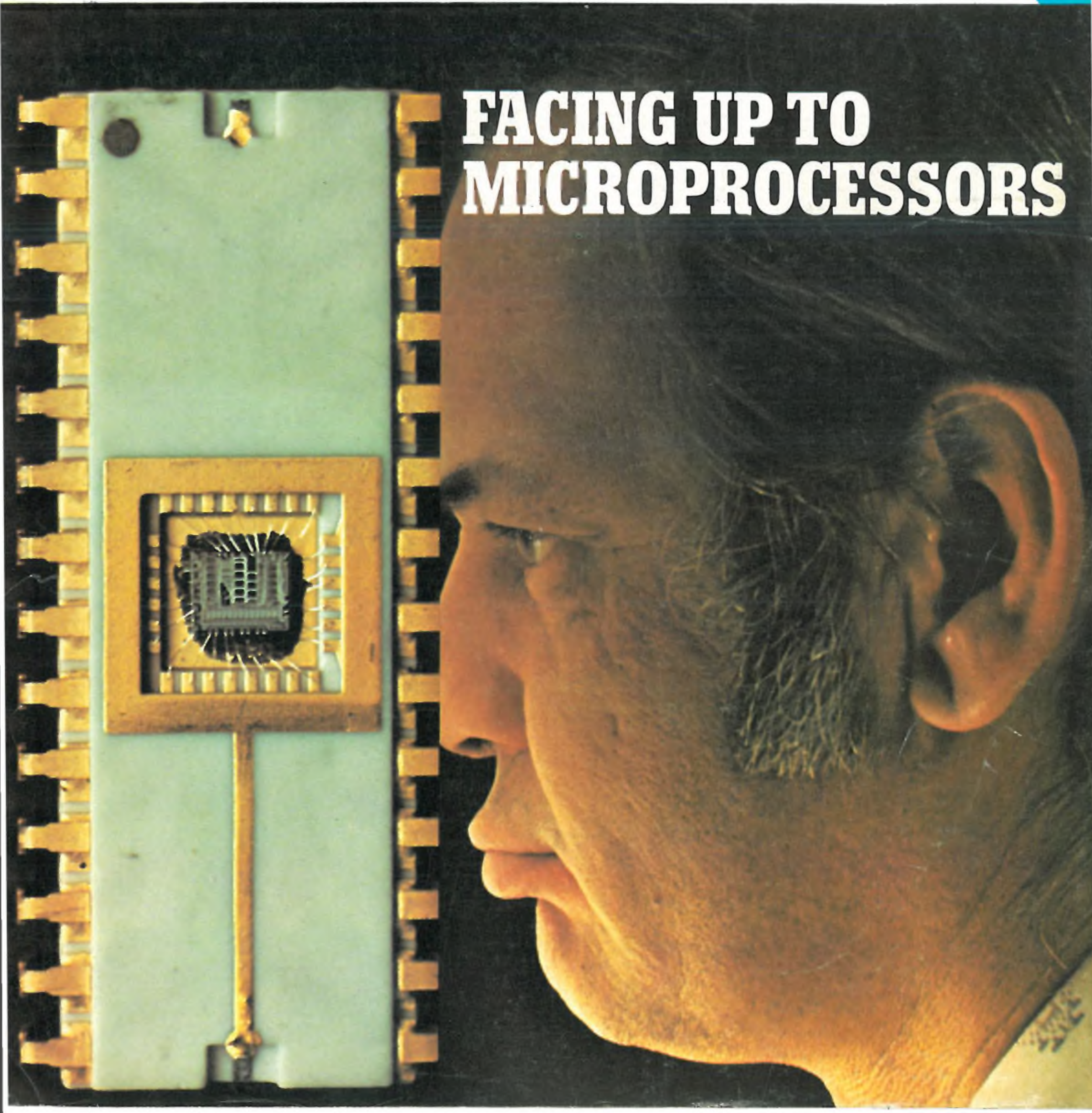
MARCH 20, 1975

INTERCON 75 IEEE GIRDS FOR A SLUMP YEAR

FOUR DOLLARS A McGRAW-HILL PUBLICATION

Electronics® International



Our puzzle just may have the answer to your puzzle!

We've formed this tangram puzzle out of some amazing materials —FOTOFORM® glass and FOTOCERAM® glass-ceramic. The pieces can be arranged in more than 100 different designs. But this kind of flexibility is only superficial.

FOTOFORM and FOTOCERAM materials are chemically inert, non-conductive, non-porous, and dimensionally stable. They don't shrink, stretch or warp, even in sheets as thin as 0.010-inch.

We can cut, etch or machine them to fit almost any application. They hold such close tolerances that we can precision-etch 10,000 holes per square inch. Holes of almost any shape, or depressions, or circuit paths. And the finished products can be polished or metalized.

We think FOTOFORM and FOTOCERAM materials have more than 100 industrial applications. Want more information? Write under your letterhead, tell us the application you have in mind. We'll send you a puzzle just like this one.* You may solve all of the puzzle designs, and a few production problems as well. *Limited quantity available.

FOTOFORM and FOTOCERAM materials by

Fotoceram Products Group

CORNING

Corning Glass Works
Corning, New York 14830
(607) 974-8583

Circle 900 on reader service card

This free brochure will show you fresh new approaches to electronic design.

Network analysis, control systems, logic simulation, magnetics, microwave...whatever your engineering problem, our calculator-aided design brochure will show you how to slash days—perhaps weeks—from your design schedule. It describes fully-proven combinations of computing calculators and engineering software that can give you fast, accurate solutions to your most complex problems—perhaps to the very design problems that confront you now.

From electronic super slide rules to the most powerful calculator-aided design system, there's a combination that fits your needs... and your budget. HP puts the computing power where you need it—right at your fingertips. Get out from under tedious number crunching and back to creative engineering design. We'd like to show you rather than tell you, so call your local HP Sales Office. Or send for our 12-page, illustrated brochure... it's free.

HEWLETT hp PACKARD

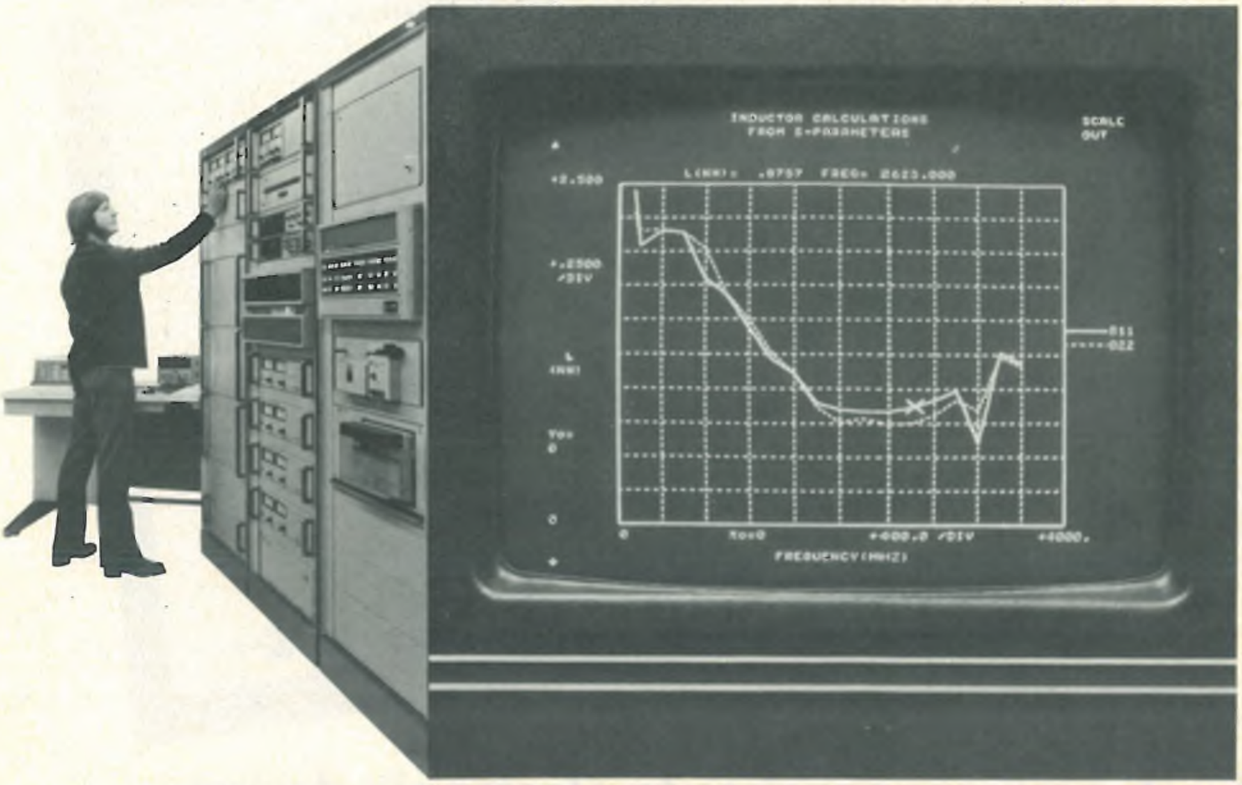
Sales and service from 172 offices in 65 countries.
P O Box 301, Loveland, Colorado 80537

O.K., I'd like to see how HP computing calculators can help solve my design problems. Please send me your free brochure.

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City/State ____________________ Zip ____________
Phone ____________________

HP-Calc. Inq.
P.O. Box 301, Loveland, Colorado 80537 816J

Shouldn't a CRT display reflect your system's true performance?



(Model 1317, 17" Diagonal Display)

Count on it with an HP display... including new large-screen models with improved performance your OEM systems demand. The high writing speed and fast settling time of our 14- through 21-inch displays means simplified output programming and greater information density in computer graphics, analytical research, radar and other display applications. Yokeless electrostatic deflection simplifies operation, eliminates geometric correction circuitry and unnecessary delay lines, and reduces required power by a factor of 5 or more. Bright, easy-to-read displays result from the 28.5 kV accelerating potential. And dynamic focusing assures a sharp trace at any screen location, over a wide range of intensities.

You also get versatility in HP displays. A variety of standard options allow you to tailor a display to your system's needs. Our rugged new 1317A and 1321A models give you options of TTL blanking input, differential inputs and gamma correction to match your system design and simplify interface problems. You have a choice of CRT sizes and shapes for stand-alone or rack-mounted applications. And you can get various phosphors that range from slow P7 and P39 to fast P31

In addition to top performance and versatility, you get the quality, reliability, and product safety you expect from a leader in CRT technology. Optional UL listing is available. Plug-in board construction simplifies servicing...and HP's worldwide support means rapid parts replacement and service—an important consideration when you're designing a display into your system. So, for a display that reflects your system's true performance, look into HP's large-screen display family. For more information, contact your local HP field engineer. Or, write Hewlett-Packard.

084/6A

HEWLETT hp PACKARD

Sales and service from 172 offices in 65 countries.
1501 Page Mill Road, Palo Alto, California 94306

for technical information circle 2 readers service card
for immediate applications assistance circle 231 readers service card

Electronics

The International Magazine of Electronics Technology

Vol. 48, No. 6 • March 20, 1975

Highlights

The cover: Confronting microprocessors, 101
Would-be designers of microprocessor-based systems need first to familiarize themselves with the chip characteristics. Also, they should either make a special study of low-level programing languages or hire a software consultant. Cover is by Art Director Fred Sklenar.

What microprocessors can do for instruments, 76
A microprocessor can simplify an instrument's operation, improve its accuracy, and add novel self-test and self-calibration features. But the chips are too expensive to be worth designing into equipment costing less than $200.

TV signal is a handy frequency standard, 107
Accurate calibration of a crystal oscillator takes a quarter of an hour if the phase comparison is made with a television color-reference signal. With NBS radio signals, the same job takes days.

Intercon/75 and IEEE shift their emphasis, 118
The show will be more sales-oriented than before, and the technical sessions will stress straightforward engineering. In becoming more career-oriented, IEEE is investigating EEs' employment problems and is seeking to develop greater continuity of policy.

A preview of products to be introduced at the convention starts on page 139.

And in the next issue . . .
Special report on batteries . . . foldout chart of electronic symbols . . . the rapid evolution of data acquisition.

Electronics

Publisher's letter

With winter officially over, can Intercon be far behind? The annual convention of the IEEE is about to open again, but the institute's officials are wondering if Intercon's winter is over yet.

According to associate editor Jerry Walker, who wrote the article starting on page 118, exhibit-space rentals are running even with last year, and officials even expect a slight increase. "If so, and if attendance matches or exceeds last year's figure of 25,000, it may be a harbinger of better times ahead."

But if the institute's leadership is wondering about Intercon's future, its members are wondering about something else—when the IEEE's two-year-old mandate to be more active in career-related affairs will really blossom. As you'll read in our Intercon-time round-up, and in our editorial on page 10, most of the initiatives that IEEE has undertaken since the members voted to change its constitution have yet to bear fruit. Still, important first steps have been taken as IEEE gingerly tries out its leadership role.

Part of our Intercon coverage, incidently, is a preview of some of the more interesting new products that are due for their debut at the show. You'll find that report on page 139.

Microprocessors, among the fastest movers in the already fast-paced solid-state field, are rapidly working their way into instruments. This issue, we have put together a double-barreled status report on how the microprocessor is changing the ways in which instruments are designed.

First, on page 76 you'll find a look at what's here now and what's coming as microprocessors add worthwhile new capabilities to instrumentation. "For example," as we point out in the article, "they could be used for instrument self-test, diagnosis, and calibration."

Then, on page 101, we have a detailed presentation on just what to watch out for when working with microprocessors. "Hardware problems, while formidable, can be solved by traditional methods," say the article's authors. "But not so for software. The problems associated with becoming familiar with the microprocessor and its interfaces, and with learning programing, can, at best, lead to some extremely harried designers or, at worst, to a poor design."

Just how fast the microprocessor wave is moving in instrumentation is still not clear. But one thing is certain: instruments will never be quite the same again.

Rarely has one of our periodic spot-checks of the economic health of the electronics industries meant so much to so many readers. With the national economy in such rocky shape—and amid predictions of worse things to come—what is the short-term outlook for electronics? For our latest "how's business?" report, company officials from all industry segments were asked what they see now and what they expect in the months ahead.

Their conclusion: things don't look as bad as expected. But turn to page 68 for their reasons.

March 20, 1975 Volume 48, Number 6
94,709 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 TWX N.Y. 710-581-5234. Cable address: M C G R A W H I L L N. Y.

Subscriptions limited to persons with active, professional, functional 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, including product manufactured or services performed. Subscription rates: qualified subscribers in the United States and possessions, Canada, and Mexico \$12.00 one year, \$24.00 three years; all other countries \$25.00 per year, except Japan and Israel \$50.00 per year, Brazil \$40.00 per year, Australia and New Zealand \$60.00 per year, including air freight. 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 one year; all other countries \$50.00. Single copies: \$4.00.

Officers of the McGraw-Hill Publications Company: John R. Emery, President; J. Elton Tuohig, Executive Vice President-Administration; Gene W. Simpson, Group Publisher-Vice President; Senior Vice Presidents: Ralph Blackburn, Circulation; Walter A. Stanbury, Editorial; John D. Hoglund, Controller; David G. Jensen, Manufacturing; Gordon L. Jones, Marketing; Jerome D. Luntz, Planning & Development.

Officers of the Corporation: Shelton Fisher, Chairman of the Board and Chief Executive Officer; Harold W. McGraw, Jr., President and Chief Operating Officer; Wallace F. Traendly, Group President, McGraw-Hill Publications Company and McGraw-Hill Informations Systems Company; Robert N. Landes, Senior Vice President and Secretary; Ralph J. Webb, Treasurer.

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.

Readers comment

Will not crack

To the Editor: In the new product writeup about our glass-tube heaters [*Electronics*, Feb. 20, p. 125] it is stated that these devices will crack when the applied power equals or exceeds their continuous power rating. This is not true. Our tubes will definitely not crack at rated power or even at three times rated power. They must be significantly overdriven, as indicated in the second paragraph, to make them crack.

As a matter of fact, a major microwave-oven manufacturer, as well as a leading thermal-cutoff manufacturer, are using our tube heaters to dissipate more than 50 watts for one-time-only operations.

Prabodh Shah
Corning Glass Works
Corning, N.Y.

'Dip effect' probed

To the Editor: Your interesting article "Gain up, size down" [*Electronics*, Dec. 26, 1974, page 23] discusses the phenomenon of the inhibited "emitter dip effect," but in my opinion the explanation seems either incomplete or incorrect.

In early 1971 we conducted research on the emitter dip effect with the result that the observed increase of diffusion depth is, in fact, an oxygen-induced phenomenon. When using doped oxides as a source for the emitter diffusions in a neutral gas ambient (N_2), the "emitter-push-out" disappeared completely, even for very high surface concentrations of the base diffusion. The same result has been obtained by protecting the diffusion windows against oxygen (after a standard predeposition) by means of a nitride layer.

In contrast to this technique, standard emitter predeposition and drive-in diffusion cycles always proceed in an oxygen ambient.

It is evident that a layer of polysilicon will act in a similar way, protecting the surface of the monocrystalline silicon against the action of oxygen.

R. Taubenest
Neuchatel, Switzerland

Want a prime source for all your components?

Consider the diversity in 50 electronic product lines from a company called TRW.

The fourteen Electronic Components Divisions of TRW, Inc. produce over 50 major product lines. Passive, active and electromechanical components—we can supply virtually any part you need. High volume, high technology, or both. We either already make it, or we can make it to your specifications. If you're looking for diversity in your prime source, you've just found it in a company called TRW.

TRW® ELECTRONIC COMPONENTS

Headquarters: 10880 Wilshire Boulevard, Los Angeles, CA 90024

TRW® CAPACITORS
TRW® CINCH CONNECTORS
TRW® CINCH-GRAPHIK
TRW® CINCH-MONADNOCK
TRW® CONSUMER INTERNATIONAL
TRW® ELECTRONIC FUNCTIONS
TRW® GLOBE MOTORS
TRW® HOLYOKE WIRE & CABLE
TRW® IRC NETWORKS
TRW® IRC POTENTIOMETERS
TRW® IRC RESISTORS
TRW® SEMICONDUCTORS
TRW® SUPERMET PRODUCTS
TRW® UTC TRANSFORMERS

Circle 7 on reader service card

News update

■ Solarex Corp. had an idea, and the people who run the company figured that the best way to convince people that it was a good one was to start small. So the Rockville, Md., firm set out to prove that solar cells designed just for terrestrial applications can do the job [Feb. 21, 1974, p. 32]. The result has been a successful initial product and, now, an expanding line. Solarex started with a solar energizer designed to maintain the charge on batteries of parked cars and docked boats. A major factor in making silicon cells available for such jobs is to get their cost down, something that Solarex apparently has done in developing a cell with the surface electrode in chevron-shaped patterns. What's more, says president Joseph Lindmayer, the cells, sliced from an ingot that's 10 mils thick, don't need any structural support in mounting or anti-reflecting optical coating. Lindmayer says the cells are 15% efficient even without the coating. Now, says Lindmayer, the product line includes larger arrays for remote locations such as lighthouses, and data buoys.

■ UGLI is getting prettier. UGLI, which stands for Universal Gate for Logic Implementation, is a joint project of the Air Force Avionics Laboratory at Wright-Patterson Air Force Base and Hughes Aircraft Co. A year ago, it had resulted in development of a prototype universal logic gate expected to be less expensive than custom-designed LSI circuits, more powerful as a design tool than read-only memories and programed logic arrays, and as fast as MECL 10,000 [Feb. 7, 1974, p. 42]. Now, an improved version of UGLI has emerged. It can be used with LSI, where a large pad-relocation-interconnected wafer is used instead of individual gates. The new universal logic gate forms a 4-by-4-bit three-stage multiplier with 34 cells and a delay of 10 to 11 nanoseconds; with conventional logic, up to seven stages—with a delay of more than 20 ns—would be needed, say the developers.

—Howard Wolff

Why pay $2400 for a TRUE RMS Digital Voltmeter that won't do as much as ours for $1395...

The Ballantine Model 3620A measures pure sine, complex and pulse waveforms from over 1 MHz down to below 1 Hz . . . to 0.1 Hz optionally. Full scale ranges are from 10 mV to 1000V. Push "DC Coupled" button to read true rms of combined ac and dc component present.

Now just check these other important features: ▪ Measures ac, dc and ac+dc to beyond 1 MHz ▪ Accuracy ± (0.1% RDG +0.1% Range) ▪ Resolution to 1μV ▪ ac measurements to 1 Hz ▪ Line or Battery operation ▪ Fully guarded input; floating or grounded ▪ 90dB common mode rejection @ 60 Hz ▪ No thermal lag — direct computation of true rms — fast response to 300 msec ▪ 4½ digits, high contrast, ½" high; 19,999 counts ▪ Automatic test equipment systems compatibility ▪ dB display 120dB total range; resolution to 0.01dB.

Make Us Prove It . . .
Send for the "TRUE EVIDENCE" and/or request a demonstration.

BALLANTINE LABORATORIES
P.O. Box 97, Boonton, New Jersey 07005,
Phone (201) 335-0900, TWX (810) 987-8380
Four Decades of Innovation in Electronic Instrumentation

"See us at IEEE booth #2632"

Circle 9 on reader service card

Editorial

IEEE as professional activist

It's been almost two and a half years since an overwhelming majority of its members voted to change the IEEE's constitution to permit the addition of career-oriented activities. In that time, the institute has been struggling to handle that mandate.

On the positive side, it has taken membership surveys on salaries and fringe benefits and distributed the resulting averages as guides for members in job negotiations. It set up an office in Washington, D.C., as an outpost in dealing with the Federal Government on matters pertaining to technology. It also hammered out a set of ethical guidelines for engineers and recently used the guide as the basis for entering a trial as a friend of the court.

And the IEEE has been working on pensions for the EE. Earlier this month, it joined the Pensions for Professionals operation to provide members with machinery for planning various kinds of retirement funds. All of these actions indicate a growing awareness of the professional aspirations of its members.

On the negative side, the institute has still not come anywhere near establishing itself as the voice of EEs in the outside world. Because of an unsteady beginning, the Washington office has not yet made significant impact on Government.

More important, however, members can wonder if the institute is living up to what might reasonably have been expected when the constitution was changed. Is the organization simply reacting to economic conditions, rather than promoting the profession? There are still conflicts within the IEEE between management-oriented and design-oriented members, between "town" and "gown," and between technical-firsters and career-firsters. The result is that the leadership is still not completely comfortable with a professional activist role.

Time will certainly solve some of these problems, but there is room now for positive steps. These include:

- *Putting the general manager in the forefront. It's not practical to expect the IEEE president to articulate and carry out a professionalism program in one year. Instead, this role should be shifted squarely to the general manager. He should be responsible for initiating career-related plans, as well as ensuring continuity.*
- *Beefing up the Washington office to make it the center for professional action. To be heard in Washington today requires a conscientious, all-out effort of the kind that is, so far, lacking from the IEEE. This step is being planned, but will require undivided attention and follow-through.*
- *Refining the means of planning professional activities to open up ideas from rank-and-file members—and even outsiders. By now the board of directors and headquarters staff must realize that there are many sources of good ideas on the careers front. Committees headed by electronics companies' top brass or academicians from engineering schools may not be representative. There should be a permanent, top-level "jobs committee," which would be active on behalf of working EEs in good times as well as bad.*
- *Continuing the initiative begun a couple of years ago to get the IEEE's name before the general public. This effort has been discouraging, because the mass media are not knowledgeable enough when it comes to sorting out technology and engineering. It's still painfully true that newspaper and TV reporters think engineers run trains.*

Yet to be resolved is what to do about Intercon. It undoubtedly must change if it is to adjust successfully to a new environment. But we have reservations about the effectiveness of the regional fragmentation presently planned for Intercon. Possible alternatives will be the subject of a future editorial.

The fastest 2102's and the easiest-to-use 2102's are 9102's.

Specifications	9102D	9102C	91L02C
Power (worse case)	290mW	330mW	175mW
Access and cycle times	250ns	300ns	300ns
Operating Temperature Range	0 – 70°	-55 – 125°	0 – 70°
Data Hold Time	Zero	Zero	Zero
Address Hold Time (Write Recovery Time)	Zero	Zero	Zero

Blazing speed and design simplicity: Advanced Micro Devices' 1K static RAM's. The 9102's.

Zero data and address hold times eliminate write cycle delays and extra timing slots in your system. You can change address & data and address & write pulses simultaneously.

Get the full story. Write or call for a free copy of our new 9102 Family brochure.

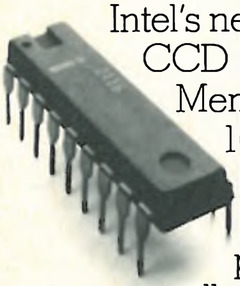
Get the best 2102's you can buy. Just ask for them by name: Advanced Micro Devices' 9102's.

Advanced Micro Devices

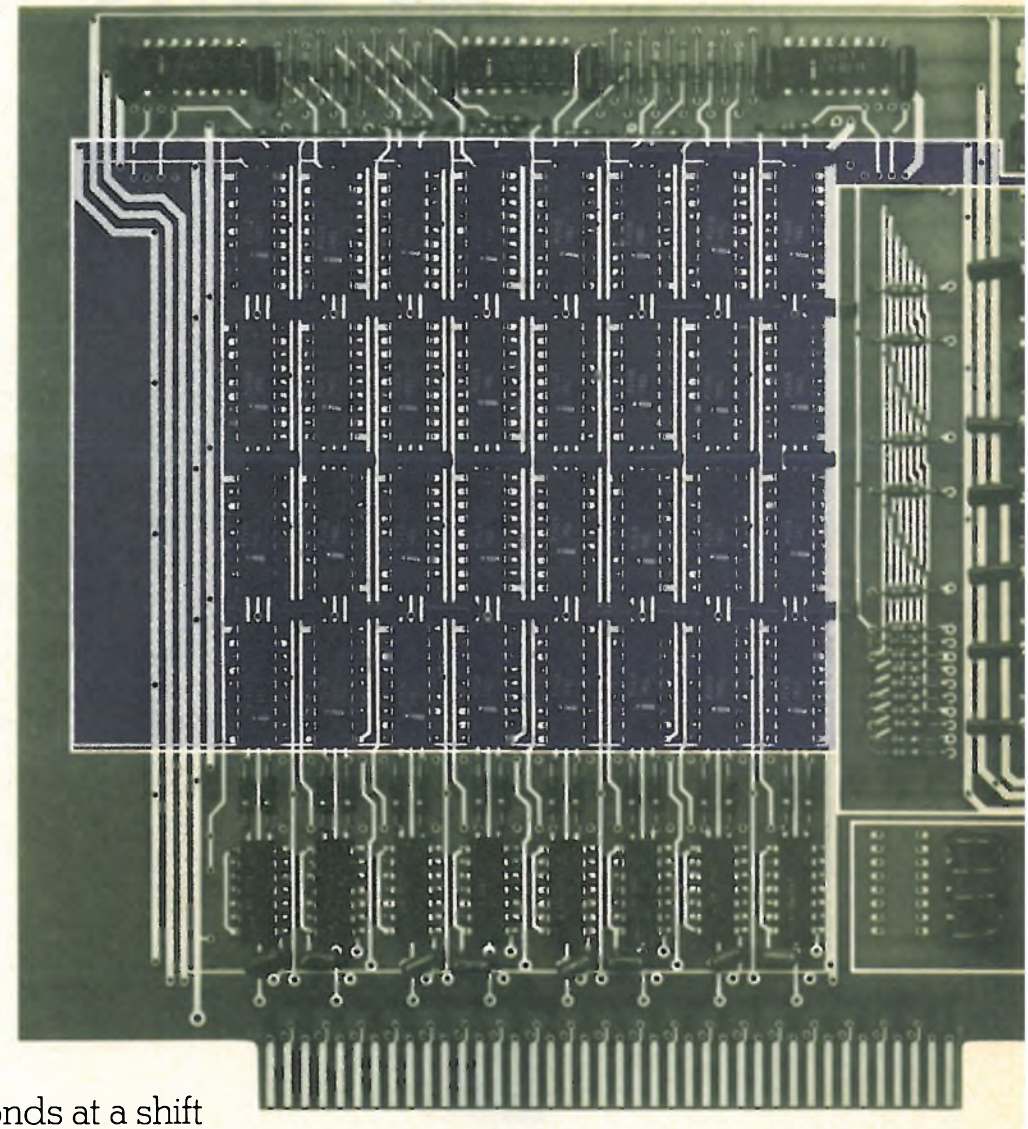
Corporate offices are at 901 Thompson Place, Sunnyvale, California 94086. Telephone (408) 732-2400 or toll free from outside California (800) 538-7904/Southern California: Beverly Hills (213) 278-9700/Mid-America: Oak Brook, Illinois (312) 323-9600/Edina, Minnesota (612) 835-4445/Dallas, Texas (214) 423-1502/Eastern United States: Roslyn Heights, New York (516) 484-4990/E. Syracuse, New York (315) 437-7546/Baltimore, Maryland (301) 744-8233/Wellesley, Massachusetts (617) 237-2774/Britain: Advanced Micro Devices, Telephone 01-730-0855/West Germany: Advanced Micro Devices, Munich, Telephone (089) 53 95 88/Southern Europe: Advanced Micro Devices, S.A. Neuilly, France, Telephone 747-4194/Japan: Advanced Micro Devices, K.K., Telephone (03) 346-0363. Distributed nationally by Hamilton/Avnet, Cramer and Schweber Electronics.

Circle 254 on reader service card

Intel's 18-pin 16K single card memories



Intel's new 2416 CCD Serial Memory stores 16,384 bits in a single 18-pin package, allowing you to build bulk memories with a density of at least a million bits per card. Furthermore, the Intel 2416 is organized as 64 recirculating 256-bit shift registers, so it has the speed and format flexibility of an assembly of small registers. In a program swapping operation, for example, your system could transfer data as fast as any CPU could use it.

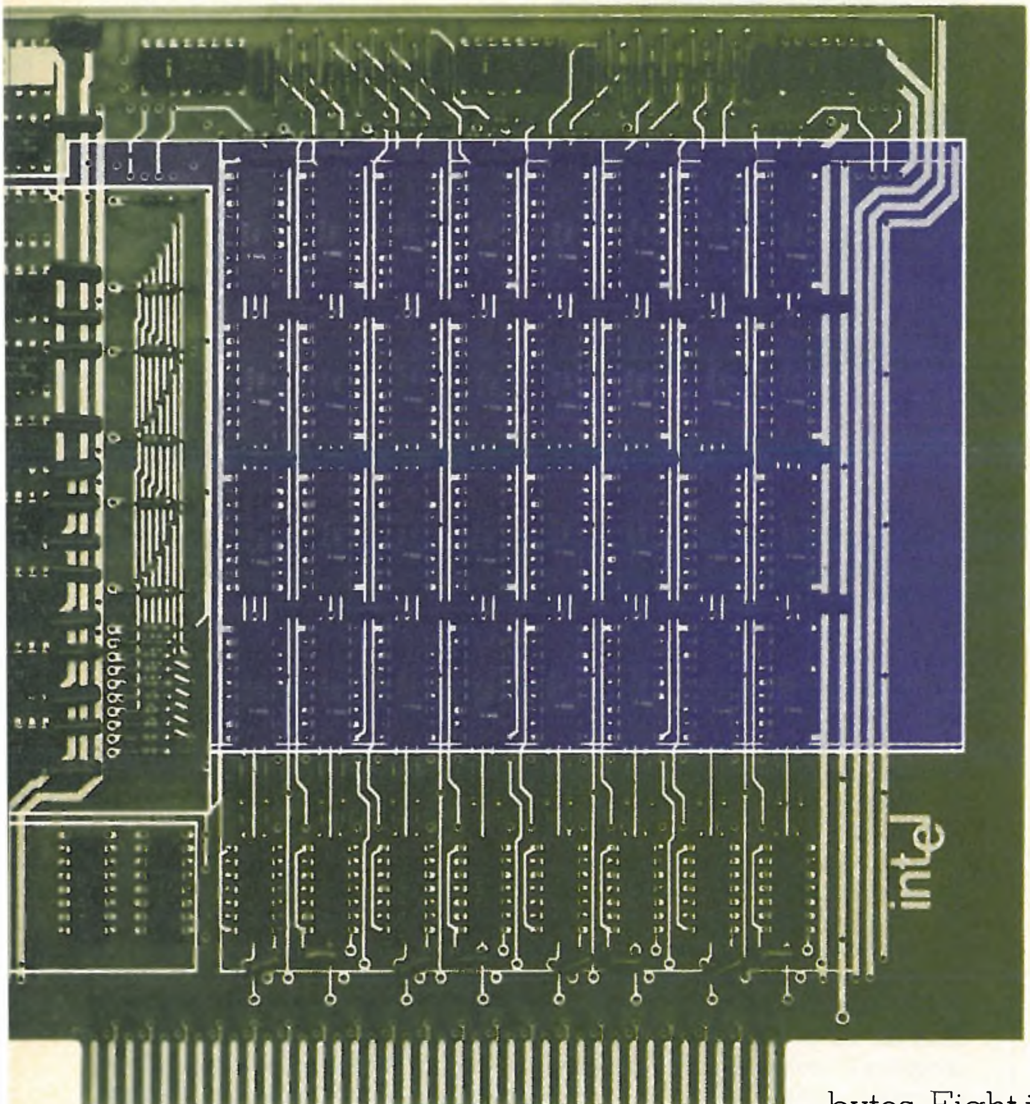


1,048,576-BIT MEMORY CARD USI

Any of the 16,384 bits can be accessed in less than 200 microseconds at a shift cycle of 750 nanoseconds. Between shift cycles, you can read or write a bit, a byte or a word at serial data rates faster than 2 megabits per second (a speed easily multiplied at the system level). A RAM-like I/O control with a cycle time less than 500 nanoseconds makes any register or a succession of registers accessible between shift cycles.

Yet the Intel 2416 is economical to use, with its standard +12, −5V supplies and standard 18-pin plastic DIP (or 22-pin ceramic DIP). You can build fast, versatile bulk memories into computers or microcomputers, business equipment, POS

CCD makes megabit a reality today.



64 INTEL 2416 CCD MEMORIES

systems and programmable calculators, or replace conventional shift registers at low cost in CRT terminals, instruments and communications buffers. And it readily emulates any small disc or drum system wherever the lower cost of CCD, better speed, high reliability, compactness and low power are needed.

For instance, the single-card, million-bit serial memory system shown here can work in disc or drum modes with a maximum latency of 200 μsec and data rates to 64 megabits per second. The 64 Intel 2416 packages are organized as 128 kilobytes. Eight identical cards would operate as a megabyte system.

Start upgrading your bulk memories from electro-mechanical to solid state today. For immediate delivery, or further information, contact our European Headquarters, 216 Avenue Louise, Brussels B1050, Belgium, Tel: 649-20-03, Telex: 24814; or Intel Japan, Kasahara Bldg., 1-6-10, Uchikanda, Chiyoda-ku, Tokyo 101, Japan, Tel: 03-295-5441, Telex: 781-28426.

intel® delivers.

People

Zraket giving Mitre's touch to socially oriented systems

Change of pace. Mitre's Zraket looks toward energy, CAI, and urban transport.

The Mitre Corp. is best known for its systems engineering for the Air Force and the Department of Defense. But having made Charles A. Zraket the new senior vice president for technical operations, the company is also out to make its mark in energy—especially photovoltaics, urban transportation, and computer-aided instruction. Zraket himself initiated these programs when for 12 years he headed Mitre's Washington, D. C., operations. "They've been personal as well as business interests of mine for a long time," says the energetic Zraket.

The 51-year-old electrical engineer, who has been with Mitre since it was founded in 1958, is responsible for all of the Bedford, Mass., company's technical and administrative activities.

"Obviously our first priority is to look at the future support of the Air Force," he says. "It has undergone major changes in the cost of doing business, in manpower constraints, and in applying advanced technology. We must help decide how the electronics revolution can be applied in more effective and less costly systems." Air Force and other DOD work accounts for about two thirds of Mitre's budget, which was $64 million in fiscal 1974.

But he expects Mitre's budget in the energy field—now 10% of the total—to double in the next two or three years. Mitre is already involved with planning national energy R&D for the new Federal Energy Research and Development Agency. In Washington, Mitre has set up what Zraket says is the world's largest photovoltaic-cell test facility, and the corporation is talking to ERDA about establishing a facility to demonstrate the ability of photovoltaics to generate appreciable amounts of power.

In computer-aided instruction, Mitre has developed a system for interfacing ordinary television sets with a computer through a wide-band cable, called Ticcit for time-shared interactive computer-controlled information television.

Zraket also sees the computer helping urban transportation systems increase their operating efficiency. "You have to talk computer-based automation," he says. "The problems are not in vehicles but in controlling them."

Although Zraket doesn't see many brand-new programs coming along for a while, he isn't worried. "We'll have our hands full in the next five years just doing what we've started."

Bowmar's new chief starts the cleanup

Bowmar Instrument Corp.'s new chairman and chief executive officer is wasting little time or sentiment in trying to put the troubled company back on a firm financial footing. William M. Crilly, the former Pan American World Airways executive vice president who succeeded Edward A. White at Bowmar's helm in New York a month ago, is already talking with several unnamed interests about the company's prized (but expensive) MOS-production operation in Chandler, Ariz.

"We'd rather not sell the Chandler facility, but that's something we'll just have to consider," says Crilly, an aeronautical engineer whose background also includes executive positions with Eastern

People

Airlines and Douglas Aircraft Co. Bowmar filed for protection under Chapter XI of the bankruptcy laws last month after losing $23 million during the fiscal year ending Sept. 30, 1974 [*Electronics,* Feb. 20, p. 26].

It may not be a seller's market, but Crilly says something has to go if Bowmar is going to survive its predicament. "At this point, it's a matter of dollars and cents at Chandler. There is no way you can run at 20% capacity and make money. The least desirable approach would be to mothball the plant."

Hopefully, he says, "We might find a joint-venture partner [for Chandler]. We might even take it outside the Chapter XI proceedings and still operate it with a partner. I can tell you one thing—we've been approached by a lot of bargain hunters."

Dropped. Bowmar has already dropped its microwave-oven operation in Newbury Park, Calif. Security systems for the home, produced at Bowmar's Fort Wayne, Ind., facility, is a potential disposable. Desktop calculators are "under review" and may be dropped altogether. At this point, says Crilly, who appears to be going about his business with aplomb, "we would sell them in bulk if someone were interested."

Of calculators—the company's mainstay and yet, ironically, the heart of its problems—Crilly has already dropped the top-of-the-line MX100 and MX140 and cut prices $10 to $20 on three of its middle-priced units. As for Bowmar's European marketing activities, which have been criticized in the past as competitively weak, the new president says, "If anything, we'll step up foreign marketing in calculators, watches and light-emitting diodes."

Most consolidations are already completed. Consumer activities have moved to the Phoenix area with most manufacturing now in Nogales, Mexico. The $1.5 million in financing recently received by Bowmar "looks adequate for six to eight weeks," Crilly concludes. "That's our long-term planning at this point."

SURPRISE!

The first 24 mcd LED lamp!

	RED	YELLOW	GREEN
NARROW BEAM 5082 -	4658	4558	4958
	4657	4557	4957
WIDE BEAM 5082 -	4655	4555	4955
	4650	4550	4950

And that's 24 mcd at only 10 mA for our brightest red lamp. At 20 mA you can get over 48 mcd of light output.

HP's new high efficiency material makes these new bright LED's possible. With our brightest yellow you get 16 mcd at 10 mA. Our brightest green offers 16 mcd at 20 mA.

Three colors, two beam angles, and two luminous intensity categories are available in the popular T 1-3/4 package. Twelve new LED's, one just right for your application.

All are available for immediate delivery, just \$0.89* each or \$1.15* each at the 100 piece level, depending on brightness category.

Contact Hall-Mark, Schweber, Wilshire or the Wyle Distribution Group (Liberty/Elmar) for immediate delivery. Or, write us for more details. They offer you new ways to apply solid-state technology in your products.

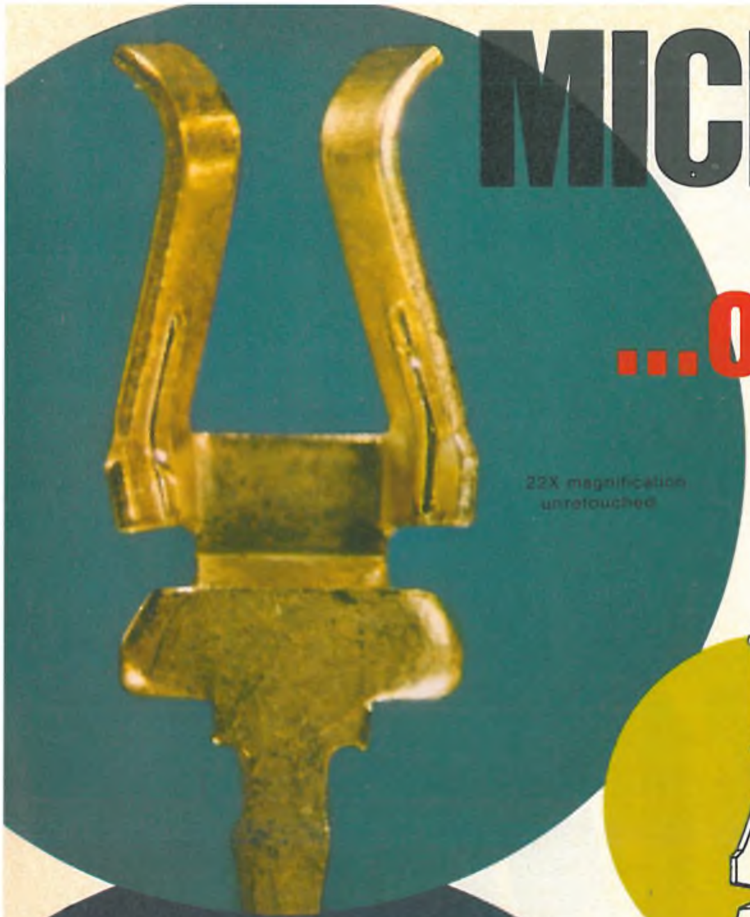
01502 *Domestic USA Prices Only.

HEWLETT hp PACKARD

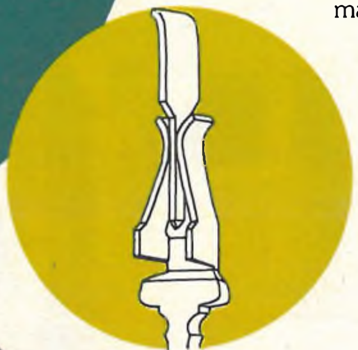
Sales and service from 172 offices in 65 countries.
1501 Page Mill Road, Palo Alto, California 94304

MICROPHOTOS

...of high-reliability



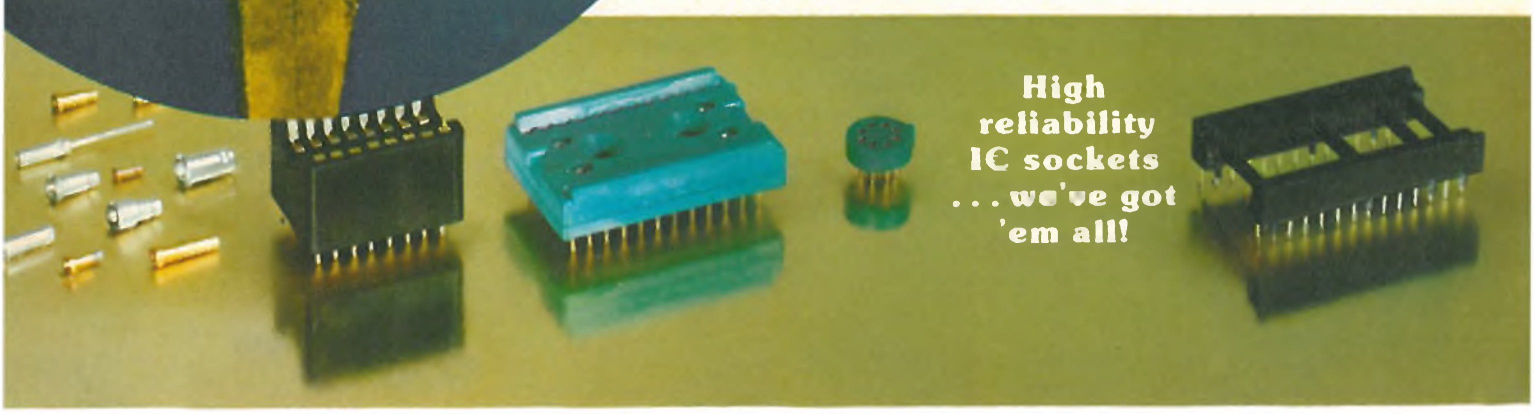
ROBINSON-NUGENT "SIDE-WIPE" SOCKET CONTACT after 5 insertions of DIP lead frame. Contact has been spread apart to show inside faces of contact. See how the RN contact—because it mates with the *smooth, flat side of the IC lead frame*—retains its surface integrity. This 100% greater lead frame contact results in minimum electrical resistance—continued high reliability for your IC connections.



Lead frame in place in RN ***"side-wipe"*** *contact.*

AN ORDINARY EDGE-BEARING SOCKET CONTACT after 5 insertions of DIP lead frame. Contact has been spread apart to show inside faces of contact. Notice how the contact has scars and abrasions from *rough, irregular edge of IC lead frame.* Electrical contact is degraded and resistance is increased. Reliability is obviously reduced.

Lead frame in place in an ordinary ***edge-bearing*** *contact.*



Meetings

Reliability Physics Symposium, IEEE, MGM Grand Hotel, Las Vegas, Nev., April 1–3.

Fourth Annual Symposium on Incremental Motion Control Systems and Devices, University of Illinois Electrical Engineering Department, Urbana, Ill., April 1–3.

Paris Components Show, (*Salon des Composants Electroniques*), Porte de Versailles, Paris, April 2–8.

Southeastcon '75, IEEE, Sheraton Center, Charlotte, N.C., April 6–9.

Intercon—IEEE International Convention, Coliseum and Americana Hotel, New York, N.Y., April 8–10.

Intermag—International Magnetics Conference, IEEE, Imperial College, London, England, April 14–17.

International Circuits & Systems Symposium, IEEE, Marriott Motor Hotel, Newton, Mass., April 21–23.

Reliability Software International Symposium, IEEE, International Hotel, Los Angeles, April 22–24.

Society for Information Display International Symposium, SID, Shoreham Americana Hotel, Washington, D.C., April 22–24.

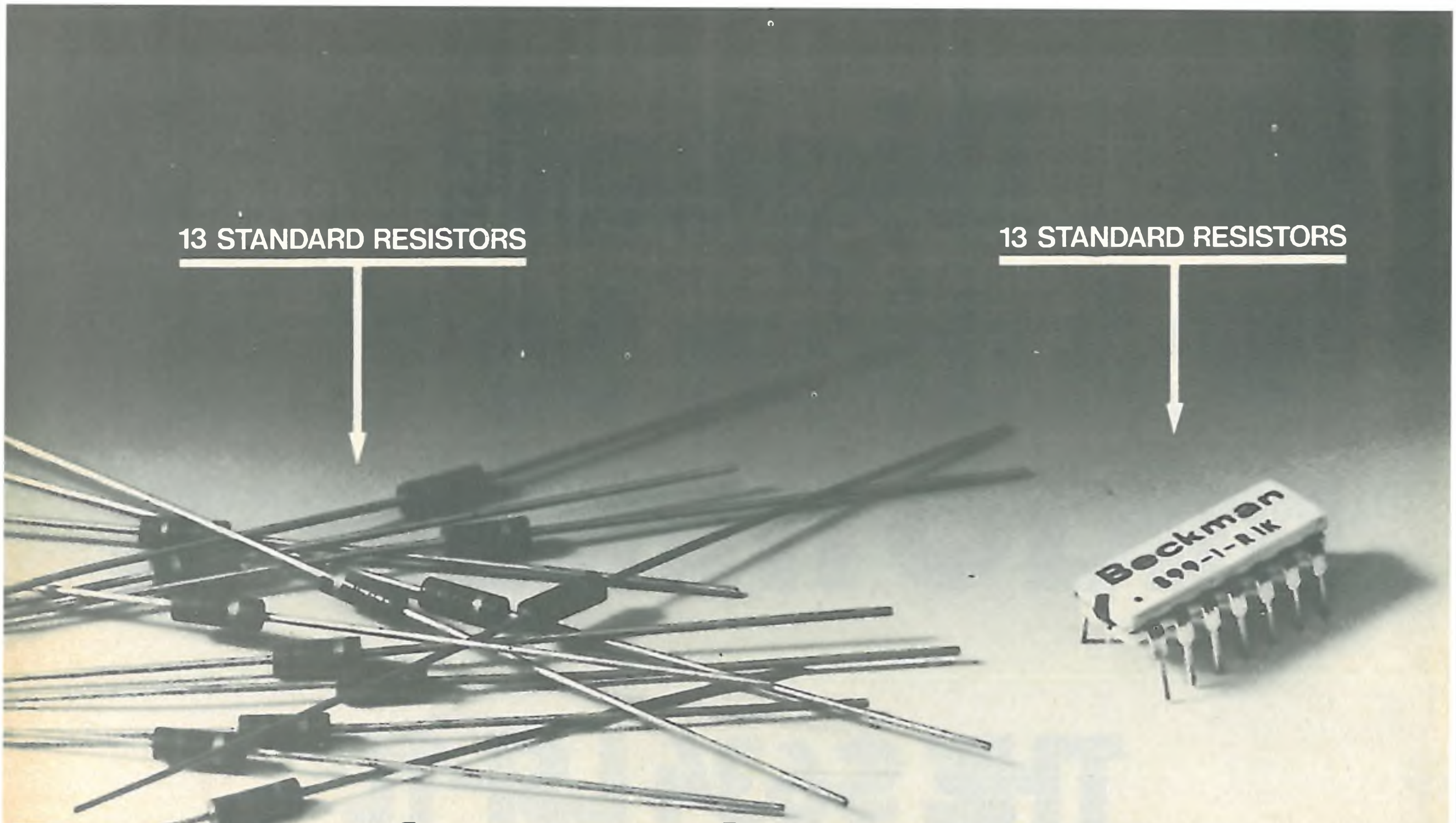
International Optical Computing Symposium, IEEE, Mayflower Hotel, Washington, D.C., April 23–25.

National Relay Conference, NARM and Oklahoma State University, Stillwater, Okla., April 30–May 1.

American Ceramics Society Electronics division Meeting, Sheraton Park and Shoreham Americana, Washington, D.C., May 3–8.

International Microwave Symposium, IEEE, Rickey's Hyatt House, Palo Alto, Calif., May 12-14.

Electronic Components Conference, IEEE, EIA, Statler Hilton Hotel, Washington, D.C., May 12–14.



Beckman's one-piece money saver saves time and space, too.

To keep working with discrete standard resistors just isn't logical. Not when there are ceramic DIPs available that do the same jobs in less space—quicker, easier and cheaper. Whether inserted automatically or by hand.

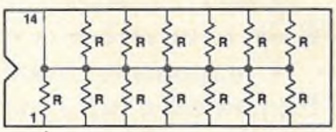
Stocked locally for immediate delivery, too. At "on the board" cost-saving prices, in small or large quantities.

(Check the specs.) No wasted time while they're "made to order," unless you want custom modifications, which we can do fast.

And remember, ceramic. Ceramic reliability at plastic prices.

Why wait? Call your local Beckman Representative now for applications assistance or more information.

Beckman
INSTRUMENTS LTD.
COMPONENTS INTERNATIONAL

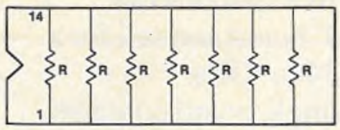


MODEL SERIES 899-1
Resistance Values. 78 Standard versions available 22ω to 100K.

Common Applications: Digital pulse squaring; MOS/ROM pull-up/ pull-down; "wired OR" pull-up; power driver pull-up; open collector pull-up; TTL input pull-down; TTL unused gate pull-up; high-speed parallel pull-up.
Standard Tolerance: ± 2.0%

MODEL SERIES 899-2
Resistance Value (ohms): 10K
Common Applications: Inverting operational gain; potentiometric gain; differential gain; noninverting gain; gain adjustment.
Standard Tolerance: ± 2%

16 pin versions available.
Ask for Series 898



MODEL SERIES 899-3
Resistance Values. 78 Standard versions available. 22ω to 100K.

Common Applications: Line termination; long-line impedance balancing; power gate pull-up; ECL output pull-down resistors; LED current limiting; power driver pull-up; "wired OR" pull-up; TTL input pull-down.
Standard Tolerance: ± 2%

Head Office.
Beckman Instruments Ltd.
Components International
Queensway, Glenrothes
Fife KY7 5PU
Scotland
Tel. 0592 753811
Telex 72135

Subsidiaries.
Beckman Instruments GES.M.B.H.,
Helipot Components Division,
Postfach 21,
Sieveringerstrasse 81,
A-1197 Vienna
Austria.
Telephone: 322150 Telex: 07/4099

Beckman Instruments France S.A.
52 Chemin des Bourdons
Gagny 93220
France
Tel. 927 77 77. Telex 91921

Beckman RIIC GmbH,
8 Munich 40,
Frankfurter Ring 115,
Federal Republic of Germany.
Telephone: 38871 Telex: 5215761

Beckman Instruments Italiana S.p.A.,
Via Arese 11,
20159 Milano,
Italy.
Telephone: 6888951 Telex: 36484

Circle 237 on reader service card

Authorised dealers in every other country.

Electronics newsletter

Fairchild, Reticon list 1,728-element image sensors

The image-sensor race between Fairchild Camera and Instrument Corp.'s charge-coupled-device arrays and Reticon Corp.'s MOS photodiode arrays is nearly a dead heat. Within a week or so of one another, **both are announcing availability of 1,728-element linear image sensors** aimed at optical page-scanning systems like those used in facsimile.

Fairchild's device, the CCD 121, contains 1,728 sensor elements, two charge-transfer gates, a pair of two-phase 866-bit analog shift registers, an output-charge detector/preamplifier, and a compensating output amplifier in a 24-pin dual in-line package measuring 0.52 by 0.004 inch. Reticon's RL-1872F contains 1,872 photodiodes, along with shift registers and multiplex switches for internal scanning and readout in a 22-pin package measuring 0.40 by 1.6 in. Reticon says the array can scan a page in less than a second with better than 4.5-mil resolution, making possible facsimile transmission of highly detailed images.

TI puts 2-in. tape in a portable calculator

Watch for Texas Instruments to announce a new portable electronic printing calculator to its retailers within a month. Unlike other "handheld" printing machines on the market, which rely on ticker-tape output, **the TI unit will print up to nine digits on a 2-inch-wide roll of heat-sensitive paper.** The 5-by-7-dot-matrix characters are printed a line at a time by a TI-built thermal print head.

The calculator, featuring four functions with percent, also has chain-constant and fixed/floating decimal operation. High-level buffers permit multiple entries while the unit is in a printing mode, as well as two-key rollover—a second key can be pressed before the first one is released. The unit is relatively large—8.7 by 3.9 by 2.7 in.—for a portable calculator and will run up to six hours on rechargeable batteries.

Uranus to advise builders of Soviet watch facility

A visit to Uranus Electronics in Port Chester, N.Y., by Soviet Electronics Ministry officials almost two years ago is finally paying off for the privately owned digital-watch maker. Uranus president Morris Levine returned from Moscow earlier this month with a signed agreement for his company to provide **technical assistance in building a Soviet electronic-watch factory.**

Levine says the Soviets will produce watches with both light-emitting diode and the liquid-crystal displays plus C-MOS chips of their own designs. Meanwhile, a group of Soviet electronics specialists **visited facilities of General Instrument Corp.'s Microelectronics group** in Hicksville, N.Y., and its corporate offices in Manhattan a few weeks ago to "talk a deal," although GI is keeping quiet about the visit.

Univac goes to semiconductor memories in 1100

Sperry-Rand's Univac division has introduced two large-scale, high-performance computers—part of its venerable 1100 series. **The new machines are the first Univac mainframes to use semiconductor memory.** Both were demonstrated this week at the Roseville, Minn., 1100 facility, along with new disk storage and general communications subsystems, as well as an improved version of the 1100 operating system.

The 1100/20 has an instruction-cycle time of 875 nanoseconds for a possible 860,000 instructions per second. It also can be expanded from a unit processor with 13,072 words of storage to a multiprocessor with 524,288 words of main memory. The 1100/40, which has 300-ns cycle time, has both primary and extended storage.

Mostek to sell 2-function unit for checkbooks

CheckMaster, a two-function electronic checkbook calculator **that will hold and display checking account balances for a year,** will be announced early next month by Mostek Corp.'s new consumer electronics operation. The battery-powered machine, built into a plastic checkbook case and selling for $39.95, relies on a unique circuit design for its seemingly nonvolatile memory.

In the "off" position, the p-channel depletion-load chip is continuously supplied with less than 100 microamps, and the user's balance is maintained in a static shift register memory that is clocked only during operations requiring memory access. Even in the power-up mode, the chip requires less than 2 milliamps' current. The design also includes a power-up clear circuit so the balance isn't changed when the unit is turned on.

Collins enters small-plane instrument market

Rockwell International's Collins Radio Group is expanding into instruments for single- and light twin-engine aircraft—**the only avionics market area in which it does not already compete.** Leading the drive is a new line of five solid-state communications and navigation instruments called the Collins Micro Line, with which the company expects to capture a significant share of a business it estimates at about $75 million annually.

The Micro line, which Collins says it will add to later, now consists of the VHF-251 transceiver, the VIR-351 receiver for vhf navigation, the AMR-350 audio center and marker beacon receiver, the IND-351 VOR/ILS course indicator, and the GLS-350 glideslope receiver.

Mostek's Corvus sold to Colex

Mostek Corp. has sold its Corvus consumer electronics subsidiary to Colex Ltd. of Hong Kong. **Mostek will manufacture and market its new CheckMaster calculator, and digital electronic clocks,** under its own name.

Addenda

National Semiconductor Corp. is planning to introduce by midsummer a Schottky bipolar version of its IMP-16 microprocessor. **The new chip will be twice to four times as fast as the MOS device** and will be followed by an 8-bit bipolar version later in the year. . . . New FAA signs warning airline passengers of X-ray scrutiny aren't complete, says Frank Munley of Ralph Nader's Aviation Consumer Action Project. He says the signs **do not warn of the cumulative effect of X-rays on commercial film;** the Nader group may sue the agency to have the warning signs amended, says Munley. . . . Fairchild is closing its Shiprock, N.M., semiconductor facility in the wake of a recent takeover of the plant by militant American Indians.

The fastest data acquisition system. Anywhere.

Our 4855 ultra-high speed sample-hold ahead of our 4133 ultra-high speed 12-bit ADC. System aperture time is an ultra-low 1 nsec. Guaranteed throughput rate is 350 kHz. And you get this system speed at 0.03% total accuracy.

The 4855/4133 combination gives you a functional capability you can't achieve elsewhere. For example, the exceptionally low feedthrough of the 4855 allows you to multiplex during conversion without affecting system speed and accuracy.

FFT, high speed data acquisition, video digitizing, radar pulse digitizing and multi-channel simultaneous sample and hold—applications where greater than nanosecond uncertainty slow you down.

The 4855's 250 nsec acquisition time to 0.01% accuracy assures exceptionally high throughput rates for precision systems. The 4133 gives you high linearity, excellent stability and 2.5 μsec max. conversion time.

Together they're unbeatable for highly accurate, high speed data acquisition. And they're only available from Teledyne Philbrick at unbeatable prices ($160 and $485 in 100's).

For complete information, write for our Application Bulletin today. Or "DIAL" (our Direct Information Access Line) 617-329-1600. Teledyne Philbrick, Dedham, MA 02026. In Europe, Tel. 673.99.88, Telex: 25881. Or write, 181 Chausee De La Hulpe, 1170 Brussels.

See us at Salon des Composants Allée F-93

I can measure lower distortion than you've ever seen. I'll show you at INTERCON.

Hi!

Yes, I can measure distortion down to .002% (−94 dB) with this new Sound Tech *system*.

And I can measure it in 5 seconds.

That's because Sound Tech's new 1700A is push-button controlled—and it nulls *automatically*.

What's more, the 1700A is both an ultra-low-distortion signal source *and* a total harmonic distortion analyzer—*a complete distortion measuring system*.

You'll like these other 1700A features, too:

- Covers 10 Hz to 110 kHz
- Has differential input
- Measures signal ratios up to 100 dB
- Measures 30 microvolts to 300 volts as a high-sensitivity ac voltmeter
- Reads power into 8 ohms

I'll be at INTERCON to show you how easily the 1700A measures.

Booth 2633.

See you there.

—Rosemary

Ultra-low-distortion oscillator

See this at INTERCON, too.

It's an ultra-low-distortion oscillator for use in measuring lowest distortion amplifiers. Has less than .001% distortion. Covers 10 Hz to 110 kHz. Push-button frequency selection. Output variable from less than 1 millivolt to 3 volts.

SOUND TECHNOLOGY
1400 DELL AVENUE
CAMPBELL, CALIFORNIA 95008
(408) 378-6540

Circle 28 on reader service card

TRW Systems sets gate-density record for bipolar logic

Emitter-follower logic is applied to 11-chip, 16-bit microprogramable computer; 50,000-device chip possible

Emitter-follower logic, although 10 years old, has been fashioned by TRW Systems Group into one of the industry's most powerful computer-circuit technologies. So the big payoffs from bipolar LS may not all go to glamorous new processes like integrated injection logic.

Under the direction of the manager of the Microelectronics Center, Barry Dunbridge, one-chip processors containing more than 17,000 EFL devices (over 5,000 gates) have been built at the Redondo Beach, Calif., company. Such device density is over 10 times that of today's most complex transistor-transistor-logic LSI processor chips.

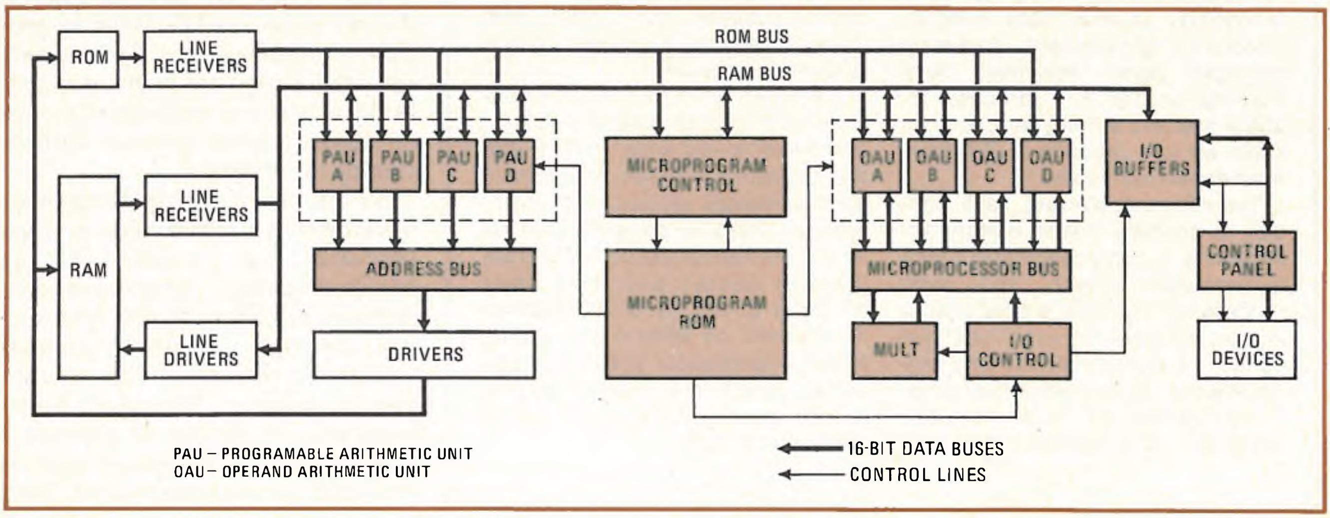
The improved EFL process was developed for in-house custom programs under Air Force contracts, but can easily be transferred to commercial semiconductor production. TRW already has agreements with semiconductor manufacturers, who are enthusiastic about the high yields on large chips offered by the relatively simple three-diffusion (3D) process (see "Motorola readying LSI emitter-follower logic . . ." p. 30). For example, the on-wafer yield for a die measuring 300 by 300 mils is 30%.

Such high yields signal TRW's near-attainment of a major semiconductor-development goal—a low-defect bipolar process capable of packing 10,000 gates on a chip [*Electronics*, March 6, p. 57]. This so-called 10K bipolar LSI excites computer and semiconductor manufacturers alike, many of whom are counting on it for the step-function improvement in price and performance that will explode demand for medium and large computers even further.

Hardware. Using only 11 chips, Dunbridge's group has built a high-performance 16-bit microprogramable parallel computer for an Air Force signal-processing system. A companion circuit for the system's front end is a signal-processing arithmetic unit that contains 14,000 bipolar devices on a single, high-yield 302-by-360-mil chip [*Electronics*, March 6, p. 32]; it dissipates only 5.1 watts at clock-cycle speeds of 120 nanoseconds. Better yet is another TRW processing chip, the MPY-1, which, with over 17,000 devices, must hold the bipolar density record.

According to Jim Buie, one of the key designers on the EFL project (and also the inventor of TTL in 1961), the 16-bit computer has now reached the final debugging stage. The machine is composed of eight

Speeder. Sixteen-bit computer built with TRW's high-yield emitter-follower logic has a typical instruction cycle time of 120 ns. Under TRW license, Motorola Semiconductor plans to start producing the parts and may announce a new MC5800 chip family by September.



4-bit-slice microprocessor chips that make up both the central programable address unit and the operand arithmetic unit (see p. 29). The three remaining chips are a 16-bit parallel multiplier [*Electronics*, Jan. 23, p. 29], a control chip for microprograming, and a single jumbo input/output chip.

More coming. Buie points to even more impressive developments with a triple-diffused LSI process that has been extended into the higher-performing current-mode-logic configuration. "With CML," says Buie, "we can boost the frequency range of our 3D transistors to approximately 30% of the actual transistor cutoff." This permits the devices to operate two to three times faster than before. And since CML and EFL can be made directly compatible, a designer can use them side by side on a chip to optimize the performance of different segments of the circuit.

For example, CML is faster but more limited for combinational logic functions than EFL, so that in an EFL-CML D-type flip-flop, the internal registers could be built with CML, the gates with EFL. The resulting flip-flop runs with a propagation delay of only 25 ns (for a typical load of 80 picofarads) while dissipating only 32 milliwatts.

Paralleling these circuit advances is the development of advanced 3D LSI designs that could improve still more dramatically the speed-power product of today's 3D techniques and lead to still higher levels of bipolar complexity. It all boils down to gates that occupy a quarter of the space of TRW's already tiny EFL structures.

In addition, these gates may be built with transistors operating at cutoffs as high as 500 MHz, almost five times faster than in present EFL circuits. As a result, a typical 300-by-300-mil processor chip dissipating only about 5 W could accommodate an incredible 50,000 devices—probably enough for a full 16-bit miniprocessor. □

Motorola readying LSI emitter-follower logic based on license from TRW

Motorola's Semiconductor Products division, Phoenix, is starting production of large-scale emitter-follower-logic devices. The company plans to announce a set of standard EFL minicomputer chips, probably in September.

The 11-chip set forms a 16-bit miniprocessor with transistor-transistor-logic speed and microprocessor size. The chip set is made from masks developed by TRW Systems, which has granted Motorola a technology license. Jack Saddler, Motorola's government marketing manager, says, "We have been working on the EFL process for about one and a half years, and we know we can produce it. We have even enhanced it some."

The minicomputer set, says Saddler, is oriented toward military applications, notably electronic countermeasures, speech, and radar processing. The firm is now checking out software for such functions as fast Fourier transforms and digital filtering. As to commercial uses, "the computer is a number cruncher," says Saddler. "We know the military needs this capability, but we aren't sure whether many commercial applications do." He adds that Motorola will only produce hundreds of the chips this year.

Saddler notes that the microprocessor concept is especially exciting to military customers because they need sophisticated systems in small quantities. "They've been wrestling with how to implement custom applications without the low-quantity orders the semiconductor suppliers don't want. With microprocessors, the customizing is all done in software."

Saddler predicts wide applications of microprocessors in military systems—so wide, in fact, that the company will also introduce a special military version of its commercial MC6800 series n-channel MOS microprocessor. Motorola plans to discuss and show these products at the 1975 International Symposium on Military and Industrial Microprocessor Systems in San Diego, June 3 to 6. The symposium is sponsored by AH Systems Inc. of Chatsworth, Calif.

Memory

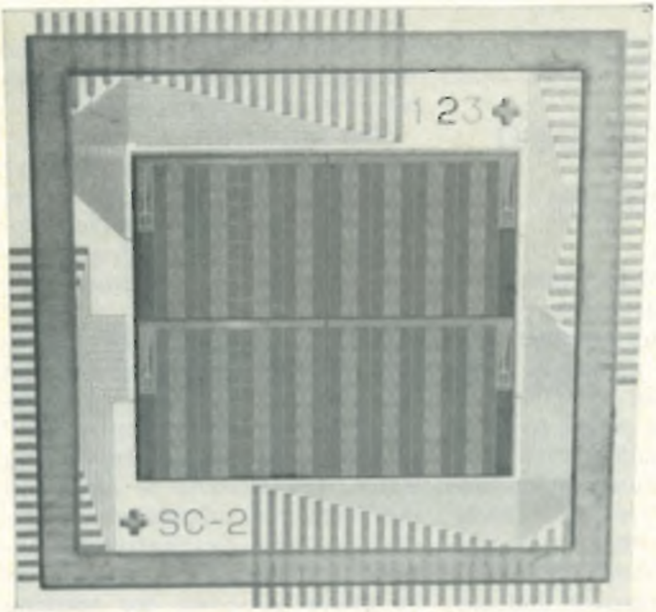
Superchip boosts RAM size to 40-k

Large semiconductor-memory systems are built up from lots of relatively small memory chips that have been cut from a silicon slice, packaged, and interconnected on a printed-circuit board. Obviously, things would be much easier if those chips could be interconnected while they're still in the slice.

This is exactly what Honeywell Information Systems is trying to do with its developmental Superchip—a metal-oxide-semiconductor memory which, measuring 1.1 by 1.2 inches, occupies most of a 2-inch-diameter silicon wafer. The super-sized chip is fabricated with 256 arrays of shift registers containing 256 bits each for a total of 65,536 bits. Functionally, Superchip, designated the SC-2, is divided into four groups of 64 arrays all connected to each other via a common bus system.

The result is that Honeywell doesn't need a 100% yield to produce a useable device. Rather, only the good arrays are interconnected; faulty arrays and even entire groups of arrays can be omitted without ruining the wafer.

So far, the best chip Honeywell, working with a semiconductor manufacturer, has produced of the block-oriented, random-access memory had about 40,000 operating bits, although it hopes to produce 100,000-bit devices. With its approach, however, Honeywell hopes eventually to be able to produce a memory for its computer systems that falls between high-speed RAMs



More bits. Honeywell's Superchip contains 65,536 bits divided into four groups on silicon slice measuring 1.1 by 1.2 inches. Common buses for 256-bit array at at the top of each group.

and slow but inexpensive memories such as disks.

Honeywell's work is reminiscent of Texas Instruments' discretionary-wiring and Hughes Aircraft Co.'s pad-relocation techniques of a few years back. These were efforts to increase the number of useable logic gates on a piece of silicon, as well as custom-design the gates' interconnections.

Unfortunately, those systems required an extra mask unique to each wafer, to lay down metalization that would connect good arrays and avoid faulty ones. And discretionary wiring turned out to be more expensive than the standard devices that semiconductor manufacturers were beginning to turn out in large quantity.

Step ahead. "We developed Superchip in an attempt to be a slight step ahead of the semiconductor industry," says the director of advanced technology programs, John W. Bremer. Primarily, Bremer wants to be ahead in cost. He notes that the support of a 1,024-bit chip—wiring, testing, assembly and packaging—can equal the price of the part.

"If we can get more bits per semiconductor, even if the semiconductor is bigger, we are ahead of the game," he says. Bremer's goal is to obtain memories for half to a quarter the price of commercially available semiconductor memories and to keep assembly costs the same or lower. A packaged 4,096-bit device will cost about ¼ cent per bit in 1975, he estimates.

Each 256-bit shift register is a dynamic, p-channel, silicon-gate MOS device. Each register array also contains a clock driver, a 13-bit programable read-only memory and associated pads, an address comparator, and a 22-bit-wide common bus.

Avalanched PROMs form one input to the comparator; the other input comes from the bus. After the wafer is fabricated with the PROM devices left open, each array is probed to determine if it works. If it does, 12 PROMs are programed with a unique address by applying current to the probe pads. If it doesn't, a 13th PROM is activated to disconnect the array from the common bus.

This connect/disconnect philosophy can also be applied to the buses. Each of the four groups of arrays has its own bus with group clock drivers, for increasing speed, and bus disconnects. A faulty group can be disconnected from the main bus while the rest of the wafer continues to function.

The address buses and comparator logic allow random access to each shift-register array, which then cycles through an entire 256 bits. Access time of the SC-2 is 5 to 10 microseconds to set up all drivers and to go to the address comparator. The cycle rate is 1 megahertz, so the actual time it takes to transfer an array's worth of information is 256 microseconds. The memory is refreshed every time that it is accessed. □

Industrial electronics

Metal-rolling micro takes care of tuning

Computerized thickness controls have been available to the metal-rolling industry for probably 10 years, but shops unable to justify the expense must use manually adjusted analog systems. These are not only time-consuming to adjust, or tune—they must also be retuned each time, for example, the mill changes the metal or the thickness that it's rolling.

At last week's IEEE Industrial Applications of Microprocessors meeting in Philadelphia, Industrial Nucleonics Corp., Columbus, Ohio, introduced a system that brings computer control to the analog-systems users. It's doing this by applying the logic and memory capabilities of a microprocessor system to a gage controller that can be set for any metal and thickness merely by dialing two thumbwheel switches. The system itself takes care of the tuning—holding the metal to tolerance by controlling the dc motors that regulate the tension on the sheet-metal payoff reels, and the force on the bite rollers between which the metal is squeezed.

"Tight tolerances have become increasingly important to the rolling industry because of a growing trend to specify sheet to a minimum instead of a nominal thickness," explains John Underwood, senior product engineer at Industrial Nucleonics. "The customer pays for the sheet based on what it would weigh if it were the same minimum thickness throughout. Undertolerance is not acceptable, and any overtolerance is money out of the mill's pocketbook."

The new controller, priced at about $45,000—which is competitive, says the company, with analog gage controls—is used in conjunction with Industrial Nucleonics' AccuRay 510, an isotope-based thickness gage that determines thickness on the basis of the amount of radiation penetrating the metal. Its output, in volts per mil, is sampled by an analog multiplexer which also samples roll speed, roll force and sheet-metal tension. The values are fed to an analog-to-digital converter and made available to the microprocessor—an Intel Corp. 8008 in the initial field-test unit, but production systems may use the 8080.

Dialed in. Also fed to the microprocessor are 33 bits that represent the metal-thickness set point and the type of material being rolled. These numbers, set by dials on the thickness gage control panel, are used in the special control algorithm which the microprocessor solves.

Switches on the controller panel turn on simple or differential backlash compensation for the screws that control the roll loading and reset the metal tension. The switches also select the variables to be displayed and can be used to modify operating constants during the initial setup. But once the system is set up for a metal, the controller never has to be retuned if, for example, thickness must be changed.

The controller memory typically consists of about 3,000 8-bit words of programable read-only memory, 256 words of random-access memory, and 32 words of field-alterable ROM. Because the controller must retain its memory without power, RAM is used only to hold current-variables and status bits. The bulk of the control program and information relating to the installation are contained in PROM. Set points, limits and control algorithm constants which may be changed periodically are stored in the Farom.

There also are on-line diagnostic routines for go/no-go self-checks that are run once per second. Bit patterns, outputted to a diagnostic port at points in the programs, provide an oscilloscope or logic analyzer trigger, as well as a visual indication of controller operation. □

Memory

French introducing domain memory

Magnetic bubbles hold a great deal of promise for mass-storage of digital data, but many observers say they won't hit the market in a big way until the 1980s. Meanwhile, a French company is poised to enter the market with a competitive technology—moving-domain memories. The European entry is Crouzet SA in Valence, France, which will join Cambridge Memories Inc., Cambridge, Mass., a company that has domain-tip hardware on the market.

Moving-domain memories are attractive for a number of reasons: they're nonvolatile, like core memories, but much smaller; they operate reasonably fast; they need no external magnetic bias to form and hold the domains, as do bubble memories; and they can be batch-fabricated using conventional microcircuit techniques.

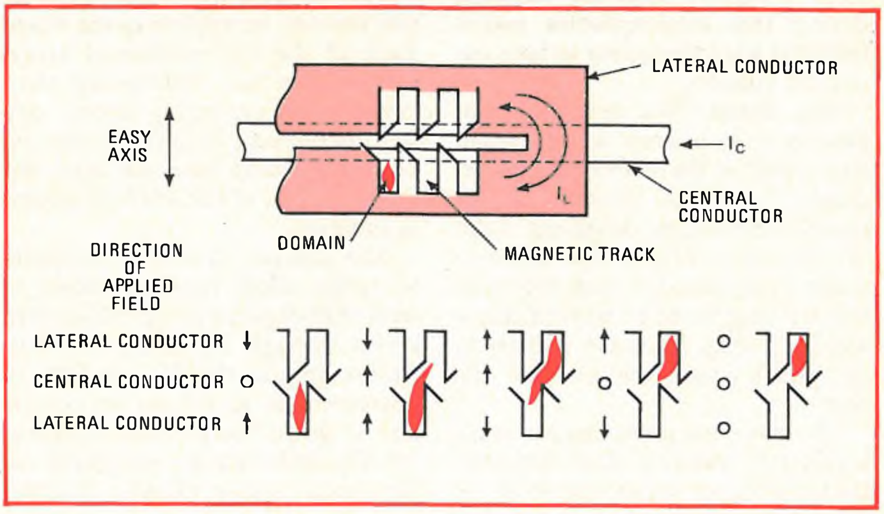
This summer, Crouzet's aerospace and systems division will deliver a prototype 2-megabit image-refresh memory destined for a military digital-TV system. The company also has in the works a refresh memory for a cockpit display, and for the French space agency there's a prototype study for a satellite memory.

Disk replacement. Claude Battarel, the Crouzet technical executive who heads the memory program, also sees a potential commercial application, as a small high-performance replacement for small disk memories. "By the end of 1975," says Battarel, "the cost on a memory card for MOD memories should run 0.2 cent per bit, which looks competitive with 6-micrometer bubbles" (the size most people are working with). And Battarel is convinced that MOD can compete with a second contender—the charge-coupled-device semiconductor memory—as its prices go down the learning curve.

Crouzet's current MOD has 35,000 bits per substrate. But the company already is working on an improved MOD with a density four times that—geometry will change, magnetic tracks will be smaller, and conductors will be smaller. At the same time, there'll be a significant cut in the memory's power consumption to about 2 watts per megabit from the 30 W/Mb per second or so of the present version.

Crouzet builds its MOD memories on glass substrates that measure 63 by 54 by 0.8 millimeters. Each carries eight independent shift registers

Magnetic-memory movement. Sequence of sketches shows, from left to right, how magnetic fields created by currents in lateral and central conductors are able to move a magnetic domain from one finger-like area to the next in shift-register fashion.



If you can't bring your troubleshooting into your lab,

roll Tektronix TM 500 to the problem.

