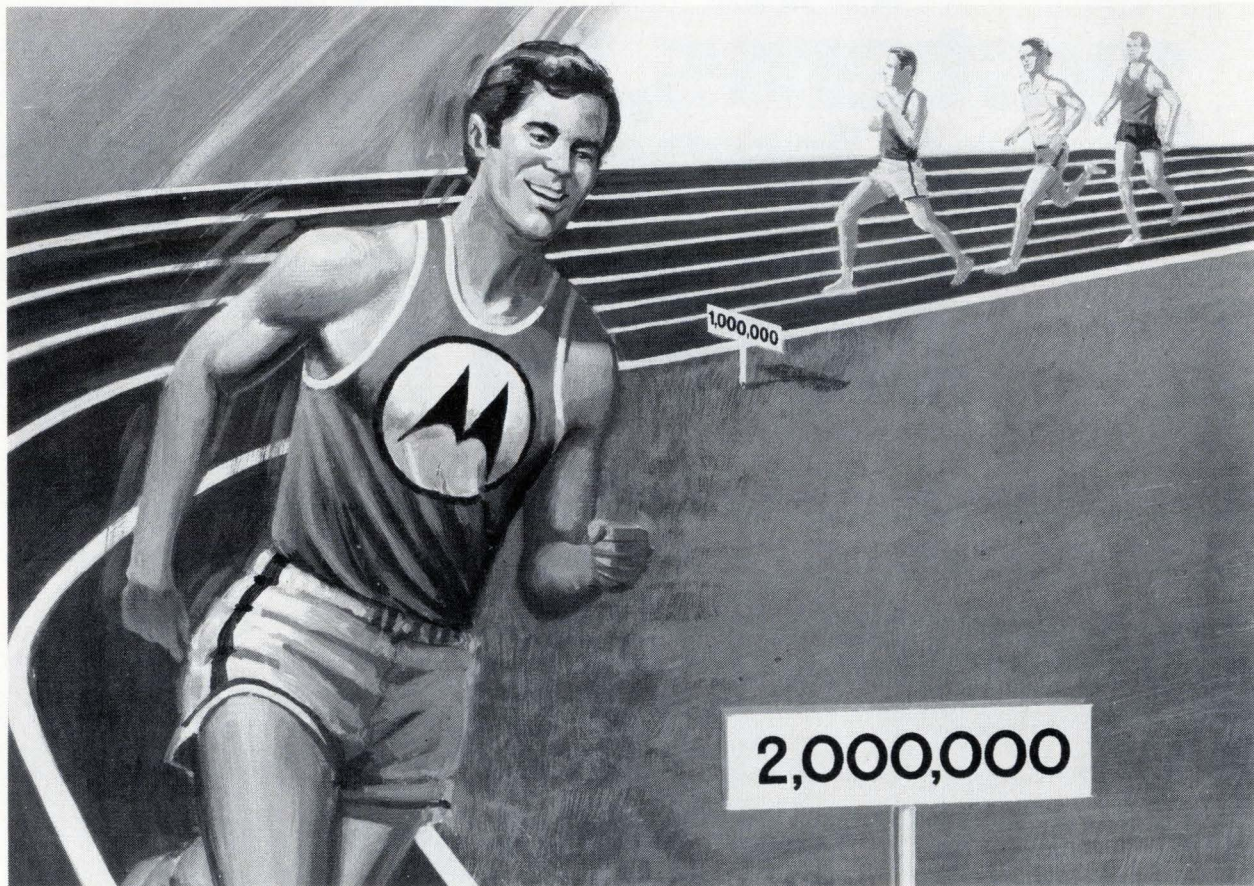
The breakthrough you've been waiting for. An easy-to-use, low-cost laser writing system.

The CR 135 WriteLite Modulated Laser from Coherent Radiation. For complete information, write: Coherent Radiation, 3210 Porter Drive, Palo Alto, CA 94304.

 **COHERENT RADIATION**
3210 Porter Drive • Palo Alto, California 94304 • (415) 493-2111

Circle 187 on reader service card

PROVEN PERFORMANCE CRYSTAL CLOCK OSCILLATORS



Motorola's K1100A leads the industry with a crystal clock oscillator that has a proven track record of more than one million units. That's right . . . over one million oscillators are in use by satisfied, repeat customers. That's not all . . . we feature fast deliveries.

How versatile is the K1100A? With over 1200 frequencies already designed, and same day shipment for standard stock frequencies of 4, 4.9152, 5, 10, and 20 MHz . . . you make the decision.

Oscillators are available from 250 kHz to 32 MHz, +0.01% stability from 0°C to 70°C, TTL compatible, and standard +5V dc input.

For full specifications and prices on the oscillator that design engineers trust, write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, Illinois 60131.
Or call (312) 451-1000, ext. 4183.



MOTOROLA
Communications and Electronics Inc.

64 crosspoint Self-latching reed matrix

CLARE'S NEW MINI MEMORY MATRIX OFFERS A PACKAGING SELECTION THAT STRETCHES THE IMAGINATION.

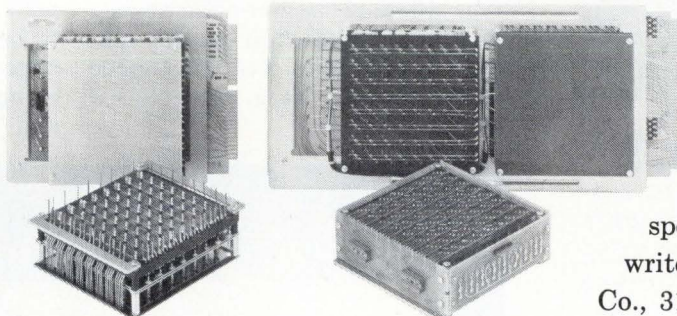
Four compact packaging formats offer engineers real flexibility in creating multi-pole switching arrays for telecommunications, process controls and automatic test equipment systems. The basic 64-crosspoint switching module is built around Clare's durable magnetic self-latching dry reed switch capsule. With Rhodium-plated contacts insuring several million operations.

IT REMEMBERS. IT ERASES.

The multiple crosspoint coils are uniquely interconnected to provide coincident selection paths. Simultaneous current pulses on the X and Y axes address the crosspoints. A new selection automatically erases the previous selection. Dielectric spacing inhibits crosstalk while providing a stand-off rating at 600 Vdc on standard models, 800 Vdc as an option.

CHOOSE FROM WIREWRAP, CABLE PLUG-IN, OR PCB TERMINALS.

Both the wirewrap and cable plug-in units are available in 2 or 4-pole 8X8 arrays. The PCB unit comes in 2-pole 8X8 and 8X16 arrays.



The PCB unit is compatible with conventional pre-wired card cage assembly techniques. The cable plug-in units mate with standard 9-pin in-line socket and 16-pin DIP jack terminations.

It's New! It's Revolutionary!
We call it the Mini Memory Matrix

FOR MORE INFORMATION ...

The new 969 Series is certainly worth finding out about. A New Mini Memory Matrix catalog is now available. Also available are two "TAR" (Technical Application Reference) publications: TAR-Clare Mini Memory Matrix and TAR-Clare Self-Latching Dry Reed Relays. For more specific design information, write G. Neeno, C. P. Clare & Co., 3101 W. Pratt Ave., Chicago, Ill. 60645. Phone: (312) 262-7700.

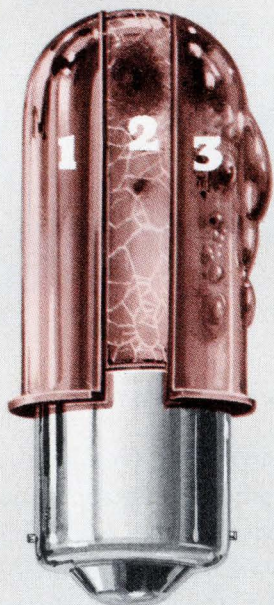
**QUALITY, SERVICE,
RELIABILITY**

C. P. CLARE & COMPANY a subsidiary of
GENERAL INSTRUMENT CORPORATION



new from CLARE

Which coloring method do you like?



- 3. Plastic caps? fades & melts
- 2. Paint? fades & cracks.
- 1. Silikrome® filters? No problems!

We're No. 1

Interchangeable and reusable, Silikrome® filters are your best way to provide accurate color selection and extended life for miniature incandescent or automotive lamps. Silikromes are excellent heat dissipators. *They make lamps last 5-6% longer!* These snap-on Rub-R-Glas™ boots stay colorfast and pliant even after 40,000 hours at -160°F to 500°F. To see for yourself why Silikromes are Number One, write or call for literature. Contact: APM-Hexseal, 44 Honeck St., Englewood, N.J. 07631; (201) 569-5700

The Clean Fighters



190 · Circle 190 on reader service card

New products

Subassemblies

Modem filters contain switches

Pair of FSK modules includes buffered switches for channel selection

In frequency-shift-keying modem applications, the frequency-switching components for the transmitter and receiver filters must be buffered from the external control circuit to prevent degradation of filter characteristics. Now, from Frequency Devices comes a pair of modular FSK filters that incorporate buffered direct-frequency-switching components inside their packages. As a result, filter gain, frequency response, and phase response are independent of the impedance, offset, and drift of the external control circuit.

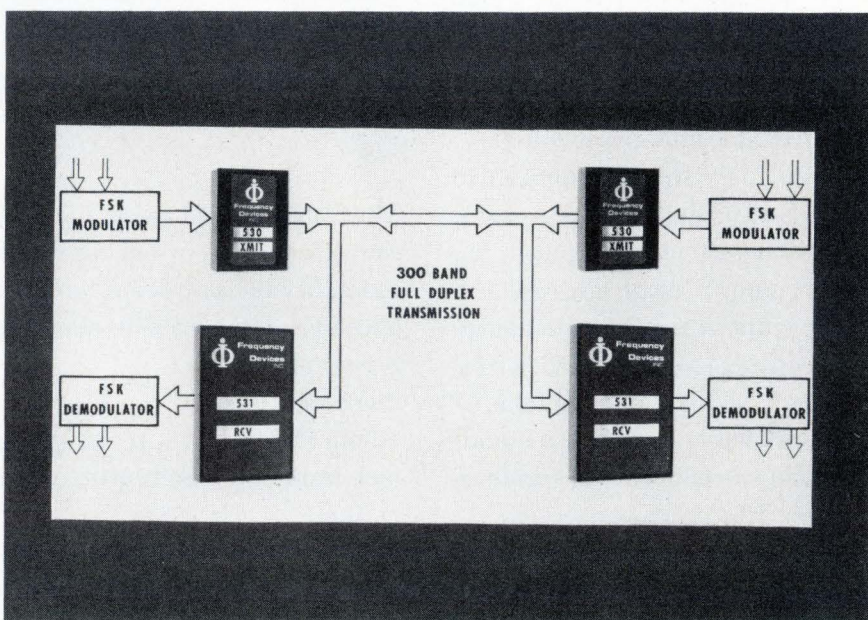
The model 530 transmit filter and the model 531 receive filter are designed to be compatible with Bell's type 103/113 answer-and-originate modems. The FSK pair permits full-duplex operation over voice-grade telephone lines at a rate of 300 baud.

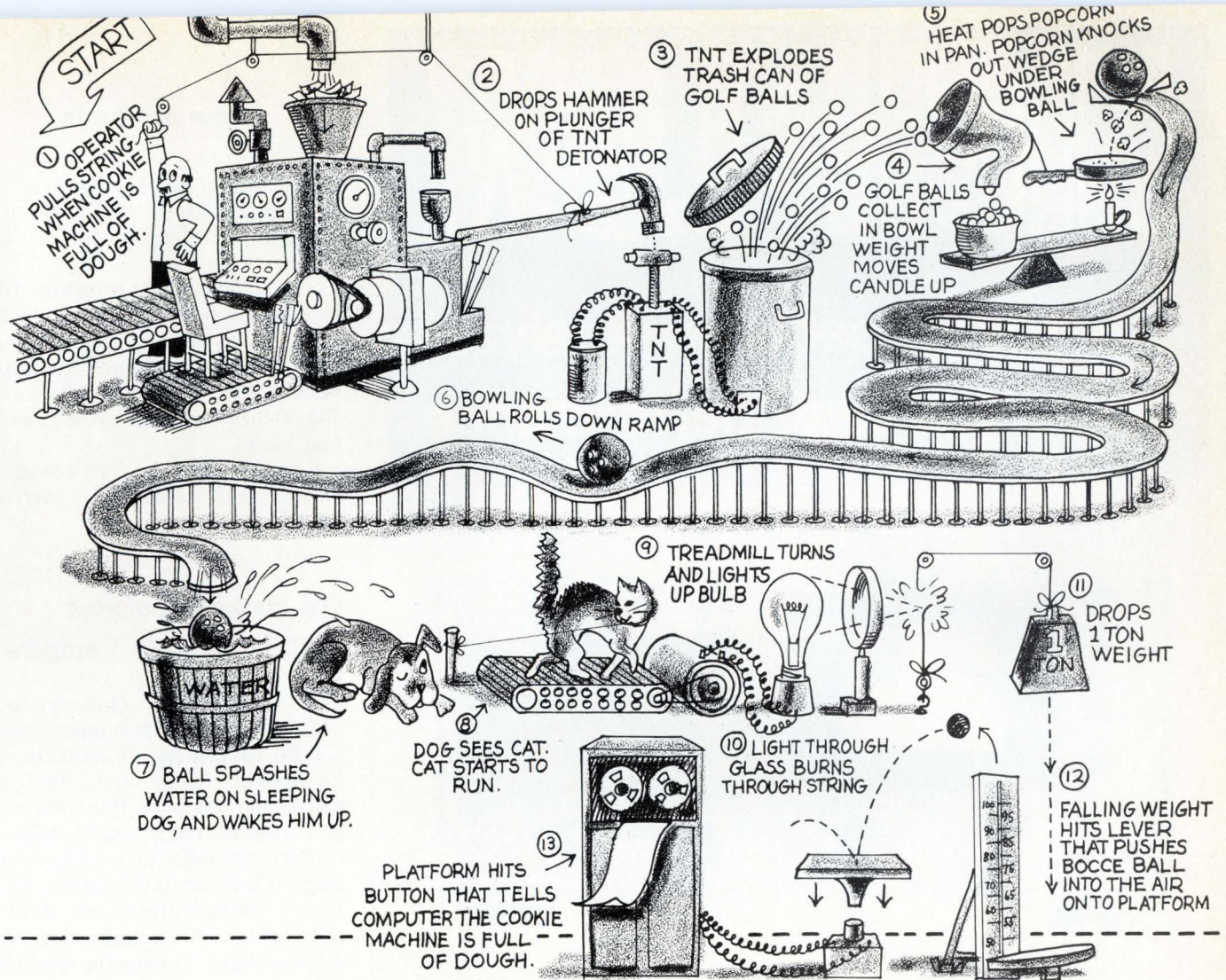
These new units also feature constant-bandwidth designs. In each model, the bandwidth (at 3 decibels down) for both of the selectable channels is essentially identical. This minimizes channel-to-channel group-delay differences and provides equal transition times when switching from one communications channel to the other.

For each module, the channel-select input can be driven directly by transistor-transistor, diode-transistor, or complementary-MOS logic. With the channel-select input open or at logic high, the passband is centered for mark/space frequencies of 1,070 and 1,270 hertz. When this input is grounded or tied to logic low, the passband shifts to mark/space frequencies of 2,025 and 2,225 Hz.

Channel gain is matched to within 0.1 dB for the model 530 and to within 0.2 dB for the model 531. At 2,025 Hz, the minimum low-channel rejection is -30.9 dB for the 530 and -50.8 dB for the 531. Similarly, the minimum high-channel (1,270 Hz) rejection is -39.9 dB for the 530 and -68.9 dB for the 531.

Both models can operate over a power-supply voltage range of ± 12 to ± 18 volts dc. With an input impedance of 100 kilohms and an output impedance of 50 ohms, each unit provides a short-circuit-pro-





How to avoid the interfacing nightmare.

If you've got a computer, the easiest way to avoid the kind of nightmare interfacing can become with *anybody's* machine is to simply come to us—the world's largest supplier of interface modules.

Besides being number one in sheer volume, we're also number one in technology. With a new line of microcomputer products for the LSI-11: A DMA module, an expansion backplane that doubles card capacity, and a foundation module for custom interfacing. Plus a new

line of high density wire wrap cards for our larger machines. All part of our substantial library of off-the-shelf solid state modules and compatible hardware featuring the best cost-performance ratio in the business.

The Logic Products Group can also help you establish new designs, give all kinds of applications assistance, even develop custom designs from scratch.

Why not send for our new Logic Handbook describing all our products. It'll give you a pretty good

idea of how we can take on the interfacing nightmare.

And turn it into one sweet dream.

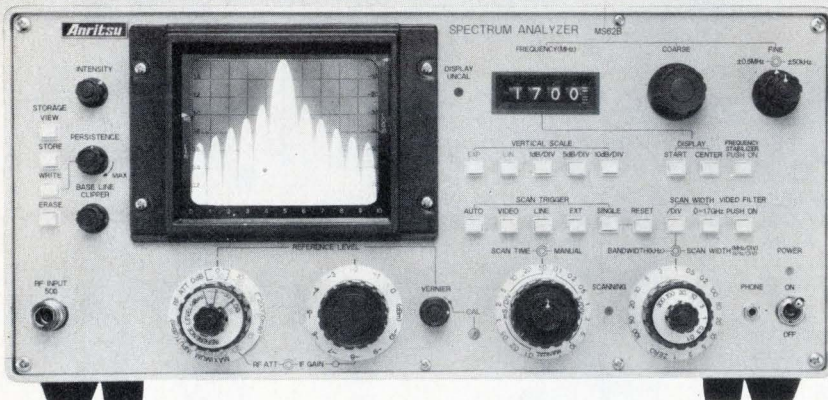
For your free Logic Handbook, call 800-225-9480 (Mass. 617-481-7400 ext. 6608). Or write: Components Group, Digital Equipment Corp., One Iron Way, Marlborough, Ma 01752. Canada: Digital Equipment of Canada, Ltd. Europe: 81 Route de l'Aire, 1211 Geneva 26, Tel. 42 70 50.



digital
COMPONENTS
GROUP

HIGH & LOW

Anritsu's Spectrum Analyzer offers you high performance at low power consumption.



MS62B

- Only 55W power consumption (capable of battery operation), the lowest in the world
- Wide 70dB dynamic range even with -30dBm input signal
- Covers 100kHz 1700MHz frequency range
- All-around measurements include pulse signal, CW signal, mixer/demodulator spurious signal, transmitter spurious radiation, AM signal, FM signal, pulsed AM signal, field strength, etc.
- Compact construction for space-saving installation
- Virtually maintenance-free

Anritsu

ANRITSU ELECTRIC CO., LTD.

