APRIL 13, 1978

OPTOELECTRONICS, PACKAGING PACE COMPONENTS CONFERENCE/127

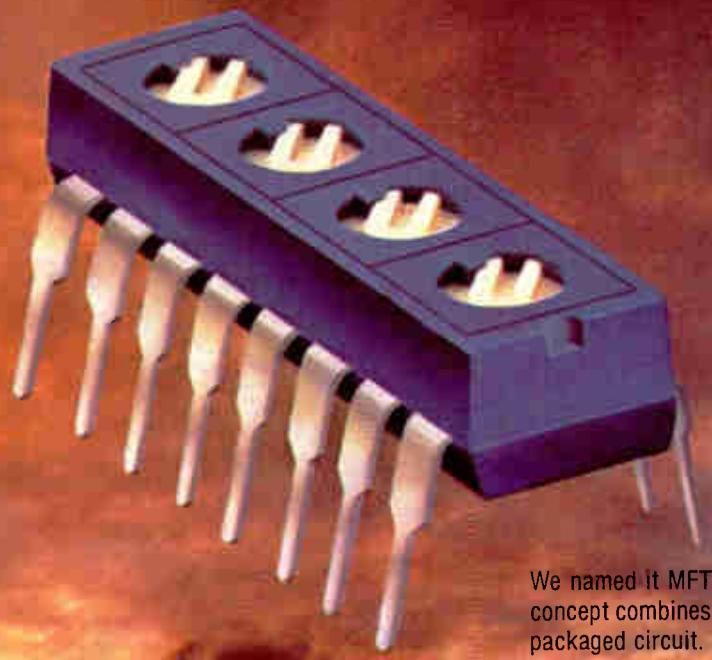
Special report: Have CCD and bubble memories arrived?/106

Big ROMs bring high-level languages to microcomputers/119

FOUR DOLLARS A McGRAW-HILL PUBLICATION

Electronics International

A New Dawn In Trimmer/Resistor Technology...



We've put it all together in one space/cost saving package.

We named it MFT™ . . . our multi function trimmer. This revolutionary concept combines cermet trimmers and fixed resistors into a single pre-packaged circuit. A consolidation of functions has been designed into a new product line of cost-effective DIP components.

All trimmer applications require a fixed resistor to either divide a voltage or limit a current. The nine MFT trimmer models will functionally satisfy almost any trimmer application.

SAVES SPACE — MFT trimmers drastically reduce PC board space required for the peripheral components of a linear IC.

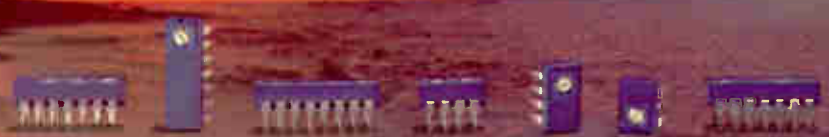
SAVES TIME — MFT trimmers reduce the time and cost of designing circuits. It also saves production time as MFT trimmers are compatible with DIP automatic insertion equipment. And, there are less components to purchase and handle.

SAVES MONEY — MFT trimmers lower total "on-board" component costs. In addition, MFT trimmer DIPS are compatible with automatic test equipment, reducing inspection costs.

INCREASES PERFORMANCE — Temperature tracking is better than discrete components . . . 50 ppm/°C. Trimmers/Resistors are manufactured simultaneously on a common substrate. MFT trimmers are more reliable as a result of pre-tested circuitry and reduction of connections.

The sealed multi function trimmers are available in nine configurations of the multiple trimmer and network combinations. Call or write today for your MFT trimmer catalog.

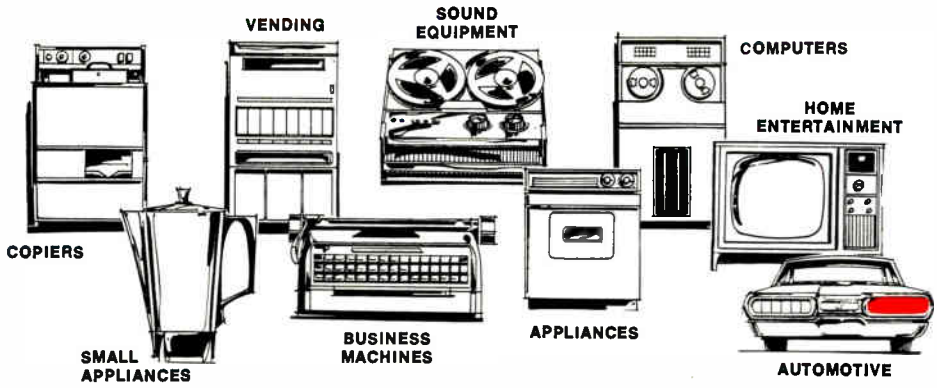
TRIMPOT PRODUCTS DIVISION, BOURNS, INC., 1200 Columbia Avenue, Riverside, CA 92507. Phone: 714 781-5204. TWX: 910 332-1252.