- **digital multimeters**
- **counters**
- **generators**
- **amplifiers**
- **power supplies**
- **oscilloscopes**
- **a blank plug-in for your own circuitry**
- **and more**

The TEKTRONIX Rollabout Configuration of TM 500 modular instruments helps you conveniently take your test and measurement "laboratory" right to the problem . . . whether it's routine maintenance, calibration, repairs, QC or production testing, or whatever. TEKTRONIX TM 500 modular instruments are designed to fulfill your needs in such widely divergent areas as: computer circuitry and data handling equipment, numerically controlled machines, laboratory instrumentation, communications equipment, and medical instrumentation.

The modular Rollabout Configuration provides up to six operating test and measurement instruments, which you can tailor from a growing line of 29, plus the TEKTRONIX portable or plug-in oscilloscope of your choice . . . all on a SCOPE-MOBILE ® cart. TM 500 modular instruments can work together through a common interface circuit board within their mainframe enclosures, and they can also function totally independently. Some are general purpose, such as DMMs, some are highly specialized, such as those for oscilloscope calibration. They comprise a test and measurement system that is difficult to duplicate with "monolithic" instruments.

The TM 500 Product Line is a growing, compatible family of 29 plug-in modular instruments, accessories, and one, three, four, and six-compartment mainframes providing the common power supply. The modular Rollabout Configuration can accommodate two TM 503, 3-compartment mainframes. Select the plug-ins from 11 signal sources, 5 counters, 2 digital multimeters, 5 power supplies, 3 signal processors, 1 oscilloscope, and an X-Y monitor. There's also a blank plug-in kit to make it more convenient for you to assemble the specialized circuits you require. A TM 500 modular Rollabout Configuration lets you take the instrumentation you need where you need it.

Find out what TM 500 instrumentation can do for you. Send for the TM 500 Booklet A-3072 with full specifications and suggested selections of instruments for typical applications. Or contact your local Tektronix Field Engineer for a demonstration of how TM 500 instruments can solve your needs. Write to Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

TEKTRONIX®

committed to technical excellence

For a demonstration circle 123 on reader service card.

Circle 33 on reader service card

of 4,352 bits. The clock cycle is 2.8 microseconds, and the average access time for an octet (the bits in the eight registers are transferred in parallel) is 6 milliseconds. By astute utilization of the memory, however, the access time can be cut when the full 32-kilobit bit capacity is not required. Improved units will have 512-bit registers, and average access time of about 300 μs.

The shift registers are based on a magnetic track with a central path flanked on either side by "fingers" that store the domains. Actually, the track is made up of two 1,000-angstrom-thick layers of nickel-cobalt, a continuous "soft magnetization" layer with a "hard" layer atop it. It's the pattern etched into the "hard" layer that guides the domains as they step along the register in response to writing and reading pulses fed to the register.

Here's the cross section of a substrate from the bottom up: glass substrate, 8 millimeters; two layers of nickel-cobalt, each 1,000 angstroms thick; a 15-μm layer of insulation; the central conductor meander of copper 8 μm thick; a second 15-μm layer of insulation, and on top the lateral conductor of copper 15 μm thick.

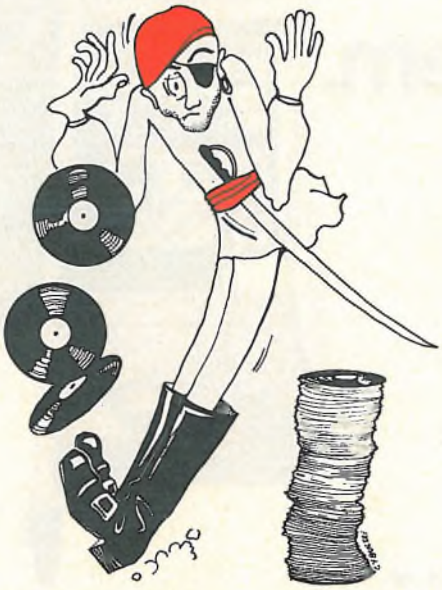
The width of the track, from the tip of one finger to the tip of the finger opposite, is 200 μm. The width of the finger (along the track axis) is 12 μm, and the pitch is 50 μm. These dimensions are well within the range of the thin-film microcircuit techniques Crouzet employs to produce the substrates. □

Consumer electronics

Subaudible tone protects records

Top recording stars are not only big business but big losers as well when their records and tapes are pirated and sold by "outside" interests. Lost sales and royalties could amount to as much as $200 million annually, according to industry estimates.

But a small company in New York, Audicom Corp., thinks it can put an end to the pirating with a subaudible tone-coding system that would be tagged onto each recording. Originally developed by the late Murray G. Crosby, the inventor of fm multiplex stereo, for keeping track of radio and television commercials as they are broadcast, the tones could be used to identify a recording's original source, according to Audicom.



Typically, says Alex J. Rutman, Audicom's executive vice president, a "pirate" of records or tapes will superimpose material onto the stolen recording, such as an occasional guitar chord. When challenged, he usually claims that the entire recording was made by different artists as a "sound-alike" production, pointing to the minor differences as proof. The Audicom system is expected to change all that.

The system places a subaudible identifying code on the original master recording, actually a narrow frequency "notch" of 200-hertz bandwidth, centered at 2,877 Hz. The code runs for 2.5 seconds. Within this notch, a carrier 55 decibels below peak audio amplitude provides an 8-character signal code in frequency-shift form. A receiver/monitor detects and decodes the signal and a built-in electronic clock adds time information. The code, which can be applied to any recorded medium, may be inserted several times in each recording or commercial.

Unmistakable. Rutman says the same signal will appear on any recording produced by a pirate, thereby identifying the material as that of the original producer. And the signal can be detected when the recording is broadcast. This is important, says Rutman, because broadcasters are required to pay royalties to the producers of the recording. In fact, he says that the final version of the proposed general copyright revision bill now before Congress includes an amendment that would force broadcasters to pay for every play of every record. Obviously, says Rutman, Audicom considers this will generate a major market for its system.

Audicom is now in the midst of raising capital to complete the testing required by the Federal Communications Commission and to market its system to record companies, broadcasters, and advertising agencies. The company plans eventually to place receiving stations in the top 200 broadcast markets in the country.

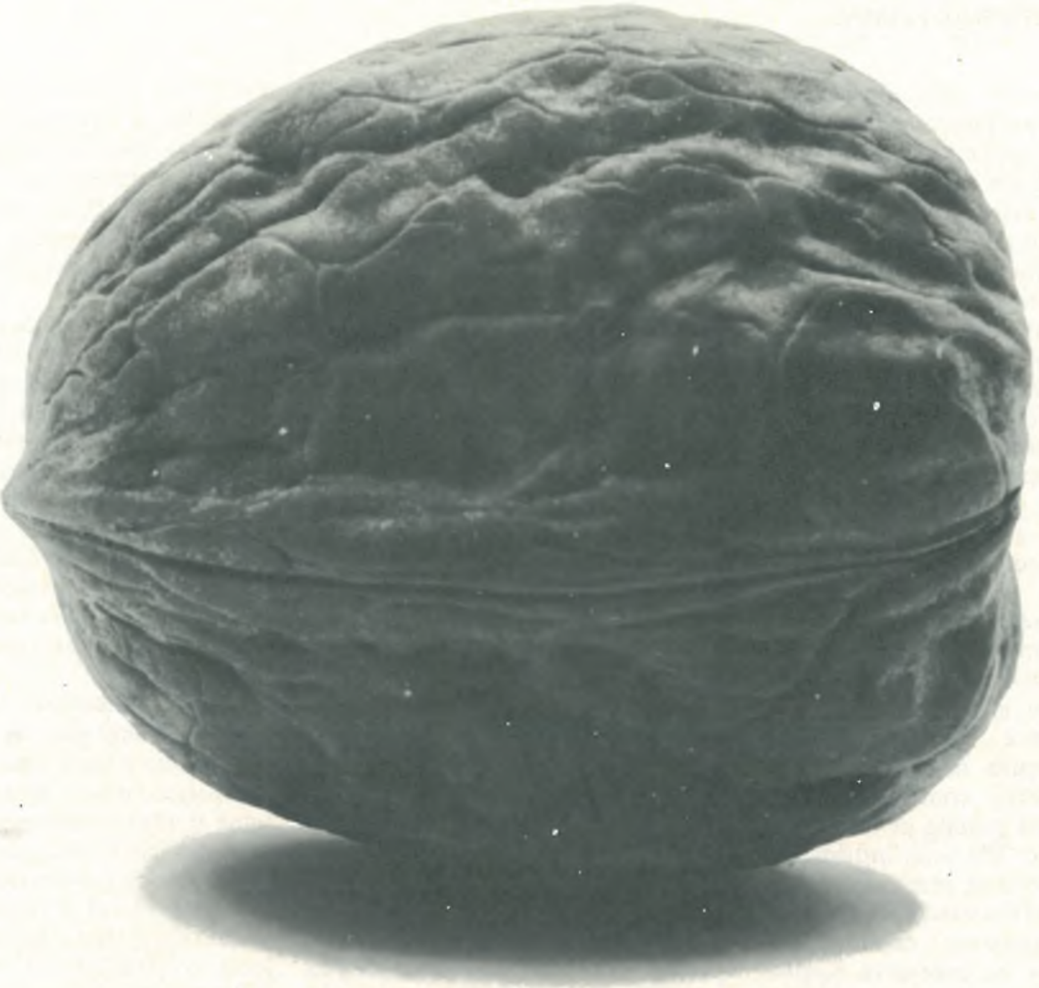
Decoded signals would be recorded daily and polled by telephone at the end of each broadcast day. The data would be fed into a central processing unit for generation of proof of performance and billing and collection reports, station logs, competitive media reports, music-publisher royalty reports, and advertiser audits. □

Packaging & production

Flexible circuits get cheaper laminate

A Los Angeles inventor has developed a relatively inexpensive technique for coating a thin plastic film on copper foil. The technique is said to make high-temperature flexible

TM – Contour Cable is a trademark of Hughes Aircraft Company.



We specialize in flat cable and flexible circuit problems nobody else can crack.

A lot of people make flat cable. A lot of people make flexible circuits. We're one of the few who make both.

But the big difference isn't only what we can manufacture, it's what we can design.

Hughes CONTOUR™ Cable solved problems for the Viking Mars probe. We worked out solutions for the Minuteman missiles. We cracked tough packaging problems for shipboard and airborne systems, radar, sonar, high-speed computers.

And we can crack your tough ones, too.

Not wild-eyed, super-expensive, forever-and-a-day solutions. Practical solutions. Maybe even less-expensive-in-the-long-run solutions.

And once we design it, we'll make it. In one of the industry's newest, most complete facilities.

Think of it this way. If it's simple and easy, anybody can do it, including us. But the tough nut is our specialty.

A tour? Or a consultation to discuss your design requirements? Just call (714) 548-0671 and ask for Dave Cianciulli.

Or write: 500 Superior Ave., Newport Beach, California 92663.

HUGHES

HUGHES AIRCRAFT COMPANY
CONNECTING DEVICES

Cables, circuits, connectors . . . only Hughes puts it all together.

printed circuits cost-competitive with those manufactured for low-temperature applications.

The developer, a chemist named George Wilhelm, claims an operating temperature higher than 400°F for foil coated with polyimide, compared to the 120°F for low-temperature polyester.

If the technique can be translated into large-scale production, it may be suitable for high-temperature applications like kitchen ovens and, more significantly, for high-volume applications such as cameras and automobile dashboard assemblies. Flexible circuits are needed in these applications because of the tight space requirements that only they can meet. However, the fact that the circuits could be soldered in production is more important than their heat tolerance. Existing low-temperature circuits must be soldered under carefully controlled conditions to avoid peeling or melting of the dielectric. The auto industry, in fact, uses press-fit mechanical contacts to avoid the need for solder.

High-temperature circuits now available use an expensive Kapton film laminated to the copper with an even more expensive sheet adhesive. But Wilhelm says his process should yield circuits 50% to 75% less costly than Kapton circuits. Other attempts have been made to coat copper with bulk liquid plastic, says Wilhelm, but, to his knowledge, they have been unsuccessful.

Curling. When a plastic such as the polyimide is applied in liquid form it shrinks as it solidifies, causing the laminate to curl. Wilhelm claims to have overcome this to a large degree with a proprietary process. He hopes to place the technique in production or license it. He says a large computer company is now evaluating some of his circuits.

Using the laminates he has made, Wilhelm has fabricated several flexible circuits, some of which were shown at a London trade show in December by Frank P. Recchia. Recchia is in market development at D.S. Gilmore Laboratories, the polyimide supplier in North Haven, Conn.

Although the dimensional stability of the laminate is not as good as one using Kapton, "it's still an excellent high-temperature material and is acceptable for many applications to upgrade Mylar," says Recchia. He adds that there was "much interest" in the circuits at the London show.

Wilhelm sees some applications for the film in semiconductor packaging. In particular, he cites the tape-fed bonding techniques, such as Minimod, which are receiving increasing attention at integrated-circuit makers. He says he has eutectically bonded silicon chips to a copper laminate with 30 seconds of scrubbing at 800°F without delamination. □

Microwaves

Microwave devices withstand VSWR

Microwave transistors are usually judged by their gain and output, with electrical ruggedness coming in a distant third for consideration. But in transistors developed for the 1,640-megahertz uplink transmitter for the Marisat marine satellite system, TRW Semiconductors Inc., Lawndale, Calif., has used a combination of techniques to ensure that the devices can withstand an infinite voltage-standing-wave ratio. This means the transmitter output can be opened or shorted without damage to the output transistors—important in mobile and shipboard applications where antennas are subject to damage or misuse.

Thomas J. Kelly, project manager at Scientific-Atlanta Inc., the prime contractor for the Marisat terminals [*Electronics*, Nov. 14, p. 39] says, "The other units we tried were extremely delicate, but you can do anything to the TRW units and it doesn't hurt them. They work well even at the high temperatures."

Contributing to the ruggedness are diffused emitter-ballast resistors, with monolithic zener diode protection. These resistors allow the transistors to be operated without the expensive load isolators normally required, explains TRW microwave sales manager Bill Sebastian. In addition, the transistors use a proprietary gold-metalization system for long life.

The diffused emitter-ballast resistors equalize current drawn by each "finger" of the interdigitated structure normally used for such high-frequency transistors. Conventional microwave transistors either omit this step or use thin-film resistors. Sebastian points out that this thin film is, unfortunately, the hottest part of the transistor; it is deposited on an oxide layer that acts as an insulator, preventing heat dissipation.

Better dissipation. The diffused resistor, being part of the silicon, has, unlike a thin film, better heat dissipation while also having the same thermal coefficient. The diffusion also can be designed to run out of carriers before the device draws a destructive level of current. Another advantage is that a higher resistance level is possible—50 ohms rather than the 10 ohms obtainable with thin films of nichrome.

The diffused resistor, because it has a different resistivity than the substrate, also forms a zener diode to the collector. TRW uses the zener diode to provide overvoltage protection. Another zener added between base and collector serves a similar function. Sebastian says the devices appear to have one disadvantage: "They're a little harder to broadband because of slightly higher feedback capacitance."

The gold metalization process substantially reduces metal migration, a problem in fine-geometry devices such as microwave transistors if conventional aluminum is used. The transistor, for example, has 50 3-micrometer-wide fingers spaced 1 μm apart on a 20-by-20-mil chip. TRW uses a titanium-tungsten-gold system. Platinum rather than tungsten had been used but led to processing problems, says Sebastian.

The metals are sputtered onto the wafer, giving better coverage than

collimated deposition, especially over steps in the oxide. A proprietary plating process instead of back etching is used to define the metal, thereby reducing undercutting and permitting thicker metalization.

The Marisat transistors are 10-watt devices, but 1- and 3-watt units have already been designed. Moreover, TRW is adopting the process for all of its radio-frequency products, including high-frequency single-sideband devices. □

Microprocessors

Bipolar micro has two-port RAM

Most semiconductor microprocessors to date have been MOS LSI devices aimed at controller applications. Only recently have a few companies turned to developing comparable bipolar units that also meet the needs of computer designers. The latest firm to do so is Advanced Micro Devices of Sunnyvale, Calif., which has used its low-power Schottky process to build the AM2901 4-bit slice microprocessor.

AMD joins Intel Corp., Santa Clara, Calif., and Monolithic Memories, Sunnyvale, Calif., as suppliers of microprocessors based on conventional bipolar logic. These products offer a maximum potential of about 1,000 gates per chip and should not be confused with the more powerful bipolar LSI being developed with newer processes like integrated injection logic and emitter-follower logic. Both I^2L and EFL chips promise 10,000 logic gates per chip and minicomputer-like performance (see p. 29).

AMD plans to start sampling the AM2901 next month and hopes to displace Intel's series 3000 2-bit slice [*Electronics*, Sept. 5, 1974, p. 89]. Monolithic Memories fabricates a 4-bit slice.

"For the applications we have in mind—emulating minis, CPUs, peripheral controllers, and program-

News briefs

Squabble intensifies between BART and Westinghouse
The squabbling in San Francisco between the Bay Area Rapid Transit and Westinghouse Electric Corp. has intensified since BART's board of directors voted to remove the Westinghouse gear from all of its 176 lead cars, the special cars in the front of each train that contain the propulsion equipment and train controls. BART says it's making the move because of Westinghouse's refusal to provide detailed specifications for its equipment. At this point, says Harvey W. Glasser, chairman of BART's engineering committee, the board decided "there was no point getting in deeper [with Westinghouse], since the stuff was failing." Next stop is in the courts, where BART and Westinghouse hope to settle the $109 million suit filed last November by BART. Meanwhile, BART will continue to use the Westinghouse on-board equipment until it can redesign the system.

Air Force plans new 1,100-person lab
A new Air Force Command, Control and Communications Laboratory will be created at Hanscom AFB, Bedford, Mass., during fiscal 1976 if Congress approves. The new organization, with a proposed staff of 1,117, will consolidate 252 jobs at AF Cambridge Research Laboratories on the base with another 865 from Rome Air Development Center, Griffiss AFB, Rome, N.Y. which is to be closed.

Canadians give up on semiconductor producer
Microsystems International Ltd., which has lost $45 million since it was formed in 1969, is phasing out of semiconductor production over the next three months. Operations of the 88%-owned Northern Electric Co. subsidiary in Ottawa, Ont., and Penang, Malaysia, will close because of what Northern Electric officials say is an accelerated drop in demand for MIL's products and a substantial price erosion in semiconductor markets.

Business data processing gets Data General system
With its new C/300 data-base-oriented medium-scale computer system, Data General Corp. is after a market now being served to a large extent by big mainframe computers. The first business system from the Southboro, Mass., mini maker is aimed at data-processing users who want to expand central data bases downward to operational levels performing functions such as sales, manufacturing, and distribution. As such, the C/300, which ranges in price between $77,000 and $160,000, fills a gap between intelligent terminals and large general-purpose systems.

Interdata 8/32 Megamini computer introduced
Interdata Inc. of Oceanport, N. J. introduced its 32-bit Model 8/32 Megamini computer [*Electronics*, Feb. 20, p. 26], designed to compete directly with Data General Corp.'s Eclipse 200 and Digital Equipment Corp.'s 11/70 16-bit general-purpose minis. Available in June, 1975, and priced at $51,900 with 1 megabyte of memory, Model 7/32, which the company considers to still be at an early stage of its product life cycle, will continue as Interdata's low-price entry in the 32-bit minicomputer market.

Signetics sale to U.S. Philips proposed
Hardly anyone was surprised when Signetics Corp. confirmed rumors that it was for sale by reaching a preliminary agreement with U.S. Philips Trust, a majority owner of North American Philips. The proposed sale price is $43.8 million for Philips to buy Corning Glass Works' 70% interest in Signetics. Philips' German component-producing subsidiary, Valvo Gmbh, which regards Signetics as a threat in the European market—especially in linear ICs for entertainment electronic products—is happy about the proposed move. One Valvo official says, "We've now gotten a strong competitor off our necks." The sale is still subject to Signetics, Corning, and U.S. Philips Trust approval.

able microprocessors among other things—Intel's is far better than anything else previously on the market," says Sven Simonsen, AMD's technical director. "So in our design we felt it was necessary to go Intel's 3000 series one better in every way we could.

"For one thing," he says, "the AM2901 is fabricated using AMD's low-power Schottky process [*Electronics*, Feb. 6, p. 142] which allows the dual in-line 40-pin package to dissipate typically only 750 milliwatts."

Two-port RAM. Functionally, the AM2901 consists of a 16-word-by-4-bit two-port random-access memory, a high-speed arithmetic-logic unit, and associated shifting, decoding and multiplexing circuitry.

"Particularly important in our design is the use of a two-port RAM, as compared to the one-port approach that Intel has taken with its 3000 series," Simonsen says. "The two-port memory gives our system an edge in speed. Our total microcycle time is about 100 nanoseconds compared to the typical 125 ns of a one-port design.

"But it is what you can do in the microcycle that is important, as well as how many microcycles it takes to do a particular operation. That is where the two-port approach comes in."

In an operation like A + B, for example, the AMD two-port device can read and add in 1 microcycle of 100 ns. By comparison, says Simonsen, a one-port machine is quite a slowpoke: it must first take the A out of memory and put it in an accumulator and then in the next microcycle take the B out of memory, put it in the accumulator, and add the two.

"What this means is that in most of the applications for this kind of device—add, subtract, AND/OR—a one-port design must go around the microcycle twice to do the same thing a two-port machine can do in one," he says. He adds that the 2901 CPU should be available by early summer.

Following its introduction, he says, work will begin on fabricating the elements to go with the 2901. There will be three of these—a sequencer to handle the 47 9-bit instruction words, an address register, and an incrementer. □

Lasers

CO laser is built small enough to fly

The Air Force Avionics Laboratory has developed a carbon-monoxide laser compact enough for use in airborne avionics. Starting a year ago with an "enormous" lab version of a carbon-monoxide gas-dynamic laser, the laboratory stripped it of much of its size and weight by redesigning the electric discharger and by modifying the laser's aerodynamic flow. The resulting 3-cubic-foot package produces the most power for its size of any laser in the Air Force inventory.

Built under contract by Calspan Corp., Buffalo, N.Y., the new laser functions at outputs up to 500 watts with efficiencies greater than 10%.

Match. It's well suited for atmospheric transmission, say its developers, because it's a good match for the 4.8-to-5.1-micrometer atmospheric window—a part of the spectrum that allows laser transmissions unhindered by absorption in water vapor. The new version achieves 90% of its optical output at wavelengths below 5.1 μm, compared with previous carbon monoxide lasers that have only 60% output in that range.

Calspan has a $100,000 contract for optimizing the device and delivering a prototype with even higher power levels by the end of the year.

Lasing in gas dynamic lasers is caused by electrical, chemical, or thermal excitation of the gas in a head-end chamber; the excited gas is pumped out of the chamber through a constricted throat and allowed to expand in a nozzle to yield supersonic velocities, as well as lowered temperature and pressure. It's this cold, excited gas—30 to 50 kelvin in the CO version—that gives the laser its characteristic spectrum. The optical cavity downstream consists of two internal mirrors mounted on the nozzle perpendicular to the direction of gas flow.

Conventional electrical discharges resemble fluorescent lights, achieving full-volume excitation with very low pressures but requiring large pumps to pull the gas into the nozzle. But a redesign of the electrical discharger enables the new laser to work at higher pressure so that the size of the downstream gas pump and the size of the laser can be trimmed sharply.

The CO is injected through a narrow orifice around an annular electrode, creating enough turbulence and sonic velocity to break up and sweep away the instabilities that cause undesirable arcing. With the new discharger, the designers found they could get large-volume excitation at the high pressures; the prototype chamber typically runs at two atmospheres. □

Solid state

Plastic package goes to 200 W

With power semiconductors in plastic packages winning acceptance in automobiles, television, and computer and industrial power supplies, Texas Instruments has boosted the ratings of its plastic power devices. TI hopes it can cut further into applications served by devices packaged in metal cans with a new plastic TO-3 package that will dissipate 200 watts at 25°C.

Previously, the top power dissipation had been 125 W at that temperature. At 100°C, the TI package now being sampled will dissipate 65 W. Moreover, the plastic parts will be priced 15% to 20% less than metal-can equivalents.

The new high-power epoxy package—roughly twice the size of the 125-W unit and with a larger heat sink—has mounting holes that align with its metal-can equivalent. But

it tells the whole story —DYNAMICALLY

Get a Single Integrated Reading of the Total Power Density from Several Sources

300MHz to 18GHz

Now in one instrument you get more value, more measurements than ever before — at no extra cost. New Model 8306 has 30dB dynamic range, full scale in three ranges 1mW/cm², 10mW/cm² and 100mW/cm² with the same probe.

The Narda 8300 series are compact, easy-to-read, radiation monitors which accurately measure near and far field power densities over broad frequency ranges . . . they simultaneously respond to different polarizations and direction of incident power. Read the total power density at any one point from CW, FM, pulsed RF and microwave sources used in communication, radar, ECM and industrial applications.

Write for complete information.

"SEE US AT IEEE SHOW — BOOTH #2418, 2420 & 2422."

Circle 41 on reader service card

wherever microwaves go... narda

THE NARDA MICROWAVE CORPORATION · PLAINVIEW, L.I., NEW YORK 11803

516-433-9000 • TWX: 510-221-1867 • CABLE: NARDACORP PLAINVIEW NEWYORK unlike earlier TI parts in plastic, the leads will not fit printed-circuit-board holes drilled for equivalent parts in metal cans.

"Instead, we're giving the customer the option of below- or above-board assembly," notes Tom Palmer, consumer/industrial marketing manager in TI's power department. "The leads are arranged to accept a slip-on connector." The three leads, however, are long enough to be bent and soldered below the board if the user drills the special holes.

To connect the new package, Molex Inc., Lisle, Ill., has developed a lead-clip connector with flexible, stranded copper wires that can be mounted on the board. And Thermalloy Co., Dallas, has a socket that will accept either the TO-3 metal can or the plastic package.

But the price break contemplated by TI does not necessarily worry other semiconductor manufacturers working to bring down the prices of metal-can parts. For example, Thomas Ruggles, product planning manager for power transistors at Motorola Semiconductor, says Motorola is not planning to use plastic for anything above 100 W. "At that level, most of the cost is in the die and not in the package," he says. "Metal cans are not any more costly, but are more reliable because of the hermetic seal they offer. So we're concentrating on automating the assembly of metal-can devices."

First devices in the new TI package being sampled include a 1,400-volt, 7.5-A horizontal-deflection transistor for color-television sets. For the automotive industry, TI will be using the package for a 400-V, 7.5-A high-voltage transistor. Since these are fast-switching devices, they can be used for switching regulators, as can a new 400-V transistor rated at 10 A.

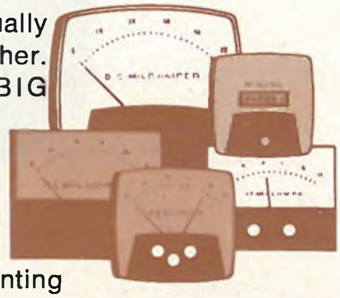
These parts will be in volume production by the third quarter, Palmer notes. Further down the road are general-purpose transistors, including a 400-V, 25-A, silicon-controlled rectifier, and 30-A npn-pnp complementary pairs in 40-, 60-, 80-, and 100-V versions. □

All Panel Meters are not created equal.

We try to build an edge into General Electric panel meters.
For instance, you won't see a GE panel meter turn yellow, because we use a special white paint that stays white. You won't get eyestrain either. GE panel meters come with extra-wide scales, big numerals, tapered pointers, and shadow-free cover plates for quick, sure readings. We're fussy about things like that.

Once you've installed them, forget 'em.
GE's famous reliability just doesn't happen, we *build* it in! We designed-out a lot of extra parts that might fail, just to give you extra instrument reliability. To make sure, we added a 20% overload capability to our voltmeters and ammeters. Still not satisfied, we decided to measure instrument quality from parts to finished product in order to screen out anything marginal. Now, it's just too tough for a lemon to squeeze through.

GE panel meters come from a good family.



They look good individually and they look good together. Choose the rounded BIG LOOK® design for unique style and wide-eyed readability. Or choose the clean HORIZON LINE® case for its behind-panel mounting flexibility *(without* the usual bezel), and its snap-off mask available in six colors. GE makes panel meters to suit you and to add snap to your application.

You can count on General Electric panel meters.

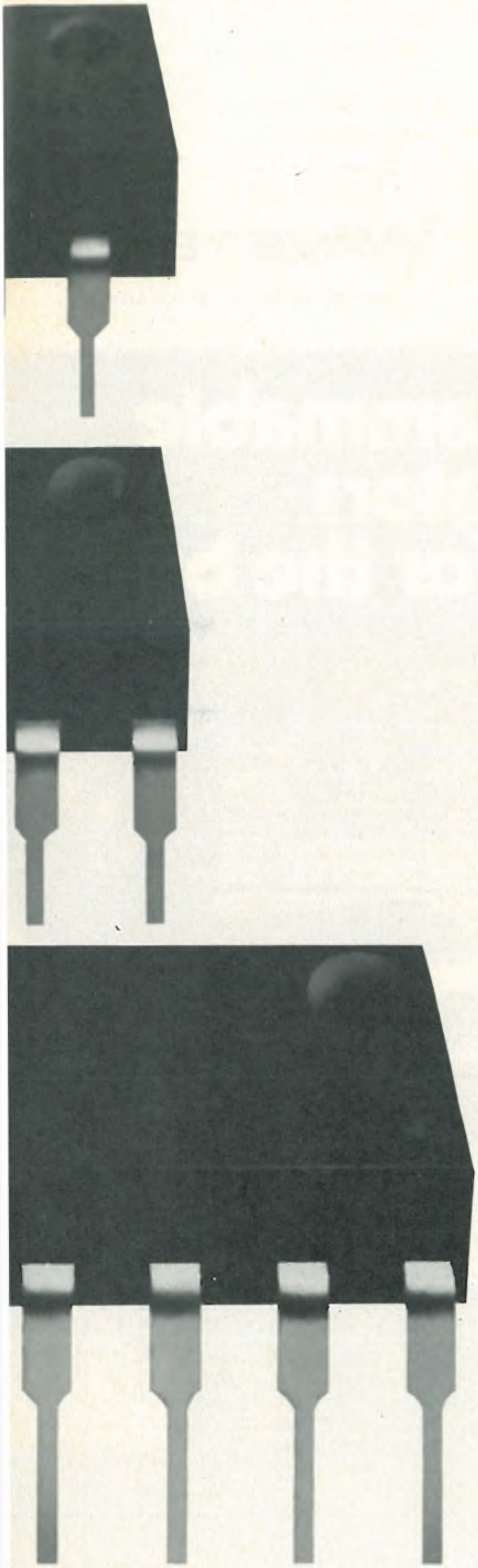
They're built to help you do a better job. At GE, we're not interested in product equality. We want ours to be *better* than the rest.

For a complete catalog of competitively priced and readily available GE panel meters, see your nearby authorized GE distributor. Or write to General Electric Company, Section 592-43, One River Road, Schenectady, N. Y. 12345. 592-43

Specify General Electric... just for good measure.

Circle 45 on reader service card


0
5
10
15
20
A-C AMPERES
GENERAL ELECTRIC
GENERAL ELECTRIC



You can't see the LEDs in our opto-isolators... but they're there.

That's one reason why the No. 1 producer of LEDs has now become a high-volume producer of opto-isolators. Our opto-isolator production capacity has multiplied ten times in the past 12 months. And our line has become broad enough to satisfy nearly every application. For example:

General purpose. Litronix has a full line of phototransistor/LED opto-isolators in standard dual-in-line packages.

Low cost. If you're looking for opto-isolators at a really competitive price, we can offer units for less than 60¢ each in quantity orders of 1,000.

High CTR. If you need plenty of output current, we have models that match an IR LED with a photodarlington sensor to give you a current transfer ratio of 300%.

High speed. If you want ultra-fast response, we have an opto-isolator that uses a built-in IC to transmit data at rates up to 5 megabits per second.

Our innovative, solid-state line runs from the simplest to the most sophisticated.

We're a dependable source for opto-isolators because we're a vertically integrated company—a fancy phrase meaning that we make everything in-house. We don't buy any high technology parts outside. This gives us better quality control. Better price control. And better delivery.

So don't forget: our expertise in LEDs has made us a leader in opto-isolators, too. Solid-state reliability comes in many forms.

For details on Litronix opto-isolators write us at 19000 Homestead Road, Cupertino, California 95014. Phone (408) 257-7910. TWX 910-338-0022.

No wonder we're No. 1 in LEDs

litronix

IBM takes itself out of the running for NASA contract

IBM Corp.—under heavy Government fire for a proposed takeover of CML Satellite Corp.—**has taken its Federal Systems division out of contention for the $600 million tracking and data-relay satellite system wanted by NASA** [*Electronics*, Feb. 20, p. 50]. As an IBM marketing official put it: "Timing was the problem. With the CML deal questioned by the Federal Communications Commission and the spate of antitrust lawsuits against us, we couldn't afford to look like we were trying to muscle into another market." However, IBM has not withdrawn from the CML acquisition. Comsat General Corp., which owns one-third of CML stock, also would have been IBM's partner in the data-relay work.

The IBM decision leaves two corporate combinations considered the leading contenders for the data-relay satellite work: one is Western Union with TRW Systems group, the other is an RCA/GE/Philco-Ford combine.

Anti-skid suppliers brace for hearings

Makers of electronic anti-skid hydraulic brake systems for medium- and light-weight trucks are girding themselves for an April 1 hearing called by the National Highway Traffic Safety Administration. A lot of business could be riding on it, **for the NHTSA has agreed to consider a proposal to postpone indefinitely a Sept. 1 deadline for the installation of anti-skid devices on new light and medium trucks.** Truck manufacturers, who fear that the added $600 to $700 per vehicle for the brakes (including $100 for electronics) will further depress sales, are on the other side of the debate. It remains to be seen what the NHTSA will do, having previously refused to lift a March 1 deadline for air-brake anti-skid systems on heavy trucks.

Questions of reliability have usually headed up attacks on the electronic anti-skid requirements. In that regard, the chief engineer for brake safety at the NHTSA, Vernon Bloom, says the systems developed thus far are at the "half-way-decent point."

Economy affects EIA member roll

The Electronic Industries Association, evidently reflecting the nation's economic condition, recorded the loss of 16 member companies at its Spring Conference in March. Some of them are big names, like Monsanto Co. and the multi-division member International Rectifier Corp. Also quitting was Philco-Ford Corp. following its withdrawal from entertainment electronics. But it posted a gain of seven new membership applications, the most notable of which was one from Quasar Electronics Corp., successor to Motorola, Inc., within the EIA Consumer Electronics group. **The changes leave EIA with somewhere between 185 and 190 members. The association also stands to gain 100 or so members through its recent merger with the Association of Electronics Manufacturers.** The AEM is now part of EIA Distributor Products division.

The EIA Board of Governors reallocated its 56 seats among the association's eight divisions to reflect the changing membership. The March reallocation, performed every three years, doubled the number of seats allocated to Distributor Products to six to accommodate the expansion following the merger with the AEM. At the same time, the Government Products and Solid State Products divisions each lost two seats, reflecting their declining income.

Washington commentary

Prospects and pitfalls for electronic funds transfer

Electronic funds transfer or EFT is regarded by many in the banking and electronics communities as a massive new market for computers, communications, and point-of-sale equipment, as well as a giant step toward the much-discussed "cashless society." Congress last year established a 26-person National Commission on EFT to study the issue and its impact on competition, credit, and privacy. The commission, still to be named, must report no later than November, 1976. Donald I. Baker, deputy assistant attorney general for antitrust, recently proposed an agenda for the commission and speculated on the future of EFT. Highlights of Baker's presentation follow. **—Ray Connolly**

Congress has created a big commission to do a big job: to tell us where to go in the burgeoning field of electronic funds transfers. The job is big because it involves technology of yet uncertain dimensions. The job is also big because any such change necessarily affects economic interests rooted in the past.

The inquiry should start with what we have in the paper-based world. How does it work technically? What are its costs, its scale economies, and its operating characteristics? What subsidies are built into it? How would it perform and develop if left to carry on on a "business as usual" basis? These are just basic, technical questions.

Next, we must ask a parallel set of questions about EFT technology. What kinds of computer-communications systems are in place, or have been tried? In the financial sector, these must include both clearance systems between institutions, and various systems which enable the customer to direct financial transactions (including point-of-sale systems, automated tellers, check guarantee systems, and on-line terminals in the corporate treasurer's office). Each should be looked at separately and in relation to each other.

Policies by design

The relationship between technology and services must also be investigated. Does a particular technical development change what is actually being offered to the public, or does it simply change the cost and operational characteristics of an old service? This distinction may prove important because it may well affect the incentives for introducing EFT technology.

In a sense, these questions are simply directed to the engineer and the entrepreneur. They ask how would EFT be likely to develop if freed of either legal restraints or special subsidies. Nobody expects, in the real world, that this would be allowed to happen entirely, but it is important to make this "norm" clear. Only if we do so will we have a factual basis for designing public policies.

Having developed a full factual record, the commission can then turn to the task of developing policies and legal tools to implement those policies. This exercise in turn requires a very careful scrutiny into the whole issue of values. The Congress has already given the commission some very general guidance in this area and no doubt will prove more willing to second-guess the commission's judgment on value questions than technical questions.

The importance of the commission's mission is, alas, underscored by some of the sadder chapters of modern American economic history. We have been among the most innovative people on earth in developing new technology. We have been [also] among the least successful in implementing those technological inventions in regulated environments where the technology threatened the economic *status quo*.

CATV's message

Cable television represents perhaps the best—or worst—example. About five years ago, everyone looked on cable the way we now look at EFT—as the wave of the future. Unfortunately, cable ran into the broadcasters and their regulators. The conflict was not compelled by technology or logic: our system of broadcast regulation exists because frequency spectrum is scarce and thus Government regulation was necessary to avoid interference. Cable television greatly reduced the spectrum scarcity as a practical factor. Unfortunately, cable thus threatened the economic value of the existing scarcity. This proved too much for the regulatory system. The broadcasters' regulator, the Federal Communications Commission, assumed some *de facto* jurisdiction over cable systems and placed on them legal limitations which increased their costs and severely limited their growth—especially in large metropolitan areas where broadcasting spectrum is both the scarcest and most valuable.

The same thing can happen to EFT. It can be loaded down with legal restrictions to protect existing interests and with expensive obligations to serve the dreams of social engineers. If this happens, it is likely to lose cost-effect advantages it now has and to become a relatively minor factor in the muddled future.

Introducing 1200 feet of Step-Mate.

This is an ad about an unusual tape reader: Step-Mate. And about what makes it even more unusual than it already is: our new spooler.

With the spooler, Step-Mate can handle up to 1200 feet of tape at a time, on 7½-inch spools. The whole unit, only 8¾ inches high, fits in any RETMA rack. And, with a choice of three different connector types (edge card, ribbon, or subminiature 25-pin), it's exceptionally easy to interface.

Step-Mate, if you don't mind our reminding you, is our reader which reads one character per command pulse. And it does this at speeds up to 150 characters per second. In addition it has a life expectancy greater (probably) than yours, with LEDs for never-fail light sources, error-free phototransistor read sensors, a gentle-on-the-tape barrel sprocket, a genuine step-motor drive, and a self-cleaning read head. Finally, it reads virtually all 5, 6, 7, and 8-level tapes without adjustment.

So there you are, a new tape reader without equal, at a price also without equal, $905 with power supply, $795 without.

Our brochure will tell you more. Write for it. Or, for instant action, call collect.

EECO

FOR READERS

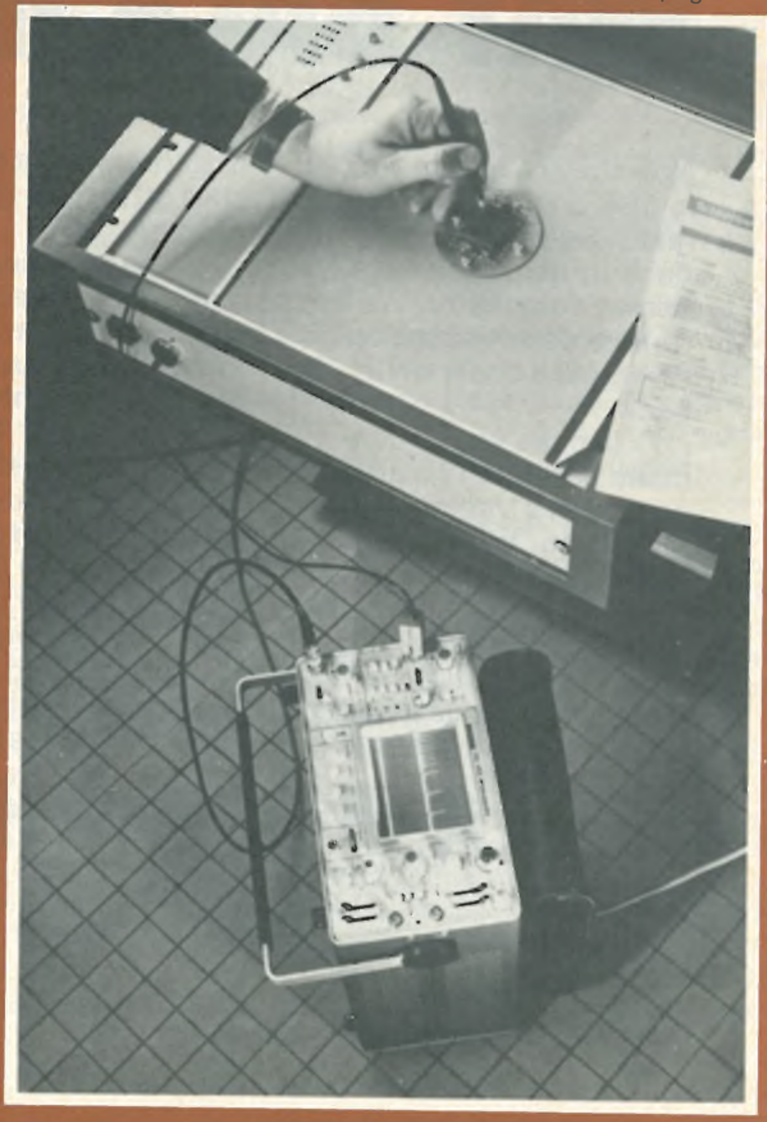
1441 East Chestnut Avenue, Santa Ana, California 92701
Phone 714/835-6000

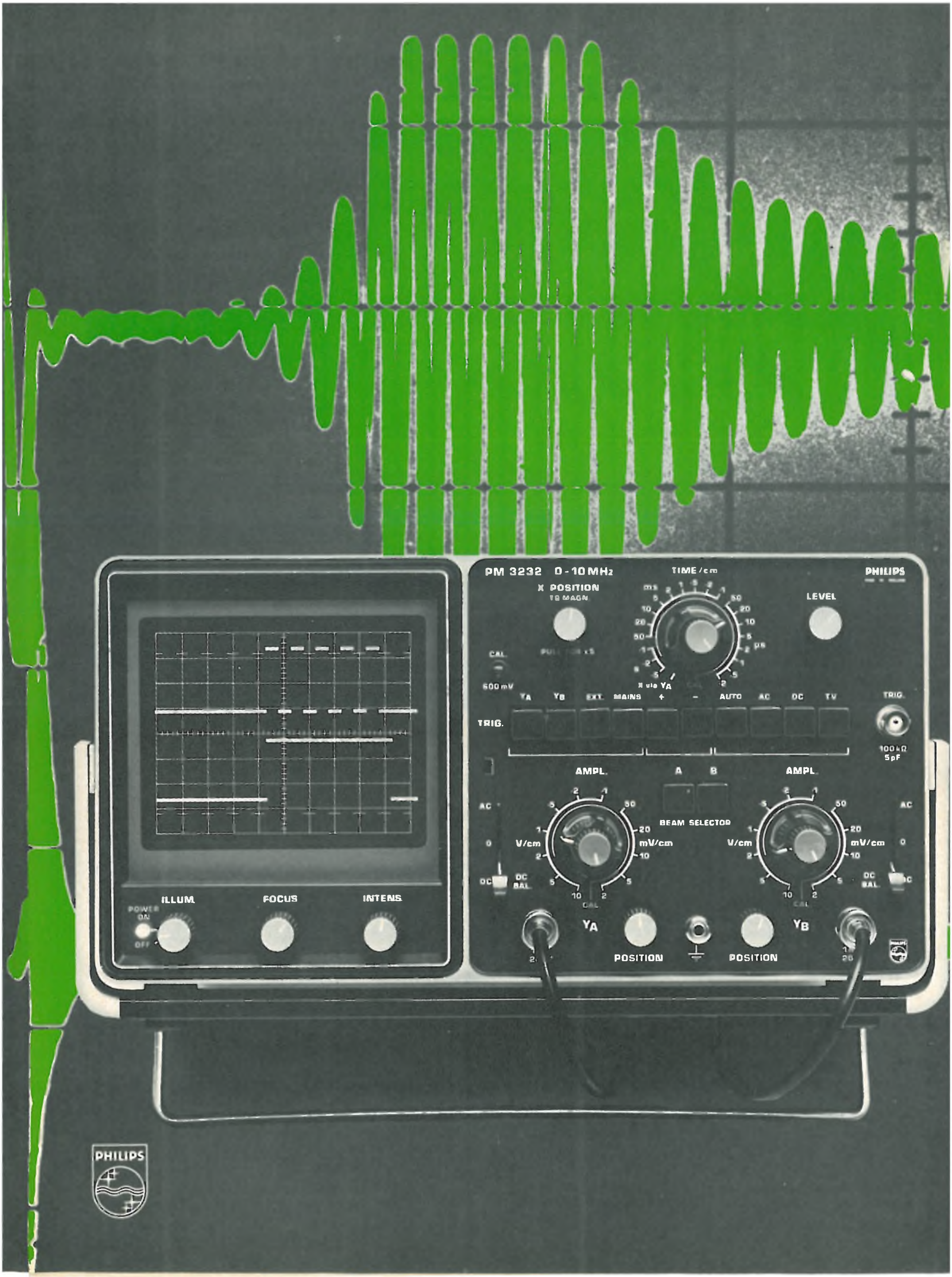
March 20, 1975

Electronics International

Oki optoisolator protects computer systems: page 5E

Schlumberger's portable two-channel scope is built around three pc boards: page 19E




PM 3232 0-10 MHz
TIME/cm
PHILIPS
X POSITION
LEVEL
TRIG.
AMPL.
BEAM SELECTOR
V/cm
mV/cm
ILLUM.
FOCUS
INTENS.
POSITION
PHILIPS

The signals and nothing but the signals

10 MHz continuous displays for real time and storage

True dual beam operation is used in these three 10 MHz : 2 mV oscilloscopes to give bright, continuous displays and thereby eliminate the phase error problems of time-shared instruments.

All models feature comprehensive triggering facilities and a logical front panel layout, plus a rigid construction and line or 24 V DC operation. In addition the storage version employs variable persistence to bring important additional display benefits.

What is true dual beam operation?
This is an improved display technique in which two beams are generated in one gun. The X-plates are shared but the Y-plates are entirely separate and driven independently thereby removing the need for chopped or alternate modes.

The resulting continuous display eliminates ambiguity in the triggering conditions. This often occurs in time-shared instruments : for example, if the signal or part of the signal appears just as the beam is switched then it is lost completely!

As well as this important benefit, the technique also allows twice the normal light levels to be employed. Maximum advantage can therefore be taken of the 10 kV crt (8.5 kV for the storage instrument).

Universal triggering
All controls are logically grouped and push-button selected. The oscilloscopes have DC and AC coupling, plus a special TV position that gives fully automatic line or frame derived triggering (for models PM 3232/33).

All instruments also have an « auto » position in which the trigger level is derived from the signal itself. In the absence of a signal the time base is free running, when the signal appears it triggers automatically. It is thus easy to find the trace at all times.

Easy operation
The front panel layout speaks for itself. There is no clutter or confusion, making the instruments ideal for education and service applications. The screen is a large 8 x 10 cm with continuous, bright traces that do not need to be interpolated and that allow extremely low duty cycle signals to be displayed.

You can therefore see and measure more, and measure it more easily.

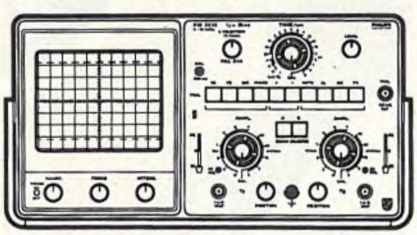
New storage possibilities
The combination of true dual beam operation and « half tone » storage is absolutely ideal for single shot and random signals. These phenomena are exactly the kind that can and do get lost in a time-shared instrument, that are difficult to interpolate and that may be impossible to repeat. The storage model PM 3234, however, ensures that the whole signal is seen and captured, either for 15 minutes at min. brightness or 3 minutes at max.

Another new display dimension comes from the use of variable persistence. This is adjustable from 0.3 seconds to 1.5 minutes and provides clear displays of difficult-to-see signals like low frequency signals suffering from flicker or high frequency, fast rise time pulses with low duty cycles.

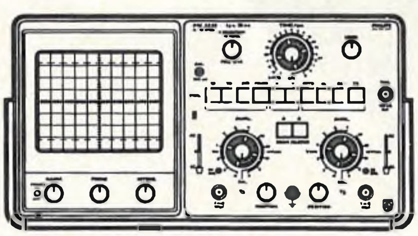
All the previously described « real time » features are also found in the PM 3234, making it one of the most versatile and easy-to-operate storage instruments on the market.

For more information on these advanced and universal 10 MHz oscilloscopes write to :

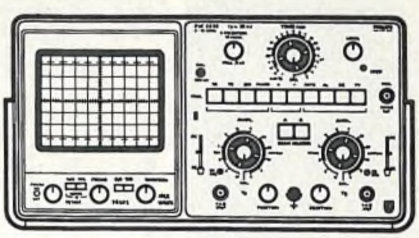
Philips Industries, Test and Measuring Instruments Dept.,
Eindhoven, The Netherlands.



PM 3232 10 MHz : 2 mV large 8 x 10 cm screen; line /24 V DC



PM 3233 As for '32 plus signal delay in both channels



PM 3234 As for '32 plus variable persistence and storage

PHILIPS

Circle 257 on reader service card

From 0,2 A to 500 A
You are right to choose
SILEC-SEMI-CONDUCTEURS

- RECTIFIER DIODES / ZENER DIODES
- THYRISTORS / TRIACS
- UNIJONCTION TRANSISTORS
- GLASSIVATED CHIPS
- EPOXY BRIDGES...

FOREIGN SUBSIDIARIES

GERMANY AND AUSTRIA
SILEC HALBLEITER GmbH
7536 Ispringen Pforzheim
Industriestrasse 20

Vertretung und
Distribution fur Bayern
METRONIK GmbH
8025 Unterhaching
bei Munchen
Munchener Strasse 60

ITALY
SILEC S.p.a
Piazza Buonarroti 32
20149 - MILAN

SPAIN
S.C.I.
Guzman el bueno 114
MADRID - 3

FOREIGN AGENTS AND DISTRIBUTORS SSC

SOUTH AFRICA
LIBERTY ELECTRONICS
PO Box 334 BOKSBURG

ARGENTINE
CARLOS ALBERTO BANETT
Casilla Correo 1733
BUENOS AIRES

BELGIUM
CLOFIS S.p.r.l.
539 Steenweg op Brussel
1900 OVERIJSE

BRASIL
APLICACOES ELECTRONICAS
ARTIMAR LTD A
PO Box 5881 - SAO PAULO

DENMARK
AB RIFA KONTAKT BUREAU
Vermundsgade 19
2100 KOBENHAVN

GREAT BRITAIN
TRANSWORLD SCIENTIFIC LTD
Short Street -
HIGH WYCOMBE (Bucks)

FINLAND
O Y LM ERICSSON A B
02420 JORVAS

GREECE
MAKONIK
Rue Amfipoleos 18 -
Botanikos - ATHENS

THE NETHERLANDS
CLOFIS NEDERLAND B V
Oudemanstraat 2
2010 DEN HAAG

NORWAY
SVERRE HOYEM A S
PO Box 919 - OSLO 1

SINGAPORE
GENERAL ENGINEER
CORPORATION
173 B Cecil Street
SINGAPORE 1

SWEDEN
AKTIEBOLAGET RIFA
161 11 BROMMA 11

SWITZERLAND
ROTRONIC AG
Rautistrasse 12 - 8047 ZURICH

POLAND HUNGARY USSR YUGOSLAVIA BULGARIA CSSR RUMANIA
SEMIRA
40, rue des Tilleuls
92100 BOULOGNE

Oki's optoisolator can drive up to 10 TTL stages

Device has short propagation delays and high breakdown voltage to protect computer and communications systems

Optoisolators are being used in ever increasing numbers to isolate data-processing and transmission systems from peripheral equipment. For this purpose, a device should have short propagation delays to avoid degrading system characteristics and a high breakdown voltage to isolate and protect the equipment. Such a device has been introduced by Oki Electric Industry Co.

The configuration of the optoisolator eliminates mechanical problems of earlier devices, and the new device also has better electrical characteristics. The optoisolator, encapsulated in an eight-pin dual in-line ceramic package, contains three semiconductor elements—a diffused gallium-arsenide light-emitting diode, a p-i-n silicon photodiode, and an integrated circuit that has two directly coupled stages of amplification, a Schmitt-trigger circuit for waveform shaping, and a transistor with an open-collector output. A strobe terminal is also available. The gain and current-handling capabilities enable the optoisolator to drive as many as 10 stages of transistor-transistor logic.

Propagation delay of the device, developed under the supervision of Shigeo Wako, is less than 200 nanoseconds. This is good enough for present requirements. Distortion of the pulse waveform is only 1% at a transmission rate of 50 kilobits per second, and voltage is rated at 1,500 volts.

Certain aspects of the development were guided by Kazumasa Ono of the Musashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp. This interest indicates an NTT desire for the device.

Configuration. The diffused LED is planar, a handier configuration than that of the liquid-epitaxial devices usually used in photocouplers. Zinc is diffused into a portion of one side of the n substrate to form a p region. Leads from both the p and n regions are bonded to one side of the diode in the same manner as in other planar diodes, thereby eliminating the need to bond a lead to the substrate side.

The diode radiates from the n, or substrate, side in the normal manner because the infrared absorption of the n side is smaller than on the p side. The LED is separated by a sheet of glass 100 micrometers thick from the photodiode to which it is optically coupled. The small spacing gives high coupling efficiency, and glass provides a high voltage breakdown. This configuration also makes it easy to align the LED and photodiode precisely.

Radiated output of the LED is maximum for junction depths of about 20 μm, which is close to the mean free path of minority carriers. The propagation delay time is degraded as junction depth is increased, but impurity concentrations in excess of 10^{18} atoms per cubic centimeter give faster response than lower concentrations. The combination of deep diffusion and the high concentration of impurities yields an adequate diode output while maintaining the desired response time of less than 100 ns. Most of the other 100-ns delay is from the amplifier that follows the photodiode.

The LED's quantum efficiency is 4%, an unusually high value for diffused LEDs, even though it is on the low side for liquid-epitaxial LEDs. The diode radiates at 9,000 angstroms. A silicon photodiode has greater efficiency at this wavelength than at the 9,400 Å of LEDs in most other optoisolators, thus enhancing transfer efficiency.

Photodiode. The p-i-n silicon photodiode operates at a reverse bias of 5 V, the voltage at which most logic circuits operate, and the same voltage is used for the amplifier circuit. On an n substrate with an intrinsic epitaxial layer 10 μm thick, a diffusion into the epitaxial layer goes about 2 μm deep. This type of device is extremely fast and has relatively high sensitivity. Delay time is about 10 ns.

Previous optoisolators have been made of a liquid-epitaxial LED and a phototransistor with leads bonded to both sides of the chip. In general, these LEDs have a response time from about 1 microsecond to 800 nanoseconds at best. A phototransistor has a higher gain than a photodiode, but operating speed falls as an inverse function of the increase in gain and typically ranges from 1 to 10 μs.

These two semiconductor elements are usually mounted on cantilevered extensions of the lead frame inside the package, and the space between them is filled with silicone resin. This method of mounting needs about 500 μm, and this fairly large spacing contributes to low coupling efficiency.

Coupling efficiency is also variable because the accuracy of spacing and lateral positioning tends to be low. And since the leads from the LED and the phototransistor are on opposite sides of the same space, there is always the danger of arcing between them. □

France

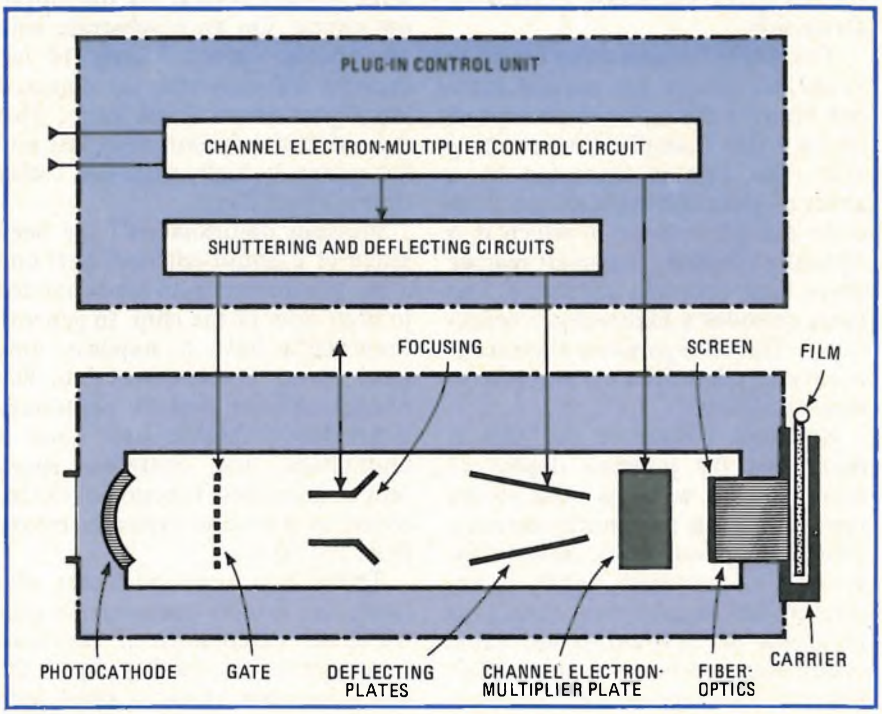
Image converter helps multiply gain of Thomson-CSF's streak camera

Nuclear bombs give off plenty of light when they explode, so the low light gain of the original streak cameras developed to record bomb tests turned out to be an important virtue.

But streak cameras have since been turned to humanitarian tasks—plasma-fusion studies, basic nuclear investigations, and laser chemistry, for example—where light levels are not always high enough to be photographed at nanosecond exposure speeds.

The more gain, the better, asserts Pierre Nodenot of the special-applications department in Thomson-CSF's Avionics and Space Equipment division. Thomson-CSF has boosted the variable light gain that ranges from 2 to 30 in the model TSN503 streak camera it put on the market four years ago [*Electronics*, Electronics International, Nov. 8, 1971, p. 10E]. Now, the department has wrought a startling improvement with its TSN504: the gain has been boosted to values as high as 5,000.

To be sure, there's a tradeoff. The fastest exposure time for the TSN504 is 50 nanoseconds, compared to 2 ns for the TSN503. But the tradeoff is temporary, maintains Nodenot, sales engineer for the camera. "As soon as we get to know the tube better," he says, "we'll get down to 2 ns."



Electrons from the photocathode of this streak camera are multiplied by secondary emission as they pass through the image-converter plate to the fluorescent screen.

Multiplying. The tube Nodenot refers to is an image converter that has been developed by Laboratoire d'Electronique et de Physique Appliquée and recently put into production by Hyperelec, which, like LEP, is a Philips-group company. This tube, designated the PF500, differs from conventional image converters in that it has a channel electron-multiplier plate.

Electrons from the photocathode, after they have been focused and accelerated, are multiplied by the thousands through the process of secondary emission as they pass through the plate. (To keep the gain homogeneous over the surface of the plate, it is tilted to an angle of 13°.)

The enhanced electron stream emerging from the plate is converted back to photons by a fluorescent screen deposited onto a fiber-optic faceplate. The recording film is held flush against the outer face of the fiber-optics. This proximity of the two surfaces eliminates light loss.

Potentiometer setting. The optical gain is set from zero to 5,000 by adjusting a potentiometer that varies the voltage applied across the channel multiplier plate. To trigger the camera, a 50-volt pulse with 2-ns rise time and 200-ns duration is applied to the camera's control electronics.

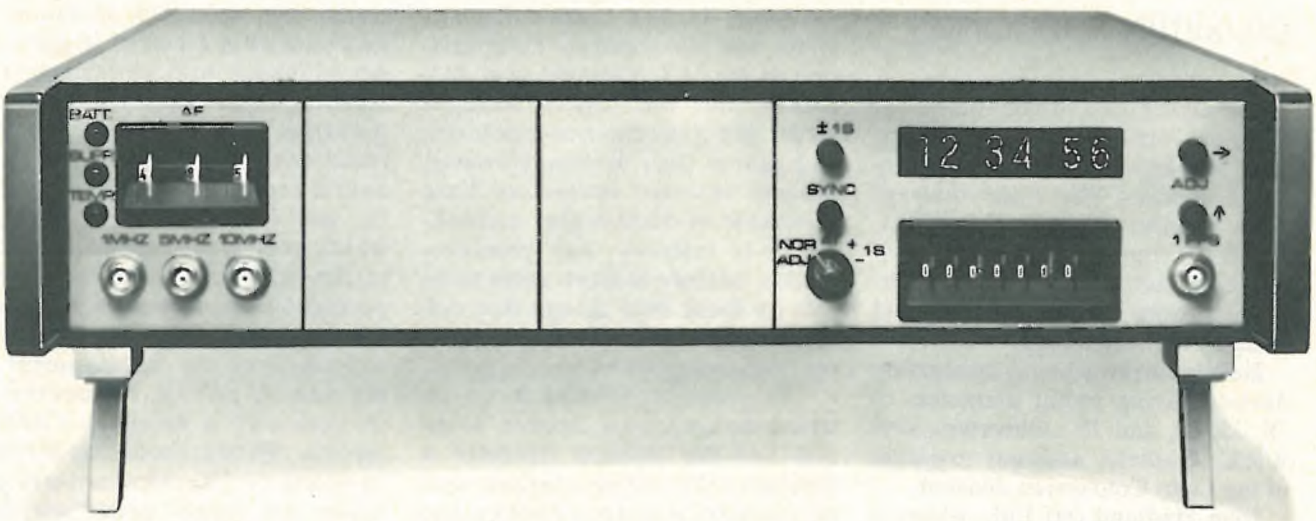
Pulses are then generated to drive the control grid, the channel multiplier plate, and the deflection plates. The triggering delay is 25 ns, and jitter is no more than 1 ns. Maximum sweep speed is 0.8 millimeter per nanosecond over the screen, which has a usable area of 25 by 40 mm. The resolution is 10 line-pairs per millimeter.

Both the tube and the camera were developed in close collaboration with France's atomic energy agency, Commissariat à l'Energie Atomique. And—not surprisingly—the first six TSN504s have been delivered to the CEA.

Sales to outsiders—at prices ranging from $55,000 to $66,000—will

We, the unbending gnomes of Neuchâtel, present a world "first."

Namely our B-5450



First, it is a frequency standard with the highest short- and longterm stability.

Second, it is a quartz clock with built-in interval meter for time comparison.

Long term stability $< 1 \cdot 10^{-10}$/day
Short term stability $\sigma < 1 \cdot 10^{-12}, \tau = 1$ s
Digital frequency adjustment
Time setting accuracy 0.1 μs
Built-in time comparator Δt
Leap second ±1 s capability
Options: frequency divider and multiplier
Low profile construction for 19" rack 2 U

OSCILLOQUARTZ SA
The unbending gnomes of Neuchâtel

16, rue Brévards, 2002 Neuchâtel 2, Switzerland
Tel. 038 25 85 01, Telex 35 315

Circle 259 on reader service card

start this spring. Nodenot already has found prospects in the United States, Russia, and France. □

Great Britain

Intensifiers have proximity focusing

Proximity-focused diode-image intensifiers are about to challenge such conventional intensifiers as inverter models. That's the message from English Electric Valve Co., which is about to market a range of the compact devices after overcoming some problems that had hung up the technology.

Development is being finished on devices having useful diameters of 18, 25, 40, and 75 millimeters, says B.R.C. Garfield, assistant manager of the Light Conversion division.

John Hadland (PI) Ltd., which is developing a new image-converter camera, may be the first to use the intensifiers. Two of the diodes with fiber-optic windows will replace lenses and some four-stage magnetic intensifiers.

Basically, a proximity-focused diode is an image intensifier in which a plane photocathode is parallel to and closely spaced from a plane phosphor screen. An applied accelerating field causes electron imaging by the direct transfer of photoelectrons across the narrow gap between the phosphor and the photocathode.

Useful. The proximity diodes were originally developed by EEV as low-light preamplifiers for channel intensifiers, but other potential applications include television-camera systems, preamplifiers for vidicon tubes, and shutter image converters for gating applications in aerial-reconnaissance cameras. An undisclosed manufacturer also is trying the diode as an output intensifier for ultrafast streak or framing-image tubes, and the diodes are being considered for astronomical uses in the impending international ultraviolet Explorer satellite.

Proximity diodes should be tough competition for other intensifiers where compact size, weight, and shape are important. Garfield says they compare favorably in gain, resolution, and background-noise characteristics. Each diode is only 14 millimeters thick.

Other companies making proximity diodes include Galileo Electro-optics and ITT Electron Tube division in the U.S., Garfield says. EEV claims that the higher voltages across the gap improve resolution and gain of their devices. However, because inverter intensifiers have thousands of times higher multiplication of intensity than proximity diodes, military markets seem to be safe for them, even though they suffer from some distortion and are comparatively large.

The proximity-focused diode requires no additional electron focusing, and the biplanar structure is compact. The device operates with no geometrical image distortion and resolution is uniform over the entire image area, Garfield explains. But to achieve these performances takes 10 kilovolts applied across the gap of less than 2 millimeters. Heretofore, this presented tough problems in manufacture and materials technology.

Developments. EEV, however, has developed a vacuum-transfer process that overcomes problems inherent in the process, such as complexity, expense, and long process times. Normally, two tube sections, one containing the photocathode faceplate and the other the anode, are mounted in separate units in a large vacuum chamber. EEV shrank the size of the modules for better process control.

Improving materials technology helped, too. Garfield says better phosphors now can handle the stresses required. The company uses standard S25 photocathodes and P20 phosphors. The phosphor screen can withstand operation at field stresses in excess of 10 kilovolts per millimeter without damage. The resulting tubes are rugged and are packaged in a brazed ceramic-to-metal envelope, he says. Input and output faceplates, usually fiber-optic, are sealed to metal flanges, which, in turn, are argon-arc-welded to the tube envelope. Garfield reports good shelf life and operational life characteristics.

Because of the improvement in the transfer process, the uniformity of sensitivity is excellent, Garfield reports. Photocathode sensitivities in excess of 200 microamperes per lumen are typical under low field conditions of less than 10 kilovolts per millimeter. The Schottky effect causes sensitivity to rise markedly under high field conditions.

The good resolution characteristics are aided by EEV's use of black backing on the phosphors to cut down on backscatter, which can cause blurring. The improved vacuum-transfer process also eliminates two of the three causes of background noise in proximity diodes—dust particles that cause bright spots and glows on the image edge caused by field emissions coming from the walls. Thermionic emission is under control, Garfield says. □

Digital adaptive equalizer in BPO modem reduces digital-data distortion

Digital filtering is one way to equalize distortion on telephone lines. Hovever, the modems for the British post office's upcoming 4.8-kilobit-per-second data-transmission system for the switched telephone network represents a giant step in the technology.

Plessey Telecommunications Research Ltd. has developed a digital adaptive equalizer that acts as a small digital processor in a modem now undergoing BPO prototype testing. The modem also has export potential because its power and narrow bandwidth enable it to

News from Philips

electronic components and materials

PLUMBICON® CAMERA TUBES FOR THE NEW GENERATION OF TV CAMERAS

All the latest technology is combined in our 1-inch diameter Plumbicon® TV camera tubes of the XQ1080 series for colour and black/white applications. The XQ1080 tubes, introduced in 1971, feature an anti-comet tail electron gun for better highlight handling, light biasing to boost 'dynamic resolution', low output capacitance for optimal signal-to-noise ratio and a ceramic centring ring for precision optical alignment.

The XQ1080 series has now been completed with the release of the XQ1083 and the XQ1085 which combine the above features with extended red response for better colour fidelity. The tubes are similar but the XQ1085 has an infrared cut-off filter on the anti-halation disc. The spectral responses of the two tubes are identical to those of the XQ1073/XQ1075 series. The main application of the new types will be in the red chrominance channels of three-tube colour cameras.

®Plumbicon is a registered trade mark of N.V. Philips' Gloeilampenfabrieken, Eindhoven, The Netherlands.

Circle 710 on reader servid card.

RECTANGULAR CATHODE RAY TUBES NOW WITHIN REACH FOR LOWER BANDWIDTH EQUIPMENT

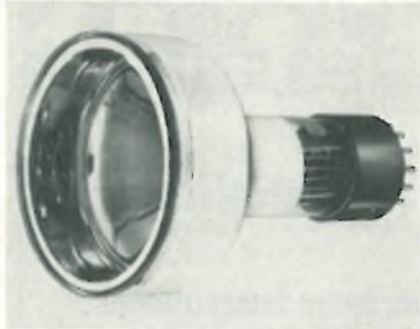
Rectangular cathode ray tubes are becoming increasingly important with the tendency to more compact, high component density equipment. In addition to providing an attractive modern appearance, they enable optimum use to be made of the available front panel space and take up less room inside the equipment.

Until now, the general use of rectangular envelopes has been restricted to tubes, mainly with post-deflection acceleration, intended for medium and higher bandwidth instruments. Meanwhile, for reasons of economy the more simple mono-accelerator tubes, used in lower bandwidth applications, have appeared in round hand-blown envelopes. Our advanced technology, backed by 80 years' experience in glass manufacture, has provided a new approach in which many of the hand operations have now been replaced by automation. The result is a new family of rectangular tubes at prices comparable to round tubes. The first tube of this new family is the mono-accelerator type D14-250GH, intended for oscilloscopes up to 10 MHz band width. It has a useful screen size of 10 x 8 cm and, at a typical accelerator voltage of 2 kV it has deflection coefficients of 24 V/cm (horizontal) and 13 V/cm (vertical). The overall length is only 331 mm, including socket. The D14-250GH has a 6,3 V, 300 mA heater; a special version for battery operation, the D14-251GH, has a 6,3 V, 95 mA heater.

In addition to its use in oscilloscopes, the new tube will find application in waveform displays and in monitors, e.g. in medical applications such as electro-cardiography.

Circle 711 on reader servid card.

VENETIAN BLIND PHOTOMULTIPLIER FEATURES 29% QUANTUM EFFICIENCY



Another new, highly stable photomultiplier tube for nuclear physics is announced under the type number XP2050. The tube is intended for use where the number of photons to be detected is very low or where a good collection from each point of the photocathode is required, as for γ-ray spectroscopy.

The XP2050 is a head on 10-stage tube with a flat window and a semi-transparent bialkaline type D photocathode having a typical spectral response of 95 mA/W at 401 nm. The useful photocathode diameter is 111 mm. The Cu-Be venetian blind dynode construction gives the tube an outstanding stability of 1% over 24 h as well as after change of count rate. The pulse amplitude resolution for ^{137}Cs is as good as 7,5%.

Circle 712 on reader servid card.

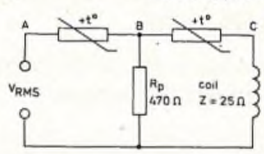
NO PARALLEL RESISTOR NEEDED WITH DUAL PTC

Dual PTC thermistors for degaussing colour TV picture tubes have hitherto required a parallel wire-wound resistor to reduce the residual current in the degaussing coil. Our new PS-PTC dual thermistors do not need this additional component, so there is no longer any danger of overheating the resistor if the coil is disconnected, and the print board size can be reduced.

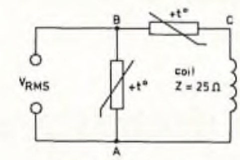
The function of PTC thermistors is to gradually reduce the initial degaussing peak current of 5 A to a steady state current of less than 2 mA peak. In the conventional circuit, the residual peak current through the "mains" PTC is higher than 2 mA and the parallel resistor is necessary to reduce the residual current through the degaussing coil.

The new PS-PTC* (parallel-series) has a parallel PTC connected across the supply, with a series PTC in the coil circuit. The series PTC would not by itself lower the current to 2 mA, but would stabilize the current above this value. By applying further heat to the series PTC, its resistance will increase to the point where the coil current is limited to 2 mA. This extra heat is provided by the parallel PTC which is in thermal contact with the series PTC. The parallel PTC is connected directly across the mains and has a higher switch temperature than the series PTC.

* Patent applied for.



Conventional method
AB = mains PTC BC = series PTC



New PS-PTC
AB = parallel PTC BC = series PTC

Circle 713 on reader servid card.

Philips Industries
Electronic Components and Materials Division
Eindhoven - The Netherlands

PHILIPS Electronic Components and Materials

PHILIPS

compensate for poor conditions on some dial-up connections.

The system operates in the time-division-multiplex mode, the shift registers have virtually an infinite storage time, and digital circuits are relatively insensitive to temperature variations. The equalizer, which uses mainly low-power transistor-transistor logic with MOS storage, occupies three plug-in printed-circuit boards measuring 10 by 20 centimeters.

When installed, the modems will enable data users, such as banks and airlines, to access a data service by dialing through the switched telephone network, instead of having to use more expensive dedicated private lines. This should be particularly useful for companies that need less than four hours of telephone time daily.

Speedy. The modem is designed to be ready for data transmission within 2.5 seconds of connection, and it handles echoes up to -6 decibels having delays as long as 20 milliseconds. Turnaround time is less than 100 ms. The bandwidth is 1.5 kilohertz between the 15-dB points of the spectrum vs 2.2 kHz in eight-phase systems used by some private-wire carriers, says R. Keith P. Galpin, senior principal engineer.

In operation, the modem receiver's signal is sampled at the equalizer's input and converted into 8-bit words by an analog-to-digital converter. These words are processed by the digital processor so that the modified words, when converted back to analog voltages, represent the original transmitted levels. The function hardware consists of only one adder and one multiplier.

So that the equalizer can adapt itself to any new telephone line, as well as keep up with any new line parameters, the designers used a mean-square error-minimization algorithm. An error signal, derived by comparing the equalizer's output with the nominal quantized levels, is used to adjust the tap coefficients in the equalizer. The error signal is correlated with the delay-line signals, and the polarity of the correlation is used to adjust the corresponding tap coefficients, explains Martin N.Y. Shum, design engineer. An integration process reduces noise on the correlation.

Cells. In studying the filtering and adapting algorithms, the designers saw that they could represent the delay line signal and its corresponding tap as a cell. The filter cycle requires a multiplication within each cell and a running summation between the cells, whereas the adaptation cycle requires a multiplication and an addition within each cell separately. A single multiplier and adder in the central processor can be time-shared by both algorithms. A built-in program that controls the sequence of operation is repeatedly used throughout the modem's operation.

Galpin says the equalizer uses 64 taps, divided between 16 for the feed-forward transversal filter and 48 for the quantized-feedback filter. Since a distorted signal spreads distortion both forward and backward, the first filter lets the signal go through 16 delays "before the equalizer takes it seriously," he says, and "makes a judgment as to what to do with it." The processor, shared among the 64, samples one tap, stores the signal, and so on—all within one cycle of the data-symbol period.

Summing. Each tap consists of a correlator multiplier feeding to a variable-gain amplifier, and the output feeds a summer. The summer's output goes to a threshold-limited quantizer. The quantizer's outputs go to the feedback filter and provide an error signal to each correlator multiplier.

The digital processor's two basic circuits, the feed-forward transversal filter and the quantized feedback filter, compensate for each other's faults. Since signal processing with a feed-forward transversal filter is a linear process, the configuration tends to enhance any noise in the input and increases the dispersion of the original distortion.

The quantized-feedback filter, on the other hand, is nonlinear, doesn't increase input-noise level, and han-

dles echoes of long delays. However, it can't deal with intersymbol interference caused by trailing signal elements and may suffer from errors.

Thus, since long time-delay echoes are common in public switched-telephone networks, the feed-forward transversal filter equalizes intersymbol interference caused by following signal elements, while the quantized-feedback filter deals with echoes and intersymbol interference from preceding signal elements. □

West Germany

Biological matter sorted by computer

As biological research focuses more and more on cellular structure, viruses, and bacteria, there is an increasing need to collect, sort, and isolate such material. But the collection, sorting, and separation processes are beyond the capabilities of many laboratories.

Two American researchers, Thomas Jovin and his wife Donna, working at the Max Planck Institute for Biophysical Chemistry in Göttingen, West Germany, have now developed a computer-based setup for high-speed collection and processing of cells and other microparticles, as well as sorting according to various measured criteria. The computer operates on line so that measurements are performed while the particles are being processed.

In preliminary tests with their equipment, the Jovins have automatically measured and sorted 10,000 cells per second. Besides high speed, the equipment processes living organisms without destroying them. For example, the delicate isolated cells of fresh-water polyps, or hydras, originally 5 millimeters long, recombined to form living organisms after the analysis.

Operation. In the process the bioparticles, which are suspended in an appropriate protective fluid, first pass through a small nozzle. Then,

these particles, which may be cells, bacteria, viruses, or any other organ of intracellular structure, are illuminated by a laser beam. About 2 millimeters below the nozzle, an electronically controlled sonic oscillator chops up the fluid stream into tiny droplets, diluted so that each droplet contains only one particle.

The laser-illuminated particle scatters the light, absorbs part of it, and, when appropriately colored, the particle is excited to fluoresce. An optoelectronic measuring setup registers the scattered and absorbed light, as well as the amount of fluorescence. The data obtained on these optical parameters is sent to the computer a Digital Equipment Corp. PDP-11/45. The computer determines the sorting criteria as the particles continue on their way through the apparatus.