MEASURING INSTRUMENTS DIVISION

SALES DEPARTMENT:

12-20, Minami-azabu, 4-chome, Minatoku, Tokyo 106, Japan

Phone: (03) 446-1111/Telex: 0-242-2353

Cable: ANRITDENKITOKYO

U.S.A. Tau-Tron Inc. Tel: (617) 667-3874 • West Germany Knott Elektronik GmbH Tel: (0 8178) 4085 • England Dymar Electronics Limited Tel: Watford 37321 • France Tekelec Airtronic Tel: (1) 946-96-48 • Italy Vianello S.p.A. Tel: 544041 • Holland Uni-Office B.V. Tel: (010) 2294 44 • Sweden Teleinstrument AB Tel: 08-38 03 70 • Singapore O'Connor's (Pte.) Ltd. Tel: 637944 • Australia NEC Australia Pty. Ltd. Tel: Melbourne 560-5233

192 Circle 192 on reader service card

New products

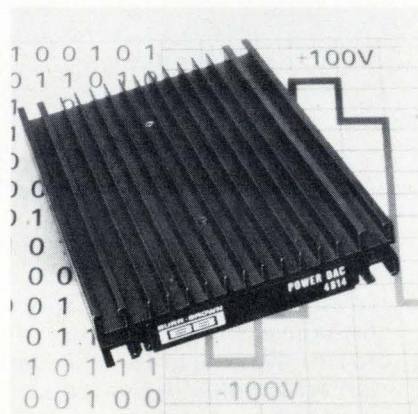
ected (to ground) output of ± 1 milliamperere. Operating temperature range for both filter models is 0°C to 70°C .

The model 530 transmit filter measures 1.5 by 2 by 0.4 inches, while the model 531 receive filter is 2 by 0.4 in. In single-unit quantities, price is \$60 for the 530, \$85 for the 531. Delivery is from stock to within four weeks.

Frequency Devices Inc., 25 Locust St., Haverhill, Mass. 01830. Phone (617)-374-0761. [381]

D-a converter puts out $\pm 100\text{ V}$ at up to 1 ampere

The model 4814 (binary input coding) and 4815 (BCD input coding) digital-to-analog converters are high-power 13-bit units that can deliver outputs of ± 100 volts at up to 1 ampere. Each consists of a d-a converter coupled to a power-output stage. Their available current drops as the voltage drops, but it never falls below 100 milliamperes. Both devices have resistor-programmable



current limits and voltage ranges, and both have a maximum nonlinearity of half a least significant bit.

Digital storage on the input eliminates critical timing requirements. Data is transferred on the positive-going edge of a strobe pulse, and the sign is strobed separately from the data.

Intended mainly for use as a programmable dc source for automatic test systems, the power d-a convert-

THE ONLY DISK DRIVES THAT DON'T NEED CLEAN AIR TO BREATHE.

Each Trident disk drive has its own enclosed air filtration system. No other removable-pack disk drives do.

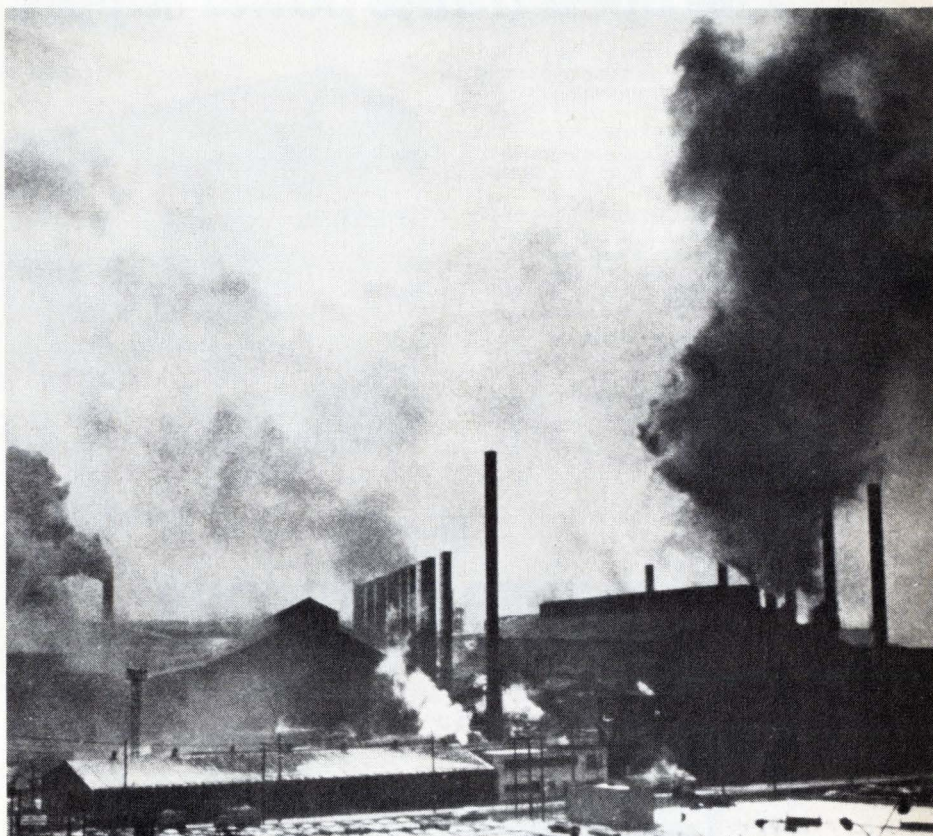
This means you can use a Trident disk drive almost anywhere. In a warehouse. Or a factory. Even in a smoke-filled room.

This kind of flexibility is just one reason Trident is the choice of growing businesses everywhere.

You find Tridents on the job in department stores—taking care of inventory control right at the point of sale.

Tridents are at the heart of the reservations systems for major hotel chains.

And Tridents are the continuing choice of the nation's leading OEMs.



NEW! **LARGE CAPACITY TRIDENTS.**

Now there are two new large capacity Trident disk drives—the T-200 and T-300.

They join the T-25, T-50 and T-80 to give you a wide range of capacities—all the way from 27 to 312 megabytes.

So now, as your needs grow, you have the capacity to meet those needs.

Each Trident model is functionally compatible with every other Trident model.

Each gives you track-following servo-technology. And each gives you one of the lowest cost-per-byte ratios in the industry.

A SOLUTION FOR YOUR PROBLEMS.

At CalComp we've been solving the data problems of growing businesses for years.

If your growing systems business needs

more flexibility, and if you want the experience and expertise that only CalComp can give you, call or write:

California Computer Products, Inc.,
EM-10-76, 2411 West La Palma Avenue,
Anaheim, California 92801. (714) 821-2011.

CALCOMP



33% more power to the people.

Power/Mate presents Econo/Mate II.

The open frame power supply.

Now Power/Mate brings you 33% more power in the same package size with the second generation of our Econo/Mate series.

The size is the same, the basic components are the same for easy interchangeability. But that's where the similarity ends.

Econo/Mate II adds features like dual AC primary and a plug-in IC regulator for improved regulation.

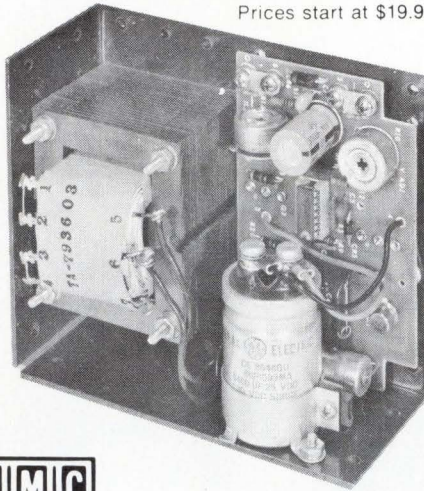
And Econo/Mate II is tough. Computer design, quality control, and Power/Mate's experience helps insure 100,000 hr. MTBF even at this higher power output.

But for all its features, Econo/Mate II is still, most of all, economical.

We wouldn't call it Econo/Mate if it wasn't.

Econo/Mate II is in stock, ready for delivery. Send for our free brochure.

Prices start at \$19.95.



POWER/MATE CORP.

World's largest manufacturer of quality power supplies:

514 South River Street/Hackensack, N.J. 07601/Phone (201) 343-6294 TWX 710-990-5023

Circle 194 on reader service card

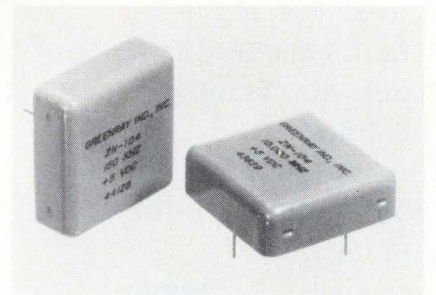
New products

ers can withstand short circuits of indefinite duration at 25°C. They have a maximum settling time, to within 0.01% of final value, of 100 microseconds. Price is \$249 each in small quantities. Delivery of the converters is from stock.

Burr-Brown Research Corp., Box 11400, Tucson, Ariz. 85734. Phone (602) 294-1431 [383]

Oscillator is designed for phase-locked loops

The model ZN-104 crystal oscillator is a voltage-controlled unit intended for use in low-cost phase-locked loops. It can be manufactured at any customer-specified frequency in the



range from 20 kilohertz to 25 megahertz. Voltage-control range is ± 40 ppm about the design frequency, allowing phase locking over the temperature range from 0°C to 50°C.

Hybrid technology makes it possible to construct the ZN-104 in a metal can measuring only 1.5 by 1.5 by 0.5 inches. In lots of 100, the oscillator sells for \$55. Delivery time is 45 days.

Greenray Industries Inc., 840 West Church Rd., Mechanicsburg, Pa. 17055. Phone (717) 766-0223 [384]

Heavy-duty power supplies are low in price

Designed to compete with open-frame supplies as far as cost is concerned, Datel Systems' MP series of heavy-duty power supplies delivers full rated output at ambient

THE TOTAL MEMORY SUPPLIER

WE HAVE DYNAMIC MOS RAMS. THINK ABOUT IT.

The most complete line of Dynamic MOS RAMs available. From 1024 x 1 to 4096 x 1, 16, 18 and 22 pin, 4096 x 1, 16K x 1 available 1st quarter '77.

Clip to letterhead. Rush complete list of total memories in stock.

Name	Title
Tel.	M.S.

811 E. ARQUES, SUNNYVALE, CA. 94086

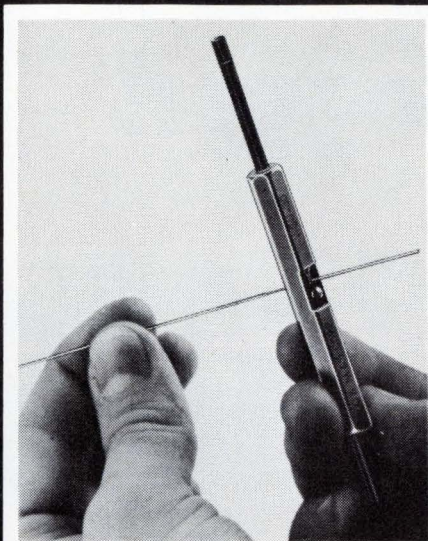
THINK Signetics

a subsidiary of U.S. Philips Corporation

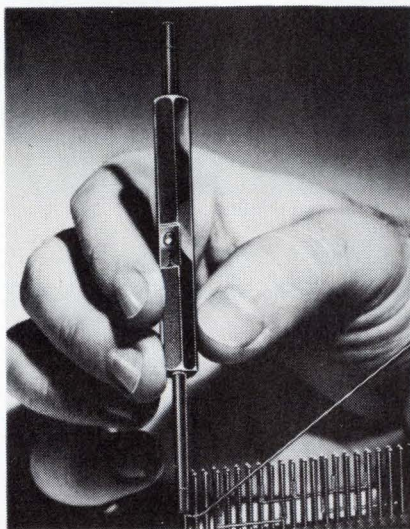
© 1976.

IN WIRE-WRAPPING HAS THE LINE...

HOBBY-WRAP-30



STRIP



WRAP



UNWRAP

OK MACHINE & TOOL CORPORATION

3455 CONNER STREET, BRONX, NEW YORK, N.Y. 10475 U.S.A. • PHONE (212) 994-6600

TELEX: 125091 TELEX: 232395

Circle 195 on reader service card

1702A MANUAL EPROM PROGRAMMER

Features hex keypad, two digit hex address and two digit hex data display. Controls include load, clear, go! (step), key/copy, data in/data out, and counter up/down. Profile card includes high voltage pulse regulator, timing, 8 bit address and 8 bit data drivers/receivers. Two 6½" x 9" stacked cards with spacers. Allows programming in 20 minutes — copying in 5 minutes. Requires +5, -9, and +80 volts.



ASSEMBLED \$299.95
KIT \$189.95

NOW

The best of two worlds... use our 1702 EPROM programmer as a manual data/address entry programmer... or connect it to your processor.

IMSAI/ALTAIR computer interface (requires 3 output ports, +1 input port) and software \$49.95

Briefcase unit with power supplies and interface connectors (assembled and tested only) \$599.95

ANNOUNCING

Our NEW 16K Byte Pseudo-Static, IMSAI/ALTAIR compatible RAM. Single card slot. Uses less power than equivalent low power RAM. All memory chips socketed. Uses all prime, factory fresh ICs. High quality, two-sided, through-hole-plated circuit board. Crystal controlled, totally invisible refresh system requires NO software management. Just plug it in and use like STATIC memory.

Complete kit \$349.95
Assembled, tested, and burned in \$549.95

ASSOCIATED ELECTRONICS

12444 Lambert Circle • Garden Grove, CA 92641
(714) 539-0735

Circle 235 on reader service card

THE TOTAL MEMORY SUPPLIER WE HAVE BIPOLAR & STATIC MOS RAMS. REMEMBER THAT.



Total line in stock. 24 Bipolars—from 8 to 1024 bits. 14 MOS Statics—from 256 x 4 to 1024 x 1 with 1K x 4 and 4K x 1 available 1st quarter '77.

Clip to letterhead. Send me complete list of total memories in stock.

Name _____ Title _____
Tel. _____ M.S. _____
811 E. ARQUES, SUNNYVALE, CA. 94086

THINK
Signetics

a subsidiary of U.S. Philips Corporation

©1976.

Circle 236 on reader service card 195

BETTER design... BETTER features... BETTER buy... **Datalogger!**

A universal data collection system with these **standard** features;

- 20 internal input channels
- Channel skip point selection
- Integral 24 hour clock, displaying hours & minutes
- Cycle interval selection
- Simultaneous visual display of time, channel & parameter
- Hard copy printout of all data
- 4½ digit display of parameter
- DC Volts, Millivolts
- AC Volts, Ohms, DC Autorange
- 5 Thermocouple types temperature measurement
- Platinum Resistance Temperature measurements
- Thermistor measurements to 0.01° resolution
- BCD output of all data
- Manual, automatic or remote cycle start

Available Options:

- Expansion to 200 channels
- Solid state switching
- Hi-low alarming
- Compatible paper tape punch

1200 Series, DC Voltage Measurements Prices start at
1500 Series, Temperature Measurements

\$2895.



DigiTec

UNITED SYSTEMS CORPORATION

918 Woodley Road • Dayton, Ohio 45403 • Ph: (513) 254-6251 • TWX: (810) 459-1728

These instruments available under GSA contract GS-OOS-29011.

For Information Only Circle **237** on Reader Service Card

For Demonstration Only Circle **196** on Reader Service Card

Free!

fixed ceramic capacitor catalog

There's a Nichicon ceramic capacitor designed to let you meet or beat almost every electro-mechanical requirement... in reliability, in dependability, in specialty applications.

OTHER PRODUCTION ITEMS INCLUDE: electrolytic capacitors, film capacitors, oil filled capacitors — without P.C.B., metallized paper capacitors, wax paper capacitors, mica capacitors, hybrid IC's and P.T.C. Thermistors.

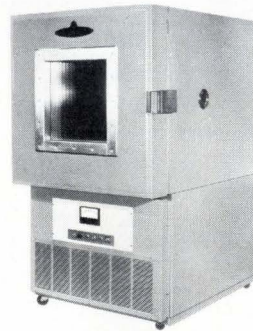


nichicon We help keep your world turned on.

NICHICON AMERICA CORPORATION
Division of NICHICON CAPACITOR LTD., Kyoto, Japan
6435 N. Proesel, Chicago, Ill. 60645 (312) 679-6530
40 Orville Dr., Bohemia, N.Y. 11716 (516) 567-2994

196 Circle 238 on reader service card

Standard test chambers at the lowest prices from the quality people.



1.2 cu. ft. chamber: **\$1,645**
4 cu. ft. chamber: **\$2,900**
8 cu. ft. chamber: **\$3,950**
16 cu. ft. chamber: **\$5,200**
32 cu. ft. chamber: **\$6,300**

Thermotron's new line of mini-max standard test chambers features uncompromising quality, prices below competition, exceptional performance and immediate delivery. The 1.2, 4, 16 and 32 cu. ft. models operate within a range of -73°C (-100°F) to 177°C (350°F). The 8 cu. ft. model operates in a range of -68°C (-90°F) to 177°C (350°F). For more information, including details on Thermotron's nationwide field service network, write today.

Thermotron Corporation

Kollen Park Drive, Holland, Michigan 49423
(616) 392-1492

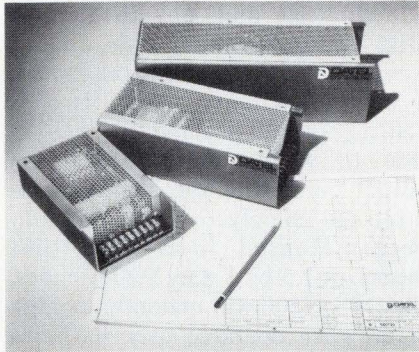


Circle 239 on reader service card

New products

temperatures from 0°C to 65°C and must be derated only 15% at 71°C. The supplies operate from 115/230 volts ac at 50 to 60 hertz, with no derating for 50-Hz operation.

The series has 16 models with commonly used single, double, and triple outputs. Output powers range from 15 to 105 watts. Features of the MP series include output current limiting, remote sensing, $\pm 5\%$ out-



put voltage adjustment, and overvoltage protection on all 5-v outputs. Basic specifications include maximum output ripple of 3 millivolts peak to peak, line and load regulation to 0.1%, and efficiencies of 40% to 50%. Small-quantity prices vary from \$38 to \$119. Delivery time is four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Eugene L. Zuch at (617) 828-8000 [385]

Digital clock movement has 0.84-inch numerals

A miniaturized electronic digital-clock movement with light-emitting-diode numerals 0.84 inch high also includes a MOS clock circuit, a power supply, and other, discrete, components. The movement, which is contained on a single printed-circuit board measuring 3.75 inches by 1.75 inches, needs only a transformer and switches to become a pretested digital clock for incorporation into a clock radio, a digital alarm clock, or an instrument panel clock. In lots of 100 pieces, the clock movement sells for \$15 each without an alarm tone, and \$16.50 with. The alarm tone is

A new subminiature pushbutton switch with a lot of pull.

C&K's newest innovation is a 6 amp subminiature pushbutton switch available in the following four models: *SPDT Alternate Action (8161)*; *DPDT Alternate Action (8261)*; *SPDT Momentary (8168)*; and *DPDT Momentary (8268)*. This dynamite little switch features an electrical life of one hundred thousand operations at full load, and utilizes C&K's fieldproven "toggle switch" terminal and sealing options. It's also a space saver. For a special little switch that really pulls its own weight, contact C&K today for a free engineering sample.

C&K Components, Inc.

103 Morse Street
Watertown, MA 02172
TEL: (617) 926-0800
TWX: 710 327 0460
TELEX: 92 2546

Free Engineering Sample On Request



Circle 197 on reader service card

■ THE TOTAL MEMORY SUPPLIER ■

WE HAVE BIPOLAR & MOS PROMS. THINK OF THAT.