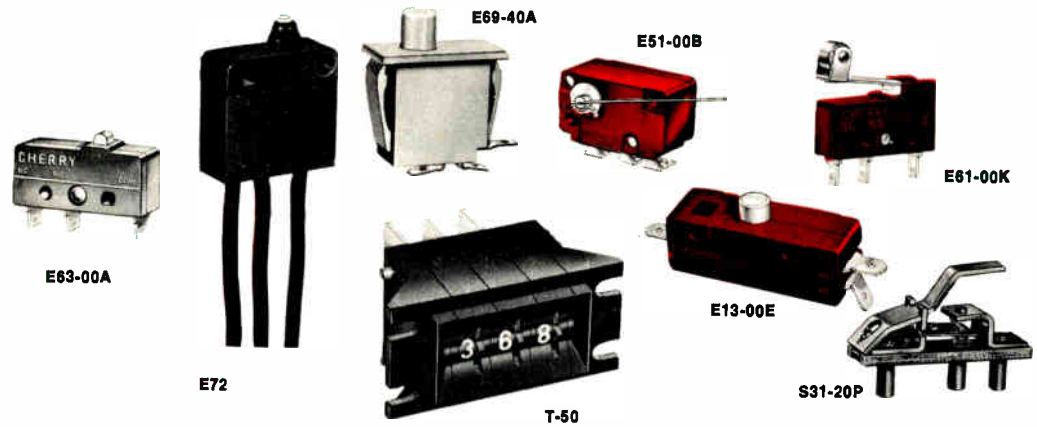
BOURNS®

For Immediate Application — Circle 120 For Future Application — Circle 220

If you make any of these products



...you can make it better with a CHERRY switch!



Specify a Cherry switch for your product, and that will be one component you won't have to worry about. Cherry snap-action switches with unique coil spring mechanism are world renowned for quality and long life. Cherry gold crosspoint contact switches are the most dependable for low energy circuits. Cherry thumbwheels are the most technically advanced in the industry. Give your product the advantage of Cherry quality . . . phone, write or TWX for a copy of our catalog detailing over 500 switches!

CLIP & MAIL FOR FREE SAMPLE SWITCH

We'll send your choice of the switches pictured . . . plus our Distributor Catalog and a complete list of 42 stocking distributors. Better yet, call or TWX today!

NAME_____

TITLE_____

COMPANY_____

CITY_____

STATE/ZIP_____

CHERRY ELECTRICAL PRODUCTS CORP.
3608 Sunset Avenue, Waukegan, Illinois 60085
Phone: 312/689-7700 — TWX: 912/235-1572

CHERRY®

Cherry Worldwide: Cherry Electrical Products Ltd., Sandridge, England • Cherry Mikroschalter GmbH, Bayreuth and Auerbach, Germany • Hirose Cherry Precision Co. Ltd., Kawasaki, Japan • (LICENSEE) G. W. Engineering Pty., Ltd., Caringbah, NSW, Australia

Electronics
The International Magazine of Electronics Technology
Vol. 51, No. 8 • April 13, 1978

Highlights

Cover: I²L gives 10-bit converter on chip, 99
Integrated injection logic makes possible a fully self-contained 10-bit analog-to-digital converter chip. Besides providing high performance, this bipolar technology gives circuit density to the new device.

Cover is by Art Director Fred Sklenar.

Ready, set, go codec! 77
As telephone systems turn to digital, they need many, many coder-decoder devices to convert voice to digital bit streams and back again. All around the world semiconductor manufacturers are gearing up to make codecs and the other integrated circuits that phone companies will need.

Bubbles, CCDs challenge big memories, 107
Charge-coupled-device and bubble memories are ready to take on the traditional magnetic-storage media for large storage systems. This special report assesses the two solid-state technologies in terms of performance, cost, and suitability.

Compatible components meeting coming up, 127
Increasing compatibility between components and integrated circuits will be reflected at the 28th Electronic Components Conference. Optical components, packaging techniques, and capacitor and resistor technologies will exemplify the trend.

And in the next issue . . .
Spectrum analyzer tells all, at a lower cost . . . data-acquisition system fits on one chip . . . what's happening in printed-circuit technology: a special report.

Electronics

Publisher's letter

Many engineers who are top designers have often been caught in the dilemma of being promoted out of what they like doing—engineering—up into management positions that they enjoy much less.

That almost happened to Paul Brokaw, director of product planning for Analog Devices Inc., who is the author of the article on I^2L technology behind a new 10-bit a-d converter (p. 99). Brokaw's product development efforts began growing over the last few years, and with them his staff, so that before long he was doing more and more administrative tasks (no fun) and less and less designing (first love).

But he managed to change the situation, in effect setting up a dual-ladder promotion system in order to keep a hand in the design effort. "I'm kind of the chief busybody these days," Brokaw relates. "I can oversee projects and work on them too. It's a good job—although I may be far from the bench, I'm still close to the blackboard."