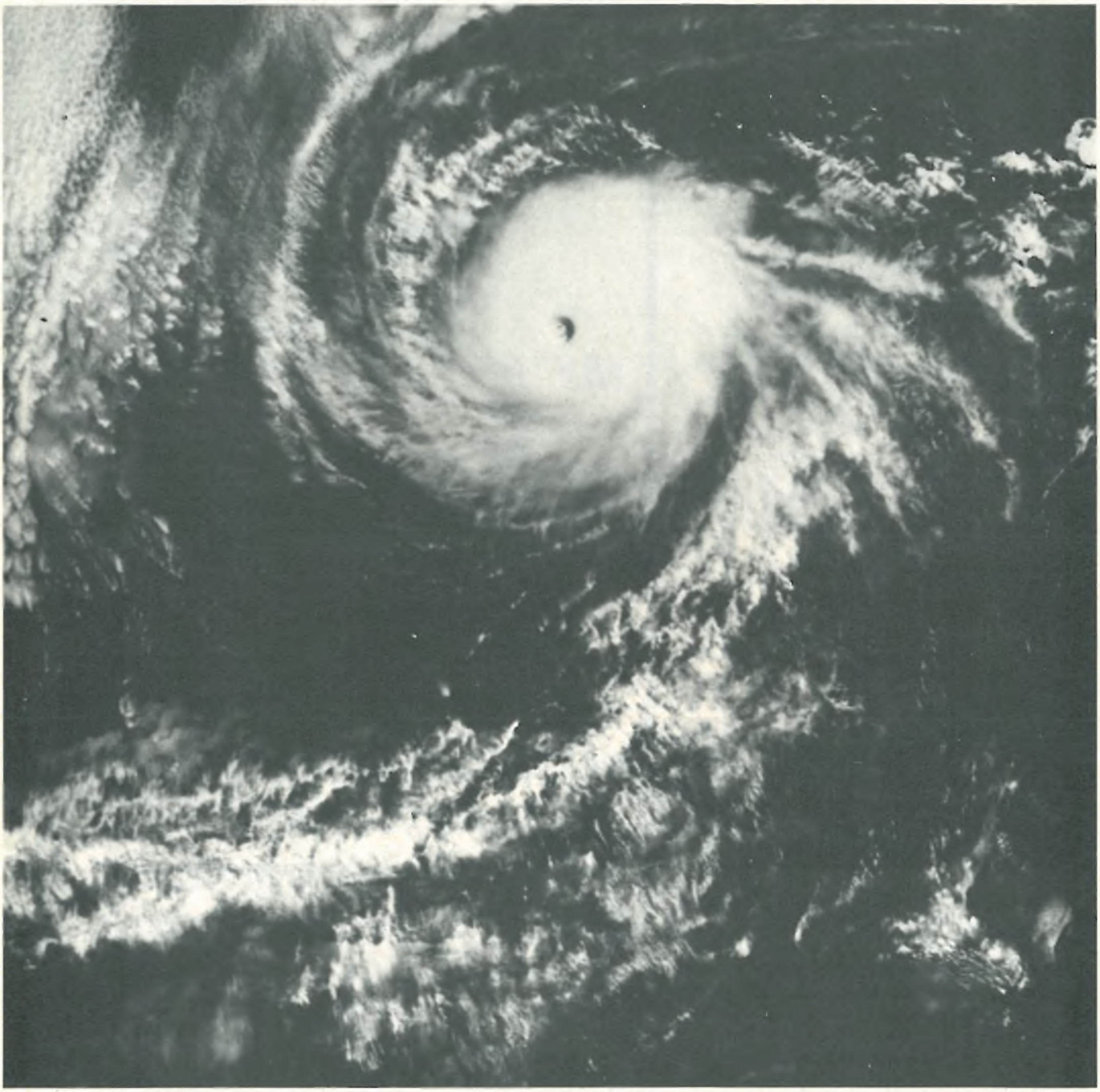
Depending on its optical characteristics, a droplet containing a particle is either negatively or positively charged, and both the polarity and the amount of charge identify the droplets in the subsequent sorting process. The droplets are sorted as they fall through an electrical field produced by parallel anode-cathode plates.

Separation. Negative droplets are attracted by the anode, and positive ones are deflected toward the cathode. The degree of deflection depends on the amount of charge in the droplets. Five different vessels collect the droplets according to the degree of their deflection. After the suspending fluid is separated in a centrifuge, the five categories of particles, each with identical optical characteristics, are obtained. The particles can then be studied under a microscope.

The optical data, determined while the particles are illuminated, accurately characterizes the cells, Jovin says. Scattered-light values indicate both the form and the size of the cells. Whats more, the fluorescence tests make it possible to trace certain antibodies bound to the particle or cell surface. These tests, Jovin points out, are important because they can trace the origins of particular virus infections. □

They know where you're going Bertha

Confronted by the unpredictable fury and erratic courses of hurricanes, men, with the chauvinism of which they are so generally accused, naturally gave them women's names. The habit sticks though hurricanes are no longer so unpredictable.
They zig-zag across the low latitudes as erratically as ever; the change is in the amount of data on the meteorological events that drive them - and other, less spectacular, kinds of weather - which is now continuously collected and rapidly processed.
By far the largest and most sophisticated centre for such processing is that at Kansas City, where data from weather ships, satellites and groundstations are collected automatically by a huge Philips message-switching installation, with five separate



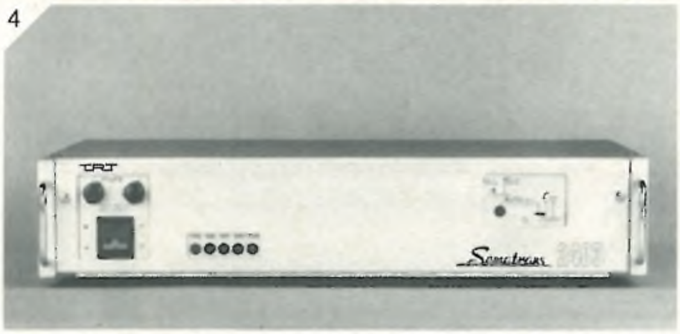
processors, handling a total of 485 telegraph circuits. Every hour it interrogates thousands of measuring stations - that takes two minutes.
This vast amount of data is processed, and the resulting detailed forecasts are distributed to several hundreds of thousands of destinations. That takes twenty minutes.

1

2

3

4



1 **Visual Communication Display.** Some animals probably see objects only when these move. The human eye retains something of this primitive selectivity which is, maybe, why moving text signs are such an effective way of communicating information. The Philips system is particularly simple to operate. The moving legend can be generated from punched tape or directly from a keyboard.

2 **Page a man, anywhere in the plant?** Sure. We have extended the transmitting range of our inter-office paging system to ten kilometres. A small pocket pager will alert individuals, or groups with the same call numbers, by a tone only or by a tone followed by a spoken message. The system can be linked-in with mobile radio networks.

3 **You know all about electronics, what about telephony?** Apart from being deeply involved in electronics, Philips have wide experience in telephony, telegraphy and telex. It might pay to call us in as consultants, to make sure that all telephone and data network facilities are used to maximum business advantage - perhaps in conjunction with mobile radio links or (city-wide) paging systems. And if extension or improvement of the network is considered, we might come up with some novel ideas.

4 **Data communication over public telephone networks.** We call it SEMATRANS 2403. It is a fast modem having a capacity of 1200 to 2400 bits per second in duplex traffic. It is our latest commodity to connect computer to terminal over the same lines you use to call your office.

If you would like to know more about us, mail the coupon, or write to Philips, GAD-EMB-2/room 16, Eindhoven, Holland.

Please send me the brochure "Products, Systems, Projects"

Specific interest:

Name:

Position:

Country/city:

Address:

Post to: Philips, GAD-EMB-2/room 16, Eindhoven, Holland.

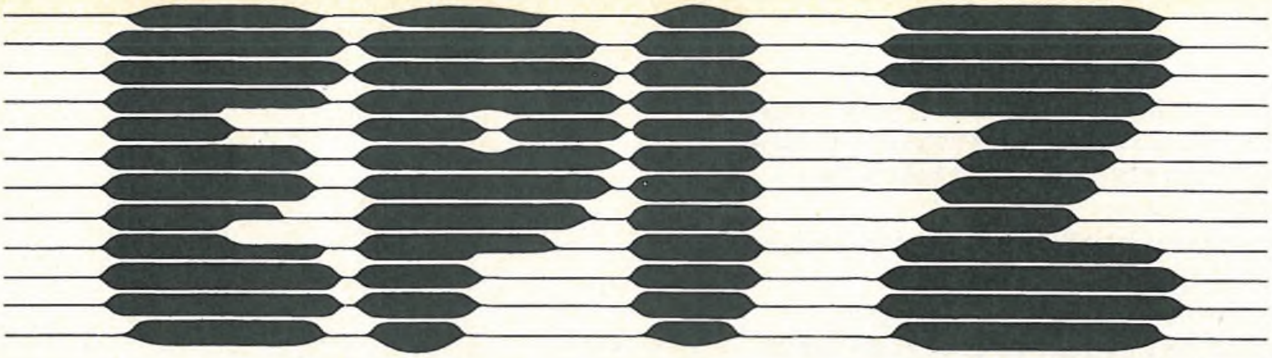
PLEASE WRITE IN CAPITALS. 23-11

PHILIPS

working on communications

PHILIPS

Circle 103 on reader service card



EUROPEAN ZENER DIODE 2.4 V→75 V

sescosem

Original Epi Z technology providing :

- **high reliability**
  C.C.Q. approved series
  BZX 46 C - BZX 85 C
- **mass production**
  economical series
  BZX 83 C
- **low noise**
  BZV 39 C
  Nominal noise voltage guaranteed over the whole range of operating current above 10 μA
- **range extension**
  down to 2.4 V

PEREZ PUBLICITÉ 96 A

THOMSON-CSF

SEMICONDUCTOR DIVISION
50, rue Jean-Pierre-Timbaud / B.P. 120 / 92403 Courbevoie
Telephone 788 50 01 Telex Sescom 61560 F

SALES REPRESENTATIVES IN EUROPE

BELGIQUE - Bruxelles - Thomson S.A. Tel.648.64.85Twx : 23.113 – **BRD** - München - Thomson - CSF GmbH Tel. (089) 76.75.1 Twx : 5.22.916 – **DANMARK** - København - Scansupply Tel. Aegir 5090 Twx : 19037 – **ESPAÑA** - San Juan Despi (Barcelona) - Componentes Electronicos S.A. Tel. 319.46.50 Twx : 53.077 – **FINLAND** - Helsinki - OY Sufra AB Tel. 49.01.37 Tlg : Pierrejoly Helsinki – **GREAT BRITAIN** - London - Thomson CSF UK Ltd Tel. (01) 579.55.11 Twx : 25.659 – **ITALIA** - Milano - Sescosem Italiana Tel. 68.84.141 Twx : 31.042 & **ROMA** Tel. 31.27.22/35.30.05 Twx : 61.173 Telonde – **NEDERLAND** - La Haye - Compagnie Générale d'Electricité Tel. 60.88.10 Twx : 31.045 – **NORGE** - Oslo - J.M. Feiring A/S Tel. 02.68.63.60 Twx : 16.435 – **ÖSTERREICH** - Wien - Transalpina Tel. (0222) 56.15.71 Twx : Ausland 12.717 – **PORTUGAL** - Lisboa 2 - Sd. Com. Rualdo Tlg : Rualdo Lisboa Tel. PP.C 33 725 – **SUISSE** - Berne - Modulator S.A. Tel. 232.142/43 Twx : 32.431 – **SVERIGE** - Solna - Elektroholm AB Tel. 08/82.02.80 Twx : 19.389

Tight design. All circuitry for scope is on three boards: the vertical amplifier one shown under test, a time-base board (right, foreground), and the power supply.

Portable 85-MHz scope uses ICs for most functions

by Arthur Erikson, Managing Editor, International

Two-channel instrument from Schlumberger aimed at analyzing communications, computer logic equipment

Any product in the pipeline at Schlumberger Instruments and Systems gets a thorough checkout after each major design stage. But the designers, production engineers, and sales engineers at the company's St. Etienne Center worked together more closely than ever to produce their new 5212 portable 85-megahertz oscilloscope that is hitting the market this month. They met at least once a month for the past year and a half.

The collaboration has paid off, the St. Etienne crew is convinced. "We've got a complete instrument, with all the operating gadgets imaginable and an exceptionally bright screen," enthuses Georges Bertron, marketing manager for the St. Etienne Center.

Most of the 5212's functions are performed by integrated circuits; the production people have only three printed-circuit boards to worry about—one for the time base, one for the vertical amplifier, and one for the power supply.

The mechanical layout is equally spare, being essentially an open girder with the cathode-ray tube mounted inside, the pc boards on three sides, and the front and rear panels at the ends.

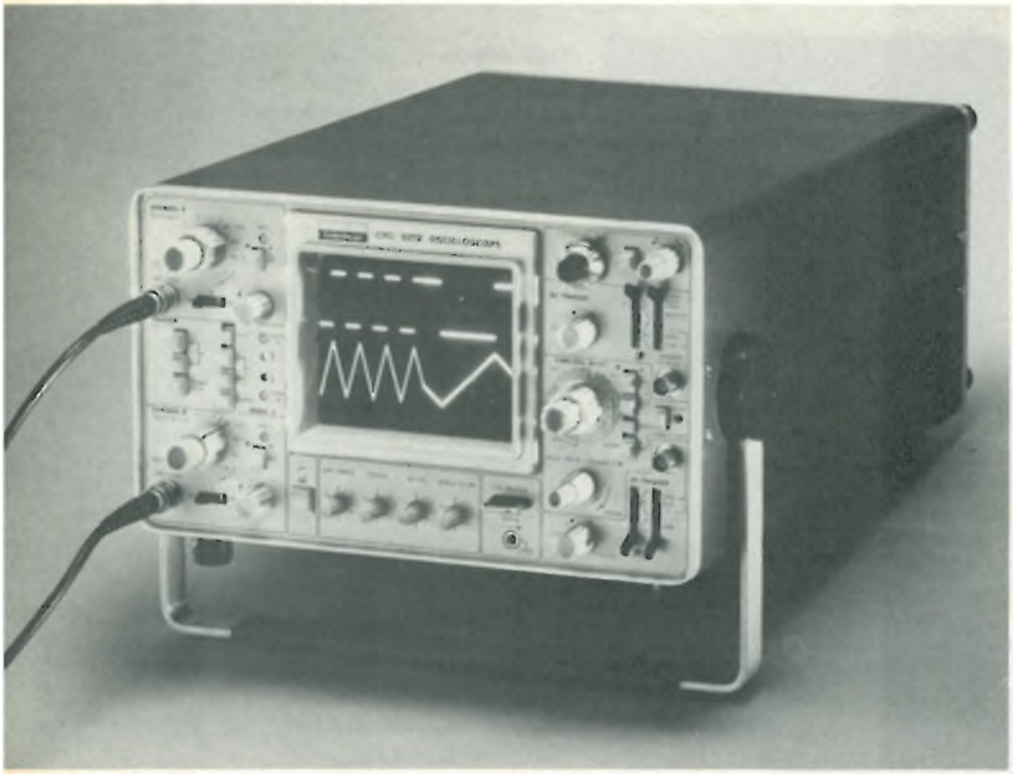
Add the covers, and the model 5212 weighs in at approximately 9.5 kilograms, which corresponds to about 21 pounds.

Schlumberger will sell the 5212 for less than 10,000 francs. For their money, buyers will get what they need to analyze digital communications equipment and computer logic systems.

The oscilloscope can produce a stable display with just about any kind of digital input signal, according to Alain Quéau, who heads up the oscilloscope design team at St. Etienne. Adds Quéau, "It's also good for picking up transients in analog circuits since the rise time is four nanoseconds."

The 5212 has two channels, each with sensitivity at 85 MHZ, adjustable from 5 volts/division to 5 millivolts/division. When higher sensitivity is needed, one channel can be switched for one mV/division up to 20 MHz while the other retains the 5 mV/division value. If the signal level and the sensitivity don't jibe and the spot goes off the screen, a diode lights to show which way it went off.

Choices. The two channels can work independently or together in



Bright. Schlumberger built new scope around a special Thomson-CSF tube that has no field mesh; gives traces bright enough to be photographed with 3,000 ASA film.

several ways. By pushing a button, for example, the input signals can be summed. Or the "B" channel can be inverted to obtain the difference. There's a tap, too, at the vertical amplifier outputs to pick off the input signals at a level of about 25 mV/division.

As for the two time bases, they can be used singly or mixed, too. Full-sweep speeds range from 100 nanoseconds/division to 1 second/division, with a 10-to-1 expansion possible for a better look at key parts of waveforms.

Synchronization can be internal, from either vertical channel, both of them, or the sum or difference of the two. "You can synchronize on a clock and a signal that occurs every ten pulses, for example," says Quéau.

External sync is possible with signals as high as 100 MHz and if a look at the external synchronizing signal is what's wanted, there's a pushbutton for that, too. For particularly complex signals, the hold-off of the sweep delay can be adjusted.

Although the 5212 rates only as a medium-range instrument as far as frequency goes, 85 MHz is high enough that Quéau based his vertical amplifier and his time bases on emitter-coupled-logic technology. For the vertical amplifier, Schlumberger worked out a custom IC design that puts 21 ECL-like transistors to work in an analog amplifier. The 5212 has three of these ICs; two serve as preamplifiers for the two channels, the third as the final stage of the vertical amplifier. "The transistors actually have cutoff frequencies of 1.5 GHz," notes Quéau, "and the amplifier's passband is 250 MHz."

Quéau didn't fully integrate the vertical amplifier, however. Field-effect transistors are needed to get the high impedance required for an oscilloscope, and Quéau felt that no supplier in Europe had an industrial technology for integrating FETs. Hence, discrete FETs plus some standard TTL packages for the switching logic are used along with the three custom ICs.

No custom circuit. Again because the technology isn't yet available, Quéau avoided a custom IC for the time bases, whose sweep circuits are based on FETs. Pulse-shaping and control circuitry for the time bases are implemented by standard ECL packages. "There are no tunnel diodes in the design," he says.

The technology was there, however, for the CRT. It's a Thomson-CSF "quadrupolar" type with an 8-by-10-centimeter screen. The traces are bright and sharp enough to be photographed on 3,000 ASA film at writing speeds up to 2 centimeters per nanosecond.

The tube was optimized with the 5212 in mind. It has a slot lens and two sets of quadrupolar lenses instead of a field grid for post-deflection acceleration. Since the writing beam's electrons don't get partially scattered by a mesh, the spot on the screen is very fine.

Also, the quadrupolar lenses amplify by five or six the effect of the electrostatic deflection plates. Still another advantage: the post-acceleration voltage, which is nominally 15,000 volts, needn't be precise, and that simplifies the power-supply design.

Schlumberger's design team packed all the pertinent operating features they could think of into the 5212. But they also remembered the people who have to maintain oscilloscopes.

The boards for the vertical amplifier and the time bases are largely accessible with the instrument's cover removed. And there are a half-dozen test points to facilitate troubleshooting. The vertical amplifier board and the time-based board can both be unscrewed from the backbone "girder" and still operate through their connectors. "You can demount either board in about a quarter of an hour," says Quéau.

Quéau expects that companies or government agencies that use the 5212 heavily will handle their field maintenance by replacing entire boards, repairing the defective ones in base shops.

Schlumberger Instruments and Systems, 5 rue Daguerre, 42030 St. Etienne Cedex, France [441]

Mobile Radio Test Set
for VHF/UHF bands

Output Tester MS52A

Signal Generator MG54B
335 to 470MHz

This test set is a measuring instrument composed of a signal generator and an output tester which are capable of carrying out following characteristic measurements for the maintenance of single channel FM mobile radio equipment. In the outdoor operation this test set can be operated by a built-in battery (optional) instead of AC mains, so the testing of a mobile radio equipment is very convenient. This is an economical, easy-to-use test set which can be employed in the measurement of equipment having a narrowed bandwidth.

For Transmitter ● Output power and frequency deviation

For Antenna ● VSWR

For Receiver ● S/N and sensitivity
● IF center frequency adjustments
● Discriminator characteristics
● Audio output power
● Overall selectivity

The Signal Generator MG54C for 60 and 150MHz bands is available in addition to the MG54B. The MG54C can be used for the maintenance of mobile radio equipment for 60 and 150MHz bands in conjunction with the Output Tester MS52A.

Technical data sheet is available on request.

Anritsu

Anritsu Electric Co., Ltd.

MEASURING INSTRUMENT'S DIVISION
SALES DEPARTMENT: 4-12-20, Minami-azabu, Minato-ku, Tokyo 106, JAPAN
Phone: Tokyo (03) 446-1111/Telex: 0-242-2353/Cable: ANRITDENKI TOKYO

Circle 105 on reader service card

Tester debugs microprocessors that use Intel CPU chips

Microprocessors are costing less and doing more. But the more circuit functions that designers pack into one chip, the harder it is to locate faults and programing errors. Sometimes the result is that the money saved with the system in the first place is wasted through extra time spent in debugging. Now a small electronics team in Geneva, Switzerland, has developed a debugger it claims can cut troubleshooting time from two and a half months to between one and three weeks for the average application.

The debugger is built by the Electronics division of Oxy Metal Industries S.A., an Occidental Petroleum subsidiary.

Jacques Lederrey, manager of Oxy microcomputer applications and leader of the development effort, describes the equipment somewhat dramatically as a means of carrying out "open-heart surgery" on microprocessor systems built around the Intel 8008 or 8080 CPU chip. "The complexity of circuits is such that we often use it badly or make mistakes," he says, "The program is never right the first time, and the problem is that we don't have the means to find the mistakes. You can't examine the inside of an IC."

At least, until now you couldn't. Lederrey defines his debugger—one model each for the 8008 and the 8080—as "a window through which we can analyze a CPU chip."

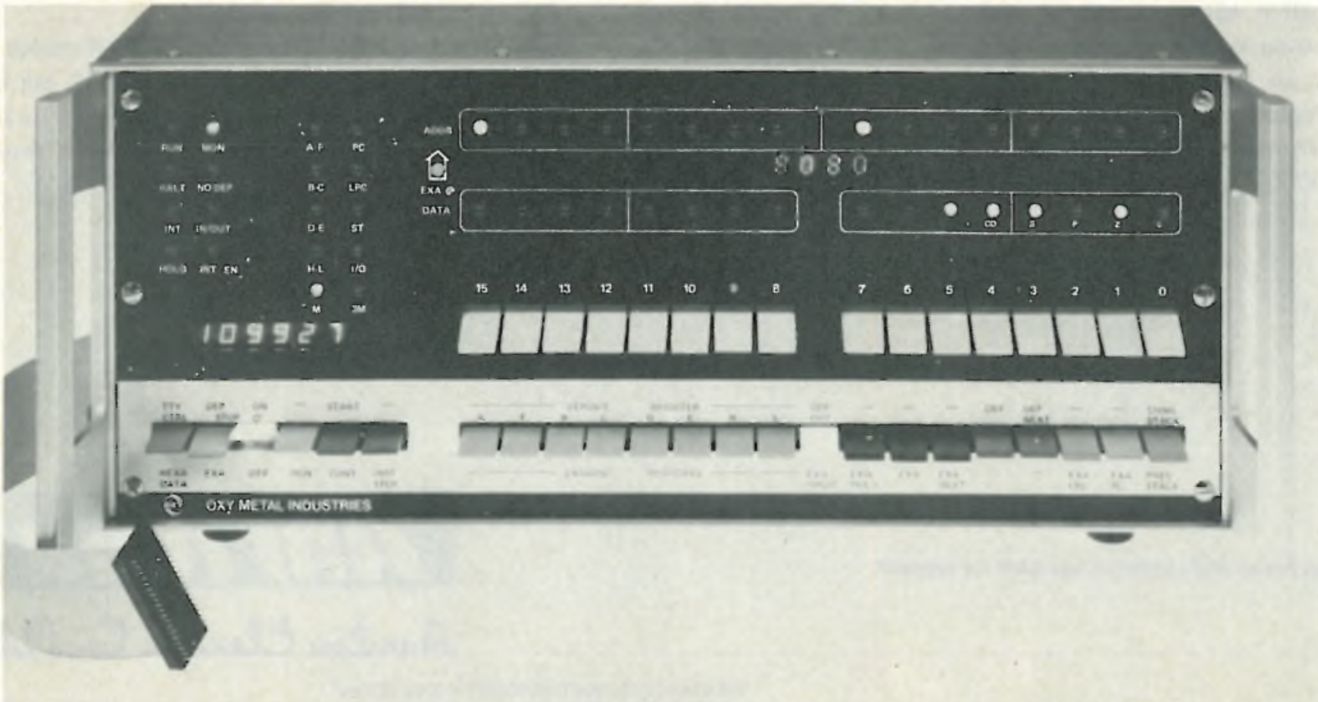
The trick is to build the debugger around a chip similar to that in the system under analysis, and then to use the debugger as an interface between the microcomputer and the external process it has been designed to control.

Tracking. To track down the faults in his system, the user takes out his CPU chip and replaces it with the debugger's interface connector (left foreground of photo below). To narrow the search for the errors, the systems engineer can then switch the debugger into one of several modes. He can use it to operate the memories and interfaces of his system, or he can use the debugger's own memory in combination with the interfaces of the end-application of his system.

In any of these modes, the debugger is built to zero in on any function for close analysis. It operates in an instruction-by-instruction mode rather than in response to each machine cycle. It can examine and deposit instructions in any register of the central processing unit. It can do the same thing for any memory location or for the input-output interface. After any stop or break point, the debugger can trace the source of the last programed step even when the CPU itself cannot answer the question.

To check on the speed of the system, the debugger can provide a display of the execution time between any two program steps. Once a fault is located, the debugger can then be used to load, read, move and substitute memory content in hexadecimal or binary formats. The whole testing procedure can be done in real time through direct connection with the process or an electronic simulation.

If the process has to be kept rolling during the testing and fault analysis, the debugger's own ran-



dom-access memories can be loaded with correct instructions and used as a temporary bypass for a defective or wrongly instructed read-only memory.

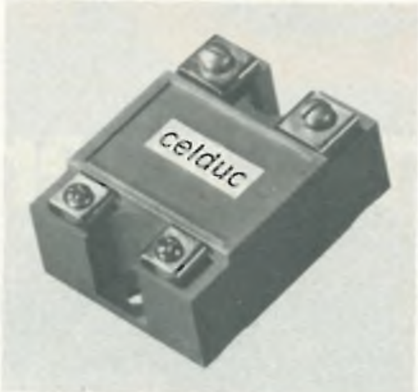
Flexibility. Some U. S. companies have already built debugger machines using their own interfaces and memories to directly monitor the process application. But Lederrey claims they do not offer the same flexibility in enabling the debugger to switch from one mode to another. Neither are they yet capable of working with Intel 8080 chips, he says, adding, "Such systems cannot check the customer's hardware, only his software."

In such a fast-moving business, no claim remains wholly valid for long. Motorola, for example, has put together an attaché-case-sized unit—the MES 6800—to evaluate systems using the M6800 microcomputer family. The compact unit (it measures 45 by 30 by 10 centimeters) needs only to be plugged into a regular power point and coupled up to a teleprinter to produce a fully operational debugger for the approximately 10 products that are in the M6800 range.

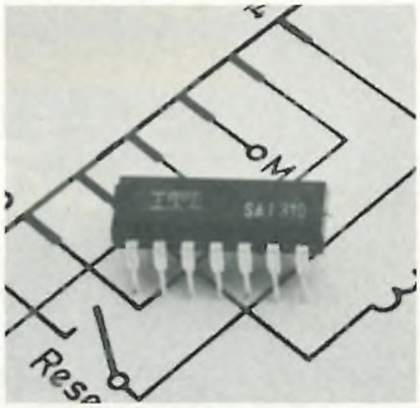
The Motorola approach may herald a new trend. Officials at Motorola's European headquarters in Geneva look upon a debugging package like MES 6800 as a more manageable replacement for the old-fashioned data book or "owner's handbook." A data book for sophisticated equipment like microprocessors would be so fat that an engineer would spend too much time finding the right page. Instead, a debugger system can be offered fairly cheaply to big customers as part of the sales package.

Motorola policy is not yet formulated, but Geneva engineers who designed the system figure it could be offered for a price as low as $1,000. That would shake potential rivals (although in different product lines) like Oxy Metal Industries, which is thinking in terms of 11,500 Swiss francs, or close to $5,000.

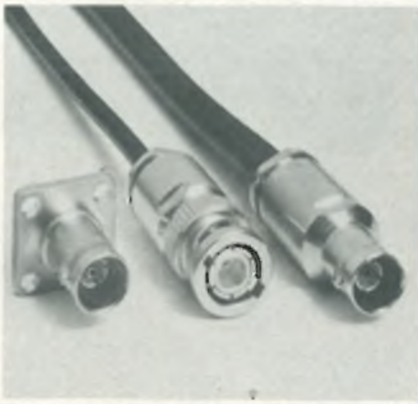
Microcomputer Applications, Oxy Metal Industries (Suisse) S.A., Avenue de l'Etang 65, 1211 Chatelaine-Geneva, Switzerland [442]



A solid-state synchronous relay designated the SC-5 can handle 4 to 20 amperes, 110 to 220 volts ac, with inrush current up to 10 times nominal current. A light-emitting diode and a photodetector isolate the input and output circuits. CELDUC, 42290 Sorbiers, France [443]

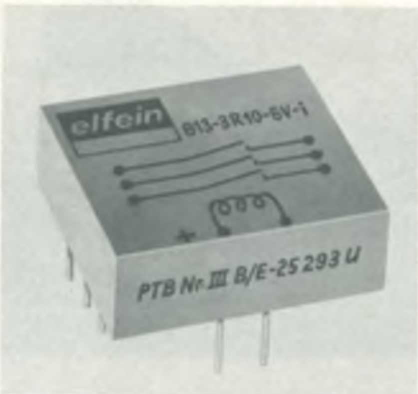


The SAJ310H C-MOS clock circuit pulls only 100 μA from a single 1.5-V cell. The IC, designed for 4.1948 MHz operation, needs no external components other than a quartz crystal; no trimming capacitor is required. Intermetall (ITT), 78 Freiburg, West Germany [446]



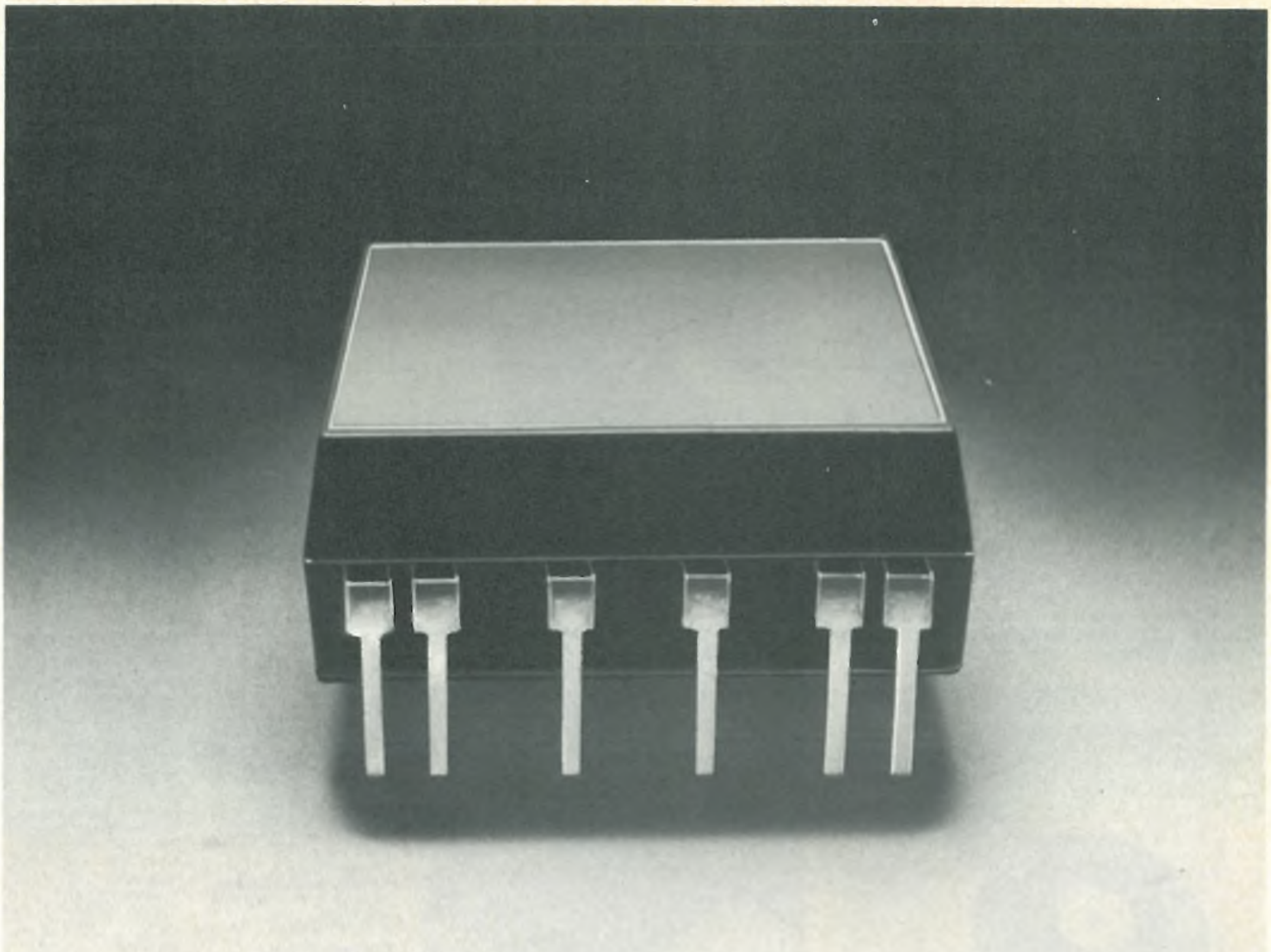
Fifty-ohm triaxial connector, series BNT, is designed for connecting cables consisting of an inner conductor and two concentric shields. It handles frequencies from dc up to 3,000 MHz. Suhner Elektronik GmbH, 8 Munich 90, Pfaelzer-Wald-Str. 68, W. Germany [444]

Frequency counter type 100 is a 50-Hz-to-40-MHz instrument with a six-digit display. It features a sensitivity of 50 mV and a quartz crystal-controlled time base accurate to one part in 10^6. List price is only about $320. Dietechnik, 8041 Grossnoebach 53, West Germany [447]



Reed relays, series 813 and 814, for applications in measuring and control equipment, have contact resistance of ±2 milliohms. Isolation resistance is better than 10^{14} ohms. Devices measure 30 by 27.5 by 11 millimeters. Elfein, 6 Frankfurt, Wiener Str., West Germany [445]

Disk diode type DSA505 is designed for a maximum peak voltage of 2,300 V. It can be used as a free-running diode in chopper circuits. Measuring 57 mm in diameter, the diode is fully diffused and has ceramic insulation. BBC, 68 Mannheim 1, P. O. Box 351, West Germany [448]



THE BREAKTHROUGH HAS BEEN MADE...

NOW, A SOLID STATE

SWITCH WITH THESE UNBELIEVABLE CHARACTERISTICS ???

LOAD HANDLING:
Low-level analog - nanoampere, microvolt levels
Power - 100 VA, 2 Amps, 500 Volts
Common mode - 1500 VAC
Frequency - DC through MHz range

SWITCHING IMPEDANCES:
ON - 20×10^{-3} ohms
OFF - 10^{10} ohms, 2.0 pf.

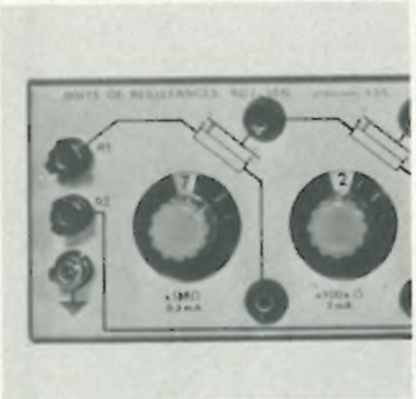
ISOLATION PROPERTIES:
True four-terminal input/output isolation - 10^{10} ohms, 1.5 pf., 1000 VAC

MULTIPOLE FLEXIBILITY:
Up to 5 isolated outputs

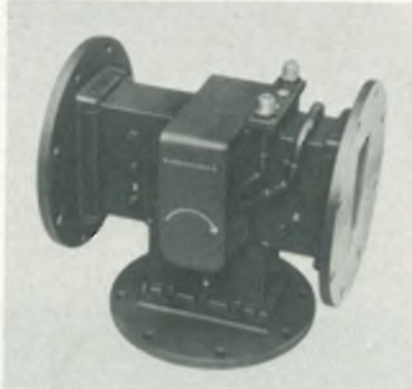
PACKAGING:
No heat sinks. PCB mounting

MarkCom

New products international

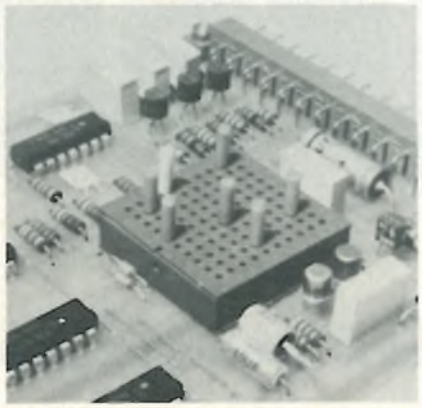


Resistance decade box RD 7 05 covers the range from 1 ohm to 11.1 megohms. The seven-decade unit is calibrated to an accuracy of 0.05% and has a temperature coefficient of less than 1.5 parts in $10^4/°C$. AOIP, 83-85 Blvd. de la Gare, 75013 Paris, France [449]



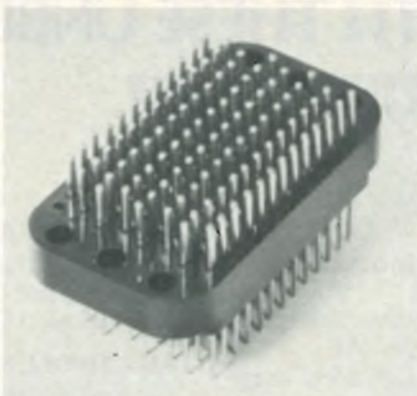
High-power circulator is intended mainly for industrial microwave ovens operating at 2,450 MHz. The unit can handle 5 kW average power, with peaks to 30 kW. Insertion loss is 0.3 dB maximum; isolation, 20 dB minimum. Datron, 14 rue de Fontenay, 94300 Vincennes, France [452]

Photoelectric detector pairs a gallium-arsenide emitter and a silicon receiver for counting applications up to 50 kHz. The detector includes an amplifier so it can drive relays directly. It operates on 5, 12, 15, or 24 V. Baumer Electric, CH8500, Frauenfeld, Switzerland [450]



Programing block mounts directly on pc boards with 0.1-inch spacing. It has a 10-by-10 layout with gold-plated contacts that can handle 2 amperes at 50 volts. Several blocks can be ganged together for large matrixes. Ghielmetti AG, CH4500 Soleure, Switzerland [453]

Insulation tester type 5491 is a battery-powered logarithmic-indicating instrument with two measuring ranges, each covering three decades: 0.1 to 100 gigohms and 0.1 to 100 terohms. Measuring voltage is only 7.5 V. Kistler AG, CH-8408 Winterthur, Switzerland [451]



Multipin connectors have nickel-plated and tinned, rather than gold-plated, pins for the mating function. Prongs for wire-wrapping are tinned phosphor bronze. Contact rating is 5 amperes, isolation is 5,000 megohms. GTE Sylvania, BP 20, 76710 Montville, France [454]

NOT WITH SOLID STATE !!!
THIS PERFORMANCE IS STANDARD WITH
CLARE HGJ AND MHMG
MERCURY-WETTED RELAYS

A proven approach Clare mercury-wetted contact relays solve complex switching problems which cannot be economically handled by solid state devices. They easily switch low-level or logic loads as well as the high common mode voltages or power levels so often found in system applications. Versatile signal handling capability, positive-off switching, immunity to transients, stable parameters plus multipole outputs make Clare mercury-wetted contact relays hard to beat. Clare is already supplying these new relays in quantity to manufacturers of computer control systems, telecommunication equipment, and automated testing instrumentation.

Reliable The heart of both the MHMG and HGJ series is a Clare manufactured hermetically sealed glass capsule. Contact switching is mercury-to-mercury. So there is no contact wear, no contact bounce, constant ON and OFF impedances - every operation. The mercury-film contact surfaces are constantly renewed, thus assuring reliable and consistent operation. Clare mercury-wetted relays are rated for billions ($> 10^9$) of operations.

Flexibility The HGJ2MT version is specifically designed for low-level analog multiplexing and data logging applications in high common mode environments. The MHMG series are compact packages with up to 5 separate contacts.

Please use the magazine reader reply card to request a copy of the Clare Catalog 800 and the Technical Application Reference brochure on mercury-wetted relays.

For more information, contact:
C.P. CLARE INTERNATIONAL N.V. Rue Général Gratry, 102
1040 Brussels, Belgium - Tel. 02/736.01.97 - Telex 24157

C. P. CLARE INTERNATIONAL N.V.
a subsidiary of
GENERAL INSTRUMENT CORPORATION

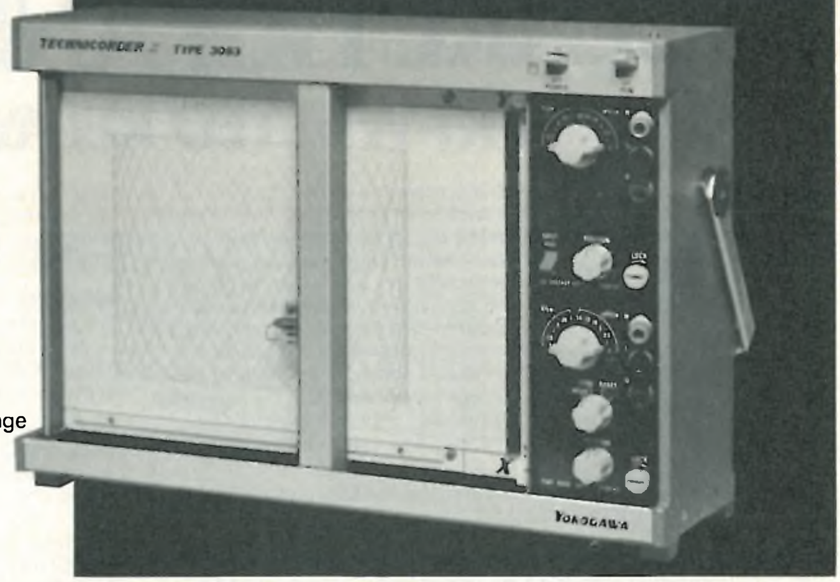
MarkCom

A4 size X-Y recorder with 0.3% accuracy and 5μV/cm sensitivity

The YEW Type 3083 is a multi-selectable, ac servo system X-Y recorder having a recording area of 250×180mm. It is packaged in a compact die-cast case to assure long-life and stable operation. Its modular construction makes maintenance and inspection easy, and a complete line of plug-in units, including a Time Base Unit (with 10 dc voltage ranges), makes selection of the measurement range and function simple.

In addition to an excellent inking system, Type 3083 provides a pen holder which permits recording with general-use felt-tip or ball-point pen, or even a pencil. The standard model is provided with a remote control of chart drive and pen lift.

- ***Both roll chart and sheet recording***
- ***Plug-in flexibility***



• Main Specifications

Number of Pens: 1
Recording Mechanism: Ink writing (felt-tip and ball-point pen also usable)
Effective Recording Area: 250mm (x-axis) ×180mm (y-axis)
Accuracy: ±0.3%
Max. Sensitivity: 5μV/cm
Chart: Roll chart paper or A4 size sheet
Position of Use: Horizontal, vertical and inclined use
Plug-in Units Available: Time Base Unit (0.5mV to 5V/cm dc voltage ranges in 10 steps and 0.5 to 10 sec. time sweeps in 5 steps), DC Voltage Units (single -, 13-, 17- and 19-range, 5μV to 5V/cm), AC Voltage Unit and Offset Unit Zero-set; Adjustable full scale (240mm) Input resistance; 1MΩ constant
Paper Take-up Unit (Optional): Chart speeds; 2 to 60cm/min., mm/min. and cm/hr. in 4 steps

YEW • *For Electronic Measuring, Recording Instruments:*

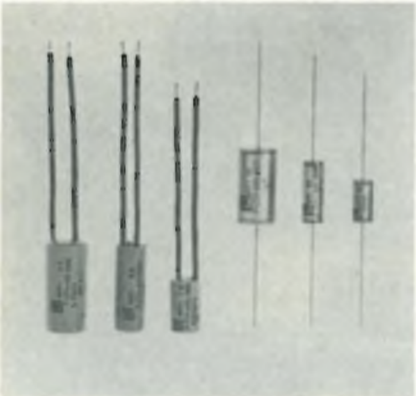
YOKOGAWA ELECTRIC WORKS, LTD.

Yaesu-Mitsui Bldg., 5-7 Yaesu, Chuo-ku, Tokyo 104, Japan Phone: 274-6511 Telex: J28544 YEWTOK

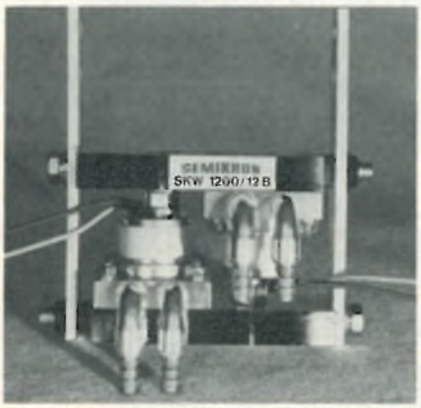
Overseas Offices: • YOKOGAWA ELECTRIC (EUROPE) B.V., Nederhoven 17-19-21, Buitenveldert, Amsterdam, The Netherlands. Phone: 020-423194 Telex: 44-14094
• YEWTEC CORPORATION, 1995, Palmer Ave., Larchmont, New York, 10538, U.S.A. Phone: 914-834-3550, Telex: 710-566-1104

Representatives in Europe: • Belgium: COMPTOIR COMMERCIAL INTERNATIONAL S.A., (03) 32. 78. 64 • France: TEKELEC AIRTRONIC, 626-0235 • Finland: FINN METRIC OY, 460 844 • West Germany: NBN ELEKTRONIK, (08151) 13036 • Italy: VIANELLO S.P.A., 5483811 • Norway: AS MAXETA, 53090 • The Netherlands: TECHMATION NV. 020-456955 • Spain: ATAIO INGENIEROS, 215-35-43 • Sweden: TELEINSTRUMENT A.B., 08/38 03 70 • Switzerland: OMNI RAY AG, 01-340355 • United Kingdom: MARTRON ASSOCIATES LTD., Marlow (06284) 5071.

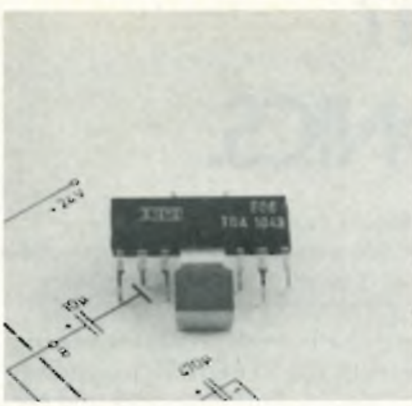
New products international



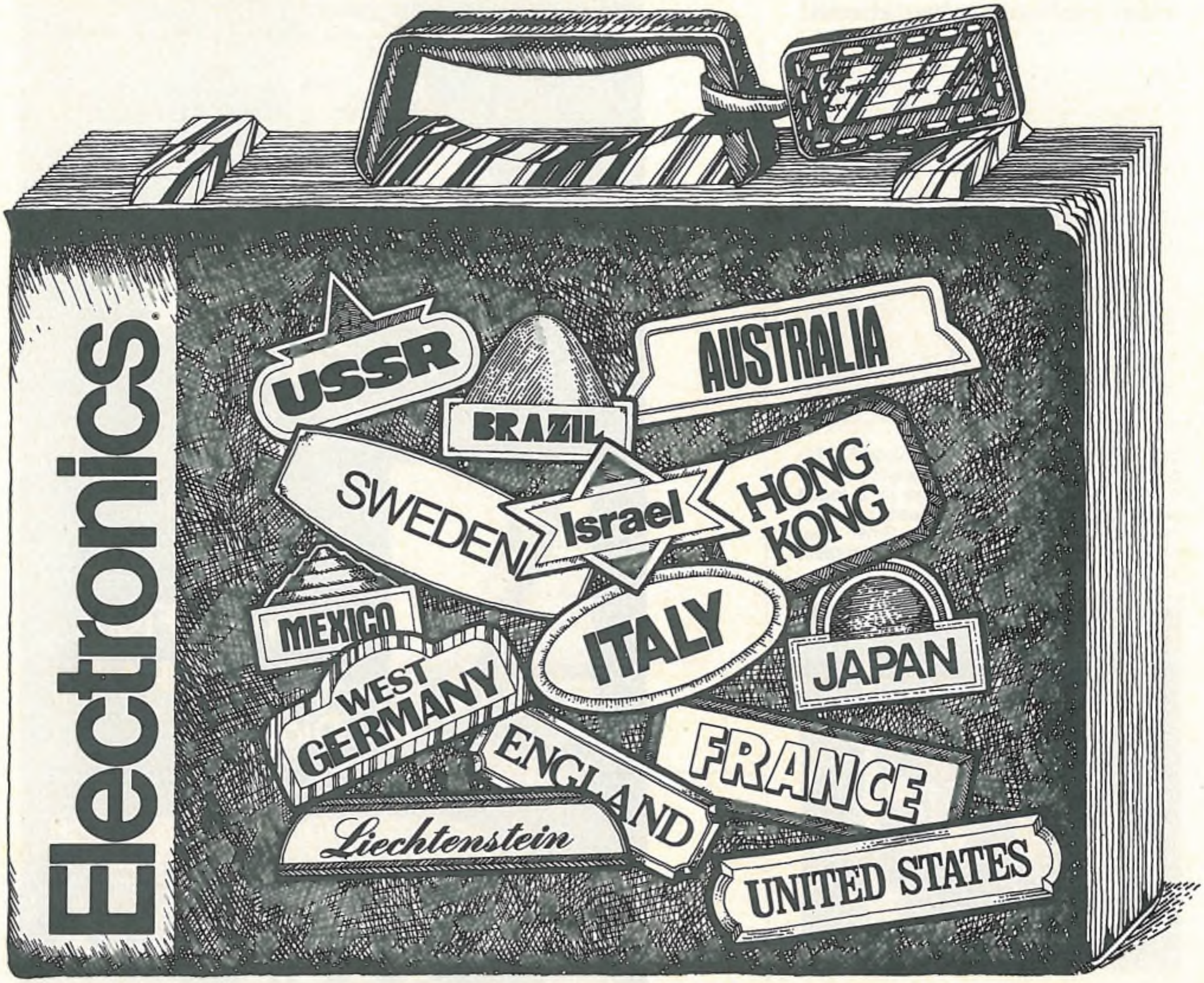
Spark-suppression capacitors, types F1771, are metalized-polyester-foil versions for a nominal 250 volts. They come in a round plastic can, in a rectangular plastic can, and as a foil-surrounded cylinder. Ernst Roederstein GmbH, 83 Landshut, Ludmillastr. 23–25, West Germany [455]



Water-cooled ac current switch SKW, with two anti-parallel thyristors, can be used in welding equipment. It is designed for periodic peak voltages up to 1,400 V and current values up to 1,450 A. Switch-on time is 40 milliseconds. Semikron, 85 Nuernberg 5, Wiesentalstr. 40, West Germany [456]



The TDA1043 integrated sound circuit for line- and battery-powered television sets contains an fm/i-f amplifier, a coincidence demodulator, a volume controller, and a low-frequency amplifier with a power-output stage. Intermetall (ITT) GmbH, 78 Freiburg, West Germany [457]



What are your colleagues doing around the world?

Find out in ELECTRONICS.

Go first class. Go to ELECTRONICS and you'll find out first hand where the biggest growth potential is today. And where it'll be tomorrow.

ELECTRONICS knows, because its 31 editors, 11 World News Bureaus and 200 correspondents make it their business to stay on top of what's happening in the ETM—the Electronics Technology Marketplace—worldwide. Only ELECTRONICS offers readers annual market reports and forecasts on Japan and Europe as well as the U. S.

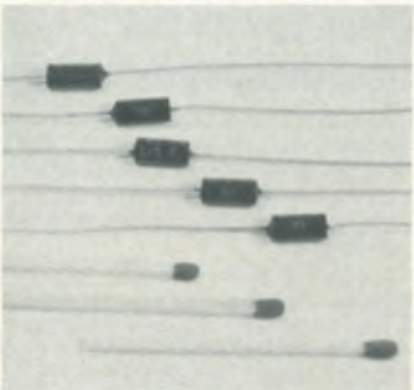
ELECTRONICS is *the* Source, disseminating information, and establishing and maintaining communications among people in electronics, wherever in the world those people may be.

We sell over 86,000 subscriptions to 122 countries all over the globe. You should be getting your own copy of ELECTRONICS right off the press because the world of electronics—your world—is between the covers of ELECTRONICS magazine.

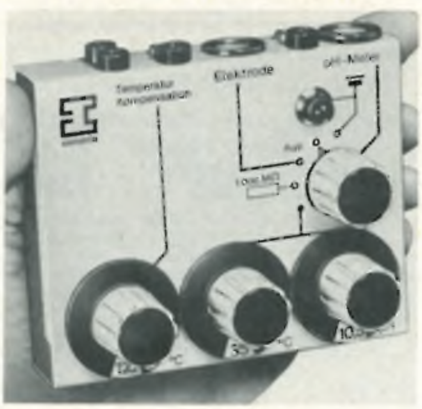
Fill out the enclosed subscription card and send it off. ELECTRONICS is the one magazine you can't afford to be without.

Electronics IS THE SOURCE. McGraw-Hill

Subminiature coaxial termination resistors for 50-ohm systems and for frequency ranges up to 4,000 MHz handle ¼ W and are available with MIL-C-39012 connectors series SMB, SMC and SMS (male and female). Suhner GmbH, 8 Munich 90, Pfaelzer-Wald-Str. 68, West Germany [458]



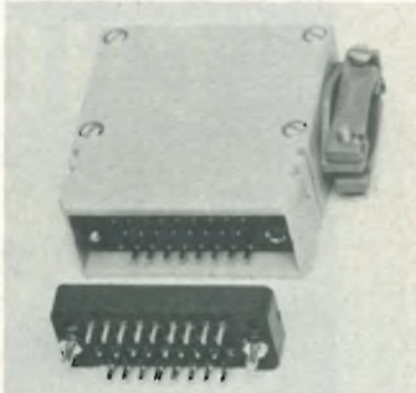
"Miniohm" is a miniature precision wire resistor 4 millimeters in diameter and 8 mm long. It is available at values from 1 ohm to 300 kilohms and with tolerances of 1%, 0.1%, 0.025%, and 0.01%. IV Electronic, 6 Frankfurt 50, Erbsengasse 27, West Germany [459]



In simulator of pH values, the electrode's temperature compensation and automatic compensation are taken into account. The device simulates 24 pH steps from 0 to 14 pH with accuracy within ±0.2% of the preset value. Elementa GmbH, 85 Nuernberg, Hallerstr. 8, West Germany [460]

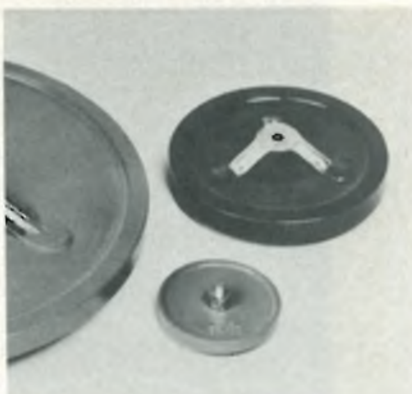
Circle 112 on reader service card

New products international



Series M34 connector is a two-shell plastic structure designed to save space. Leads can be brought in from behind or from the side. Connector has two contact levels in an easily accessible area. Contact GmbH, 7 Stuttgart 80, Schulze-Delitzsch-Str. 29, West Germany [461]

Planar photoelement BPW35 is 10 by 10 millimeters in size. Manufacturing technology gives it high sensitivity, even in the 450-nanometer (blue) range, making it suitable for quantitative light measurements. AEG-Telefunken, 6 Frankfurt 70, AEG-Hochhaus, West Germany [462]



High-frequency disk capacitors, series FP, have nominal power ratings of 6 to 60 kVA and operate on voltages from 2 to 6 kV. Capacitance values are from 25 to 6,000 pF. Applications are in hf and medical electronics equipment. Draloric GmbH, 8672 Selb, P.O. Box 1180, West Germany [463]

"Virtual storage helped us handle increasing production while maintaining high standards of customer service."

Few developments so greatly enhance the usefulness of the computer as does virtual storage. By increasing the effective or "virtual" capability of the IBM System/370 to manage information, virtual storage opens the way to a wide range of user benefits.

Here one company reports on its experience with a virtual storage system.

Motorola's Thomas Koch demonstrates communications equipment at Schaumburg, Ill. division headquarters.

At Motorola, "it's the key to our worldwide data system."

"We strive to maintain a tight delivery schedule for our customized communications systems—worldwide. Our two Model 158s with virtual storage are the key to a worldwide data system that helps make such quick deliveries possible."

So says Thomas Koch, manager of international manufacturing operations of the Communications Division of Motorola at Schaumburg, Illinois. Plants in the United States and abroad now share a common data base for order entry, purchasing and material control, with the application running under virtual storage at Motorola's Chicago computing center. As a result, manufacturing operations are closely adjusted to product demand, production can be scheduled with closer tolerances and shipment dates made with assurance.

"Growth is a fact of life at Motorola," says Koch. "We wanted to be able to handle constantly increasing production while maintaining our high standards of customer service. Virtual storage has been of immense help in enabling us to achieve this."

For further information, call your local IBM Data Processing Division office. Or write IBM Corp., Dept. 83F-E, 1133 Westchester Avenue, White Plains, N.Y. 10604.

Computers help get things done. **IBM**®
Data Processing Division

The fastest connection between two

We make sure that

New

Group Delay and Attenuation Measuring Set LD-30

Group Delay and Attenuation Measuring Set LD-3

E 5101

LD-30 **Group Delay and Attenuation Measuring Set, 200 Hz – 20 kHz**

For exact distortion measurements on data lines, even more precise and easier than proposed in CCITT Rec. 0.81. In LD-30 we have invested over 15 years experience with the carrier changeover principle (which the CCITT adopted from us) plus the knowledge gained from the practical and proven experiences with our Measuring Setups, LD-2 and LD-3. The new LD-30 offers all that a craftman wants.

- Economical sender/receiver in one case.
- Speech facility plus loudspeaker built into setup.
- Simple operation, ergonomic arrangement of front panel.
- Remote control of send level and frequency via transmission path as well as measured values retransmitted to send side.
- Also suitable for level measurements.
- Push buttons for simple calibration of X-Y axes on a recorder.
- Measuring ranges: group delay distortion $\pm 50\ \mu s$ to $+15/-10$ ms, attenuation frequency distortion ± 0.5 to ± 50 dB.
- Resolution, 1 Hz, for setting of sweep limits, measuring and reference frequencies.

LD-3 **Group Delay and Attenuation Measuring Set, 200 Hz – 20 kHz**

For all those who want a separated sender and receiver corresponding to CCITT O. 81, completely compatible with the LD-30.

Wandel u. Goltermann

D-7410 Reutlingen 1 · W.Germany · P.O.B. 259
Telephone (0 71 21) 84 41 · Telex 07 29 833/wug d

points is a data transmission line.

it's in good shape.

Attenuation and Group Delay Equalizer DLZ-4 — Telephone Channel Simulator TLN-1 — Data Circuit Test Set DLM-1

E 5101

DLZ-4 **Attenuation and Group Delay Equalizer, 300 Hz – 3.4 kHz**

For fast and extremely accurate equalization of CF channels and lines with loading coils. The given and the required characteristics of the transmission circuit determine the type and number of partial equalizer plug-in units.

- Exactly reproducible equalizer settings.
- Line-up with computer or equalizer catalog.

TLN-1 **Telephone Channel Simulator, 300 Hz – 3.4 kHz**

For simulating group delay distortion and attenuation frequency distortion of 1 to 6 CF or loading-coil line sections. Isolated inputs for the introduction of impairment signals.

DLM-1 **Data Circuit Test Set**

The versatile setup for in-service measurements on data lines. Sender and receiver in one case.

- Phase jitter measurements, according to CCITT Rec. 0.91, in a range within ± 300 Hz of a 1020 Hz test tone. Measurement ranges: 3°, 10°, 30°.
- Frequency shift measurements corresponding to CCITT Rec. 0.111: two tone measuring method (1020/2040 Hz); in ranges: 1, 3, 10 Hz.
- Noise measuring from −80 to −30 dBm, psophometrically weighted.
- Level measuring in range −50 to +10 dBm with 1020 Hz or 2040 Hz test tone.

WG

Representatives in more than 50 countries. Affiliates in:
BR Wandel & Goltermann L. A. · RIO DE JANEIRO, Tel. 2356987
CDN R-O-R Associates Ltd. · SCARBOROUGH Ont., Tel. 416-291-7121
F Wandel & Goltermann France · 94-RUNGIS, Tel. 6776770
GB Wandel & Goltermann U.K. Ltd. · LONDON W 3, Tel. 9926791
S Wandel & Goltermann AB · STOCKHOLM, Tel. 472920
USA W & G INSTRUMENTS Inc. LIVINGSTONE N.J. Tel. 201994-0854

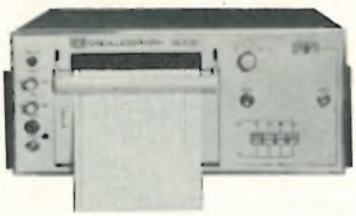
Visit us at the Hannover-Messe 1975, from 16 to 24 April 1975 Hall 12, Stand 300

Circle 240 on reader service card

SE Labs recorders

Light-beam Oscillographs

SE692 Portable Recorder
6 channels on a four speed 92mm chart. Low cost galvanometers up to 2kHz. AC mains and/or dc power input. Only 2.2 amps and weighing in at 7.6 kg — a truly portable recording package at a good price.



SE3006 U.V. Recorder
The best "all rounder" for simple straight forward recordings. No fuss no frills performance at a very economical price. 6 in. chartwidth up to 12 channels.

SE3006DL U.V. Recorder
De-Luxe performance at low cost, 6 in chartwidth, 12 channels. Full facility unit.

SE6008 U.V. Recorder
Our latest model - superb performance at really economical cost. 8 in. chartwidth, servo drive to 4M/ sec. Up to 25 channel capability, many, many novel features.

SE3008 U.V. Recorder
Tried and proven model - a general purpose "workhorse". 8 in. chartwidth. 25 channels. Many options.

SE2112U.V. Recorder
Another tried and proven model - 12 in. chartwidth economically priced. Many options available.Up to 50 channel capability.

SE6012 U.V. Recorder
Our ultimate model - the latest technology coupled with years of experience. 12 in chartwidth 50 channels. 5M/sec forward, reverse drive, integral take up etc.

Galvanometers
SE precision galvanometers provide these oscillographs with measurement sensitivities from 0.8μA/cm to 36 mA/cm and high fidelity recording capability from 0 to 8kHz.

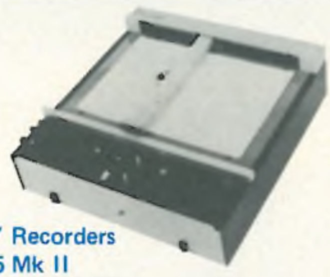
the image makers

Potentiometric Recorders

SE3300 Series

A versatile series of recorders and modules for all applications of potentiometric recording. Single and two pen versions. A choice of writing mechanisms. Input modules for differing sensitivity requirements and many add on function modules eg. AC true RMS, integrating module, etc. Build up from a simple single channel unit to a complex 8 channel dot recorder!

Two new models for A3 operation to be announced shortly!



X – Y Recorders SE225 Mk II

A general purpose X – Y recorder with a good specification at a realistic price. Choice of sensitivity configuration giving a maximum 0.05V/cm on an A4 chart. A compact unit with many features and a specification to equal more expensive recorders. Time base unit gives added versatility and there is also a chart adaptors available.

Galvanometric Heat Stylus Recorders

Economical direct write units. Single double, triple channel recorders with vertical or horizontal chart travel. Frequency response to 100Hz Sensitivities 10mV/mm choice of chart speeds; full 50mm pen travel; available in OEM or cased configurations.

Super 8

Superlative performance from this eight channel pen recorder. Unique variable drive from 0.25 to 100mm/sec. Frequency response to 100 Hz; Sensitivity 10mV/mm; channel width full 50 mm: OEM configuration.

Hire or Buy

For a small charge you can hire any of the instruments shown here, singly or as part of a system which we can design for you.
If you decide later to purchase the equipment, we can refund part of the hire fee to you.
You save your capital and space. You beat obsolescence.
Why not ring our Hire Department for details?
Included in the range are Transducers, Recorders, Oscilloscopes, Digital Instruments, Data Systems, Magnetic Recorders, Computer Terminals, Modems, Hard Copy Printers, Facsimile Transceivers.

SE Labs(EMI) Ltd North Feltham Trading Estate, Feltham, Middlesex. Telephone: 01-890-1166 Telex 23995
Northern Sales Office, Bessell Lane, Stapleford, Nottingham. Telephone: Sandiacre 7255
Scottish Office, 18, Sycamore Drive, Hamilton, Lanarkshire. Telephone: Hamilton 28674

EMI A member of the EMI Group of Companies
International leaders in Electronics, Records and Entertainment

Circle 241 on reader service card

THE
THE NERVOUS

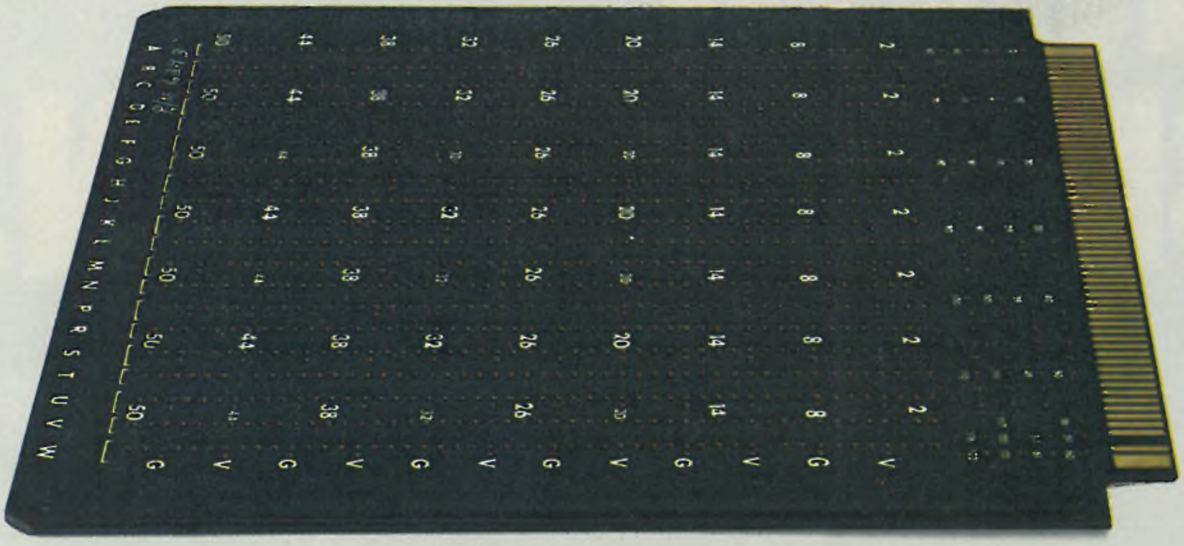
The Danameter II

We guarantee this instrument will hold its specs for at least one year.

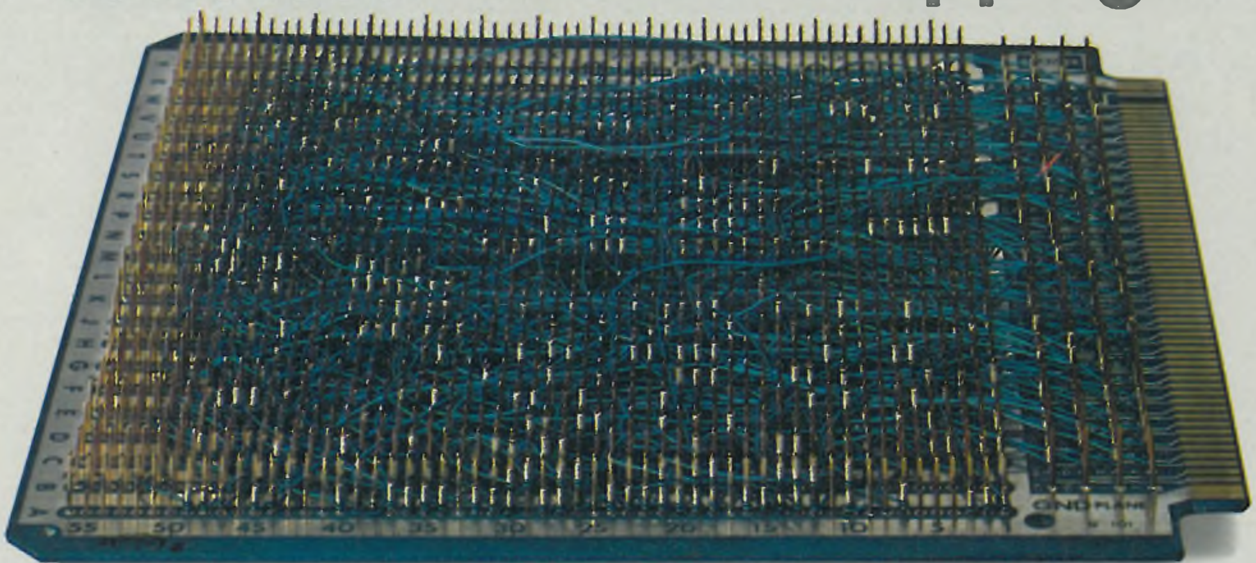
This means you won't have to re-calibrate it for a year. And you won't have to change its battery for at least one year. (When you finally do, it'll cost you about 70 cents.)

You can take it out in the field and kick it around. And a year from the day you buy it. The Danameter II

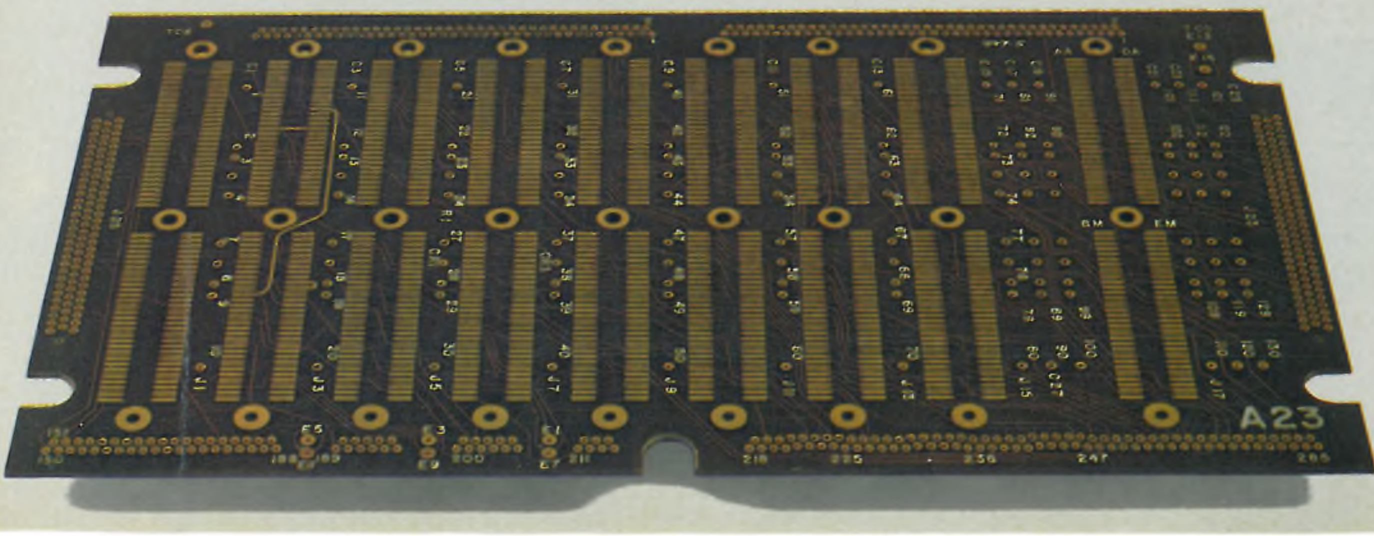
Compare Multiwire:™



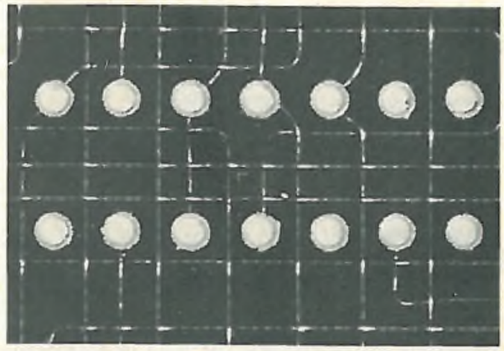
costs less than wirewrapping...

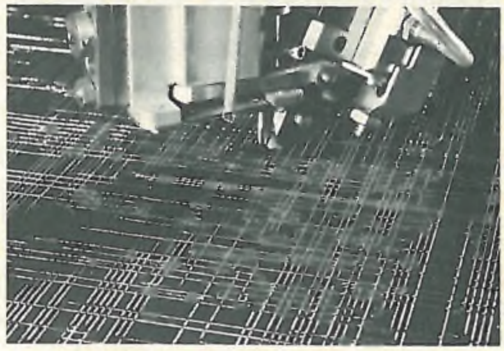


works better than multilayering.



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

Circle 65 on reader service card

NASA seeks standard parts

Important savings expected in planning for 41 spacecraft in the Earth Observatory Satellite series; electronics worth $200 million

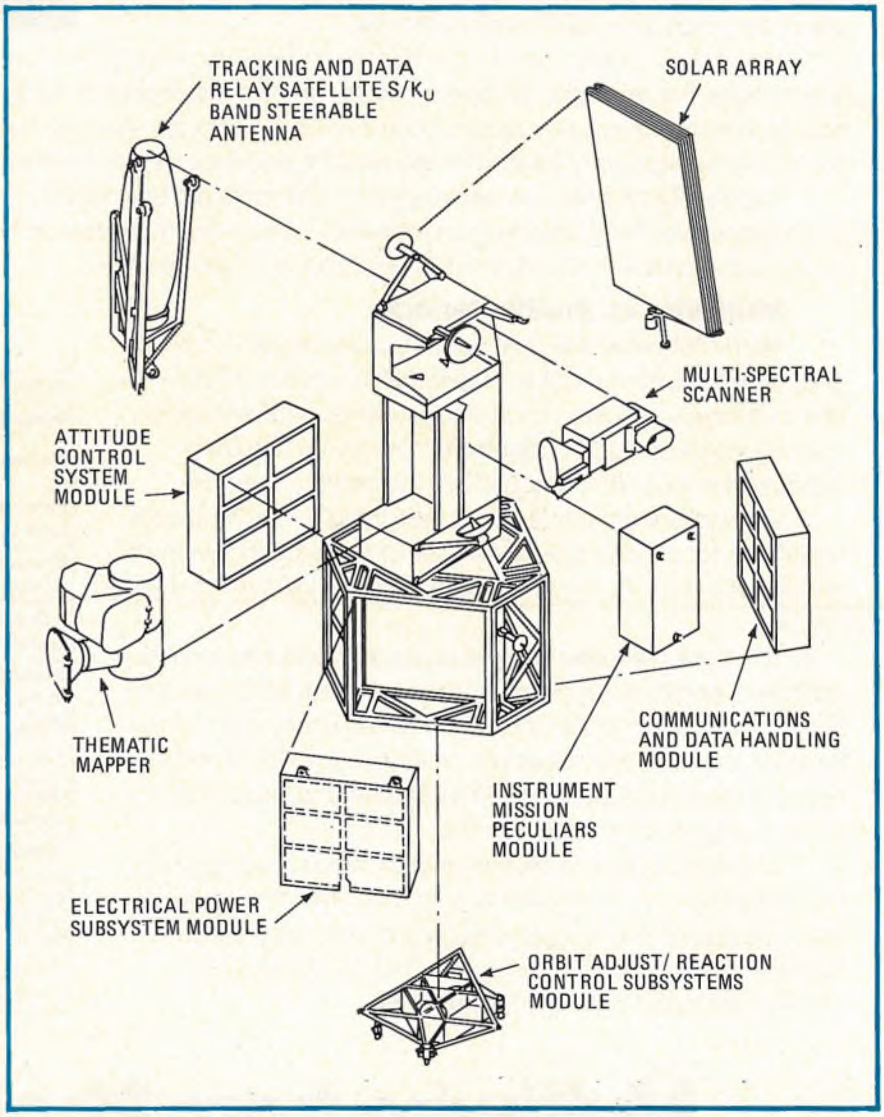
by Larry Marion, Washington bureau

NASA is trying to counter rising costs by asking contractors to use standard parts for the 41 Earth Observatory Satellites (EOS) to be launched from 1979 to the 1990s. Contracts for more than $200 million in standard EOS electronics modules will be sought beginning in July for applications such as command- and data-signal transceivers, electric-power, and attitude control systems, according to Frank J. Cepollina, manager of NASA's modular spacecraft program.

The EOS series, which evolved from the Applications Technology Satellites (now called Landsats), will include land, air, and water surveying missions. The Landsats are limited to land observation.

NASA estimates EOS cost, including modules, assembly, and testing, at approximately $7.2 million per spacecraft. But the three design contractors involved have come up with their own numbers. The TRW Systems group says $5.7 million, Grumman Aerospace Corp. estimates $6.3 million, while General Electric's space division is high guesser at "less than $8 million." William A. White of NASA's modular spacecraft staff says redundancy requirements were revised after corporate cost estimates were prepared, and that a high-level NASA committee is reviewing them for comparable figures. Industry and NASA officials agree, however, that the final costs will be a bargain.

Standardized spacecraft can save "hundreds of millions of dollars" compared to the cost of custom-designed spacecraft, Cepollina says. "This program can reduce system costs by one-third to one-half." Grumman's project manager, John Marino, and Aerospace Corp.'s Ernie Pritchard, who is director of a cost review for NASA, hold similar expectations. Marino figures that "cost benefits can be expected after two missions, while for 10 missions the savings would be on the order of $100 million." And Pritchard says: "Standardization of EOS satellites



Standard parts. That's the way NASA wants to handle its EOS family in an effort to cut costs. Three contractors—Grumman, TRW, and GE—are in the running. This is Grumman's version.

significantly reduces design, development, test, and evaluation costs. There will be a 36% to 54% savings for EOS projects."

While the economies are not questioned, some NASA project managers do not relish standard parts in experimental spacecraft. "When do standardized spacecraft become standardized missions?" wonders a deputy project manager for a major NASA earth study program. "I'm worried about what happens during the interim phase, between custom design and the availability of standard parts."

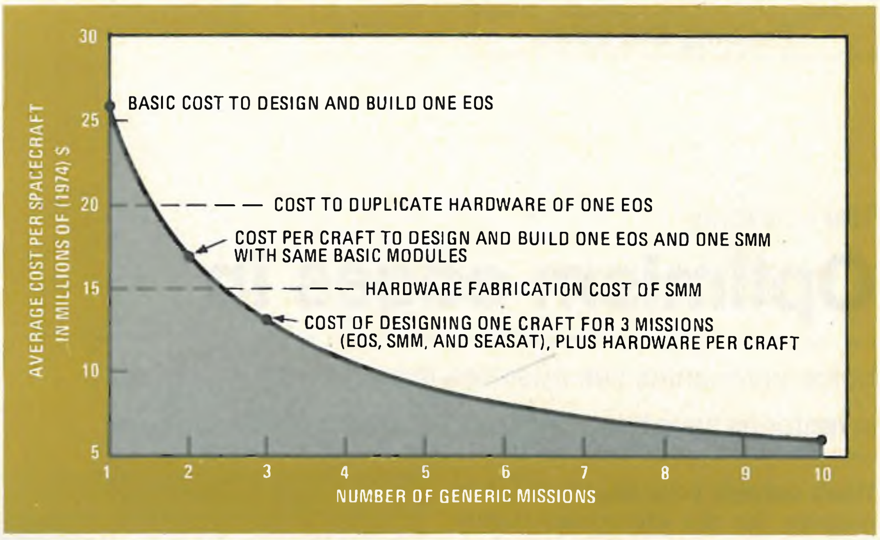
Another manager questions whether NASA would be able to maintain a warehouse of parts for up to five years to amortize development costs. And a 15-year veteran of spacecraft design wonders, "Have they studied the problems involved in guaranteeing shelf-life for five years?"