Long list in stock. 17 Bipolars—from 256 to 8K bits —with 16K available soon. 4K and 8K MOS EROMS available 1st quarter '77.

Clip to letterhead. Send list of total memories in stock.

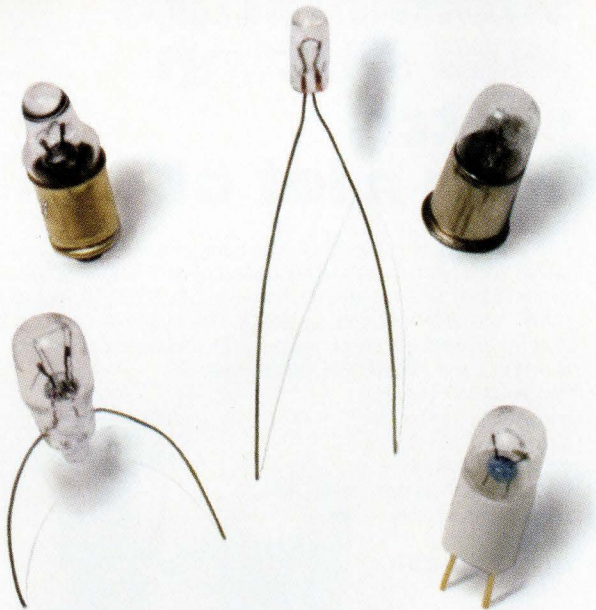
Name	Title
Tel.	M.S.
811 E. ARQUES, SUNNYVALE, CA. 94086	

THINK signotics

a subsidiary of U.S. Philips Corporation

©1976.

asking about SUBMINIATURE LAMPS?



CHICAGO MINIATURE HAS THE ANSWER!



Chicago Miniature has the answer for every subminiature application. All base configurations or wire terminal . . . all colors . . . standard products and specials . . . whatever you need with high quality at competitive prices. There's off-the-shelf delivery on most items from your distributor. For more information, or expert design help, contact Chicago Miniature Lamp Works, 4433 N. Ravenswood Avenue, Chicago, Illinois 60640. Phone (312) 784-1020.

CHICAGO MINIATURE LAMP WORKS

GENERAL INSTRUMENT CORPORATION 

New products

capable of directly driving an 8-ohm speaker.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [387]

Low-cost power supply
has 150,000-hour MTBF

Priced at only \$31.95 in singles and \$26 for 10 and up, the model DPS5S500 power supply has a mean time before failure of 150,000 hours. The high-reliability module is a 5-volt supply with line and load regulation to within 0.5%. Maximum output current of the short-circuit-protected supply is 500 milliamperes. Housed in a case that measures 2.5 by 3.5 by 0.875 inches, the DPS5S500 will maintain its high MTBF when operated over the temperature range from 25°C to 71°C. Delivery of the power supply is from stock.

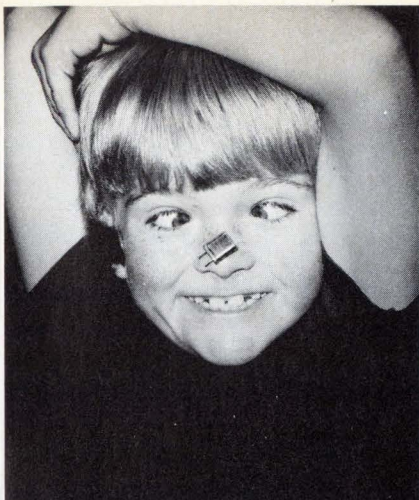
Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830. Phone (617) 373-9104 [388]

Direct-coupled amplifier
has 1-nanosecond rise time

Housed in a compact 16-pin dual in-line package, the VV100 fixed-gain amplifier is a direct-coupled device with a rise time of only 1 nanosecond. Designed for use with photomultiplier tubes, the amplifier has a noninverting gain of 10 and an input impedance of approximately 1 kilohm.

The amplifier requires an input terminating resistor, power supply bypass capacitors, input and output dc trims, and an output shape capacitive trim. It has a linear range





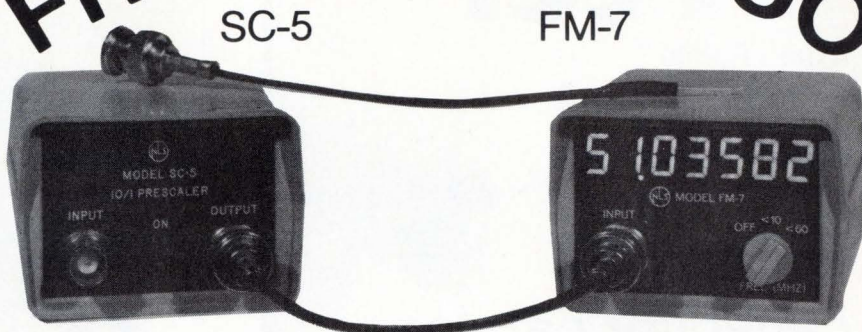
**DON'T GET BENT
OUT OF SHAPE
OVER QUARTZ
CRYSTALS**

Write or Call

SE
Savoy Electronics Inc.
Manufacturers of Quality Quartz Crystals Since 1937
Dept. EL-976 P.O. Box 5727, Fort Lauderdale, Florida, 33310.
305/563-1333

Circle 199 on reader service card

FREQUENCY DUO



With Rechargeable Batteries & Charger Unit. **\$127**

With Rechargeable Batteries & Charger Unit **\$195**

Features Include:

- By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF and UHF frequency bands).
- The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%.
- The SC-5 is accurate to one part per million.
- Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included.
- Dimensions of each are 1.9" H x 2.7" W x 3.9" D. • The units may be obtained separately or as a "Frequency Duo."



Non-Linear Systems, Inc.

See your local distributor!
Distributor inquiries invited.

Originator of the digital voltmeter.

Box N, Del Mar, California 92014 Telephone (714) 755-1134

For SC-5 Circle 241 reader service card

For FM-7 Circle 275 reader service card

Converting Force to mV's? That Takes Interface...



...Interface, Inc., designer and builder of a full line of precision strain gage load cells for force measurement and test systems. This low range Minibeam cell offers a guaranteed error band of less than $\pm 0.04\%$, is thermally compensated to within 8 ppm/°F, yet is priced as low as \$160 in unit quantities. Like all Interface load cells, it's warranted for 2 years.

For specifications on 5 to 150 pound capacity Minibeams that operate in tension or compression—for details on load cells with capacities to 100 tons, contact Interface, Inc., 7401 E. Butherus Dr., Scottsdale, AZ 85260 USA. (602) 948-5555. Telex 668-394.



Low Profile



Sealed Super-Mini



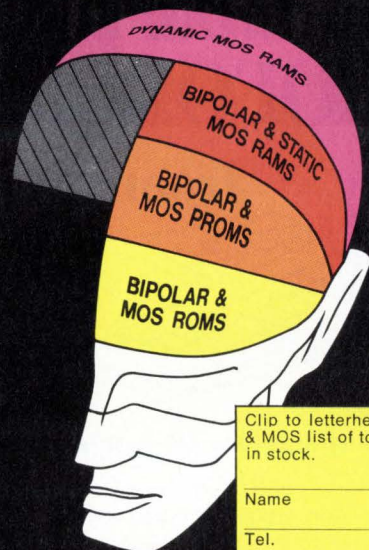
Super-Mini

Interface
ADVANCED FORCE MEASUREMENT

Circle 242 on reader service card

THE TOTAL MEMORY SUPPLIER

**WE HAVE
BIPOLAR & MOS ROMS.
DON'T FORGET IT.**



Wide variety in stock. 13 Bipolars—from 256 to 16K bits. Plus 7 Static MOS including 8K and 16K. Plus 4 character generators including 8K. Both TS & OC.

Clip to letterhead. Send Bipolar & MOS list of total memories in stock.

Name	Title
Tel.	M.S.

811 E. ARQUES, SUNNYVALE, CA. 94086

**THINK
Signoties**
a subsidiary of U.S. Philips Corporation

©1976.

Circle 243 on reader service card 199

Free!

Axial—Radial



Miniature aluminum electrolytic capacitor catalogs.

Capacitance values from .47 mfd through 10,000 mfd and voltages from 6.3V. to 100V. are readily available. Operating temperatures are from -40°C to +85°C at full rated voltage.

OTHER PRODUCTION ITEMS: Computer Grade Aluminum Electrolytics, Ceramic Capacitors, Film Capacitors, Oil Filled Capacitors—without P.C.B., Metallized Paper Capacitors, Wax Paper Capacitors, Mica Capacitors, Hybrid IC's and P.T.C. Thermistors.

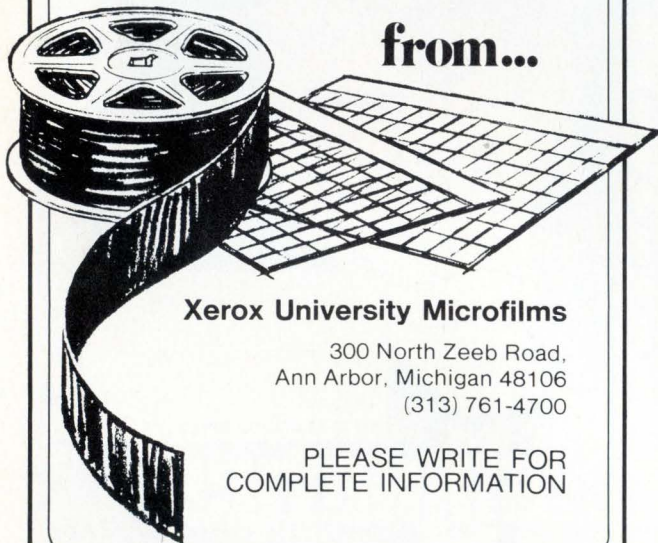


nichicon *We help keep your world turned on.*
NICHICON AMERICA CORPORATION
Division of NICHICON CAPACITOR LTD., Kyoto, Japan
6435 N. Proesel, Chicago, Ill. 60645 (312) 679-6530
40 Orville Dr., Bohemia, N.Y. 11716 (516) 567-2994

Circle 200 on reader service card

This Publication is Available in MICROFORM

from...

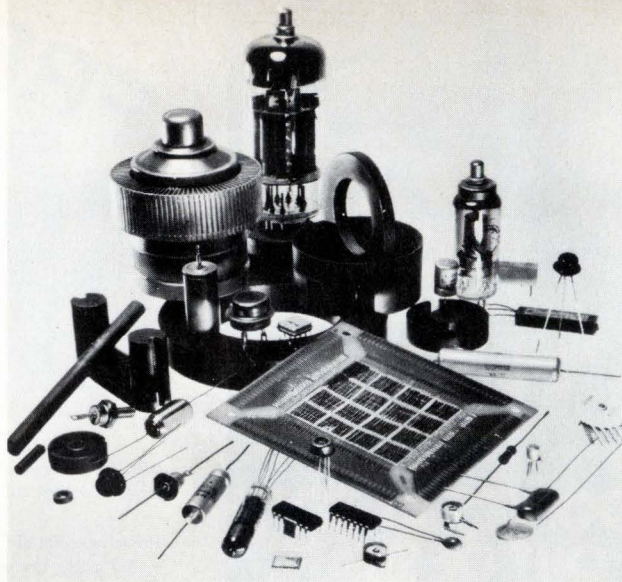


Xerox University Microfilms

300 North Zeeb Road,
Ann Arbor, Michigan 48106
(313) 761-4700

PLEASE WRITE FOR
COMPLETE INFORMATION

200



Reliability... would you vouch for it?

You should — if you use
ELORG electronic components

because they have been tested by years of operation in the most various circuitry.

Thoroughly designed, repeatedly tested before approved for series production. Manufactured with meticulous observance of process specifications. Carefully checked by quality control officers.

Integrated circuits. Semiconductor devices. Electron tubes. Resistors. Capacitors. Ferrites.

ELORG — the embodiment of the great scientific and industrial potential in all fields of electronics.



32/34 Smolenskaya-Sennaya
121200 Moscow G-200 USSR
Cables ELORG MOSCOW 200
Telephone 251-39-46 · Telex 7586

Circle 245 on reader service card

New products

from -5 volts to +200 millivolts. Output drift is less than 100 microvolts/°C.

In hundreds, the VV100 sells for \$43.50.

LeCroy Research Systems, 700 S. Main St., Spring Valley, N.Y. 10977. Phone (914) 425-2000 [386]

Stepping-motor drivers have adjustable currents

Compatible with four-phase stepping motors, a family of stepping-motor drivers is offered with nominal currents of 2, 5, and 10 amperes. But, since stepping motors rarely require exactly 2, 5, or 10 A, all members of the family provide means for the user to adjust the current to meet the requirements of the motor being used. The drivers are mounted on standard 19-inch panels and include six-foot motor cables.

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138 [389]

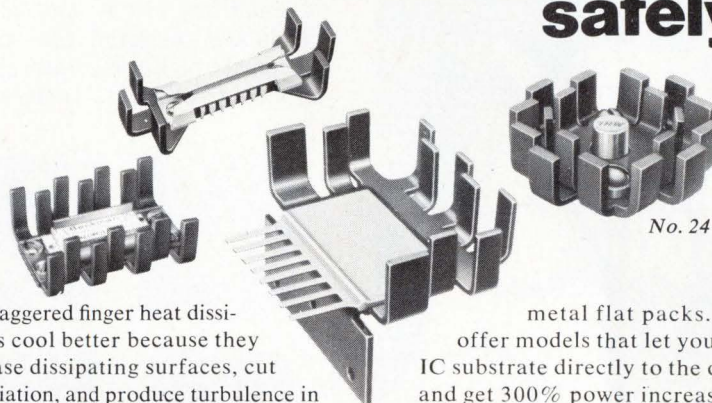
Voltage reference is housed in a standard TO-5 package

The series 840 precision voltage reference is a self-contained hybrid circuit that has been functionally laser-trimmed to provide 10 v dc $\pm 0.1\%$. The ready-to-use circuit is housed in a compact standard TO-5 package. Its case ground makes it very resistant to noisy environments, and its hermetic construction makes it immune to many other environmental problems.

Applications include use as a voltage reference for data converters and as a comparator reference.

The model 840-T1 is designed for operation over the temperature range from -55°C to 125°C; it sells for \$15 each in hundreds. The 840-T2 is specified from -25°C to 85°C and has a 100-piece price of \$12.35. Both units are available from stock. Beckman Instruments Inc., Technical Information Section, Helipot Division, 2500 Harbor Blvd., Fullerton, Calif. 92634 [390]

Now staggered fingers let you pour the power to IC's and hybrids safely



No. 24 of a Series

Our staggered finger heat dissipators cool better because they increase dissipating surfaces, cut re-radiation, and produce turbulence in forced air, and now they're available for IC's and microcircuits in special packages as well as standard. TO's, DIP's, .500" and .650" wide ceramics, 1"-square sealed

metal flat packs. We even offer models that let you pot your IC substrate directly to the dissipator and get 300% power increases easily. Ask for our new catalog. IERC, 135 W. Magnolia Blvd., Burbank, Calif. 91502, a subsidiary of Dynamics Corporation of America.

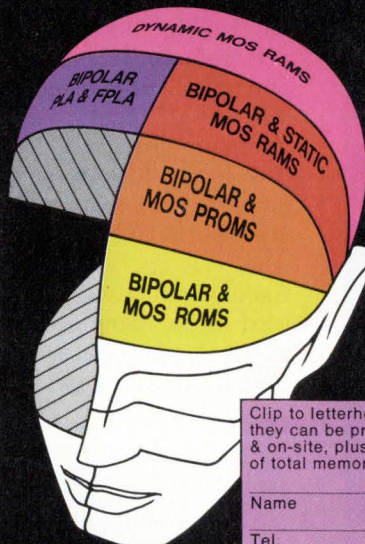
IERC



Heat Sinks

Circle 201 on reader service card

THE TOTAL MEMORY SUPPLIER WE HAVE BIPOLAR PLAS/FPLAS. SOMETHING TO REMEMBER.



Variety of Bipolars in stock. Field programmable input/output... connections in the package for greatest flexibility. Both TS & OC available and second sourced.

Clip to letterhead. Show me how they can be programmed in-house & on-site, plus send complete list of total memories in stock.

Name _____ Title _____
Tel. _____ M.S. _____
811 E. ARQUES, SUNNYVALE, CA. 94086

THINK **Signetics**

a subsidiary of U.S. Philips Corporation

© 1976

NATIONAL BEWARE!

**We've got
the bite
on you!**



MSK IS ON THE PROWL!

We're proud to announce the MSK032 . . . the new competition for the LH0032. Its "pin compatible" and competitive in both cost and specifications. Check these specs!

NATIONAL

Gain: 70 dB Typ.
Slew: 500 V/uSec Typ.
1% Settling: 100 nSec Typ.
Bandwidth: 70 MHz Typ.

MSK

Gain: 70 dB Min.!
Slew: 500 V/uSec Min.!
1% Settling: 100 nSec Min.!
Bandwidth: 70 MHz Min.!

*And there are No Funny Harmonic Distortions Around 3 MHz Either!!

Having any difficulty getting delivery on your LH0063 Buffers? Try an MSK 330. It's pin compatible and delivery is from stock!

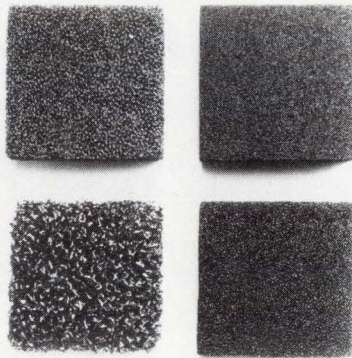
MSK

M.S. Kennedy Corp. Pickard Drive,
Syracuse, New York 13211
Tel. 315-455-7077

Circle 202 on reader service card

New products/materials

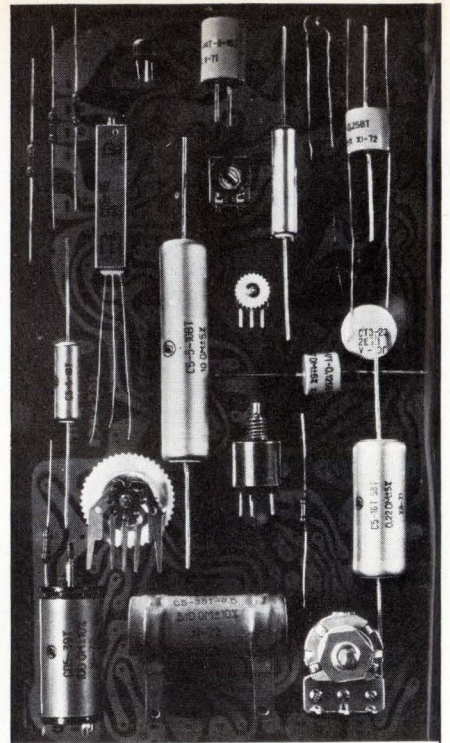
Reticulated vitreous carbon, a rigid, foam-like material made of one of the most chemically inert forms of carbon, has an unusual combination of qualities. It is an electrically conductive material that combines extremely high-temperature strength with low thermal conductivity—it



can be used up to about 600°F in air, or up to about 6,000°F in a nonoxidizing atmosphere. It is an excellent thermal and acoustic insulator, and it is well suited for use as a filter for molten metals, corrosive chemicals, and high- and low-temperature gases and liquids. A particularly attractive application of the material is in high-energy-density batteries, such as sodium/sulphur and lithium-aluminum/iron-disulphide systems, where its "caging" effect can improve cell performance. It comes in a variety of porosities. Experimental quantities sell for 25 cents per cubic inch; minimum order is \$25.