During the shake-down cruise of the USS Dwight D. Eisenhower (CVN-69), the Navy's newest nuclear aircraft carrier, Washington bureau manager Ray Connolly had a chance to go aboard and do a report on the $2-billion-plus ship's electronics complement (p. 82).

He came away impressed by the hard-working dedication of the fleet, as the Navy calls its men on sea duty. "They are just beginning to use hardware that most industry engineers would consider old in terms of state of the art and forgot about some years ago. They have problems, particularly in the seagoing environment, with maintenance and with the level of skill of technicians that most engineers probably haven't thought about," Ray comments.

The two-day visit came just prior to Operation Shamrock—the code name for President Carter's St. Patrick's Day visit aboard the carrier. One of the snafus that had to be corrected before the visit was a faulty elevator, which takes crew members up the 10 levels from the flight deck to the bridge. After walking up the ladder (salty talk for stairs) to interview the ship's skipper, Capt. William Ramsey, Ray could appreciate their concern.

April 13, 1978 Volume 51, Number 8 97,568 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 ID #172400.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype 12-7960 TWX 710-581-4879. Cable address: M C G R A W H I L L N E W Y O R K.

Subscriptions limited to professional persons with active responsibility in electronics technology. No subscriptions accepted without complete identification of subscriber name, title or job function, company or organization, and product manufactured or services performed. Based on information supplied, the publisher reserves the right to reject non-qualified requests. Subscription rates: in the United States and possessions $15 one year, $26 two years, $38 three years; company addressed and company libraries $20 one year, $36 two years, $50 three years; APO/FPO addressed $35 one year only; Canada and Mexico $17 one year, $29 two years, $43 three years; Europe $42 one year, $71 two years, $100 three years; Japan, Israel and Brazil $70 one year, $115 two years, $165 three years; Australia and New Zealand $95 one year, $170 two years, $240 three years, including air freight; all other countries $45 one year, $80 two years, $112 three years. Limited quota of subscriptions available at higher-than-basic rate for persons allied to field served. Check with publisher for these rates. Single copies: $4.00. Please allow four to eight weeks for shipment.

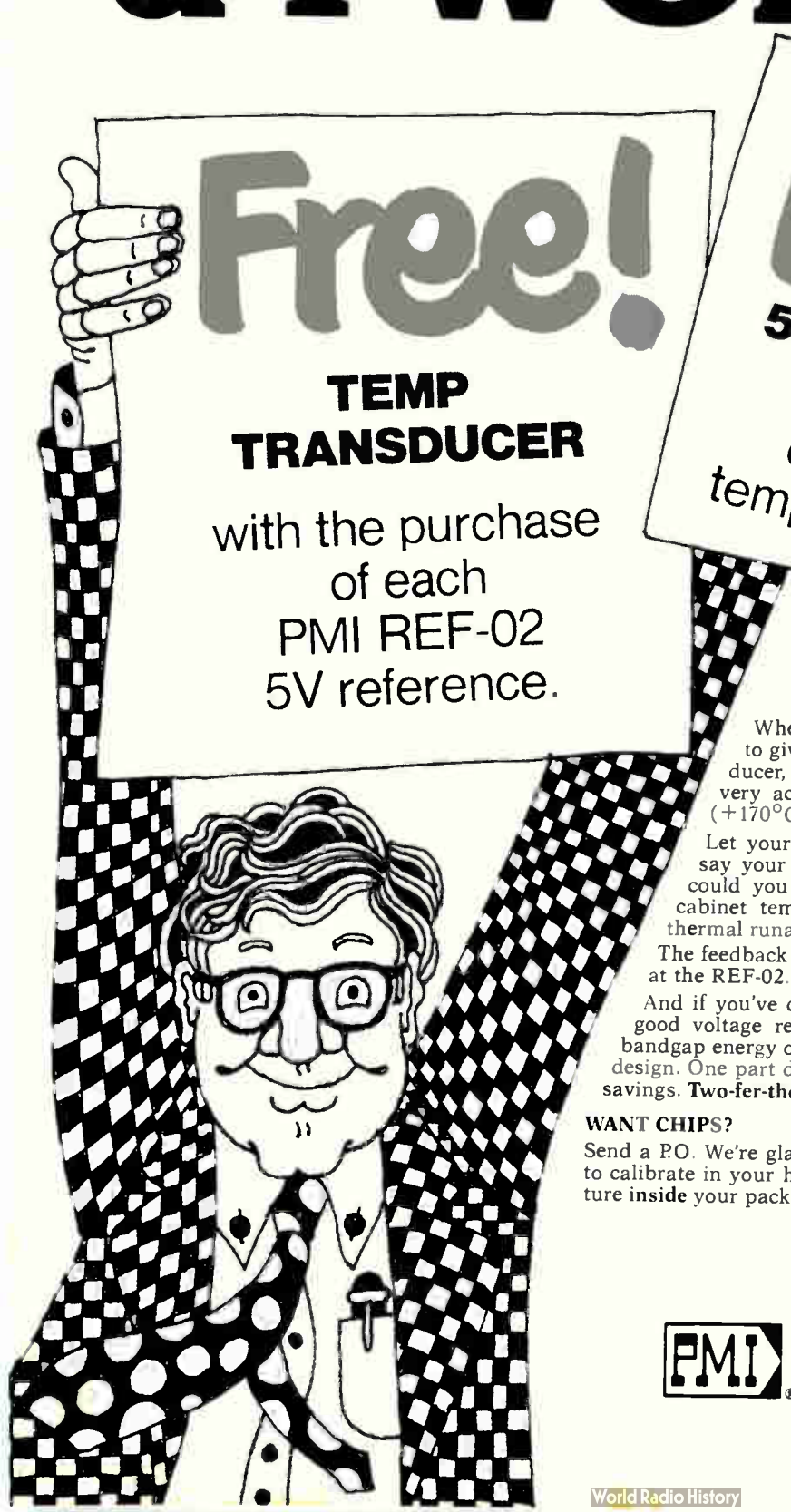
Officers of McGraw-Hill Publications Company: Gordon L. Jones, President; Paul F. McPherson, Executive Vice-President; Group Vice-President: Gene W. Simpson; Senior Vice-Presidents: Russell F. Anderson; James E. Boddorf, Planning & Development; David G. Jensen, Manufacturing; Ralph R. Schulz, Editorial; Vice-Presidents: Denis C. Beran, European Operations; David P. Forsyth, Research; Douglas Greenwald, Economics; James E. Hackett, Controller; Robert L. Leyburn, Circulation; Edward E. Schirmer, Sales.