Three design contractors submitted similar EOS configurations to NASA in December 1974, recommending that the basic modules be matched with various earth-scanning sensors on a metal skeleton. Although all three contractors recommended a command- an data-control signal-transceiver module—consisting of a central processor and memory modules, plus S-and Ku- or X-band transponders—system capacities differed. Contractors also recommended a twisted-pair data bus to connect the command module with "mission-peculiar" instruments.

How many bits? Grumman suggests a CPU with 32 kilobits of memory, GE suggests 40 kilobits, while TRW suggests 16 kilobits. "With an on-board computer, EOS can execute a mission by itself," says NASA's White. Grumman's Marino says the CPU will permit faster signal processing—up to 120 megabits per second—compared to currently operating spacecraft transmitting similar data at up to 15 Mb/s.

NASA says the computer will be one of the most sophisticated ever to be placed on a satellite, and certainly the most independent one. Moreover, its MTBF will be at least two or three years, with an upper limit of four years.

Between 1,000 and 2,000 watts of peak power will be needed for EOS in most cases, says White. TRW's design includes up to four, 40-amp/hour batteries with a total output of 333 watts of peak power. With solar arrays directly adding power to the system on a power bus, total system output is 2,000 watts.



Cost curve. NASA would save more than $100 million over the course of 10 missions if it standardizes spacecraft parts, according to this chart from Grumman Aerospace Corp.

GE's power system includes up to five batteries with a total of 100 amp/hr. capacity— up to 2,250 watts from a full-up system, including solar arrays. Grumman's power system promises up to 3,500 watts peak power, with an average power rating of 1,500 watts.

Precision pointing and stability for EOS is vital for accurate earth scans, so three-axis stabilization is required. A gimbaled star tracker, three momentum wheels, and three magnetic torque bars are recommended by Grumman to provide attitude pointing accuracy to within 0.01°, and stability to within 10^{-6} degree/second. GE has a fixed-head star sensor coupled with three magnetic torque bars and three momentum wheels for 0.006° stability.

TRW predicts 0.009° stability with three of each—wheel, bars, and star trackers. Accuracy is estimated to be within 30 seconds of arc. Electronics in the attitude-control module are linked via the data bus to the command module's on-board computer for position correction.

The first standardized EOS mission will be "Egret," a low-orbit satellite to monitor gamma radiation in the atmosphere. Egret modules will be sought in a request for proposals due close to July 1. "The RFP will be worth about $4 million," says Cepollina.

Egret's first sibling, called the Solar Maximum Mission (SMM), will measure radiation during solar flares. The White House has promised NASA that the agency could begin hardware procurement of SMM in the 1977 fiscal year beginning October 1976, important for development of sophisticated electronic controls to enable the satellite to focus on the sun during solar flares expected in the next few years. Following SMM will be the EOS-A twins, improved versions of Landsat 1 and 2 already in orbit. EOS-A will have a mapper capable of 30-meter resolution, compared to the 80 meters of Landsat. A more sophisticated EOS-B will have speedier data rates of up to 240 Mb/s.

Other EOS missions include water- and air-pollution monitoring, called EOS-C and E. Another series of monitors will be launched into geosynchronous orbit around earth. The National Oceanographic and Atmospheric Administration has requested a cloud-monitoring satellite, called Tiros-0, to be launched in 1983 or later. Included in NASA plans is a biomedical experiment with an instrumented monkey, reminiscent of the 1960s.

Despite this return to the past, industry officials say standardized spacecraft are the beginning of a new era. □

The economy

Optimism edges in

Some companies see business improving as customers' inventories have been brought into line and money eases

How's business? At Zenith Radio Corp., president John J. Nevin (top) predicts industry-wide TV sales will be down slightly from last year. As for semiconductors, Intel's president Robert Noyce (above) is more optimistic, predicting business will turn around late in 1975.

Don't uncross your fingers yet, but business for the electronics industries doesn't seem to be as bad as generally expected. While 1975 won't be a good year, and some companies surveyed are not too optimistic, others are beginning to see some light penetrating the recession's gloom.

In the semiconductor industry, layoffs and production cutbacks during the second half of 1974 apparently have had the desired effect. Robert Noyce, Intel Corp.'s chairman, believes that the industry is headed for improvement and will turn around late in the year. "Unless there is a continued decline in the general business environment," he says, "we have probably reached bottom." Contributing to this feeling, says Noyce, is the fact that "customers' inventories are getting down to a minimum."

Noyce says that Intel's shipments have been "down but firming." Last year's third and fourth quarters were down 10% each from the previous quarter, but 1975's first quarter was only 5% behind the last quarter of 1974.

Fairchild sees "no V-notch recovery" for the industry, but rather a gradual one that should start in the second half. For the first two months of 1975, bookings are up from last year's corresponding period, and though Fairchild's sales dropped last year, "inventories came down as well," says an official. And compared to the 1970 recession, when it lost $18 million, the company is in solid shape because it earned $26 million last year, says the official.

At Advanced Memory Systems, inventories for the quarter ended Dec. 31 were down $800,000 from the $7 million total of the previous quarter. Shipments, meanwhile, were valued at $7.5 million, the same as those of the comparable year-ago quarter. AMS' backlog is up 12% from a year ago, but president Orion L. Hoch says that "part of that is because we're working with longer lead times" of six to nine months due to the need to order critical materials.

"Some weeks we see signs of turning up," says Hoch, "others, I'm not so sure. But compared with three months ago, Hoch says, "There are more positive signs but no trends. It was hard to close orders three months ago; now, there is a little more activity."

Mostek Corp.'s Berry Cash, executive vice president, sees a reluctance on the part of customers to build up big inventories. "Distributors are beginning to buy a little," he says, "and customers' inventories are in better shape, so they are beginning to buy." But orders are small; customers are buying only for two to three months at a time.

Inventory buying was forecast in January, points out J. Fred Bucy, chief operating officer at Texas Instruments Inc. [*Electronics*, Jan. 9, p. 67]. Warning of false indication of growth, Bucy said, "In the first half of the first quarter we'll see some increase in orders because customers just did not buy for inventory in the last quarter of 1974. They'll be buying for replacement in inventory in the first quarter. Some people will read this as an upturn, but I think that history will show that this is just a flash in the pan, and we'll continue to slide."

Among components makers, Les-

What's new in solid state...

Four RCA op amps that make the CA3130 what it is.

Our CA3130 gets many of its winning ways from four very capable relatives. Four RCA op amps that can fill special requirements you may have. If you need programmable linear gain control, check the CA3080. For high crossover frequency plus high slew rate, there's the CA3100T. For high output current and easy programmability, the CA3094E. For low power supply drain, the CA3078T.

The CA3130 is the ideal choice when you're looking for a good measure of all of these characteristics in one device. That's what makes the CA3130 so great. Its versatility comes from the unique combination of MOS/FET, bipolar and COS/MOS on the same chip. And its surprisingly low 1K price of 75¢ makes it a natural for your high-volume products.

Beyond the table, here's more typical data about the CA3130:

Input Impedance: 1.5 TΩ ($1.5 \times 10^{12}\,\Omega$).
Input Current: 5 pA.
Input Offset Current: 0.5 pA.
Input Offset Voltage: 0.8 mV (CA3130B).
Settling Time: 1.2 µsec.

An output voltage swing to within 10 mV of either supply rail.

Strobing terminals.

If you are interested in one or all of these op amps, contact your local RCA Solid State distributor. Or RCA.

Write: RCA Solid State, Box 3200, Somerville, New Jersey 08876; Ste. Anne de Bellevue 810, Canada; Sunbury-on-Thames, U.K.; Fuji Bldg., Tokyo, Japan.

RCA

	CA3080E	CA3100T	CA3094E	CA3078T	CA3130
Gateable plus programmable gain control	> 60 dB				Gateable
Unity gain crossover frequency, MHz		40			15
Slew Rate, V/µsec		25			10
Output, mA (peak)			300		22
Power consumption, mW				.0015	2.5
Single supply voltage required, V				1.5	5.0
Price (1K), $	0.55	1.50	0.90	1.25	0.75

RCA. A full house in linear ICs.

Circle 69 on reader service card

Probing the news

lie W. Chapin of Helipot says, "most manufacturers are still experiencing pretty much of a downturn." Chapin, vice president and manager of the Beckman Instruments division, says that sales to the military are strong, but that high-end consumer and industrial products are off. "The distributor business," he says, "is firming just a shade." He attributes this to the working off of excess inventory. As for an upturn, Chapin says, "Everyone is exhibiting a little wishful thinking and talking about the last half," but he believes 1976 will be a good year.

Business at the Amphenol division of Bunker Ramo Corp. has been improving ever since last fall's low point was reached. Herbert F. Motz, president of the division, says, "We've seen what I believe to be a trend since about November—business is improving in very, very small steps." Motz adds, "A good part of the downturn was the reduction of inventories at distributors and OEMs. Now they're getting their inventories in order, so the climb that we're seeing reflects actual usage out in the field. After we get back up to the actual usage plateau, growth will depend on the economy and the confidence of people." But Amphenol's figures reflect Motz' conviction that this recession is much deeper than 1970's. In the first two months of this year compared to the same period in 1974, inventories are up 15%, shipments are down 15%, and bookings are down 20%.

Edson D. de Castro, president of minicomputer maker Data General Corp., is cautiously optimistic. The order rate, he says, is "tough to read because of stretch-outs and cancellations, but we see some signs of this unrest subsiding. People have gotten a little better reading of where they are, and they know the level they'll be operating on." De Castro says Data General's inventory of components and subassemblies is too high—at the end of December it exceeded that of the previous quarter and year. Despite this, de Castro expects Data General to grow by about 25% this year from last year's $83 million in sales; he says that minicomputer trends are so steep and strong that business cycles don't have much impact.

Also holding its own is mini maker Computer Automation Inc. President David H. Methvin says, "We planned for $5.1 million in volume for each quarter this year, and we should just about make it." He says sales for the year will be up a little over last year's, but they will be down this quarter from last year's comparable period.

"I don't see any upturn," says Methvin, "but I don't see things going to hell in a handbasket, either." The company president says that his gut feeling is that business will turn up toward the end of the year.

Methvin notes that the order rate is pretty steady. "Backlog has been drifting down for several quarters with the big guys stretching out some. We've also redefined some of our backlog to make it more conservative." He says that new customers seem to be healthy, and that bright spots include oil-related industries—"They're still spending money at a prodigious rate."

Hewlett-Packard Co. is "right on target," says Alfred P. Oliverio, vice president of marketing, even though first-quarter 1975 sales dipped to $212 million from the $245 million of the previous quarter. The reason, he says, is traditionally slow first-quarter buying. First-quarter orders are up over the previous period, $240 million to $203 million, and H-P anticipates a 1975 order growth rate of 15%, although 10% of that is for inflation.

Perhaps hardest hit by the recession has been the consumer electronics industry. It's a highly competitive arena where manufacturers consider disclosure of backlogs, order rates, and inventories aid and comfort to the enemy. However, Zenith Radio Corp., the nation's largest maker of color television sets, expects to see the industry's sales to dealers this year in the range of 7 million to 7.5 million sets, slightly less than 1974's 7.8 million and dramatically less than 197[illegible] record 9.3 million.

Zenith's president, Jo[illegible] J. Nevin, says that at the end of [illegible], industry inventories were [illegible]% above year-end 1973 levels. Of this, Nevin says, Zenith had 12%, with 20% of industry sales. Zenith production in January was down 23% from the previous January's totals, compared with 49% for the entire industry, says Nevin. □

'Not as bad as you think'

With inventory playing such a big role in determining when the recession hits bottom, distributors should have a pretty good line on the condition of business. "It's not as bad as you think it is," says Paul Carroll, president of Semiconductor Specialists Inc. of Chicago. "We hit our low in November, and since then we've seen shipments increase at a steady 10% per month. And bookings are climbing even more dramatically."

However, says Carroll, inventories are still too high. "The only way to get them down is to sell, since manufacturers have taken back all they will. And they're still unbalanced, particularly in 7400 [TTL] and C-MOS."

Carroll attributes the growth since November—which is still 20% less than the peak a year ago—to the depletion of customers' inventories and the drop in interest rates. As for a turnaround at the manufacturers' level, he says, wait until the second half. And he expects midyear shortages in C-MOS and certain memories—like the 1103 and 2102.

In Newton, Mass., Timothy X. Cronin, president of Cramer Electronics Inc., says Cramer is about 10% ahead of 1974's fourth quarter in sales and 15% ahead in shipments and bookings.

Cronin says that he thinks there is a lot of inventory on manufacturers' shelves, but they have reduced capacity about 25% to 30%. Demand is flat now, but in the near future it will outstrip the capacity to produce, he forecasts. Starting in June, manufacturers will find themselves in a shortage position, says Cronin, adding that "selective holes" will develop during the summer months.

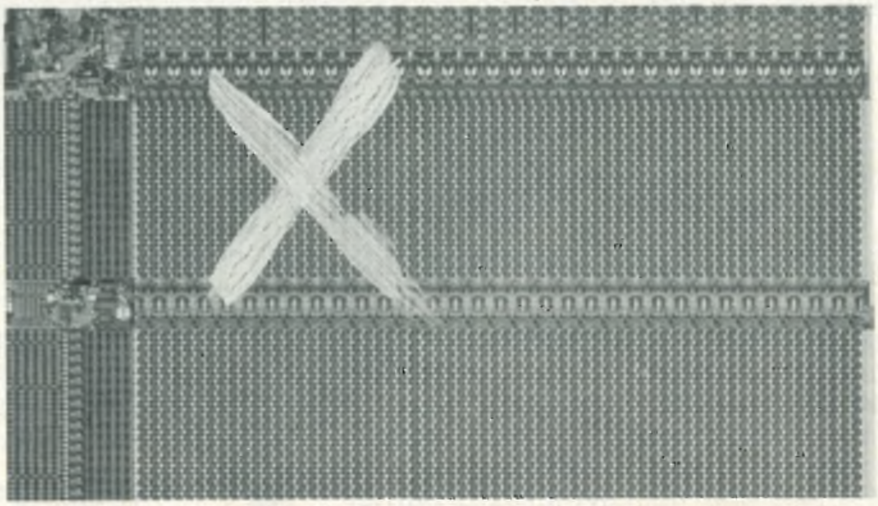
Solid state

'Partial' devices being revived

Some memory makers find that RAMs with only 1.5, 3, or 6 good kilobits help recover development costs along low part of learning curve

by Bernard Cole, San Francisco bureau manager

Back in the mid-1960s, Texas Instruments sold a "relaxed" transistor-transistor-logic family—devices had fanouts of 6 or 4 instead of the normal 10, and counters had one bad flip-flop. The advantage of these so-called partials to the buyer was, of course, a lower price. But as TTL climbed the learning curve, yields improved and the price per device dropped. The profits from TTL partials became marginal, and TI discontinued the practice.



Partially good. The sale of partial memories raises some questions: How good must they be? What's the profit cut-off point? Some makers, as a result, are staying out of the business.

Now, history appears to be repeating itself, this time, with memories—particularly random-access memories. Companies are looking to partial devices as a way to recoup the substantially increased cost of developing memories as early as possible in the learning curve. As the industry digs out of the recession at the time it is moving toward larger-scale integration, manufacturers are selling partially defective 2,048-bit or 4,096-bit devices—they will eventually sell 8,192-bit parts—as memories with capacities of 1 or 1.5 kilobits, 2 or 3 kilobits, 4 or 6 kilobits.

Many companies—including Intel Corp., Mostek Corp., Motorola Semiconductor, Fairchild Semiconductor, and National Semiconductor—have started to use and sell partials, or they are considering the step. A few others—among them Advanced Memory Systems Inc. and Cambridge Memories Inc.—have been using and selling partials for a number of years. Some, like TI and American Microsystems Inc., have studied the problem and decided it is not worth it.

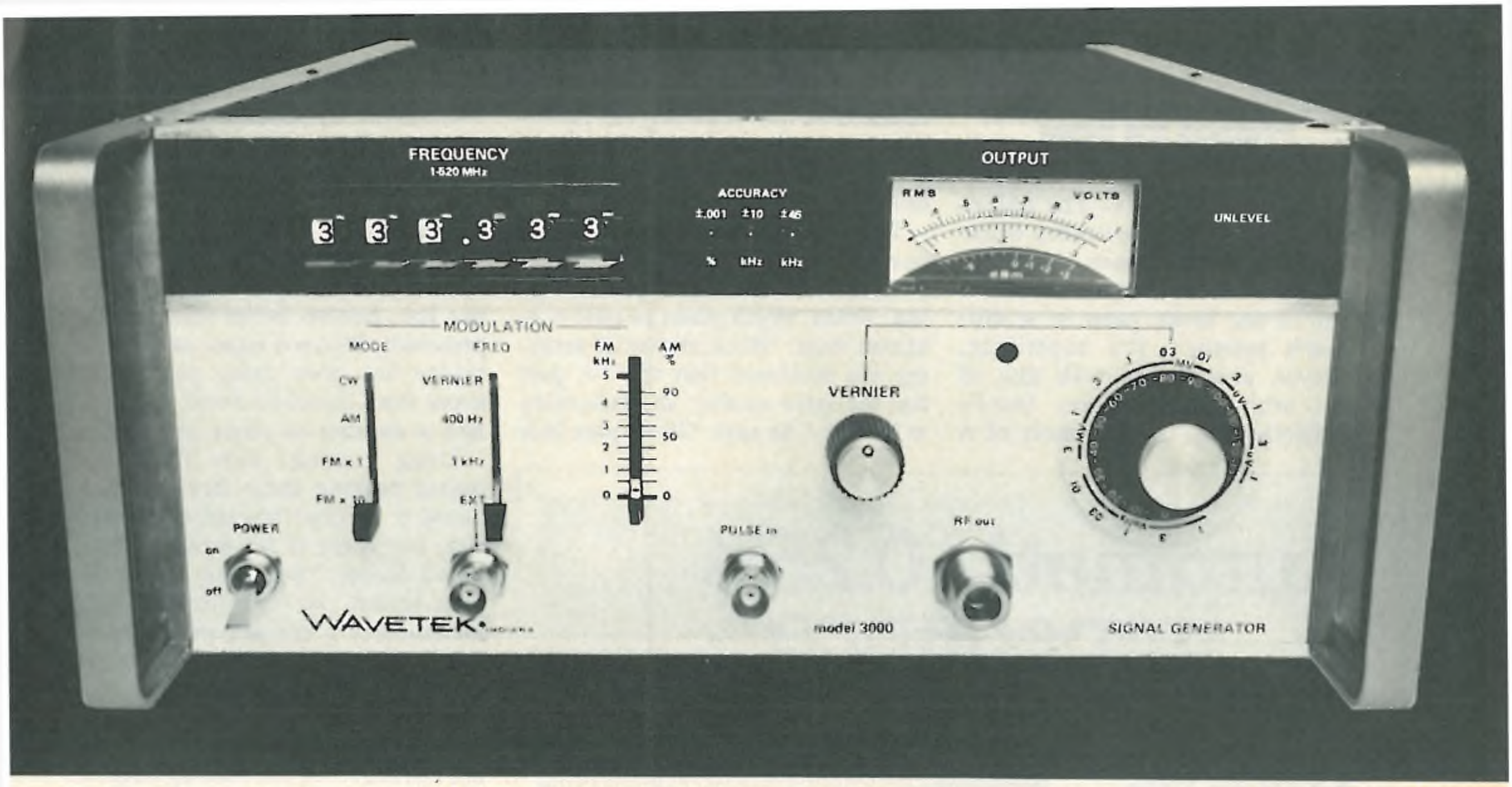
"There's a lot of good memory being thrown away at present," says Durrell Hillis, n-MOS marketing manager at Motorola Semiconductor Products Inc., Phoenix, Ariz. "But setting up a system to use them is not as simple as it seems at first." He says that Motorola is investigating, but has not decided what to do.

Identify and test. The reasons for this hesitation are clear from the beginning, when it is necessary to first identify and then test and separate partials from fully operational devices. Mike Markkula, Intel's North American marketing manager, says, "First, it's important to determine the reasons for the defects in the partials. If the reason is related to a lousy process, selling or using all the partials in the world won't help you. If it's a random defect, it is just a matter of determining which quadrant and marking it."

But how many quadrants of a RAM can be defective before it becomes uneconomical to use? That depends on a delicate balance between component cost and system cost. Motorola's Hillis estimates that it takes at least a 2:1 price advantage for partials to be attractive. Certainly, all three kinds of partials—those with one, two, or three quadrants out—fill the bill. Ron Livingstone, memory marketing manager at National, points out that system cost is something else altogether. "From this point of view, three fourths is the best rule of thumb," he says.

TI approached. Edwin S. Huber Jr., MOS memory marketing manager at TI, says the company has been approached by several customers—principally makers of fairly large add-on memories—to supply them with "three-quarter" good 4-k RAMs, but TI has turned them down. The major reason for this, he says, is the reliability problem.

"We took our parts that were partially good and ran accelerated life



For $1,975 you have no right to expect a signal generator like this.

For $1,975 you should have to settle for tubes, or for a non-phase-locked generator.

But here's the Wavetek 3000, so you can toss your expectations out the window. This solid state signal generator is not only phase-locked and accurate (±0.001%), it's programmable as well. And it covers the entire range from 1 to 520 MHz in a single band. Yet once we've received your order, you can expect a signal generator like this one right away . . . for just $1,975.

That may not be right, but it sure is reasonable.

SPECIFICATIONS
Frequency Range: 1–520 MHz
Frequency Accuracy: ±0.001%
Resolution: 1 kHz
Stability: Less than 0.2 ppm per hour
Output Range: +13 dBm to −137 dBm
Flatness: ±0.75 dB
AM Modulation Range: 0–90%
FM Deviation: 0–5 kHz and 0–500 kHz
Internal Modulation Rates:
400 Hz and 1 kHz
Dimensions:
12" wide x 5½" high x 13¾" deep
Price: $1,975

WAVETEK®
INDIANA INCORPORATED
P.O. Box 190, 66 North First Avenue
Beech Grove, Indiana 46107
Tel. (317) 783-3221 TWX 810-341-3226

Circle 242 on reader service card

tests on them at 125°C. The failure rates were two to three times worse than it was for good parts, and that's significant enough that we don't want to see those parts in a customer's system." TI's experience, however, doesn't jibe with that of most other RAM makers. Intel's Markkula says, "I think most of it depends on how reliable your part is in the first place. Our studies show that partials are just as reliable as fully goods."

The big problem is a marketing one, says Berry Cash, executive vice president of Mostek Corp., Carrollton, Texas, which plans to offer a 3-kilobit RAM. "It's a matter of assuring the customer that the 3-k part has the same quality and reliability as the 4-k," he says. "If the part fails because the threshold has drifted or because of leakage, it won't work as a 3-k part. But if it fails because one of the sense amps doesn't work, it will be O.K. as a 3-k."

However, the experience of at least one user, Cambridge Memories Inc., Boston, belies this. Its vice president, Richard Egan, says Cambridge has been using partial 1-k RAMs from Fairchild Semiconductor and a number of other companies.

Using partials, says Egan, requires packing more devices on a board to achieve the same memory size, but there is no problem with board layout. "By using an intelligent layout, we can use all-100% memories or a mix of partial memories," he says. "Specs and reliability aren't compromised, and the cost is considerably lower."

Motorola's Hillis adds, "Partials are attractive on the leading edge of the production curve, but become marginal as production increases and yields improve." Then the question becomes: what is the cutoff point beyond which partials are no longer profitable? National's Livingstone suggests that a good rule of thumb for cutoff is when package cost equals chip cost.

But, asks TI's Huber, how does a company keep from painting itself into a corner with a large customer using partials? He points out that it would be easy for his company, because of its volume, to supply lots of partial 4-k RAMs. "But the partially good 4-k is only a short-term patch," he says. "Over the long term, those rejects are not going to be generated by manufacturers. They'll disappear as yields continue to improve, and then the manufacturers will be stuck with a volume market that he'll have to downgrade 4-ks for, to continue to sell."

What it may require, says Intel's Markkula, is marketing partials and complete devices as a package, rather than separately. "This approach relieves both the user and supplier of a number of problems. The supplier can be assured he isn't cutting his own throat, and the user will know he's getting good parts. He'll know the supplier runs the risk of losing his contract for fully goods as the yields improve if he messes up on the partials." □

HD/CMOS achieves LSI circuit densities unmatched by any other CMOS process.

HD/CMOS II is even better.

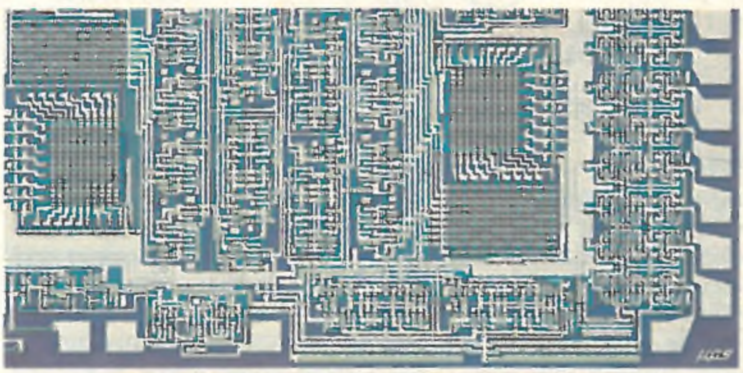
Our High-Density CMOS process for custom Large-Scale Integration was an innovative development that made CMOS ideal for use in dedicated LSI subsystems. Since its introduction over two years ago, HD/CMOS has been used in volume production for a wide variety of applications in the fields of electronic timekeeping, portable instrumentation, medical and consumer electronics.

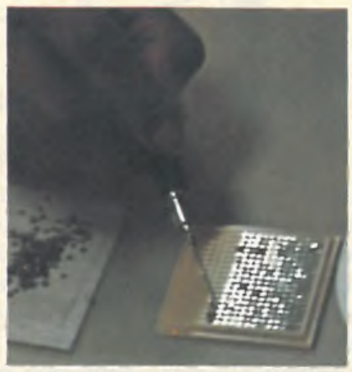
Continuing refinement of this unique processing technology has resulted in a major new breakthrough. We call it HD/CMOS II. It gives you even greater circuit densities, lower power operation, and faster switching speeds. In fact, it's presently providing the highest density of circuit integration yet attained for random logic designs.

HD/CMOS may be ideal for improving your product. If so, it can produce exciting and profitable rewards in the marketplace.

Applying the advanced technologies of LSI to customer products is our sole business. We can help you answer questions about cost/quantity tradeoffs, long-term profitability of the host product, and choosing the right processes to optimize performance and reliability.

If you're considering LSI, consider Micro Power. We sell more than circuits. We sell solutions.





Contact us for complete details:

MICRO POWER SYSTEMS

3100 Alfred Street
Santa Clara, CA 95050
Telephone (408) 247-5350
TWX 910-338-0154

MPS/Japan
21 Mori Bldg., 2-2-5 Roppongi
Minato-ku, Tokyo, Japan
Telephone 586-0471

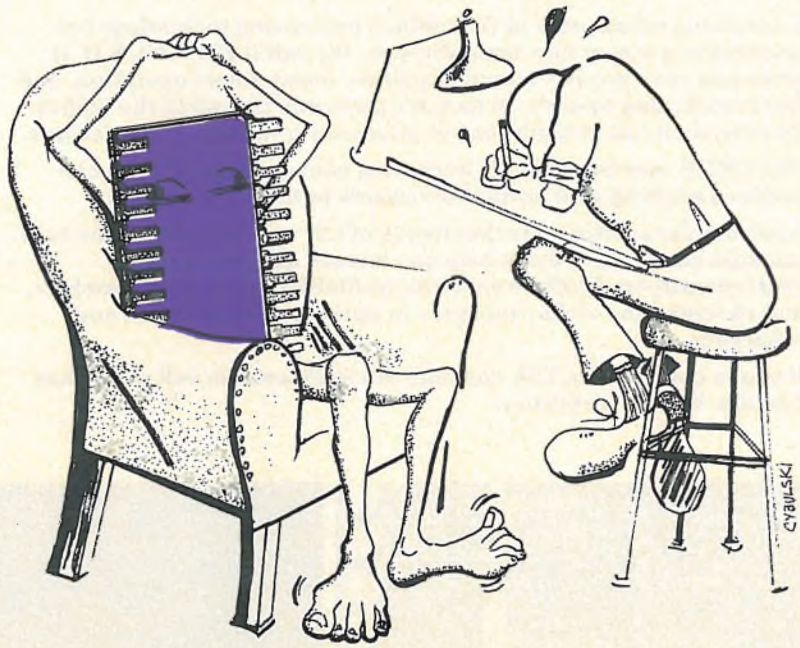
Probing the news

Instrumentation

Microprocessors await the call

Instrument makers agree that the devices will play big role, although some jobs appear to be out of their bailiwick

by Andy Santoni, Instrumentation Editor



Despite some reservations, instrument makers are excited about the possibilities of microprocessor-based designs and are eager to apply them in a wide variety of products. And while most instrument houses are designing and even testing such products, few executives will say precisely how their companies are using semiconductor microprocessors. Instead, they prefer to save their enthusiasm for the general concept.

Microprocessors do not only supply internal and external controls, they are also reducing maintenance problems by providing internal equipment diagnosis, self-test, and self-calibration. The devices are also improving reliability and accuracy. And the microprocessor can convert instrument-output codes into digital-transmission form or for computer use.

However, the designer must assure himself that the microprocessor offers the best operation for his instrument—microprocessors are relatively slow—and that the expense is justified.

The most obvious applications would be to have microprocessors handle the same kinds of tasks as minicomputers, but on a smaller scale. If a minicomputer gives a system flexibility because its operation can be changed by software, a microprocessor can provide the same kind of capability to an instrument. Such instruments as digital scanners can employ microprocessors so that one design can be adapted to many jobs, says Albert Frowiss, vice president of Doric Scientific Corp., San Diego, Calif.

Control. Also, like minicomputers, microprocessors can control processes, either internal or external to the instrument. Internally, a microprocessor can scan front-panel controls, stimulate the appropriate circuitry, and turn on the proper displays and other outputs, as does the John Fluke Mfg. Co. microprocessor-controlled frequency synthesizer (see p. 104). Externally, a microprocessor can perform many process-control functions, as in Doric's instruments. "The real need is in an area where you have a number of variables that bear some relationship to one another," says Fred L. Katzmann, president of Ballantine Laboratories Inc., Boonton, N.J. Process control, for example, may require monitoring pressure, volume, and temperature signals.

Functions. Within instruments, microprocessors can perform certain functions that would be too expensive or cumbersome to perform any other way. For example, they could be used for instrument self-test, diagnosis, and calibration; an estimated 25 million man-hours are devoted each year to calibration in the United States alone. Normally, says Alan B. MacLane, general manager at Systron-Donner Corp.'s Instrument division, an instrument has to go in for calibration every 90 days or so, and it stays in the shop for about a week. "Many companies might spend 10% of the value of the test equipment in calibration and maintenance," or $100 per instrument per year, he notes. Using a microprocessor for self-calibration could cut calibration time by 25%, says MacLane, and could lower the price of some components within the instruments because high precision would not be necessary.

Self-calibration would not only

HERMES LOOP ANTENNA

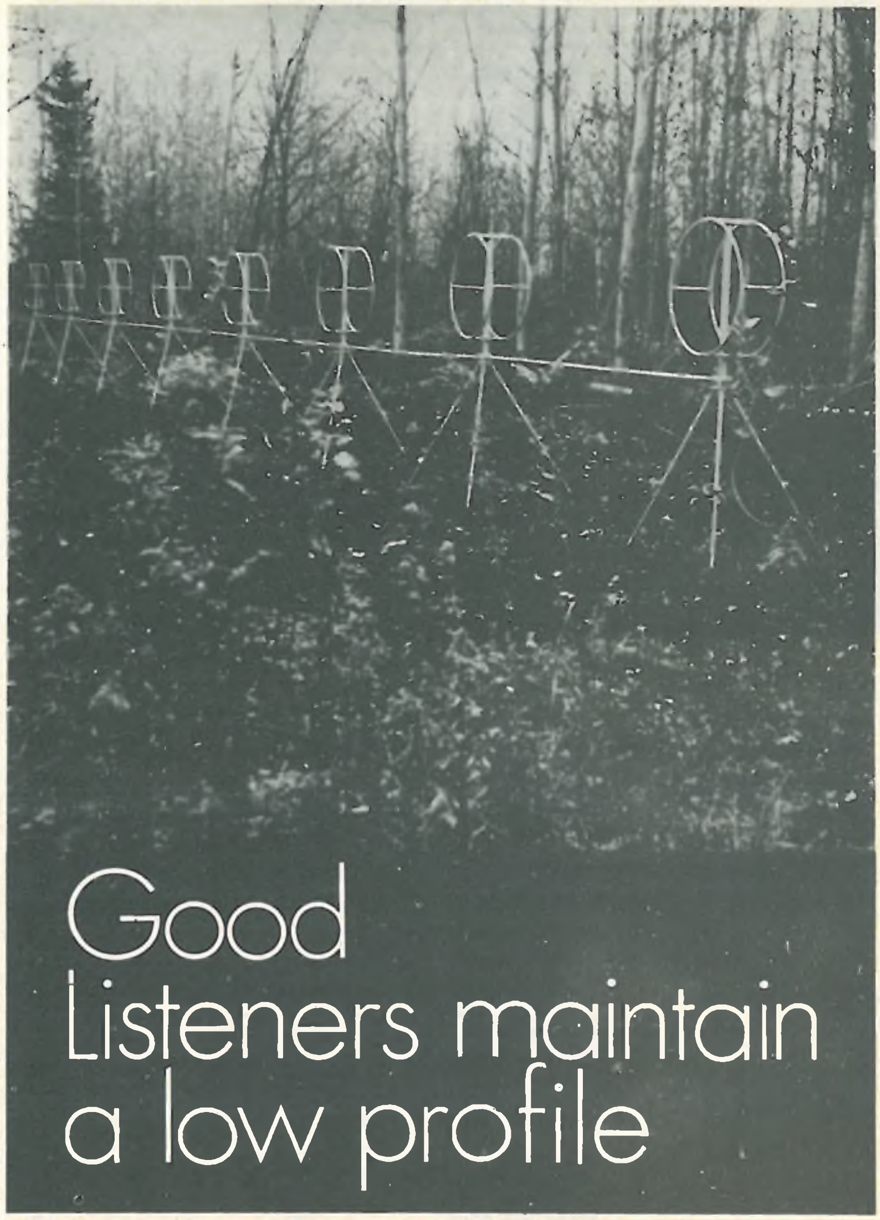
THREE SAMPLE SITES
ON THE NORTH AMERICAN
CONTINENT —

DIFFERENT LATITUDES
DIFFERENT CLIMATE

FROBISHER BAY, CANADA

MARSHFIELD, MASS.

NEAR SAN DIEGO, CALIF.



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.
Excellent directional characteristics 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

save money, but also improve measurement accuracy because the instrument's accuracy would not be affected by calibration drift. Microprocessors can improve accuracy in other ways, too. They can average large numbers of readings and ignore "outliers"—erroneous readings far from the average. They can also eliminate arithmetic errors by performing mathematical operations and displaying answers directly.

Accuracy. Walt Fischer, group leader at the Colorado Springs division of Hewlett-Packard Co., notes that a microprocessor significantly improves the measurement accuracy of the firm's model 1722 oscilloscope. Obtaining accurate measurements from an oscilloscope, he says, generally requires a great deal of ability on the part of the operator. He must be able to interpolate readings and make decisions, and he can make significant errors if, for example, he leaves switches in uncalibrated positions. Microprocessors can help because they can improve bookkeeping by tracking switch positions, says Fischer.

One other function a microprocessor can perform in an instrument, says Wim Velsink, vice president of Tektronix Inc., Beaverton, Ore., and director of Tektronix Laboratories, is output-code conversions. Simple software changes would permit an instrument to deliver data in any of many forms: binary, BCD, ASCII, or others. Today, says Velsink, "you have a choice of building several interfaces or saying goodby to segments of the market."

Reliability. And while improving instrument performance in all these ways, says Hamilton Chisholm, engineer at HP's Stanford Park division in Palo Alto, Calif., microprocessors can also improve reliability. Microprocessor-based circuits may contain fewer parts, leaving less to go wrong, and they may dissipate less power, keeping the instrument and its internal components cooler.

Fischer adds one note of caution: microprocessors should be used only where they improve the instrument's performance. "You can't get

Probing the news

so involved in the cuteness that you don't make a measurement contribution," he says.

Ballantine's Katzmann adds that microprocessors are of questionable use in one- or two-dimensional systems like most test and measuring instruments. Like voltmeters, which measure in one dimension—voltage—and oscilloscopes, which measure in two—voltage vs time—few test and measurement instruments operate in three dimensions. However, microprocessors could simplify operation by monitoring control settings and input levels and indicating when settings are right, wrong, or there is not enough information.

But microprocessors can't solve all measurement problems. Says HP's Chisholm, "One of the drawbacks of microprocessors is lack of speed." Processes within an instrument often require more speed than microprocessor software gives.

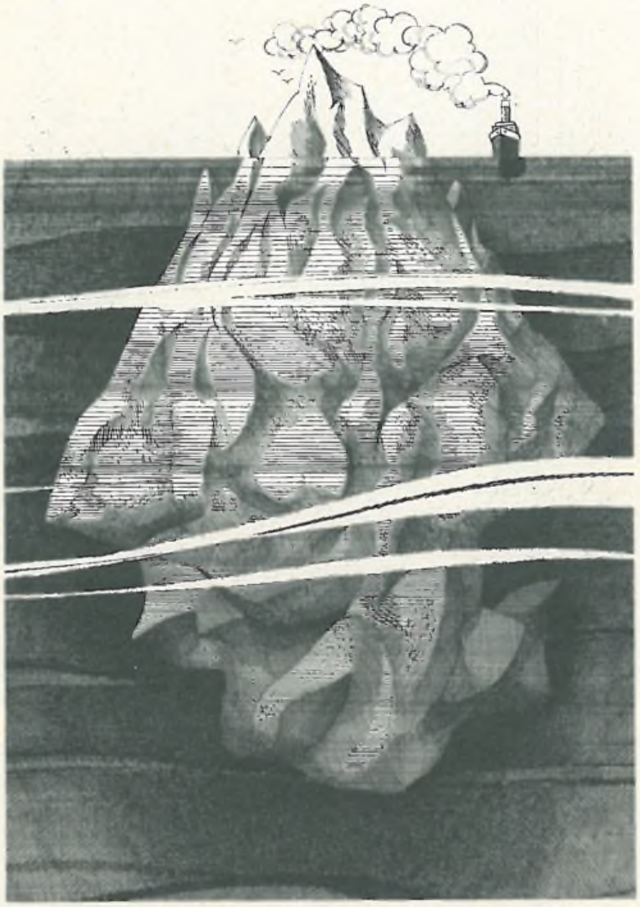
And microprocessor design requires a greater understanding of software than many users may realize. There's an insufficient awareness of the software impact of microprocessor-based instrument design, says John Brady, vice president for engineering at Dana Laboratories in Irvine, Calif.

Price. Price can also be a drawback. Says a marketer for a French instrument manufacturer, "You can't put a microprocessor in a low-cost instrument." The lowest-priced instrument using a microprocessor has to cost $200, he says.

And while "with a microprocessor, you approach the frontier between an instrument and a test system," says a designer for another French instrument maker, who wants to pay for a test system when he needs only an instrument?

Says Colin S. Gaskell, chief of new development and processes at Marconi Instruments Ltd., St. Albans, England, microprocessors may be too expensive or less efficient than other parts. Analog methods may be cheaper in some applications, and, even in digital systems, a better solution may be dedicated logic, a stripped-down minicomputer, or a custom chip. □

There's more to than



Putting a microprocessor to work for you involves a whole lot more than buying a few LSI chips and slapping them together.

You need LSI chips, of course. And National Semiconductor is the only company that makes them all: the IMP family for 4, 8, and 16 bit applications.

But to meet your cost objective, you need more. You need tools — the kind of tools that can make things easy for you. National has them.

National offers the best Prototyping Systems around; plus the only Microprogram Development System in the industry, to help you develop new machine instruction sets. On top of that we supply the kind of software, documentation, and technical support that helps bring designs in on time and under budget.

No other microprocessor supplier offers you all that.

For the production end, there's our new POWR I/O,™ an instruction set option that doubles your I/O speed while it cuts your memory requirements; a Floating-Point Math Package, so you don't have to invent one; and everything else you'll need in your system...right out to the sensors.

IMP Prototyping System.

No other microprocessor supplier offers you all that, either.

The Blue Chips™ and the Green Chips.™

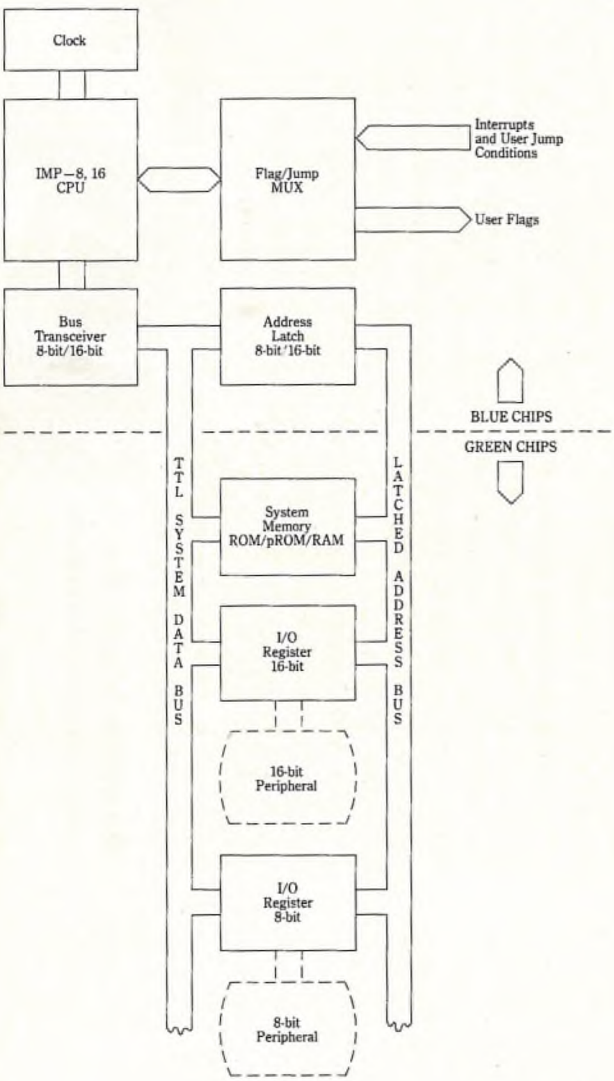
Something new.

The Blue Chips let you put together a complete 16-bit processor with only 9 chips for less than $140.00 in volume. And the optional Green Chips simplify your I/O interfaces.

The result: more bang per buck... more throughput with fewer components than any other microprocessor.

microprocessing microprocessors.

Here's a diagram of how it all goes together:



We've got it all.

A flock of companies are now trying to make hay out of the fact that they've just entered the microprocessor chip business.

We've been in it more than two years.

Two years during which we've developed microprocessors with unmatched performance. Microprocessors that do more useful work per dollar than any other you can buy.

Two years during which we've developed *everything* you need to get into microprocessing, right down to the interfaces. And we're the only company that has.

We offer the strongest support package in the industry—hardware, software, firmware, field technical support, and training.

Before you commit yourself to a company that offers you anything less than everything, you really ought to write for our microprocessor brochures.

Please send me a copy of your Microprocessor Brochures.

Name __________

Company __________

Address __________

City ______ State ______ Zip ______

Mail to: National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Ca. 95051.

National

The right time at the right place:

The AMI Electronic Watch Works is the leading producer of one-chip CMOS digital watch circuits. And we're way ahead of the field in the design and fabrication of high-quality liquid crystal displays.

Now we have two new reasons why you should buy your watch components from us: we give you two versions of the time, date and second.

Our S1410 circuit and S23610 six-digit display work together to show the time and date constantly. Push the button and the date turns to seconds until you want the date back again.

The four-digit design (S1420 circuit and S23590 display) shows the time. Push the button once, and you get the date for two seconds before it returns back to the time. Push the button twice, and you have the seconds.

Which is best? It's really a matter of individual preference. Some people enjoy the convenience of six figures. Others prefer the compactness of four, with its built-in four-year calendar. second watch (S1420 circuit and S23600 display).

That's the top of your line. Here's the rest of it.

No retailer wants to sell just one or two models. So we give you all the different circuits and displays you need to suit every taste and budget.

The standard hours and minutes watch can now be produced for an incredibly low price, using our S1400 circuit and S23570 display. (Right now, we have a special deal on these 1400 chips. Ask us about it!)

The next step up is to the Compact Watch display and its back-lighted version (S23590 and S23595). And our regular ladies' model (S23600 display) is smaller and more feminine than any other LCD watch on the market.

We make it easy for you to make watches.

In addition to individual circuits and displays, our circuits come packaged in three

A few words about quality.

We've always had a strong reputation for making reliable MOS circuits. And we've carried this strength over to our displays.

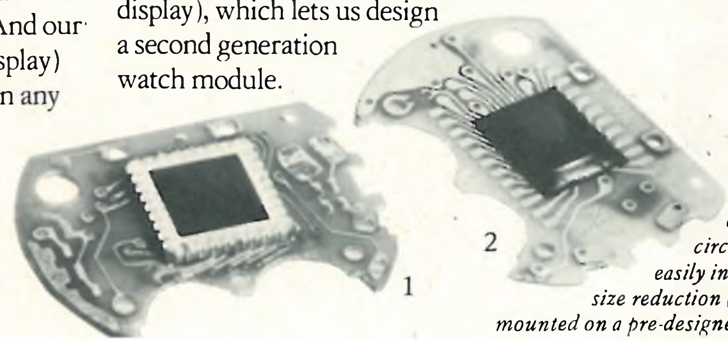
Four years ago, we set up a separate division for Liquid Crystal Display development. This experience resulted in several significant milestones. We developed a new photo process for small, sharp displays. We pioneered hermetic frit-sealing of Field Effect Displays to eliminate contamination and guarantee a strong mechanical package. We produced the first three-volt material in volume (the original ultra-low-power display), which lets us design a second generation watch module.

We've already designed special circuits for a couple of large watch manufacturers. We already supply complete modules ready for casing, as well as cased LCD and LED watches to marketers. And we're working on new generations of chips, displays and modules. So when you come to us, you always stay ahead of the times.

So call your nearest AMI sales office for information.

England • Swindon, Wiltshire • Swindon 31345
France • Vincennes • 328-0336
Italy • Milan • 29 37 45
Japan • Tokyo • (501) 2241
West Germany • Munich • (089) 48 40 51

Circle 85 on reader service card

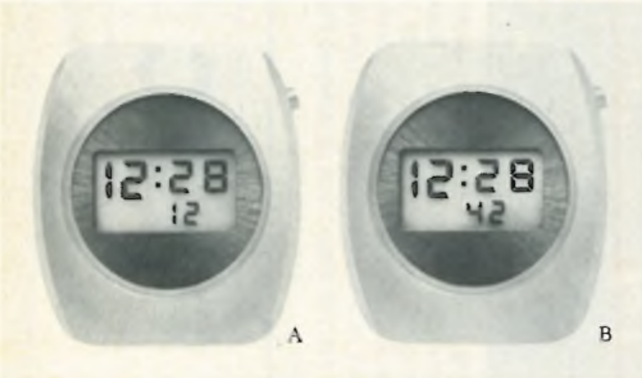


The beautiful simplicity of our leadless ceramic circuit carrier (left) lets you fit it easily into any watch design. The ultimate size reduction (right) has the circuit mounted on a pre-designed module PC board.

You can order both versions back-lighted. And we have the makings of a petite, four-digit ladies time, date, different ways. The circuit carrier (1) gives you a great deal of design flexibility.

The PC board subassembly (2) eliminates interconnects, so you can wind up with a very thin watch. It also has a compatible display, with a back-lighted option. This slim design lets you use a variety of cases and styles.

Third (and least in price) is our ceramic subassembly.



The six-digit: a) with time and date b) with time and seconds.

Besides standard font designs, we offer you complete freedom of choice in font styling, package sizes, silver or gold reflectors, and back-lighting options. In fact, these displays are so flexible that they're fully compatible not only with our circuits and IC chip packages, but also with most other watch chips on the market.

Need something special? Just ask.

We were the first producer of MOS/LSI circuits. And we intend to remain the Number One supplier to the electronic watch market. That means being flexible.

Or for technical details on circuits, phone Dick Barck at (408) 246-0330; for display data, it's John Dunn at (408) 735-9210. Or write to AMI, 3800 Homestead Road, Santa Clara, CA 95051.

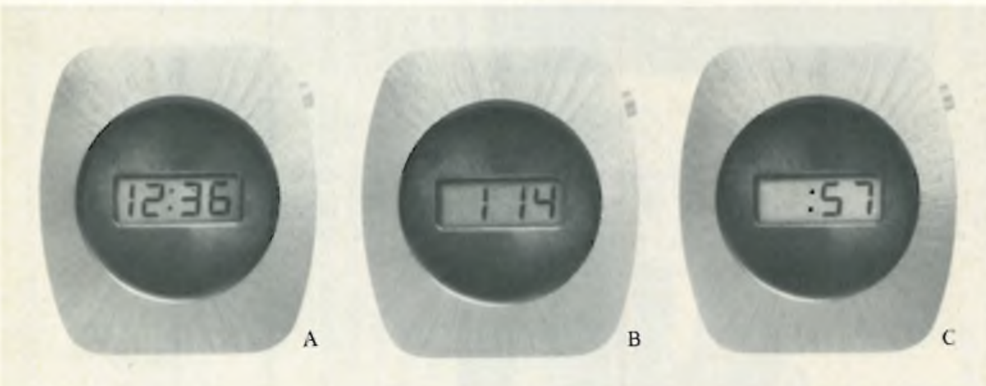
We'll give you all the time you need.

AMI Watch Displays

Model	Description	Special Features
S23570	Man's standard 4-digit	Operates on 3 volts
S23590	Compact, 4-digit	Operates on 3 volts
S23595	Compact, back-lighted 4-digit	Operates on 3 volts
S23600	Ladies, 4-digit	Operates on 3 volts
S23610	Time/Date/Second, 6-digit	Operates on 3 volts
S23615	T/D/S, back-lighted 6-digit	Operates on 3 volts

AMI Watch Circuits

Model	Description	Special Features
S1400	Hours/minutes	Ceramic subassembly
S1404	Hours/minutes	Chip carrier
S1407	Hours/minutes	Printed circuit assembly
S1410	6-digit Time/Date/Second	Chip carrier
S1412	6-digit T/D/S	Printed circuit assembly
S1420	4-digit T/D/S	Chip carrier; 4-year calendar
S1422	4-digit T/D/S	PC assembly; 4-year calendar



How to get the time, date and second on four digits: a) standard time mode b) the temporary date mode c) the seconds mode.

All displays shown actual size.

There isn't a smaller, more feminine ladies watch display on the market. And we have a Time/Date/Second version, too.

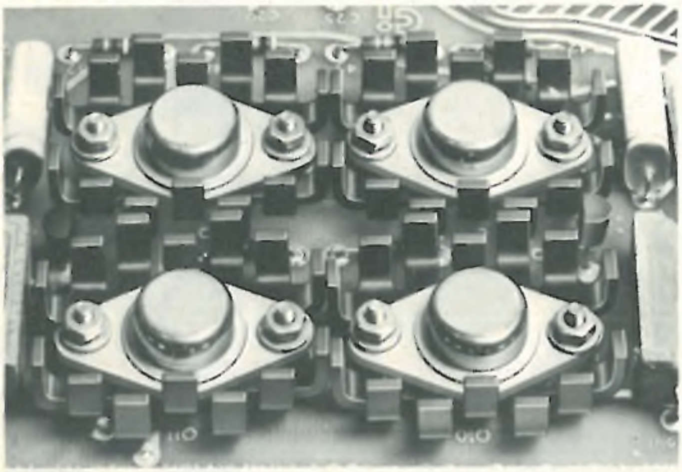
The AMI® Electronic Watch Works™

AMERICAN MICROSYSTEMS, INC.

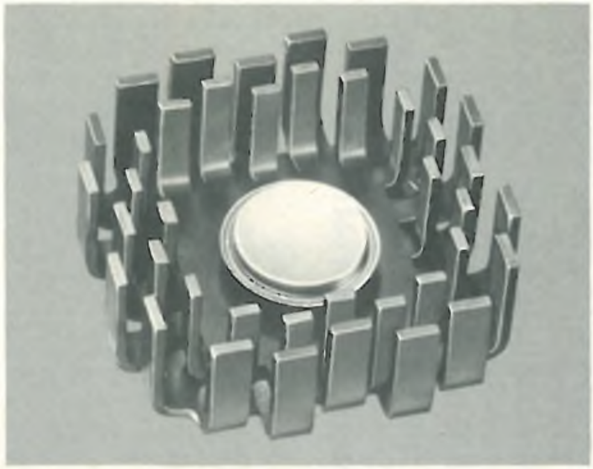
These semiconductor cooling ideas improve circuit performance and reliability, cut costs.

No. 7 of a Series

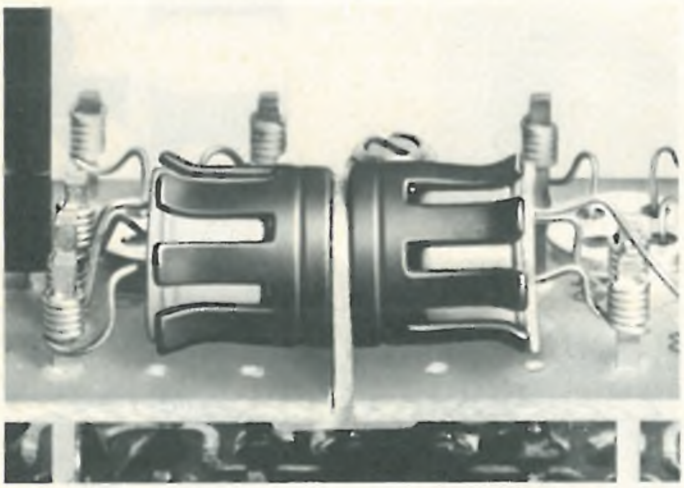
Engineers use Staggered Finger heat dissipators, Thermal Links, Fan Tops, and other IERC thermal management devices to solve a wide range of circuit design and packaging problems dealing with power, reliability, switching speeds, circuit density, stability, reproducibility, and cost. Here are four ideas that may suggest new ways you can put IERC dissipators to work for you.



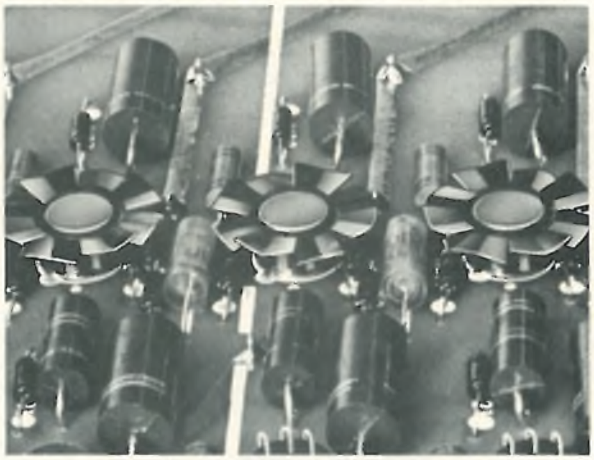
More power, higher reliability from the same TO-66s is a paradoxical requirement, but designer met it in this amplifier circuit with LB Series Staggered Finger dissipators. Nominal case rise above ambient of 90°C for bare case TO-66s permits 3 watts dissipation per device. Adding LB s doubled transistor life by giving 10°C temperature drop while increasing power to 5.5 watts per device.



Design-to-cost criteria were missed in a touchy servo amplifier because 4 parallel devices required too much testing and matching. Designers went to single TO-6 cooled by nested HP1 and HP3 Staggered Finger dissipators. At 100°C case rise above ambient, the single TO-6 dissipates 36 watts, plenty for the application.



Erratic flip-flop in high-G environment posed problem until IERC Thermal Links came to the rescue. Thermal Links held the TO-5s firm, increased their thermal mass, and linked the two cases to a common heat sink. Resulting lowered junction temperature permitted more stable operation and higher reliability while thermal matching assured a balanced circuit.



Faster switching speeds and lower junction temperatures at the same power levels without spending a bundle was called for after bread board testing of this circuit. Adding IERC Fan Top dissipators to the TO-5s held junction temperatures well below maximums and substantially improved rise and fall times. And the press-on Fan Tops cost just pennies.

For more information
on heat sinks and dissipators for milliwatts to kilowatts, send for the IERC Short Form Catalog today. It covers the most complete line of thermal problem solving devices available anywhere.

IERC

DCA

Heat Sinks/Dissipators

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION/A SUBSIDIARY OF DYNAMICS CORPORATION OF AMERICA/135 WEST MAGNOLIA AVENUE, BURBANK, CALIFORNIA 91502

IF YOU USE RELAYS, YOU CAN'T AFFORD NOT TO HAVE THIS CHART!

IF THE CHART IS MISSING, YOU CAN STILL GET ONE FREE!

Magnecraft® Relays

PLEASE SEND MAGNECRAFT/NEWARK STOCK RELAY SPECIFICATION CHART

SEND COUPON TO:
NEWARK ELECTRONICS, 500 N.Pulaski, Chicago, Illinois 60624

NAME ______________________
TITLE ______________________
FIRM ______________________
PHONE ______________________
ADDRESS ______________________
CITY ______________________
STATE ____________ ZIP ____________

NEWARK ELECTRONICS

ILLUSTRATION: Castillo de San Marcos—St. Augustine, Florida

Preparation: the key to success with microprocessors

Unwary system engineers can fall victim to time-consuming mistakes, not to mention cost, when building on new breed of semiconductors; help is available, however, for those ready to pause and pay heed

by Robert Lewandowski, *John Fluke Mfg. Co., Inc., Seattle, Wash.*

☐ A design team that takes its first crack at devising a system based on a microprocessor can be in for a trying experience. But many of the usual pitfalls can be traced to two basic oversights; they involve (1) a precipitous plunge into a project with a design group inadequately prepared for the task, and (2) failure to obtain the different kinds of help available from manufacturers, time-sharing services, and consultants.

Hardware problems, while formidable, can be solved by traditional methods. But not so for software. Microprocessor manufacturers say it is easier to turn a digital designer into a microprocessor programer rather than the other way around. While this may be true, it doesn't give a realistic picture of what can happen while a hardware designer is in the process of learning. The problems associated with becoming familiar with the microprocessor and its interfaces, and with learning programing, can at best lead to some extremely harried designers or, at worst, a poor design.

Hardware problems

Analog designers probably will not be affected, but the digital designers must become familiar first of all with the capabilities, limitations, and characteristics of the many microprocessor-system components. In addition to the central processing unit, there is a clock generator-driver, which supplies timing and synchronization to most parts of the system. There is a ROM, which contains the actual program statements executed by the CPU. There may be a memory interface device to provide address information in the correct format to allow a general-purpose memory chip to be used with a specific processor. And most systems will contain a RAM to store transient data generated by the processor during program execution.

Also, inputs and outputs will usually require interface hardware to provide timing and multiplexing so that peripheral circuitry can access the processor's data bus. In some systems, memory interface and I/O may be handled by the same hardware; other systems provide interface adapters for various types of I/O operations.

Additional hardware may also be required to interrupt processor operation for service requests, to change program flow, and to handle special modes of operation. And since the devices used within one system may span several technologies—p-MOS, n-MOS, C-MOS, and TTL—there are many different interface problems—voltage levels, propagation times, etc.—with which hardware designers must be familiar.

The software problem

Many hardware designers assume that because they have done some programing with high-level languages like Basic or Fortran, their experience will be directly applicable. Such programing is, however, a world away from the low-level languages required by most microprocessors. So while digital designers may have developed the logical way of thinking necessary to become proficient programers, the time allowed them in project schedules to get up to adequate speed in programing is frequently grossly underestimated.

If a project is on a schedule in which sufficient time cannot be given to design-team members to thoroughly learn about the device to be used, an alternative to consider is the use of a consultant.

Many consulting firms are spinoffs from microprocessor manufacturers. These people have worked on many specific applications and are familiar with both hardware characteristics and programing techniques. Some consultants will undertake the whole design—hardware and software—while others will only do the software and advise on hardware implementation. This course will allow in-house people to become experienced as they work with the consultants.

If, on the other hand, time does permit the education of staff designers, where can the education be obtained?

Closing the loop

Readers who have questions about microprocessors and would like to discuss the problems of using them with author Lewandowski may call him during the week of March 31 at (206) 774-2211, extension 2257, between 9 a.m. and noon, Pacific time.

While there is a great deal to be said for self-made men, there are definite limits imposed when it comes to microprocessors. The information available for self-study from vendors, for example, is usually non-existent, and much of what is available is in the form of specifications not really helpful for the task at hand.

Many colleges and some community colleges now offer short courses in microprocessors and even courses on machine- or assembly-language programing. These can be useful—as can the general information available on programing minicomputers (in view of the similarity between the simple mini and a microcomputer system).

A better approach is to take advantage of seminars offered from time to time by vendors or consultants in various locations around the country. These usually last two to five days, are very concentrated, and cover the basics of hardware operation and the instruction sets used by specific devices or families of devices. The seminars usually include some "hands-on" time employing a hardware simulator, which allows students actually to write and execute simple programs. Under no circumstances, however, should it be assumed that these seminars are guarantees of expertise.

When it comes down to a matter of practice, time-shared computer services can be useful. Many such services offer proprietary programs supplied by the microprocessor vendors—programs that allow the assembly of "source" programs into "object" code suitable for execution in a microprocessor.

The source program, written in the assembly language peculiar to a particular microprocessor, consists of symbolic operation codes corresponding to the actual bit patterns that cause a given operation to occur. It also consists of symbolic labels corresponding to the actual binary addresses at which the instruction op-codes will reside during program execution. The assembly language frees the programer from keeping track of the absolute address of an instruction to which the program transfers control or to which the program branches after a logical or arithmetic test. The assembly language also keeps track of the start addresses of subroutines that may be utilized by various parts of the main program.

The object code generated by an assembler is the set of binary numbers that, when loaded in the correct sequence in the microprocessor's instruction memory, causes the processor to act in the desired manner. These bit codes are permanently "burned" or "hard-wired" into the system ROM during manufacture and provide the instructions for a microprocessor to execute.

To develop a microprocessor program, the first step generally is to establish the logical sequence of events to occur by using a flow chart or similar aid. Each operation is then converted into one or more microprocessor instructions written in an assembly language. The sequence of instructions is then keyed into a data file in the time-shared computer, and the program, or source file, is acted upon by the assembler program in the time-shared system. If there are no errors in the source program, the assembler generates an output record consisting of the object file in a suitable format for storage. This object file can be sent to a vendor who can convert the bit patterns into a usable ROM.

Since ROM manufacture is an LSI semiconductor process, the initial setup is rather costly and time-consuming. It is of critical importance, therefore, that the program be debugged and operational prior to ROM manufacture. In the case of production-LSI parts, little or nothing can be done to correct errors in the original hardware. The entire process of mask generation and fabrication of new parts has to be repeated—with time delays of two to four months for each correction.

To determine whether a program is operational or not, the time-sharing services also offer a simulation program that can execute the object program on the host computer in a manner similar to the actual microprocessor. A wide variety of information is available to the operator about the execution of his program, such as program timing, current contents of internal storage registers, addresses, and the actual instruction currently being executed. The simulator can stop operation at various places in the program and force conditions to occur within the simulated microprocessor. These features, combined with on-line editing programs that allow rapid modification or correction of source programs, make an extremely powerful system for developing microprocessor programs.

One drawback of time-shared services is their high recurring costs. In addition to the rental fee of a terminal for access, there are charges for connection time, and execution charges for use of the host computer. Also, there usually is a royalty for use of the microprocessor vendor's proprietary assembly and simulation programs. Time-sharing services also have a seemingly infinite variety of billing rates and schedules, so that comparison of costs of one service to another is virtually impossible. One can easily expect costs of $1,000 to $3,000 per month for a program development, which can easily take two to four months of peak demand time.

Prototyping systems

An alternative to the strict use of a time-sharing system (and one that provides a real-time operating-hardware situation) is the prototyping system. These are sold by various microprocessor manufacturers or independent proprietary microcomputer-systems vendors. Cost can be $3,000 to $10,000, depending on complexity and features. The prototype system can provide an operating setup that has the capability of entering and editing source programs in assembly language and executing the resultant object programs with the actual microprocessor hardware. These systems allow direct hardware interface to the instrument under development via plug-in "kluge" cards, and can contain the hardware to be used in the final system.

The main differences in comparison with the time-shared approach is the prototyping system's slower speed of execution and its lack of software or program features. Also, the editing capability is usually very limited, and in some cases nonexistent. That, together with the fact that most prototyping systems operate via a conventional ASR 33 Teletype and paper tape, make their use very awkward.

During operation of a prototyping system, the assem-

Why a microprocessor?

To name three of the chief advantages of a microprocessor-based instrument, a microprocessor can produce the following results:

- Reduction of the cost and complexity of hardware by replacing existing random-logic designs with fewer parts.
- Addition of arithmetic or computational capability unavailable with random logic.
- Achievement of a "smart" instrument that can execute a sequence of instructions under program control, and possibly to control or interact with other instruments.

The question remains: when is a given application suitable for a microprocessor? The rule of thumb today is that a microprocessor-based system is worth considering if an existing design uses 50 or more packages of medium-scale integration. But there are also other necessary preconditions, namely, that:

- There is sufficient product sales volume to approach the "knee" of the vendor's price curve.
- The application is bus-oriented, thus requiring a minimum of peripheral support hardware.
- There is a significant market advantage to be gained by features that come "free" with the addition of a microprocessor.
- There is the potential for future extension of the design techniques to other applications.

The desirability of a bus-oriented structure is based on the microprocessor's limited input/output capability. Most microprocessors transmit data on a character-serial bus (that is some multiple of 4 bits). This can, unless the system is already bus oriented, necessitate a large amount of outboard hardware to multiplex and distribute the data over wide parallel input and output structures. The extra components would seriously reduce the cost-effectiveness of the microprocessor solution.

The addition of computational ability greatly increases an instrument's usefulness, allowing it to convert measured electrical parameters—volts, ohms, etc.—into engineering units—pounds per square inch, pH, feet per second—while also performing self-calibration and fault diagnosis. It should be noted, however, that although most available microprocessors have some arithmetic capability, high speed "real-time" computation is severely limited because devices generally available have no hardware arithmetic features and must use repetitive program techniques. Speeds of execution under these conditions are well-suited for human interface, but not for high speed machine-to-machine interactions.

Front-panel controls are areas in which a microprocessor can be used to great advantage in the design of a "smart" instrument. Compare, for example, the electronic calculator to a mechanical calculator of five years ago. The mechanical calculator required that the entered data be justified with respect to the decimal location, and frequently required adjustment or re-entry of the data to accommodate the limited dynamic range of the machine.

A similar problem can be seen in a keyboard-programed frequency synthesizer that has a seven-decade display.

Entry of a number significantly smaller than full scale requires entering a number of zeros ahead of the most significant digit, making data entry rather clumsy. To implement the free-form entry with random logic requires a complex and costly design. But a microprocessor can meet the requirements easily.

One of the bonus features is the microprocessor's ability to store and recall various front-panel control settings or programs at the touch of a button. This makes it possible, for example, to store all the specific frequencies and signal levels required for production testing a narrow-band filter. A single button recalls the data previously stored, and allows the operator to examine or adjust the device under test at each critical frequency.

This technique can be extended to allow the user to enter his own programs into the microprocessor for specific applications. This requires both a complex keyboard or program entry method and a user who is familiar with programing the particular microprocessor in the instrument. Nevertheless, it can result in an extremely powerful instrument suited for a variety of applications.

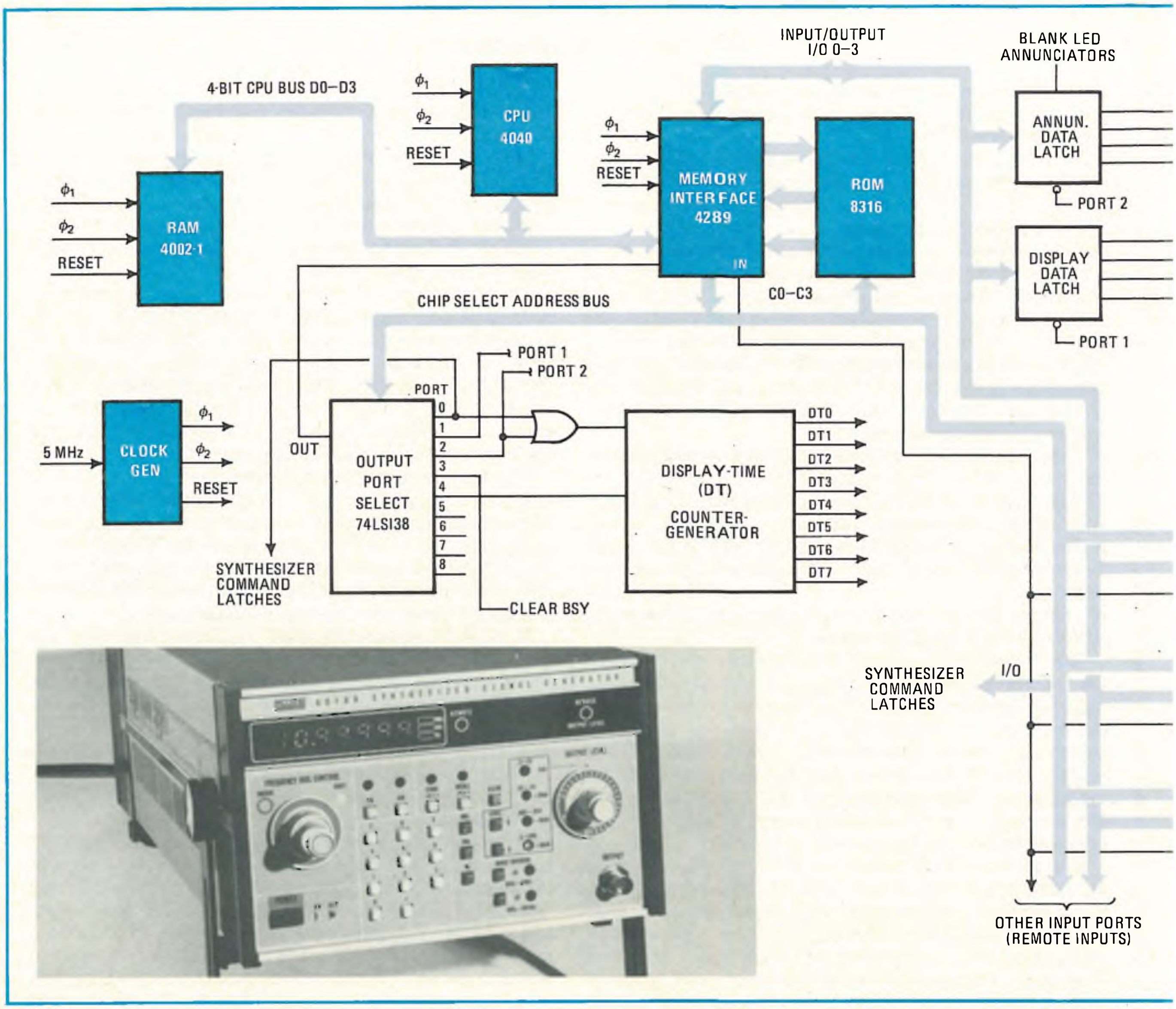
A microprocessor-controlled instrument can offer sophisticated remote programing capabilities, especially when equipped with the proposed international Electrotechnical Commission general-purpose bus interface [*Electronics*, Nov. 14, 1974, p. 95]. The structure of the IEC bus is ideally suited for use with a microprocessor, allowing the instrument to take the role of listener, talker, and possibly system controller when used in the appropriate application.

At present, in instruments designed with random-logic controllers, a high price must be paid for the IEC bus option because of the large amount of additional circuitry necessary to receive or send the ASCII control characters. But the only hardware needed when interfacing a microprocessor to the bus are the bus drivers and receivers, and the random logic for both timing and recognition of addresses and universal commands. The recognition and interpretation of ASCII control characters (in the case of a listener) and the encoding of data to be transmitted by a talker are all done under program control. They may even be handled by the same methods using the same subroutines, as are used to process signals from the front panel control.

An instrument with microprocessor control can be programed to perform the controller function in a bus system, although an instrument with programing flexibility of a calculator is usually assigned this task. The control programs for a microprocessor in an application as a system controller could be very complex, requiring significant execution time, but it could represent a cost-effective solution for certain applications.

bly program (punched on paper tape) is read into storage in the system via some sort of monitor or control program which resides in the system's ROM. Program control is transferred to the assembler and the user's source program is read in from paper tape. The complete assembly of the source program takes two or three entries ("passes") of the entire tape, depending on the system. The object tape is generated during the final "pass" and can then be read into program storage within the system and executed by the microprocessor.

Loading the assembler, assembly, loading the object tape, and execution of the object program can easily take from an hour, for a small program, to well over eight hours for a large program. And the program stor-



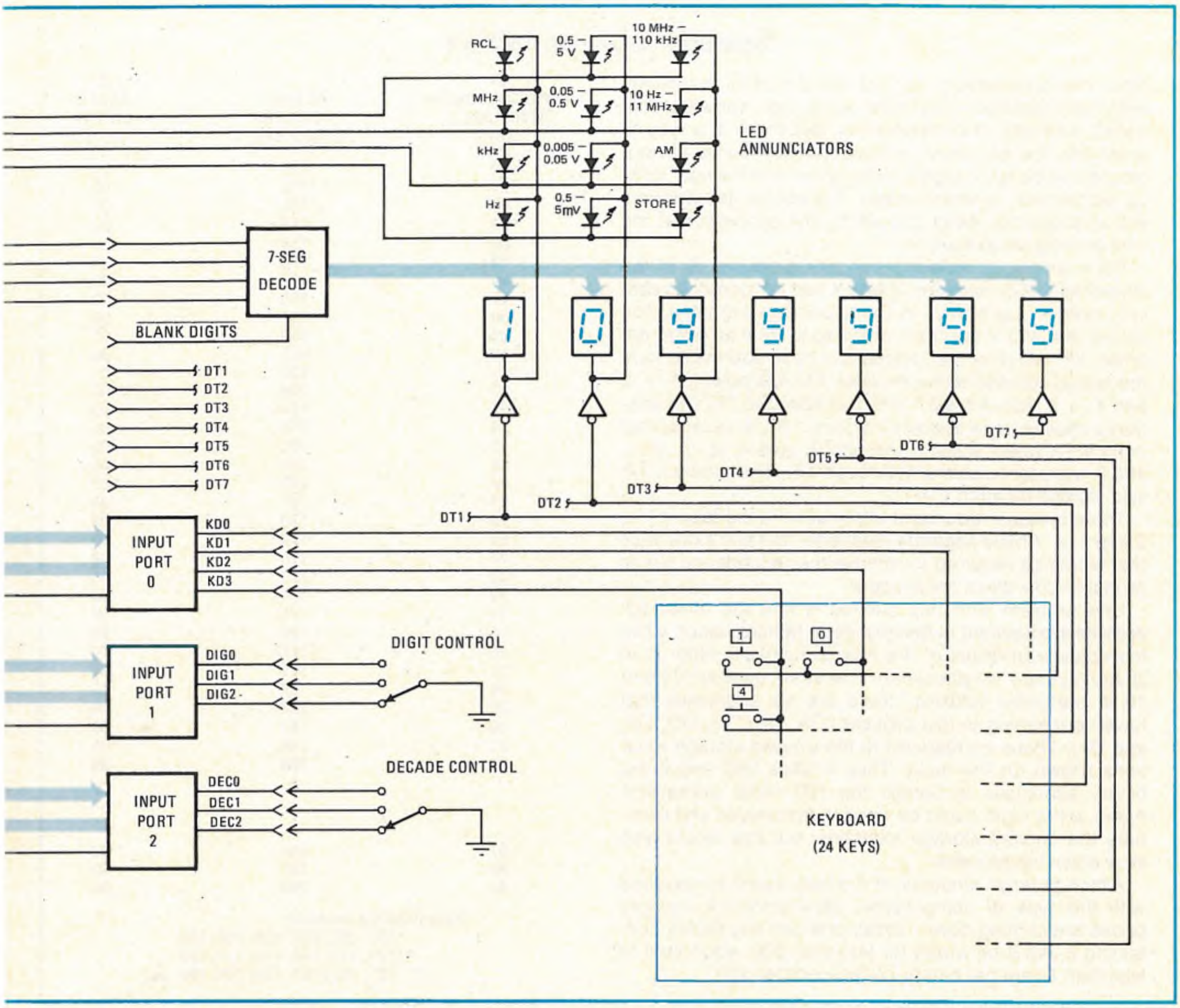
Synthesizer. In a new application, a microprocessor has been built into a 10-hertz to 11-megahertz frequency synthesizer to handle a 6-digit display, a dozen LED annunciators, and a 24-button keyboard. The chip set consists of five parts: a CPU, ROM, RAM, clock generator, and a memory interface circuit. In addition, about 30 TTL ICs are needed to handle the interfaces with other components.

age within the system is volatile. So when the system is powered down, the stored object program is destroyed and the object tape must be re-loaded for a new execution. Data on the object tape is usually densely packed so that reading a large object program is usually less than half an hour.

Some shortcuts are available—but they cost. Some of these are: storing the assembler on PROM (programable read-only memory) within the system; the use of a high-speed paper-tape reader and punch for data input and output (five to 15 times faster than a teletypewriter); or the use of minicomputer peripherals adapted for microprocessor systems, such as cassette tape systems, floppy disk systems, CRT terminals, and line printers. These devices can reduce system operating times by factors of 50 to 150. They can also provide other benefits, such as mass data storage and low-cost/high-speed hard-copy data. But the added peripherals can easily bump system costs by more than $10,000 and require a large amount of custom interface hardware and software.

Keep in mind that assembly of the source program is not necessary each time a change or correction is made in the object program. Most prototyping systems provide for "patching" or making program corrections via direct entry of machine code into memory. For small changes, this provides a means of keeping the original program running to check for other errors. Large changes (such as relocation of large blocks of code within memory) are very difficult and can create more problems than they solve.

Another factor that can keep the assembly of large source programs from becoming a man-killing job is that the main program can be assembled in blocks with vacancies inserted for future "patches." Only an affected block need be reassembled to correct errors. When the program is completely de-bugged, the blanks



can be removed and the program reassembled, creating one continuous program with no wasted space.

One frequently hears that microprocessor systems offer greater flexibility for design changes because all it takes is simple modifications to the program. This can lead the programer into days or weeks of debugging the "simple" program modifications. This is particularly true when the person making the changes did not write the original program. A densely packed, efficient program is like a finely "tweaked" analog circuit in which significant problems can be caused by subtle changes. A change to one part of the program can cause catastrophic occurrences in totally unrelated areas.

In-house computers

There is still another alternative, the use of an in-house computer system for program development. Microprocessor vendors have available assembly programs written in languages like Fortran, which can be used on a variety of computer systems and provide essentially the same capabilities as the time-shared services, in many cases the programs being the same. However, note that the computer required for such applications is large, costly, and may not be available.

Last of the alternative program development methods are the high level programing languages, like PL/M [*Electronics*, June 27, 1974, p. 103], available for some processors now on the market. They are similar in complexity to Basic or Fortran, where one program statement will generate many microprocessor instructions directly, as opposed to assembly languages which generate one microprocessor instruction from each program statement. These languages are relatively easy to learn. They are claimed to be within a small percentage of the efficiency of an experienced programer writing in assembly language, at least as far as the number of instructions to accomplish a particular task is concerned. However, the compilers for these languages are very large and usable only on large machines. Some time-sharing services offer them, and they may be more cost effective than assembly language methods.