Chemotronics International Inc., 2231 Platt Rd., Ann Arbor, Mich. 48104. Phone H.C. Geen at (313) 971-4600 [476]

Gadolinium gallium garnet, which is used in the manufacture of magnetic-bubble devices, is now available from Union Carbide as 3-inch waf-



**For Mini- and Micro-Circuits:
The Infallible
Soviet Resistors**

- "MLT" fixed metal-film resistors
- "S2-331" non-wire fixed resistors
- "S1-4" fixed carbon resistors
- "SP3-22" fixed composition resistors, type "Malyutka"

Type	Resistance	Max. voltage [V]	Norm. dissipation power [W]	L [mm]	Dia. [mm]	Mass [g]
MLT-1	24ohm-10Mohm	500	1.0	13.0	6.0	2.0
MLT-2	24ohm-10Mohm	750	2.0	18.5	8.6	3.5
S2-331	10ohm-2Mohm	200	0.125	6.0	2.4	0.15
S2-331	10ohm-3Mohm	250	0.25	7.0	3.3	0.3
S2-331	10ohm-5.1Mohm	350	0.5	10.8	4.2	1.0
S1-4	10ohm-2Mohm	250	0.125	7.5	2.4	0.22
S1-4	10ohm-1Mohm	350	0.25	10.5	3.9	0.5
SP3-22	100ohm-1Mohm	150	0.1	7.0	3.0	0.4

Exporter:

ELORG



32/34 Smolenskaya-Sennaya
Moscow 121200, USSR
Telex 7586

Circle 247 on reader service card

Plug-in protection for μ Ps and minicomputers

Sola's Minicomputer Regulator provides a dedicated power line plus crucial line-voltage protection.



SOLA ELECTRIC **SE**
SOLA BASIC

A small investment can give your equipment both a dedicated line and protection against malfunction and damage due to brownouts and other line voltage irregularities.

The portable Sola Minicomputer Regulator accepts line voltage variations from 95 to 130 volts . . . then stabilizes output within $\pm 3\%$ variation. Output remains within $\pm 5\%$ operational range even when power line voltages drop to 65% of nominal. The unit responds to all line or load variations in less than 25 milliseconds, and provides complete isolation from electronic noise. All by simply plugging it in—no need for an electrician.

The Minicomputer Regulator. Part of Sola's complete selection of line voltage regulation devices—CVS constant voltage transformers . . . computer line Solatrons for large-frame computers . . . UPS and standby power systems.

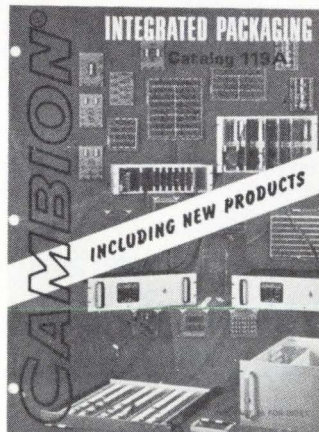
They are all in stock at your Sola distributor. Or contact Sola Electric, 1717 Busse Road, Elk Grove Village, Illinois 60007. Phone (312) 439-2800.

Think of us as your DEDICATED LINE.

Circle 203 on reader service card

What every IC system designer needs is easy to get.

Cambion's Integrated Packaging catalog 119A has 70 pages full of products for the designer. Breadboards, Wire-Wrap* cards, card files and hardware, logic assemblies, power supplies, sockets. These are only a few of the quality Cambion products featured. Write today for your FREE copy, Cambridge Thermionic Corporation, EA 6, 445 Concord Avenue, Cambridge, MA 02138.



Standardize on

CAMBION[®]

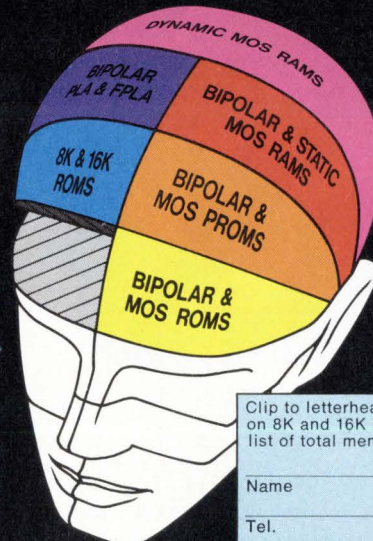
The Guaranteed Electronic Components

*Reg. TM
Gardner Denver Co.

Circle 248 on reader service card

THE TOTAL MEMORY SUPPLIER

WE HAVE 8K OR 16K N-CANNEL ROMS. KEEP THAT IN MIND.



Easy to buy, one time mask charge per code. Easy to order 300 piece minimum. Easy to get. One hundred piece minimum delivered as fast as four weeks after receipt of order.

Clip to letterhead. Send details on 8K and 16K ROMS plus full list of total memories in stock.

Name _____ Title _____
Tel. _____ M.S. _____
811 E. ARQUES, SUNNYVALE, CA. 94086

THINK
Signetics

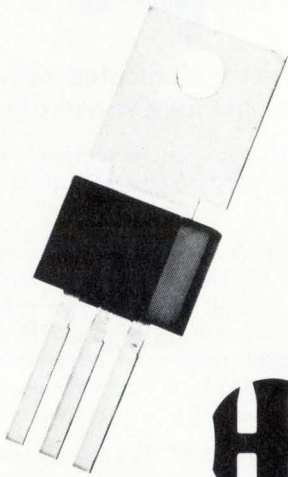
a subsidiary of U.S. Philips Corporation

©1976.

Circle 249 on reader service card

203

The First Power Triac Under 30c



Hutson Industries technology has combined with low-cost industry standard packaging to provide a 4 amp power triac available through 600 volts. Hutson is producing this package in excess of 10,000 devices a day . . . and now you can get this 4 amp triac at a price below any previous price in the industry.

Imagine . . . a 200 volt, 4 amp, 50 mil I_{GT} (Quad I & III) priced at 27 cents each in quantities of 10,000! Call or write Hutson TODAY!



HUTSON INDUSTRIES

P.O. Box 34235
2019 West Valley
View Lane
Dallas, Texas 75234
(214) 241-3511
TWX 910-860-5537

EUROPEAN OFFICE:
30 Rue Pierre Semard
Yerres, 91, France
Telephone: Paris
925-8258
TELEX 210-311

Circle 74 on reader service card

ICC's low-cost A.C. adapters get full play everywhere



Video games, calculators, and rechargeable battery operated products of all kinds use ICC battery charger/adapters. Two series are custom designed for outputs up to 15 volts at 4.2 watts. Optional features include IC voltage regulation, extremely low ripple filtering, and spurious harmonics suppression. UL and CSA recognized.

For free product bulletin write to:

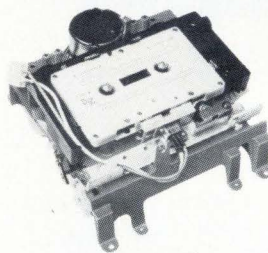
International Components Corporation

P.O. Box 66350, O'Hare Station • Chicago, IL 60666
Phone: (312) 772-4400 • TELEX: 254182
Tokyo • Hong Kong • West Germany

Exclusive world-wide marketing organization for
INTERNATIONAL CONVERTER CORPORATION

204 Circle 204 on reader service card

All-new Phi-Deck,[®] precision remote controlled cassette transports starting at under \$100!



Featuring:

- Re-engineered precision parts
- New cast frames
- 4 motor reliability
- Remotely controlled
- Precise, fast head engage/disengage
- Quick braking
- Various speed ranges

Electronic packages for control or read/write

For application in:

- | | |
|-----------------------------------|---------------------------------------|
| 1. Micro processing | 6. Data duplicating |
| 2. Data recording/logging/storage | 7. Security/automatic warning systems |
| 3. Programming | 8. Test applications |
| 4. Instrumentation | 9. Audio visual/education |
| 5. Industrial Control | 10. Hi-Fi |
| | 11. Others |



Triple I A Division of The Economy Co.

1901 North Walnut P.O. Box 25308
Oklahoma City, Oklahoma 73125 (405) 521-9000

- I am interested in application no. _____
 Have Representative call Send application notes

Name _____ Title _____
Company Name _____
Address _____
City _____ State _____ Zip _____
Phone Number _____

Circle 254 on reader service card

New products/materials

ers. Previously, GGG material was only offered in diameters up to 2 in. The core-free wafers are presently being supplied in evaluation quantities. These substrates are 25 mils thick, are polished to an epitaxial finish, and sell for \$195 each.

Union Carbide, Crystal Products Department, 8888 Balboa Ave., San Diego, Calif. 92123 [477]

A solder cream formulation that combines a fine-mesh powdered solder with a noncorrosive flux and vehicle system flows at 374°F, making it useful in all standard soldering



applications. The homogenized material can be dispensed with a manual syringe or with automatic equipment. It contains no cadmium or fluorides, and is noteworthy for its long shelf life.

Assembly Systems Inc., P.O. Box 9084, Dept. S, Providence, R.I. 02940 [478]

Pressure-sensitive adhesive composites for use in the fabrication of shunt stacks, transformer core assemblies, and other transformer components can reduce labor costs by eliminating the taping or adhesive-application step in the placement of insulation. Typical products currently available with pressure-sensitive adhesives are aramid papers and Estermat composites.

Keene Corp., Chase-Foster Laminates Division, P.O. Box 4305, East Providence, R.I. 02914 [479]

CSC'S NEW DESIGN-MATE 4. AN 8-FUNCTION DIGITAL PULSE GENERATOR FOR LESS THAN MOST DVM'S.

Wherever you need crisp, clean, fast output pulses compatible with virtually all logic families and discrete circuits, Design-Mate™ 4

is the logical choice. It produces symmetrical and unsymmetrical pulses ranging from 0.5Hz to 5MHz. And has a 100mV—10V variable output, with rise/fall times of less than 30 nanoseconds plus TTL sink output for up to 40 loads. Pulse width and spacing are independently-controllable from 100 nanoseconds to 1 second (10⁷:1 duty cycle) in seven overlapping ranges. And with the DM-4 you can select continuous operation, manual one-shot or external triggering to 10MHz with synchronous output gating. And a lot more. Which adds up to a high quality clock source, delayed pulse generator, synchronous clock source, manual system stepper, pulse stretcher, etcetera, etcetera . . . minus the 'high quality' price tag.



For more information, see your CSC dealer. Or write for our catalog and distributor list.

CONTINENTAL SPECIALTIES CORPORATION



EASY DOES IT

44 Kendall Street, Box 1942

New Haven, CT 06509 • 203-624-3103 TWX: 710-465-1227

West Coast office: Box 7809, San Francisco, CA

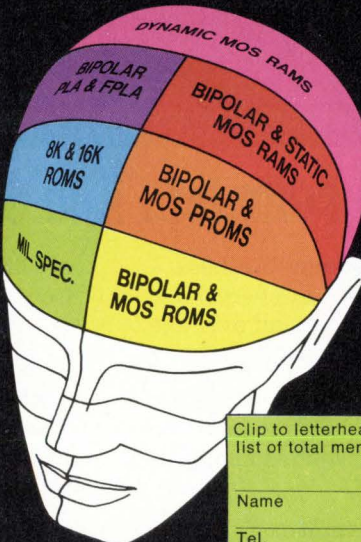
94119 • 415-421-8872 TWX: 910-372-7992

Canada: Len Finkler Ltd., Ontario

Circle 205 on reader service card

© Continental Specialties Corp. 1976

THE TOTAL MEMORY SUPPLIER
**WE HAVE BIPOLAR
MIL-SPEC MEMORIES.
STORE THAT AWAY.**



Total lineup manufactured in fully military approved plants. RAMs, ROMs, PROMs, FPLAs to 883 processing. Dual in-lines & flat packs ready to take on toughest assignments.

Clip to letterhead. Send entire list of total memories in stock.

Name _____ Title _____
Tel. _____ M.S. _____
811 E. ARQUES, SUNNYVALE, CA. 94086

THINK
signetics

a subsidiary of U.S. Philips Corporation

©1976.

We're the only total memory supplier.

Remember it.

Only Signetics has a complete line of Bipolar & MOS memories.

There are definite advantages in doing business with a total supplier. Most obvious, you get everything you need from one source without shopping all over the country. So you save time and all the hassle.

In addition, you get increased buying power. Because when you buy in volume, you naturally get the lowest price. So you save money. It all sounds simple because it is.

Signetics has made a positive commitment to stay ahead in technological leadership in Bipolar & MOS memories. No brag, just fact. With years of experience in supplying the needs of major customers and being a subsidiary of U.S. Philips Corporation, Signetics has the resources to make it happen.

Signetics has a total product line of memories — RAMs, ROMs, PROMs, FPLAs/PLAs and a long list

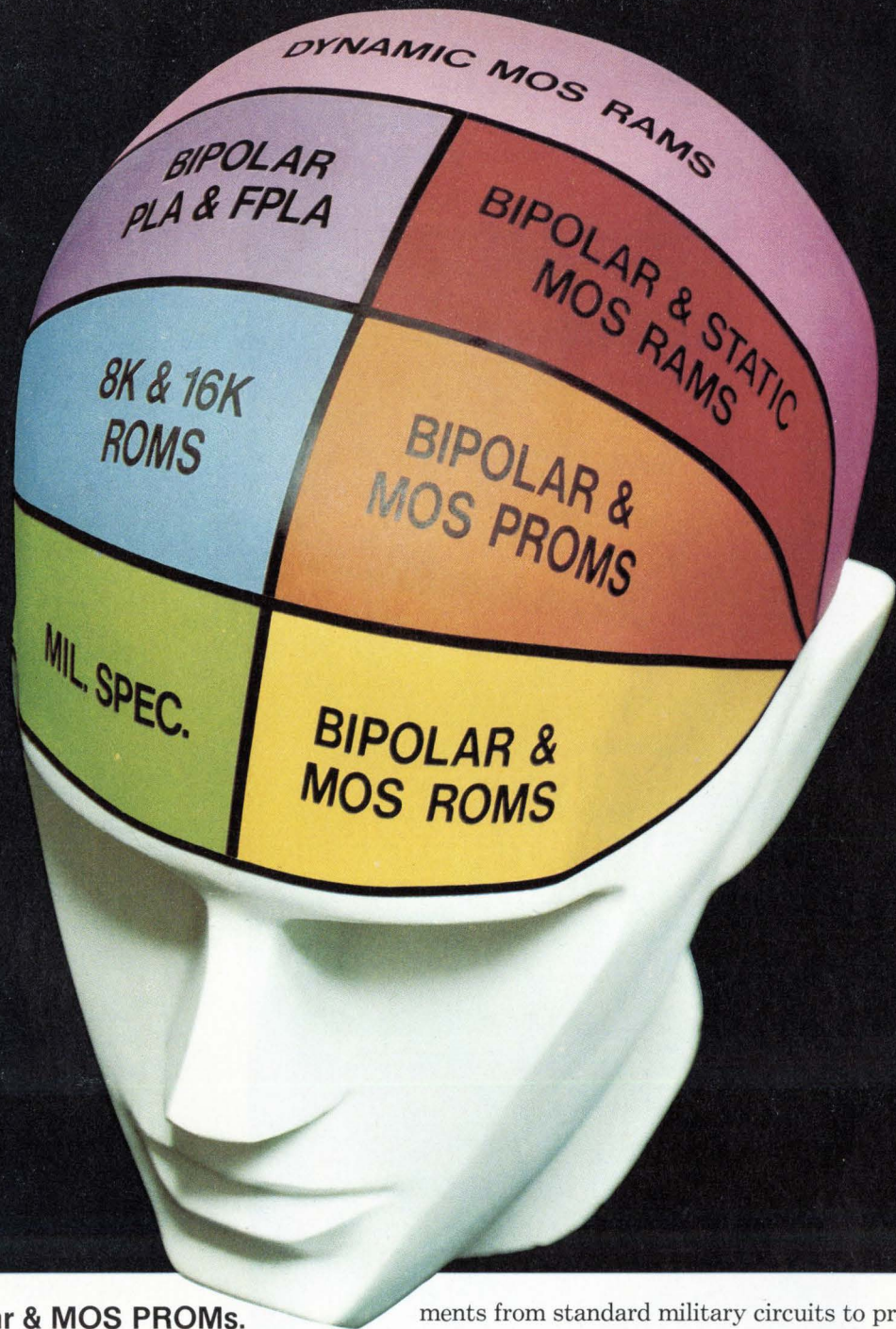
of Shift Registers including 12 Static and 8 Dynamic from 100 to 1024 bits.

Signetics Bipolar & Static MOS RAMs.

Signetics' total line of Bipolar & MOS devices includes all the hard-to-find and in-demand devices. 24 Bipolars — 8 to 1024 bits. 14 MOS Statics — 256 x 4 to 1024 x 1. 1K x 4 and 4K x 1 available 1st quarter '77.

Signetics Dynamic MOS RAMs. The most complete line of dynamic MOS RAMs from 1024 x 1 to 4096 x 1 (16, 18 and 22 pin). 1024 x 1 to 4096 x 1 organization. 16K x 1 available 1st quarter '77.

Signetics Bipolar & MOS ROMs. These mask-programmable chips offer easy word expansion. 13 Bipolars in stock — 256 to 16K bits. 7 MOS Statics in stock — up to 16K bits. Plus 4 character generators including 8K's. Both TS and OC available.



Signetics Bipolar & MOS PROMS.

All readily available through a vast Signetics distributor programming network. The new 18-pin devices offer small size, high PC board packing density, low complexity, very low power, and low component and system cost. 17 Bipolars in stock from 256 to 8K bits, with 16K available 1st quarter '77. 4K and 8K MOS EROMS available 1st quarter '77.

Signetics Bipolar FPLAs/PLAs. All devices deliver increased do-it-yourself flexibility and greatest system reliability with fewer parts and connections. It's easiest, fastest and simplest to modify and correct logic functions by limited editing of input/output connections within the package, and it's second sourced. Both TS and OC are available and in stock.

Signetics Bipolar MIL-SPEC Memories.

Total line manufactured to 883 military standards and available in dual in-line and flat pack configurations. In addition, Signetics supplies logic and analog require-

ments from standard military circuits to proprietary high performance series—making Signetics the total military supplier, too.

Clip to letterhead for fast response.

- Send me a full list of total Bipolar & MOS memory line.
- Please have a Field Applications Engineer call me for an appointment.

My application is _____

Name _____ Title _____

Telephone _____ Mail Stop _____

THINK signetics

811 E. Arques Ave., Sunnyvale, Ca. 94086

© 1976.

A subsidiary of U.S. Philips Corporation

Circle 207 on reader service card



HP 9830* users... your floppy disk is here! \$3895.

■ The FD-30 runs on cassette commands... that means **no software changes!** Because it runs on your **existing** programs.

■ The FD-30 finds files **50 times faster** than either the 9830 or the 9865A cassette drive.

■ The FD-30 **stores 5 cassettes of data** at the cost of one cassette.