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

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.

Our REF-02's a TWOFER.



Free!

TEMP TRANSDUCER

with the purchase of each PMI REF-02 5V reference.

FREE

5 VOLT REFERENCE

with purchase of each PMI REF-02 temperature transducer.

When you consider that we've wired up an unused pin to give you—at no additional cost—a temperature transducer, our 5V reference circuit, REF-02 is a **steal**. And it is very accurate, from super low (−150°C) to super high (+170°C)!

Let your imagination explore the idea for a minute. Let's say your system design requires a **voltage reference.** What could you do with a free temperature sensor? ☐ monitor cabinet temperature ☐ thermal drift correction ☐ prevent thermal runaway.

The feedback signal for a temperature control loop is right here, at the REF-02.

And if you've designed in a **temperature sensor** and could use a good voltage reference (ours is very reliable—referenced to the bandgap energy of silicon) the REF-02 offers a way to simplify your design. One part doing the work of several invariably translates into savings. **Two-fer-the-price-of-one.**

WANT CHIPS?

Send a P.O. We're glad to sell REF-02 Chips. And you'll find them easy to calibrate in your hybrid. How about knowing the ambient temperature **inside** your package!

PMI®

Precision Monolithics Incorporated
c/o BOURNS AG
Baarerstrasse 8
6301 Zug, Schweiz

BOURNS AG

Circle 249 on reader service card

Add a Burroughs Microprocessor Display

...it's as easy as B.C.D.

Now Burroughs makes it easier than ever to add an alphanumeric display to your product. Microprocessor control has been built into our popular SELF-SCAN® panels, so all you do is plug them in and input BCD signals for display of a full 64-character ASCII subset. The microprocessor eliminates 95% of the input circuit design normally required and minimizes the load on your system's microprocessor.

You get all the brightness, legibility and sales appeal of the popular SELF-SCAN display (more than a quarter-million in operation worldwide). SELF-SCAN displays are rugged yet lightweight and have a thin cross section. All this is yours at a very affordable price — as little as $315 in 100 quantities.

Our new brochure contains all the information you need to start saving design time, weight, space, and big dollars as well. Get your copy today; call or write Burroughs Corporation, Electronic Components Division, P.O. Box 1226, Plainfield, NJ 07061. (201) 757-5000. Overseas, contact Burroughs ECD International, Langwood House, High Street, Rickmansworth, Hertfordshire, England. Telephone Rickmansworth-70545.

the first name in displays
the last word in displays

Burroughs

"On display at Electro '78: Hamilton/Avnet 1523"