Once the program development is complete and the

Speedy look-up tables

Most microprocessors do not have built-in, hardwired arithmetic routines. They must use slower, software-controlled methods of computations. But there is a way to overcome this handicap, at least partially. Some computations can be done significantly faster with memory look-up techniques, in which tables of precomputed answers are arranged for rapid access by the processor at the time of program execution.

For example, in multiplication, the products, Z, of the single-digit BCD numbers X and Y can be stored in read-only memory, as shown in the accompanying table. The values of X and Y are first combined to form an offset address, XY, which is then added to a base address to form the actual address of the product. For example, if X = 2 and Y = 7, then XY is 27, which is added to 157 (an arbitrarily chosen base address) to form 17E (a hexadecimal number—sixteen digits, 0 through 9, plus A, B, C, D, E, and F represent decimal 0 through 15). The product, 14, is in storage location 17E.

There is much redundant information in the table (7 × 2 and 2 × 7 have separate locations), but any extra logic that would be required to remove the redundancy would probably slow down the process.

One problem with this method is that the offset addresses are handled in decimal code (actually BCD), while the actual addresses of the ROM sequentially step up in binary (actually hexadecimal). Therefore, between 09 and 10 in the offset address, there are six addresses that have no meaning in this process (OA, OB, OC, OD, OE, and OF). These correspond to the unused storage locations shown on the table. Thus it takes 260 sequential binary addresses to handle the 100 offset addresses. Again, extra logic could be used to test values and eliminate the unused storage locations, but this would also slow down the process.

Although large amounts of memory could be required with this type of computation, semiconductor memory prices are coming down. Today one can buy ROMs containing 2,048 8-bit words for less than $30, equivalent to less than 1 cent per binary-coded-decimal digit.

XY OFFSET ADDRESS INTO TABLE (BCD)	ACTUAL ADDRESS (HEXADECIMAL)	Z TABLE ENTRY (BCD)
00	157	00
01	158	00
02	159	00
03	15A	00
04	15B	00
05	15C	00
06	15D	00
07	15E	00
08	15F	00
09	160—*	00
10	167	00
11	168	01
12	169	02
13	16A	03
14	16B	04
15	16C	05
16	16D	06
17	16E	07
18	16F	08
19	170—**	09
20	177	00
21	178	02
22	179	04
23	17A	06
24	17B	08
25	17C	10
26	17D	12
27	17E	14
28	17F	16
29	180—***	18
30	187	00
31	188	03
32	189	06
⋮	⋮	⋮
97	24E	63
98	24F	72
99	250	81

Unused storage locations:
*161, 162, 163, 164, 165, 166
**171, 172, 173, 174, 175, 176
***181, 182, 183, 184, 185, 186 etc.

hardware design operational, the next step in the design process will be the stand-alone prototype instrument. To make this transition, a programable ROM is used to store the object program (typical PROMs have capacities of 256 eight-bit words). These devices can be programed on the prototyping system or by peripheral programing units, depending on the compatibility of the devices being used. Some PROMs can even be erased and reprogramed. Other PROMs can be programed only once, by using destructive programing methods, and once a bit is set, it cannot be erased.

An alternative method is to go directly from the prototyping system to a mask-programed ROM. However, the major disadvantage in the design cycle of this route is that they require a lead time for manufacture, which can vary from about 12 weeks for a first mask device to 8 for a last mask device. It is also possible to use PROM program storage on a production basis for a small quantity of instruments with a minimal amount of program storage in each.

The final problem area is that of production testing of the components, sub-assemblies and finished instruments. Of course, complete measurements of all parameters on microprocessor components can require extremely complex and costly test equipment. But comparable results can be attained with relatively simple functional testing, and with a minimum of additional test-equipment cost. This can be done by using a prototype instrument as a test bed and checking its performance with each new microprocessor component.

Troubleshooting and repair of functional modules or final assemblies can be best accomplished—with a minimum of aids—by direct component substitution. A word of warning, however, on preliminary inspection and handling of circuits: caution is needed so that solder bridges or other short circuits, or failed or improperly inserted parts, do not destroy expensive CPU or ROM ships at the moment of turn-on. It is relatively easy, while substituting components, to destroy several devices before a fault is located. And since most processor components are MOS, careful handling is required to prevent damage due to static electricity. □

Calibrating crystal oscillators with TV color-reference signals

Phase-comparison with networks' rubidium standards yields resolution in minutes that would require days of checking against WWV or WWVH; National Bureau of Standards has designed simple measurement circuitry

by Dick D. Davis, *National Bureau of Standards, Boulder, Colo.*

☐ A crystal oscillator can be calibrated accurately in about 15 minutes by comparing its phase to that of the color-reference signals broadcast by the four major television networks. It would take days of comparing the frequencies of the oscillator to those of the signals broadcast by National Bureau of Standards radio stations WWV and WWVH to achieve accuracy of that order.

And since NBS monitors network signals and publishes offsets with respect to its standards, oscillator calibrations by such phase comparisons can be traced to NBS. What's more, NBS has applied for patents on a number of circuits that make phase comparison with color-TV subcarriers relatively simple. Among them are the color-bar comparator, the digital-subcarrier comparator, and the frequency-measurement computer, which are described in this article.

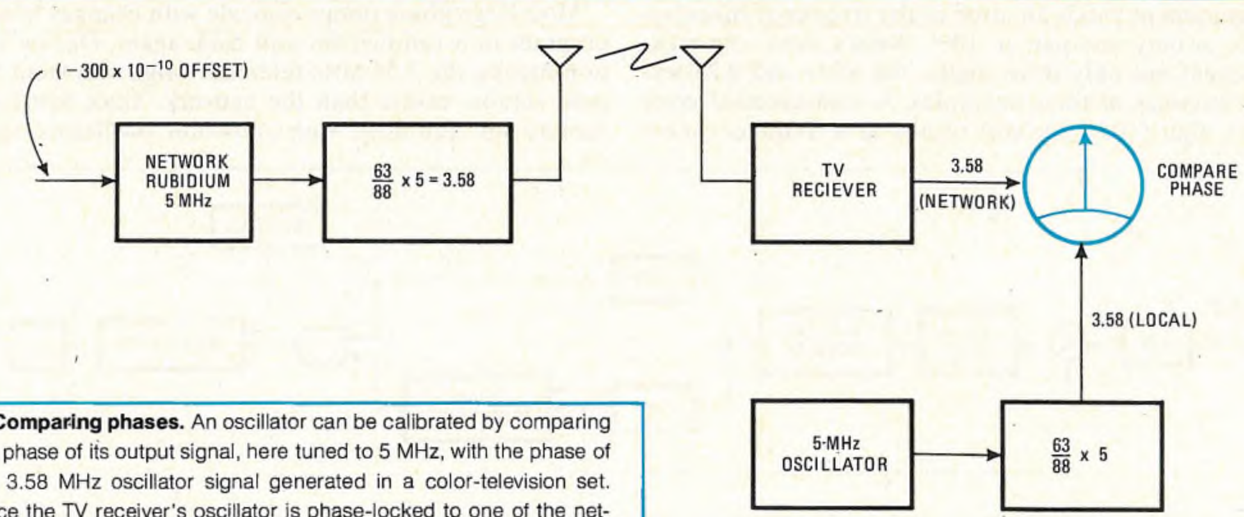
A TV receiver tuned to a network color program is a highly accurate reference because ABC, CBS, NBC, and PBS all use rubidium oscillators to generate 3.58-megahertz signals, and every color-TV set phase-locks to those references. A scheme for comparing the phases of the two signals is shown in Fig. 1.

If the frequency of the reference signal is 3.58 MHz, the full-scale reading on the phase meter, one 360° cycle, is about 279 nanoseconds. If the oscillator's frequency differs from the reference, the phase difference varies with time. For example, if the two frequencies differ by one cycle per second, the meter would deflect from zero to full scale in one second, return to zero, and start over again in the next second.

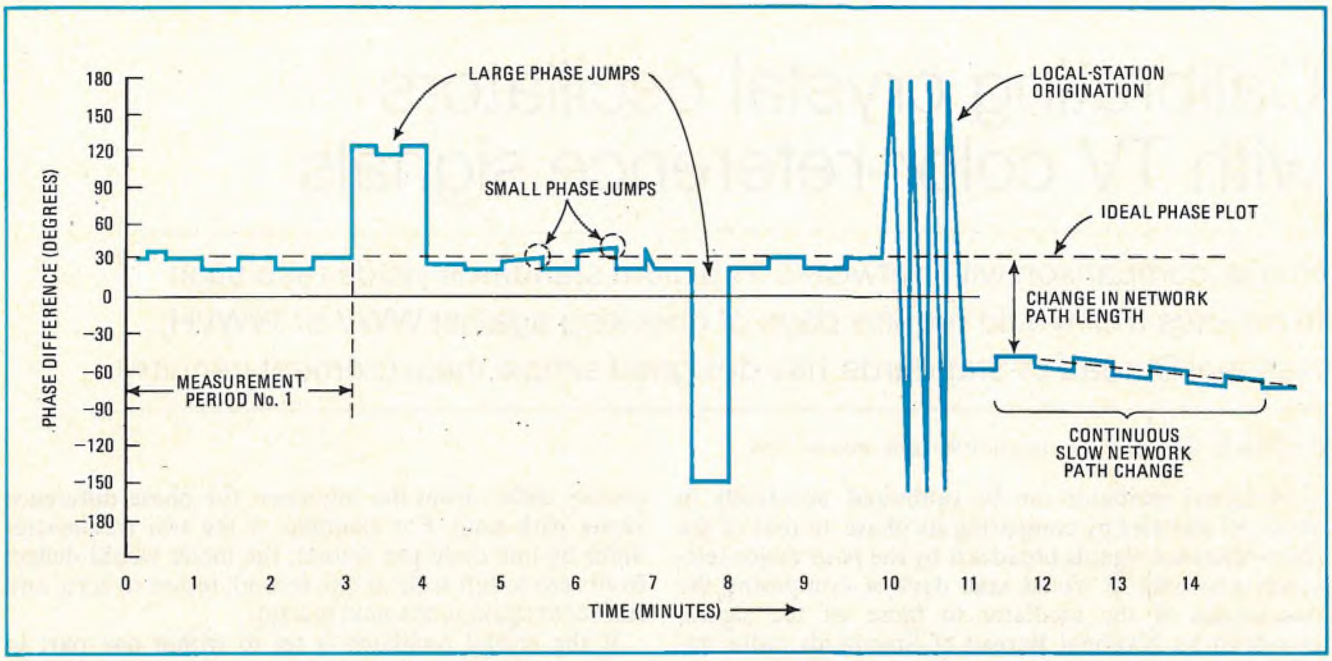
If the crystal oscillator is set to within one part in 10^{10}, or 1×10^{-10}, of the 3.58-MHz reference frequency, the phase meter will accumulate 1×10^{-10} nanoseconds of phase difference after 1 ns of observation time, or 0.1 ns per second of observation time. Since the meter will move full-scale, or 279 ns, in 2,790 seconds, a high measurement resolution is possible. For example, if the 2,790-second period is measured with an uncertainty of ±10%—279 seconds—the resolution is ±10% of 1×10^{-10}, or $\pm 1 \times 10^{-11}$.

Taking advantage of offsets

Several years ago, the networks began using rubidium atomic oscillators to increase the stability of their color subcarriers. These were standard 5-MHz rubidium oscillators with added circuitry that synthesized 3.5795454. . . . MHz by multiplying 5 MHz. by 63/88. Some time after these units were put into service, the international standard of frequency, the reference tracked by NBS, was changed by $+300 \times 10^{-10}$. The network



1. Comparing phases. An oscillator can be calibrated by comparing the phase of its output signal, here tuned to 5 MHz, with the phase of the 3.58 MHz oscillator signal generated in a color-television set. Since the TV receiver's oscillator is phase-locked to one of the networks' highly stable and accurate rubidium oscillators, it provides an accurate, stable, and convenient reference.



2. Phase plot. The phase difference between signals from an oscillator under test and the network's color subcarrier is never constant for more than a brief period. This must be considered when calibrating an oscillator to a TV color-subcarrier reference.

rubidium oscillators are therefore offset with respect to these standards.

Thanks to the offset of the networks' oscillators with respect to NBS standards, a crystal oscillator can be checked for accuracy in less than 10 seconds with resolutions in the range of a few parts in 10^{10}. The time required to accumulate 360° of phase shift in these network standards is

$$P = T/Q$$

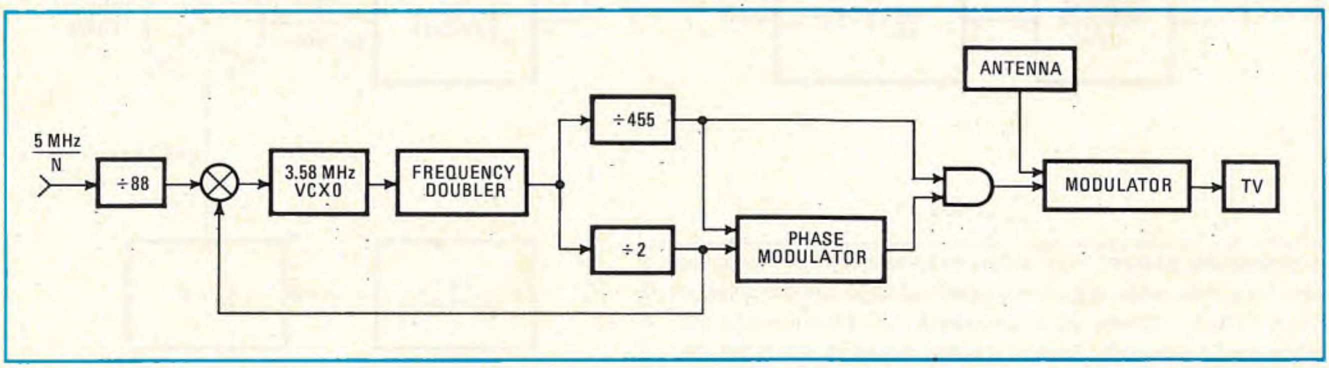
where T is the period of the reference signal and Q is the offset of the unknown. With a 3.58-MHz reference and 3×10^{-8} offset, the period of the beat note is 9.31 seconds.

If the offset were 3.01×10^{-8}, the period of this beat note would be 9.28 seconds, a change of 0.03 second. Conversely, an error of 0.03 second in making a period measurement yields an error in the frequency measurement of only one part in 10^{10}. What's more, the measurement has only three digits—the 9.31- and 9.28-second intervals of these examples. A measurement error of ±1 digit (±0.01 second) results in a frequency-measurement error of only $\pm 3 \times 10^{-11}$.

The ultimate resolution of this measurement technique is limited by a slow continuous net change in the path length the signal travels between the network's standard and the receiver (Fig. 2). In most cases, resolution is limited to about 10 ns in 15 minutes, which corresponds to a resolution of 1.1×10^{-11}.

Figure 2 also illustrates three types of phase instabilities that must be considered: large and small phase jumps and local station originations. Large phase jumps are caused by switching from one video-tape machine or camera to another, as different lengths of cable are inserted in the path. Small phase jumps result from phase distortion in the microwave system that carries network programs and from multipath between the local station's transmitter and the receiver, as well as differential phase distortion in the receiver.

Most large phase jumps coincide with changes from a program to a commercial and back again. During station breaks, the 3.58-MHz reference originates from the local station, rather than the network. Since few local stations are equipped with rubidium oscillators, their



3. Comparator. The output of a crystal oscillator, operating at the frequency of the color subcarrier and phase-locked to an oscillator under test, is combined with the signal entering a TV set so that the phases of the two signals can be compared.

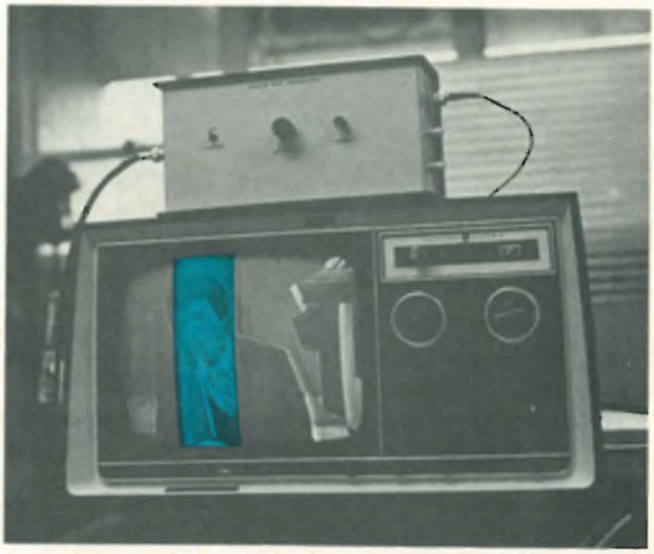
references cannot be used for calibration to the same accuracy as with network signals because they are often offset by 1×10^{-7} or more.

Using the color-bar comparator

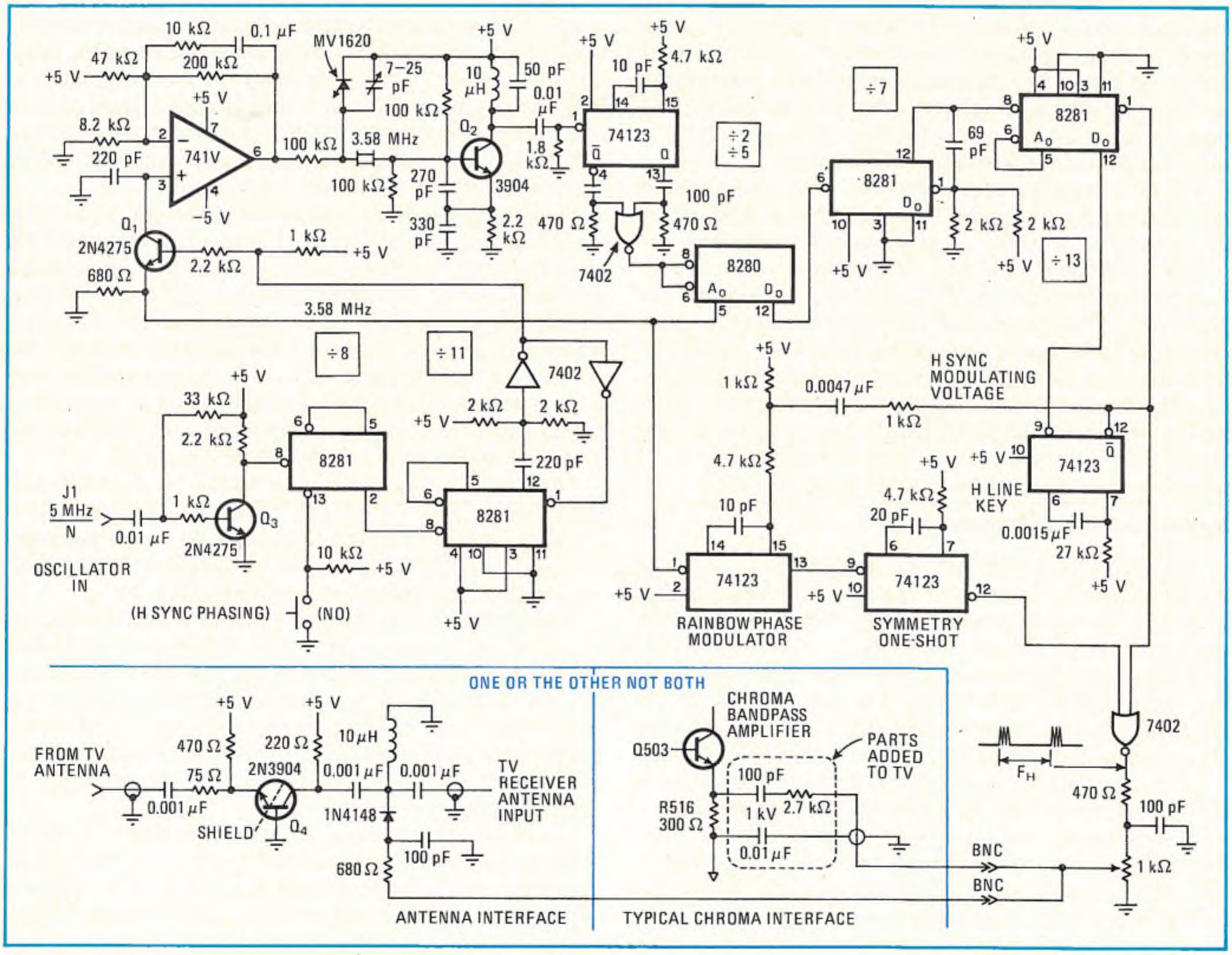
The simplest NBS circuit, the color-bar comparator, is shown in block-diagram form in Fig. 3. The input signal, at a frequency of 5 MHz or an integer submultiple, is divided by 88. This divided-down signal drives a 3.58-MHz voltage-controlled oscillator. The 3.58-MHz output is doubled, then divided by two to provide a phase-locking feedback signal. The frequency-doubled signal is also divided by 455, which provides a signal at the TV receiver's horizontal-oscillator frequency. That signal ultimately generates a stationary vertical bar on the screen (Fig. 4).

The color of the vertical bar changes as the phase relationship changes between the network rubidium and the oscillator under test. The phase modulator changes the color of the bar across its width so that times between these color changes can be measured. For example, the time between one solid red bar and the next can be measured.

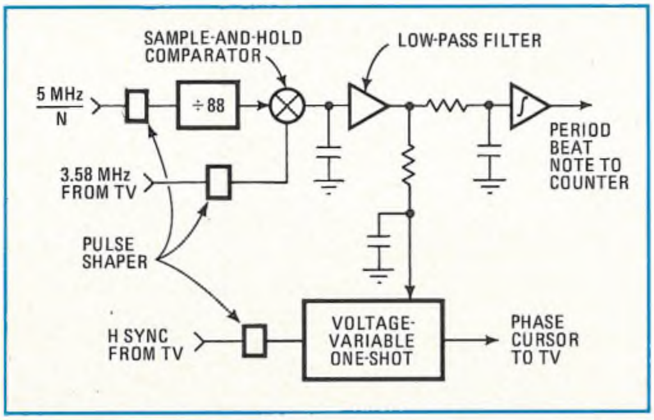
Without the modulator, the entire bar would change



4. Display. The color-bar comparator generates a vertical bar on a television screen, and colors move across the bar. By timing one complete cycle—from solid red to solid red, for example—the frequency offset of the oscillator under test from the National Bureau of Standards oscillator can be determined.



5. Generator. After division by 88, the signal from an oscillator under test phase-locks a crystal oscillator. The output of the color-bar generator can be interfaced to a color-TV receiver, either through the antenna terminals or directly into the chroma circuit.



6. Alternate. A sample-and-hold circuit can compare the phase of the 3.58-MHz color-subcarrier standard with the phase of the signal from the oscillator under test every 88 cycles of the test input.

color at one time, making it difficult to tell exactly when a given change takes place. It would also be difficult to tell whether the frequency of the test signal is higher or lower than that of the reference signal because it would be necessary to remember in what order the colors change.

In the schematic of the color-bar comparator (Fig. 5), the input signal is divided by 8 and then by 11 in the two 8281 input dividers. The output of the second 8281 drives the base of Q_1, a phase-locked-loop comparator. A 741 operational amplifier connected as an RC integrator tunes the voltage-controlled crystal oscillator at the color-subcarrier frequency of 3.58 MHz.

The VCXO's output signal drives a 74123 one-shot circuit that shapes the pulse. Two signals are taken from the one-shot, and the positive-going transitions are coupled through a 7402 NOR frequency doubler to a divide-by-two (part of an 8280) and fed back to Q_1 for phase lock. The crystal oscillator, operating at the color-subcarrier's frequency and phase-locked to the oscillator under test, is required because the necessary 3.58-MHz signal cannot easily be synthesized from the input signal. Part of the 8280, which divides by two, also divides by five. Subsequent dividers at ratios of 7 and 13 provide a total division ratio of 455 (5 × 7 × 13).

Making the presentation clear

Although this system can be used without access to the inside of the TV set, the rainbow will be of higher quality if the signal is injected into the receiver's video circuits. This eliminates modulation of the receiver's audio carrier, which causes a beat note that varies with the audio content of the program. An example of the circuitry required to inject the signal directly into the chroma-bandpass amplifier is shown in the schematic.

After an oscillator is connected to the color-bar generator and the color-bar generator is connected to a television set, the oscillator is adjusted so that the rainbow appears to move across the bar from right to left in abut 10 seconds. If the oscillator frequency is far off, the colors in the rainbow pattern will change rapidly, and the entire bar will move in the direction of the color change.

Since the period of the beat note equals the period of the reference divided by the offset, the frequency of the color comparator output signal is

$$f = 1/PQ$$

where P is the period of the beat note and Q is the offset of the network signal as published by NBS.

When the oscillator under test is adjusted for an output of 5 MHz, the frequency of the color-comparator's output is 3.58 MHz. The period of the beat note in seconds is then approximately 279/Q, where Q is expressed as parts in 10^{-9}.

Measuring the subcarrier digitally

The digital subcarrier comparator shown in the block diagram of Fig. 6 and schematically in Fig. 7 allows measurement of the period of a beat note to ±0.01 second. To obtain a measurement precision of $\pm 1 \times 10^{-10}$, an average of at least 10 readings, representing about 90 seconds of data, must be taken. A measurement to this precision using the 60-kHz transmission of WWVB would require two to eight hours under stable conditions. To improve the subcarrier-comparator measurement to $\pm 2 \times 10^{-11}$ would require averaging 100 sample-period measurements—about 15 minutes of data recording.

The digital subcarrier comparator provides an analog readout of phase on the screen in the form of a narrow vertical line that moves slowly from left to right, then retraces rapidly right to left when the local oscillator is high in frequency. This sawtooth response allows positive setting of the local oscillator because, if the local oscillator is low in frequency, the cursor line will move right to left and fly back from left to right.

This comparator is somewhat different from the color-bar comparator in that it does not synthesize 3.58 MHz from the oscillator under test. Instead, a sample-and-hold circuit compares the phase of the 3.58-MHz standard with the phase of the signal from the oscillator under test, which is at a frequency of 5 MHz/N, once every 88 cycles of the input. If N = 1, the comparison rate is approximately 56.8 kHz, and the phase of each 88th cycle of the 5-MHz signal is compared with the phase of each 63rd cycle of the 3.5-MHz television signal.

The effect is the same as if 63/88 × 5 MHz were synthesized and compared with the TV receiver's 3.5 MHz. The sample-and-hold comparator output passes through a low-pass filter to eliminate sampling and other high-frequency noise from the beat note.

The beat note is processed through a Schmitt trigger to provide a start-stop signal for a digital counter. If difficulty is experienced in adjusting the counter start-stop circuits to trigger on the same slope (both positive or both negative), a flip-flop may be added to the Schmitt-trigger output. This will give a symmetrical square-wave output, and each half cycle will be equal to one cycle of the beat note.

The steps in calibrating an oscillator with the digital comparator are the same as for the color bar. The phase cursor is used to make a coarse adjustment of the oscillator, and then the oscillator is adjusted to the period computed from the offset published by NBS until the readout equals this period.

Another version of the digital-subcarrier comparator computes the offsets corresponding to 10 10-period averages and displays them directly on the TV screen. By averaging 10 of these 10-period averages, accuracies approaching $\pm 1 \times 10^{-11}$ can be achieved.

The frequency-measurement computer determines the period of the 3.58-MHz beat note, computes the offsets, scales the results for 4-digit readout in parts in 10^{11}, and displays the one- and 10-period averages. A block diagram of the instrument is shown in Fig. 8.

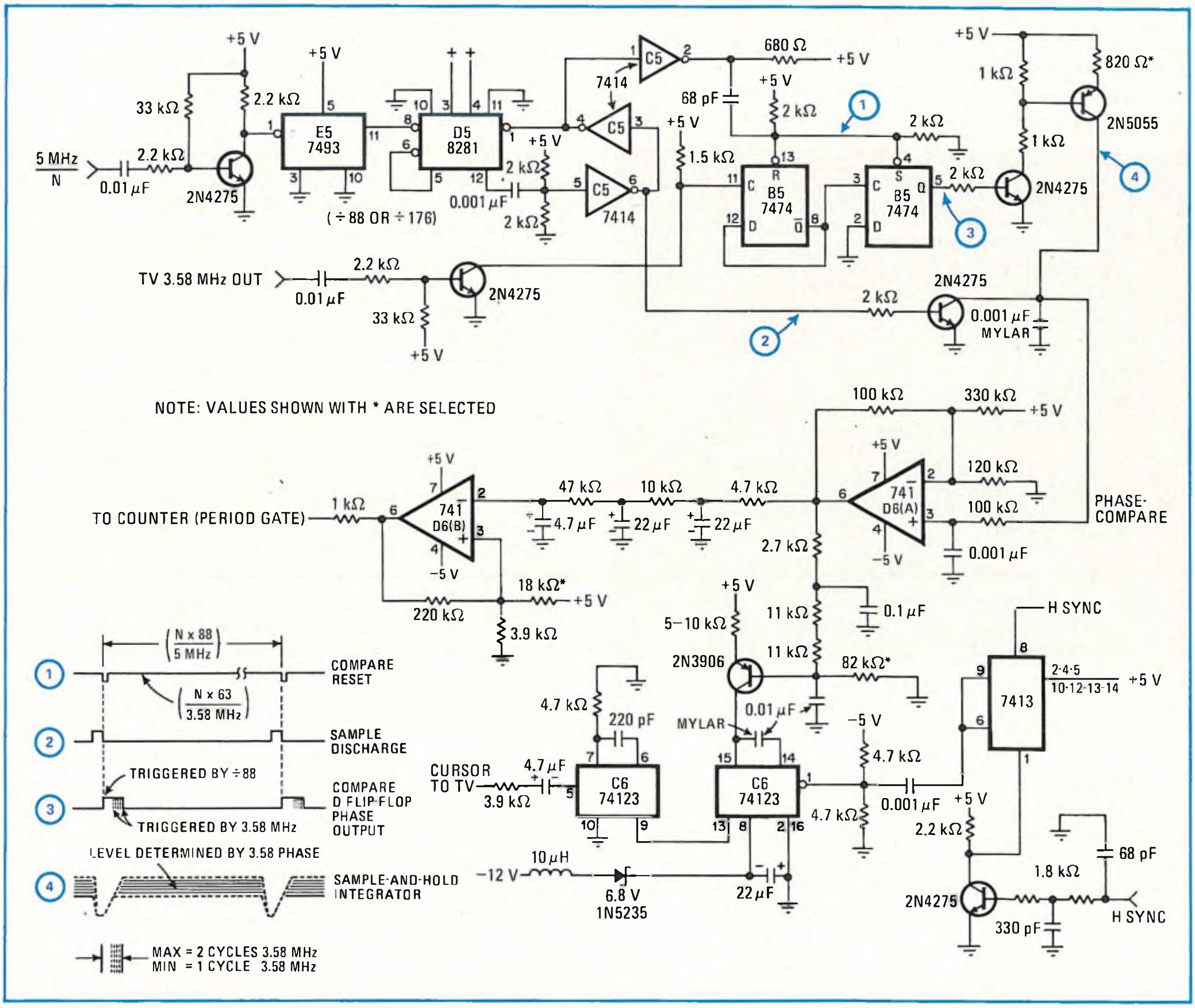
The phase-comparator-and-cursor-generator section is equivalent to the digital-subcarrier comparator. It compares the 3.58-MHz TV signal with the signal under test and generates a beat note and a cursor. The offset scaler accepts the beat and the 3.58-MHz reference signal, f_1. The rate generator provides pulses at $R = \Delta f \times 10^4$, which is 10,000 times the beat frequency. These rate pulses are gated on for a time T_G equal to $10^7/f_1$. The count output to the data-store counters is therefore

$$R \times T_G = \Delta f \times 10^4 \times (10^7/f_1) = (\Delta f/f_1) \times 10^{11}$$

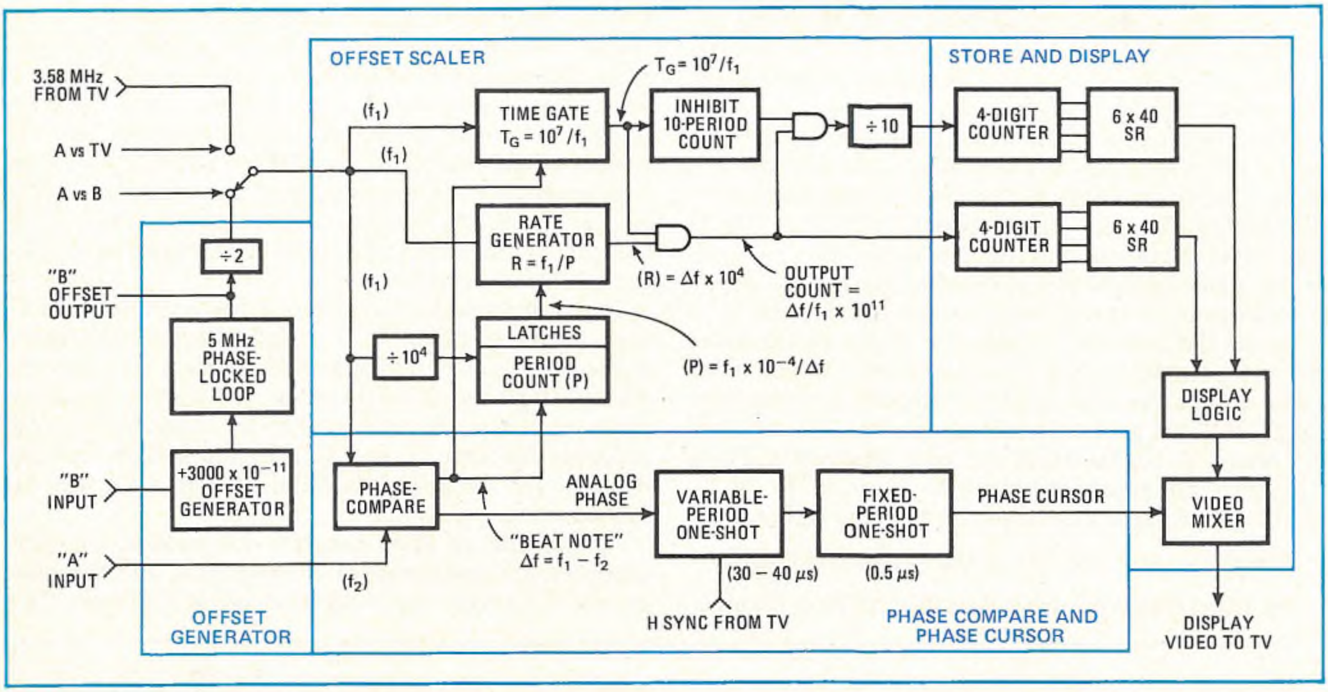
The gated frequency from the offset scaler is accumulated in the two 4-digit counters in the data-store-and-display section. After each cycle of beat-note measurement, the single-period counter is gated on for 2.79 seconds. The accumulated single-period count is then dumped to the single-period store for readout. The 10-period 4-digit counter is preceded by a divide-by-10, so from each single-period average, it accumulates 1/10 of its total count. At the end of 10 one-period averages, contents of the 10-period counter are dumped to the 10-period store for readout.

The readout data is presented as two columns of 10 4-digit numbers (Fig. 9). The left column represents single-period offset readouts, and the right column represents 10-period offset readouts. To start a measurement sequence, the user pushes the reset button. All readouts are reset to zero, and the top 4 digits in each column are intensified, indicating that data will be loaded in these positions.

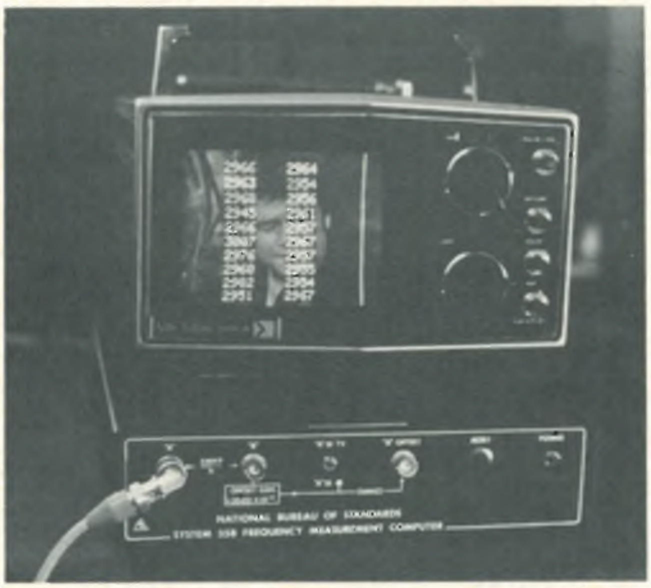
At the end of approximately 13 seconds, the first single-period measurement is completed, and the data is loaded into the top 4 digits in the left column. The



7. Digital comparator. One output from the sample-and-hold comparator can generate a cursor on a television screen while a second output feeds a counter for digital readout of offset. Waveforms at four points in the circuitry are also shown here.



8. Signal flow. A signal of unknown frequency (A) can be compared with either the color-subcarrier 3.58-MHz signal or another reference signal (B) for on-screen display. The B-input offset generator provides the offset necessary to make accurate measurements quickly, a self-check capability for the computer, or a means to make comparisons to a zero-offset color subcarrier.



9. Computer. Frequency offsets and averages of 10 offset readings can be computed. The values can be displayed, along with a phase cursor, on a television screen.

second 4 digits in the left column are then intensified. On each following 10-second interval, data is loaded into succeeding positions in the left column until 10 single-period averages have been accumulated. The first 10-period average is then loaded. The process continues until all 10 10-period averages have been loaded.

Adding refinements

One feature added to the frequency-time computer in use at the National Bureau of Standards permits the user to leave the instrument unattended during its 15-minute run. A circuit compares the result of the latest single-period measurement with the expected value and, if there is a significant difference, ignores the measurement. This compensates for large phase jumps that may occur in the broadcast signal if, for example, the broadcast switches between network and local origin.

The frequency-time computer also contains circuitry that allows the comparison of two oscillators with each other. A reference oscillator connected to one input is compared with a $+3{,}000 \times 10^{-11}$ offset replica of the second input. If the two signals have no offset with respect to each other, the on-screen readout will be 3,000. Readout accuracy is within $\pm 1 \times 10^{-11}$ for 22 minutes of data, which represents 10 10-period readouts at a sampling frequency of 2.5 MHz, with $3{,}000 \times 10^{-11}$ offset. This mode is also useful for comparing oscillators against zero-offset color subcarriers. WTTG-TV in Washington, D.C., for example, uses an oscillator stabilized with a cesium reference by the U.S. Naval Observatory.

If the offset and direct inputs are connected to the same oscillator, the readout should be 3,000. This provides a simple check of the frequency-time computer's circuitry. □

Closing the loop

The author will answer questions about this article at the National Bureau of Standards booth at IEEE Intercon. He will also answer calls on April 22 at (303) 499-1000, Ext. 3639. His address is National Bureau of Standards, MS 277.06, Boulder, Colo. 80302. Manufacturers interested in producing phase-comparator circuits should also call or write NBS.

Systems Supermarket

If you are in the market for a computer-controlled automatic testing/troubleshooting system, GR is the place to do your shopping. Here you will find a wide selection of automatic systems for testing digital, analog, or hybrid (digital and analog) circuits. And the new CAPS-VII software package that is now available is the current state-of-the-art for testing/troubleshooting software.

For a guide to help you compile your shopping list, request a copy of our new Systems Brochure. It concisely describes and illustrates the several standard GR systems you'll find any day being assembled off the aisles of our systems supermarket.

Photo above shows several systems in production at the Concord plant's Systems Center, one of three such centers.

2210-C Analog Test System
A general-purpose analog test system.

1792-D Logic-Circuit Test System
For high-speed, parametric digital and analog testing.

1790 Logic-Circuit Analyzer
A basic functional and diagnostic test system for logic elements.

2210-A Analog Test System
A low-cost dedicated analog test system.

1793 Logic-Circuit Tester
A "starter system" — provides rapid digital testing of complex logic circuits at minimum initial cost.

1792-B Logic-Circuit Test System
Designed for the production environment, where low-cost testing and troubleshooting are mandatory.

2214 Analog Test System
A commercial-electronics analog test system.

General Radio

GR Test Systems Division

300 BAKER AVENUE, CONCORD, MASSACHUSETTS 01742

NEW YORK (N.Y.) 212 964-2722, (N.J.) 201 791-8990 • BOSTON 617 646-0550 • DAYTON 513 294-1500
CHICAGO 312 992-0800 • WASHINGTON, D. C 301 948-7071 • ATLANTA 404 394-5380
DALLAS 214 234-3357 • LOS ANGELES 714 540-9830 • SAN FRANCISCO 415 948-8233
TORONTO 416 252-3395 • ZURICH (01) 55 24 20

GR COMPANIES • Grason-Stadler • Time/Data

Circle 113 on reader service card

Designer's casebook

Silent timer warns of tape run-out

by Vernon R. Clark
Applied Automation Inc., Bartlesville, Okla.

At concerts and lectures especially, a cassette tape often runs out unnoticed. One solution is to install timing circuitry in the cassette-recorder case that will cause a light to flash when it's time to reverse or replace a cassette or to switch to another recorder. This silent warning system is also useful in duplicating cassette masters, where a preset recording time is important.

The alarm circuit operates from any voltage in the 5-to-15-volt range and can either be connected to the recorder bus or use its own battery. When the circuit is turned on, a light-emitting diode begins to blink once or twice per second, indicating that the circuit is functional and ready to start timing. When the start-timing button is pushed, the LED stops flashing and stays off for the duration of the timing period. At the end of the timing period, the LED begins to flash again, giving the signal to flip the tape.

The two main components of the circuit are a 14536 programable-timer integrated circuit and a 74C00 quad NAND gate IC. The timer contains an oscillator and a 24-stage counter. It counts pulses from the oscillator and, when some specified counter stage goes high, delivers a positive output pulse from the decode-out terminal (pin 13). Which of the counter stages triggers the output is specified by the voltages on pins 9, 10, 11, and 12. If these pins are high, high, low, and low, respectively (logic 1100), an output appears every time that stage 12 of the counter goes high. With all four pins high (logic 1111), output appears when stage 24 goes high.

Since this system was designed for a standard C90 cassette, which runs for 45 minutes a side, the timer is adjusted to provide a timing period of 44 minutes, or 2,640 seconds. Therefore the oscillator frequency is set at

$$f_{osc} = 2^{23}/2{,}640 = 3.2 \text{ kilohertz}$$

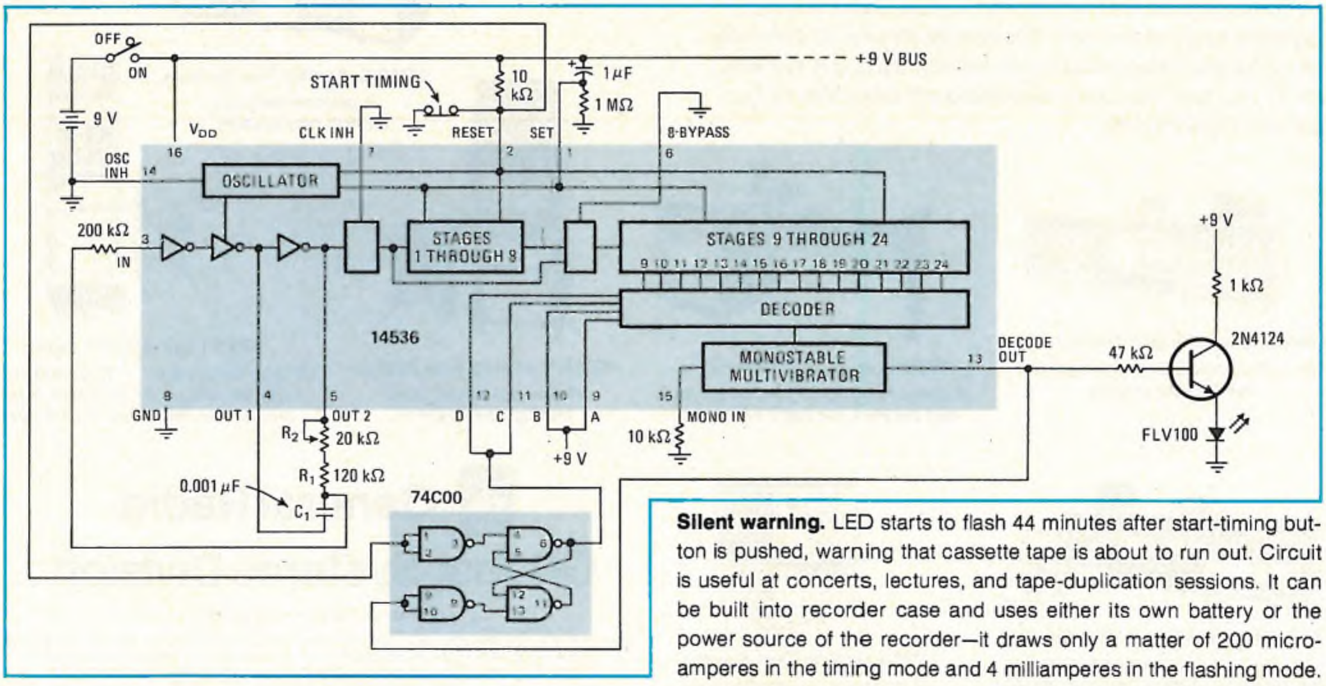
so that counting stage 24 will go high 44 minutes after the counter starts counting pulses from the oscillator (provided the decoder logic is 1111).

With this oscillator frequency, if the decoder terminals are set at logic 1100, stage 12 goes high after 2^{11} pulses, or

$$2^{11}/3.2 \text{ kHz} = 0.65 \text{ second}$$

The oscillation frequency is set by the time constant of C_1 and $(R_1 + R_2)$. A frequency meter is connected to pin 5, and R_2 is adjusted till the meter shows 3.2 kHz.

The circuit operates as follows: while the on-off switch is off, all pins are low. When the switch is turned on, pins 9 and 10 of the timer go high because they are wired to the positive-voltage bus. Therefore the decoder is programed with logic 1100, and the LED begins to flash every 0.65 second. When the start-timing button is pushed, the quad NAND circuit sets the decoder to logic 1111, so the LED stops flashing and the 44-minute count begins. After 44 minutes, the decode-out terminal (pin 13) goes high, resetting the decoder to 1100 so that the alarm signal flashes again. □



Silent warning. LED starts to flash 44 minutes after start-timing button is pushed, warning that cassette tape is about to run out. Circuit is useful at concerts, lectures, and tape-duplication sessions. It can be built into recorder case and uses either its own battery or the power source of the recorder—it draws only a matter of 200 microamperes in the timing mode and 4 milliamperes in the flashing mode.

Antilog function generator keeps VCO output linear

by J. A. Connelly and C. D. Thompson
Georgia Institute of Technology, Atlanta, Ga.

Accurate voltage control of oscillator frequency is crucial for such applications as electronic music synthesizers, filter test circuits, and phase-locked loops. In the voltage-controlled oscillator (VCO) described here, each 1-volt change in the control voltage changes the output frequency by one octave with a maximum deviation of ±0.4% over the entire audio range. This precision is achieved by temperature-compensation and buffering.

Circuit can be built with readily available parts, and the design equations allow adjustability and flexibility to meet a variety of specific needs. The total range of oscillation frequency can be shifted down one octave, for example, by doubling the capacitance of C_1 in the VCO.

This VCO is basically a relaxation oscillator: current source Q_5 charges low-leakage polystyrene capacitor C_1 until unijunction transistor Q_4 fires (at about 9 V); C_1 then discharges rapidly, and the cycle starts all over again. The sawtooth output voltage essentially results from the voltage across C_1 minus a couple of junction voltages, buffered by high-impedance MOSFET Q_2; by Q_3, which carries the current to fire Q_4; and by the unity-gain op amp. Most of the resistors limit transistor currents to safe levels.

The oscillation frequency is determined by the charging current into C_1. This current, which is the collector current from Q_{5B}, depends upon the control voltage because the base-to-emitter voltage V_{BE} in both halves of Q_5 is derived from the control voltage, thus,

$$I_C = \beta I_S \exp(qV_{BE}/kT)$$

where β is the short-circuit current gain, I_S is the reverse saturation current, kT/q is 0.026 per volt at 27°C, and V_{BE} is scaled from the control voltage V in a voltage-divider network:

$$V_{BE} = VR_{TC}/(R_{IN} + R_{TC})$$

Therefore, the collector current is given as a function of the control voltage by

$$I_C = \beta I_S \exp\left[\frac{qR_{TC}V}{kT(R_{IN} + R_{TC})}\right] = \beta I_S K^V$$

In this expression, the scale factor K is just a substitution that replaces several terms: that is,

$$K = \exp\left[\frac{qR_{TC}}{kT(R_{IN} + R_{TC})}\right]$$

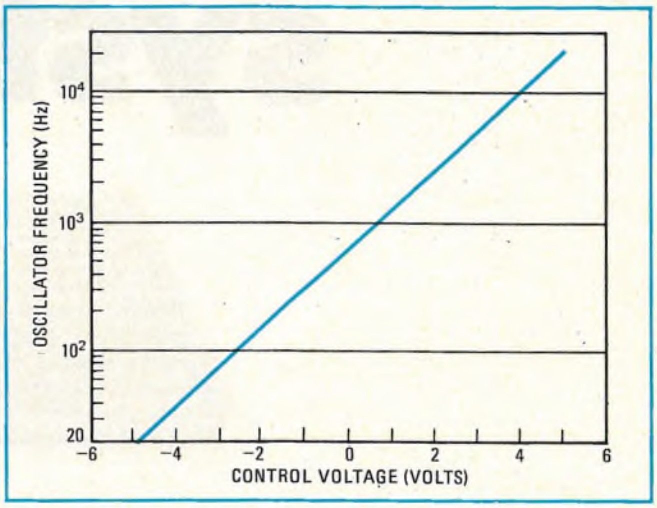
Current I_C is an antilog function (or exponential function) of voltage, and therefore the current source is called an antilog function generator.

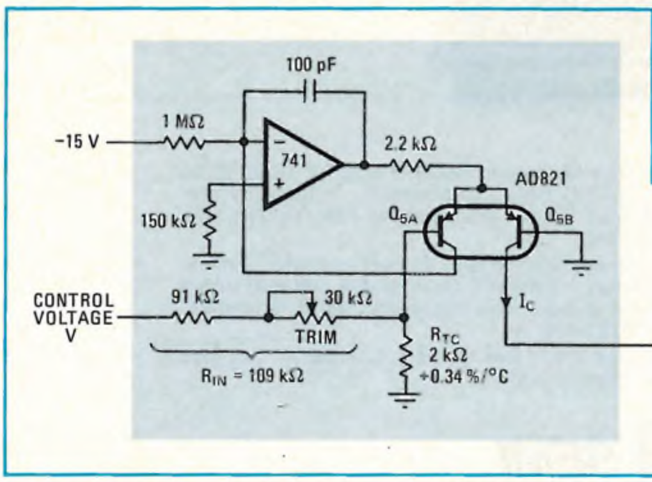
Because the frequency is directly proportional to I_C,

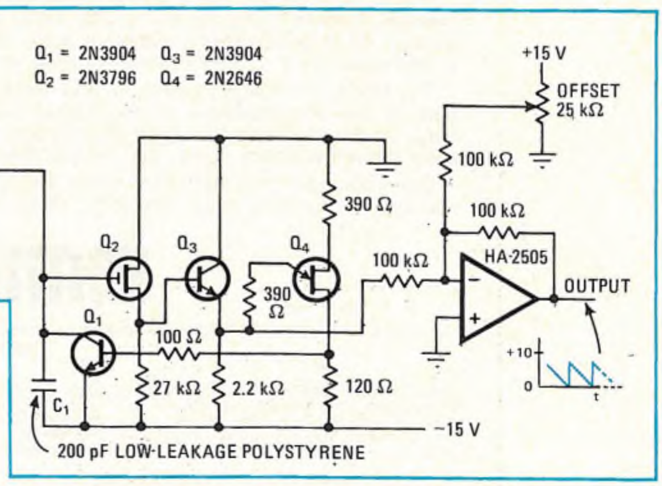
$$f \sim K^V = f_0 K^V$$

where f_0 is the free-running frequency (i.e., the oscillator frequency when control voltage V is zero). The frequency f_0 depends on the parameters of Q_5, the firing voltage of Q_4, and the capacitance of C_1.

The value of scale factor K is set by the resistors R_{IN}

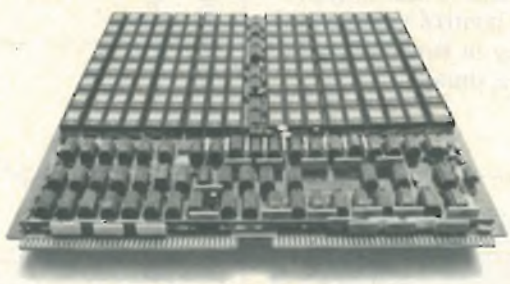






Voltage-controlled oscillator. Basic circuit is relaxation oscillator built around timing capacitor C_1 and unijunction transistor. Antilog function generator (in shaded area) supplies charging current that varies exponentially with control voltage. Tuning curve is 1-octave-per-volt straight line. If R_{IN} were 31.4 kilohms, tuning curve would be one-decade-per-volt straight line.

It's 4K! It's fast! It's static! It's a whole RAM system!



It's all of those and more, much more. It's our new Microram 3400N — a 32K x 16 or 18 bit memory system using our own SEMI 4402, 4K STATIC RAM components . . . the only production 4K STATIC RAM's available today. The 4402 is fast, with a worst case access time of 200 nsec. And . . . it's second-sourced, of course!

The Microram 3400N is form, fit, and functionally compatible with all core and NMOS members of the Micromemory family, and is completely contained on a single printed circuit card. Optional features include chassis and power supply. The Microram 3400N is immediately available with a worst case access time of 275 nsec.

Call your nearest EMM sales office and discover how "The Memory Company" can give you system building block flexibility, 4K to 32K, core or NMOS.

EMM SEMI

A division of Electronic Memories & Magnetics Corporation • 3883 North 28th Avenue, Phoenix, Arizona 85017
(602) 263-0202

EMM OFFICES: WESTERN REGION, Regional Office, San Francisco, (408) 247-9711, Los Angeles Area, (213) 644-9881, Orange County Area (714) 639-5811, Minneapolis Area, (612) 941-2404, Phoenix Area (602) 968-2492, Dallas Area (214) 231-7207, EASTERN REGION, Regional Office, Boston, (617) 861-9650, Chicago Area, (312) 297-7090, Washington, D.C. Area (703) 941-2100, New York Area 516) 423-5800, Cleveland Area (216) 842-8920 INTERNATIONAL OFFICES, European Headquarters, Belgium(031) 76.69.75, United Kingdom (01) 751-1213, West Germany (089)714.30.40.

REPRESENTATIVES: Gentry Associates; Orlando (305) 894-4401, Huntsville (205) 534-9771, Burlington, N.C. (919) 227-3639.
In Canada: Megatronix, Ltd., Toronto (416) 742-8015, Montreal (514) 488-0404, Ottawa (613) 729-4004, Vancouver (604) 526-3312
In Japan, Nissho Electronics (03) 542-2351.

and R_{TC} in the divider network. If K is 10, the oscillation frequency changes by one decade when V changes by 1 V. With the resistance values shown in the circuit diagram, however, K is 2, so the frequency changes by one octave when V changes by 1 V.

The temperature sensitivity of I_C is compensated by the temperature coefficient of thermistor R_{TC}, +0.34%/°C, which is equal in magnitude and opposite in sign to the effect of q/kT in the expression for K. Thus, scale factor K is independent of temperature if the thermistor and Q_5 have equal temperatures. To ensure this condition, the thermistor is mounted in thermal contact with the header of Q_5.

The tuning curve shows the experimental performance of the VCO. The maximum departure from the straight-line relationship is only ±0.4% over the audio-frequency range from 20 Hz to 20 kHz. Outside that range, the voltage control becomes less precise. □

Radiation monitor has linear output

by Paul Prazak, *Burr-Brown Research Corp., Tucson, Ariz.*, and Lt. William B. Scott, *Edwards AFB, Calif.*

A commercial silicon diode can be used as a direct-reading detector of gamma rays and high-energy X rays in radiotherapy. Besides generating an output that is linearly proportional to the radiation intensity, the diode makes a small enough probe to map the radiation field accurately. The monitoring system of diode plus two operational amplifiers provides an output voltage that varies linearly from 0.1 volt to 10 V as the dose rate varies from 10 rads per minute to 1,000 rads/min.

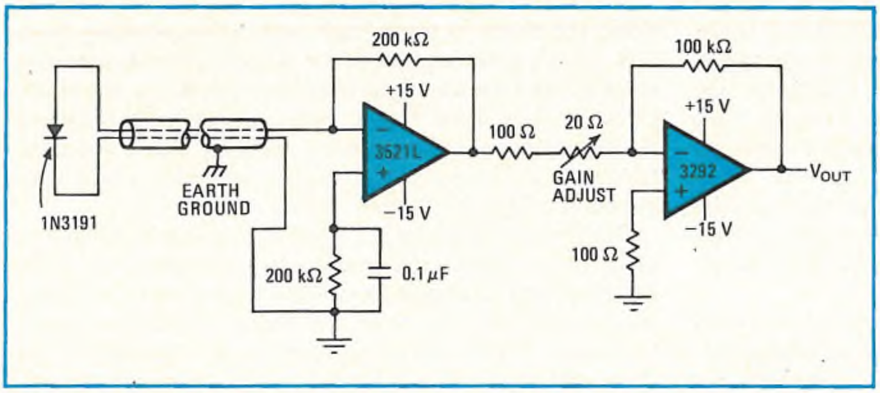
The 1N3191 or other off-the-shelf diode is operated in a zero-bias short-circuit mode. Irradiation of the diode junction creates electrons and holes that are collected by the depletion gradient, producing a nanoampere current which is proportional to the intensity of the radiation.

To amplify the small signal from the diode, a 3521L operational amplifier with low bias current (10 picoamperes maximum) and ultra-low offset voltage drift (±1 microvolt/°C maximum) is used. As shown in Fig. 1, the 3521L is connected in a current-to-voltage configuration where the inverting input appears as a virtual ground. This FET-input op amp delivers output voltages of 100 μV to 10 millivolts, which are well above the noise level. The 200-kilohm resistor between ground and the noninverting input serves to balance the amplifier, and the 0.1-microfarad capacitor stabilizes the amplifier by shunting out noise and preventing oscillations resulting from positive feedback.

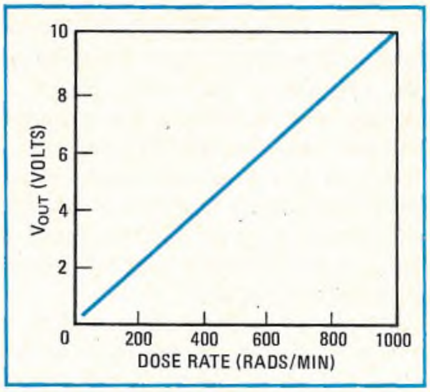
An additional stage of gain amplifies the signal to the desired level. The offset-voltage drift of this stage must be extremely low because it is amplified along with the signal. Therefore the chopper-stabilized 3292 op amp, which has a maximum offset drift of only ±0.3 μV/°C is used here. The 100-ohm resistor again balances the inputs to the amplifier. The gain of this stage should be around 1,000; it is adjusted by means of the 20-ohm potentiometer so that an output voltage of 0.10 V to 10.00 V corresponds to a dose rate of 10 rads/min to 1,000 rads/min at the detector, as shown in Fig. 2.

The output voltage can be displayed on a 3½-digit panel meter, so that the numerals directly indicate radiation intensity. An alternative is to use an ultralinear voltage-to-frequency converter, an optical coupler, a counter, and a display to completely isolate the radiotherapy patient from the monitoring and recording system. An advantage of this approach is that the integrating input of the voltage/frequency converter would average out any high-frequency noise in the system. □

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published.



1. Dosage-rate meter. Commercial diode is detector in this highly accurate radiation monitor. Low-drift FET-input op amp amplifies detector current to usable level, and chopper-stabilized amplifier then provides additional gain while minimizing any error caused by ambient-temperature fluctuations. Gain is adjusted so that output voltage is 1% of incident radiation intensity in rads per minute; therefore voltage can be displayed on 3½-digit DVM for direct reading of dosage rate. Cost of parts for this monitor is about $90.



2. Linear response. Output voltage from monitor is linearly proportional to radiation intensity at diode. Over dosage rate range shown, total system error is less than 1%. Small size of diode probe permits accurate mapping of radiation field.

Intercon/75 will find IEEE toiling against the economic slump

Institute ponders its fiscal woes and the problems of idle members, while show organizers foresee slight increase in exhibition rentals; optimists hope that good attendance will signal the beginning of a turnaround in electronics business.

by Gerald M. Walker, *Associate Editor*

☐ A successful outcome for the upcoming international convention of the Institute of Electrical and Electronics Engineers is only one concern of the IEEE in these times of economic gloom. There is also the problem of what to do for the growing number of out-of-work members, and the problem of meeting organizational expenses as hard times threaten to shrink the institute's income.

As for Intercon/75, to be held April 8 through 10 at the Coliseum and Hotel Americana in New York, there have been signs of optimism. The organizers note that, as of late February, the amount of exhibition-space rentals was keeping pace with last year. In fact they say they expect a slight increase—to 200 paid exhibitors from 180 last year. If so, and if attendance matches or exceeds last year's figure of 25,000, it may be a harbinger of better times ahead; that is, it may indicate that electronics engineers are out shopping once again.

After this year, this show will no longer be held only in New York City. It will be held in 1976 in Boston under a new title, Electro, and thereafter alternate between New York and Boston, much the way Wescon alternates between San Francisco and Los Angeles. Electro, scheduled for May 11 through 13, 1976, will also absorb the Nerem show.

The decision to alternate between two cities was an outgrowth of some of the new realities the IEEE leadership has had to face. First, the cost and inconvenience for exhibitors putting up a show in New York have been escalating sharply. Second, Intercon attendance has become increasingly regional—in character if not in name, although a thousand foreign registrants are expected this year. And the show is no longer the center stage for unveiling new products. However, it maintains its draw as a major industry meeting ground. Semiconductor companies, for example, still send marketing people to Intercon even though they dropped out of booth-buying long ago.

All of these points argued for a change of scene to bring the show to more engineers. Extrapolating from this, there's good argument for launching a Midwestern version. And eventually it may be feasible for manufacturers to buy East Coast, West Coast, and Midwest booths with one commitment covering three separate IEEE shows. This move, of course, depends on how well the Boston-New York plan works.

Right now, Intercon/75 promises a few innovations of its own. There's the timing for one thing. Not only are the dates changed from March to April, but there will be three days of show and technical sessions rather than four. There will be one late night, April 9, for the show at the Coliseum. This will make it easier for exhibitors to get their gear in and out of the two show floors at minimum cost and also shorten the time attendees will need to spend away from their benches. The number of show hours, however, will be virtually the same. A second change is moving the technical sessions uptown from the Statler Hilton to the Americana, which is closer to the Coliseum and away from the rather dreary neighborhood that bothered some out-of-towners last year. There will be more booths for distributors and sales representatives this year, which will bring in products from manufacturers who did not buy their own booths. It will also continue to give the show a decidedly more sales-oriented aura than it had in the boom years of the 1960s.

As part of the selling emphasis, Intercon/75 will feature an area on each of the two floors designated Applications Forum. Individual exhibitors can apply for use of a forum for one hour at no charge to make a product demonstration to a crowd that would be too large to fit into a regular booth area.

A meat-and-potatoes program

Technical sessions this year have been purposefully kept to solid engineering fare. There are no way-out subjects or career topics. Marketing-type talks are also getting the soft pedal. The reason, as attendance last year clearly indicated, is that peripheral subjects are duds. Topics like pension plans, the engineer and social values, incorporating human values in decision analysis—all on the program in 1974—flopped.

So it's down-to-earth, nuts-and-bolts engineering this year (see "The program at a glance," p. 120). Program chairman Peter H. Goebel of Motorola Inc. explains: "Engineers come to Intercon to see some positive developments, to find out what their fellow professionals are doing. They don't want to hear more problems; they get enough of that at work."

The technical program is divided into five general areas: computers, control and test equipment, components, communications, and instruments. Each area has six or seven sessions arranged so that EEs can catch all of the talks related to one of the five categories in two days—either Tuesday and Wednesday, or Wednesday and Thursday—and not have to hang around for all three days.

A new feature this year, the one-on-one technical forum, will bring some of the flavor of the technical sessions at the Americana over to the floors of the Coliseum. Each afternoon, some speakers from a panel representing each group listed above will be on hand at a large area on the second floor so attendees can discuss the topics in depth. Space will be allotted for the speakers to display their illustrations and talk to EEs on a one-on-one basis, a kind of extension of the exchanges at the meeting-room podium that follow delivery of a paper.

The six topics to be aired at the one-on-one sessions are the "Microcomputer Revolution," "Advanced Techniques for Automatic Test Equipment," "Trends in Electronic Measuring Instruments," "Electronics in Modern Transportation," "Satellite Communications Systems," and "Computer Technology During Hard Times."

Hard times in the industry have had an impact on the technical program. As Goebel explains, lining up speakers during the uncertain months in the last quarter of 1974 was more difficult than usual. A would-be speaker, particularly in the semiconductor industry, might express interest in presenting a paper but add that he might soon be out of work. By the same token, Goebel has been concerned about the impact on total attendance from the recession and industry retrenchment. Expecting a drop in the number of engineers able to travel from the Midwest and the West, Intercon organizers have intensified promotion in the New York area (see "Intercon's version of WIN," p. 119).

The technical program has gradually acquired its own personality rather than being simply a rehash of papers delivered earlier. Once again there's been an effort to provide fresh material.

Among the highlights will be discussions by suppliers and users of microprocessors. In the control and test equipment section will be talks on fault diagnosis of analog circuits and test generation, plus standardization of automatic test equipment. A couple of instrumentation meetings will be off the beaten path—these dealing with medical electronics and robotics. Among the components topics will be application of monolithic linear circuits. And engineers following communications technology will find a session devoted to loop electronics as an alternative to wire transmission. In all, there will be 36

Hopeful. With the number of exhibitors holding even, William Weber hopes Intercon will do well.

Intercon's version of WIN

One of the attendance promotion ideas that Intercon is trying this year is the "pink card" plan, also called the "uninflated" prepaid registration order. Designed for companies that may be sending several persons to the show, it works this way: after approximating how many people it wants to send, a company orders a stack of pink registration cards. Intercon then bills the company $1 for each card that is actually presented at the show, but not for unused cards. The regular registration fee is $8 for IEEE members and $10 for nonmembers.

When the company receives its bill, it also receives a printout of who used the cards and their affiliations. The maximum charge to a company is $1,200. The only hitch is that the pink-card users still have to get in line with users of the prepaid cards at the Coliseum registration counters.

sessions, plus one evening highlight based on a panel discussion of the implications of nuclear power.

In addition to the regular technical program, various groups and societies will convene 11 special sessions on Monday, April 7, before Intercon. Two such programs will deal with a systems approach to energy management, which should be a hot topic in light of the Ford Administration's energy program. These sessions, sponsored by the Systems, Man, and Cybernetics Society, will include speakers from Federal agencies.

The program at a glance

With 36 sessions covering five product categories, the Intercon/75 technical program this year offers a number of down-to-earth engineering discussions. Here are some of the more important ones:

Microprocessors will get a large measure of attention. At Session 1, the topic will be the "Microcomputer Revolution," and talks will cover microprocessors for general-purpose computation, microcomputers, and solid-state mass memories. Session 7, on "Microprocessors: An Alternative to Random Logic Design," will explore field repair of microprocessor-based systems, a new and growing problem. And "Microprocessors in Instrumentation," Session 19, will focus on reports from the John Fluke Manufacturing Co., Tektronix Inc., Norland Instruments, and Hewlett-Packard Co. The papers will advise on why, where, and how to use microprocessors.

Test equipment and systems will also get a good share of the limelight. Standardization of automatic test equipment, a controversial topic these days, will be discussed in session 9 by a panel from the U.S. Navy, Army, and NASA. It will touch on hardware and software and the interface between various ATE systems.

"Test Generation Techniques for Digital Circuits," Session 15, and "Diagnostic Techniques for Logic Circuit Boards," Session 21, will yield a total of eight papers with nuts-and-bolts information emphasizing the automation of fault diagnosis. Session 32, "Testing LSI Devices," will include a talk on charge-coupled devices. This is a rare opportunity to hear about testing CCDs, a subject heretofore largely ignored.

In communications, Session 10 will touch on international digital-transmission standards, new data-network viability, regulatory aspects of spectrum use, and packet switching. Analog and digital transmission systems will be covered in Session 8, including talks on a digital carrier subscriber system, a frequency-division-multiplex subscriber system, and a single-channel subscriber carrier.

Advances in computer technology are bringing on new storage devices like high-speed cache memories, solid-state drums, and very large stores. The technology of hierarchial storage systems will be presented in Session 20 by papers from Honeywell Information Systems Inc., IBM, Sperry Univac, and Digital Equipment Corp.

A panel discussion that's bound to provide verbal fireworks from speakers and audience alike is Session 6, concerning component specs and applications, entitled "What You Don't Know Can Hurt You." Viewpoints of users and suppliers in specifying, testing, and applying semiconductors and passive components will be heard. And attendees will get a chance to chime in about their particular problems.

The Technology Forecast and Assessment Project will sponsor two pre-Intercon forums, too. One will cover "Energy—View From the Year 2000,"—and the other will be a forecast of the future of components. Solid-state devices, electron tubes, power devices, and passive components will be discussed in the components forum.

Finally, the IEEE Educational Activities Board will sponsor four special-fee, one-day courses during Intercon week covering microprocessors, data processing, computer-interface standards, and computer networks. The admission price of $60 for IEEE members or $75 for non-members to any course includes registration to the show and technical sessions as well.

Recession alert

Like the industries its members serve, the IEEE is under pressure to cut costs. This comes at an awkward time—when the rising number of unemployed and underemployed EEs is causing more and more concern.

IEEE membership has been increasing for the past two years, reaching 173,523 last December, compared with 168,000 the previous year. However, the rising costs and an expected drop in income from sources other than dues will squeeze this year's budget. Meanwhile, the institute's leadership has been criticized for such alleged extravagances as holding its Annual Assembly in Bermuda and for pushing ahead with plans to move into new administrative quarters in Piscataway, N.J.

To deal with the cost problem, the institute's executive committee has asked the general manager to study all expenses and programs with a sharp eye for savings. The main objective is to head off another increase in dues that would no doubt stir up more grumbling from members. At present, however, it appears that 1975 operations can break even without an increase. There is a pitfall in this, in that if more members become unemployed, and thereby be given a break on their dues, actual income will fall short of the projected figures.

Since the membership voted in November 1972 to amend the constitution permitting the institute to take up career-related projects, IEEE has become active in promoting the profession. As a result, employment problems are high on the institute's priority list this year. And while it is not yet certain that unemployed EEs will be as numerous as they were during the 1969–71 slump, the difference this time is that the institute has some machinery to bring into play in this regard, at least to find out how bad the problem is.

The IEEE has started making monthly surveys of members to get an idea of the number of EEs having employment problems. And, since merely collecting data seemed too lame an approach by itself, the IEEE executive committee decided in December to revive a program that was tried in 1972. It involves workshops set up at the grass-roots level. These have two objectives: first, to help out-of-work EEs overcome the psychological and procedural hurdles of looking for jobs, and second, to uncover job openings by word of mouth from other members.

The latter objective may be the more beneficial. As the new IEEE general manager, Herbert A. Schulke, puts it: "A key lesson learned in 1970–71 was the need to unearth engineering opportunities. Starting at the local level gets the best results. They [at the local level] know of the vacancies better than any national data bank. We want a kind of buddy system, where those with jobs help find opportunities for those unemployed."

President Stern sets goals

Since the IEEE has expanded its scope of activities into career matters, the role of the president has changed greatly from its previous ceremonial or honorary aspect. Yet there are limits imposed by the one-year term that cut into how much a president can accomplish. Arthur P. Stern, this year's IEEE president who is vice president and general manager of Magnavox Co.'s Advanced Products division, hopes to do something about this problem.

Stern feels that the institute needs greater continuity from year to year. "In these times, the environment is tough," he says. "Members are demanding more. So we can't afford a parade of people marching through, assuming responsibility at the beginning of the year and dropping it at the end. I will be actively engaged in developing ways to improve continuity."

His first objective will be to make sure that the chief operating officer is the general manager and to keep the staff free of interference in its daily operations from the policymakers on the executive committee. This will require "restraint on the part of the executive committee not to meddle," he emphasizes. Stern's second goal is to provide close cooperation with his successor to reduce the abruptness in the change of command next December.

Stern also feels that the IEEE does not need a second president—one for professional activities beside one for technical programs—as he now has help in the form of an executive vice president (a new position held this year by Joseph K. Dillard of Westinghouse Electric Corp.). While Stern plans to concentrate on career-related tasks, Dillard will emphasize the technical and educational side.

IEEE's constant gadfly

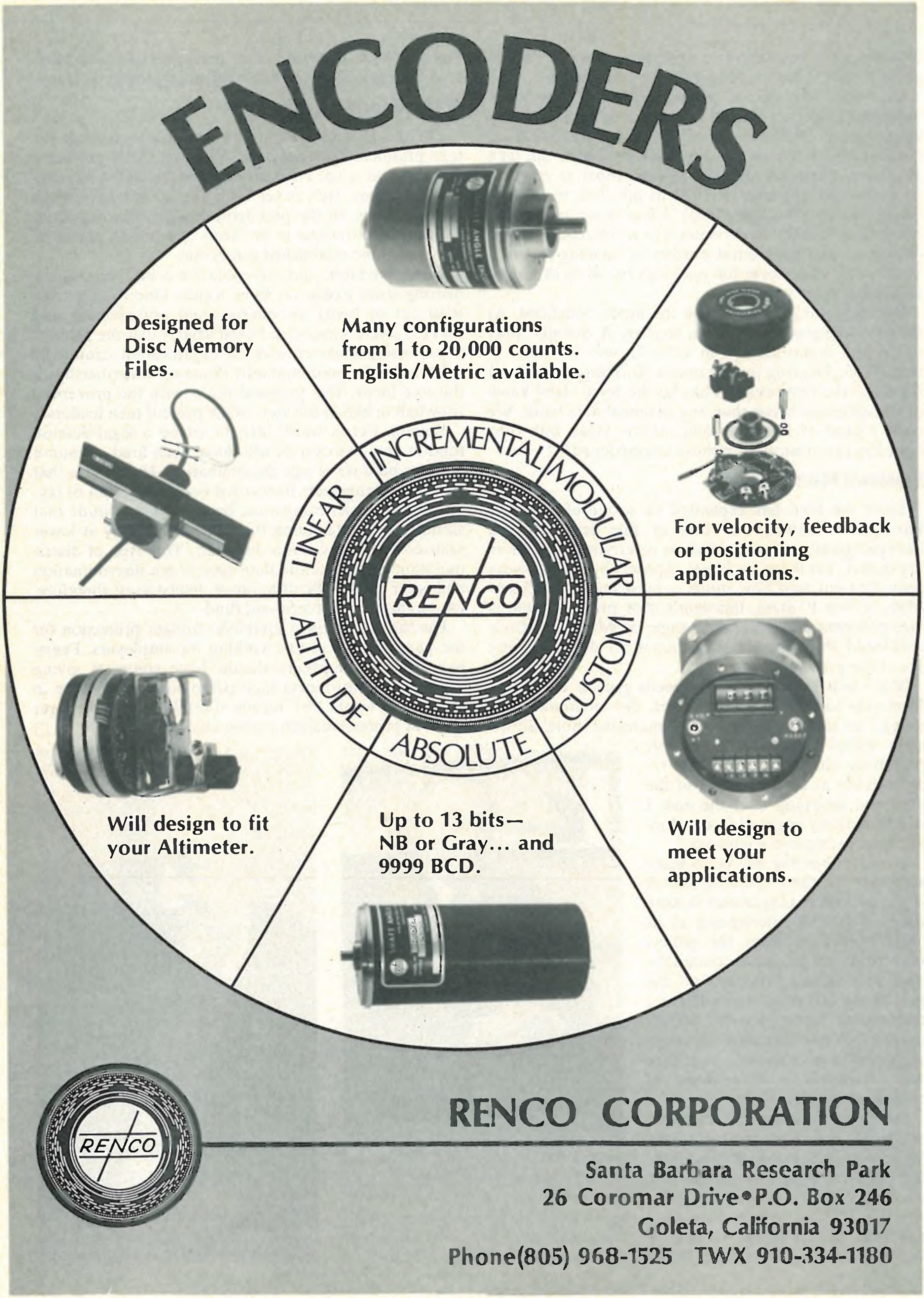
For the last few years a burden that goes with the IEEE president's job has been dealing with Irwin Feerst. An abrasive critic, Feerst is also a source of some constructive ideas. He's never been able to muster enough support to get on the presidential ballot, but Feerst often raises issues close to the heart of working EEs as he jousts with the established leadership.

This year Stern and the executive committee will be hearing from Feerst on three topics. One is to get the IEEE out of being an international organization and make it solely American. Feerst argues that the goals of a professional career-oriented organization cannot be met unless the predominantly American membership is the sole focus. This proposal ranks with the proverbial snowball in hell in the view of the present IEEE leaders.

Second, Feerst wants IEEE to set up a legal-defense fund to help EEs over 40 who have been fired or cannot get jobs because of age discrimination. He charges that middle-age engineers have often borne the brunt of layoffs in electronics companies, based on the attitude that younger graduates bring the latest technology at lower salaries than the veteran designers. This type of discrimination is more subtle than race or sex discrimination and is far more difficult to prove, Feerst says; therefore, EEs ought to have a legal-aid fund.

His third cause is to establish stronger protection for the patent rights of EEs working for employers. Feerst believes that engineers should have contracts giving them more control over their patented products than in the past. It would be a means of establishing a stronger sense of professionalism among EEs, he argues. □

Retrenching. H. A. Schulke, IEEE general manager (left), and A. P. Stern, president, have tough job of cutting costs when members are demanding more services. High on their priority list for this year is dealing with rising unemployment among members.


ENCODERS
Designed for Disc Memory Files.
Many configurations from 1 to 20,000 counts. English/Metric available.
For velocity, feedback or positioning applications.
INCREMENTAL
MODULAR
CUSTOM
ABSOLUTE
ALTITUDE
LINEAR
RENCO
Will design to fit your Altimeter.
Up to 13 bits— NB or Gray... and 9999 BCD.
Will design to meet your applications.
RENCO
RENCO CORPORATION
Santa Barbara Research Park
26 Coromar Drive • P.O. Box 246
Goleta, California 93017
Phone(805) 968-1525 TWX 910-334-1180

C-MOS flip-flop can do more than logic tasks

The high impedance and threshold properties of the complementary-MOS flip-flop enable it to handle several unconventional jobs, such as pulse generation, duty-cycle modulation, and limit detection

by Thomas T. Yen, *Statham Instruments Inc., Oxnard, Calif.*

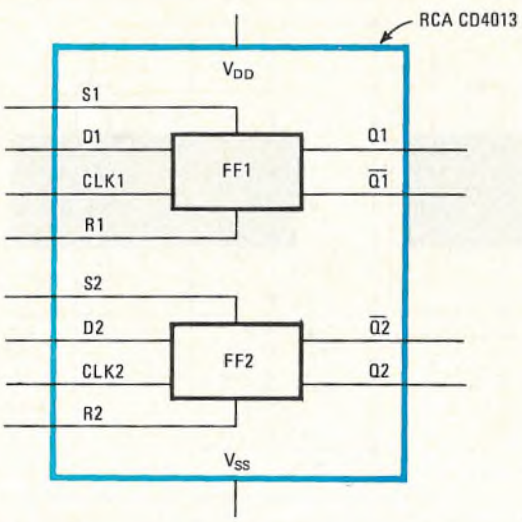
☐ The advantages of complementary-MOS logic—like high noise immunity, low power dissipation, and wide operating range—are well known by now. What may not be as well known is the versatility of the C-MOS flip-flop. Because of its high threshold voltage and high input impedance, it can be made to perform tasks other than the logic applications for which it normally is intended. Its input impedance, which is on the order of 10^{12} ohms, means that source loading is never a problem, and its logic-high threshold level, which is typically about 45% of the supply voltage, permits very large time constants to be realized.