■ The FD-30 applied in conjunction with Infotek's EM-30 16k-word memory and FAST BASIC ROMS gives unprecedented desk-top power.

■ The FD-30 transfers data to or from the 9830 even faster than the 9880B mass memory system. The 9880 requires 23 seconds to store a 10,000 word array via MAT PRINT. The FD-30 does this in 7 seconds via a simple STORE DATA.

■ The FD-30 **sells for a fraction of the 9880B**. And it is a far lower cost answer to most 9830 applications.

NO SOFTWARE REQUIRED!

The cassette control commands and syntax of the 9830 are obeyed to the last detail by the FD-30. All programs which operate with the 9830 cassette drive will run without modification. The result is a phenomenal reduction in program execution time and an increase in on-line data capacity.

NO INSTALLATION

Within minutes, the floppy drive takes on the appearance of original equipment as it fits neatly between the computer and printer. Only four inches are added to the overall height of the system.

OTHER INFOTEK-9830A/B COMPATIBLE PRODUCTS:

EM-30 32,192 Byte Memory System
FAST BASIC I ROM
FAST BASIC II ROM
TC-30 Real Time Clock
PS-30 Paper Tape Punch/Reader

*a product of Hewlett-Packard



Infotek Systems

733 EAST EDNA PLACE • COVINA, CALIFORNIA 91723
(213) 966-7431 • TWX 910-584-1812

New books

Filtering in the Time and Frequency Domains, Herman J. Blinchikoff and Anatol I. Zverev, Wiley-Interscience, 494 pp., \$27.50.

A Sourcebook of Modern Transistor Circuits, Laurence G. Cowles, Prentice-Hall, 360 pp., \$17.50.

Handbook of Operational Amplifier Circuit Design, David F. Stout and Milton Kaufman, eds., McGraw-Hill, 434 pp., \$24.50.

Permanent Magnet Design and Application Handbook, Lester R. Moskowitz, Cahners, 408 pp., \$39.50.

Handbook of Solid-State Troubleshooting, Hershhal Gardner, Reston, 318 pp., \$15.95.

Transistor Circuit Analysis and Application, Ben Zeines, Reston, 374 pp., \$16.95.

Electronic Circuit Analysis and Design, William H. Hayt Jr. and Gerold W. Neudeck, Houghton Mifflin, 423 pp., \$15.95.

Solar Cells, Charles E. Backus, ed., IEEE Press, 503 pp., \$17.95, \$8.95 (paper).

Digital Signal Processing, Abraham Peled and Bede Liu, Wiley, 304 pp., \$16.95.

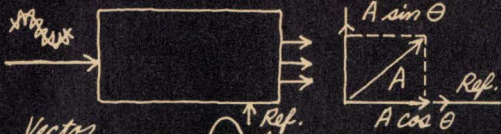
Shock and Vibration Handbook, Cyril M. Harris and Charles E. Crede, eds., McGraw-Hill, 1,322 pp., \$32.50.

Electronic Assembly and Fabrication, Gershon J. Wheeler, Reston, 207 pp., \$10.

Waveform Quantization and Coding, Nuggehally S. Jayant, ed., IEEE Press, 610 pp., \$14.95.

Electrical and Electronics Graphic Symbols and Reference Designations, IEEE and ANSI, IEEE Press, 235 pp., \$19.95.

Handbook of Thick Film Technology, P. J. Holmes and R. G. Loasby,

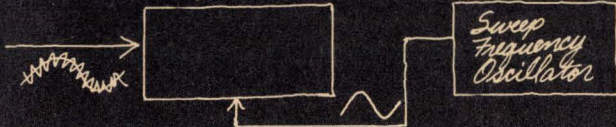


Vector Voltmeter:

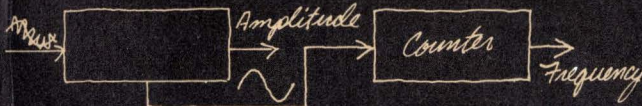
Three outputs simultaneously available. Continuous 360° phase offset capability for phase nulling to .1°. 90° & 180° switches accurate to .1 degree.



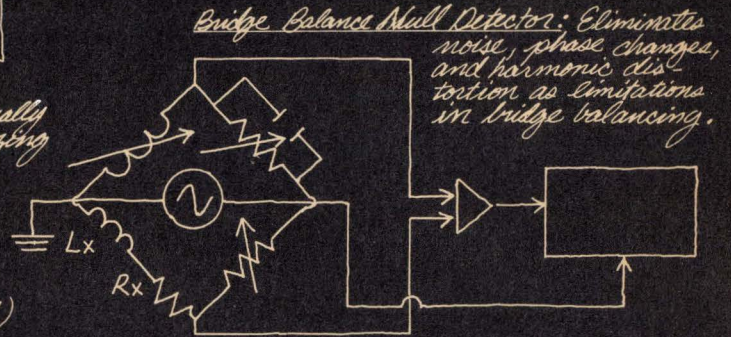
Narrow Band AC Voltmeter: Measure cross talk, power supply rejection, and other low level coupling phenomena. Automatically tracks signal frequency.



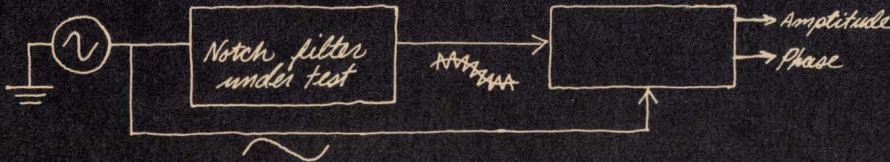
Ultra Sensitive Spectrum Analyzer: Tune manually with controls provided, or sweep by synchronizing to external sweep oscillator.



Tracking Filter (measure frequency of noisy signal)
Signal tracking mode phase locks internal oscillator to noisy signal.



Bridge Balance Null Detector: Eliminates noise, phase changes, and harmonic distortion as limitations in bridge balancing.



Transfer Function Analyzer
Measure notch filter depth and phase characteristics.

Measure noisy signals up to 200 kHz—like you've never measured them before.

A new test and measurement tool, the Dynatrac[®] 3 lock-in analyzer, measures amplitude, frequency, phase and narrow band noise at signal levels from picovolts to volts, frequencies from .1 Hz to 200 kHz, and selectable bandwidths from .001 Hz to 100 Hz. It easily detects signals that are 100 dB below an interfering signal—a dynamic range that is currently beyond the state of the art in digital technology.



Because of its ability to measure signals in the presence of noise, there are many applications in which Dynatrac 3 picks up where the performance of vector voltmeters, phase meters, lock-in amplifiers, wave analyzers, transfer function analyzers,

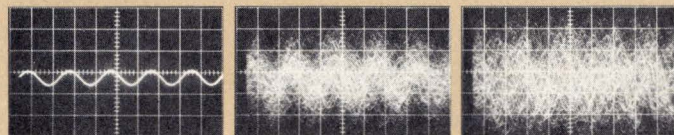
bridge balance null detectors, and noise meters leave off.

With its phase option, Dynatrac 3 measures the phase of signals completely obscured by noise with an accuracy of ±1° and resolution and stability of .1°.

Dynatrac 3 delivers trouble-free performance with RFI protection. And a floating guarded front end eliminates ground loops.

The sketches above illustrate just some of the many applications for this unique new test and measurement tool.

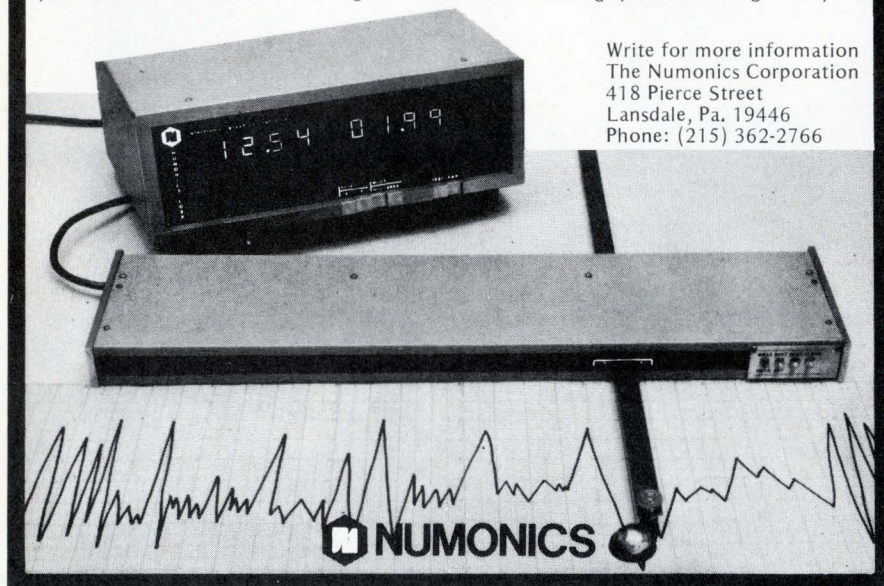
To get the complete Dynatrac 3 story (and to tell us about your signal measurement problems), contact Ithaco, Box 818-E, Ithaca, New York 14850. Or telephone (607) 272-7640 or TWX 510-255-9307.



FROM \$2000

When it comes to graphics...
WE'VE GOT YOUR NUMBER

Maps, charts, aerial photos...if the information you need is graphical, the Numonics Digitizer can turn it into good, straight numbers. The Numonics Digitizer is desk top size, but offers a 30"x36" working area with resolution down to the closest 0.01". Very economical. . .and yet it has standard features like big readout and parallel BCD-buffered output. Plus optional direct measuring capability for area and curve length, with or without scaling. As quickly as you set the scale and trace the graphics, we've got your number. Let us tailor our digitizer into a data handling system that's right for you.

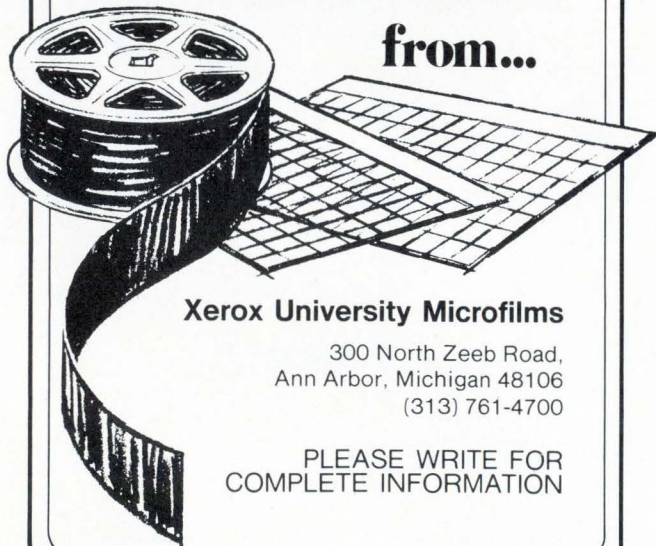


Write for more information
The Numonics Corporation
418 Pierce Street
Lansdale, Pa. 19446
Phone: (215) 362-2766

Circle 210 on reader service card

**This
Publication
is Available in
MICROFORM**

from...



Xerox University Microfilms

300 North Zeeb Road,
Ann Arbor, Michigan 48106
(313) 761-4700

PLEASE WRITE FOR
COMPLETE INFORMATION

New books

eds., Electrochemical Publications (Ayr, Scotland, UK), 430 pp., \$57.50 (plus \$1.75 postage to U.S.).

Advances in Electronics and Electron Physics, Volume 40A: Photo-Electronic Image Devices, B. L. Morgan, R. W. Airey, and D. McMullan, eds., Academic Press, 517 pp., \$44.25.

APL/360 Programming and Applications, Herbert Hellerman and Ira A. Smith, McGraw-Hill, 203 pp., \$8.95 (paper).

Mathematical Elements for Computer Graphics, David F. Rogers and J. Alan Adams, McGraw-Hill, 239 pp., \$9.95 (paper).

Computers at Large, Charles Sippl and Robert Bullen, Bobbs-Merrill, 222 pp., \$10.

High-Speed Silicon Planar-Epitaxial Switching Diodes, Miklos Kocsis, Halsted Press, 177 pp., \$25.

Electronic Fundamentals and Applications for Engineers and Scientists, Jacob Millman and Christos C. Halkias, McGraw-Hill, 482 pp., \$14.95.

Designing Technical Reports: Writing for Audiences in Organizations, J. C. Mathes and Dwight W. Stevenson, Bobbs-Merrill, 396 pp., \$14.95.

Communications Satellite Systems: An Overview of the Technology, R. G. Gould and Y. F. Lum, eds., IEEE Press, 164 pp., \$15.

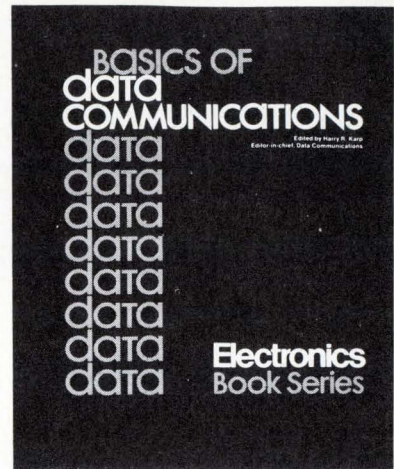
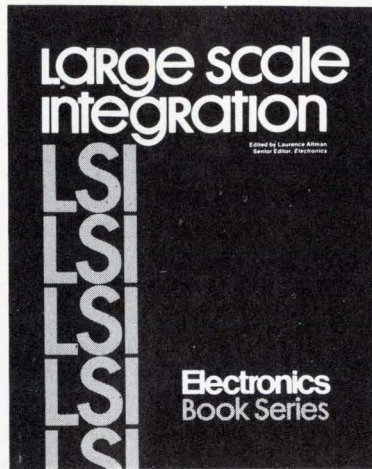
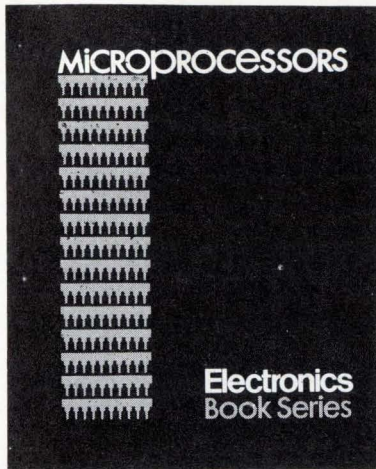
Theory of Electrical Filters, J. D. Rhodes, Wiley, 224 pp., \$22.95.

Sound Recording, John Eargle, Van Nostrand Reinhold, 323 pp., \$16.95.

400 Ideas for Design, Vol. 3, Electronic Design magazine, Hayden, 352 pp., \$13.95.

Computer Design Development: Principal Papers, Earl E. Swartzlander Jr., ed., Hayden, 320 pp., \$13.95.

The Electronics Book Series offers you:



1 MICROPROCESSORS

The microprocessor has permanently changed the methods of designing and building electronic equipment—from process and industrial control to computer-based designs in instruments communication and consumer/commercial equipment.

This book cuts through the confusion, presenting the design and application potential of this exciting technology in a manner that will appeal to the design engineer who needs to know how to use microprocessors as well as the system analyst who must assess the tradeoffs between microprocessors and other techniques to accomplish his system goals.

Using articles from the pages of Electronics, this book contains practical and up-to-date information on available microprocessor devices, technology and applications.

2 LARGE SCALE INTEGRATION

The Electronics Book Series offers you a handbook on the current and revolutionary impact of LSI on digital design. This 220-page book presents a unique opportunity for circuit designers, systems designers, and engineering managers and supervisors to bring their expertise into line with today's LSI design requirements.

"Large Scale Integration" is a compendium of recent articles published in Electronics. Although in some ways it is a companion piece to "Microprocessors" because it explains the new circuits that play in mp systems, it is much more. "Large Scale Integration" deals with the entire range of design applications: main memory systems, peripheral memories, memory controllers, on-line industrial controllers, data acquisition boards, communication systems, calculators, watches, etc.

3 BASICS OF DATA COMMUNICATIONS

Data communications is one of the fastest-growing electronic equipment markets in the U.S.—during the decade of the '70's, better than 15-20% per year, compounded!

Chances are you are going to be a part of the data communications market. There's no better place to start than getting a copy of "Basics of Data Communications"—a 316-page compilation of essential articles which have appeared in Data Communications magazine. From the basic, tutorial, still state-of-the-art information published in the 1972 and 1973 Deskbook issues (now out of print), on through information on the practice of present-day data communications, this book includes forty-seven articles covering more than eleven key areas.

Electronics Book Series • PO Box 669, Hightstown, N.J. 08520



- 1 Send me _____ copies of "Microprocessors" at \$8.95 per copy.
- 2 Send me _____ copies of "LSI" at \$9.95 per copy.
- 3 Send me _____ copies of "Basics of Data Communications" at \$12.50 per copy.

Discounts of 40% on orders of ten or more copies of each book.

I must be fully satisfied or you will refund full payment if the books are returned after ten day trial examination.

Payment enclosed Bill firm Bill me

Credit Cards Charge My Book To

American Express Master Charge
 Diners Club BankAmericard

Name _____
 Title _____
 Company _____
 Street _____
 City _____
 State _____ Zip _____
 Signature _____

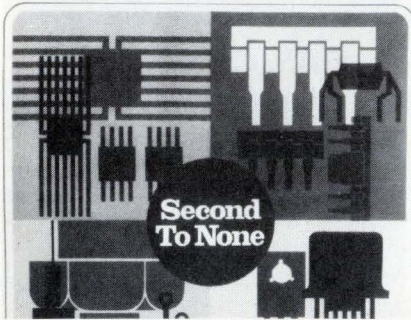
Acct. No. _____
 Date Card Expires _____
 Interbank No. _____

(1st No's. above name on Mastercharge only.)

New literature

Semiconductors. The ITT line of semiconductors, including linear ICs, digital ICs, custom circuits, and discrete devices, is covered in a 40-page edition of the company's catalog. Copies are available from ITT Semiconductors, 74 Commerce Way, Woburn, Mass. 01801. Circle reader service number 421.

SEMICONDUCTORS **ITT**
CONDENSED
CATALOG



Microcircuit reliability. Entitled "Digital Detailed Data," a 250-page databook put out by the Reliability Analysis Center, Griffiss Air Force Base, N.Y. 13441, presents reliability data on monolithic logic circuits by technology, by manufacturer, and by part number. The databook (Catalog No. MDR-4) contains more than 2,500 line entries, providing all the information needed for device failure-rate computation per MIL-HDBK-217B reliability prediction models. Single copies of the book sell for \$50 in the U.S. For further information, circle reader service number 422.

Line-voltage regulation. A 16-page booklet on the theory, design, and operation of line-voltage regulation equipment includes a discussion of the causes of irregular voltage, the problems it creates, and various solutions utilizing constant-voltage regu-

lation. For a copy of the booklet, request catalog No. 653 from Irv Roane, Sola Electric, 1717 Busse Rd., Elk Grove Village, Ill. 60007 [423]

Satellite communications. A 72-page catalog from Scientific-Atlanta gives details on the company's line of products for satellite-communications earth stations. Among the products that are described are antennas, antenna mounts, ground-communications equipment, and equipment for single-channel-per-carrier operation. Copies are available from M. L. Hudspeth, Satellite Communications Division., Scientific-Atlanta Inc., 3845 Pleasantdale Rd., Atlanta, Ga. 30340 [426]

Timing and control. Specifications and data on a line of timing and control components are contained in a 16-page catalog offered by North

EEV marine magnetrons?