Circle 252 for detailed information
Circle 9 for general information

AEROSPACE/DEFENSE

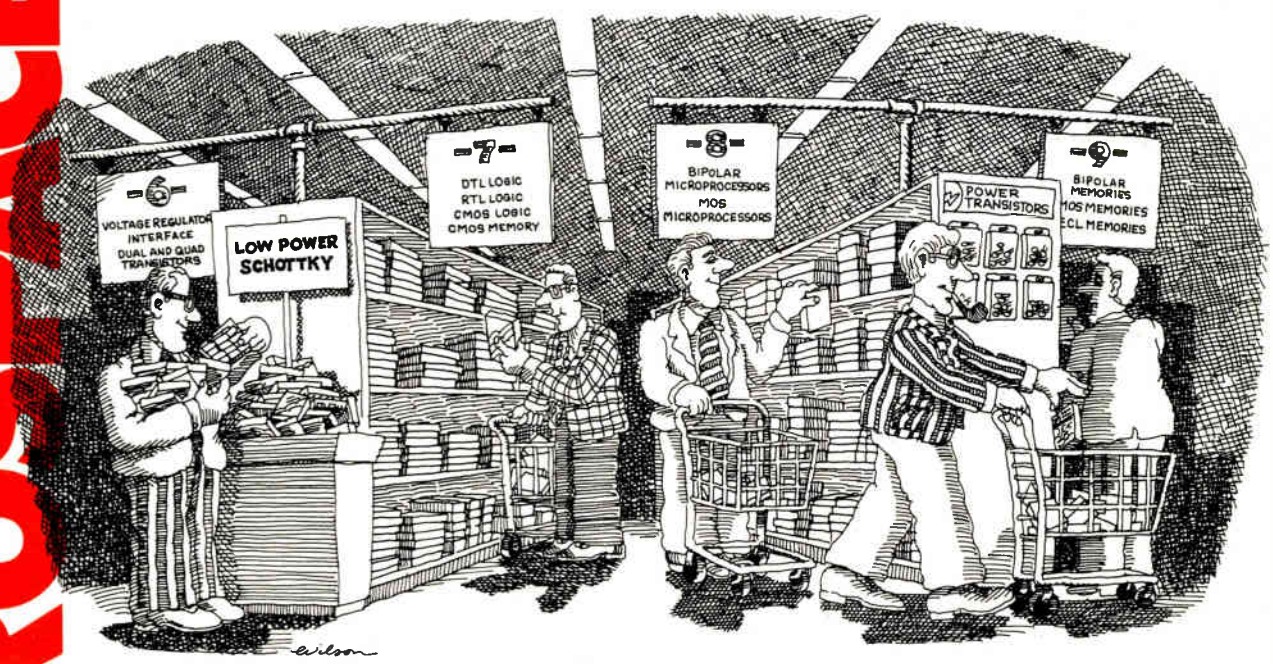
INTRODUCING ONE-STOP SHOPPING FOR THE MIL SPEC MARKET.

Fairchild has taken all the complexity out of buying complex aerospace and defense quality semiconductors.

Our new Unique II program offers you the easiest, most efficient way to obtain the microcircuits and discretes you need, right down to the last mil spec.

Unique II gives you a comprehensive selection of products and processes that meet all the very latest government standards and specifications.

In effect, we offer the world's most detailed semiconductor menu. It allows you to order up components any way you want them.



EVERYTHING YOU NEED, WHEN YOU NEED IT.

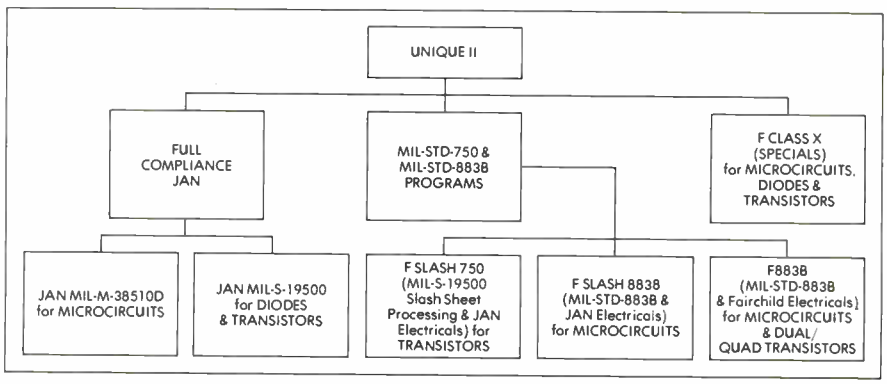
You won't find a fuller spectrum of parts and processes than those covered by Fairchild's Unique II program. And nobody can deliver them faster.

We're equipped to meet your reliability, cost and availability objectives. From the simplest transistor to the most complex microcircuit. If it's on your list, odds are it's on ours.

BRING US YOUR REQUIREMENTS.

The Unique II program provides full-compliance JAN microcircuits to MIL-M-38510D. Full-compliance JAN, JAN TX and JAN TXV diodes and transistors to MIL-S-19500. Full-spectrum processing including MIL-STD-750 and MIL-STD-883B with your choice of screening/test flows.

We also offer a unique Fairchild CLASS X program to accommodate your requirements for special flows, product performance, documentation and control.



EXPERIENCE YOU CAN TRUST.

Fairchild is an old hand at meeting tough aerospace/defense requirements. We've got components in avionics equipment, satellites, missiles, ground support equipment and communications equipment. Recently we've supported such programs as the F14 and F18, F15 and F16, MX, MINUTEMAN, TRIDENT, CAPTOR, PATRIOT and the SPACE SHUTTLE.