For example, the model 4013, a dual data-type flip-flop with set/reset capability, can operate as a one-shot with an output-pulse width that can be adjusted over a 10,000:1 range. The device can also be wired for use as a limit detector for sensing pulse rates, as a temperature-level alarm, or as a go/no-go diode-leakage tester. Other possible applications include use as a duty-cycle modulator or as a pulse generator having an output-duty cycle adjustable over a wide range. If a second 4013-type flip-flop is used, the result can be a simple pulse-rate discriminator or even a logic-controlled duty-cycle modulator.

This sort of flexibility is not limited to the 4013-type flip-flop—other C-MOS flip-flops can also be used in a similar variety of circuits. A closer look at the applications just mentioned for the 4013-type device will help to illustrate how it's done.

As shown in Fig. 1, the 4013-type integrated circuit consists of two identical D-type flip-flops, each having independent data, clock, set, and reset inputs, as well as complementary outputs. It is intended for use as an R-S flip-flop, a toggle flip-flop, or a D-type flip-flop, as well as in shift-register or counter applications. As indicated by the unit's truth table (Fig. 1), the logic level present at either D input is transferred to the corresponding Q output during the positive-going transition of a clock pulse. Either flip-flop can be set or reset independently of the clock pulse by placing a logic high on either the set or reset line.

To wire this C-MOS IC as a one-shot, an RC network is connected to the Q1 output with a feedback path to the R1 input, as shown in Fig. 2. When a trigger pulse is ap-



TRUTH TABLE

CLK	D	R	S	Q	$\overline{Q}$
$\uparrow$	0	0	0	0	1
$\uparrow$	1	0	0	1	0
$\downarrow$	X	0	0	NO CHANGE	NO CHANGE
X	X	1	0	0	1
X	X	0	1	1	0
X	X	1	1	1	1

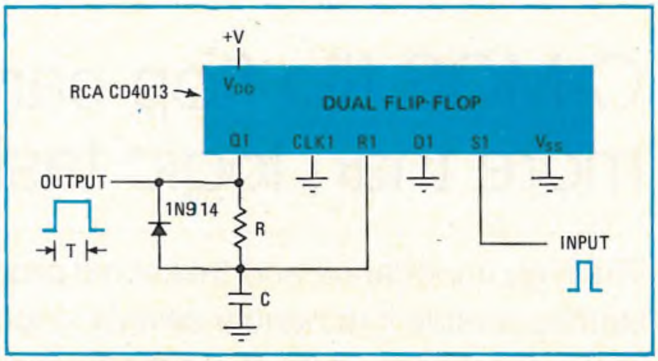
X = DON'T CARE

1. The basic device. The 4013-type C-MOS integrated circuit is a dual data-type flip-flop offering set/reset capability. Each of its two flip-flops has independent data (D), clock (CLK), set (S), and reset (R) lines, plus independent complementary outputs (Q and $\overline{Q}$). As the truth table shows, a logic signal is transferred from the D input to the Q output during a positive-going clock transition.

plied to the S1 input, the output will be a pulse having a width (T) of approximately 0.66RC second. Because of the flip-flop's high input impedance, the maximum value of resistor R can be as high as 10 megohms. The resistor's minimum value, on the other hand, is limited by the flip-flop's maximum output current capability. Typically, resistor R can be as low as 20 kilohms. Just by varying the value of resistor R, then, the output pulse width of this one-shot can be adjusted over at least a 500:1 range.

The lower limit of capacitor C is determined by the flip-flop's minimum reset pulse width, which is about 125 nanoseconds. When the capacitor is discharged, its voltage should remain higher than the flip-flop's reset threshold voltage for a very short time. This duration is the minimum reset pulse width. A typical value of capacitor C is 0.033 microfarad. When the triggering frequency is low, capacitor C can be quite large, provided that its discharge current does not exceed the flip-flop's maximum output drive current. The diode in the circuit ensures that the capacitor discharges quickly.

If the values of both resistor R and capacitor C are varied, the output pulse width of the one-shot can generally be adjusted over about a 10,000:1 range. When the triggering pulse to the S1 input is longer than 0.66RC, the output voltage will stay high as long as the trigger voltage remains high. The one-shot can be reset by applying a voltage to the flip-flop's CLK1 input, instead of returning this pin to ground as shown in the diagram.



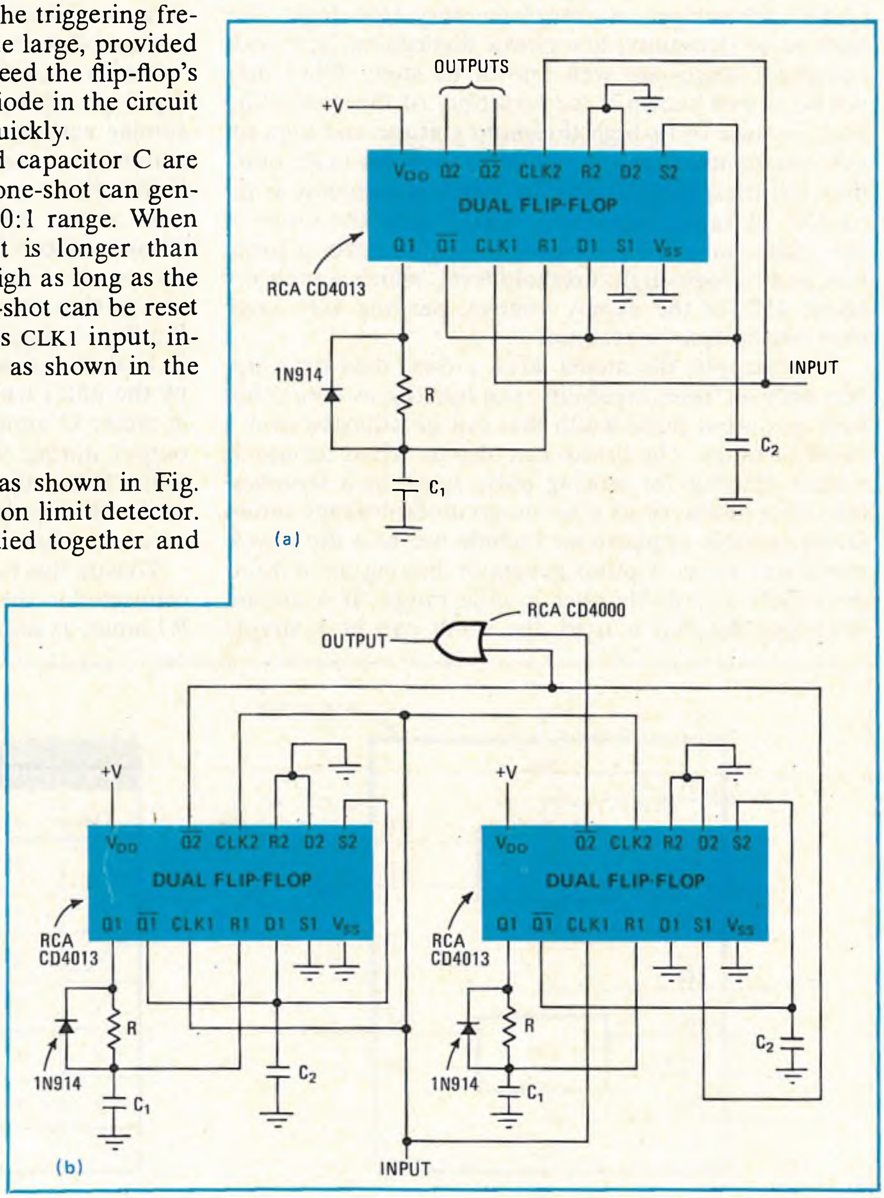
2. One-shot hookup. Only one of the flip-flops in the 4013 type is needed to realize a monostable multivibrator. Because both resistor R and capacitor C can have a wide range of values, the output-pulse width of this one-shot can be varied over a 10,000:1 range.

Building detector circuits

If the 4013-type flip-flop is wired as shown in Fig. 3(a), the device becomes a multifunction limit detector. Here, input D1 and output Q1 are tied together and then run to the S2 input. The clock inputs, CLK1 and CLK2, are triggered simultaneously by the same train of narrow pulses. Part of the flip-flop remains wired for one-shot operation, as illustrated in Fig. 2.

The circuit can be used as a pulse-rate limit detector. When the period between input pulses (T_0) becomes equal to or less than the one-shot's timing period (T_1), outputs Q2 and $\overline{Q2}$ will change state, producing an output pulse for every other input pulse. As long as this input off-time period is greater than the one-shot's period, output Q2 will remain high, and output $\overline{Q2}$ will remain low. The period of the one-shot is approximately equal to $0.66RC_1$.

Capacitor C_2 delays the pulse to the S2 input so that the pulses to the CLK2 terminal are not overridden. Increasing the value of this capacitor, which is typically 0.0068 μF, not only widens the circuit's output pulses, but also introduces a small amount of hysteresis around the cir-



3. As a detector. The 4013-type flip-flop can also operate as a limit detector. In (a), output pulses are produced at Q2 and $\overline{Q2}$ when the input pulse off-time is less than the one-shot's period ($T_1 = RC_1$). If resistance R is a thermistor or a photocell, the circuit will perform as an ambient-level alarm. Adding a second 4013 type, as in (b), creates a simple pulse-rate discriminator whose output is synchronized with the input and has the same period.

cuit's detection point. (Depending on the application, this hysteresis may or may not be desirable.)

In addition to being used as a pulse-rate detector, the circuit can be adapted for other applications. Since resistance R can have a wide range of values, a resistive element, such as a thermistor or a photocell, can be substituted for a resistor. If the input pulse rate is kept constant and resistance R varies instead, the circuit can function as an ambient-level alarm for sensing temperature or light. When the preset ambient level is exceeded, an output-pulse train will be produced.

The circuit can also be part of an automatic control system. Suppose, for example, that the input-pulse rate corresponds to motor speed. Suppose also that resistance R is a temperature-sensitive element. In this arrangement the circuit can be used to lower the limit of a motor overspeed alarm on a hot summer day.

Resistance R in the one-shot's timing network can be eliminated altogether, leaving only the diode and capacitor C_1. Here the output-pulse width is determined by the diode's leakage current, which is an exponential function of the ambient temperature. At a controlled temperature, the circuit can be used as a go/no-go tester for diode leakage. It can also operate as a temperature-level alarm. And if a photodiode is substituted for the junction diode, the circuit can become a light-level alarm or a dark-current tester for photodiodes.

There are also medical applications for this detector circuit. For instance, with appropriate modification, it can be operated as a tachycardia detector for monitoring heart beat.

By adding a second flip-flop to the circuit of Fig. 3(a), as in Fig. 3(b), a pulse-rate discriminator is realized. When the input period is less than the one-shot period, the $\overline{Q2}$ output of the left-hand flip-flop generates pulses at every other input pulse, while the $\overline{Q2}$ output of the right-hand flip-flop produces pulses for those inputs missed by the left-hand flip-flop.

The OR gate at the output of the circuit remains inhibited until the input-threshold frequency is reached. Once this happens, the gate will produce a pulse train that has the same period as the input signal and that is synchronized with the input. Because the discriminator circuit operates in real time, its response has an unusually sharp cutoff, but practically no delay.

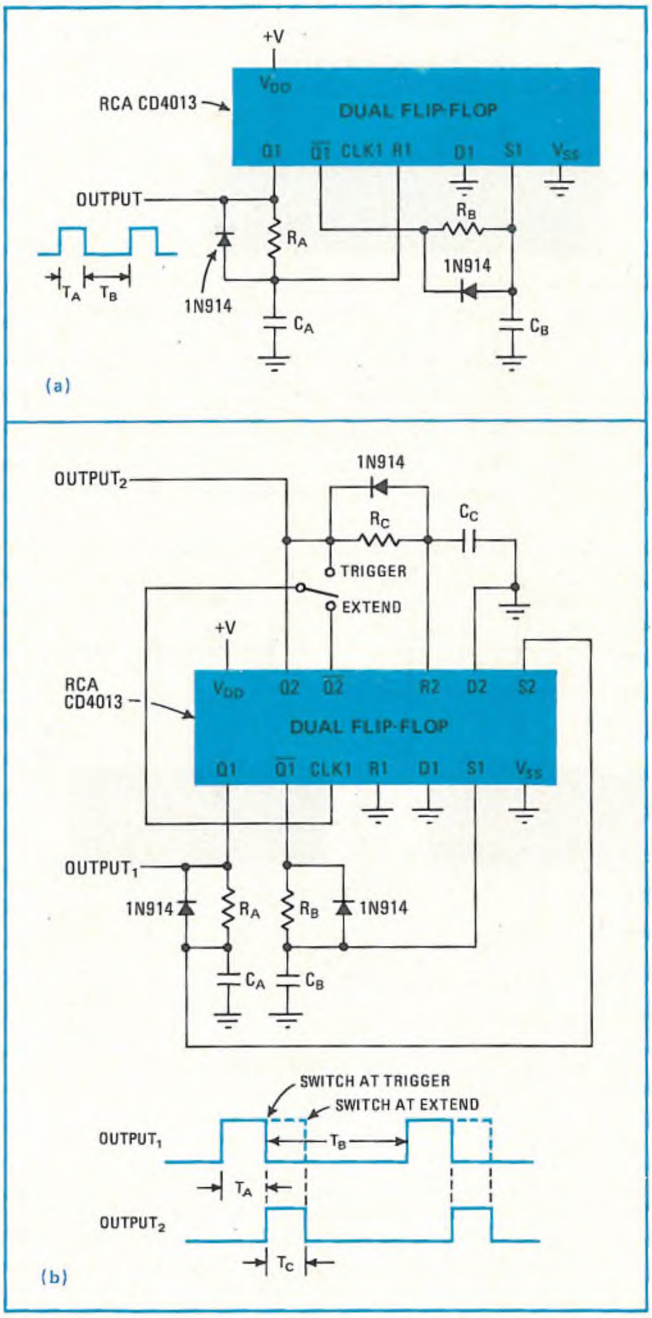
Generating pulses and modulating duty cycle

Another application for the 4013 flip-flop is as a pulse generator, as in Fig. 4(a). Different time constants are introduced into the device's set and reset lines. Resistor R_A and capacitor C_A control the delay from the Q1 output to the R1 input, while resistor R_B and capacitor C_B determine the delay between the $\overline{Q1}$ output and the S1 input.

The circuit's output will be a square wave having an on-time (T_A) of approximately $0.66R_AC_A$ and an off-time (T_B) of about $0.66R_BC_B$. The output pulse frequency is simply $1/(T_A+T_B)$. Since T_A and T_B can be adjusted separately, the circuit's output duty cycle can be varied over nearly a full 100% range. The values of the timing resistors and capacitors have the same limitations as those for the one-shot circuit of Fig. 2. Again, the diodes assure fast capacitor discharge.

This simple pulse generator can be made to produce delayed trigger pulses by utilizing the other half of the 4013-type flip-flop, as shown in Fig. 4(b). Additionally, the on-time of the pulse generator can be extended.

With the switch in the TRIGGER position, the Q1 output will remain high for a period (T_A) of approximately $0.66R_AC_A$ seconds. This signal activates the S2 line so that Q2 goes high and resets Q1. The Q2 output stays high for a period (T_C) of about $0.66R_CC_C$ second, and the Q1 output stays low for a period (T_B) of around



4. Generating pulses. Half of the 4013-type flip-flop can be wired as a pulse generator (a) having an output duty cycle that can be adjusted over a wide range. By using both halves of the flip-flop, it can be made to produce a delayed trigger pulse, as in (b).

$0.66R_BC_B$ second. The cycle repeats after the T_B period is complete.

With the switch in the EXTEND position, the Q1 output remains high for a period of $T_A + T_C$ before it is reset. The Q2 output again goes high at the end of the T_A period until T_C seconds have passed. Then the off-time period of T_B begins. The position of the switch, therefore, determines whether the delayed pulse at Q2 is within the on-time frame of the Q1 pulse or occurs immediately after the Q1 pulse.

A variation of this delayed trigger-pulse circuit enables a single 4013-type flip-flop to perform as a duty-cycle modulator, as in Fig. 5(a). When D1 is low, the circuit behaves exactly like the one of Fig. 4(b) with the switch in the TRIGGER position—namely, the output at Q1 will be high for T_A seconds and low for T_B seconds. However, if T_B is greater than T_C and D1 is high, the on-time of the Q1 output will still be T_A, but the Q1 off-time will be T_C because of the feedback path between $\overline{Q2}$ and CLK1.

The circuit, therefore, can be used to modulate the duty cycle of the control signal at D1. The off-time of the output will be alternated between T_B and T_C, and the ratio of T_B to T_C can be very large. Capacitor C_1, which is typically 150 picofarads, is needed to delay the pulse to CLK1 so that the reset signal does not override the clock signal.

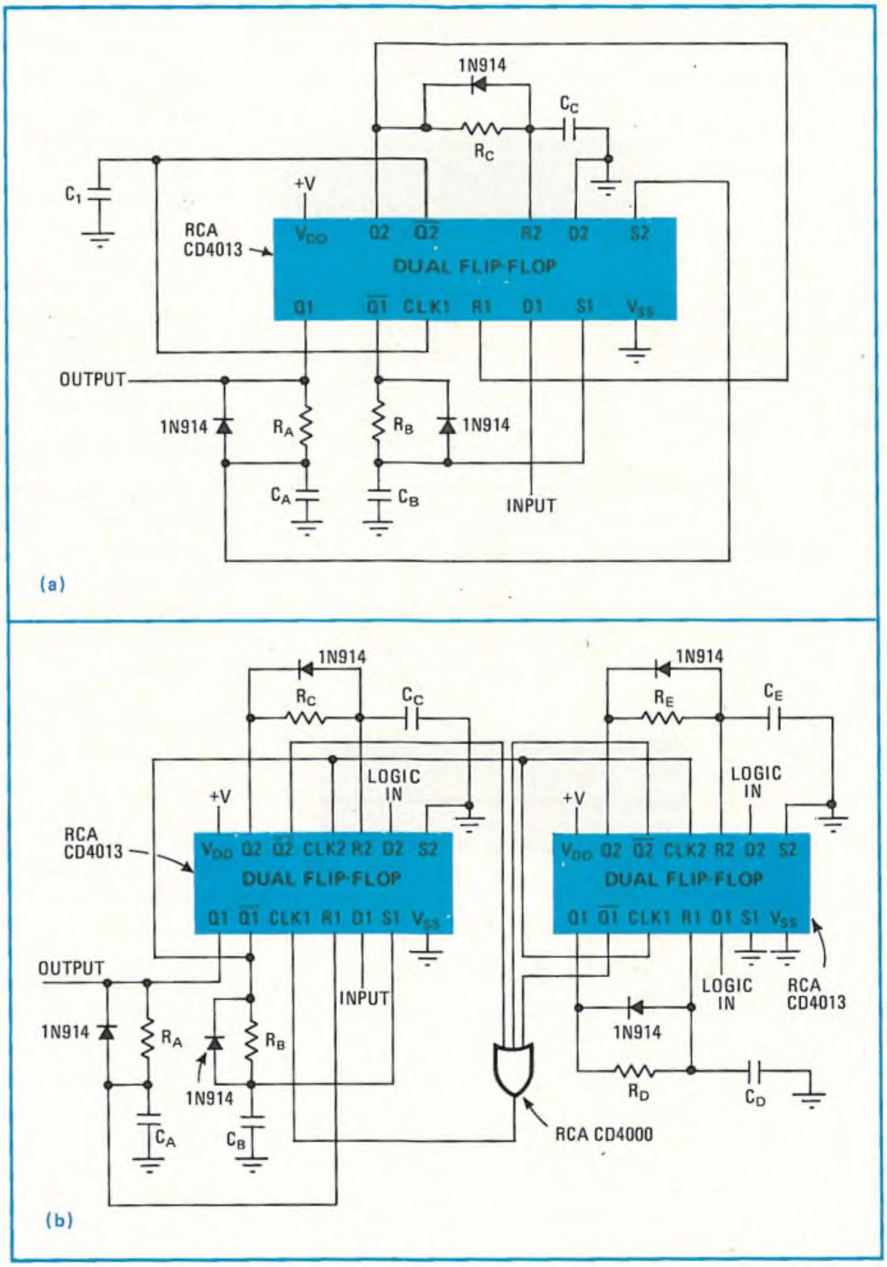
With a second flip-flop package, a more complex duty-cycle modulator can be built. In the circuit of Fig. 5(b), the control signal is applied to the D1 terminal of the left-hand flip-flop. The on-time of the output waveform remains unchanged at T_A seconds, but the off-time depends on the voltage level present at the LOGIC IN data terminals of the flip-flops when the Q1 output is reset.

If the D2 data input of the left-hand flip-flop and both data inputs of the right-hand flip-flop are all grounded, the off-time will be T_B seconds. Placing a logic high on the D2 input of the left-hand flip-flop produces an off-time of T_C seconds. Similarly, a logic high on either the D1 or D2 input of the right-hand flip-flop gives an off-time, respectively, of either T_D or T_E seconds. The circuit, therefore, performs as a logic-controlled duty-cycle modulator.

Other C-MOS flip-flops

As this article has demonstrated, the 4013-type C-MOS flip-flop can be used to implement low-power pulse circuits with relative simplicity. The device's four input terminals—data, clock, set, and reset—in addition to its high input impedance and threshold voltage levels, permit its inputs and outputs to be connected in a variety of ways.

The 4027-type C-MOS flip-flop, a dual J-K device having set/reset capability, offers even greater flexibility than the 4013 type because its J and K logic inputs are additional controls over the clock input. Another versatile C-MOS flip-flop is the 4043-type quad R-S unit. With this, it is possible to build a low-power wide-range four-stage ring counter, in which all four timing periods can be adjusted individually over a broad range by simply varying resistor and capacitor values. □



5. Modulating duty cycle. A single 4013-type flip-flop can be wired as a duty-cycle modulator (a). With two flip-flops, a logic-controlled modulator (b) can be built. Here, the off-time of the output depends on the logic level present at the three LOGIC IN ports. The output on-time is the same for both of these circuits.

Solid-state temperature sensor outperforms previous transducers

Temperature detector profits from linear heat sensitivity of a transistor's base-emitter voltage; the result is a low-cost package with a stable, accurate output that needs no amplification

by Robert A. Ruehle, *Relco Products Inc., Denver, Colo.*

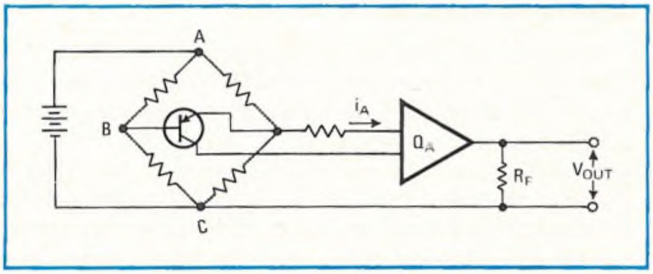
☐ Although the inexpensive silicon transducer has become available to industry only in the past year or so, the military has used it for nearly 10 years. It has traveled aboard scientific satellites and high-altitude balloons, survived the steam and hot water of an active volcano, and dived into the ocean to measure temperatures in an underseas habitat.

Until the past couple of years, the costs of the high-quality components required for the silicon transducer have been so high that the device was impractical for the commercial market, which could be served by cheaper, existing transducers. What's more, the military until recently bought most of the output from the manufacturers that were making the unit.

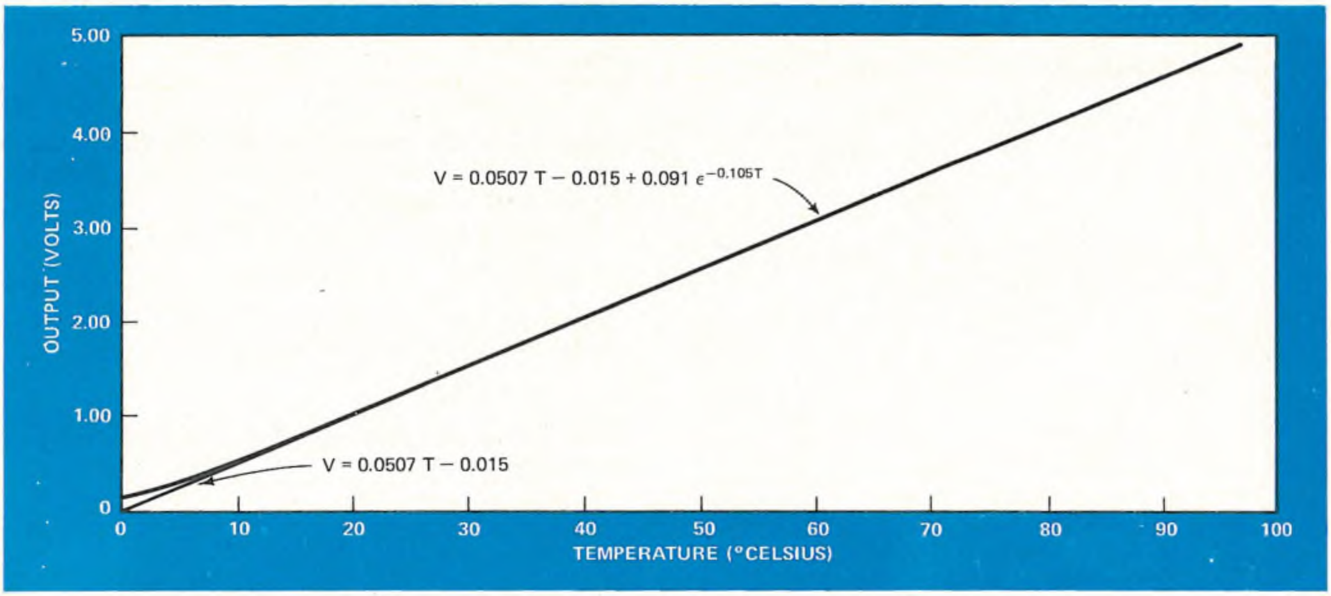
But now the new transducer, which can be purchased for about $15, is being built into instruments—among them a digital thermometer. Although this transducer outperforms traditional temperature-measurement devices, its temperature range is limited to a range of -100°C to 150°C. Its most notable characteristic is its large and highly linear output, adjustable from 10 millivolts per degree celsius to 360 mV/°C. Measurements made with the instrument are highly accurate, and the output remains exceptionally stable for long periods.

Good sensitivity and a wide range of temperatures have been offered for many years by thermocouples, thermistors, and resistance-temperature devices. However, the thermocouple requires cold-junction temperature compensation, the thermistor is extremely nonlinear, and the RTD is relatively expensive.

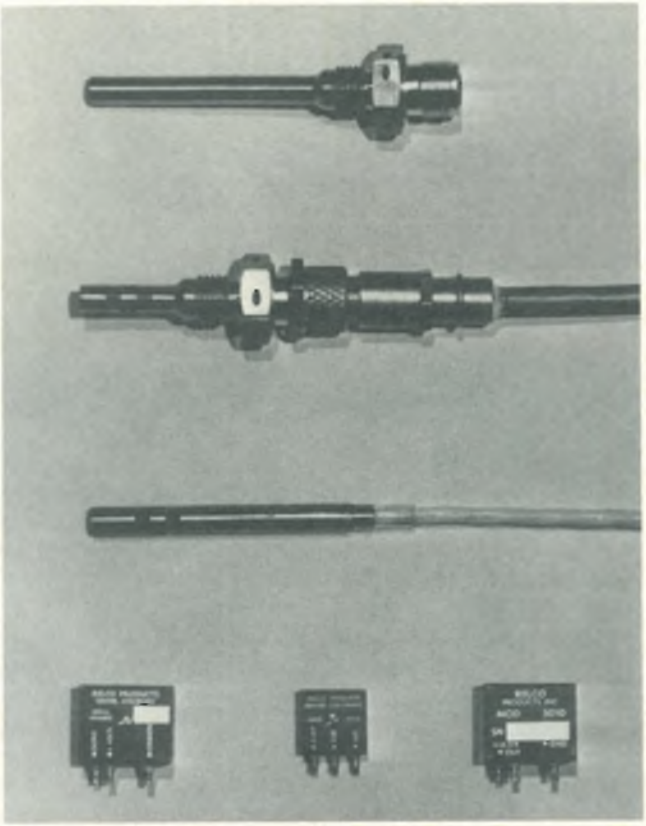
The silicon temperature transducer takes advantage of the characteristic that a transistor's base-emitter volt-



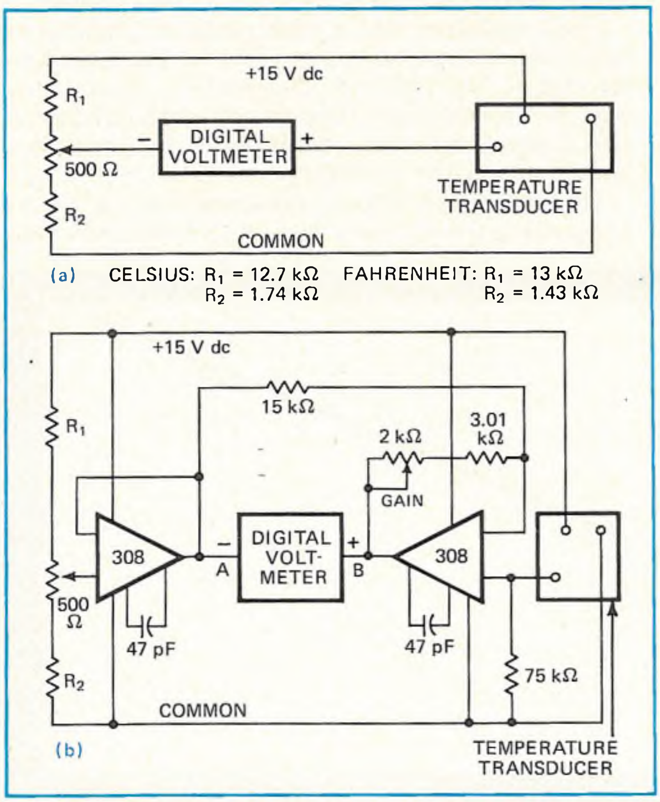
1. Solid-state transducer. A self-adjusting bridge circuit holds base current constant; the base current, in turn, keeps the collector current constant. As a result, the emitter-base voltage is a linear function with respect to temperature.



2. Linear output. Nonlinear portion of transfer function becomes negligible at higher outputs. And between 1 and 5 volts, output deviates from straight line by less than ±0.1%. The value of constants in transfer function depends on the specific transistor used.



3. Temperature transducer. Units come in a variety of sizes, shapes, and housings to fit the application.



4. Digital thermometer. Adjustment of potentiometer and internal gain of digital panel meter in (a) trims out manufacturing variations in slope and zero-intercept. Where it is not practical to adjust the DPM's gain to trim system sensitivity, the circuit in (b) can be used.

age varies directly with temperature. In a transistor, the collector current, I, is proportional to the emitter current, I_e.

$$-I_c = \gamma I_e - I_{co} \quad (1)$$

where the constant γ is the short-circuit forward-transfer ratio, and I_{co} is the collector reverse current. The emitter current, in turn, is proportional to the emitter's reverse current I_{eo}, the absolute temperature, T, and the emitter-base forward-bias voltage, V_{eb}. This relationship is shown by the equation

$$I_e = I_{eo}(e^{qV_{eb}/nKT} - 1) \quad (2)$$

where q is the electronic charge, n is a number ranging from 1 to 2, and K represents the Boltzman constant.

Taking the logarithm of Eq. 2 and rearranging the result yields

$$V_{eb} = \frac{nK}{q} \, ln\left[\frac{I_e + I_{eo}}{I_{eo}}\right] T \quad (3)$$

If the emitter current is held constant, the term in brackets becomes a constant, and the emitter-base voltage becomes a linear function of temperature. As a result, theoretically, a transistor can serve as a linear precision temperature transducer.

Applying the theory

Although this phenomenon of the transistor's emitter-base voltage to vary linearly with temperature has been known for some time, its application hasn't been practical because the proportional relationship between temperature and voltage differs from one transistor to the next. Within a production run, the V_{be} for a particular temperature may vary as much as ±100 mv. To factor out this variation, a self-adjusting bridge circuit with negative feedback has been developed (Fig. 1). In this circuit

$$V_{AB} = V_{AD} + V_{DB} \quad (4)$$

Now the voltage drop between the emitter and base of transistor Q can be considered to be made up of three parts.

$$V_{DB} = V_{eb} + i_e r_e + i_b r_b \quad (5)$$

where V_{eb} is the emitter-base forward bias, i_e is the emitter current, r_e is the emitter resistance, i_b is the base current, and r_b is the base resistance.

Combining equations 4 and 5 produces

$$V_{AB} = V_{AD} + V_{eb} + i_e r_e + i_b r_b \quad (6)$$

Since the base and emitter currents of a transistor are related by a constant of proportionality β

$$i_e = (1+\beta) i_b \quad (7)$$

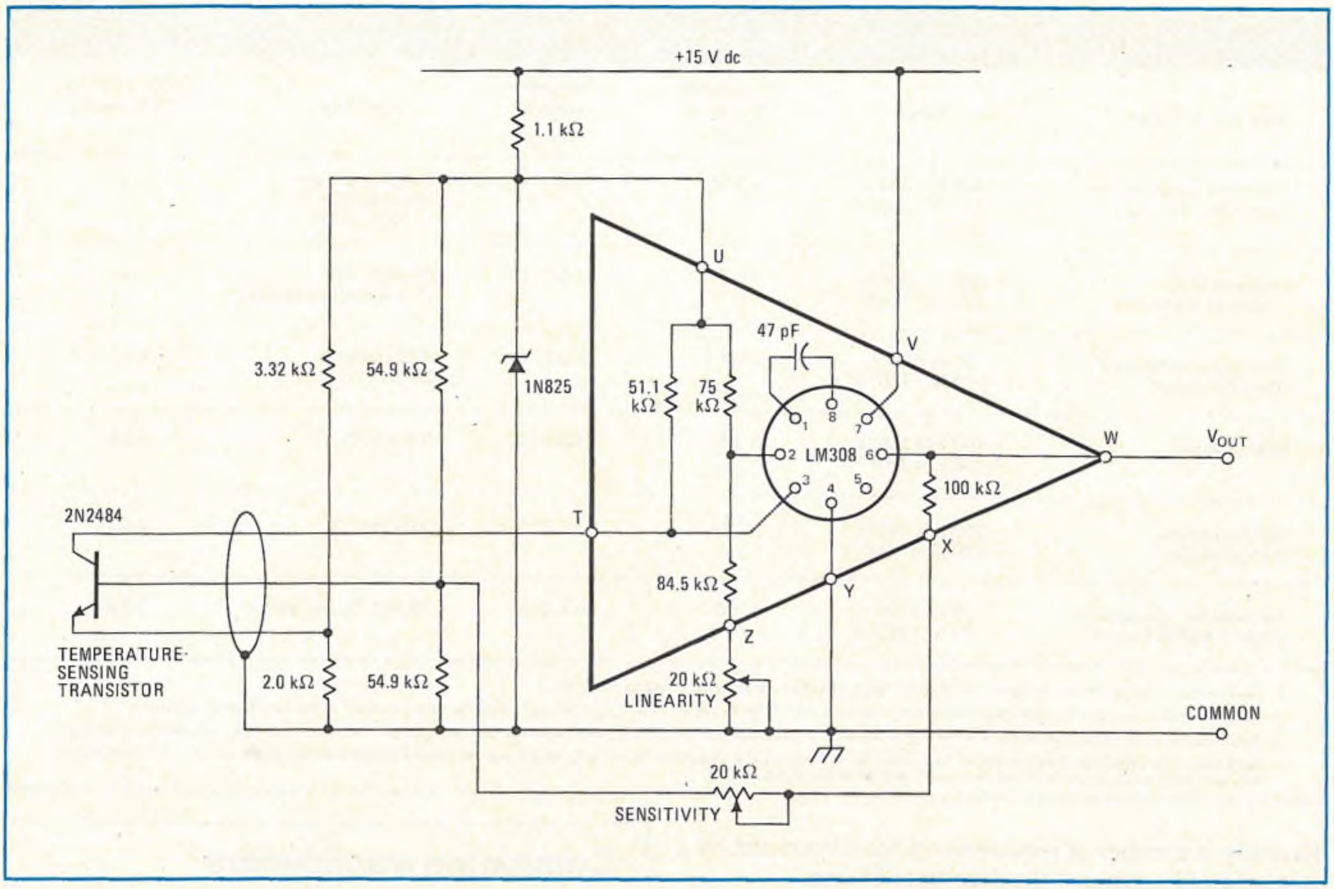
where β is termed the forward-current-transfer ratio or amplification factor and

$$\beta = i_c / i_b \quad (8)$$

Eq. 7 can be substituted into Eq. 6 to yield

$$V_{AB} = V_{AD} + V_{eb} + i_b[(1+\beta)r_e + r_b] \quad (9)$$

By definition, the term inside the brackets is the emit-



5. Sensitive unit. A remotely located 2N2484 serves as the temperature-sensing element. To eliminate collector-base leakage current, the collector-base voltage is adjusted to zero with the linearity potentiometer; the sensitivity pot adjusts circuit gain. Linearity is typically within ±0.05%. If better linearity is required, the open-loop gain must be increased by using an amplifier with a higher gain feedback.

ter-base resistance, r_{eb}; therefore, Eq. 9 can be expressed as

$$V_{AB} = V_{AD} + V_{eb} + i_b r_{eb} \quad (10)$$

The circuit is set up initially at some operating point so that any change in the collector current appears greatly amplified as the current, i_A through the resistor, R. And any change in V_{AB} is accompanied by an equivalent change in V_{AD}. V_{AB} is constant for a constant supply voltage and fixed values of R_1, R_2, R_3, and R_4, so that

$$\Delta V_{DB} = \Delta i_b r_{eb} + \Delta V_{eb} \quad (11)$$

Since the operation of the circuit is based on maintaining the transistor current at a constant level, Eq. 11 reduces to

$$\Delta V_{DB} = \Delta V_{eb}$$

Further mathematical manipulation can show that the change in the current i_A is proportional to ΔV_{eb}. By making the output voltage of the amplifier, Q_A, equal to the change in i_A, the output of the transducer can be expressed as

$$V_{OUT} = MGT$$

where M is a constant equal to the value in the brackets of Eq. 3 and G is a constant determined by the closed loop gain of the circuit. This equation shows that it is, indeed, possible to obtain a linear voltage signal proportional to temperature by using a transistor operated under constant-current conditions.

Experimental results

Tests made on several hundred silicon temperature transducers fabricated in various configurations have verified that the transfer function can be expressed by the equation

$$V_{OUT} = AT + B + Ce^{-\alpha(T-T_o)}$$

where A, B, C and α are constants and T is equal to or greater than T_o.

Figure 2 graphs the output of a typical transducer at various temperatures, along with its transfer function. While the mathematical analysis assumes that the closed-loop gain is much greater than unity, this is not true at very low output voltages.

A drop in the open-loop gain initially causes a small nonlinearity to appear in the output. This nonlinearity becomes negligible at higher outputs, and between 1 to 5 volts, the output deviates from a straight line by less than ±0.1%.

At first, all transducers were built for temperature-telemetry applications where an output of 0 to 5 V was typically required. As shown in Fig. 3, these transducers are built in a variety of sizes, shapes, and housings to fit the applications for which they were designed.

COMPARING TEMPERATURE TRANSDUCERS

Type of transducer	Range	Nonlinearity (% of span) (Note 1)	Long-term stability (Note 2)	Sensitivity	30-day accuracy (°C absolute) (Note 3)
Transistor temperature transducer (Fig. 5)	−100 to +150°C −150 to +300°F	± 0.05	± 0.1°C	Adjustable from less than 10 mV/°C to 360 mV/°C	± 0.1
Platinum RTD (100-ohm ice point)	−200 to +600°C −330 to +1,100°F	± 0.5	± 0.1°C	0.4 mV/°C (1 mA through sensor)	± 0.1
Thermistor composite (dual thermistor)	−55 to +85°C −70 to +185°F	± 0.8	± 0.1°C	Adjustable to 20 mV/°C max	± 0.15
Silicon diode	−100 to +150°C −150 to +300°F	± 1.0	± 0.1°C	2.5 mV/°C	± 0.5
Iron-constantan thermocouple	−200 to +750°C −330 to +1,400°F	± 2.0	± 1.0°C	0.05 mV/°C	± 1.2
National Semiconductor Model LX5700 (Note 4)	−55 to +125°C −70 to +257°F	± 1.0	± 0.2°C	10 mV/°C nominal	± 3.8

1. Nonlinearity is specified for the span, which is the lesser of either the range or −100 to +150°C.
2. Data on IC thermocouple is estimated from limits of error given in ISA Standard C96.1, together with stability data on commonly used reference junctions.
3. Accuracy figures are based on using external signal-conditioning and readout electronics having approximately equal cost. Self-heating error is included for each device.
4. Data taken from National Semiconductor data sheet dated August 1974. Accuracy figure includes uncertainty caused by self-heating device, which is 2°C minimum, but does not include errors from reference drift and amplifier instability.

Recently, a number of requirements have been met by a standardized version of the aerospace design.

One of these applications was a low-cost precision digital thermometer with a slope of 10 mV/° C and an intercept of +2 V at 0°C. A digital panel voltmeter connected to the transducer output as shown in Fig. 4(a) is calibrated so that the display changes one unit for every 10 mV change at the input so that temperature can be read directly to within ±0.1°C.

To calibrate the DPM, the temperature is held at 0°C while the potentiometer is adjusted until the display reads zero. This trims out the manufacturing tolerances on the zero intercept. To trim out the manufacturing tolerance on the slope, the temperature is raised to 100°C, and the gain of the DPM is adjusted until the display reads 100.0.

In applications where it is not practical to adjust the gain of the digital panel meter to trim system sensitivity, the circuit of Fig. 4(b) can be used. Here a buffer amplifier at the transducer output and a 2-kilohm potentiometer correct system sensitivity to yield 10 millivolts per degree at points A and B.

The circuits in (a) and (b) both require a regulated voltage source, divider networks, buffer amplifiers, and trimming potentiometers, together with a transducer and readout. All these items have been combined into a single instrument that operates off either ac line power or internal batteries.

Figure 5 is a schematic diagram of one version of the new transducer. This design uses a remotely located 2N2484 as the temperature sensor. As was pointed out in the theory of operation, the circuit maintains a constant base current in the sensing transistor in order to obtain a linear output signal proportional to temperature. To do this, the collector-base leakage current must be eliminated from the collector circuit. This is accomplished by adjusting the collector-base voltage to zero with the linearity potentiometer. The sensitivity potentiometer is used to adjust the circuit gain for an output signal sensitivity of 10 mV/°C. The linearity of the circuit is typically ±.05%. If better linearity is required, the open-loop gain must be increased by substituting a higher gain feedback amplifier, such as the type AD508.

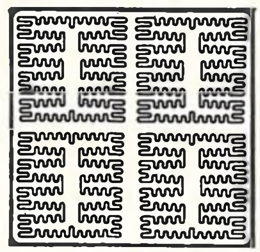
The table, which compares the transistor temperature transducer with other common methods of measuring temperature, shows that the circuit of Fig. 1 provides the best performance within it's range of operation. This new transducer system is also the most economical. □

Comparing transducers

Another version of the solid-state temperature transducer can be seen in the LX5600 and the LX5700 from National Semiconductor [*Electronics*, Nov. 14, 1974, p. 130]. These units exploit the temperature sensitivity of the emitter-base voltage, but in an entirely different manner from Relco's device. National uses a pair of matched transistors operating at different collector currents. The difference in their base-emitter voltages can be shown to be proportional to the absolute temperature of the transistors and to the natural logarithm of the ratio of their collector currents.

Since the National unit is packaged as one IC, a self-heating error amounts to several degrees. Relco uses discrete components to reduce self-heating and also mounts the temperature-sensing transistor away from the amplifying circuit. —Margaret Maas

Semi-conductor chips for hybrids



When your hybrid designs call for semiconductor chips, your first choice should be Solitron. We have an immediate supply of chips for power transistors, planar diodes and field effect transistors. You can order individually tested silicon chips. Complete wafers. Chip on molytab with ultrasonically bonded aluminum leads. Just about everything you need to build your own hybrids.

Solitron offers epitaxial, triple-diffused and single-diffused mesa dice, including a full line of NPN/PNP complementary devices, and planar power Darlington transistors. Our capabilities can meet design requirements up to currents of 200 amps, gains of 10,000 and reverse breakdown voltages of 1,000 volts.

The very latest state-of-the-art technology combined with exhaustive qualification testing guarantees the quality and reliability of Solitron chips. For example, our dice are 100% tested to meet the rating of the die either in chip or wafer form.

Solitron engineers are also available to assist you with your hybrid circuit designs.

Today, contact Joe Bilger, our Marketing Manager. He'll immediately send you a free copy of Solitron's new Semiconductor Chip Catalog.

Solitron
DEVICES, INC.

1177 BLUE HERON BLVD./ RIVIERA BEACH, FLORIDA 33404
(305) 848-4311 / TWX: (510) 952-7610

SAN DIEGO, CALIF.
92100
8808 Balboa Avenue
CMOS Devices
FET & Dual FET Transistors
MOS Devices
MOS/FET Memory Arrays
Shift Registers
Diodes/Rectifiers
Zeners
High Voltage Rectifier Stacks

RIVIERA BEACH, FLA.
33404
1177 Blue Heron Blvd.
Hi-Rel Power Transistors (Silicon)
Industrial/Commercial Power Transistors (Silicon)
Power Hybrids (Standard)
Custom Hybrids
Schottky & Planar Diodes
Semiconductor Die (Silicon)

TAPPAN, N.Y. 10983
256 Oak Tree Road
Diodes & Rectifiers
Zeners
High Voltage Assemblies
Power Rectifiers
Thick Film Hybrid Circuits

from Solitron

THE LEADER IN HYBRID TECHNOLOGY

Circle 131 on reader service card

Now You Can Record Data On 70mm Film From 4600 Line CRT With CELCO's DSC-III Photo Recorder.

Everything you need for data recording is here for you to start producing high-resolution photographs on 70mm film. Right now! Our Photo Recorder is fully integrated to accept digital and/or analogue inputs. All the necessary power supplies, electronics, and logic are included to operate this self-contained system.

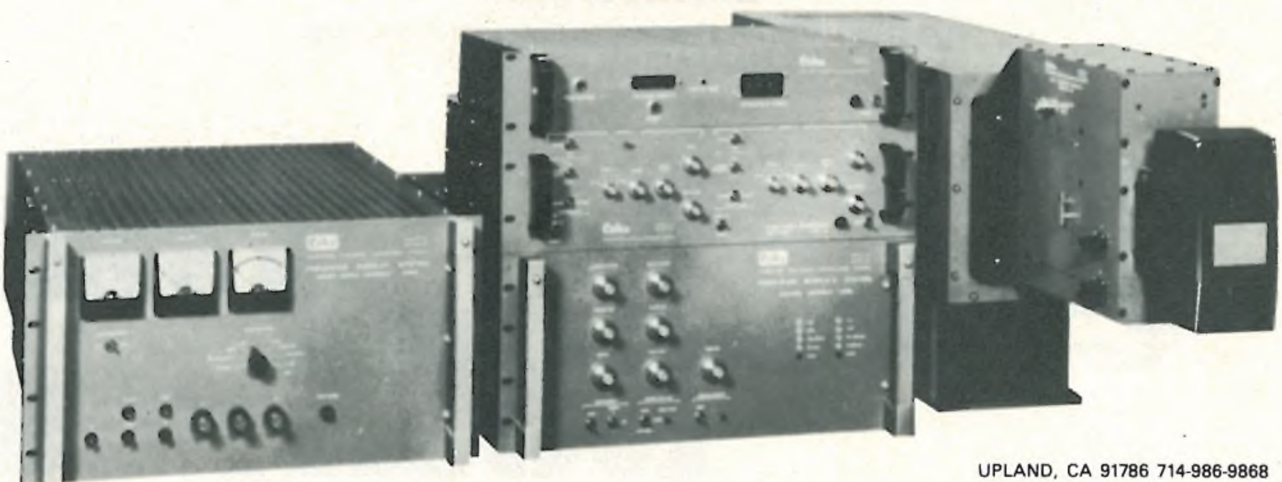
The CELCO digitally controlled camera includes transport drive, lens, shutter and photomultiplier assembly which can be directly interfaced to TTL control lines from a computer. Film transport speeds are available from one second per frame, and faster. Unique camera optics of the CELCO camera accomodates a variety of film transports and magazines.

THE CELCO DSC-III 70mm photo recorder provides new flexibility for diverse applications. Satellite "Quick Look" monitors for immediate recording or ERTS photos. Complete systems for Large-Format Scanning ("MASTERSCAN") to digitize photos, letter masters and x-rays can be recorded on this 70mm Photo Recorder for hard copy and/or digital storage and retrieval.

Operate on digital data obtained in biological experiments from a scanning CRT microscope or other method for hard copy selective storage and retrieval.

If you have a data recording application, write or call CELCO today for more information on how you can start producing your own high-resolution photographs on 70mm film.

Celco CONSTANTINE ENGINEERING LABS CO.



UPLAND, CA 91786 714-986-9868
MAHWAH, NJ 07430 201-327-1123

Engineer's notebook

Multiplying factors correct power for ac waveforms

by William D. Kraengel, Jr.
Valley Stream, N.Y.

The growing use of waveform generators, voltage-controlled oscillators, and multivibrators as signal sources means that engineers often have to measure currents and voltages in the form of rectangular, triangular, or sawtooth waves or pulse trains. (Conversion factors for voltmeter measurements on such waveforms were tabulated in *Electronics*, Aug. 30, 1973, p. 104.) The average power that one of these waveforms dissipates in a resistor (R) over an integral number of cycles is given by the root-mean-square voltage across the resistor (V_{rms}), the rms current through the resistor (I_{rms}), or both:

$$P = V_{rms}I_{rms}$$
$$= V_{rms}^2/R$$
$$= I_{rms}^2R$$

If measurements are made with meters that give true rms readings, the correct value for power can be calculated from the equations given above. But if the response of the ammeter or voltmeter is not truly rms, power values must be calculated from equations that contain a factor to correct for the meter response:

$$P = (V_mI_m) \times M$$
$$= (V_m^2/R) \times M$$
$$= (I_m^2R) \times M$$

In these equations, V_m and I_m are voltage and current values shown by the meters, and M is a multiplier that provides the correct value for power. Thus M is a combination of the conversion factor for meter response and the form factor for the waveform. Multiplier M is dimensionless.

The accompanying table shows values of M for various waveforms and various meters. For example, if a sawtooth voltage across a resistor is measured with a meter that responds to average voltage and is calibrated to rms for sine waves, then the power dissipated in the resistor is given by

$$P = (V_m^2/R) \times (32/3\pi^2)$$

For meters with a true rms response, M is always 1, so no column for true rms is included in the table.

If power is found from readings of both current and voltage meters, and the two meters have different responses, the power must be calculated from

$$P = V_mI_m\,(M_VM_I)^{1/2}$$

where M_V is the multiplier in the table that corresponds to the voltmeter response, and M_I is the multiplier that

MULTIPLIER (M) FOR POWER CALCULATION

Waveform	Ammeter or voltmeter response (see below)				
	I	II	III	IV	V
Sine:	1	1	$\pi^2/8$	1/2	1/8
Full-wave rectified sine:	1	1	$\pi^2/8$	1/2	1/2
Half-wave rectified sine:	2	1/2	$\pi^2/4$	1/4	1/4
Sine pulse:	T/t	t/T	π^2 T/8t	t/2T	t/2T
Segmental sine:	4E/C	E	π^2 E/2C	E/2	E/8
Full-wave rectified segmental sine:	4E/C	E	π^2 E/2C	E/2	E/2
Half-wave rectified segmental sine:	8E/C	E/2	π^2 E/C	E/4	E/4
Sine squared:	$12T/\pi^2t$	3t/4T	3T/2t	3t/8T	3t/8T
Fractional sine pulse:	$4B/\pi A$	B/π	$\pi B/2A$	$B/2\pi$	$B/2\pi$
Triangle or sawtooth:	$32/3\pi^2$	2/3	4/3	1/3	1/12
Full-wave rectified triangle or sawtooth:	$32/3\pi^2$	2/3	4/3	1/3	1/3
Half-wave rectified triangle or sawtooth:	$64/3\pi^2$	1/3	8/3	1/6	1/6
Triangle or sawtooth pulse:	$32T/3\pi^2t$	2t/3T	4T/3t	t/3T	t/3T
Square:	$8/\pi^2$	2	1	1	1/4
Dc and full-wave rectified square:	$8/\pi^2$	2	1	1	1
Half-wave rectified square:	$16/\pi^2$	1	2	1/2	1/2
Rectangular pulse:	$8T/\pi^2t$	2t/T	T/t	t/T	t/T
Exponential pulse: (critically damped)	$2T/\pi^2e^2t$	$e^2t/2T$	$T/4e^2t$	$e^2t/4T$	$e^2t/4T$

$$\left.\begin{aligned} A &= [(\sin\alpha - \alpha\cos\alpha)/(1-\cos\alpha)]^2 \\ B &= [2\alpha + \alpha\cos 2\alpha - (3/2)\sin\alpha]/(1-\cos\alpha)^2 \end{aligned}\right\} \alpha \equiv \pi t/T \text{ radians}$$

$$\left.\begin{aligned} C &= (1-\cos\theta)^2 \\ E &= (\pi\theta/180) - (\sin 2\theta/2) \end{aligned}\right\} \theta = \text{Conduction angle (degrees)}$$

$e = 2.71828\ldots.$ $\pi = 3.14159\ldots.$

Ammeter or voltmeter response

I = Average-responding, calibrated rms for sines
II = Peak-responding, calibrated rms for sines
III = True average
IV = True peak
V = Peak-to-peak

corresponds to the ammeter used in the measurement.

The accuracy of some of these correction factors depends on how nearly the actual waveform approaches the ideal. Also, most ac meters do not give accurate readings for frequencies below 10 or 20 hertz, and they do not give any indication for dc. Thus the full-wave-rectified square wave may produce zero readings, depending upon the meter used. □

HP-45 calculator speeds rf amplifier design

by William J. Martin
Motorola Communications Division, Fort Lauderdale, Fla.

Important characteristics of an rf transistor amplifier can be evaluated quickly from the two-port scattering parameters of the transistor by using a Hewlett-Packard HP-45 scientific calculator. The calculations of stability, gain, and matching impedances use special programs for handling the complex terms in the amplifier analysis on the HP-45.

In using these programs, the designer should enter his data exactly as shown in the left-hand column and key it as shown in the center column. The result will appear as shown in the right-hand column after the last key in the center column is pressed.

The design of a 500-megahertz amplifier is carried through here to illustrate the procedure. This amplifier uses a Fairchild 2N2857 transistor with V_{CE} = 10 volts and I_C = 2 milliamperes; manufacturer's data give the S parameters in polar form (R,θ) as

$$S_{11} = 0.394 \angle -158.7^\circ$$
$$S_{12} = 0.048 \angle 63.5^\circ$$
$$S_{21} = 2.084 \angle 79.2^\circ$$
$$S_{22} = 0.816 \angle -20.4^\circ$$

The first step is to determine whether the transistor is stable under the given operating conditions. Calculation of the stability factor, K, requires complex quantity Δ, given by

$$\Delta = S_{11}S_{22} - S_{12}S_{21}$$

The program for obtaining Δ on an HP-45 calculator is as follows

$S_{11\theta}$	↑	
$S_{22\theta}$	+	
S_{11R}	↑	
S_{22R}	X, →R, Σ+	
$S_{12\theta}$	↑	
$S_{21\theta}$	+	
S_{12R}	↑	
S_{21R}	X, →R, Σ −,	
	RCLΣ, →P	Δ_R
	↔	Δ_θ

With the S parameters given above, this program yields

$$\Delta = 0.251 \angle -164.8^\circ$$

Stability factor K is readily calculated from

$$K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{21}S_{12}|} = 1.208$$

Because K has a positive value greater than unity, and S_{11} and S_{22} are less than unity, the 2N2857 is unconditionally stable; i.e., no source or load reflection coefficients exist that can cause instability. If the 2N2857 had not satisfied the stability criteria, the calculations would have been repeated for other transistors until a stable device was found.

To achieve the maximum possible power gain from this amplifier, the source and load impedances must be conjugately matched to the transistor. Therefore the next step in the amplifier design is to find these impedances. First a complex quantity, C_1, must be found. It is given by

$$C_1 = S_{11} - \Delta S_{22}^*$$

(The asterisk indicates a complex conjugate.) The HP-45 routine for C_1 is

$S_{11\theta}$	↑	
S_{11R}	→R, Σ+	
Δ_θ	↑	
$S_{22\theta}$	CHS, +	
Δ_R	↑ ↓	
S_{22R}	X, →R, Σ−,	
	RCLΣ, →P	C_{1R}
	↔	$C_{1\theta}$

In this example, the value of C_1 is

$$C_1 = 0.202 \angle -173.2^\circ$$

Another necessary quantity is B_1, given by

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 = 0.427$$

The input reflection coefficient ρ_{MS} that is required to conjugately match the transistor is

$$\rho_{MS} = C_1^* \left[\frac{B_1 \pm (B_1^2 - 4|C_1|^2)^{1/2}}{2|C_1|^2} \right]$$

The plus sign is used before the radical if B_1 is negative. The minus sign is used if B_1 is positive (as in this example). The value of ρ_{MS} here is

$$\rho_{MS} = 0.719 \angle 173.2^\circ$$

To compute the output reflection coefficient that is required to conjugately match the output of the transistor, complex quantity C_2 must be found.

$$C_2 = S_{22} - \Delta S_{11}{}^*$$

The HP-45 routine for C_2 is completely analagous to that for C_1 and yields

$$C_2 = 0.721 \ \underline{/\ -22.3^\circ}$$

Quantity B_2 is also required. It is given by

$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2 = 1.448$$

The output reflection coefficient ρ_{ML} for conjugate match to the transistor is

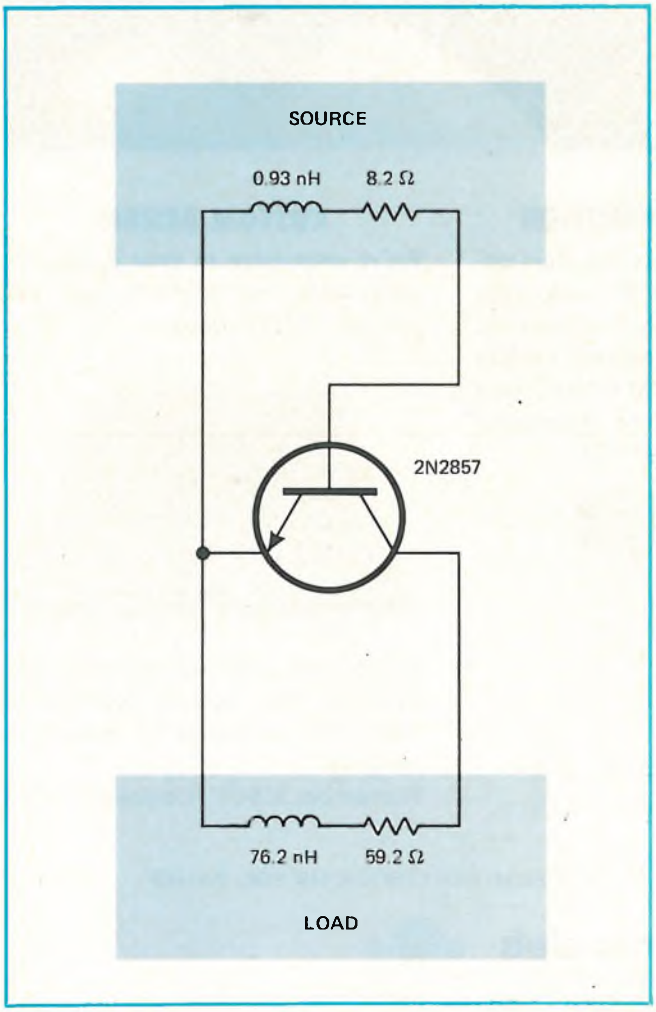
$$\rho_{ML} = C_2{}^* \left[\frac{B_2 \pm (B_2{}^2 - 4|C_2|^2)^{1/2}}{2|C_2|^2} \right]$$

The plus sign is used for negative values of B_2, and the minus sign for positive values of B_2. Here

$$\rho_{ML} = 0.910 \ \underline{/\ 22.3^\circ}$$

Reflection coefficients ρ_{MS} and ρ_{ML} can be converted to

Matched circuit. Source and load impedances shown produce maximum possible power gain (13.6 dB) from 2N2857 operating at 500 MHz with V_{CE} = 10 volts and I_C = 2 milliamperes. Calculations of impedances and gain, as well as verification of amplifier stability, require only transistor S parameters and HP-45 scientific calculator.



source and load impedances, respectively, by a graphical method (plotting on a Smith chart) or by the following HP-45 routine, which gives polar, series, and parallel forms for the impedance.

ρ_θ	↑		
ρ_R	→ R, 1, +, → P		
0	↑, 1, → R, Σ +, ↓, ↓		
ρ_θ	↑		
ρ_R	→ R, Σ −,		
	↓, ↓, RCL Σ+, → P,		
	↔, CHS, ↓, ÷,		
	↑, ↓, ↓, +, ↔, 50, X	MAG.	POLAR
	↔	θ	
	↔, → R,	R_S	SERIES
	↔,	X_S	
	↔, → P, ↓, ↑, ↓, COS,		
	÷, 50, X	R_P	PARALLEL
	↓, ↔, SIN, ÷, 50, X	X_P	

The results, in series form, for this example are

$$Z_{source} = (8.19 + j\,2.91) \text{ ohms}$$
$$Z_{load} = (59.23 + j\,239.15) \text{ ohms}$$

Thus, the circuit shown in the accompanying diagram provides maximum possible power gain from this amplifier at the given values of frequency, voltage, and current.

The final step in the design analysis is to calculate the value of this maximum possible power gain. It is given in decibels as

$$G_{max} = \frac{|S_{21}|}{|S_{12}|} \, |K \pm (K^2 - 1)^{1/2}|$$

The plus sign is used in front of the radical if B_1 is negative. The minus sign is used if B_1 is positive. In this example the minus sign is used, and

$$G_{max} = 13.6 \text{ dB}$$

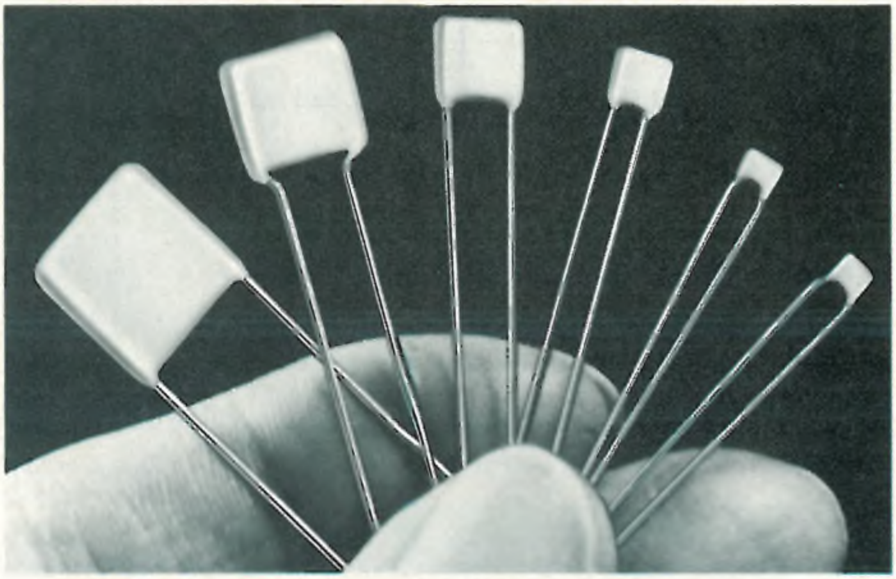
for a Fairchild 2N2857 transistor operated at 500 MHz with V_{CE} = 10 V and I_C = 2 mA.

This brief presentation has shown HP-45 routines for only the complex quantities Δ, C_1, and Z. Routines in the same format for the other quantities discussed (K, B_1, B_2, ρ_{MS}, and ρ_{ML}) are available from the author. Also available are routines for ρ_{MS}' and ρ_{ML}'. Quantity ρ_{MS}' gives the complex source impedance once the complex output impedance is known (from constant gain circles if a power gain other than G_{max} is desired). Quantity ρ_{ML}' gives the complex output impedance once the complex input impedance is known (e.g., for best noise match). □

Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

QUALITY IN VOLUME

When you achieve it, you can offer true competitive value. That's just what we're doing at USCC/Centralab for 1975. MONO-KAP™ radial, and MONO-GLASS axial monolithic ceramic capacitors are now available to volume users *from stock* to eight weeks. Our investment and "learning curves" last year guarantee competitive responsiveness – USCC will welcome your specials and non-stock orders. Here's an offer you haven't heard lately – your money is going to buy more at USCC. Cash in on the best values in monolithic ceramic capacitors.



DISCRETE ASSEMBLY

MONO-KAP™ radial-leaded epoxy coated capacitors are reliable performers; they're rugged enough to work in MIL environments. 4.7 pF to 10 Mfd., 50 to 200 WVDC in 4 dielectrics, including Z5U, in a variety of case sizes featuring meniscus control to 0.032 inches. Large quantity orders from stock.

AUTOMATIC INSERTION

MONO-GLASS axials are glass encapsulated, designed for automatic PCB insertion; furnished reel-packed for high volume applications. They're available in 50 and 100 WVDC from 1 pF to 1.0 Mfd.; four dielectrics: COG, X7R, Z5U and Y5V.

CUSTOM DESIGN

We're responsive to your design requirements; get USCC's new expanded 1975 catalog.

If you need a special, call (213) 843-4222 or your nearest overseas location for assistance or evaluation samples.
Remember, USCC/Centralab. Value.

FOR QUICK REFERENCE, SEE OUR PRODUCTS IN YOUR EEM, GOLD BOOK OR EBG PAGES.

USCC **USCC/Centralab**
Electronics Division ▪ Globe-Union Inc.
2151 North Lincoln Street ▪ Burbank, California 91504
(213) 843-4222 ▪ TWX: 910-498-2222

Engineer's newsletter

Add to your retirement income

The IEEE has just joined Pensions for Professionals Inc., a pension-management agency whose services will now be available to IEEE members. The pension services are complicated and should be checked out pretty carefully, but the range is extensive, including everything from the well-established Keogh plan for the self-employed to conventional corporate pension plans for small companies that lack their own. **PFP is also looking into the new sheltered Individual Retirement Account (IRA) pension activity** of banks and insurance companies, which grew out of the pension reform bill (Employee Retirement Income Security Act) recently passed by Congress. And by the way, the IEEE is still working on trying to set up an employer-funded plan designed exclusively for engineers—but nothing's definite yet.

How to avoid drilling holes when mounting pc boards

You can mount printed-circuit boards on a prototype chassis without drilling holes in either the boards or the chassis. Simply use ordinary rubber grommets as pc-board standoffs, says Bill Schweber of Norwood, Mass. **The pc board can be slid into the grooves of the grommets, and the grommets then glued to the chassis with contact cement.** If one grommet does not provide sufficient clearance between the chassis and the underside of the board, two or more grommets can be glued together until they are high enough. You can even mount boards vertically, rather than horizontally, using only three to four grommets. This technique is especially handy if the final board locations are not definite or if the boards must be removed frequently for modification.

Stamp out that pure-gold plating

If you're managing an equipment-assembly operation, you'll want to know that the use of connector contacts inlaid with a gold alloy will virtually eliminate one of the biggest causes of assembly failure. Normally, contacts are plated with pure gold, but pure gold cracks or becomes porous when bent, causing the connector to fail sooner or later. Recently, however, when Technical Materials Inc. tested alloy inlays against pure-gold-plated contacts, it was found that **the gold-plated samples flunked the 180° bend test at all radii (0.003 to 0.125 inch), while the alloys generally passed with flying colors.**

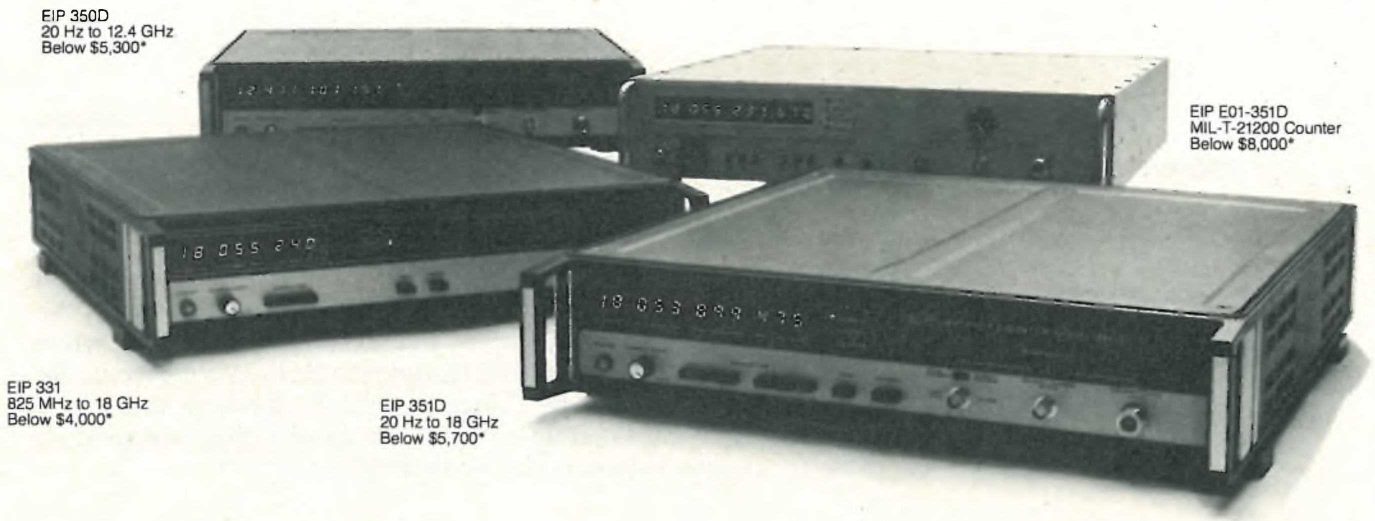
The 15 gold alloys tested were rolled to varying degrees of hardness and then bent 180° over mandrils of varying radii. The softer the alloy and the more gold it contains, the easier it is to form.

Two books discuss logic-circuit testing and heat removal

And here are two new books to check out. For test engineers, a multivolume handbook on logic-circuit testing has been developed by a Phoenix company recently founded by the former president and vice president of test-system maker Mirco Systems. The volumes are intended to **shorten evaluation time, and they give detailed data about the suppliers and their test systems.** They are priced at $50 to $100 from Omnicorp., 7101 N. 12th Place, Phoenix, Ariz. 85020.

A 180-page book from heat-sink supplier Aham Inc. discusses **heat removal.** Author Jack Spoor presents methods of removing heat, calculations and precautions. Write Aham Inc., 968 W. Foothill Blvd., Azusa, Calif. 91720.

—Laurence Altman



Get more than you pay for with EIP microwave counters

Across the board, EIP counters cost less than comparable counters, yet they're simpler, can handle any application, and are systems compatible.

OUR COUNTERS AND WHAT THEY COST

The 331. 825 MHz to 18 GHz. Sensitivity −15 to −20 dBm. Minus 20 to −25 dBm optional. Below $4,000.* No comparable counter made.

The 350D. 20 Hz to 12.4 GHz. Sensitivity −20 to −25 dBm. −30 dBm optional. Below $5,300.* Compares with counters costing hundreds of dollars more.

The 351D. 20 Hz to 18 GHz. Sensitivity −20 to −25 dBm. −30 dBm optional. Below $5,700.* Compares with counters costing hundreds of dollars more.

The E01. A 350D or 351D designed to MIL-T-21200 environmental specifications. Below $8,000.* No comparable counter made.

WHAT THEY GIVE YOU FOR YOUR MONEY

Simplicity—EIP counters are all fully automatic. Simply apply the signal to the appropriate input, and the counter does the rest. EIP's displays use bright, non-flickering LEDs, sectionalized to eliminate decimal positioning, frequency range annunciators, and confusing overflow. And EIP counters all have leading zero suppression.

The ability to handle any application—EIP's Autohet(TM) technology allows measurement of signals with FM deviation to 200 MHz at FM rates to 10 MHz. Using an EIP microwave counter, you can easily test high density communications links without removing them from service, and test EW/ECM circuits, too.

If you're measuring signals only in the microwave range, EIP makes the Model 331 so you don't have to pay for more capability than you need.

If you need a ruggedized/environmental counter, EIP has the E01, the only such counter in the industry.

Systems compatibility—Parallel digital output and programing plus high speed reading rates up to 900/second make EIP counters ideal for use with automatic test equipment.

It'll take us only 5 minutes to prove you really get more than you pay for with EIP microwave counters. Call Rick Bush collect at (408) 244-7975 for a demonstration.

DANA
EIP

EIP, Inc.
3230 Scott Boulevard
Santa Clara, CA 95051
Telephone (408) 244-7975

**U.S. Prices, F.O.B. Santa Clara*

Intercon/75 target: price-conscious buyers' market

Exhibitors at IEEE show, April 8–10 at N.Y. Coliseum, to stress cost-effectiveness in instruments, other items. Following are some of the products to be introduced.

Low-priced portable scope has modular design

Not all measurement applications require the kind of performance—wide bandwidth, high sensitivity, and maximum flexibility—presently available in state-of-the-art instruments. It is often advisable to accept somewhat less than the highest performance in exchange for a more modest price.

Tektronix engineers had this kind of cost-effectiveness in mind when designing the model 455 portable oscilloscope. Its capabilities are sufficient for most scope applications, and its price is kept low by limiting some of its performance—bandwidth, for example.

Bandwidth of the 455 is 50 megahertz. Tektronix' model 465, similar to the 455 in most other respects, has 100-megahertz bandwidth. But the 455 is priced about \$300 to \$400 less than the \$2,000 465.

Like the 465, the 455 offers dual-channel operation, vertical sensitivity from 5 millivolts per division to 5 volts/div, and delayed sweep. An optional battery pack is available, and all accessories for the 465 fit the 455.

Although the 455 does not have the plug-in flexibility of Tektronix' 5000- and 7000-series laboratory oscilloscopes, it does have more flexibility than many other portable scopes because of its modular construction. Its distinct display, vertical amplifier, and sweep generator modules are also designed to make field repairs easier.

But more important, modular construction permits the design of oscilloscopes customized for specific applications. An entire new series of oscilloscopes based on the 455 package could easily be built by designing variations of each module.

The 455's package marks another departure for Tektronix. Unlike earlier Tektronix scopes, which have vinyl-clad aluminum housings, the 455's case is made from a reinforced plastic, similar to that used in Tektronix' 200-series miniscopes. The plastic case is lighter and less expensive than aluminum, but still rugged enough to withstand the rigors of field-service use. It also insulates the user from being shocked accidentally by the scope circuitry.

Other features of the 455 include trigger view, beam finder, lighted deflection-factor indicators, and an 8-by-10-centimeter display.

The major market for the 455, as with any portable oscilloscope, is in field service. Application areas include computers and computer peripherals, office machines, industrial

control systems, communications equipment, and military electronics. Because of its price and performance, some 455s should also find their way to electronics assembly lines.

Delivery time is eight weeks.

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 [371]

LSI multimeter warms up in 10 milliseconds

In March of 1969, when Schneider Electronics started selling its Digitest 500 multimeter, the instrument included its logic and counting circuits on a single custom-built chip. Three years ago, a new version had

a chip that carried the analog-to-digital converter as well. Now, the French company has put practically everything on a single custom-made chip.

As a result, the Digitest 200 has only 100 components, counting everything down to the screws and washers. Because this is about a quarter of the parts needed for the previous version, assembly costs are slashed, and the instrument has the highly competitive price of $199. And because of large-scale integration, Schneider has packed features into the instrument that were not possible before for low-cost, portable 3½-digit 2,000-count multimeters.

What's most unusual about the instrument is its warmup time—10 milliseconds or less, compared with seconds or even minutes for conventional multimeters. The chip also carries a circuit that signals when the count on any range is 199 or less, meaning a more accurate reading can be had on the next lower range. The chip corrects automatically for zero drift and full-scale voltage. Finally, a lamp automatically warns of unacceptably low battery voltage.

It's the low thermal inertia of the chip plus the method used for a-d conversion that make for the fast warmup. The chip, which carries the equivalent of 4,000 field-effect transistors, measures 4 by 5 millimeters. The conversion technique is based on the constant-charge-discharge principle. Essentially, the unknown voltage charges a capacitor, which is then discharged in discrete steps in order to get a digital count.

Capacitors for the conversion are outboarded, along with two IC operational amplifiers and a comparator. Also outboarded are a capacitor for an on-chip oscillator, a voltage divider for the power supply, and an interface transistor for the display. All the other circuitry is on the chip, a p-channel MOS device with low-threshold voltage and gates that are doubly isolated by oxide and nitride. The 40-pin package is made of ceramic.

Schneider Electronique, 27 rue d'Antony, 94150 Rungis, France [372]

Schneider Electronics, 11 Riverside Ave., Medford, Mass. 02155 [338]

Major specifications

Dc volts	100 μV to 1,000 V
Ac volts	100 μV to 750 V
Ac/dc current	100 nA to 2 A
Resistance	0.1 Ω to 2 MΩ
Temperature	–55°C to +200°C
Accuracy	From within ±0.2% of range to within 1.5% of reading, depending on range
Weight	600 g (without batteries)

'Calculating oscilloscope' is programable

What do you call an instrument that takes almost any input waveform, can be programed to do almost anything to it or nothing at all, and then displays it in analog and/or alphanumeric form? Cordis Corp.'s Norland Instruments subsidiary calls its product a "programable calculating oscilloscope," but that's not nearly a complete description.

The NI2001 digitizes each input waveform and displays it either as-is or after further processing, in analog form and/or as an array of signal parameters, on a 4-by-5-inch Hewlett-Packard monitor. (The 5-by-7-in. monitor shown in the photograph at the top of page 143 is under development at Norland and should be available later this year.)

Inputs to the NI2001 are routed through plug-in data-acquisition units with controls similar to those of a standard oscilloscope. Provision is made for two plug-ins with up to four channels of data and 8-, 10-, or 12-bit resolution, at sample rates up to 1 megahertz.

Digitized input data is stored in a 4096-by-12-bit random-access memory, so that the NI2001 also resembles a digital signal monitor. For example, it can display waveform data acquired before a trigger signal.

The NI2001's keyboard permits programing of such functions as plotting power dissipation of a circuit as a function of frequency. Pre-

TEAC DATA RECORDERS They do more than record

The machines shown below represent a great deal of research and development. Years of experience in tape transports and recording technology. And hundreds of innovations in micro-electronics and computer-type circuits. Once they've recorded your data, they'll feed it directly to your other equipment and help you process it. We're very proud of them.