+ + + EEV MAGNETRONS FOR MARINE RADAR STOP.

EXPANSION COMPLETE STOP ALL TYPES NOW

AVAILABLE STOP FOR EX STOCK DELIVERIES

ORDER NOW. ENELECTICO

American Philips Controls Corp., Cheshire, Conn. 06410. Among the products contained in the catalog are ironless-rotor dc motors, solid-state relays, surface thermostats, magnetic switches, stepper motors, and elapsed-time indicators. [424]

Microwaves. The 1976 Narda catalog, a 170-page compendium of products in the 1-to-18-GHz range, contains data on many products not announced previously. Catalog No. 20 also tells about Narda's new line of GaAs FET amplifiers for communications, radar, and electronic warfare systems. Copies of the catalog can be obtained from Narda Microwave Corp., Plainview, N.Y. 11803 [425]

Adhesive-dispensing equipment. A line of equipment for mixing and dispensing epoxy resins and other adhesives is described in a 16-page

catalog that has been released by Otto Engineering Inc., 36 Main St., Carpentersville, Ill. 60110. Attn: Ronald E. Sparks [427]

Silicon on sapphire. Entitled "Silicon on Sapphire Technical Update," bulletin F-CPD-S765 describes recent advances in material and processing technology. The four-page brochure particularly emphasizes the suitability of SOS techniques for complementary-MOS circuitry. To request a copy, write to: SOS Bulletin, Union Carbide Corp., Crystal Products Dept., 8888 Balboa Ave., San Diego, Calif. 92123 [428]

Indicator lights. A broad line of incandescent and neon indicator lamps is described in a full color catalog put out by the Carr division of TRW Inc., 31 Ames St., Cambridge, Mass. 02142. Configurations illustrated in the catalog include

round, square, and rectangular, with the latter especially recommended when lettering is desired. [430]

Component packaging. A family of component mounts, spacers, and spreaders is detailed in a 16-page packaging digest put out by Bivar Inc., 1617 E. Edinger Ave., Santa Ana, Calif. 92705. Both permanent and washaway spacers are covered in catalog 576-M. [433]



Yes.

To meet increasing worldwide demand, we've stepped up production of EEV marine magnetrons.

Now you can order all EEV types and be sure of getting them from stock.

You'll be sure, too, of getting the world's best tubes. EEV's unique metal/ceramic magnetrons can last 60% longer



than other makers' glass types.

Get the best. Fast. EEV/M-OV magnetrons, modulator tubes, duplexer devices, CRTs - in fact, all the tubes you need for marine radar.

From EEV/M-OV international stockists everywhere. Or if you'd like our equivalents list, contact Chelmsford.

EEV and M-OV know how

Members of GEC - turnover £1902 million

THE M-O VALVE CO LTD, Hammersmith, London, England W6 7PE. Tel: 01-603 3431. Telex: 23435. Grams: Thermionic London. GLISH ELECTRIC VALVE CO LTD, Chelmsford, Essex, England CM1 2QU. Tel: 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford. **Genalex** 

CLASSIFIED SALES REPRESENTATIVES

Atlanta... Joe Lane ... 404/892-2868
 Boston ... Holt Buchanan ... 617/262-1160
 Chicago ... Bill Higgins ... 312/751-3733

Cleveland ... Mac Huestis ... 216/781-7000
 Dallas ... Rick Ofstie ... 214/742-1747
 Denver ... Shirley Kotz ... 303/837-1010
 Detroit ... Mac Huestis ... 313/873-7410

Houston ... Rick Ofstie ... 713/659-8381
 Los Angeles ... Stan Kassim ... 213/487-1160
 New York ... Dave Hawksby ... 212/997-3594
 Philadelphia ... Dan Ferro ... 215/568-6161

Pittsburgh ... Dan Ferro ... 412/391-1314
 San Francisco ... Mary Kenny ... 415/362-4600
 Stamford ... Holt Buchanan ... 203/359-2860
 XEROX 100 TELECOPIER ... 212/997-6800

Break Away To Colorado Now.

Superior candidates are needed for permanent assignments working on desk top computers and peripherals.

If you want to associate with a people-oriented company in Colorado, then consider Hewlett-Packard's Loveland Division. With us you'll enjoy the advantage of small community living within an hour's drive of metropolitan Denver and the Rocky Mountain National Park.

Design Engineers working in:

- . **Softwares**
- . **Logic**
- . **Circuits**
- . **LSI**
- . **MOS/Thin Film Processes**
- . **Mechanical**

Hewlett-Packard is looking for design engineers who have state-of-the arts skills in one or more of the above areas, and have the aptitude and the desire to expand themselves into the other disciplines.

A strong broad academic background will be necessary to pass our technical screening. Successful candidates will be part of a team doing "hands-on design" of desk top computers and peripherals.

Qualified? Interested in a dynamic secure career with a respected company? Respond in confidence to Kathleen Kline, Professional Recruiting, Hewlett-Packard Company, Calculator Division, P.O. Box 301, Loveland, Colorado 80537. We are an equal opportunity employer dedicated to affirmative action.



SENIOR PROJECT ENGINEER

If you are a BSEE looking for a dynamic organization in which you will be challenged in designing and developing miniature (under 1/4 HP) AC and DC motors for highly sophisticated industrial applications, then you will certainly want to explore this opportunity with us.

You should have experience in motor systems for computer printers, tape drives, banking terminals, typewriters, etc. Knowledge of motor controls that are used in these systems including digital and analog feedback. Stepper motor experience is desirable. 10 or more years experience should qualify you for this senior position.

We offer excellent salary and fringe benefits package. Send resume to:

EMPLOYMENT MANAGER

**TRW
GLOBE
MOTORS**

2275 Stanley Avenue,
Dayton, Ohio 45404

An equal opportunity employer m/f

THIS SPACE AVAILABLE. ONLY \$184.

Your recruitment advertising in this four inch space will cost you only \$46 per inch, or \$184.

You'll reach over 68,000 domestic engineers and technical people, as they're reading to combat job obsolescence, while they're thinking about their future and bettering themselves.

There's no charge for typesetting and free layout service is provided. For more information, call or write:

Electronics

Post Office Box 900
New York, N.Y. 10020
Phone: 212/997-2556

Job-Seekers:

Be the first to know with McGraw-Hill's Advance Job Listings

By having our new weekly ADVANCE JOB LISTINGS sent First Class to your home every Monday, you can be the first to know about nation-wide openings you qualify for both in and out of your field.

This preprint of scheduled employment ads will enable you to contact anxious domestic and overseas recruitment managers BEFORE their advertisements appear in upcoming issues of 22 McGraw-Hill Publications.

To receive a free sample copy, plus information about our low subscription rates (from three months to 12), fill out and return the coupon below.

ADVANCE JOB LISTINGS
P.O. BOX 900
NEW YORK, N.Y. 10020

Please send a sample copy of ADVANCE JOB LISTINGS to:

Name _____

Address _____

City _____

State _____

Zip _____



Avionics Professionals

As a leader in the advanced computer oriented avionics systems field, we are in a position to offer interesting and challenging career employment to professionals with specialized experience and training. Current requirements include:



SYSTEMS SOFTWARE PROGRAMMERS: To design and implement systems support software including assemblers, compilers, simulators, and linkage editors for a family of airborne minicomputers. FORTRAN and Assembly language programming background on System 370 or equivalent large scale computers required. Experienced personnel as well as new graduates are encouraged to apply.

CONFIGURATION MANAGEMENT SPECIALISTS: Requires specialized practical experience in configuration management as applied to major systems (hardware & software) for DOD inventory. Thorough familiarity with DOD specifications and standards for configuration management is essential, as is a background in data management. A college degree is preferred.

MAINTAINABILITY & TEST EQUIPMENT ENGINEERS: To provide project management and technical direction for maintainability analysis, test equipment and design, digital/analog system BITE, test point definition, software specifications and analysis, management and planning of maintainability demonstration. Requirements call for a BS in engineering as well as knowledge of digital and analog circuits, FORTRAN and statistical analysis. Ability to interface with AGE and test equipment design and ILS LCC/RIW analysis is essential. Field test experience desirable.

STANDARDS ENGINEER: Requires 2 years minimum standards and/or specification writing as well as electro-mechanical design experience. Knowledge of military standards desirable.

Located in the desirable Western Michigan area, the heart of Michigan Lake Country, these opportunities provide an environment for professional and family growth in an environment offering many educational and recreational opportunities.

LSI/INSTRUMENT.

Tomorrow's technology in yesterday's world.



LEAR SIEGLER, INC. INSTRUMENT DIVISION

4141 EASTERN AVENUE, S.E., GRAND RAPIDS, MICHIGAN 49508
An Equal Opportunity Employer M/F

Send your resume and salary history in confidence to Mr. W. G. Mellinger, Dept E.

RF COMMUNICATIONS SYSTEMS ENGINEER

Must be experienced in all aspects of H/F voice and data system design. Need aggressive individual to assume project responsibility from proposal stage to installation and customer acceptance. Send resume and recent salary history to:

SUNAIR ELECTRONICS, INCORPORATED
3101 S. W. 3rd Ave.
Ft. Lauderdale,
Florida 33315
Attn: Personnel Dept.

Equal Opportunity Employer

MICROPROCESSOR ENGINEERS

Hardware Design & Development
Software Design & Development

Our Microprocessor Department has been set up due to the overwhelming increase in demand for engineers and scientists in this field. To explore those opportunities with our clients throughout the U.S., send your resume stating geographic preference and present salary—or request confidential application:

Search Director
Microprocessor Department
REGIONAL CONSULTANTS, INC.
213 W. 9th Street, Cincinnati, Oh. 45202
(513) 579-1513

RATES \$46 per advertising inch (1/8"). Commissionable.
SIZES 1/8" to 10" deep in widths of one column (1 1/8"), two (3 3/8"), three (5 1/8"), and four (7").
CLOSING Two weeks prior to mailing.
MAILING One week prior to issue date.
ISSUE DATE Every other Thursday.
AD ORDERS/BOX NUMBER ANSWERS Send to Electronics, Post Office Box 900, New York, N.Y. 10020.



CONSUMER ELECTRONIC OPPORTUNITIES

Litton Microwave Cooking Products is the nation's leader in the manufacturing of microwave cooking products. Continuing growth within the field of microwave cooking systems has provided the following opportunities:

PROJECT MANAGER

The successful applicant should have a BSEE or BSME with a minimum of 6 years of direct project management experience in electro-mechanical product design. Further, a strong background in electrical and electronic systems preferred, with the capability of functioning in a nonstandardized growth area. Promotional qualities are essential.

SENIOR ELECTRONIC ENGINEER

The qualified individual should possess a BS or MS in electrical engineering with 4+ years of direct experience in solid state digital and analog circuit design with a minimum of 2 years design experience using microprocessors. In addition, the individual should have an in-depth familiarity with coding and programming of microprocessors with direct experience in industrial electronic applications.

PROJECT ENGINEER

The successful candidate will have 4+ years of electrical-mechanical design in consumer products. Additional exposure in areas of program planning electronic and electrical systems design, functional documentation and preparation of programs and project exposure essential.

SENIOR DESIGN ENGINEER

Successful candidate will have a BSEE in electronics with exposure to electronic digital display systems and logic memory systems with 3+ years of electronic design exposure, microwave design engineering helpful.

Litton Microwave Cooking is located in an attractive suburban setting, offering excellent living conditions, exceptional educational facilities and a variety of recreational and cultural attractions. If you are qualified for the above positions, please forward resume including salary history to:

T. L. Koenecke

LITTON MICROWAVE COOKING
1405 Xenium Lane N.
Minneapolis, Minn. 55440

We Are An Equal Opportunity Employer M/F



RF COMMUNICATION ENGINEERS

This is an opportunity for you to join a group of engineers who are producing communication equipment, primarily in the area of amateur radio, that has earned a top position in the industry. We are a growing company that can provide the right individuals the opportunity to be creative and to advance.

The successful candidates will be given total project responsibility from conceptual design to completion. We seek engineers with a BSEE or MSEE and a minimum of 3 years of proven capabilities in the design of communication equipment. A strong background in HF-SSB, BHF-FM receiver and transmitters is required. A familiarity with synthesizers is desirable.

We offer competitive starting salary, a comprehensive benefit package, stable employment and a pleasant life style in a small community on the shore of Lake Michigan. Send your resume and salary history in confidence to:

HEATH COMPANY

Personnel Dept.
Benton Harbor, Mich. 49022



An Equal Opportunity Employer M/F

FREE Your dream job.

We hope you're happy in your current position, but there's always that ideal job you'd prefer if you knew about it.

That's why it makes sense to have your resume on file in the Electronics Manpower Register, a computerized data bank containing the qualifications of career-conscious ELECTRONICS readers just like yourself.

You'll benefit from nation-wide exposure to industry firms privileged to search the system, and since the computer never forgets, if you match up with their job requirements you'll be brought together in confidence.

To take advantage of this free service, mail your resume to the address below.

ELECTRONICS MANPOWER REGISTER
Post Office Box 900/New York, N.Y. 10020

Engineering

ELECTRICAL ENGINEERS R & D

Aggressive, growing manufacturer of data communication terminals has choice opportunities for experienced Electrical Engineers with a minimum of a BSEE degree to handle expanding Research and Development programs.

Strong background in computer software development or digital logic design required.

We offer attractive starting salaries plus participation in a liberal benefit program.



An Equal Opportunity Employer M/F

RATES \$46 per advertising inch (1/8"). Commissionable.
SIZES 1/8" to 10" deep in widths of one column (1 1/8"), two (3 3/8"), three (5 1/8"), and four (7").
CLOSING Two weeks prior to mailing.
MAILING One week prior to issue date.
ISSUE DATE Every other Thursday.
AD ORDERS/BOX NUMBER ANSWERS Send to Electronics, Post Office Box 900, New York, N.Y. 10020.



Would
you hire
an engineer
who
couldn't
understand
this
magazine?

Of course not. ELECTRONICS is the technical publication for technical people. If they can't understand it, they can't receive it. That's why, when you're looking for qualified engineers, you should consider our Classified Section.

For only \$46.00 per inch your recruitment advertising will reach 46,000 pre-screened engineers—that's just \$1 per thousand!—as they're reading to combat job obsolescence, while they're thinking about their future and bettering themselves.

There's no charge for typesetting and free layout service is provided.

For more information call or write:

ELECTRONICS

Post Office Box 900
New York, N.Y. 10020
Phone: 212/997-2556

We have been placing graduate
ENGINEERS
in **FEE-PAID** positions
THROUGHOUT THE U.S. since
'59. Over 1,000 client companies.
We are graduate engineers working
full-time for you. Send resume
& salary history today or request
confidential application.
ATOMIC PERSONNEL, INC.
Suite L. 1518 Walnut St., Phila., Pa. 19102
An Employment Agency
For All Technical Fields

POSITION VACANT

Faculty Position in Solid State Electronics—Applications are solicited for a senior faculty position in the Department of Electrical Engineering and Computer Science at M.I.T., rank and salary commensurate with qualifications. Duties include: teaching, thesis supervision and research in the area of integrated circuit technology or solid state devices, and expansion and improvement of an existing microelectronics laboratory. Applicants should preferably have had industrial experience in device development and should have an interest and ability to develop collaborative programs with groups at M.I.T. that seek to apply semiconductor technology to a variety of fields, e.g., computer technology, signal processing, biomedical engineering, and optical and microwave communications. Ability to work with industrial organizations is highly desirable. Previous teaching experience also desirable. Applications from women and minority professionals are encouraged. M.I.T. is an equal opportunity employer. Resumes should be sent to Professor Paul Penfield, Jr., Associate Department Head, Department of Electrical Engineering and Computer Science, Room 38-401, Massachusetts Institute of Technology, Cambridge, MA 02139. For further information, contact either Professor Penfield or Professor M.S. Dresselhaus, Chairman of Search Committee at above address.

EMPLOYMENT SERVICE

Electronics' Industry Newsletter tells you which firms have current employment opportunities, in the field of Electronics, for all types of Engineers, Sales Representatives, Technicians, Executives, Computer Personnel and others. Latest product information is also reported. For information write: Electronics' Industry Newsletter, Dept. 304A, 23573 Prospect Avenue, Farmington, MI 48024.

DON'T forget the Box Number when answering the replies.

CHECK for Accuracy.

INCORRECT Box Numbers may result in a delay in re-forwarding your reply.

Engineering Professionals

San Francisco Peninsula

GTE Sylvania's Western Division of the Electronic Systems Group is on the move. Located in Mountain View, California, we are 1700 people deeply involved in a variety of technical projects and programs in Reconnaissance, EW and lasers. This division has a place for top professionals ready to take on the challenges and rewards in supervisory and non-supervisory positions. We have opportunities available now in the following disciplines:

- Signal Processing
- ELINT Systems
- Microprocessor Applications
- Security Systems—
Intrusion Detection Devices
- RF Systems
- Laser Products and Systems
- Real-Time Software Development
- Associative Data Base
Management
- Computer aided Test
- Control Systems
- Power Supply Development

If you enjoy a professional attitude and a place to broaden and develop your knowledge, then we'd like to hear from you. You'll receive an excellent salary, great benefits package including tuition reimbursement, relocation assistance, and the opportunity for travel. U.S. Citizenship required. Please direct your inquiries in confidence to Dept. E-298, GTE Sylvania, P.O. Box 188, Mountain View, California 94040. An equal opportunity employer, M/F.

GTE SYLVANIA

ENGINEERING

Continuing expansion of our engineering activities has created 2 new opportunities.

MICROPROCESSOR ENGINEER with hardware experience in computer/peripheral interfaces, including microprocessors. Software background including assembly language programming is desirable.
SYSTEMS PROGRAMMER with knowledge of PDP 11 operating systems, especially RSK.

Contact Robert Masterson (216) 361-3315

➔ **GOULD INC.**
Instrument Systems Division
3831 Perkins Ave., Cleveland, Ohio 44114
an equal opportunity employer

HERE'S HOW TO...

Up-date your electronics know-how
with minimum cost, time,
and effort ...
for top potential return in
job opportunities ...

The brand-new McGraw-Hill Course in Continuing Education for Electronics Engineers **ELECTRONIC CIRCUIT DESIGN WITH SOLID-STATE DEVICES**

8 no-frills self-study lessons do it!

Let a panel of top electronics experts help put you up front in the newest, hottest areas around today ...

- ▶ How to bring yourself up to date with actual information you can use on the job
- ▶ How to design electronic circuits for various applications with the use of solid-state devices and the design data the Course gives you
- ▶ How to understand and design linear, differential, and operational amplifiers
- ▶ How to apply digital and linear integrated circuits in many fields

PLUS these special extras:

- ▶ Master Outline & Course Guide
- ▶ Study Guides for Each Lesson
- ▶ Self-checking Quizzes
- ▶ Electronic Circuits Portfolio (with Lesson 5)
- ▶ Final Exam and Course Completion Certificate

You Can Examine Lesson One and the Master Outline and Guide FREE for 10 Days Before You Decide You Want to Take the Whole Course!