GET THE WHOLE SHOPPING LIST.

For more information on our Unique II program, please call or write the Fairchild office nearest you:

France: Fairchild Camera & Instrument S.A., 121 Ave. d Italie 750013-Paris Tel 00331 584 55 66 Telex 0042 200614. **Italy:** Fairchild Semiconduttari S.P.A. Via Rasellini 12 20124 Milano Tel 02 6887451 Telex 36522 **Germany:** Fairchild Camera & Instrument (Deutschland) GmbH 8046 Garching Hackbruck Daimlerstr 15 Munchen. Tel: 089 320031. Telex. 52 4831 fair d. **England:** Fairchild Camera & Instrument (UK) Ltd 230 High St Potters Bar, Hertfordshire EN6 5BU. Tel: 0707 51111 Telex 0051 262835. **Sweden:** Fairchild Semiconductor AB Svartengsgatan 6, S-11620 Stockholm. Tel: 8-449255 Telex 17759

FAIRCHILD

Editorial

The military's changing role

Within the last few years, many observers of electronic technology began to view military requirements as playing a role of diminishing importance in pushing the state of the art. In the not-so-distant days when aerospace customers were dominant, military demands definitely set the pace. But with the emergence of the microprocessor, the lead has shifted to the commercial sector, where electronics firms are pursuing a range and variety of applications undreamt of a decade ago.

This is not to deny that there are a number of significant new products only now fanning out into industry that were nurtured on military contracts. Bubble memories and fiber optics owe their present commercial acceptance largely to military backing. But now it looks as though military planners are beginning deliberately to seek out products that have their origin in industrial needs or at least run parallel to those needs.

This novel convergence of military and commercial requirements is evident in the new policy of the Air Force Avionics Laboratory at Wright-Patterson Air Force Base, Dayton, Ohio (see p. 86). Admittedly, the Air Force is still looking for high-performance radiation-hardened semiconductor devices for low-volume production, while the industry is looking to lower-cost, high-volume products.

On the other hand, the Air Force laboratory has set up a policy of encouraging the commercialization of its product developments on the grounds that it reduces costs and also increases the competition for contracts. It is clear, then, that the military has not abandoned its support of product development but, instead, has altered the form that support may take.

The examples are many. At the avionics laboratory a new digital phase-locked-loop chip has been developed that is headed for the commercial market through Texas Instruments. This device costs far less than analog PLLs implemented as hybrids and with discretes and can replace them in a number of different communications terminals.

Also significant is the Air Force contract for a bus interface chip. It stipulates that the prime contractor must set up a second source, a requirement which will certainly help to promote the use of the interface chip outside the armed forces.

Evidently, the military opportunities are still out there. But as one industry executive points out, "you have to know how to pick your spots."

There is a question, though, as to how far this convergence can go in the era of very large-scale integration. On the surface, it appears that the military would not be able to deal with the economics of VLSI in terms of volume. This situation would certainly seem to spell a divergence of interests.

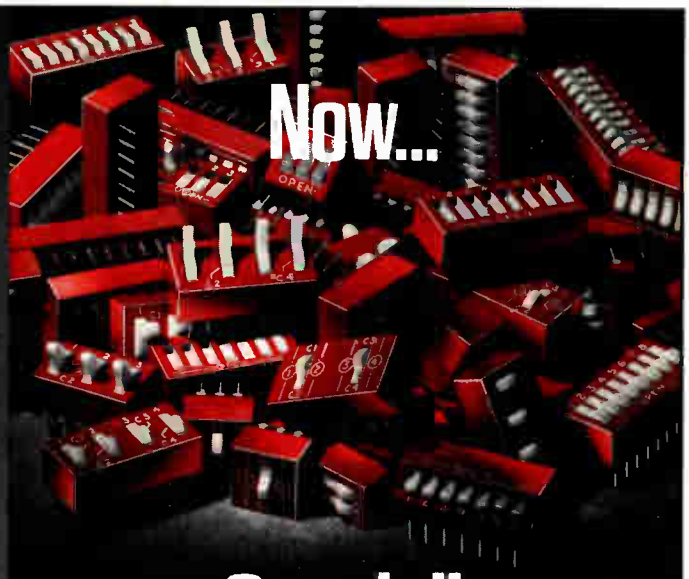
But Air Force product-development managers point out that situations change. It is quite possible that, rather than adding more functions, the increased complexity of VLSI could be used to enhance reliability. The military would specify standard chips, but repartitioned to dedicate some of the cells to internal testing. This concept has commercial appeal, too.

Taking Wright-Patterson as an example, it appears that the philosophy is to accentuate convergence with commercial developments even if it means changing product definitions. In the end, it would mean a far healthier relationship between the military and the electronics industries.

First...

Grayhill brought you the different DIP Switch.

Now...