Consider the R-260 Portable Data Recorder, smallest of the units pictured below. It records on eight channels. Seven for data, one for voice. (Its big brother, the R-280, has 14 channels.) It operates at 30, 15, 7½, 3¾, 1⅞ and ¹⁵⁄₁₆ ips. It has excellent frequency response and signal to noise characteristics, and meets IRIG and EIA standards. It also features bi-directional recording and reproduction, a tape search control and automatic remote control. Power requirements? A car battery.

Of course, our R-570 is a bit more sophisticated. It records on 14 channels and is designed for permanent installations. But we manufacture a whole line of data recorders and acquisition systems. We at TEAC are interested in all types and applications of magnetic recording technology. It's our primary business. And, being specialists, we think we do a better job. If you'd like some data, just call your TEAC representative.

R-510 R-570 R-260 R-280

TEAC®

TEAC CORPORATION Shinjuku Bldg., 1-8-1, Nishi-Shinjuku, Shinjuku, Tokyo, Japan

Think TEAC Talk with one of these representatives:

ENGLAND: International Instruments Ltd. Cross Lances Rd, Hounslow Middx Tel: 01 (572) 2255, (570) 6464 **FRANCE: TEKELEC AIRTRONIC S.A.**, Cite des Bruyères, Rue Carle-Vernet 92 Sevres, Tel (626) 0235, (626) 2438 (Paris) **GERMANY: nbn Elektronik Starnberg**, 813 Starnberg Heinrich-Wieland-str. 1 Tel (08151) 13036, 12158 **NORWAY: Rodland & Relling A.S.**, Gladengveien 3A Oslo 6 Tel (472) 674590 **SPAIN: ATAIO INGENIEROS S.A.**, Madrid 16, Enrique Larreta 12 Tel (215) 3543 **SWITZERLAND: MEDITECH AG (Instrumentation Products)**, Flurstrasse 93, 8047 Zurich Tel 051-549830 **AUSTRALIA: JACOBY, MITCHELL LTD.**, 215 North Rocks, North Rocks N.S.W. Tel 6307400

Why you can afford the very finest in function generators.

Because Interstate's new F77 truly is a universal signal source. With F77's 0.00002 Hz to 20 MHz range, you can test with frequencies from infrasonics through video, and beyond. There are 6 output waveforms, 7 operating modes, and precision interface controls (waveform inversion and a 5/95% waveform variable symmetry vernier, for example) that can be actuated with remarkable variations. And output amplitude is specified at 15 volts p-p into 50 ohms — that's 50% more voltage swing than most 20 MHz function generators provide.

Because the F77 also incorporates a very capable, independent sweep generator offering linear and logarithmic performance, with a selection of auxiliary outputs. Sweep up or down, sweep reset control, and continuous, triggered, burst, sweep-and-hold modes, too. Interstate's special frequency dial has a direct-reading sweep limit cursor, plus two calibration scales (X1 and X2) to improve resolution and permit continuous tuning across the 20 Hz-to-20 KHz audio band.

Because this function generator is the first of its kind to deliver real pulse generator capability. The F77 produces a 15 ns rise time pulse to 20 MHz with constant width setability from 30 ns to 10 milliseconds, and full offset and mode flexibility. The generator's fully-calibrated attenuator gives you 15-volt unipolar pulses into high impedance loads, particularly useful for testing MOS, or millivolt pulses down to 1.5 mv.

Because there's also a constant duty cycle pulse (in addition to F77's standard pulse) for a variety of digital signal response applications. Circuit sensitivity to duty cycle on/off times can be tested using varying pulse rates without adjusting the width control.

Because the F77 can be used as an analog power amplifier to amplify externally applied signals as much as 600%. Even TTL pulses can be amplified to drive 50-ohm loads, and the resulting output has controlled dc offset and attenuation.

Because the F77 gives you many other high performance and human engineering features, like VCF capability for sweeping frequency-sensitive devices, and "oscilloscope-style" triggering with a variable start-stop phase control to generate haversines and havertriangles. There's even a "brown-out" switch to allow the instrument to operate at low line voltages.

Because the F77 only costs $1.095.*

*U.S. price; other 20 MHz Series 70 models available from $695.

IEC

Subsidiary of A-T-O Inc.

INTERSTATE ELECTRONICS CORPORATION

707 E. Vermont Ave., P.O. Box 3117. Anaheim, California 92803 (714) 772-2811

Circle 142 on reader service card

programed, fixed functions include rise-time, integral, differential, peak-to-peak, and rms calculations.

Other capabilities include expansion of the display about a selected data point and optional output of an analog signal (through a d-a converter) or digital control pulses.

Price of the NI2001 is about $13,000 to $15,000, depending on options chosen. Deliveries of the "calculating oscilloscope" are expected to begin in May.

Norland Instruments, P. O. Box 47, Fort Atkinson, Wis. 53538 [373]

Digital voltmeter offers versatility

Combining the stability of a laboratory standard with the convenience of a system-oriented instrument, a precision voltmeter from Dana Laboratories offers multifunction capabilities.

The series 6900 digital voltmeter has 6½-digit (1.6 million-count) resolution, five dc voltage ranges from 1 V to 1,000 V full scale, and a 3-wire ratio capability. Base price is $4,995.

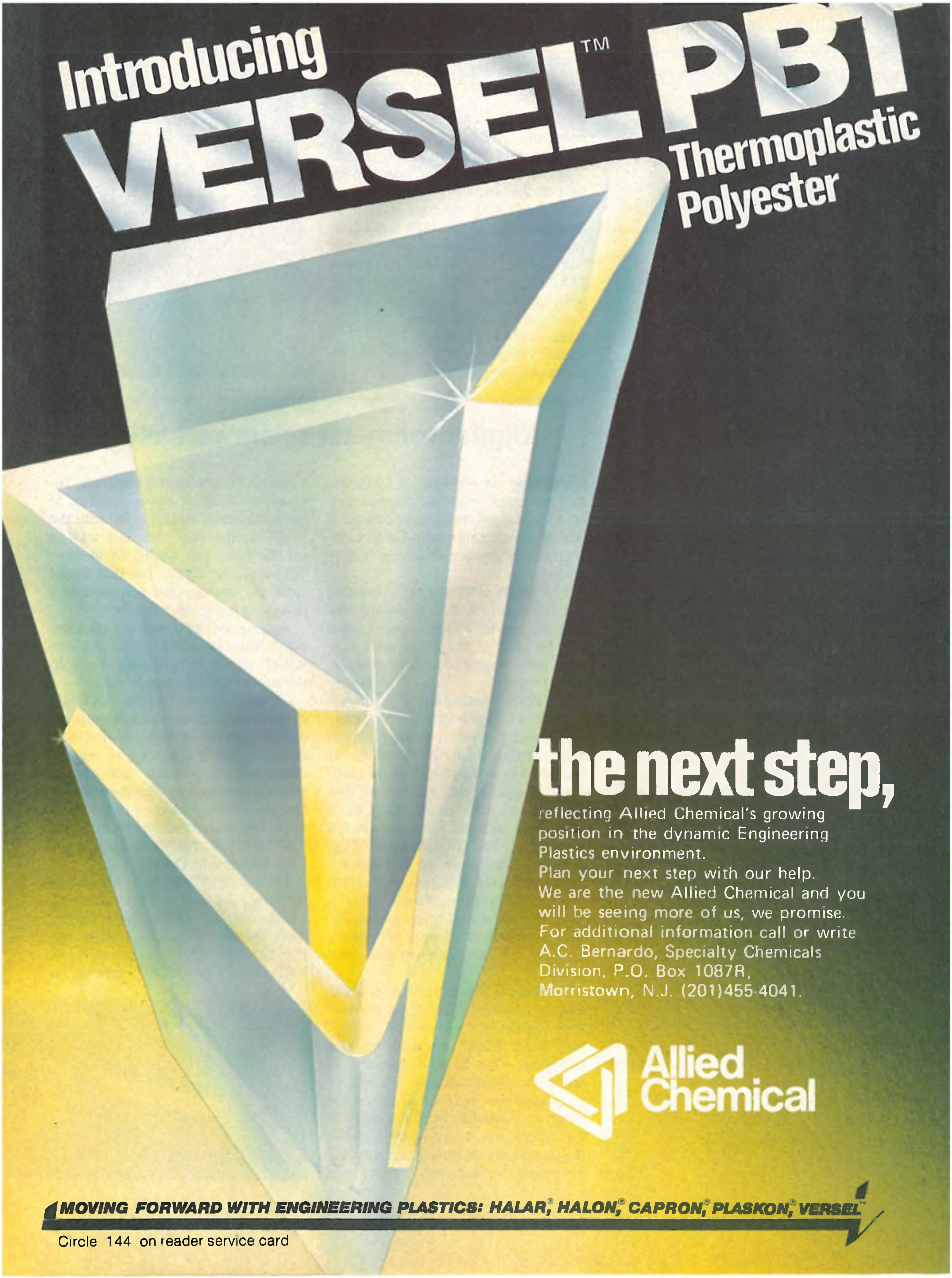
Accuracy, including the uncertainties of Dana-specified calibration sources, over a 90-day period and measured at 23°C ±5°C, is within ±47 parts per million of reading ±50 parts per million of full scale on the 0.1-V range; 12 ppm of reading, 6 ppm of full scale on the 10-V range; and 25 ppm of reading, 8 ppm of full scale on the 1,000-V range. Relative accuracy, assuming perfect calibration sources, over a 24-hour period and measured at 23° ±1°C ambient, is ±3 ppm of reading ±3 ppm of full scale on the 10-V range.

To achieve these accuracies, Dana uses a standard dual-slope conversion technique "with a few tricks," says John Brady, engineering vice president. One trick is designed to eliminate misreadings caused by transients that may occur when the integrator switches from the input to the reference. At that point in the measurement cycle, a fixed number of pulses is ignored before the counter circuits start to operate. Instead, a dc offset corresponding to that number of counts is fed into the unit's comparator. Another way to do the same job would be to filter the integrator signal, but this would slow the instrument's response to a changing input, says Brady.

Analog and BCD outputs are standard features of the 6900. An optional remote-programing capability, priced at $300, can be added.

Other options for the 6900 include 4-wire ohms-measurement capability, priced at $350; 4-wire ratio circuitry, $200; and two ac voltage measurement options: true-rms or average-responding calibrated in rms sine wave. Either ac option provides full-scale readings from 1 V to 1,000 V in four ranges and operation from 20 hertz to 1 MHz.

Also at the IEEE show, Dana will introduce its first portable counters. Unlike earlier Dana units, which were for benchtop and system use, the 525-MHz 7570, priced at $799, and the 1-GHz 7580, priced at


Introducing
VERSEL™ PBT
Thermoplastic Polyester
the next step,
reflecting Allied Chemical's growing position in the dynamic Engineering Plastics environment.
Plan your next step with our help.
We are the new Allied Chemical and you will be seeing more of us, we promise.
For additional information call or write A.C. Bernardo, Specialty Chemicals Division, P.O. Box 1087R, Morristown, N.J. (201)455-4041.
Allied Chemical
MOVING FORWARD WITH ENGINEERING PLASTICS: HALAR,® HALON,® CAPRON,® PLASKON,® VERSEL™
Circle 144 on reader service card

$1,099, are for field service. They have die-cast aluminum cases and operate from 115-V and 230-V (±10%) lines at 50 to 440 hertz.
Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 92664 [374]

Precision resistor arrays from stock

Because of their specialized nature, high-quality thin-film resistor networks are regarded as custom devices having lengthy delivery times. However, Hybrid Systems Corp. of Burlington, Mass. will be offering six new standard networks that are available from stock or within four weeks. The company is also promising delivery times of six to eight weeks for custom networks.

All the standard circuits are made up of high-stability nichrome resistors. The model HSD 4200 is an eight-resistor network in which each resistor can be accessed individually; the value of each resistor is 10 kilohms.

The HSD 4300 is an R/2R current divider consisting of 200-and 500-ohm resistors. The HSD 4400 summing network contains thirteen 5-kilohm resistors. The HSD 4700 is a five-decade divider made up of six resistors ranging in value from 100 ohms to 9 megohms. The model HSD 4800 is an R/2R ladder network of 25- and 50-kilohm resistors. And the HSD4900 is a 12-bit binary ladder.

These standard models can be supplied either in hermetically sealed ceramic dual in-line packages or in chip form. They are also available in versions that are fully processed to MIL-STD-883.

The absolute value of an individual resistor can be laser-trimmed to an accuracy of within ±0.1% or better, and resistor ratios can be trimmed to within ±0.01%. Typically, untrimmed resistors exhibit an absolute tolerance of ±1%. The temperature coefficient of absolute resistor values ranges from 0 to +50 ppm/°C, and noise is held to less than 0.1 microvolt/volt.

The long-term stability of nichrome resistors is excellent—after a year at room ambient, absolute values drift less than ±0.1% and ratios less than ±0.01%. Tracking accuracy between resistors in the same network is also very good—it's better than ±1 ppm/°C over the temperature range of -55°C to +125°C.

In quantities of 100 to 499, the HSD 4200 is priced at $2.90 each; the HSD 4300 at $16.55; the HSD 4400 at $4.10; the HSD 4700 at $7.30; the HSD 4800 at $35.50; and the HSD 4900 at $37.50. In the same quantities, prices for the fully processed military units range from $3.90 to $69 for individual networks. There's a flat fee of $500 (including tooling costs) for prototype quantities of custom networks, the company says.
Hybrid Systems Corp., 87 Second Ave., Burlington, Mass. 01803 [375]

4½-digit meter measures true rms

With the introduction of its model 7224, Systron-Donner Corp. of Concord, Calif., claims to be one of the first to offer a true-rms converter in an inexpensive 4½-digit multimeter. A true-rms converter, according to Chuck Bishop, multimeter product manager, is the only device for measuring ac signals accurately when the signal is either a sine wave with

more than 1% to 2% distortion or has another shape, perhaps triangular or rectangular.

The 7224 is a 20,000-count autoranging instrument that is suitable for both bench use and, with an optically isolated binary-coded-decimal output, for use in small systems, the company says.

The specially designed "Accu-Ohm" resistance-measuring circuit allows the convenience of two-wire resistance measurements with accuracies usually equivalent to those of four-wire systems. A front-panel control allows lead resistance to be nulled to zero. In addition, the model 7224 has a 10-ohm range with 0.001-ohm resolution—performance usually associated with more expensive five-digit instruments, Bishop says.

The 4½-digit multimeter features a seven-segment planar display with 0.55-inch characters. The readout includes automatic polarity, decimal point, and units annunciator.

The instrument measures dc and ac voltages, and resistance. Maximum dc voltage is 1 kilovolt, and resolution varies from 10 microvolts to 100 millivolts in decade steps. Full-scale step response is less than 1 second to rated accuracy. Normal-mode noise rejection is about 60 dB at 50 hertz and 60 Hz. Common-mode noise rejection is about 120 dB on dc and about 100 dB at 50 Hz and 60 Hz with a 1-kilohm source unbalance. Offset current is ±20 picoamperes.

In either the ac voltage averaging converter mode (option 07) or the true rms mode (option 08), the model 7224 can take 500 volts maximum with a 10-microvolt to 0.1-volt resolution in decade steps. Input impedance is 1 megohm shunted by 100 picofarads.

Input configuration is fully floating and guarded on all functions. In the fast-sample-rate mode the model 7224 is capable of 2.5 readings per second at 10,000 counts and 1.6 readings per second at 20,000 counts. The slow-mode sample rates are an eighth of the fast rates.

The 4½-digit multimeter is about 3.5 by 8.5 by 13 inches and weighs about 10 pounds. Warmup time to rated accuracy is about half an hour. The unit needs a maximum of 15 watts at 100, 115, 200 or 230 V over a 48-to-440-hertz range.

As a standard unit, the model 7224 costs $699. With option 07 (ac averaging) the price is $725. With true ac rms (option 08) the price is $850. If added later, the ac averaging option is priced at $50 and the true ac rms at $200.

Concord Instruments Division, Systron-Donner Corp., 10 Systron Drive, Concord, Calif. 94518 [376]

Synthesizer switches in 2 μs

Intended primarily for frequency-agile applications, including radar, electronic warfare, and automatic test systems, a direct frequency synthesizer operates from 10 kilohertz to 180 megahertz and switches in 2 microseconds.

First of a family of synthesizers that will eventually reach 1.4 gigahertz, the model 360 consists of a main frame, an rf plug-in section, and a modulation module. A frequency extender with a fully synthesized signal and a 10 MHz range is available if the rf section is to be operated above 180 MHz.

The main frame provides 11 front-panel decade switches for manual setting of frequencies and can also be remotely programed through the rf plug-in rear connector. Frequency resolution depends

on the rf section installed but typically it is 1 Hz.

The rf section has an output level of 0 to + 13 dBm, continuously variable. Modulation is external a-m, 50 Hz to 2 kHz for 95% modulation (uncalibrated). The modulation module, which provides the circuitry necessary for amplitude, frequency, or phase modulation of the output signal, is physically a replaceable part of the plug-in section. If modulation is not a requirement, a simpler module providing only external a-m is available.

For slow-switching applications at vhf, Ailtech says the frequency extender can be removed and an rf plug-in containing a phase-locked loop can be driven directly from the output of the main frame. Two operational frequency standards are offered with aging rates of 3 parts in 10^8 and 1 part in 10^9 per 24 hours. Alternately, the unit can be driven from an external 5 or 10 MHz source at 0 dBm.

The control format is binary-coded-decimal (BCD) parallel logic

with no need for code conversion. The inputs are TTL-compatible. Ailtech says that reduction of the number of comb line frequencies from 10 to two, through the company's BCD synthesis technique, eliminates about 80% of the comb frequency generating circuitry. Another advantage of BCD, says Ailtech, is the necessity for no more than 40 dB of isolation between the comb lines to achieve a spurious-response level of -100 dB. Ailtech is quoting 60 days delivery time at $8,995.

Ailtech, Cutler-Hammer Co., Farmingdale, N. Y. 11735 [377]

350-MHz analyzer resolves 1 kHz

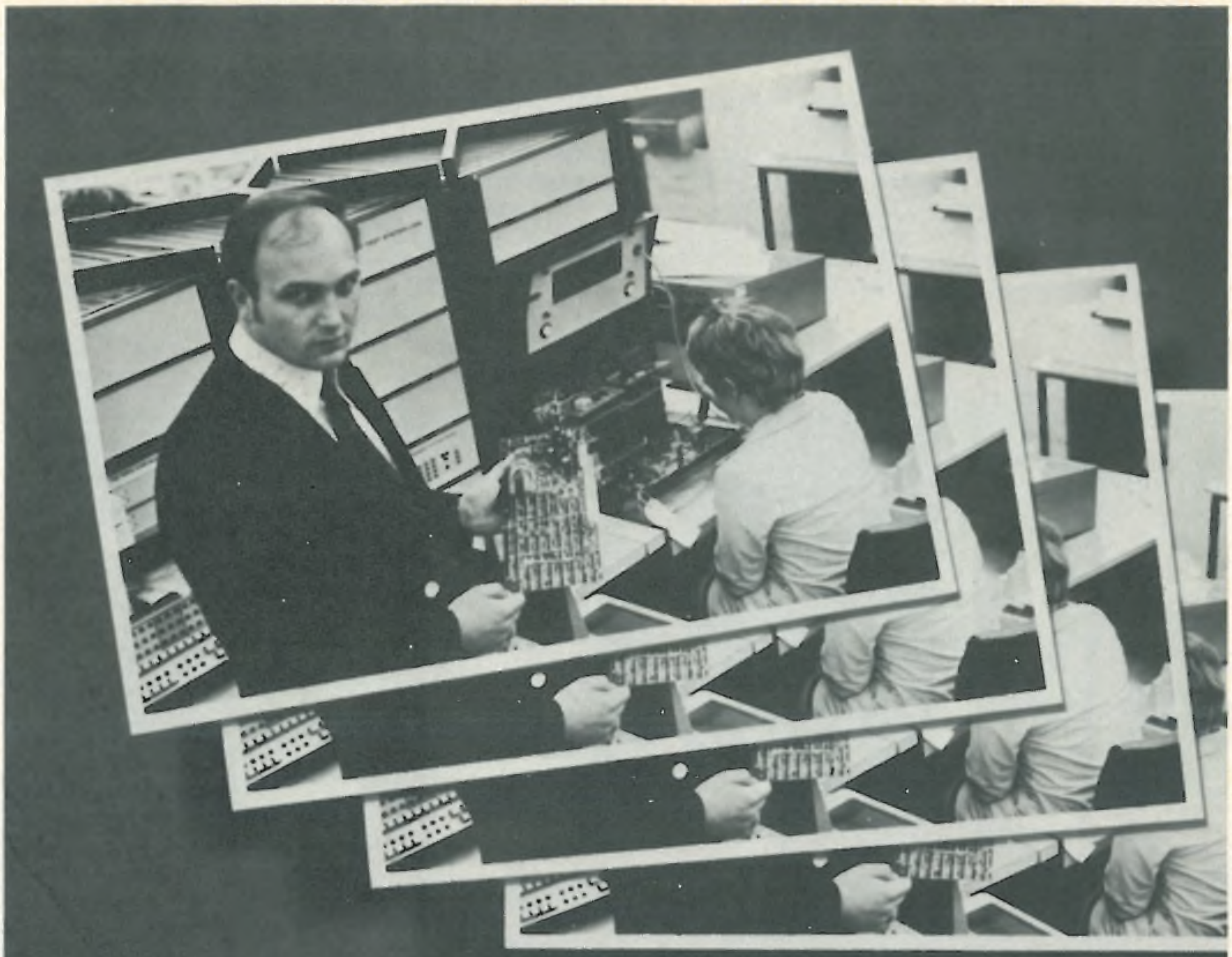
Spectrum analyzers can make a wide variety of measurements, but their high cost and complicated operation often make them unsuitable where many of them are required, or where unskilled operators must

use them—as in production-line testing. Generally, one high-performance spectrum analyzer is purchased for the lab, and that instrument has to be time-shared among a group of engineers.

The model 8557A spectrum analyzer from Hewlett-Packard Co. is designed to be simple enough to use and low enough in price to be practical for production use, but it performs well enough for most lab applications.

As a plug-in for H-P 180-series oscilloscope mainframes, the 8557A is priced at $3,450. Complete with a 182T mainframe, which provides a 7-inch cathode-ray-tube display, the unit is priced at $4,650.

The 8557A is comparable in many ways to H-P's 8558B, which is about $500 higher. At least part of the price differential is attributable to the more limited bandwidth of the less expensive unit. The 8558B



Something from Rank Xerox that's worth repeating.

At Rank Xerox's Welwyn Garden City Plant, the reaction to Teradyne's L100 Circuit Board Test System is unequivocal. Says Alan Wainwright, Manager of Manufacturing Engineering, Electronics: "Our first L100 arrived one month ahead of schedule, and it enabled us to support a product that was very important to us. It was delivered on a Friday afternoon and was testing boards for us by noon Saturday.

"I don't recall ever having received this kind of service before, and it sets a new standard for us to judge others by."

Rank Xerox now has six L100's at Welwyn Garden City, with more on the way. Each system is at the center of a test-diagnose-repair-retest loop, staffed by technically unskilled personnel. Total test and handling time for a typical defective board is a minute or two, and 75% of the failing boards pass after one trip around the loop. The L100's at Rank Xerox work 24 hours a day, 5½ days a week.

Rank Xerox is far from an isolated case. Well over 100 Teradyne board test systems are now at work throughout the world, and the experience of Rank Xerox is typical of most.

Interested? For full details, write Teradyne, Inc., 183 Essex Street, Boston, Massachusetts 02111. In Europe: Teradyne, Ltd., Clive House, 12 Queens Road, Weybridge, Surrey, England.

TERADYNE

CHICAGO (312) 298-8610/DALLAS (214) 231-5384/NEW ENGLAND (617) 458-1256/NEW YORK (201) 334-9770/SUNNYVALE (408) 732-8770
LONDON (0932) 51431/PARIS 265 72 62/ROME 59 47 62/MUNICH (089) 33 50 61/TOKYO (03) 406-4021

CRITICAL APPLICATIONS DEMAND CRITICAL SERVICE

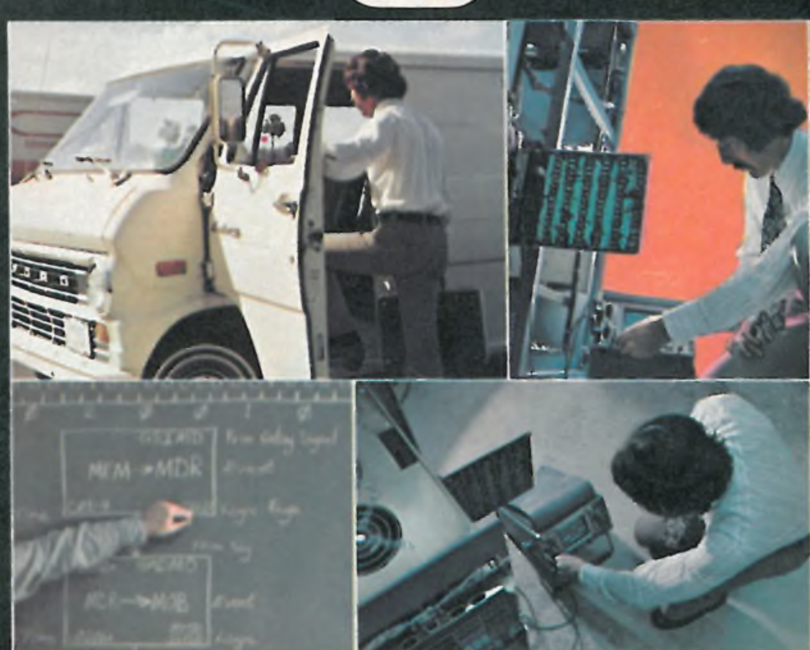
Downtime can be a disaster in simulation, data base management, and scientific applications. You know then, how good the company behind the computer really is.

That's why, at Harris, service is critical. Our computer systems are working in critical environments around the world. And Harris service supports them; With quick response field engineering. With people whose total responsibility is to keep your investment working for you.

After all, building reliable machines is only half the job. Write: Harris Computer Systems, 1200 Gateway Drive, Ft. Lauderdale, Fl. 33309.

Europe: Techmation N.V., Gebouw 105/106. Schiphol-Oost, Netherlands.

HARRIS COMMUNICATIONS AND INFORMATION HANDLING



Circle 152 on reader service card

operates from 100 kHz to 1,500 MHz, while the 8557A operates from 100 kHz to only 350 MHz. But the 8557A can still handle many of the same jobs as the more expensive unit, and is as simple to operate, the company says.

For most measurements, only three controls are used. Either the center frequency or the start frequency of the display, indicated on a digital readout, is set with the TUNING control. The FREQUENCY SPAN control is then used to set the width of the frequency window to be viewed. Optimum resolution, from 1 kilohertz to 3 MHz, is then determined either automatically by the analyzer or by manual override. A REFERENCE LEVEL setting then calibrates the display in absolute power units.

The reference-level setting is the absolute power level of a signal that reaches the top of the display. The range is -110 dBm to +20 dBm. The analyzer indicates optimum and maximum power input level for the chosen amplitude setting, minimizing the possibility of overdriving.

Frequency response of the 8557A is ±0.75 dB, over-all absolute amplitude-measuring accuracy is ±2.25 dB, and frequency readings are correct to ±3 MHz. Dynamic display range exceeds 70 dB.

Standard input impedance is 50 ohms. An optional 75-ohm impedance is available at $100. H-P's current delivery estimate is 30 days.

Inquiries Manager, Hewlett-Packard Co, 1501 Page Mill Rd., Palo Alto, Calif. 94304 [378]

Analog voltmeter spans 12 MHz

Although digital instruments are handling more and more voltage measurements, analog voltmeters are still more suitable and economical in some applications. Analog meters are better for making peaking and nulling adjustments, for example, and lend themselves more readily to special, nonlinear scales.

Sometimes a unit of measure such as the decibel is more convenient than the volt, in communications and acoustical measurements, to name two important areas. The model 3056A ac voltmeter, to be introduced at IEEE Intercon by Ballantine Laboratories Inc., is designed for just such applications.

The 3056A is an average-responding, rms-calibrated voltmeter that operates from 5 hertz to 12 MHz. Its mirrored scale reads decibels linearly and volts on a logarithmic scale. The dB range is 150 dB, from -90 to +60 dB, in 20-dB steps. The wide range of each step minimizes switching when making measurements that cover wide dynamic ranges—such as amplifier frequency-response studies.

Corresponding full-scale voltage ranges are 100 microvolts to 1 kilovolt. An accessory probe to extend the instrument's capability to 2 kV is available as an option.

Priced at $410, the 3056A features a front-panel control that makes it possible to set the meter at a convenient cardinal scale mark at the start of a procedure. This relative reference control allows continuous reduction of the meter's gain by a maximum of 3 dB below its calibrated value. When the relative reference control is set to its detented position, 0 dB is referred to 1 millivolt across 1,000 ohms.

The instrument also has a front-panel switch that allows the input signal to float as much as 500 V above or below chassis ground. A built-in 100-kHz low-pass filter allows meaningful measurements to be made when reading low-frequency signals in the presence of high-frequency noise.

Accuracy of the model 3056A across the 40 Hz to 2 MHz range is ±0.2 dB of reading or ±1% of full scale, whichever is better. As an ac amplifier, the 3056A provides a maximum voltage gain of 10,000 over the frequency range from 10 Hz to 10 MHz. Two ac amplifier outputs are provided: 1 V at 600 ohms and 150 mV at 50 ohms. A dc output proportional to meter deflection is also provided. This signal, measuring at least 1 V at full scale, is suitable for driving chart recorders, digital panel meters, and control devices.

The instrument can operate from either 115 or 230 V ac lines or from one external 28 to 38 V battery or other dc source. Delivery is two to four weeks.

Ballantine Laboratories, Inc., P.O. Box 97, Boonton, N.J. 07005 [379]

Unit sweeps from 0.01 to 18.5 GHz

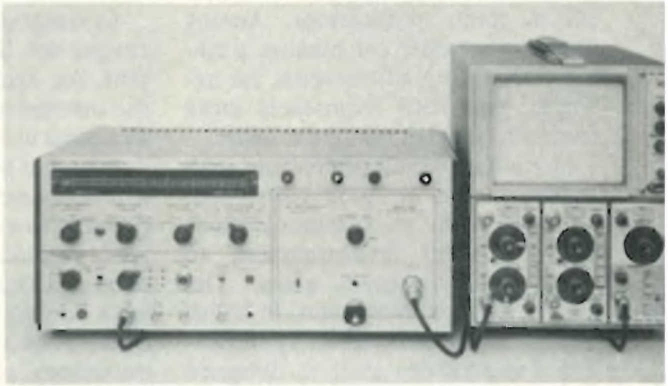
One of the difficulties of broadband testing is that it is often necessary to employ massive sweeper systems with a rack full of plug-ins in order to cover the full frequency range. Now, users of Wiltron's model 610B or 610C mainframe sweep generators will not be burdened with this handicap. The model 6247 sweeper plug in makes it possible to cover the entire 10-megahertz to 18.5-gigahertz frequency range with a single plug-in module.

The rf plug-in, says Walter Baxter, Wiltron sales manager, weighs only 14 pounds and is designed to operate in the seven-inch Wiltron sweep-generator mainframes.

The 10-MHz-to-18.5-GHz coverage is produced by sequentially sweeping through four rf bands—0.01 to 2, 2 to 8, 8 to 12.4, and 12.4 to 18.5 GHz. The four oscillators are multiplexed to a single precision type-N output connector by means of a p-i-n diode switch. They can all be swept in less than 30 milliseconds to produce a flicker-free display.

Coverage above 2 GHz is attained through the use of YIG-tuned oscillators. The 10-MHz-to-2GHz range uses a heterodyne converter consisting of a 4.1-GHz cavity-tuned oscillator, a balanced mixer, and a 10-MHz-to-2-GHz amplifier. The 2–8-GHz oscillator is used as the variable-frequency input into the mixer and is swept from 4.1 to 2.1 GHz during the 10-MHz-to-2-GHz sweep. Both the harmonics and spurious signals from the heterodyne module are 30 dB down.

Key factors in allowing the miniaturized component design of the 6247 plug are in wideband (10 MHz to 18.5 GHz) p-i-n diode switches,



2–8-GHz fundamental YIG-tuned oscillators and quad IC operational amplifiers.

Combined weight of the mainframe and plug-in is about 32 pounds. Drive circuitry for the microwave oscillators and related control circuitry is modularly constructed on three main printed-circuit boards, which are removable for servicing ease.

The plug-in has a +7 dBm leveled power output and a maximum internally leveled power variation of

1 dB. It also has a front-panel slope compensation adjustment which allows the user to compensate for frequency-dependent losses of the test setup. Residual fm is a maximum of 32 kHz peak in the cw mode.

Price of the model 6247 is $19,000.

Wiltron Co., 930 East Meadow Dr., Palo Alto, Calif. 94303 [379]

D-a converters

Power consumption is as low as 525 milliwatts for a pair of 12-bit digital-to-analog converters developed by Micro Networks. The models MN3850 and MN3860 are pin-compatible with the Burr-Brown model DAC-85-CBI-V.

Micro Networks uses its own ladder switching networks and resistor networks made from thin-film nickel-chromium which, with a tight temperature-coefficient tracking of 1 ppm/°C, allows a linearity of ±½ LSB over a range of 0 to 70°C.

The d-a converters are housed in miniature 24-pin hermetic DIPs that measure only 0.79 by 0.60 by 0.14 in. They provide user-selectable bipolar output ranges of ±2.5 volts, ±5 V, and ±10 V, and unipolar output ranges of 0 to +5 V and 0 to +10 V. Absolute accuracy, including offset and gain, is within ±0.05% maximum.

The MN3860 contains input storage registers, increasing its power consumption to 675 mW. An output operational amplifier with a settling time of 3 microseconds is provided with both models. A precision internal reference is also included, but the user has the option of operating from an external reference. The converters are laser-trimmed for zero and offset, eliminating the need for tweaking.

The MN3850 is priced at $90 each in quantities of 1 to 24, and the military version, the MN3850H, at $195 each. The MN3860 sells for $140 each; and the military version, the MN3860H, for $225 each.

Micro Networks Corp., 324 Clark Street, Worcester, Mass. 01606 [339]

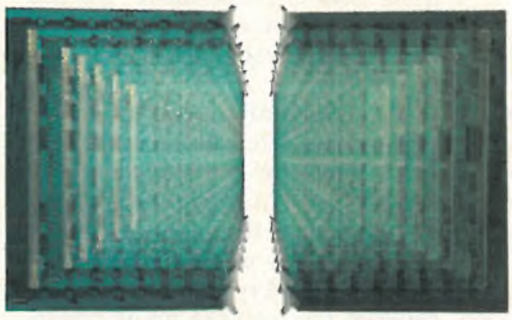
3,500,000 boards prove one thing.

A logic tester you install today and use tomorrow.

Programming delay is no delay for Trendar. Software is all but eliminated. Operator training is a matter of hours. The track record of the TRENDAR 2000A shows test stations are typically testing boards within 48 hours of delivery. And boards tested and passed by the TRENDAR 2000A work in the end product. Millions of boards of thousands of types have been accurately diagnosed and passed. The competition doesn't mention that other testers pass a significant number of still defective boards.

Don't take our word for it.

Ask companies like Tektronix, Hazeltine, Honeywell, or Datapoint about Trendar. They and companies like them have tested over 3,500,000 boards on our testers. Ask them why they're willing to put their reputation for quality on the line through reliance on the 2000A. They'll gladly tell you why they chose Trendar over systems costing three times more.



You don't need a computer to test logic boards.

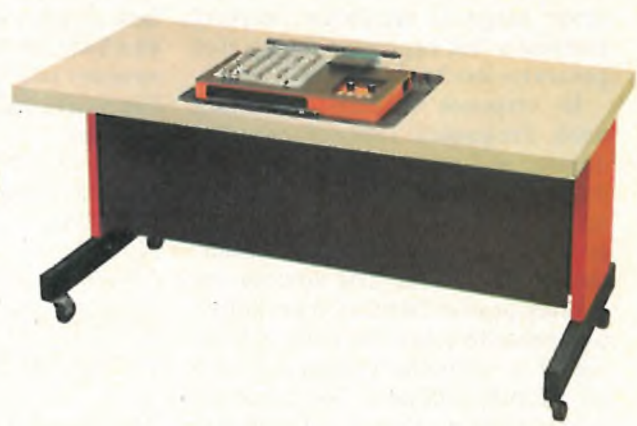
You get more than you pay for!

In these days of tight money, the $100,000 for a tester and $200,000 for programs just aren't there to be spent. Fluke-Trendar logic testers are priced from only $6,000. to $26,000.* They save user companies thousands of dollars a month while they test tough sequential boards with up to 240 IC's. They find multiple and loop faults that cause other diagnostics to crash.

You have to see it to believe it.

We've said the TRENDAR 2000A will test your most difficult boards, with no software hassle, faster and for thousands of dollars less per month than computerized testers. If you're like most, it sounds too good to be true. Make us prove it right in your own factory. Call us. Collect. Fluke-Trendar. (415) 965-0350

*U.S. price



FLUKE TRENDAR
a subsidiary of John Fluke Mfg. Co., Inc.
500 Clyde Avenue Mountain View, CA 94043

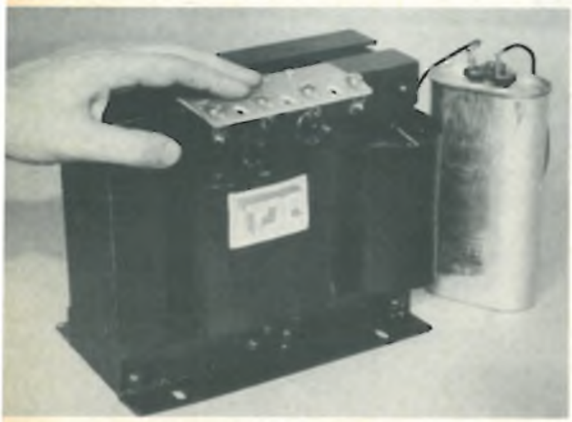
Logic testers so sophisticated they don't need a computer.

Components

Stable ac source is all-passive

Transformer-capacitor combination handles ±15% inputs, has ±3% output

The need for regulated ac sources has been increasing lately because of the greater frequency and severity of power-utility brownouts. If ac-line variations exceed the input range for which a system is de-



signed, the system can be overdriven and damaged, underdriven and unstable, or so underdriven that it simply never turns on. Regulated-ac sources can even mean a power and cost savings for dc regulated supplies. With a regulated ac input, the dc circuit can be built for a narrower range of regulation, making possible a less expensive design that generates less heat.

In response to this increasing need, Frequency Technology's TDC division in Littleton, Mass., is introducing its series OCI ac sources, which operate over an input range of 120 V ±15% and produce an output of 120 V ±3%. The sources are entirely passive ferroresonant inductive-capacitive circuits, each consisting of a magnetic component and an external capacitor. The magnetic part is made by Frequency Technology, but the company also supplies the complementary capacitor.

Although constant-voltage transformers do offer similar performance specifications, they are generally bigger, heavier, and more costly than the new series of OCI sources. These new units are intended for a broad range of applications, including computers, motor control systems, copying equipment, printing-press controls, automatic drafting systems, textile-machine controls, air-traffic-control systems, and lighting circuits.

Two standard models are available—one is rated at 2 kilovolt-amperes, while the other is rated at 3 kVA. (Other kVA ratings and voltage outputs other than 120 V can be supplied.) The operating efficiency of either model is excellent—ranging between 75% and 85% for all combinations of line and load variations.

Output regulation is typically ±3% about the nominal level of 120 V ac. If only the output changes from half load to full load, regulation can become ±5%. When the line fluctuates by ±15% and the load also varies from half load to full load, the output will still be regulated to within ±6%.

The units hold maximum harmonic output content to only 7% and provide electrical isolation between input and output circuits. They can drive low-impedance loads, such as incandescent lamps and motors that have just been turned on.

Both open-construction and metal-enclosed versions are available. Prices for the open-construction 2- and 3-kVA models are $309 and $438, respectively. The enclosed versions sell for $376 and $479. Delivery time is three weeks after receipt of order.

Frequency Technology Inc., TDC Division, Box 365, Whitcomb Ave., Littleton, Mass. 01460 [341]

Corona shield cuts erosion in high-voltage resistors

The use of a built-in corona shield in the model MH 711 high-voltage resistor eliminates the erosion which severely limits the lifetimes and stabilities of other high-voltage precision film resistors. The shield, which is grounded to one of the resistor leads, bleeds off corona energy which would otherwise erode the resistance element and possibly cause electromagnetic interference at the same time. Available in voltage ratings up to 2,000 volts (with the ability to take 50% overloads for five seconds), the MH 711 measures 1.25 inches long by 0.22 inch in diameter. The resistor is available in values from 800 ohms to 50 megohms and has a power dissipation rating of 1 watt. Its extremely high stability, as demonstrated in tests that have been ongoing for over five years, makes the MH 711 particularly well suited for critical applications in scientific instrumentation, airborne equipment, precision high-voltage power supplies, and the like. The unit price of the device varies from $2.67 to $2.94 depending upon resistance value. Delivery time is four to six weeks.

Caddock Electronics Inc., 3127 Chicago Ave., Riverside, Calif. 92507 [343]

Optically controlled stepper motor has no resonances

Stepper model SS1 is a hollow-rotor dc servo motor with an optical feedback system built in. As a result it is a true servomechanism that can be


The first interactive graphic calculator.
Just $8500.
It's the 31/10 system.
A powerful calculator, graphic terminal and software combination. The first ever to place math-power, graphics and alphanumeric display at your fingertips!
The 31/10 is personal. Fast. And highly interactive. It lets you explore ideas and concepts on the spot. Plot single variable functions, specify X-Y coordinates and a lot more. Corrections and plot changes are immediate. From data entry to display, your ideas are quickly brought to light. That's responsive!
Plug in our software packages. They put the 31/10 to work. No heavy programming experience needed. So you can deal in your concepts and not the mechanics of programming. And get graphic and alphanumeric output from natural math input.
There's more to our 31/10. Such as add-on memories for long programs. The optional silent thermal printer for listing and keeping track. Peripherals like our hard copy unit to put in hand what's on the screen.
The costs are low, the results are priceless.
Get the facts about the 31/10 and the Tektronix reliability and worldwide service behind it. See your Tektronix sales engineer for a demonstration or write: IDD Calculators, Tektronix, Inc. P.O. Box 500, Beaverton, Oregon 97077
Our programmable calculators. Natural. Powerful. Significantly less expensive.
TEKTRONIX®
Circle 159 on reader service card
0000001267

New products

fine-tuned to optimize start/stop speed, damping, or accuracy at the expense of the other two parameters. Further, unlike conventional steppers, the SS1 has no low-speed resonances at which it can lose step. The unit's damping ratio is adjustable from 0.1 to 1.0. With full damping it can run as fast as 1,400 steps per second in the start/stop mode, and 5,000 steps per second while slewing. Under no load it can take one step and settle within 5 milliseconds. Settling time, when stopping from multiple steps at high speeds, is the same as the single-step settling time. The Synstep SS1 moves in increments of 1.8° and only draws current when it moves.

Dahmen Burnett Electronics Inc., Grenier Industrial Village, Londonderry, N. H. 03053 [344]

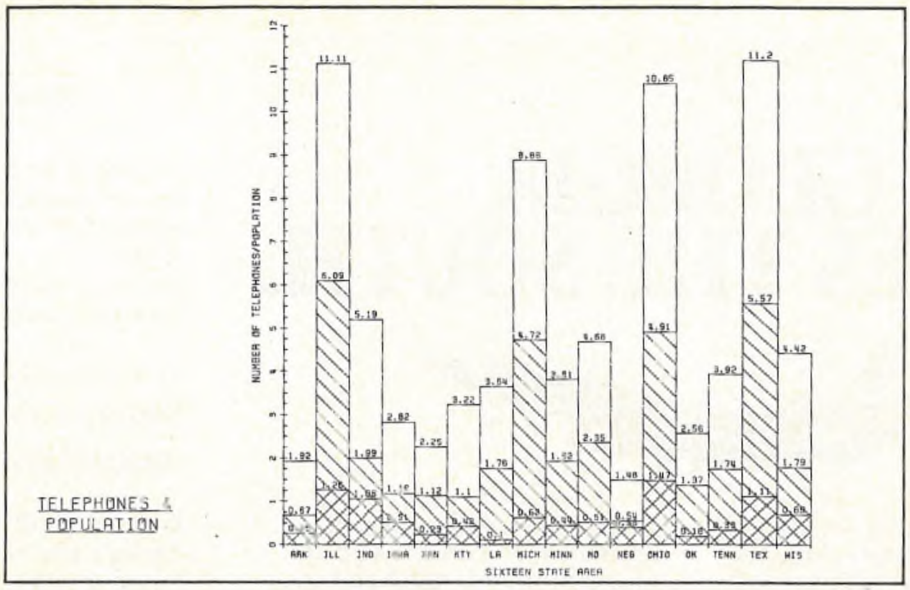
Coating makes variable inductors more reliable

Called Cor-Guard, a proprietary coating baked onto the iron or ferrite core in a variable inductor or transformer is said to eliminate the problems of low torque and core breakage long associated with variable-inductance devices. Cor-Guard has no effect on the components' electrical properties and is essentially unaffected by such industrial solvents as trichlorethylene, methyl ethyl ketone, and alcohol. The coating, which operates over the temperature range from −55 to +125°C will be used on all of Vanguard's variable coils and transformers.

Vanguard Electronics, 930 West Hyde Park Boulevard, Inglewood, Calif. 90302 [346]

Delay module for ECL can drive 70 loads

Capable of driving 70 emitter-coupled logic loads, the ECLDM is a 250-nanosecond delay device tapped at increments of 25 ns. Housed in a standard dual in-line package, the device has a maximum error of 3 ns or 5% (whichever is



After your 360/370 massages the information, a Gould Plotmaster™ can draw you a picture within 3 seconds.

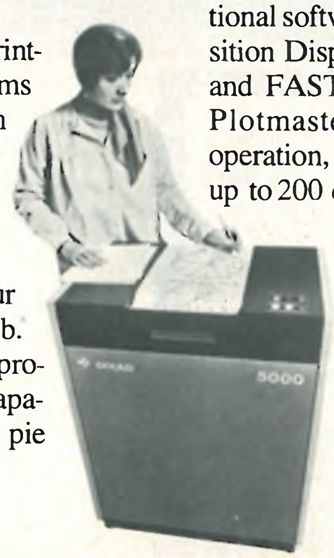
If alphanumeric information is what you want, a Gould Plotmaster can print it for you. At speeds up to 3000 lines per minute. But there are times when alphanumeric listings are just too much. Too much paper to handle, too tough to read, too difficult to digest.

And it's at times like these that a Gould Plotmaster can draw you a picture. A line chart, a bar chart, a pie chart, a graph. A picture that tells your story at a glance.

Employing high-speed electrostatic printer/plotters, Gould Plotmaster Systems give you power and versatility for both on-line and off-line operation. And they're designed to run on any IBM System/360 or 370 operating under DOS or OS, real or virtual.

Easy-to-use software packages help our Plotmaster Systems do the whole job. There's our DISPLAY™ package that provides even non-programmers with the capability of easily generating line, bar and pie charts. And there's our PLOT package which, due to the speed and flexibility of our printer/plotters, lets you do background grids, variable line weights, automatic stripping, text annotation, and allows you to erase previously programmed line segments.

In addition to business graphics, a Gould Plotmaster can add engineering/scientific graphics and computer-aided-design capabilities to your operation. These optional software packages include DADS (Data Acquisition Display), PAL (Precision Artwork Language) and FAST-DRAW.™ As for the hardware itself, our Plotmaster Systems can provide on-line/off-line operation, paper widths up to 22 inches, resolution up to 200 dots per inch, output speeds up to 7 inches per second. And, of course, a printing capability, as well.



Get all the facts on Plotmaster Systems from Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114 U.S.A. or Kouterveldstraat 13, B 1920 Diegem, Belgium.

GOULD

greater) of the nominal delay at any tap. All required driving and pick-off circuitry is contained in the 14-pin DIP.

Engineered Components Co., 2134 W. Rosecrans, Gardena, Calif. [345]

Beckman introduces line of standard LCDs for watches

Beckman Instruments is now producing a line of standard field-effect liquid-crystal displays for timepieces. Three series of the very-low-power displays are offered: two 3½-digit models (series 701 and 703) for 12-hour applications, and one (702) for 24. One of the 12-hour units, the model 703, is slightly larger in overall size and viewing area than the other displays.

The displays consume very little power (typically 1 microwatt) and are easy to read in bright ambient light. All are made for C-MOS drive and are available in 3-or 6-volt versions. The firm also claims that the liquid-crystal materials used are stable and insensitive to moisture. Operating temperature range is 0 to 50°C.

The displays are 0.19 inch high and 0.815 or 0.860 in. wide. Their packages measure approximately 1 by 0.55 by 0.1 in. thick. The 3½-digit models have 24 terminal pads, and the 4-digit, 24-hour models have 26 terminal pads.

The displays are designed for square-wave drive, with a maximum of 26 millivolts dc-drive component allowed. Operating-frequency range is 25 to 100 hertz—the lower limit to avoid flicker, and the upper because of increased power consumption at higher frequencies. Dynamic current with all segments on is typically 300 nanoamperes. Capacitance for all segments is 225 picofarads for the 6-V version, 325 pF for the 3-V one. Dc resistance is typically over 300 megohms.

Response time for the displays at 25° C is typically 250 milliseconds to turn on, 400 ms to turn off. Contrast ratio is 20 to 1.

The standard 6-V display is priced

at $8.80 in quantities of 1,000, and the 3-v version, $8. Many custom variations are available, including units for test instruments and calculators, special front styles, different sizes, and variations in threshold voltage, materials, terminal arrangements, and background polarizers.

Beckman Instruments Inc., Helipot Division, 2500 Harbor Blvd., Fullerton, Calif. 92634 [347]

Constant-impedance filters work from 300 Hz to 20 kHz

A line of constant-impedance filters for use in telephone systems, alarm lines, data-transmission facilities, and similar audio-band applications spans the frequency range from 300 hertz to 20 kilohertz. The high- and low-pass filters come with standard input and output impedances of 600 ohms, although other values can be had on request. The MLH-1100 series comes in a standard package that measures 1.69 inches by 1.625 in. by 6.5 in.

Electro Networks Division of Chloride Conrex Corp., Maple St., Caledonia, N. Y. 14423 [348]

Hall-effect switches come in V3 packages

Housed in the traditional Micro Switch V3 package, a line of Hall-effect switches can work off unregulated dc supplies in the range from 6 to 16 v dc. Using no mechanical contacts. it has an inherently bounce-free output. The switches in the line are available with either current-sinking or current-sourcing outputs. Having the same mounting dimensions as the traditional V3, they can utilize all of the latter's actuators. Intended for vending machines, automotive applications, timers, measuring instruments, business machines, home appliances, etc., the XL units sell for $1.50 each in large quantities.

Micro Switch, a division of Honeywell, 11 West Spring St., Freeport, Ill. 61032 [349]

IN DIGITAL TESTING, COVERS THE

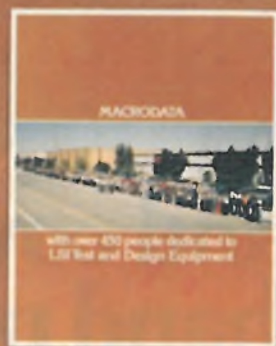
*Including PROM Programming Capability

ONLY MACRODATA FULL SPECTRUM!

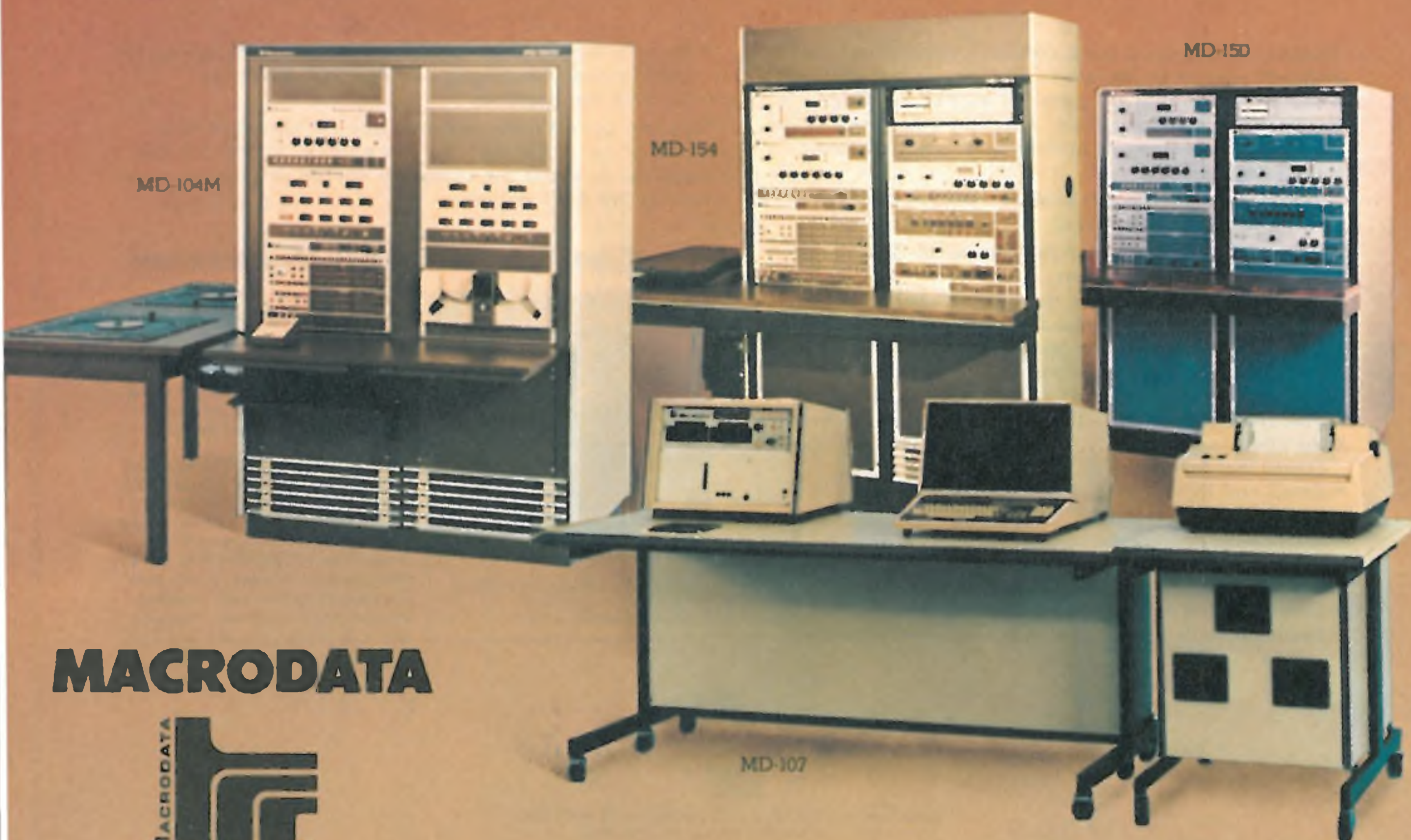
Over 450 people dedicated to digital test systems. Only Macrodata has the experience—5 years of success in digital testing with over 500 systems in the field enables us to successfully bridge the gap between the device manufacturer and the device user. We offer the right system for your job at the right price to optimize cost effectiveness of the solution. Only Macrodata has available seven different, reliable, field proven, mature systems keyed to specific applications and budgets. No compromises are necessary with our solutions. You have a cost-effective choice available only at Macrodata.

We provide in-depth application support, program libraries, experienced local service, local spares and repair depots all over the world. By design, executed over the past five years, we've set ourselves up to be truly responsive. No empty claims. No irrational promises.

We stand on our record of proven performance to provide you the backup you need— in depth.



For more information, write on your company letterhead for your copy of the new Macrodata brochure on "Cost-effective MPU and Memory Testing."



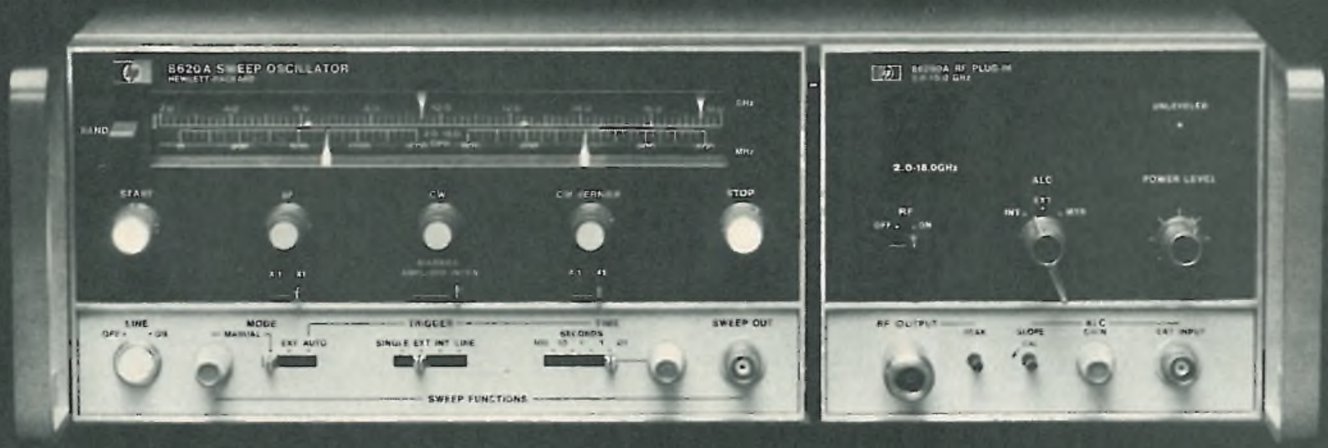
MACRODATA

MACRODATA

Macrodata Corporation, 6203 Variel Avenue, Woodland Hills, California 91364, Phone: (213) 887-5550, Telex: 65-1345

Circle 167 on reader service card

Meet our new 2-18 GHz sweeper plug-in:



Broadband coverage with narrowband precision is here!

There's never been a more compact, convenient, and accurate way to go from 2 to 18 GHz. In fact, HP's 8620A sweeper with the new HP 86290A RF plug-in is the best buy on the market, whether your need is for broadband sweeping or narrowband precision over a wide range.

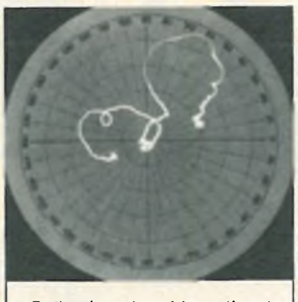
Never before has one broadband sweeper combined so many desirable features:

- Frequency accuracy is ±20 MHz at 18 GHz — more precise than a wavemeter.
- Linearity is 0.1% — more than five times better than most octave band sweepers.
- CW stability typically is 50 ppm/10 minutes — comparable to cavity-tuned sources.
- 5 dBm output, with internally leveled flatness of ±0.9 dB over the entire band — the best flatness available.
- Excellent signal purity — harmonics typically 35 dB down, low residual FM.
- Small and light — 5¼″ high; 33 lbs. (133 mm., 15 kg.); convenient for field use.
- Start/Stop and △F sweeps plus CW. Calibrated △F's as wide as 1.6 GHz, as narrow as 1 MHz. Calibrated CW vernier can set 1 MHz increments.
- Phase locking is simple and inexpensive. Full range sweeping with fixed offset tracking now possible.
- Remote digital programming option can program up to 3000 frequencies simply — gives you versatility for ATE applications.

You can get all these features and performance at a value price — $13,250* for the plug-in; $1750* for the mainframe. Write for complete details or contact your nearby HP field engineer.

*US Domestic Prices.

New Capabilities in Network Measurements



Reflection plot of broadband circulator, 2-18 GHz. (Full scale, $\rho = 1.0$)

When you use the HP 86290A with the new HP 8410B Network Analyzer, it is now possible to measure and display from 2 to 18 GHz in one continuous sweep! Network Analyzer/Sweeper tracking assures spurious free 60 dB dynamic measurement range.

When you use the 86290A with the HP 8755 Frequency Response Test Set, direct modulation of sweeper makes full power available at test device for greater measurement range. The HP 86290A/8755 swept measurement system is an economical, versatile, and accurate way to make wideband measurements in production, lab, and field.

HEWLETT PACKARD

Sales and service from 172 offices in 65 countries.
1501 Page Mill Road, Palo Alto, California 94304

45505A

Communications

Laser system runs at 1.5 Mb/s

Voice and data communications system can be set up in 15 minutes

Laser communications is often thought of as an exotic, high-priced activity that's useful mainly in secure military systems and other special situations. Actually lasers can often provide the cheapest way to solve a communications problem. The latest communicator from American Laser Systems, for example, is being marketed as a low-priced, easy-to-install alternative to conventional transmission links. As company president Duncan Campbell points out, if a company has two plants located across the street from each other, it will usually be cheaper to link them with laser beams than to dig up the road to bury a cable. And aligning the transmitter and receiver takes approximately 15 minutes, Campbell reports.

The new unit, called the model 741 laser voice and data communicator, uses a gallium-arsenide laser diode to transmit digital data at speeds up to 1.5 megabits per second. Operating at the infrared wavelength of 9,000 angstroms, its range, of course, depends upon local climatic conditions. For most of the United States, Campbell says, 10 miles is a reasonable maximum. For 99.99% reliability, three miles is perhaps a better number. It depends upon the amount of fog and smog in the area; rain and snow are less important at 9,000 Å.

In addition to accepting digital data, the laser communicator has an input connector for an analog voice signal which it can digitize and transmit instead of the digital data at any time.

The system, which can be operated without any FCC licensing, puts out 1.5-watt pulses approximately 10 nanoseconds long. This results in a 1.5% maximum duty cycle which keeps the average power below the level at which it might cause eye damage.

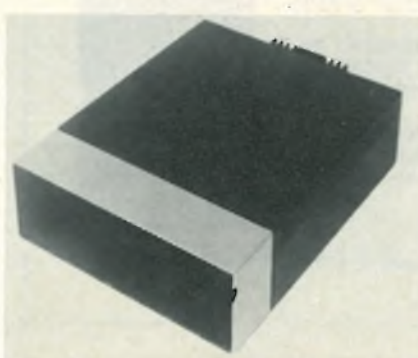
The units, which operate on C-MOS logic levels, can work with virtually all types of digital data streams: the transmitter triggers on the leading rising edge of the input pulses. With a minor modification, TTL and balanced TTL can also be accommodated.

The communicator consists of two parts—a transmitter and a receiver—one of each being required for a single one-way, one-hop transmission link. For duplex operation, two transmitters and two receivers are required. Both come complete with optics and alignment and mounting bases, and both sell for $2,500. Delivery is currently running about 90 days, although the company's older model 736 10-kilobit system is available from stock.

American Laser Systems Inc., 106 James Fowler Rd., Santa Barbara Airport, Goleta, Calif. 93017 [401]

201-type modem recognizes accidental disconnects

Designed to solve a frequent problem with dial-up 201-type modems, the GDC 201-5 modem can save money by eliminating the dedication of business machines and phone lines to dead channels. Most modems cannot recognize when a circuit has been inadvertently disconnected—whether because of line failure, failure to transmit EOT (end of transmission), or because the modem answered a wrong number. That is because most modems are designed to terminate connections on command from a business machine; no EOT, no disconnect. The result, many times, is that both phone lines and computers can be tied up, sometimes for considerable periods until an operator notices what's happening, running up bills and accomplishing nothing.

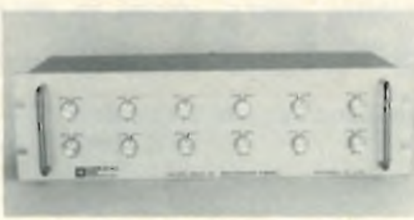


In addition to overcoming this problem, the 201-5, available in both stand-alone and rack-mount versions, permits the circuit to be switched repeatedly between voice and data modes. It is designed to operate on the dial network via automatic-originate-and-answer data couplers at rates of 2,000 and 2,400 bits per second. The price of the 201-5 is $1,331; delivery time is 30 days.

General DataComm Industries Inc., 131 Danbury Rd., Wilton, Conn. 06897 [403]

Front-end-processor switch requires no power

Using rotary switches instead of relays for increased reliability and decreased cost, the model 8506-12 is a 12-channel front-end-processor



switch that requires no operating power and is therefore immune to power failures. The unit allows an operator to switch a maximum of 12 modems from their on-line processors to back-up processors at a cost of $87 per channel. The unit switches all 25 lines in each EIA RS-232 channel interface. The switch may be expanded, one channel at a time, as requirements grow. It measures 5½ inches high by 19 in. wide by 7½ in. deep. Priced at $1,040, the model 8506-12 has a 30-day deliv-

every time from receipt of order.
International Data Sciences Inc., 100 Nashua St., Providence, R. I. 02904 [405]

Multimeter is designed for digital-transmission testing

Combining the functions of a frequency counter, noise- and level-test set, capacitance bridge, decade box, and voltmeter, the model 430 digital-transmission multimeter is a diagnostic tool for detecting and isolating problems on voice-grade and

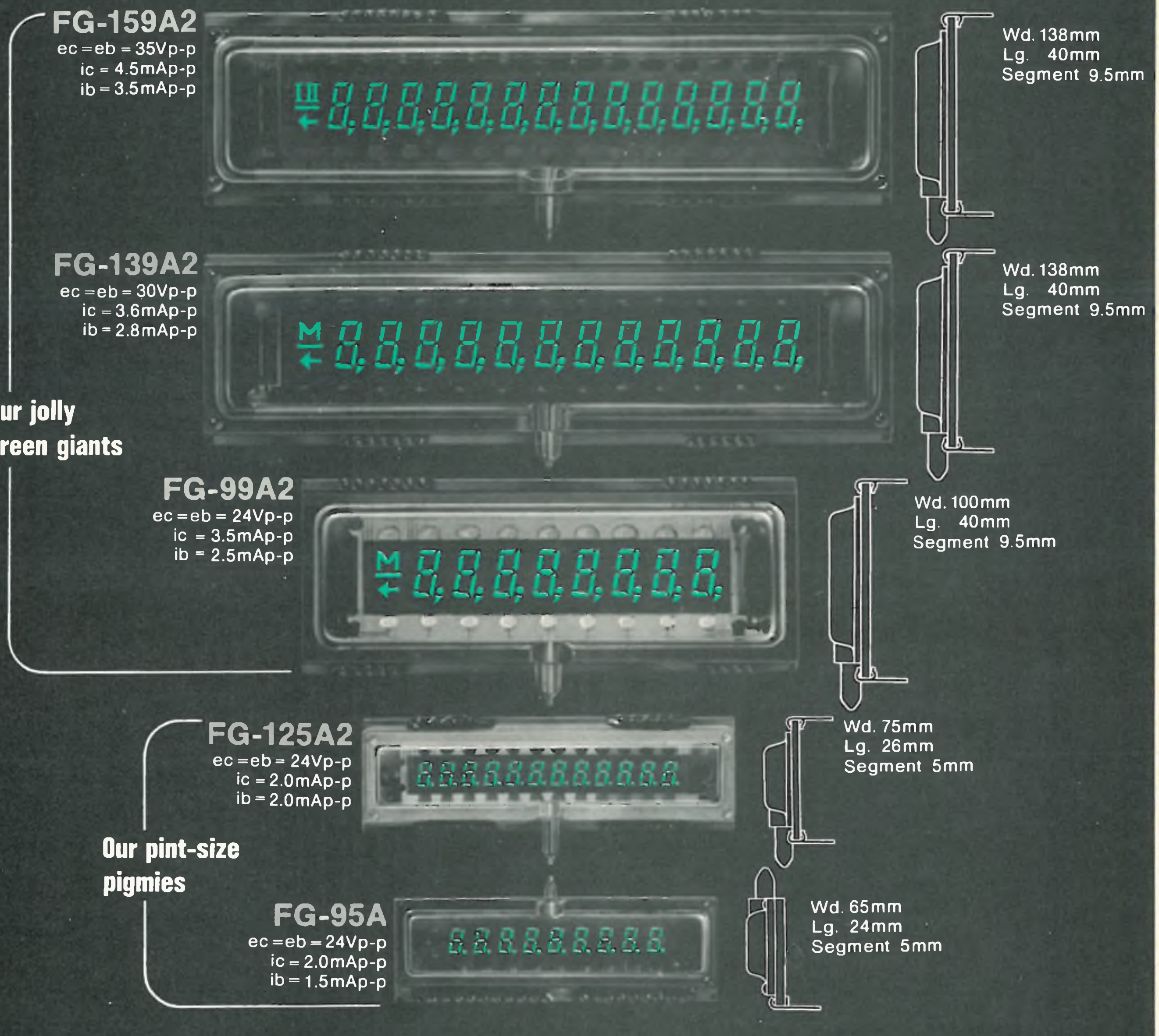
program telephone channels. The digital instrument has built-in filters for measuring noise and signal levels on both voice and program lines. Battery-powered for portability, the 430 sells for $1,395. Delivery time is 30 days.
Wavetek, Telecommunications Products, P. O. Box 651, San Diego, Calif. 92112 [404]

C-MOS FSK transmitters and receivers need little power

The series 5600 line of frequency-shift-keying transmitters and receivers uses complementary-MOS logic so that a bank of 12 modules can be operated from a single 10-volt, 1-ampere power supply. Designed for use on wire-line and carrier, links, the 5600 FSK units are capable of two- and three-frequency oper-

Think Large.
Think Small.
Think Ise *itron*

Think our three jolly green giants for desk-top electronics. Our two pint-size pigmies for carry-in-the pocket display designs. But don't stop there. Think low operating voltages, low power consumption, wafer-thin thickness and dip clip pins for fast glass encapsulation all around, and efficient mounting.



Something else to think about

Think Ise for digital readouts for instruments, clocks and other products, too.

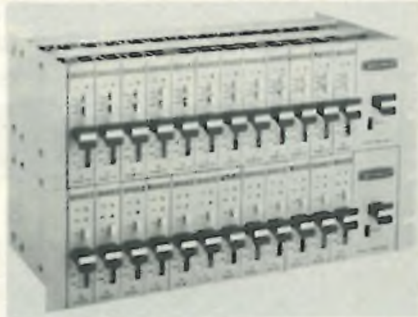
The Brighter Side of Electronics

ISE ELECTRONICS CORP.

Main Office:
P.O. Box 46, Ise City, Mie Pref., Japan
Tel: (05963) 5-2121 to 4, Telex: "4969523"

Tokyo Office:
2-7-7 Shigashi Shinbashi, Minato-ku, Tokyo, Japan
Tel: (03) 433-6616 to 9, Telex: "J26546"

Noritake Electronics Office:
22410 Hawthorne Blvd. Torrance California 90505, U.S.A.
Tel: (213) 373-6704, Telex: "230674910"



ation. Transmitter input is compatible with unipolar, HTL, relay drive, and C-MOS logic levels. Receiver outputs can work into DTL, TTL, HTL, and C-MOS devices. The MT603 transmitter is priced at $154, and the MR603 receiver sells for $235. Delivery time is eight weeks.

Bramco Controls Division, Ledex Inc., College and South Streets, Piqua, Ohio 45356 [406]

Simulator replaces datasets for short-hop links

A dial-up dataset simulator replaces both datasets and telephone lines for data communications over distances as long as 1,250 feet. Intended to provide inexpensive service between local terminals and computers, the device emulates all dataset originating and answering functions and can handle data rates as high as 9,600 bits per second. The unit is completely self-contained and sells for less than $300. Delivery time is 30 to 45 days.

Computer Transmission Corp. (TRAN), 2352 Utah Ave., El Segundo, Calif. [407]

Design for 300° C with Carborundum Ekkcel™ thermoplastic

And mold with standard injection equipment

Few thermoplastics can retain long-term performance at temperatures of 300° C (572° F). Ekkcel can. Ekkcel is the only thermoplastic that can be easily molded on standard injection molding equipment and also resist these temperatures. That's important to you — because you're interested in both the performance of a material and the costs of molding.

Ekkcel performs . . .
A wide variety of high-performance electrical and mechanical components are being designed and molded in Ekkcel. Ekkcel has extremely low moisture absorption, good friction and wear, outstanding electricals, very high radiation and chemical resistance, and superior flammability resistance — Ekkcel satisfies Underwriters Laboratory specification VE-O.

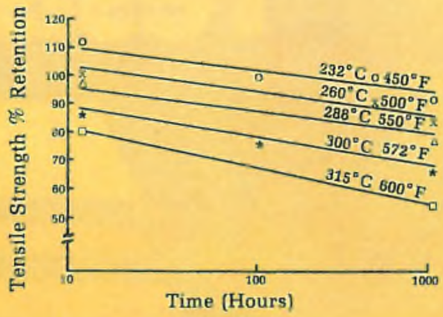
Combine these properties with excellent dimensional stability and strength up to 300° C, and you have

Ekkcel, an exciting thermoplastic for most any electrical and mechanical design.

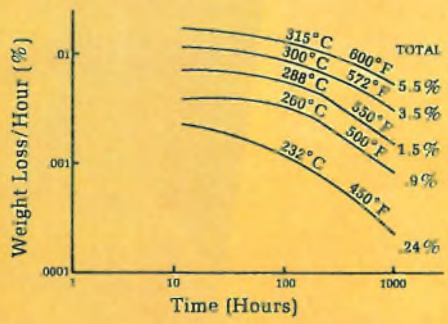
The other half: moldability . . .
Ekkcel molds on standard injection molding equipment. So you don't have to worry about expensive special molding equipment. Ekkcel resin runs easily, so you get high production rates — even with difficult-to-mold designs. You can also regrind Ekkcel — and that means lower costs.

What's your application?
If you have an application requiring performance at high temperatures, tell us about it.
Carborundum Plastics, Inc.,
Ekkcel Division,
5785 Peachtree Industrial Blvd.
Atlanta, Georgia 30341.

Effect of Heat Aging on Tensile Properties of Ekkcel I2000

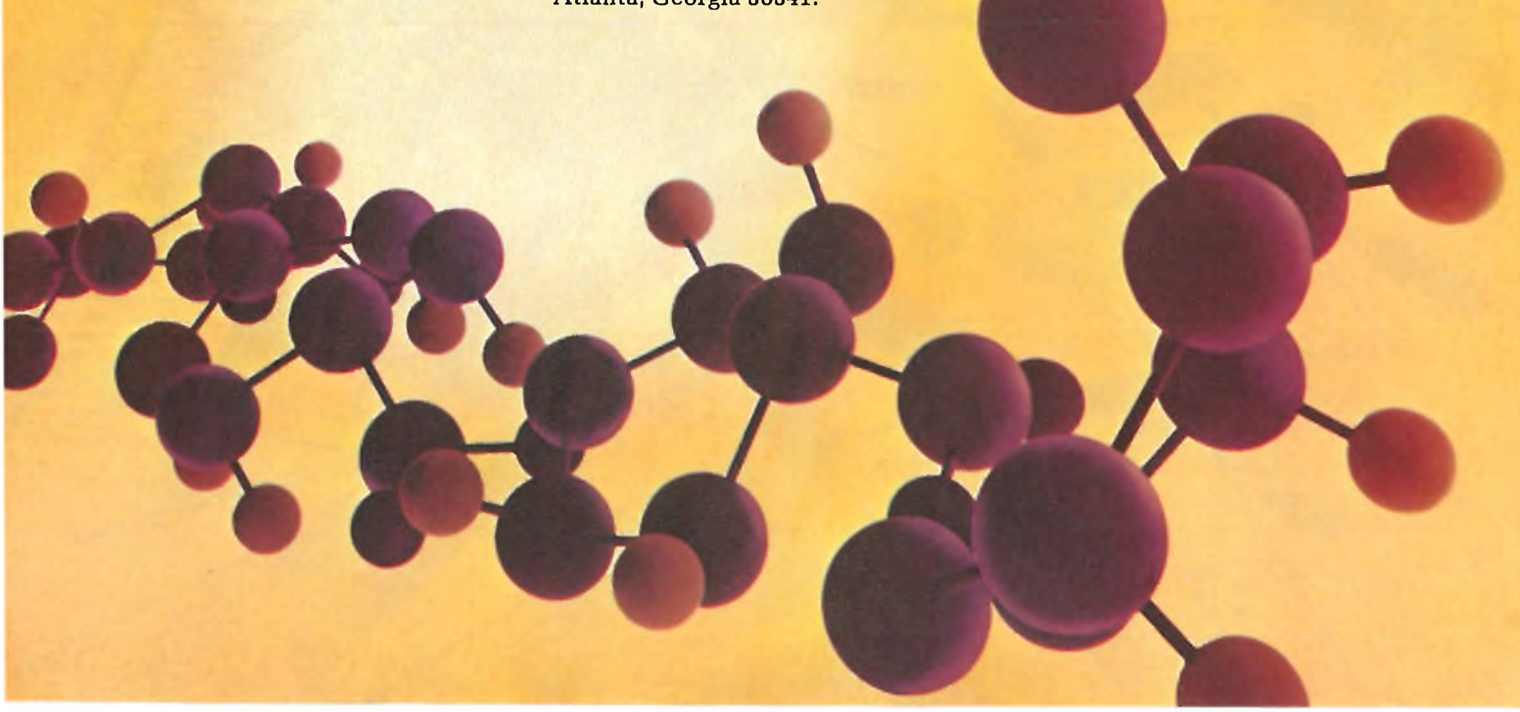


Rate of Weight Loss vs. Time Ekkcel I2000



CARBORUNDUM

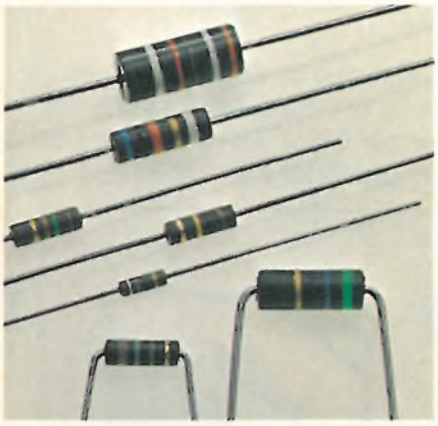
Circle 173 on reader service card



Only TRW/IRC offers you complete resistor choice.

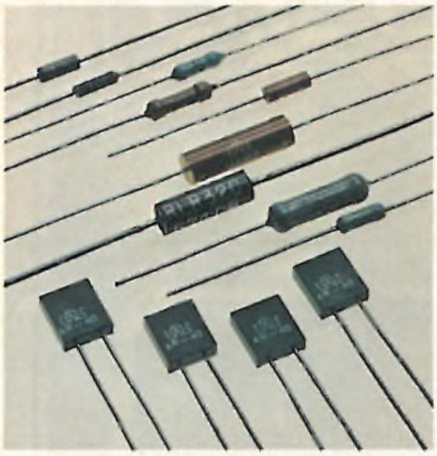
You get exactly the resistor you need for *your* application.

No compromises. No "favorites." Just quality.



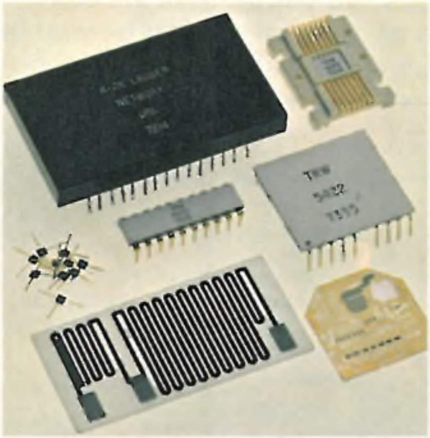
Carbon comp.