Simply complete and return the "Operation Update" Reply Card and McGraw-Hill will send you LESSON ONE and the Master Outline & Guide—with the Study Guide materials, the Reading Reference List, and your Quiz. Put these materials to the test for 10 days. Apply what you learn from them on any design problem you're grappling with. Then—at the end of the 10 days—and *only* then, need you decide to take the whole course. If, at the end of that time, you decide you do *not* want the course, all you need do is return the Lesson and the Outline and that's the end of any obligation whatsoever on your part.



MAIL YOUR "OPERATION UPDATE" COUPON TODAY!

Be sure to return your Free Examination Coupon today! The sooner you receive Lesson One and the Master Outline and Guide, the sooner you will accomplish a thorough updating of your highly valuable professional skills and the sooner you will steer yourself in the direction of bigger and better professional advantages!

TAX DEDUCTIBLE!

Just a reminder—you are entitled to deduct, tuition fees (and the McGraw-Hill Course in ELECTRONIC CIRCUIT DESIGN WITH SOLID-STATE DEVICES applies here) from your U.S. Federal Income Tax when you take any course to maintain your professional skills!

Your "Operation Update" Coupon

McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, New York 10020

Please send me for 10 days' free examination Lesson One plus the Master Outline and Guide for the NEW McGraw-Hill Course in Continuing Education for Electronics Engineers—ELECTRONIC CIRCUIT DESIGN WITH SOLID-STATE DEVICES.

At the end of ten days, if I want to continue in the Course, I will make my first payment of \$6.95 plus local tax, postage and handling. And I understand that each subsequent Lesson will be accompanied by an invoice for \$6.95 plus local tax, postage, and handling ... for a total cost of \$55.60 for the eight Lessons. (The Lessons will be shipped at six-week intervals.)

If I decide not to continue in the Course after the ten-day examination period, I will return the Master Outline and Lesson One and the matter will be closed.

Our Policy: If you're disappointed in the Course at any stage, just notify us and we will stop sending the Lessons and invoices. If you have paid in advance, we will refund the difference between the value of the lessons you have received and the payments you have made.

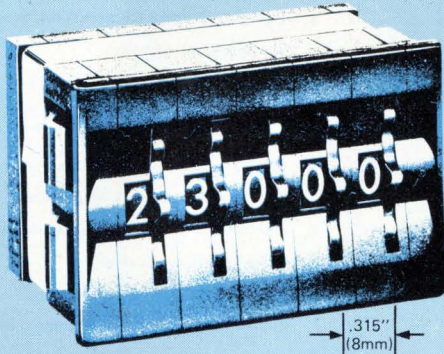
Name _____
Home Address _____
City _____
State _____ Zip _____

There is no finance charge for monthly payments.
This offer is subject to acceptance by McGraw-Hill.

41-18906

SLIMSWITCH LOW PROFILE...

**DIGITRAN QUALITY
AT LESS THAN 25¢ PER POSITION**



Series 23000 "SNAP-IN" SLIMSWITCH

They're low cost switches, but their life expectancy is still over 1,000,000 detent operations.

- Only .315" (8mm) wide.
- Assemble without the use of tools.
- Install without the use of tools or hardware.
- Available from local distributor stock.
- Specials available from the factory.

Send for a Series 23000 "SNAP-IN" SLIMSWITCH Data Sheet.

**... AND TRUE
TACTILE FEEL AS WELL!!**

**Series KL MINIKEY Keyboards
from the originators of the DIGISWITCH®**

- Less than .275" thick
- Excellent tactile feel
- Two-color molded keys
- Back or front mounting configuration
- 12 or 16 key models are standard
- Special "touch tone" versions available too
- Standard units available from local Distributor stock
- Special models available from the factory



Send for a SERIES KL MINIKEY Data Sheet.

DIGITRAN®

Pasadena, California 91105 • Phone (213) 449-3110

For more information use the Inquiry Form provided on this page.

DIGITRAN®

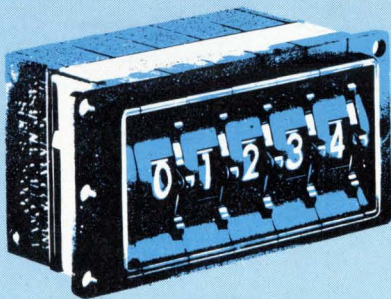
Pasadena, California 91105 • Phone (213) 449-3110

For more information use the Inquiry Form provided on this page.

ECONOMY

Series 29000 "ECONOMY" MINISWITCH®

**...The lowest cost thumbwheel switch available
that provides true environmental protection**



IT'S WHAT YOU GET FOR THE PRICE THAT COUNTS!

- Dust and moisture resistant construction
- Large easy to read dial characters
- Positive tactile characteristics
- Assemble without the use of tools
- Less cost (per digital position) than most rotary switches
- Available from local Distributor stock
- Specials available from the factory

Send for a Series 29000 "ECONOMY" MINISWITCH Data Sheet.

INQUIRY FORM

1. DO YOU WANT MORE INFORMATION? Yes, send data about:
 KL MINIKEY Keyboard Series 8000 MINISWITCH Series 23000 SNAP-IN SLIMSWITCH Series 29000 ECONOMY MINISWITCH Series 12000 MINIBUTTON Series 24000 DIGILEVER Series 28000 MINILEVER QPL Approved DIGITAL SWITCHES DIGITAL VOLTAGE DIVIDER and RESISTANCE DECADE Catalog Send me your complete "DIGITAL SWITCH" Catalog. Send a

Sales Engineer to see me. My phone is: (_____)_____

2. Is the purchase of this type product anticipated? Yes No. If "Yes", what is your application? _____

3. Is your requirement: Current 1-3 months 3-6 months longer?

4. How many assemblies per year? under 100 100-500 500-1000 or more.

5. Are you responsible for: Design Specification Purchasing?

6. Have you specified or purchased products of the type made by Digitran in the past? Yes No. If yes, whose? Digitran

Other _____

7. Have you ever been contacted by a Digitran Sales Representative? Yes No. If "Yes", When? Recently 3-6 months ago 6-12 months ago 12 months or more.

Name _____ Title _____

Company _____

Address _____

City _____ State _____ Zip _____

For detailed information about Digitran's products, please complete this INQUIRY FORM, clip and send it to:

DIGITRAN®

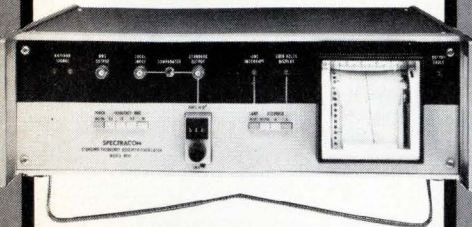
Pasadena, California 91105 • Phone (213) 449-3110

For more information use the Inquiry Form provided on this page.

THE DIGITRAN® COMPANY

A Division of Becton Dickinson Company B D E 1076
855 South Arroyo Parkway • Pasadena, California 91105

TIME & FREQUENCY....



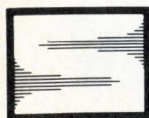
If these words are important to you then you should know more about Spectracom Corporation. We specialize in **TIME and FREQUENCY**, and produce test equipment that leads the industry.

For instance, our **WWVB RECEIVERS** are the finest available. Priced from about \$700 to \$2500, they all have features and performance found only in competitive equipment costing \$5,000 to \$10,000. And some of these features, such as positive go/no-go front panel phase lock indication, are available only from Spectracom. For the first time, you can install a receiver and immediately know beyond doubt that it is working, receiving a strong enough signal, and giving correct frequency calibration and time code information! The green "go" light will be on steadily, because our receivers work well under poor signal-to-noise conditions where other won't!

Another example is our **FREQUENCY DISTRIBUTION SYSTEM**, also the finest on the market. You don't need a separate cable for each remote station. You install our system by running one coaxial cable past each remote station in turn, similar to a cable TV system. Buffered line taps at each station give you the standard frequency you need there. If you want to add a station somewhere along the line, just cut the cable and insert another line tap for the desired frequency! Up to 25 stations can be driven from one base station that costs about \$650, and the cost is even less if you buy the system built into one of our VLF Receivers!

Our **FREQUENCY STANDARDS** can also be furnished with the Distribution Amplifier built in. We also have a Frequency Standard that is furnished as part of a WWVB Receiver, tracked continuously against the NBS standard frequency.

So you see, we have good reasons to be proud of our products. And the people who buy them and use them are proud of them too. For the highest quality and performance you can buy in Time and Frequency test equipment, or for special communications test equipment, call your Spectracom sales engineer.



SPECTRACOM CORP.
87 WEDGEWOOD DR
PENFIELD, NY 14526
PHONE 716-381-4827

Electronics advertisers

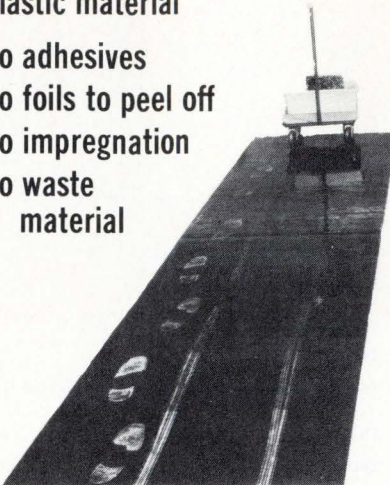
Abbott Transistor Labs Inc.	6	Digital Equipment Corporation (OEM)	42,43
* Adret Electronique	40E	‡ Digital Equipment Corporation (Components)	191
Advanced Memory Systems	69,70,71	The Digitran Company	219
‡ Advanced Micro Devices	10,11	Dow Corning Corp., Industry Div.	72,73
■ Airpax Electronics	168	‡ Eastman Kodak Company GMD GD Photofabrication-Microelectronics	15
Allen Bradley Company	24	‡ Electronic Development Corp.	164
American Microsystems Inc.	174	Electronic Memories & Magnetics	84-85
AMF/Potter & Brumfield	181	‡ Electronic Representatives Association	79
■ AMP Incorporated	22,23	Elorg Electronorgtechnica	200,202
Amphenol Connectors Division Bunker Ramo Corporation	171	EMR-Telemetry	175
Anritsu Electric Co., Ltd.	192	English Electric Valve Company Ltd.	14E,15E,212,213
APM Hexseal	190	■ Erie Technological Products Co. Inc.	93
Associated Electronics	195	Everett/Charles, Inc.	221
Belden Corporation	132	Faultfinders Inc.	152
Bell, F.W.	38	‡ Ferroxcube Corp.	173
Biomation	18,19	Fibra Sonics Inc. Division of C.E. Niehoff	182
■ Bourns Inc.	3rd C	Figaro Engineering Inc.	222
Bowman Instr. Corp.	223	■ John Fluke Mfg. Co., Ltd.	167,169
Brand Rex Corporation	2nd C	General Electric Instrument Rental Division	140
Brown, Boverie & Cie	19E	General Magnetics	224
* Burr Brown Research Inc.	3E	* General Semiconductor Industries, Inc.	17E
California Computer Products	193	■ Gould Inc.	165
Cambridge Thermionic Corporation	203	GTE Sylvania Parts Division	50
* Carlo Erba	39E	■ Hewlett-Packard	1,2,170,10E
CELCO (Constantine Engineering Labs Co.)	94	Honeywell Test Instrument Division	53
■ Centralab Electronics Division of Globe Union Inc.	83	Hutson Industries	204
■ Cherry Electrical Products Inc.	112	Iasas	221
Chicago Miniature Lamp Works	198	ILC Data Devices	20
C&K Components	197	Indiana General	149
Cinch Connectors TRW Div	107	Individualized Instructions	204
Clairex Corporation	4th C	Infotek Systems	208
Coherent Radiation	187	Intel Corporation	64A-64F
Coil-Ler Mfg Inc.	56	Intel Memory Systems	37
Computer Automation	153-160	■ Interface Inc.	199
Conap Inc.	176	International Components	204
Continental Rentals	8	* International Devices, Inc.	173
Continental Specialties Corporation	205	International Electronics Research Corporation	201
Control Data Corp	177	* Intersil Inc.	41,83,111
Corning Glass Works Fluidic Products Department	103	Interstate Electronics Corp.	48,49,104
‡ Cortron, A Div. of Illinois Tool Works, Inc.	62	■ Ithaco, Inc.	209
CPM	32E	* ITT Cannon	35E
* C. P. Clare International N.V.	11E	M. S. Kennedy	202
C. P. Clare & Company	189	■ Kepco Inc.	5
■ Custom Electronics Inc.	186	‡ Kollmorgen Corp. Photocircuits Div.	44,45
* Dale Electronics Inc. A Subsidiary of Lionel Corporation	12E,13E	L.E.A.	16E
Data General Corporation	27	Magnecraft Electric Company	13
■ Data Precision	97-99	* Magneti Marelli	5E
Datel Systems Inc	15	McGraw-Hill Book Company	218
Delco Electronics Division General Motors Corporation	28,29	MCL Inc.	186
Delevan Division American Precision Industries, Inc.	40	* Membrain Limited	20E
■ Dialight Corporation	166	Micro Networks Corporation	185
‡ Digimetric Division of Sybron	60	Micro Power Systems	80
		Millennium Information Systems, Inc.	146,147

* Molex (International) Incorporated	8E,9E
Monsanto Company	58
Motorola Communication & Electronics	188
* Motorola Semiconductor Products Inc.	142,143
Nichicon Corporation	196,200
‡ Nikkei Electronics	64
Nippon Electric Co. Ltd.	178
* Non-Linear Systems	199
Norma Messtechnik GmbH	16E
Numonics Corp.	210
OK Machine & Tool Company	195
* Oscilloquartz	4E
* Pertec-Ped	44,45
* Philips Elcoma	33E,62
Plastics Engineering Company	172
Plessey Microsystems	46,47,65
* Powermate	194
Precision Monolithic Inc.	9
Process Computer Systems, Inc.	115
Procond S.p.A.	79
Pro-Log Corporation	30
PWR, Incorporated	223
* Racal Thermionic Ltd.	25E
Ramtek	21
Raytheon Semiconductor	55
RCA Electro-optics and Devices	31E
RCA Solid State Division	7,39
RCL Electronics Inc.	14
Reticon Corporation	57
T.L. Robinson Company Inc.	222
* Rohde & Schwarz	1E
Savoy Electronics	199
* Schlumberger	6E,28E
Scientific Atlanta Optima Division	184
* SECI Divisione Componenti	18E
* Secme	38E
* Seimart	26E
Semikron GmbH	24E
Sensors Inc.	162
* Sepa S.p.A	2E
* Sfernice	21E,22E,23E
SGS Ates	179
* Siemens A.G. Munich	60
Signetics Corporation Division of U.S. Philips	194,195,197,199,201, 203,205,206,207
Simpson Electric Company	145
Singer Company Kearfott Division	136
Sola Electric	203
Spectracom Corporation	220
Spectral Dynamics Corp.	220
SPI-ITT	119
Superior Electric Company	183
Synertek	135
‡ T-Bar, Incorporated	164
Tecnetics	180
* Tektronix Inc.	127,35
Teledyne Microelectronics	131

DUST TRAP MAT

PTS the new, for ever tacky plastic material

no adhesives
no foils to peel off
no impregnation
no waste material



PTS dust trap mat, the only economic and dependable way to keep your clean-rooms clean.

Sizes 1 by 1 or 1 by 2 meter. Can be fused together for wall to wall coverage. Resistant against heavy wear. Cleans simply with water.

USA: SIGNALARM INC
PO Box 3021 Springfield, Mass. 01101
Phone: (413) 788-0224
Maker: SPIRIG ERNEST
Chemotechnic Div., CH-8640 Rapperswil,
Switzerland 055/274403 Telex 75400

Circle 108 on reader service card

**"SNAP-OUT"
CONTACT
PROBES**

REPLACEABLE ELECTRICAL CONTACTS THAT IMPROVE TESTING RELIABILITY.

- Machined Probe Tips cut through PCB build-up and residue.
- Complete selection of sizes and tip configurations.
- Replace or change probes without wiring disturbance, eliminates flexing. Receptacle stays in place.
- High contact density to 441/sq. in.* (.050" centers)
- Available from stock.

*Size "O" Spring Contact Probes

EVERETT CHARLES, INC.
2806 Metropolitan Place
Pomona, CA 91767
PHONE (714) 593-2541

Circle 109 on reader service card

Build a Microcomputer System With This \$7.95 Handbook.



At last, a practical, step-by-step approach to building an operational microcomputer for a bargain price. The *Iasis Microcomputer Applications Handbook* will guide you through all phases of actual design of a working 8080 microcomputer system including writing a system monitor program. Both development and OEM systems are covered in detail.

P.S. If the *Microcomputer Applications Handbook* isn't everything we say it is, return it within 15 days for a full refund.

ORDER BEFORE DEC. 15, 1976 AND WE'LL SHIP YOUR HANDBOOK POST-PAID.

Here's my check or money order for \$7.95. Add \$.50 for postage and handling if ordered after Dec. 15, 1976. (California residents please add \$.52 state sales tax.)

Charge my order to the credit card number below:



BankAmericard No. _____



Master Charge No. _____

For Master Charge, add 4-digit number from right above name. It is:

Here's my Signature: _____

Credit card expiration date: _____

FIRM _____

NAME _____

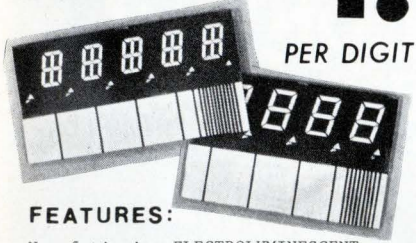
ADDRESS _____

CITY _____

STATE/ZIP _____

Mail To: IASIS, INC., 815 West Maude Avenue, Suite 18, Sunnyvale, California 94086

INTRODUCING A NEW
REVOLUTIONARY
 MULTI-DIGIT
 SOLID STATE READOUT
BELOW \$1.



FEATURES:

- Non-fatiguing ELECTROLUMINESCENT light
- Space saving thin profile
- Wired for multiplexing
- Low a.c. power consumption
- Compatible with IC logic decoders and segment drivers
- Rugged, pluggable laminated plastic construction

SPECIAL TRIAL OFFER

ORDER FROM STOCK at **97¢** per digit, any of the following multi-digit readouts having 2 to 5 digits:
 1/2" high with 9-segments
 0.6" high with 7-segments
 (minimum order--\$10.)

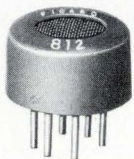
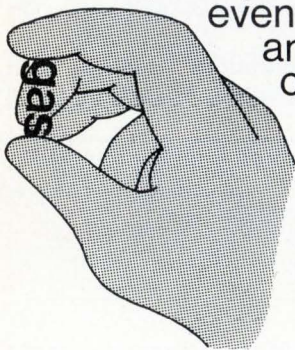
T.R. T.L. ROBINSON CO., INC.
 P.O. BOX D, EAST AURORA, N.Y. 14052
 TEL. (716) 652-2111 TELEX: 91566

Circle 222 on reader service card

Gas Sensing Semiconductor

**FIGARO
 GAS
 SENSOR**

TGS quickly senses even small amount of gas.



New Models, some with highly sensitive CO sensor, now on the market.

Please contact the address below directly for catalogs and price/delivery information.

FIGARO ENGINEERING INC.