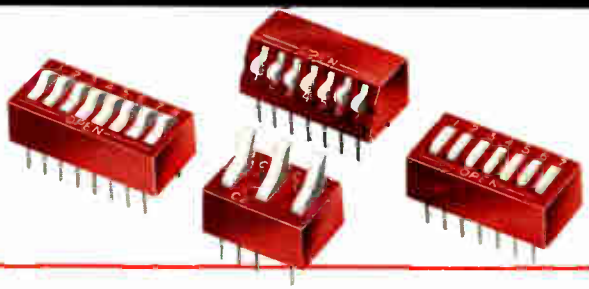
Grayhill brings you all the different DIP Switches you need!

Different actuations

Raised and recessed rockers for back panels

Toggles for front panel usage

Side actuated "Piano-DIP™" for access from racked boards

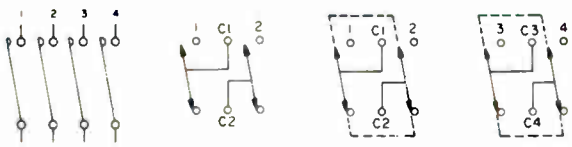


Different circuitries

SPST in 9 sizes, from 2 to 10 rockers; the DIP-C®, SPDT switching and the Double-DIP™, DPDT circuitry in 1, 2, 3 and 4 rocker versions.

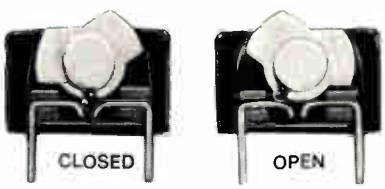
Toggle DIP™ available with SPDT circuitry, 2, 3 or 4 stations; DPDT with 1 or 2 stations.

Piano DIP™ (side actuated) from 4 to 10 stations, SPST circuitry under each rocker.



Different performance standards

Two exclusive features improve Grayhill DIP Switch reliability. Molded-in terminals protect against contact contamination. Reliable spring loaded sliding ball contact system provides DIP Switches life-rated at 50,000 operations, with positive wiping action and immunity to normal shock and vibration.



Different delivery standards, too

Most Grayhill DIP Switches are available off the shelf in production quantities from Grayhill or its nationwide distributor network.

For detailed information on Grayhill DIP Switches, consult *EEM* or write for Bulletin #276 to Grayhill, Inc., 561 Hillgrove Ave., La Grange, Illinois 60525, phone: (312) 354-1040.

Grayhill INC

ers as brash, fickle upstarts.

"Telecommunications people, especially the older guys, look at the semiconductor industry with a jaundiced eye," Ruebusch says. "They question our sincerity. They question how long we will stick with it." Ruebusch, 28, has been with Signetics for six months, where he is masterminding the introduction of an integrated-injection-logic coder-decoder (see p. 77). The holder of master's degrees in both business administration and electrical engineering, he was previously assistant product marketing manager for multiplex equipment at Farinon Inc., San Carlos, Calif., a maker of transmission equipment.

Ruebusch's customers want to know that when they design in a codec, the part will still be there when they go into production, he continues. "They have no historical basis for making that assumption," Ruebusch says. It requires a certain risk for them to bet on a given chip maker or a group of them to make parts for the 20-year periods typical of telephone gear. The semiconductor industry itself is barely 20 years old, he notes.

Long cycles. Moreover, unlike the semiconductor industry, where a useful product life can be as short as three years, "a three-year development cycle is nothing for telecommunications, and Bell thinks nothing of spending seven years to design a switch," he continues. "This is going to severely test the patience of semiconductor companies who want to compete in that business."

Ruebusch believes that the chip makers who do well in the telecommunications marketplace will be those who approach it on a long-term basis. That will require understanding the phone companies' requirements, meeting delivery dates, and ensuring reliable parts. In the long run, the telecommunications business should help the semiconductor industry to mature. "Telephone companies don't have massive ups and downs," he says. "In a recession no one gives up his telephone." This should "provide a stabilizing effect on the industry."

MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

INTERNATIONAL edition APRIL, 1978

New printer/plotter combines fast text printing and high-quality true-vector graphics

HP-IB

If your application calls for both plotting and/or printing, unattended plotting, or long-axis plots, the new 7245A is an HP-IB printer/plotter you will want to know more about.

Whether your application calls for high-quality graphics, or fast text printing, or a combination of both for extensive plot annotation, HP's 7245A Plotter/Printer is an excellent solution for your needs. With a printing speed of 38 characters per second (cps) and plotting speeds equal to or greater than that of dedicated vector plotters, the HP desktop plotter/printer is an outstanding general-purpose device for your HP-IB controller. Some areas of application are engineering design, production testing, data acquisition, process monitoring, analytical plotting, long-term business forecasting, and project management.

The microprocessor-based 7245A uses a bidirectional paper drive to advance a 61-metre (200-foot) roll of thermosensitive paper for unattended long-axis plotting. A sprocket paper drive and a patented microstep motor drive give the 7245A excellent line quality and repeatability of 0.25 millimetres (0.010 inches) maximum from any point on the chart.