Billions used in consumer, industrial, military applications. TRW/IRC carbon comp. capability ranges from standard commercial types through established reliability RCR's, to ultra-high range (10^{11} ohms). Where you're using carbon comp.'s in automated assembly, TRW/IRC packaging options can help cut the cost of interfacing with your machines. Card packs, lead tape reels, cut and formed leads...we'll be glad to explore the potential economies with you.



Metal Film

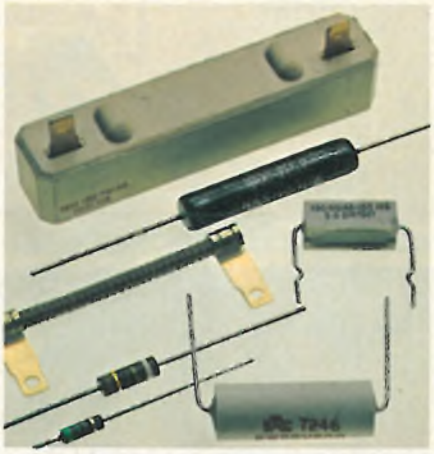
TRW/IRC has brought the state of the art in thin-film to a performance level equaling high-stability wirewounds. Capabilities include resistors with tolerances to $\pm$ 0.01% and $\pm$ 3 PPM T.C. ...high-rel units... precision subminiatures...and, of course the popular RN's. You can also look at alloy films offering high-temperature and high-voltage capability at low cost.



Resistive Networks

Advanced resistor technology here. These IC compatible, precision tantalum-film circuits provide inherent low noise, excellent stability, and hermetic performance without hermetic cost. Tolerances from 5% to 0.05% available in custom designs.

TRW/IRC also offers the industry's most complete line of discrete fixed resistors.



Wirewound

The line starts with molded wirewound resistors—"space-savers" that bridge the cost-performance gap between composition resistors and precision wirewounds.

It proceeds to standard, non-insulated types for appliance/automotive use...to precision subminiatures offering high power density... to low cost fusible, flameproof units for consumer and industrial applications... to tubular and flat power wirewounds with ratings to 250 W.

Metal Glaze™

This is TRW/IRC's thick-film technology—for all types of low power resistor applications. Metal Glaze is widely accepted for its built-in power handling reliability, resistance range, and cost effectiveness. Numerous standard and special designs—precision, semi-precision, flameproof, high-rel, high-voltage.

All types...all technologies... one source

To wrap it up, TRW/IRC offers you the most complete line of fixed resistors in the business, with many of the popular types available from one source—your local TRW/IRC distributor. Having a direct pipeline to each of our plants, he can give you fast delivery.

Contact your local TRW *sales office* for application assistance, custom designs, and special engineering help when you need it. TRW/IRC Resistors, an Electronic Components Division of TRW, Inc. Plants at Boone, N.C., Burlington, Iowa, and Philadelphia, Pa. Write TRW/IRC Resistors, 401 N. Broad St., Philadelphia, Pa. 19108. Or call (215) 923-8230.

TRW® IRC RESISTORS

Circle 175 on reader service card

Semiconductors

User programs logic arrays

Intersil, Signetics bipolar devices involve entirely different approaches

The general-purpose configuration of programable logic arrays (PLAs) gives them broad flexibility of application: they can be used to manage combinatorial logic; as controllers for sequential-state networks; as large high-speed read-only memories; as high-speed character generators for large or unusual fonts; or for several of these at the same time. What's missing from conventional PLAs is field programability—a feature that adds greatly to the usefulness of read-only memories and similar devices.

Recognizing this deficiency, two semiconductor companies—Signetics Corp. and Intersil Inc.—are introducing field-programable logic arrays. Though both companies use bipolar arrays, each approaches the problem of field-programability differently.

The Signetics device contains 16 inputs, 8 outputs, and 48 minterms, with standard nickel-chromium fused links programed by blowing the proper links to establish minterms or their inverted complements. The Intersil 14-by-8-by-48 product-term device, on the other hand, is built with conventional gold-doped transistor-transistor logic, and links are fused by the company's avalanche-induced migration, or AIM, technique.

In Intersil's IM5200 PLA, the basic operating circuit consists of 56 input inverters, which generate the true and complement of the 14 inputs; 48 28-input AND gates, eight 48-input NOR gates, and three arrays of AIM programable elements. Additional circuitry is dedicated to programing and testing before programing. All outputs have 4-kilohm resistor pull-ups that permit wire-ANDing.

In the Signetics 82S101 PLA, each output function can be programed either true active high or true active low. The true state of the output functions is controlled via an output sum (OR) matrix by a logical combination of 16 input variables, or their complements, up to 48 terms. In addition to being fully TTL-compatible, both the 82S100 and a tri-state version called the 82S101 include a chip-enable clocking input for output deskewing and inhibit.

Housed in 28-pin ceramic dual in-line packages, the Signetics devices are priced at about $40 each in 100-lots and will be available in June. The Intersil IM5200, available now, is priced at $25 each for 100-999 plus a nominal programing charge.

Intersil Inc., 10900 North Tantau Ave., Cupertino, Calif. 94014 [411]

Signetics Corp., 811 East Arques Ave., Sunnyvale, Calif. 94086.

Chip with phase-locked loop cuts communications costs

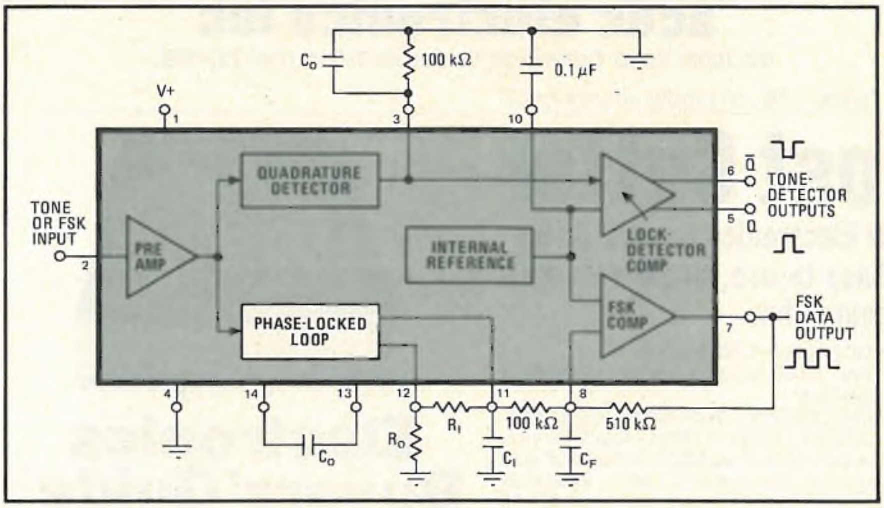
Builders of communications equipment who are on the lookout for cost-saving monolithic components will welcome Exar's FSK demodulator and tone decoder chip for data modems, remote control and telemetry systems. The 14-pin integrated circuit makes available inexpensive monolithic phase-locked-loop technology in narrow-band, high-performance communications systems.

The XR-2211 is optimized for frequency-shift-keyed modem demodulation and carrier detection but also has advantages in tone and fm communications in remote control and telemetry systems. In FSK modem applications, the company says, it offers higher performance, circuit simplification, and therefore lower cost, than other monolithic demodulators.

With its frequency stability and response speed, the XR-2211 can operate at bandwidths as narrow as ±1% without sacrificing transmission rates or reliability. In addition, the XR-2211 is the first PLL demodulator with simultaneous carrier-detection capability. Also, it operates with a simplified RC network, eliminating many external components that adds costs to system design.

As shown in the diagram below, the chip includes a phase-locked loop with an extremely stable voltage-controlled oscillator, a lock-detect subsystem, internal voltage reference, and comparators to generate demodulated FSK data and carrier detection or decoded tone data outputs. In modems, the carrier detection output can be used to enable or disable the FSK data output. Also, the PLL has an analog signal output for applications such as fm telemetry and control systems.

Simple calculation of five or six resistor and capacitor values, which



can be rounded off to standard component values, allows center frequency, bandwidth and output delay to be established independently. Only a few values need to be adjusted to change communications bands or tone frequencies, facilitating the use of a basic design for many different applications.

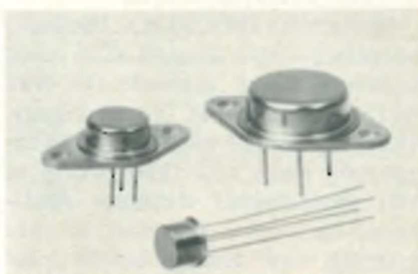
The XR-2211's typical frequency stability is 20 ppm/°C over the operating temperature range, compared with 200 ppm/°C for previous designs. Supply stability is 0.05%/volt and 0.2%/volt at 5V. Input dynamic range is 2 mv to 3v rms; frequency range, 0.01 Hz to 300 kHz; adjustable tracking range, ±1% to ±80%; and power supply range, 4.5 V to 20 V. The unit is compatible with DTL, TTL and ECL logic.

Housed in a 14-pin plastic or ceramic dual in-line package, the XR-2211 is available in three temperature ranges. Prices start at $6.02 each in quantities of 100 to 499.

Exar Integrated Systems Inc., 750 Palomar Ave., Sunnyvale, Calif. 94086 [412]

High-power Darlingtons are rated up to 300 volts

Two series of monolothic Darlington power transistors are available with breakdown voltages (BV_{CEO}) as high as 300 volts. The 2-ampere U2T700 series and the 5-A U2T800 series have provision for external biasing of both input and output transistors for greater flexibility. With typical gains of 2,000, the units can switch high-power dc loads directly from low-level logic signals. Applications range from drivers for stepper motors and print hammers to switching power supplies and de-



SIEMENS

The world of Siemens capacitors spotlight on D Series and Mil-C-39003 tantalums

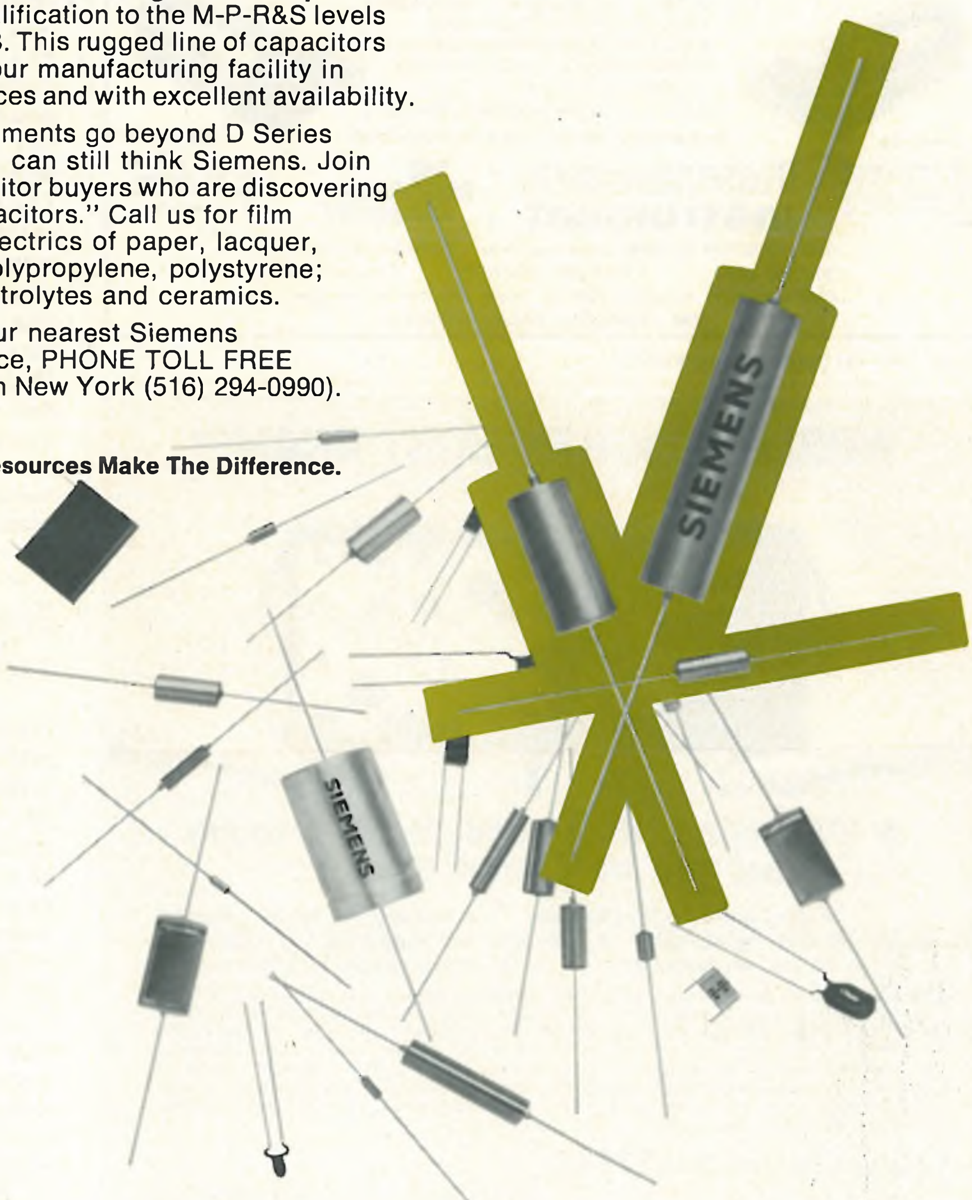
Enter "The World of Siemens Capacitors" and discover our D Series and Mil-C-39003 tantalums. Siemens offers you CSR-13, CSR-91 and CSR-09, available in **all voltages — all cap values — all case sizes,** with full qualification to the M-P-R&S levels of Mil-C-39003 1E, 2B, and 4B. This rugged line of capacitors comes to you directly from our manufacturing facility in Arizona — at competitive prices and with excellent availability.

But, if your capacitor requirements go beyond D Series and Mil Spec tantalums, you can still think Siemens. Join the growing number of capacitor buyers who are discovering "The World of Siemens Capacitors." Call us for film and metallized film with dielectrics of paper, lacquer, polyester, polycarbonate, polypropylene, polystyrene; tantalum and aluminum electrolytes and ceramics.

For the phone number of your nearest Siemens Component Group sales office, PHONE TOLL FREE (800) 645-9200 (call collect in New York (516) 294-0990).

And remember . . .

Siemens: Where Quality And Resources Make The Difference.



Siemens Corporation
Components Group

P.O. Box 1390, Scottsdale, Arizona 85252
(602) 947-2231 TWX 910-950-1292 Telex 667-406

Circle 179 on reader service card

flection circuits. Prices, in hundreds, range from $3.40 to $6.00 depending upon packaging and rating. Delivery time is two to three weeks.

Unitrode Corp., 580 Pleasant St., Watertown, Mass. 02172 [414]

ECL sense amplifier has 10-ns propagation delay

Made using emitter-coupled-logic fabrication techniques, the MC3461 sense amplifier is designed to interface n-channel MOS memories with ECL 10,000 logic elements. The amplifier has a maximum propagation delay of 10 nanoseconds (5 ns typical) and contains on-chip latches with typical response times of 1.0 ns. The pullup resistors required for the current-sinking outputs of such memories as the MCM7001 are contained on the MC3461 chip. The device has an operating temperature range of 0 to 75°C. It is housed in a 16-pin ceramic dual in-line package and sells for $8.95 in hundreds. Delivery is from stock.

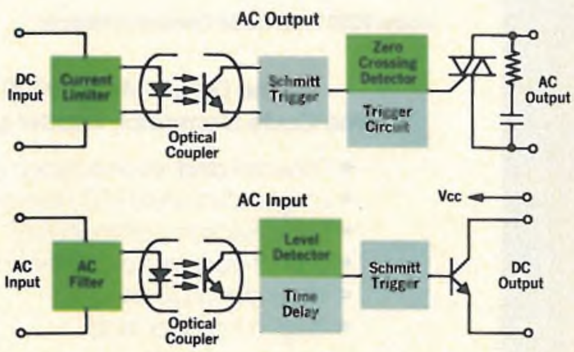
Technical Information Center, Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. 85036 [413]

Serial CCD memory stores 1,024 nine-bit words

Intended for use as a display refresh memory, in data communications networks, in smart terminals and the like, the CCD 450—a 1-kilobyte serial storage element—is the first charge-coupled-device (CCD) memory to be produced in large quantities. The memory uses Fairchild's Isoplanar buried-channel, ion-implanted barrier structure in its storage registers, with n-channel MOS structures used for the timing, charge-detection, and level-conversion circuitry. The result is a 9,216-bit (1,024 words by nine bits) memory with an average access time of 200 microseconds and a maximum power dissipation, in the read and write modes, of 250 milliwatts. In the standby recirculate mode, the

Get on board with Teledyne I/O converter modules

Now Teledyne Relays offers its proven I/O converter modules in low profile packages for direct PC board mounting. The versatile Teledyne 675 series allows you to design programmable controllers, process and machine tool controls with flexible and economical I/O interface circuitry. The full line includes both ac and dc, input and output modules. All versions are optically isolated, with 1500 VRMS isolation, to protect logic lines from ac or dc power circuits. The AC output modules feature zero voltage turn-on to reduce switching noise and high dv/dt ratings to prevent false triggering in tough industrial environments.



Typical Functional Diagrams

Get on board with Teledyne Relays. We've got thousands of I/O modules at work in the field. Call your nearest Teledyne Relays office for location of your local representative or distributor.

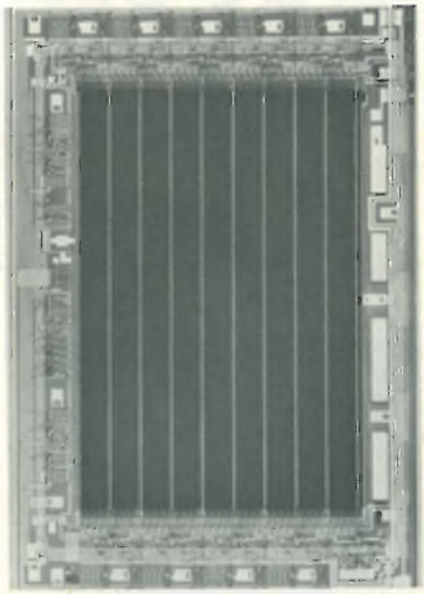
TELEDYNE RELAYS

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

Photo courtesy of Datametrics
a subsidiary of ITE Imperial Corporation.

Burgstrasse 6-8, 62 Wiesbaden, West Germany
Telephone: 06121-302031/2 Telex: 04-186851 (Trel-D)

Heathrow House, Bath Road, Cranford, Hounslow, Middlesex, U.K.
Telephone: 01-8972501 Telex: 935008



power consumption drops to 30 mW. Housed in a standard 18-pin ceramic dual in-line package, the CCD 450 can handle data rates from 50 kilohertz to 3 megahertz. Its price, for small evaluation quantities, is $90 each. Production quantity prices are expected to be about a tenth by the end of the year.

Fairchild Camera and Instrument, Integrated Circuits Group, 464 Ellis St., Mountain View, Calif. 94042 [415]

Single IC contains complete TV sound channel

The TDA1190 is an integrated circuit that contains all the active circuitry needed for a complete TV sound channel. Functions performed by the unit include i-f amplifier/limiter, active low-pass filter,

Now! A 5V, 120-amp switcher with forced-air cooling, up to 3 outputs, 75% efficiency, measures only 8"W x 10"L x 5"H, and weighs less than 12 lbs.

The newest addition to the LH line of switching regulated power supplies is the super-compact forced-air cooled 120-amp series. With dimensions ideal for computer memory system installations, these switchers are available in single or multiple output models with extremely high efficiencies: 80% on primary output, an average of 75% on all others.

Up to three outputs

Primary output is 5 VDC, 120 amps; second and third outputs are ±12, or ±15 at 8 amps. Combined load on all outputs is limited to 600 watts. All outputs are fully regulated as a standard feature, and all are adjustable from the front panel.

Outstanding features

Over-temperature protection and RFI line filtering are standard features; over-voltage protection is standard on primary output, optional on secondaries. Other options include remote on-off, master-slave paralleling, and paralleling of up to 10 units. Mounting is by side or bottom in any direction. They operate in ambient temperatures of up to 50°C without de-rating.

Selectable AC inputs

AC inputs can be externally selected 115/230V, 47 to 63 Hz, simply by changing a jumper on the front terminal strip.

Easy maintenance, high reliability

In single-output models all components are mounted on just two circuit boards, multiple-output models use three, so the entire switcher can be disassembled in less than five minutes. Through the use of ribbon cable, interconnections have been reduced 90%, greatly enhancing reliability.

Ask for full-line folder

Our new 6-page folder fully describes the new 120 amp units and other standard LH switchers, and discusses options for specific requirements. Write for a copy today.

Most comprehensive switcher line made

LH Research makes several hundred standard switchers, with single and multiple outputs from 250 to 600 watts, and AC or DC inputs. All are extremely compact and lightweight, with six package shapes to suit your assembly. Efficiencies are 75-80%, and costs are as low as 75 cents a watt. Among the newest is the double dual model, which has two isolated 250-watt outputs plus two low power outputs, and weighs only 16 pounds.

LH RESEARCH

LH RESEARCH, INC., 2052 South Grand Avenue, Santa Ana, CA 92705 • (714) 546-5279

Circle 183 on reader service card

New products

fm detector, dc volume control, and power output amplifier. Requiring only a small number of external passive components, the TDA1190 is noteworthy for its very wide dc volume-control range (typically 90 dB), its high output-power capability (typically 4.2 watts into 16 ohms), and the fact that it radiates no electromagnetic interference and therefore requires no external shielding. Price of the TDA1190 is $2.80 in lots of 100 to 999 pieces.

SGS-ATES Semiconductor Corp., 435 Newtonville Ave., Newtonville, Mass. [416]

C-MOS watch circuit drives liquid-crystal displays

A monolithic C-MOS timekeeping circuit, the model 5022, is designed for use in watches with 5½-digit liquid-crystal displays. The circuit, which drives the displays directly without external components, provides outputs for displaying hours and minutes continuously. Either seconds or the date may be displayed on the other two digits. All timesetting is achieved without rollover, and advancing the date or hours does not affect circuit accuracy. Price of the 5022 is $20 in lots of 100 pieces. Delivery is from stock.

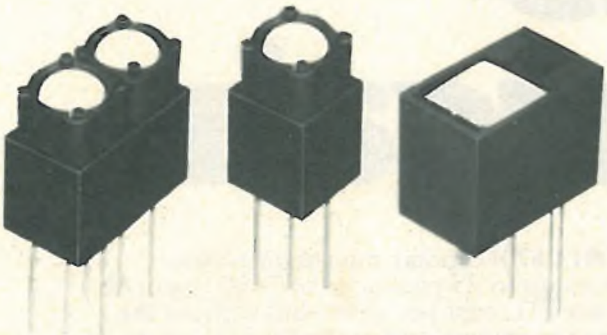
Nortec Electronics, 3697 Tahoe Way, Santa Clara, Calif. 95051 [417]

Voltage-compensated RAM has 15-ns access delay

Intended for add-on memory applications where only limited supply voltages are available, the SN10144 is a 256-bit random-access memory made of emitter-coupled logic and sporting a typical address access delay of 15 nanoseconds. The memory, which dissipates 500 milliwatts, is priced at $22.50 in hundreds. Small-quantity delivery is from stock; large orders will take eight weeks.

Texas Instruments Inc., P. O. Box 5012, MS-308, Dallas, Texas 75222 [418]

Light-Reflecting Electromagnetic Display Components



SERIES 32
0.3 inch (7.62 mm)
dual

SERIES 30
0.3 inch (7.62 mm)
single

SERIES 50
0.5 inch (12.7 mm)
single

STATUS INDICATORS

MEMORY — inherent remanent magnetism maintains the display state.

LOW POWER — one milli-watt second set/reset energy. Zero power to retain state. Drive voltages from 3-48 volts.

VISIBILITY — rotating fluorescent discs and flags provide excellent visibility over a wide range of ambient light conditions and wide viewing angles.

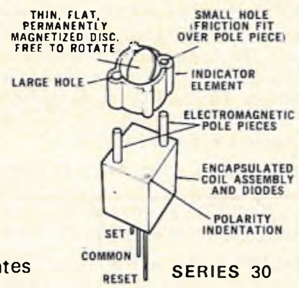
RELIABILITY — only one moving part rated for over 20 million operations. No lights or mechanical linkages to wear out. Virtually maintenance free.

FERRANTI-PACKARD STATUS INDICATORS

Ideal for
- Transient Recorders
- Industrial Process Displays
- Contact Status Indicators
- High Density Matrix Displays
- Portable Field Equipment.

Fluorescent discs and flags available in a range of colors.

The electromagnetic operation requires zero energy to maintain status.



SERIES 30

Unique memory retention eliminates the need for memory circuits and reduces power supply and circuitry costs. Indicators are fully operational over a wide range of environmental conditions.

Ferranti-Packard's status indicators are light weight (Series 30, 0.17 oz (5 grams)) and are ideal for mounting on printed circuit boards and high density matrices.

For full information and specifications, contact the Display Components Department,

FERRANTI-PACKARD LIMITED

ELECTRONICS DIVISION
121 Industry Street,
Toronto, Ontario, M6M 4M3, Canada.
Telephone: (416) 762-3661.
Telex: 06-22007. 7304

Circle 246 on reader service card

12 Bit A/D in a dip...

1 μ sec per bit

The MN5210 Series of 12 bit A/D converters guarantees total conversion time of 13μsec maximum...a clock rate of 1 MHz.

Micro Networks 12 bit A/D's are:
- Totally adjustment free and factory trimmed. The need for range and zero adjustments is totally eliminated, thereby effecting savings in space, component count, assembly, and test labor.
- Hermetically sealed 24-pin dip package – guarantees high reliability and space savings.
- Low power (700 mw) – reduces system power drain.
- Guaranteed ±½ LSB linearity over the full temperature range – assuring no missing codes.
- Available to the full MIL temperature operation of −55 to +125C.
- Optionally available processed to MIL-Std-883, Class B.

Prices: MN5210 (1-24)...$275
MN5210H (1-24)...$425

Available from stock. Technical data available on request. Write or call ... today. Tel: 617-852-5400

MICRO NETWORKS CORPORATION
324 Clark Street • Worcester, Mass. 01606

Circle 185 on reader service card

The $125 bargain.

It's MMI's 6701 bipolar microcontroller. Replaces up to 25 packages of 7400 logic. At standard TTL cost per gate—but without the interface problems and costly PC real estate required by smaller devices. Whether they want it to emulate a CPU or replace a lot of MSI TTL, your designers can design **with** our 6701, not **around** it. At $125 each in small quantities, it's a real bargain. Now available from stock at:

ALMAC/STROUM: Oregon, Portland (503) 292-3534; Washington, Seattle (206) 763-2300.

ARROW: Connecticut, Hamden (203) 248-3801; Maryland, Baltimore Area (202) 737-1700; Massachusetts, Boston Area (617) 273-0100; Minnesota, Minneapolis Area (612) 888-5522; New Jersey, Saddlebrook (201) 797-5800; New York, New York City Area (516) 694-6800; Ohio, Cleveland (216) 464-2000, Dayton (513) 253-9176; Pennsylvania, Philadelphia Area (609) 235-1900.

COMPONENT SPECIALTIES: Texas, Dallas (214) 357-4576, Houston (713) 771-7237.

FUTURE: Canada, Montreal (514) 735-5775, Ottawa (613) 232-7757, Toronto (416) 677-7820, Vancouver (604) 261-1335.

HALL-MARK: Alabama, Huntsville (205) 539-0691; Florida, Orlando (305) 855-4020; Illinois, Chicago (312) 437-8800; Kansas, Kansas City Area (913) 888-4747; Minnesota, Minneapolis (612) 884-9056; Missouri, Kansas City Area (913) 888-4747, St. Louis (314) 521-3800; North Carolina, Raleigh (919) 832-4465; Oklahoma, Tulsa (918) 835-8458; Texas, Dallas Area (214) 231-6111, Houston (713) 781-6100; Wisconsin, Milwaukee (414) 476-1270.

INTERMARK: California, San Francisco Bay Area (408) 738-1111, Los Angeles Area (213) 436-5275, San Diego (714) 279-5200; Colorado, Denver (303) 936-8284; Washington, Seattle (206) 767-3160.

KIERULFF: Arizona, Phoenix (602) 273-7331; California, San Francisco Bay Area (415) 968-6292, Los Angeles Area (213) 685-5511, San Diego (714) 278-2112; Colorado, Denver (303) 343-7090; District of Columbia (301) 948-0250; Maryland, Baltimore Area (301) 948-0250; Massachusetts, Boston Area (617) 935-5134; New Jersey, Rutherford (201) 935-2120.

PIONEER: Indiana, Indianapolis (317) 849-7300; Michigan, Livonia (313) 525-1800; Ohio, Cleveland (216) 587-3600, Dayton (513) 236-9900; Pennsylvania, Pittsburgh (412) 782-2300.

SUMMIT: New York, Buffalo (716) 884-3450, Rochester (716) 334-8110.

TECHNICO: Maryland, Baltimore Area (301) 828-6416.

Instruments

Cable testers are portable

Rugged time-domain reflectometers weigh only 18 pounds, occupy 0.6 ft^3

In an effort to give field-service personnel a portable instrument that can make meaningful checks on power- and information-carrying cables, Tektronix has developed a pair of rugged time-domain reflec-

tometers, each weighing about 18 pounds and occupying about 0.6 cubic foot.

Unlike resistive and swept-frequency testers, which can identify cable faults but not locate them, a TDR test set can pinpoint problems to within a few feet or inches. And according to John Trudel, marketing manager for the 1500 Series TDR portable cable testers, the instruments can test just about any cable assembly as well as verify the proper operation of broadband components. It can test all types of avionics cables (radar, radio, iff, DME, audio, fuel-sensor, etc.); shipboard cabling; all types of phone cables; antennas and matching networks; equalizers; petroleum-industry cabling for well-logging and communications; and many types of power-distribution cables.

The series consists of two instruments—the 1502 and 1503. The 1502, says Trudel, gives the user the performance of a high-resolution lab instrument. It is calibrated directly in reflection coefficient and distance, and is therefore simple to operate. It uses 110-picosecond-step excitation signals which provide distance resolution to within 0.6 inch at distances up to 2,000 feet, depending on the rise time and degradation characteristics of the cable.

The limited bandwidth and losses common to long cables (particularly twisted pairs) require special high-energy controlled-bandwidth test signals, says Trudel, so the 1503 was developed for these applications. It provides 10-volt sinusoidal pulses and is calibrated in decibels for direct reading of return loss. The 1503 works out to 50,000 feet and resolves faults down to 3 feet. Provision is made for selecting impedance levels of 50, 75, 93, and 125 ohms by the press of a button.

Whereas earlier TDR testers have been bulky, fragile, sensitive to environmental changes, and difficult to operate out in the open, the new machines are not only compact and portable, but rugged as well. Designed to military standard MIL-T-28800, type II, class 2, style A, the 1502/1503 is resistant to water, salt spray, snow, sand, dust, heat and cold, bumps, and vibration.

Both versions are equipped for recording "signatures" of equipment characteristics by means of an external X-Y recorder. Signatures can be checked on a routine basis, says Trudel, allowing problems to be identified and corrected before catastrophic failures can occur. An optional plug-in chart recorder is available.

The 1502, to be available in May, and the 1503, in June, are priced at $2,750 each. The optional plug-in recorder sells for $475.

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 [351]

Small 4½-digit meter is accurate within 0.01%

Since "tradeoff" is the name of the engineering game, it is reasonable to expect that a 4½-digit panel meter

that fits into a package 3 by 1.75 by 2.25 inch must be either expensive or rather inaccurate, or possibly both. This conclusion is not necessarily true, however. The model DM-4000 from Datel Systems Inc., which sells for $219 in single quantities, has a maximum error of ±(0.01% of reading + 1 count) at 25°C, and the temperature coefficient doesn't exceed 15 ppm/°C from 0 to 50°C.

Despite its small size—it mounts in a 1.75-by-3-in. front-panel cutout—the meter uses seven-segment light-emitting-diode readouts with characters that are 0.43 in. high. The 5-volt meter has an input resistance in excess of 100 megohms and an input range of ±1.9999 volts.

A stable crystal oscillator, adjusted to a multiple of either 50 or 60 hertz, gives 60 decibels of normal-mode rejection. The unit's autozero correction eliminates residual offset errors, and its internal reference of 6.4 V is brought out to a three-wire ratiometric output for temperature-coefficient tracking. As an option, Datel offers full parallel binary-coded-decimal outputs and automatic polarity and overflow display. Decimal points may be individually selected by means of the rear 18-pin dual printed-circuit-board connector. Full TTL-compatible BCD outputs, controls, and flags are also included.

Analog specifications include 120-dB common-mode rejection over a ±300-V common-mode range. The input settling time for rejection of 60-Hz hum is 50 milliseconds; the

New products

60-ms integration for 50-Hz noise is optional. The DM-4000 has an internal two-samples-per-second start clock, but an external clock of 0–5 hertz may be used.

A sister model, the DM-4300 is available with a 4¾-digit 0.3-in. LED display and ±3.999-V input.

The DM-4000 is priced at $219 each in quantities of one to nine; adding optional BCD boosts the price to $239 in unit quantities. Delivery is from stock.

Datel Systems Inc., 1020 Turnpike Rd., Canton, Mass. 02021 [352]

Voltage calibrator is accurate within 0.003%

A dc voltage calibrator with a range of 100 nanovolts to 311 V has a maximum error, calculated by the limit-of-errors method, of 0.003% of setting. The seven-digit instrument has four ranges with full-scale voltages of 300 millivolts, 3 V, 30 V, and 300 V. Broadband noise and ripple on the model 330D do not exceed 50 microvolts rms on the 300-V range

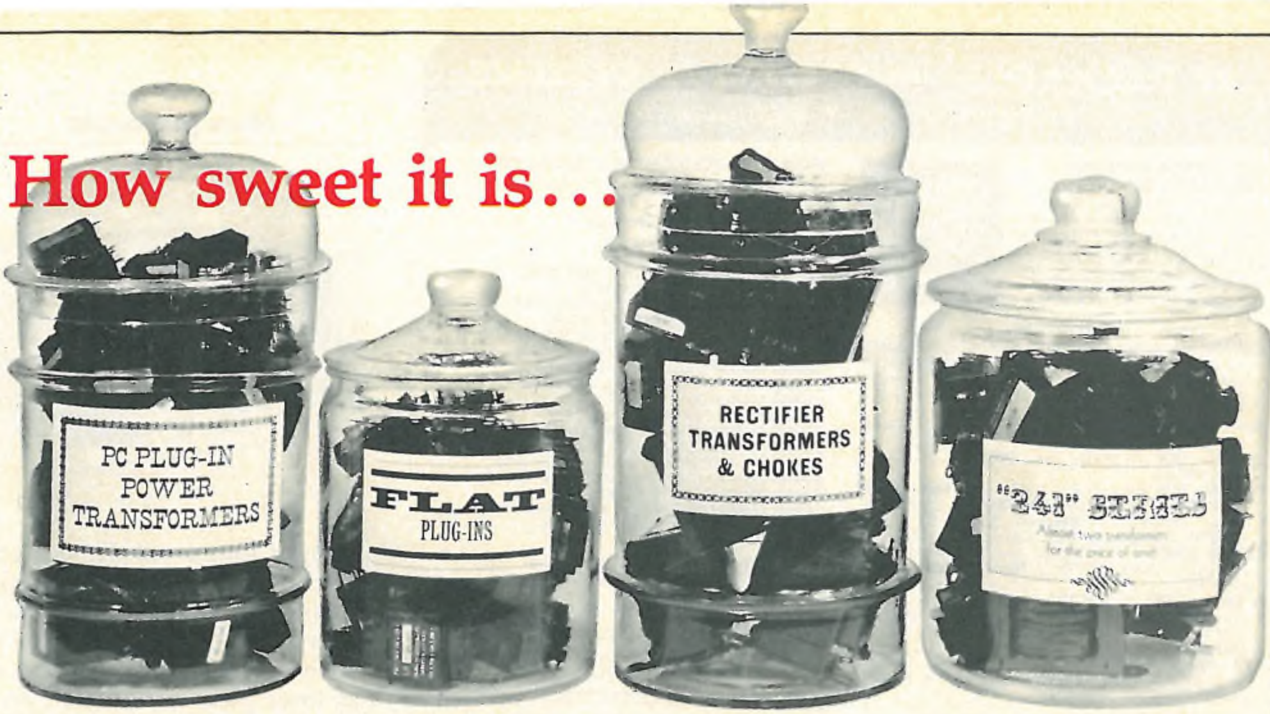
or 5 μV on the 300-mV range. There are no random spikes. When used as a voltage source, the 330D can deliver up to 100 milliamperes at 100 V and up to 25 mA above 100 V. Its output impedance is less than 20 milliohms. The unit's no-load to full-load regulation is within 0.0015%, and short-term stability is better than 0.001%.

Electronic Development Corp., 11 Hamlin St., Boston, Mass. 02127 [353]

1.5-kVA polyphase power source spans 47 to 500 Hz

Suitable for both laboratory testing and OEM applications, a three-phase

How sweet it is...



To find over 1000 ratings on the shelf at Old Fashioned prices!

First we'd like to put a "Plug-In" for our Printed Circuit Power Transformers since they are the *most complete and diversified selection available.* There are 5 basic sizes, each available with 115V or 115/230V 50/60 Hz primaries and secondary voltages from 5V to 120V. Our smallest is rated 1 VA and is 0.83 inches high. This allows *1 inch board spacing.* The largest is rated 24 VA (e.g., 24V @ 1A) which is virtually impossible to find as a standard item (except at Signal) and, it is only 1⅜ high.

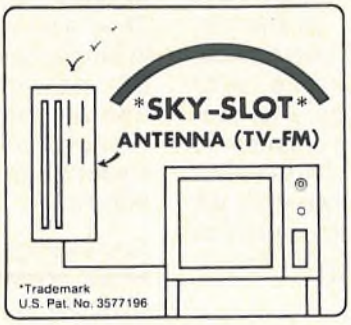
A special "plug" is warranted for our "LP" series of Flat Plug-Ins which is designed for 6VA with a height of *only 0.85 inches.* Special features are humbucking construction, non-concentric winding, dual 115/230V primaries and outputs from 5 to 230V. This is a Signal exclusive!

You will also find on Signal's shelves the most extensive line of Rectifier Power Transformers and Chokes (5 to 300V, 0.1 to 200 A). They are ideal for use in single or dual output DC power supplies. The real heavy stuff is on the floor nearby with ratings such as 12V at 1000 Amps and 3 phase transformers with DC output ratings like 24V at 200 Amps.

Something really new is our "2-for-1" series of small power transformers with ratings from 2.4 to 60 VA. A fresh design approach has cut weight, size and cost almost in half with improved performance. Special features include non-concentric winding, solder or quick-connect terminals, and 2500V hipot.

signal transformer co., inc.
1 Junius Street, Brooklyn, N.Y. 11212
Tel: (212) 498-5111 • Telex 12-5709

and Signal has it in Stock!



ac power source can put out up to 1.5 kilovolt-amperes over the adjustable frequency range from 47 to 500 Hz. In addition to its continuously variable frequency-control, the unit has three push buttons for 50, 60, and 400 Hz. Each output phase can be adjusted in amplitude from 0 to 125 V rms. The 55-pound model 315, which is claimed to be nearly a fifth the weight of comparable power sources, is priced at $3,995 in unit quantities. Standard units are available from stock. Specials can take up to four weeks for delivery.

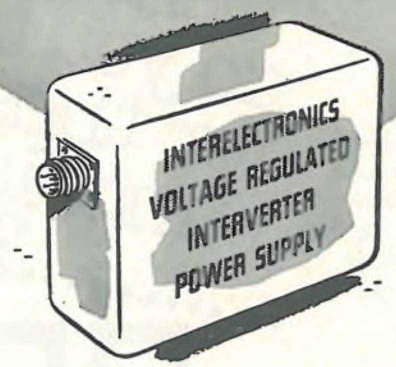
Pacific Electronics, 2643 N. San Gabriel Blvd., Rosemead, Calif. 91770 [354]

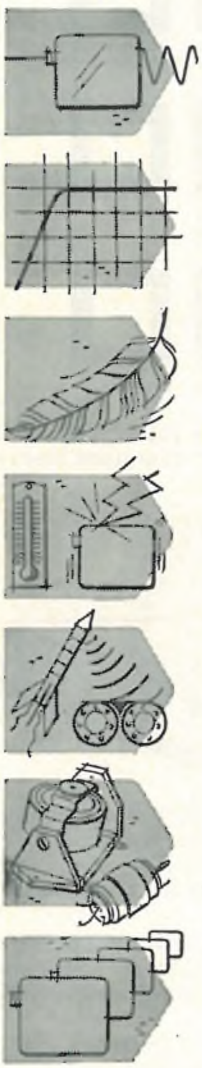
300-MHz spectrum analyzer has 72-dB dynamic range

Sporting a 72-decibel dynamic range and covering the frequency band from 1 to 300 megahertz, the model 9040 spectrum analyzer is made in two versions—as a plug-in

module for 9000-series Kay-Scopes, and as a self-contained unit with vertical and horizontal outputs that allow it to use any oscilloscope as a display. The analyzer's display flatness is within 1.0 dB across the full frequency range. Spurious responses

PROVEN RELIABILITY—
SOLID-STATE POWER INVERTERS,
**over 260,000 logged operational hours—
voltage-regulated, frequency-controlled,
for missile, telemeter, ground support,
135°C all-silicon units available now—**





Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. High conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry.)

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards.)

Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call 914 Elmwood 8-8000.

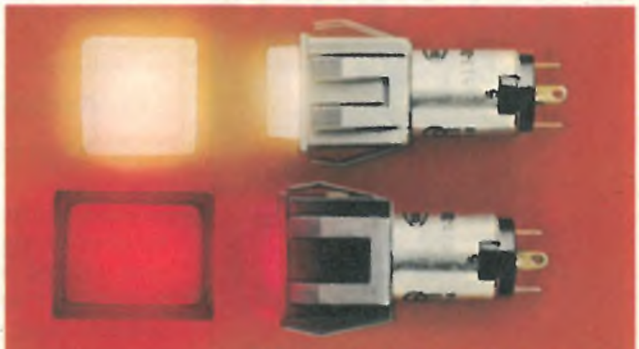
INTERELECTRONICS CORP.

700 U. S. Route 303 Congers, New York 10920

Circle 248 on reader service card

Dialight sees a need:

(**Need:** The widest choice for your every application.)



513 SERIES With bezel for snap-in panel mounting. Alternate, momentary and snap-action contacts with ratings to 5 amps. N.O., N.C. and two circuit (one N.O., one N.C.). Low level switches also available. Round, square and rectangular bezels in four colors; caps from ½" to 1½" in more than 12 colors. Illuminated caps with or without legends. **UL listed.**

PUSH BUTTON CAPS Round, square and rectangular shapes in wide variety of sizes and colors. With hot stamped, engraved or film legends.

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.

Circle 191 on reader service card

and intermodulation products are more than 72 dB down.

Kay Elemetrics Corp., 12 Maple Ave., Pine Brook, N. J. 07058 [356]

Liquid-crystal DPMs offer 1 μV/digit sensitivity

Tekelec's series TA 300 liquid-crystal-display digital panel meters are now offered with maximum sensitivities of 1 microvolt per least significant digit, making them suitable for use with low-level transducers

that typically put out only 20 millivolts full scale. With the 1 μV/digit option, a 4½-digit meter sells for $152 in 100-piece lots. The high-sensitivity option results in 10 μV/digit sensitivity when it is applied to the company's 3½-digit meters.

Tekelec Inc., 2623 Saddle Ave., Oxnard, Calif. 93030 [355]

Five-speed chart recorder is priced at $335

A line of low-cost chart recorders has a five-speed chart drive and full-scale sensitivity ranges of 10 millivolts and 100 mV with a continuously adjustable vernier between ranges. The recorders are designed around the features most frequently requested by users, the company says. The single-channel 5-inch model 160 sells for $335, while the 10-inch single-channel model 260 and dual-channel model 290 are priced at $395 and $595, respectively. Delivery is from stock.

Linear Instruments Corp., 17282 Eastman Ave., Irvine, Calif. 92705 [358]

Whether you buy one's, two's... or multitudes–

North delivers power reliability!

MODEL	11000	12000	13000	14000	15000	16000	17000	18000
VDC	AMPERES							
5.0	3.9	5.2	11.3	13.0	20.0	32.5	49.0	82.0
12.0	2.8	4.2	9.0	10.5	15.0	23.0	36.0	58.0
15.0	2.4	3.7	7.5	9.5	14.0	20.5	27.0	47.0
18.0	2.1	3.3	6.0	9.0	13.0	18.0	26.0	40.0
24.0	1.5	2.8	4.7	7.0	11.0	15.0	21.0	33.0
28.0	1.4	2.4	4.0	6.3	9.0	14.0	20.0	29.0
36.0	1.2	2.2	3.1	5.6	8.0	11.0	16.0	23.0
48.0	.95	1.8	2.6	4.2	5.0	6.0	10.0	18.0

MODEL	19000
VDC	AMPS
0-7.5	2.10
0-16	1.25
0-25	0.85
0-33	0.68

DUAL OUTPUT SUPPLIES	
MODEL	N03052
VDC	AMPS
±15 12	400MA
MODEL	N06052
VDC	AMPS
±15 12	1.0A

Listed here are the more popular models–many other voltages are available.

Many O.E.M's agree that it just doesn't make sense to risk the reputation of a major piece of equipment over a minor component–especially, when the cost difference is so little.

If you're one of them, we'd like to quote your next power supply order. Whether you need one unit–or one hundred, North has the product selection and the production capacity to deliver more standard power reliability for your dollar.

To back it up, we offer the industry's finest technical specialists and over 40 years experience as the leader in custom power supplies.

Send for a catalog today, or call 419/468-8874.

NORTH NEC
ELECTRIC COMPANY

North Electric Company / Galion, Ohio 44833 / A United Telecom Co

SP-16

Circle 193 on reader service card

The Gould 6000 Data Acquisition System: 128 fully floating and integrating inputs, scans to 200 points/sec.

The portable and rugged Gould 6000 analog to digital data logger-reader is the best way to monitor and precisely record low frequency data. It accepts both analog and digital input signals, converts the data to digital form, displays the data for real-time monitoring and stores up to 500,000 readings on a 3M ¼″ computer grade mag-tape. It offers high noise rejection, high input impedance, programmable gain and much more.

Write Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Kouterveldstraat Z/N, B-1920 Diegem, Belgium.

GOULD

Circle 266 on reader service card

FLAT-OUT VALUE ON FLAT BED RECORDERS

MFE's 2100 Series of dedicated and lab potentiometric strip chart recorders offer these advantages.

☐ 1 or 2 pen models ☐ Feed Z fold or roll paper without adjustment ☐ Tear bar adjacent to pen tips for immediate data access ☐ Up to 10 chart speeds independent of line frequency ☐ Optional TTL proportional drive ☐ Rugged die cast construction ☐ Electronic overrange protection ☐ 3200' of trace from snap-in fibre tip pens ☐ Optional event markers ☐ .25% accuracy ☐ .5 sec response ☐ Prices from $595.00 with OEM discounts

Call or write Ron Gosk for complete details:

MFE
MFE CORPORATION

Keewaydin Drive
Salem, N.H. 03079
Tel. 603-893-1921
TWX 710-366-1887
TELEX 94-7477

GSA

Circle 267 on reader service card

New products/materials

Sapphire and ruby substrates for microwave integrated circuits, silicon-on-sapphire circuits, and other hybrid applications are available in squares up to 6 by 6 inches, and in rectangular, round, or domed configurations. Finishes as fine as 250 angstroms can be supplied when required. The material is available in all popular crystal orientations: 60°, 30°, 90°, and 0°, or 1102, 1120, and 0001.

Marketing Department, Bird Precision Jewels, One Spruce St., Waltham, Mass. [476]

A silver-cleaning solution designed to remove tarnish and oxidation from silver and silver-plated parts is nontoxic and nonflammable. Called TC-100 Silver-Kleen, the product leaves no residue and hence has no effect on subsequent operations such as soldering.

Techform Laboratories, 215 West 131 St., Los Angeles, Calif. 90061 [477]

A multilayer dielectric material, which can be used with thick-film resistors without affecting their resistivity or temperature coefficients, promises greater packaging density for hybrid circuits. The new composition, number 4901, fires at 930° to 1,000°C. Resistors printed on it show virtually no change in their properties compared with resistors printed on bare alumina substrates.

Electro-Science Laboratories Inc., 1601 Sherman Ave., Pennsauken, N. J. 08110 [478]

An ultraviolet window for use in erasable PROMs (programable read-only memories) can be hermetically sealed to metal window frames. Made of a specially developed glass which has high transmissivity in the ultraviolet region of the spectrum, the windows should help overcome the reliability problems of early E-PROMS which did not have hermetically sealed windows.

Isotronics Inc., New Bedford, Mass. [479]

A conductive adhesive for bonding conductive gaskets in place, Eccoshield VCA is recommended for use with Eccoshield SV gaskets which are widely used for connect-

New products/materials

ing waveguide flanges. The pressure-sensitive adhesive has a volume resistivity of less than 1 milliohm-centimeter. It allows the flange connection to be broken and remade many times with the same gasket without impairing the rf seal.

Emerson & Cuming Inc., Microwave Products Div., Canton, Mass. 02021 [480]

A flexible epoxy system designed to replace silicone rubber does not harden with age, extreme heat, or extreme cold. Called Epoxsilrub, the two-component materials system cures at room temperature, and is especially recommended for potting applications where shrinkage and curing stresses could crush delicate components. The resin sells for $2.32 per pound in 55-gallon drums, while the hardener is priced at $2.12/lb in similar quantities.

Isochem Resins Co., Cook St., Lincoln, R. I. 02865 [361]

Sealing and cushioning washers, produced by a special process of bonding rubber to metal, ensure uniform concentricity, material thickness, and over-all thickness. The washers' sealing material is EPDM (ethylene, propylene-diene-terpolymer) which the manufacturer says is superior to neoprene in stability and ozone resistance and in resistance to extreme weather conditions. The Barseal washers can be made with galvanized steel, aluminum, or 18-8 stainless steel as the metal member.

Barwood Manufacturing Corp., 18-32 Williams St., Everett, Mass. 02149 [362]

A thermally conductive epoxy adhesive system is intended for staking transistors, diodes, ICs and other heat-generating components to radiators and heat sinks. Tra-Bond 2151 is supplied in premeasured Bipax packages for convenience and mixing accuracy. The thixotropic material cures overnight at room temperature yielding a rigid plastic that is electrically insulating and thermally conducting. The cured product is very impact-resistant.

Tra-Con Inc., Resin Systems Division, 55 North St., Medford, Mass. 02155 [363]

 Circle 196 on reader service card

Circle 270 on reader service card

New books

Photometry and Radiometry for Engineers, Allen Stimson, Wiley-Interscience, 446 pp., $19.95.

Decimal Computation, Hermann Schmid, Wiley-Interscience, 266 pp., $16.95.

Guidebook of Electronic Circuits, John Markus, McGraw-Hill, 1,067 pp., $24.50.

Laser Interaction and Related Plasma Phenomena, Vol. 3A and 3B, ed. Helmut J. Schwarz and Heinrich Hora, Plenum, 932 pp., $32.50 each.

Applications of Linear Integrated Circuits, Eugene R. Hnatek, Wiley-Interscience, 518 pp., $26.95.

Automated Design of Control Systems, C.W. Merriam III, Gordon & Breach, 339 pp., $32.50.

Linear Integrated Networks: Fundamentals, George S. Moschytz, Van Nostrand Reinhold, 583 pp., $29.95.

Industrial Lasers and Their Applications, John E. Harry, McGraw-Hill, 189 pp., $15.00.

Semiconductor Devices: Testing and Evaluation, C.E. Jowett, Cahners Books, 134 pp., $18.50.

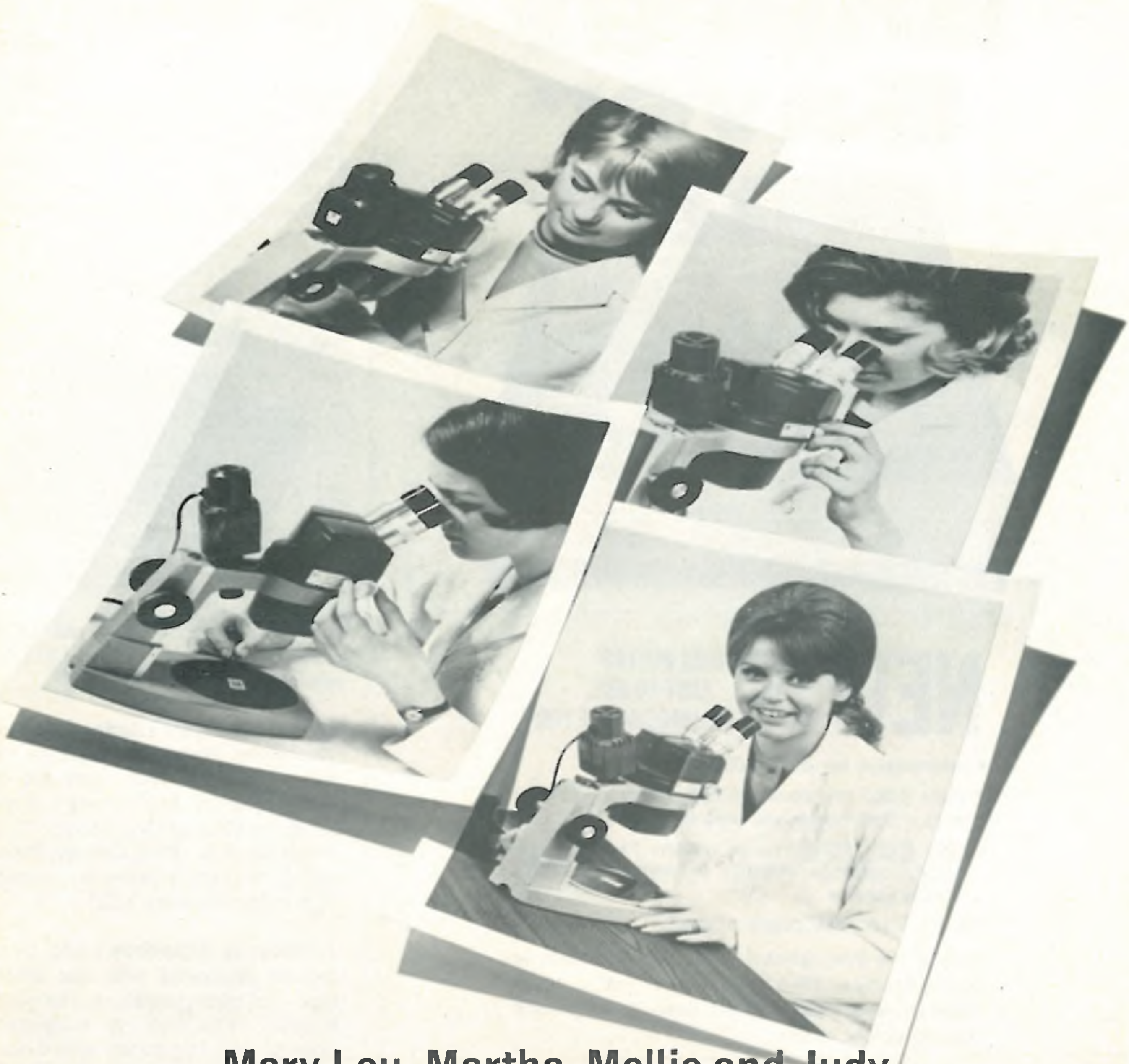
Radar Precision and Resolution, G.J.A. Bird, Halsted Press, 151 pp., $18.50.

Fundamentals of Television, 2nd ed., Walter H. Buchsbaum, Hayden, 280 pp., $9.95 cloth, $6.95 paper.

Introduction to Electronic Technology, Richard J. Romanek, Prentice-Hall, 355 pp., $14.50.

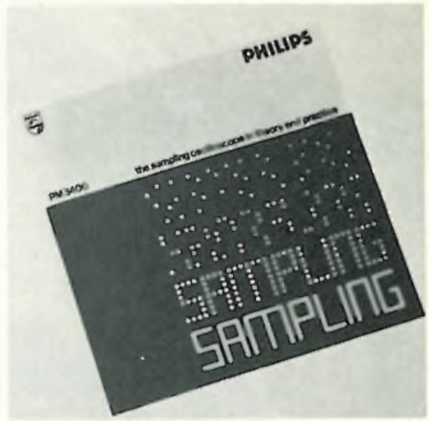
High Energy Lasers and Their Applications, ed. Stephen Jacobs, Murray Sargent III, and Marlan O. Scully, Addison-Wesley, 411 pp., $17.50.

Approximation Methods for Electronic Filter Design, Richard W. Daniels, McGraw-Hill, 388 pp., $19.50.



New literature

Sampling oscilloscopes. A 72-page book put out by Philips Test & Measuring Instruments Inc., 400 Crossways Park Dr., Woodbury, N.Y. 11797, explains and gives practical examples of how to derive



maximum benefit from use of a sampling oscilloscope. Circle 421 on reader service card.

Thick films. "The Fundamentals of Thick-Film Hybrid Technology," a 600-page loose-leaf textbook is being sold for $100 a copy. Published by State of the Art Inc., 1315 South Allen St., State College, Penn. 16801, the text is based on a series of five-day seminars. [422]

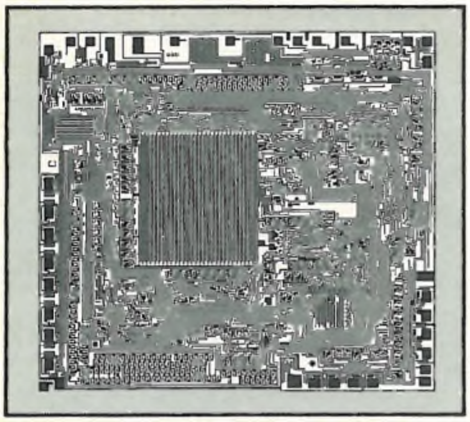
Terminating flat-ribbon cable. Generously illustrated with line drawings and photographs, a four-page booklet tells how to terminate bonded and laminated round-conductor flat-ribbon cable. The booklet can be obtained from Spectra-Strip Corp., 7100 Lampson Ave., Garden Grove, Calif. 92641 [423]

Measuring microscopes. A detailed four-page application bulletin entitled "The Microscope as a Shop Tool" describes several types of measuring microscopes and many of their applications. Available from Gaertner Scientific Corp., 1201 W. Wrightwood Ave., Chicago, Ill. 60614, the bulletin includes simple formulas for calculating the magnification of various microscopes. [424]

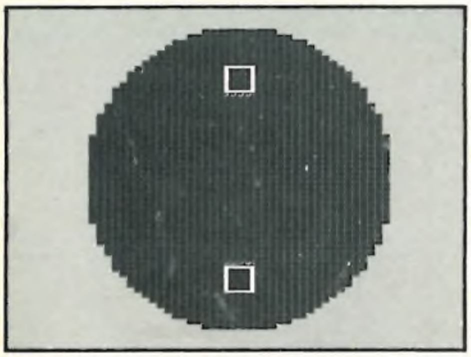
Marketing manuals. A 16-page cata-

NOW A COMBINATION PATTERN GENERATOR/ IMAGE REPEATER

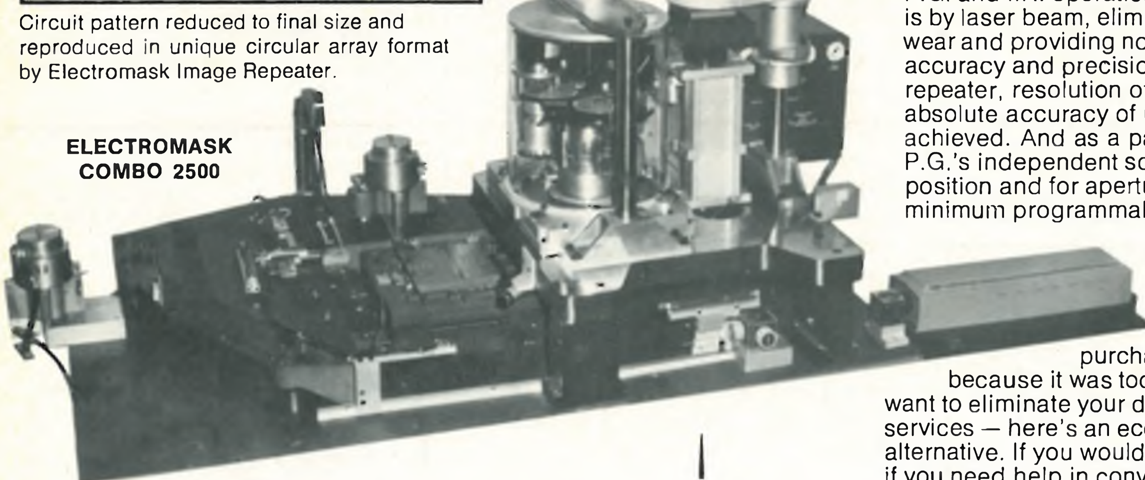
for IC maskmaking



Circuit pattern 10X final size generated by Electromask Pattern Generator.



Circuit pattern reduced to final size and reproduced in unique circular array format by Electromask Image Repeater.



Now, system and instrument manufacturers and laboratories can enjoy the same kind of IC maskmaking capability previously feasible only for large volume semiconductor manufacturers. Electromask has introduced a new combination pattern generator/image repeater which sells for almost $100,000 less than two independent units. No longer must you risk the exposure of your proprietary designs and be dependent upon outside services for your maskmaking. Now you can do it all in-house at low cost and with fast turn-around time. The new Electromask Combo 2500 makes it possible.

The 2500 gives you the complete capability of the independent Series 2000 Pattern Generator for making 10X reticles directly from digital data. Then in a matter of minutes, the 2500 switches over to duplicate the operation of the independent Electromask Series 1000 Image Repeater, reducing the 10X reticle image to final size and producing, by step-and-repeat process, a photomaster.

The new Combo 2500 incorporates the same Lasometric™ control and frictionless vacuum air bearings found on Electromask's field-proven independent P.G. and I.R. systems. For both P.G. and I.R. operations, stage positioning is by laser beam, eliminating mechanical wear and providing non-degradable accuracy and precision. As an image repeater, resolution of 0.1 micron and absolute accuracy of 0.385 micron are achieved. And as a pattern generator, the P.G.'s independent scale factor for X-Y position and for aperture size, along with its minimum programmable increment of 0.10 micron, dramatically increases circuit flexibility.

So if you've been avoiding the purchase of equipment because it was too expensive, and if you want to eliminate your dependency on outside services — here's an economically feasible alternative. If you would like to know more — or if you need help in convincing your boss — just give us a call.

™ Trademark of ELECTROMASK, INC.

TRE

ELECTROMASK, INC.

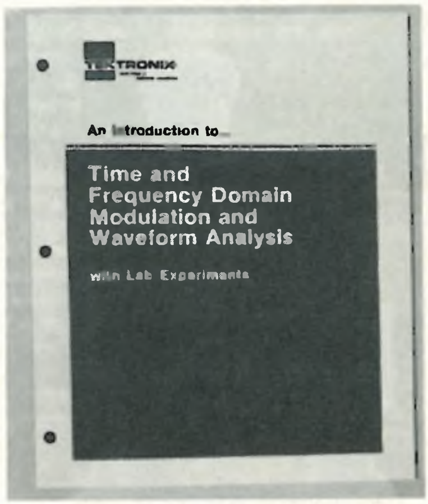
A subsidiary of TRE Corporation, 6109 De Soto Ave., Woodland Hills, Calif. 91364, Phone: (213) 884-5050, Telex 67-7143

Image Repeaters • Pattern Generators • Mask Savers • Environmental Chambers • Mask ID Printers • Precision Glass Cutters • Photomasking Services

New literature

log gives detailed descriptions of 10 marketing handbooks such as "A Handbook of Corporate Performance Criteria" and "A Statistical Handbook for Electronic Marketing. The catalog is put out by Mainly Marketing, Drawer M, Coram, N. Y. 11727 [425]

Spectral analysis. A 32-page workbook provides an introduction to the more widely used types of modulation and their time- and frequency-domain characteristics. The booklet, "An Introduction to Time and Frequency Domain Modulation and Waveform Analysis with Lab Experiments," can be obtained from



Tektronix Inc., c/o Art Andersen, P. O. Box 500A, Beaverton, Ore. 97077 [426]

Relay interchangeability. A relay cross-reference list, which covers industrial and general-purpose relays made by Potter & Brumfield, Magnecraft, Midtex, Sigma, Deltrol, Clare, Line, Guardian, Milwaukee, and Struthers-Dunn, has been released by Struthers-Dunn Inc., Lambs Rd., Pitman, N.J. 08071 [427]

Soldering tips. An explanation of how a soldering tip is constructed, how to re-tin one, and other pointers on the use and care of iron-plated soldering tips are included in a folder offered by Plato Products Inc., 4357 N. Rowland Ave., El

LEGAL NOTICE

U.S. POSTAL SERVICE
STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
(Act of August 12, 1970: Section 3685, Title 39, United States Code)

1. Title of Publication: Electronics
2. Date of filing: 9/6/74
3. Frequency of issue: Bi-weekly
4. Location of known office of publication: 1221 Avenue of the Americas, New York, New York 10020
5. Location of the headquarters or general business offices of the publishers: 1221 Avenue of the Americas, New York, New York 10020
6. Names and addresses of publisher, editor and managing editor: Daniel A. McMillan, III—1221 Avenue of the Americas, New York, New York 10020/Kemp Anderson/Sam Weber
7. The owner is McGraw-Hill, Inc. 1221 Avenue of the Americas, New York, New York 10020. Stockholders holding 1% or more of stock are: Donald C. McGraw; Donald C. McGraw, Jr.,; Harold W. McGraw, Jr.; John L. McGraw; William H. McGraw; June McGraw McBroom; Elizabeth McGraw Webster; all of 1221 Avenue of the Americas, New York, New York 10020; Way & Co. c/o The Bank of New York, P.O. Box 11203, New York, NY 10049; Perc & Co. c/o Northwestern National Bank of Minneapolis, 7th & Marquette, Minneapolis, MN 55480; Sabat Co. c/o Savings Banks Trust Co. 200 Park Avenue, New York NY 10017; Ronis & Co. c/o Bankers Trust Company, P.O. Box 704, Church St. Station, New York, NY 10008; Sior & Co. c/o Bankers Trust Company, P.O. Box 704, Church St. Station, New York, NY 10008; Stanford E. Taylor, Lloyd Harbor, Huntington, NY 11743; American National Insurance Company, P.O. Box 2664, Church St. Station, New York, NY 10008.
8. Known bondholders, mortgages, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None.
9. Permission requested.
10. Not applicable
11. Extent and nature of circulation:

	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies Of Single Issue Published Nearest To Filing Date
A. Total No. Copies Printed	93,872	95,989
B. Paid Circulation		
1. Sales through dealers and carriers, street vendors and counter sales ..	....	....
2. Mail subscriptions ...	88,631	89,937
Total Paid Circulation	88,631	89,937
D. Free distribution by mail, carrier or other means:		
1. Samples, complimentary, and other free copies	3,281	3,149
E. Total Distribution	91,912	93,086
F. Office use, left-over, unaccounted, spoiled after printing	1,960	2,903
G. Total	93,872	95,989

I certify that the statements made by me above are correct and complete.

McGRAW-HILL, INC.
Robert N. Landes

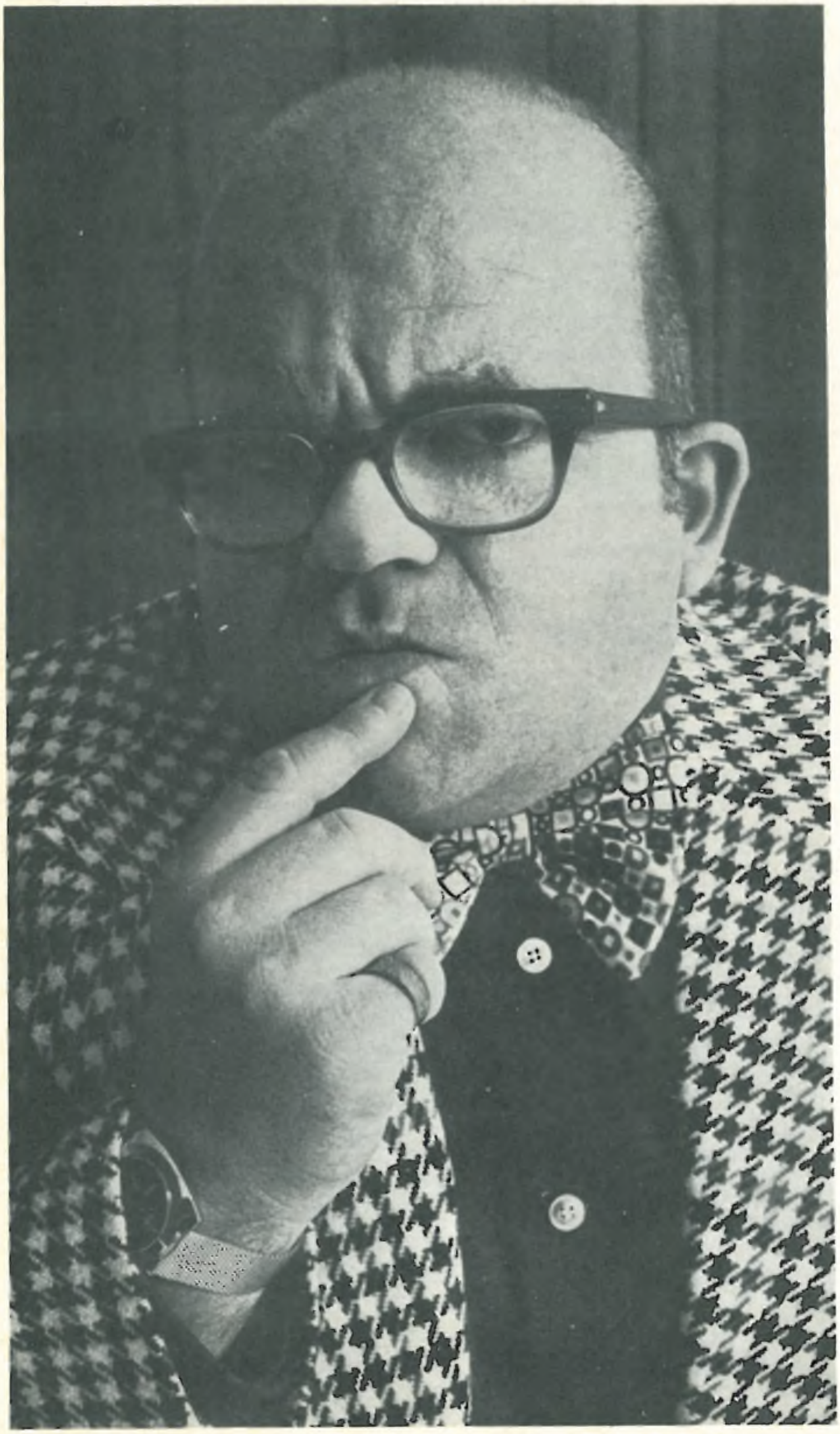
New literature

Monte, Calif. 91731 [428]

Etching thin films. Procedures for etching thin-film-coated substrates are outlined in a four-page application note published by Analog Devices Inc., Route 1 Industrial Park, P. O. Box 280, Norwood, Mass. 02062. The procedures apply to three-film (nichrome-nickel-gold) and two-film (nichrome-gold) systems. [429]

Interface bus. The Hewlett-Packard interface bus, the model for the proposed international interface standard now being considered by the International Electrotechnical Commission, is discussed in a recent issue of the Hewlett-Packard Journal. The entire January 1975 issue of the journal is devoted to the bus and to the solution of problems that may arise in connection with its use. Copies are available from Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [430]

Solenoids. A 72-page catalog gives information on the line of Guardian solenids and also includes a guide to solenoid selection, tips on increasing life expectancy, and an ordering checklist. The catalog is put out by Guardian Electric Manufacturing Co., 1550 West Carroll Ave., Chicago, Ill. 60607 [431]




UNITED STATES SAVINGS BONDS

Electronics advertisers

March 20, 1975

December 4, 1972
94 How Japan's EEs are challenging U.S. technology
102 Transferred-electron devices move into microwave systems
109 Eliminating op amp errors with automatic zero correction
Electronics
Internatio
INTEGRATION BRINGS A NEW GENERATION OF TRANSDUCERS

■ For more information on complete product line see advertisement in the latest Electronics Buyers' Guide
• Advertisers in Electronics International
‡ Advertisers in Electronics domestic edition

Advertising Sales Staff

Pierre J. Braudé New York [212] 997-3468
London 01-493-1451
Director of Marketing

Atlanta, Ga. 30309: Warren H. Gardner
100 Colony Square, 1175 Peachtree St., N.E.
[212] 997-3617

Boston, Mass. 02116: James R. Pierce
607 Boylston St. [617] 262-1160

Chicago, Ill. 60611:
645 North Michigan Avenue
Robert W. Bartlett (312) 751-3739
Paul L. Reiss (312) 751-3738

Cleveland, Ohio 44113: William J. Boyle
[716] 586-5040

Dallas, Texas 75201: Charles G. Hubbard
2001 Bryant Tower, Suite 1070
[214] 742-1747

Denver, Colo. 80202: Harry B. Doyle, Jr.
Tower Bldg., 1700 Broadway
[303] 266-3863

Detroit, Michigan 48202: Robert W. Bartlett
1400 Fisher Bldg.
[313] 873-7410

Houston, Texas 77002: Charles G. Hubbard
375 Dresser Tower, 601 Jefferson St. [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, 75 Paris 16, France
Tel: 720-73-01

Geneva: Alain Offergeld
1 rue du Temple, Geneva, Switzerland
Tel: 32-35-63

United Kingdom & Scandinavia: Keith Mantle
Tel: 01-493-1451, 34 Dover Street, London W1

Milan: Luigi Rancati
Robert Saidel (Middle East)
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
Dieter Rothenbach (East European Countries)
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

Stephen R. Weiss, Manager
[212] 997-2044

Thomas M. Egan,
Assistant Business Manager [212] 997-3140

Carol Gallagher
Production Manager International [212] 997-2045

Dorothy Carter, Production Manager Domestic
[212] 997-2908

Frances Vallone, Reader Service Manager
[212] 997-6057

Lisa Hoenig, Secretary
[212] 997-6481

Electronics Buyers' Guide

George F. Werner, Associate Publisher
[212] 997-3139

Regina Hera, Directory Manager
[212] 997-2544

NEY

PLAYS A LEADING PART IN MANY PRODUCTS WITH...

. . . LOW ENERGY ELECTRICAL PRECISION CONTACT COMPONENTS.

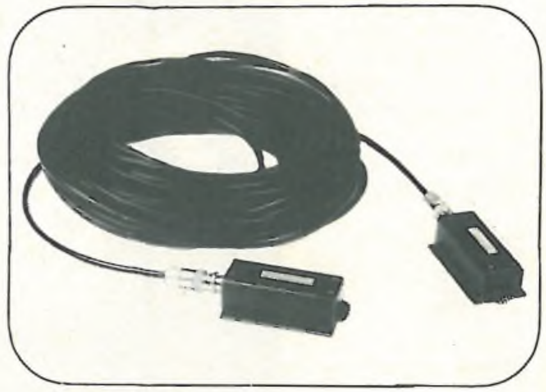
Like switch assemblies, welded and staked assemblies, wire forms, flat spring contacts, plastic molded brush and contact assemblies, rivet head contacts and complete assembled components. Our series of PALINEY® and NEYORO® alloys have become synonymous with quality in the field of precious metals. Our Design Engineers are always available to assist in the design of parts and/or complete assemblies to your specifications. For our catalog, write The J. M. Ney Co., Bloomfield, Conn. 06002

the precious world of NEY

Booth no. 1523 & 1525

Circle 212 on reader service card

OPTICAL TRANSMISSION OF INFORMATION



«TIS» OPTICAL FIBRE

For industrial applications. Maximum length: 30m; absorption: 0,70 dB/m, fitted with either with a TTL/DTL compatible transmit-receive unit operating.

«LD» OPTICAL FIBRE

Low-absorption fibre less than 30 dB/km for a diameter of 180/120 microns; plastic sheathing on BNC connector.

FORT

15, rue d'Argenteuil
75001 PARIS FRANCE
phone : (1) 260.62.75
(1) 260.64.53

SOLE AGENCIES IN:

FOURTEEN COUNTRIES

Circle 275 on reader service card

NO-BOUNCE, POSITION-FREE MERCURY FILM REED RELAY.

This fantastic Form A relay switches 1 A, 24 VDC; 0.2 A, 110 VAC; or 10 μA, 100 mVDC. Mount it up-hill, down-hill, upside down, floating — any way you want it. It will switch your load without bounce or chatter. And its initial 150 milliohm contact resistance will remain virtually constant over a life that exceeds 10^9 mechanical operations. DL is small: .787" L x .433" W x .413" H, hermetically sealed, and magnetically shielded. So pack them on your P/C board (terminals are 16-pin DIP format). DL's rugged, too. Welded internal components resist high G shock and vibration forces. There's no other relay like it in the world. Send for complete specs.

Relays for advanced technology.

Arrow-M Corp. 250 Sheffield St. Mountainside, N.J. 07092 U.S.A.
Telephone 201 232 42[illegible]

Circle 215 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 RANGE ACCURACY SIN 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	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

4 QUADRANT ANALOG MULTIPLIER

DC x DC = DC OUTPUT

Product Accuracy is ± ½% of all theoretical product output readings over Full Temperature Range of –55°C to +125°C.

Maximum Output Error for Either
X = 0, Y = 10V
Y = 0, X = 10V
X = 0, Y = 0
would be ± 2 MV over Entire Temperature Range.

Specifications: Model MCM 1478-1
Transfer Equation: E = XY/10
X & Y Input Signal Ranges: 0 to ± 10V peak
Maximum Static and Dynamic Product Error: ½% of point or 2MV, whichever is greater, over entire temperature range
Input Impedance: X = 10K, Y = 10K
Full Scale Output: ± 10V peak
Minimum Load for Full Scale Output: 2000 ohms
Output Impedance: Less than 10 ohms
Bandwidth: 1000Hz
DC Power: ± 15V, unless otherwise required, at 20ma
Size: 1.3" x 1.8" x 0.5"
Output is short circuit protected

SINE-COSINE FUNCTION GENERATOR

SFG 1491 SERIES

FEATURES:

- Provides a two quadrant sine function with better than 1% accuracy
- Excellent temperature stability
- Scaled for ± 10V input and output
- Operates from conventional ± 15V power supplies
- No external offset adjustments required
- Terminal provided to allow four quadrant operation
- Hermetically sealed package.

Specifications: (at +25°C unless otherwise noted.)
DC accuracy: ± 30 min. of arc or 0.5% whichever is greater
DC accuracy over the complete temperature range: ± 30 min. of arc or 0.75% whichever is greater
Input impedance 100K
Input voltage range (pin 1): ± 10V DC
Rated output–voltage: ± 10V DC
Rated output–current: ± 5ma
Output impedance: 1Ω
Frequency response 400 Hz
Power requirements: ± 15V @ 40ma max.
Accuracy drift vs. power supply: ± 10MV/V
Size: 2.200 x 2.100 x 0.500

There is No Substitute for Reliability

GM INC.

GENERAL MAGNETICS · INC
135 Bloomfield Ave., Bloomfield, New Jersey 07003 - Tel. (201) 743-2700

Circle 901 on reader service card