3-7-3, Higashitoyonaka, Toyonaka City, Osaka 560,
 Japan/Tel: (06) 849-2156
 Cable: FIGARO TOYONAKA/ Telex: 05286155 FIGARO J

222 Circle 255 on reader service card

Teledyne Relays	17
Texas Instruments Incorporated Components Div.	125,126,127
Thermotron	196
Thomson CSF	120
Ultra Electronics Components Ltd.	36E
United Systems Corp. a Sub of Monsanto Co.	196
Unitrode Corporation	163
Wabash Electronics	58
Wandel und Goltermann	37E
Wavetek San Diego Inc.	140
Wima Westermann	16
XLO-REMX	161
Yutaka Electric Co.	8
Zilog	150,151

Classified and employment advertising
 F. J. Eberle, Manager 212-997-2557

Atomic Personnel Inc.	217
GTE Sylvania	217
Gould Inc.	217
Heath Co.	216
Hewlett Packard	214
Lear Siegler	215
Litton Microwave Cooking	216
Regional Consultants Inc.	215
TRW Globe	214
Teletype Corp.	216

■ For more information of complete product line see advertisement in the latest Electronics Buyers Guide
 * Advertisers in Electronics International
 † Advertisers in Electronics domestic edition

Advertising Sales Staff

Atlanta, Ga. 30309: Glen N. Dougherty
 100 Colony Square, 1175 Peachtree St., N.E.
 [404] 892-2868

Boston, Mass. 02116: Frank Mitchell
 607 Boylston St. [617] 262-1160

Chicago, Ill. 60611
 645 North Michigan Avenue
 Robert W. Bartlett (312) 751-3739
 Robert M. Denmead (312) 751-3738

Cleveland, Ohio 44113: William J. Boyle
 [716] 586-5040

Dallas, Texas 75201
 2001 Bryant Tower, Suite 1070
 [214] 742-1747

Denver, Colo. 80203: Harry B. Doyle, Jr.
 123 Speer Blvd. #400
 [303] 837-1010

Detroit, Michigan 48202: Robert W. Bartlett
 1400 Fisher Bldg.
 [313] 873-7410

Houston, Texas 77002: Paul Reiss
 601 Jefferson Street, Dresser Tower [713] CA 4-8381

Los Angeles, Calif. 90010: Robert J. Rielly
 Bradley K. Jones, 3200 Wilshire Blvd., South Tower
 [213] 487-1160

New York, N.Y. 10020
 1221 Avenue of the Americas
 Warren H. Gardner [212] 997-3617
 Michael J. Stoller [212] 997-3616

Philadelphia, Pa. 19102: Warren H. Gardner
 Three Parkway,
 [212] 997-3617

Pittsburgh, Pa. 15222: Warren H. Gardner
 4 Gateway Center, [212] 997-3617

Rochester, N.Y. 14534: William J. Boyle
 9 Greylock Ridge, Pittsford, N.Y.
 [716] 586-5040

San Francisco, Calif. 94111: Don Farris
 Robert J. Rielly, 425 Battery Street,
 [415] 362-4600

Paris: Alain Offergeld
 17 Rue-Georges Bizet, 75116 Paris, France
 Tel: 720-73-01

Geneva: Alain Offergeld
 1 rue du Temple, Geneva, Switzerland
 Tel: 32-35-63

United Kingdom & Scandinavia: Robert Ghey
 Tel: 01-493-1451, 34 Dover Street, London W1

Scandinavia: Andrew Karnig and Assoc.
 Kungsholmsgatan 10
 112 27 Stockholm, Sweden
 Tel: 08 51 68 70 Telex: 179 51

Milan: Luigi Rancati
 1 via Baracchini, Italy Phone 86-90-656

Brussels: Alain Offergeld
 23 Chaussee de Wavre
 Brussels 1040, Belgium
 Tel: 13-73-95

Frankfurt/Main: Fritz Krusebecker
 Liebigstrasse 27c, Germany
 Phone 72 01 81

Tokyo: Tatsumi Katagiri, McGraw-Hill
 Publications Overseas Corporation,
 Kasumigaseki Building 2-5, 3-chome,
 Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
 [581] 9811

Australasia: Warren E. Ball
 IPO Box 5106, Tokyo, Japan

Business Department

Thomas M. Egan,
 Production Manager [212] 997-3140

Gayla Black
 Production Manager [212] 997-2044

Carol Gallagher
 Production Manager International
 [212] 997-2045

Dorothy Carter
 Production Manager Domestic
 [212] 997-2908

Frances Vallone
 Reader Service Manager
 [212] 997-6057

Electronics Buyers' Guide

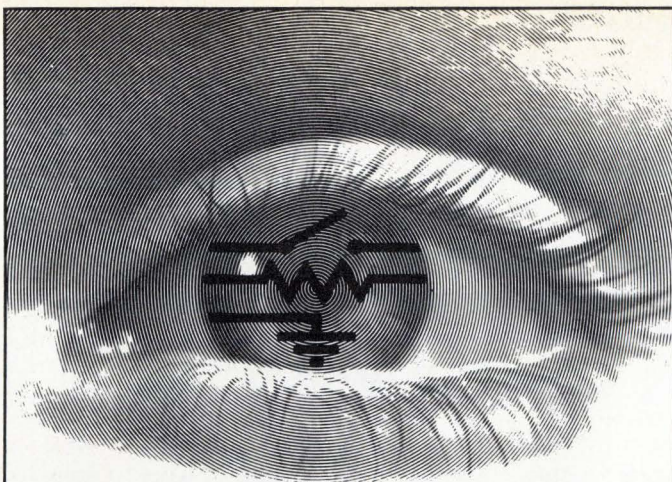
H.T. Howland, General Manager
 [212] 997-6642

Regina Hera, Directory Manager
 [212] 997-2544

Gayla Black, Production Manager
 [212] 997-2044

Classified and Employment Advertising

Frank Eberle, Manager
 [212] 997-2557



PWR TRACE ANALYZER "sees" what the eye can't.

Provides electronic insight to detect shorted or open circuits in loaded or unloaded printed circuit boards.



Using high speed solid state switching, self programming, and selectable test voltages, the TA-4 Trace Analyzer electronically locates shorts, opens, or miswires that would never be detected by any visual means. Tests single, double, multilayer and wire wrap printed circuit boards; cable harnesses and back planes before and after component assembly in a matter of seconds.

**What the Trace Analyzer sees you can believe.
Call or write for complete information.**

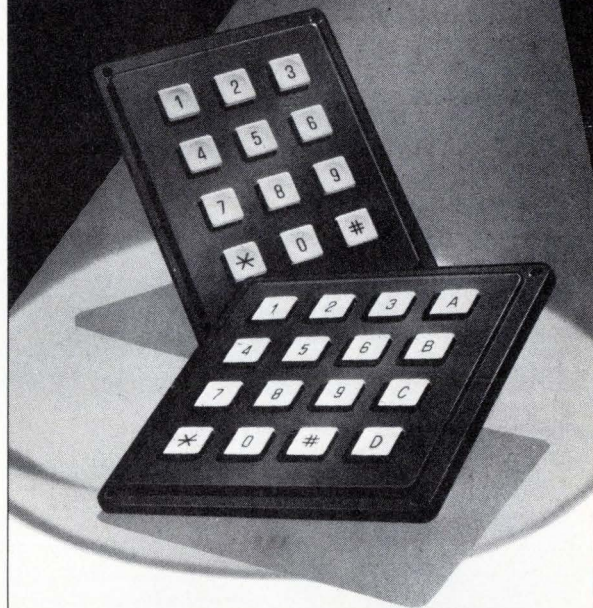
PWR INCORPORATED

A SUBSIDIARY OF METHODE ELECTRONICS, INC.

9334 Mason Avenue, Chatsworth, Calif. 91311
Phone: (213) 886-5030 • TWX (910) 493-1250

Circle 253 on reader service card

PRESENTING Bowmar's new "Standard" Keyboards



In keeping with Bowmar's role as the innovating leader in the keyboard industry these new 12 and 16 station "Standard" keyboards are the perfect companions for many of today's keyboard applications. Available off-the-shelf, each is loaded with a broad array of Bowmar quality features.

- Gold or silver epoxy contact pads
- Plastic bezel and 2-shot molded keys
- Single or double closure contacts
- Tactile/audible feedback
- Row and column or single column matrixes
- Short stroke/low profile

Please send me full information on Bowmar "Standard" keyboards.

Name

Company

Street

City

State Zip

Bowmar

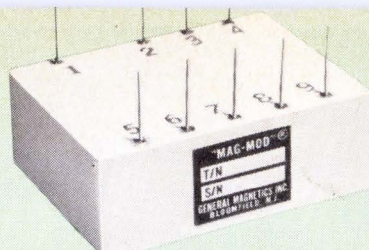
Mail to: Bowmar Instrument Corp., Dept. EN
8000 Bluffton Road, Fort Wayne, IN 46809

For Information circle 113 on Reader Service Card
For Salesman call circle 223 on Reader Service Card

Solid State Sine-Cosine Synchro Converter

This new encapsulated circuit converts a 3-wire synchro input to a pair of d-c outputs proportional to the sine and cosine of the synchro angle.

- Complete solid state construction.
- Operates over a wide temperature range.



UNIT	DMD 1436-1	DMD 1430-1	DMD 1403-2	DMD 1361-6	DMD 1361-4	DMD 1193-4	DMD 1361-8	DMD 1446-1	DMD 1193-5	DMD 1193-6	DMD 1361-10	DMD 1472-2
L - L SYNCHRO INPUT (VRMS)	11.8	90	95	90	11.8	11.8	11.8	11.8	11.8	11.8	11.8	90
FREQUENCY (Hz)	400	400	60	400	400	400	400	400	400	400	400	60
FULL SCALE OUTPUT (VDC)	±10	±10	±3	±3	±3	±10	±10	±10	±10	±10	±10	±10
OUTPUT IMPEDANCE	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<10Ω	<1Ω	<1Ω	<1Ω	<1Ω
L - L INPUT IMPEDANCE	>10K	>30K	>5K	>30K	>5K	>5K	>5K	>5K	>5K	>5K	>5K	>5K
REFERENCE VOLTAGE (VRMS)	26	115	115	115	26	115	26	115	115	115	26	115
ACCURACY SIN/COS (+25°C)	±6MIN	±6MIN	±6MIN	±6MIN	±6MIN	±6MIN	±6MIN	±0.5%	±6MIN	±6MIN	±6MIN	±6MIN
FULL TEMPERATURE SIN RANGE ACCURACY COS	±15MIN	±15MIN	±15MIN	±15MIN	±15MIN	±15MIN	±15MIN	±0.5%	±15MIN	±15MIN	±15MIN	±15MIN
D.C. SUPPLY (VDC)	±15	±15	±15	±15	±15	±15	±15	±15	±15	±15	±15	±15
D.C. SUPPLY CURRENT	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA	<30MA
BANDWIDTH	>10Hz	>10Hz	external set	>20Hz	>5Hz	>10Hz	>10Hz	>10Hz	>2Hz	>40Hz	>5Hz	external set
SIZE	1.1x3.0 x1.1	2.0x2.25 x1.4	1.1x3.0 x1.1	1.5x1.5 x0.6	1.85x0.85 x0.5	2.01x2.25 x1.4	0.85x1.85 x0.5	2x2.25 x1.4	2x2.25 x1.4	2x2.25 x1.4	2.15x1.25 x0.5	1.1x3.0 x1.1
NOTES	-	dual channel unit	-	-	-	dual channel unit	-	dual sine output unit	dual channel unit	dual channel unit	-	-
TEMPERATURE RANGE	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C

High Precision Analog Multipliers

PRODUCT ACCURACY (MCM 1519-1) ± ½% OF ALL THEORETICAL OUTPUT VALUES OVER FULL MILITARY TEMPERATURE RANGE OF -55°C TO +125°C. ZERO POINT ERROR FOR ANY INPUT COMBINATION IS ± 2MVRMS



Features:

- No external trims required
- Distortion free AC output over entire dynamic range
- Linearity, product accuracy and zero point virtually unaffected by temperature

- All units are hermetically sealed and are not affected by external fields
- High analog product accuracy and wave quality allows dual multiplier assemblies to be matched with 1% of point over the specified temperature range
- Full four quadrant operation
- Package size, power supply requirements and other specs. may be altered to your exact requirements at no extra cost.

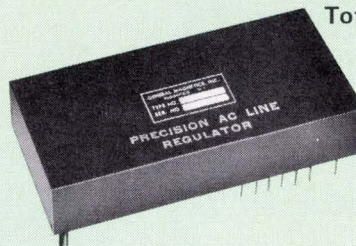
Specifications:

- Transfer equation: $E_o = XY/10$
- X & Y input signal ranges: 0 to ±10V PK
- Maximum zero point error (X=0; Y=0 or X=±10; Y=0 or X=0; Y=±10): 2MVRMS
- Input impedance: Both inputs 20K min.
- Full scale output: ±10V peak
- Minimum load resistance for full scale output: 2KΩ
- Output impedance: 1Ω
- Short circuit duration: 5 sec.
- Frequency response characteristics (both inputs) 1% amplitude error: DC to 1200 Hz (min.) 0.5 DB Amplitude error: DC to 3500 Hz min. 3 DB point: Approx. 10K hz Roll off rate: 18 DB/octave
- Noise Level: 5MV PK-PK @ 100K Hz approx.
- Operating temp. range: See chart
- Storage temperature range: -55°C to +125°C
- DC Power: ±15V ±1% @ 30MA
- Dimensions: 2" x 1.5" x .6"

Type No.	Product Accuracy	Operating Temperature Range
MCM 1519-1	± 0.5%	-55° C - +125° C
MCM 1519-2	± 0.5%	-25° C - +85° C
MCM 1519-3	± 0.5%	0° C - +70° C
MCM 1520-1	± 1.0%	-55° C - +125° C
MCM 1520-2	± 1.0%	-25° C - +85° C
MCM 1520-3	± 1.0%	0° C - +70° C

Precision AC Line Regulator

Total Regulation 0.15% Max.



Features:

- Low distortion sinusoidal output
- Regulation control better than ten times superior to commercial AC voltage regulators transformer product lines
- No active filters or tuned resonant circuits employed resulting in immunity to line frequency changes
- 6.5 watt output level
- Small size

- Output set to ±1% accuracy — this includes initial set point plus line, load, frequency and temperature changes
 - Foldback short circuit protection provided resulting in protection against overloads and short circuits of any duration
 - Low profile package with straight pins makes the unit suitable for PC board mount (unit is hermetically sealed)
 - Transformer isolation between all power inputs and the outputs.
- *Other units available at different power levels. Information will be supplied upon request.


Specifications Model MLR 1476-2:

- AC input line voltage: 115V RMS ±20% @ 400 Hz ±20%
- Output: 26V RMS ±1% (for any condition)
- Load: 0 to 250 MA, RMS
- Total regulation: ±0.15% maximum (any combination of line, load or frequency)
- Distortion: 2% maximum
- AC input line current: 100 MA. max. at full load
- DC power: ±15 V DC ±5% @ 15 MA. max.
- Phase angle: 1° max.
- Temp. Range: -40°C to +85°C
- Case Material: High permeability nickel alloy
- Terminals: Glass to metal hermetic seal pins

Circle 224 on reader service card

GENERAL MAGNETICS • INC

135 Bloomfield Ave., Bloomfield, New Jersey 07003 - Tel. (201) 743-2700



FEEL
the pot . . .



CLICK
the switch . . .



GANG
the modules . . .

and add "quality-touch" appeal
to your product.

FEEL THE POT . . . a smooth, quality feel, only from Bourns® 81/82 Model Potentiometers. Rotational torque range, only .3 to 2.0 oz. inch, is consistent for one, two, three or four cup assemblies.

Independent linearity of $\pm 5\%$ and low 1% CRV provide exceptional setability in both cermet and conductive plastic element types.

CLICK THE SWITCH* . . . one that really clicks, with positive action detent at either CW or CCW end. The Bourns Model 85/86 potentiometer/switch combination is rated at 2 amps in DPST style and 1 amp in DPDT. Contacts are constructed of fine silver with gold overlay. This provides exceptionally low contact resistance, for reliable operation at low level analog or logic signal levels — or any application requiring an "on-off" function.

GANG THE MODULES . . . potentiometers and switches. Up to 4 modules can be ganged on the same single or dual concentric shaft, without sacrifice to the satin-smooth feel or the sure-fire click. Other options include a wide choice of bushing and shaft styles, P.C. pins or solder lugs. Think of the possibilities! Now you can specify custom pots and switches assembled from "off-the-shelf" modules — at standard cost and leadtime.

Add "quality-touch" appeal to your equipment with BOURNS Model 80 Family of Modular Potentiometer/Switches. Write or call today for complete technical information, direct or through your Bourns distributor.

FEEL, CLICK, GANG . . . BEAUTIFUL!

TRIMPOT PRODUCTS DIVISION, BOURNS, INC., 1200 Columbia Avenue, Riverside, California 92507, Telephone (714) 781-5122 — TWX 910 332-1252.

*Patent pending



Int'l Sales Offices: European Hdqtrs. — Switzerland, 042/23 22 42 • Belgium 02/218 2005 • France 01/2039633 • Germany 0711/24 29 36
• Italy 02/32 56 88 • Netherlands 070/88 93 18 • United Kingdom 01/572 6531 • Japan 075 92 1121 • Australia 86 9410 • Brazil 257-3535

Circle 901 on reader service card

Type 9 CdS photoconductive material offers highest stability!

Stability at high temperatures and less light memory than any other CdS material are the chief characteristics of Clairex's Type 9 CdS. It also offers

improved linearity and broader spectral response.

Clairex photocells with Type 9 material are available in TO-5, TO-8 and TO-18 packages. If you

have photocell stability problems, try Type 9 material.

Clairex® is the industry's specialist in "light" problems. Tell us your

problem; we'll develop the solution. Call (914) 664-6602 or write Clairex, 560 South Third Avenue, Mount Vernon, New York 10550.

TYPE 9 MATERIAL

- LOW TEMPERATURE ERROR
- LOW LIGHT HISTORY EFFECT
- HIGH LINEARITY
- FAST RESPONSE TIME
- RESISTANCE TOLERANCE AT 2 Ft.-C.: ± 33
- TEMPERATURE RANGE -50 C to +75 C

TYPE	Sensitive Material	Peak Spectral Response (Angstroms)	Resistance 2 ft.-c. (Ohms)	Min. Dark Resistance 5 sec. After 2 ft.-c.	Maximum Voltage Rating (Peak A.C.)	Measurement Voltage	Maximum power 25 C
CL5M9M	Type 9	5500	11K	7.5 Meg	170V	10	0.5 watts
CL709L	CdS		28K	18.7 Meg	100V	10	125 watts
CL909L			100K	67 Meg	100V	10	250 watts

RESPONSE TIME VERSUS LIGHT

Foot Candles	01	0.1	1.0	10	100
Rise (Seconds)*	0.5	0.95	0.22	0.05	0.02
Decay (Seconds)**	125	0.21	0.01	0.002	0.01

MEASUREMENT DATA • All measurements at 2854°K • Cells light adapted 16 hrs. at 30 ft.-c. prior to test • Measurement voltage is D.C. applied voltage for measuring resistance • All readings made at 25° C ambient.

CLAIRESX ELECTRONICS
A DIVISION OF CLAIRESX CORPORATION
560 South Third Avenue, Mount Vernon, N.Y. 10550 • (914) 664-6602

CLAIRESX ELECTRONICS

A Division of Clairex Corporation

Circle 902 on reader service card