A state-of-the-art, thin-film, thermal printhead makes possible the combination of true-vector graphics and fast printing. It has 12 resistors to print 7×9 dot-matrix characters in four orthogonal directions. This allows 88 columns to be printed across the 216-millimetre-wide (8.5 inch) paper. A larger 14×9 dot-matrix font is used to print titles at 19 cps in a 44-column format.

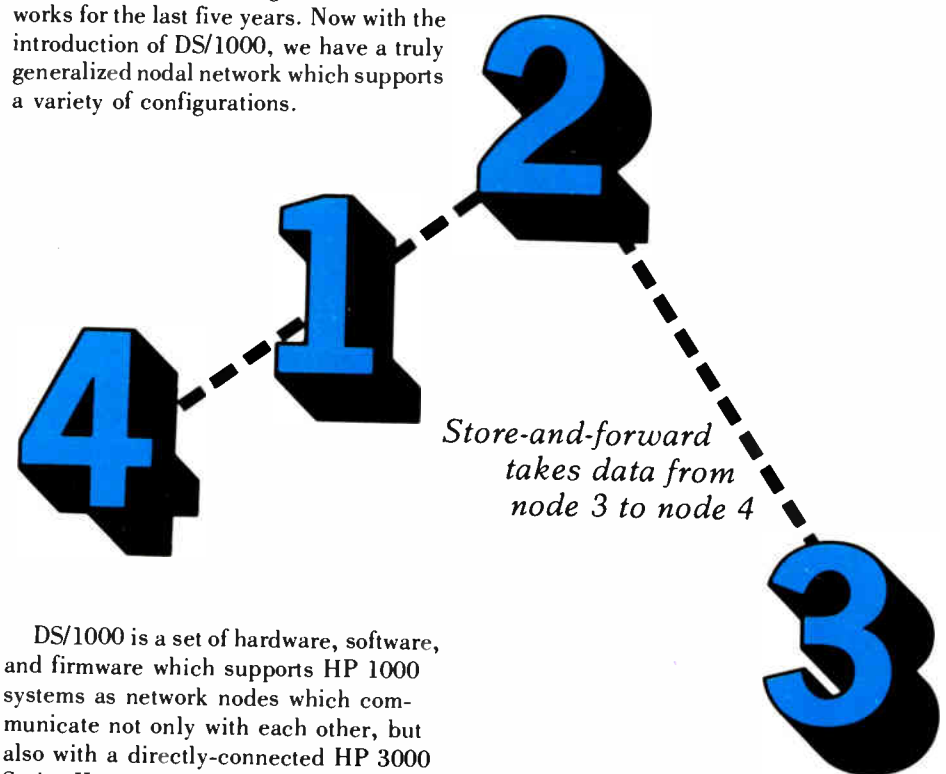
Programming is easy thanks to 46 built-in programmable instructions for features such as unit scaling, graph rotation, point digitizing, character size, slant, and direction, and selecting any of seven dashed line fonts and five drawn and eight matrix character sets, six of which are European.

Standard printer escape code sequences for the 7245A enable you to set, execute, and clear tabs, form-feed forward or reverse, change character size, underline, select any of eight dot-matrix character sets, and select the "display functions" mode for printing all 128 ASCII characters, including the control code characters.

For details, check B on the HP Reply Card.

DS 1000: The latest distributed processing link

HP is not new to computer networking. We have been delivering reliable networks for the last five years. Now with the introduction of DS/1000, we have a truly generalized nodal network which supports a variety of configurations.



Store-and-forward takes data from node 3 to node 4

DS/1000 is a set of hardware, software, and firmware which supports HP 1000 systems as network nodes which communicate not only with each other, but also with a directly-connected HP 3000 Series II computer. And, there is no significant increase in complexity for the applications programmer. All network information flow is handled by DS/1000.

With a powerful remote command processing capability, DS/1000 users at terminals on one HP 1000 node can access any other HP 1000 in the network, be it local or remote.

These users can easily utilize files, programs, and peripherals on other nodes, even when they are unattended. Individual HP 1000 nodes can be connected in any manner that suits the material flow of a plant or geography of a region—a star arrangement surrounding a central node, a ring, a string, or any combination of these. Nodes are connected with either a single four-wire cable or by full-duplex modems. DS/1000 is particularly well-suited for instrumentation, computation, and operations management tasks in functional areas such as manufacturing, R&D, quality control, and distribution.

Moreover, DS/1000 to DS/3000 communication facilitates the integration of these tasks with commercial data processing available on the HP 3000 Series II, such as production scheduling, order processing, and accounting.

Store-and-forward

Nodal addressing combined with a store and forward technique, enables users to access any DS/1000 node from any other node, and allows them to transport programs freely within the network.

A user at a node in New York, for example, can write to a line printer at a node in Boston. If the user later transports the program from New York to a node in Atlanta, the same line printer in Boston would be accessed without change to the user's program.

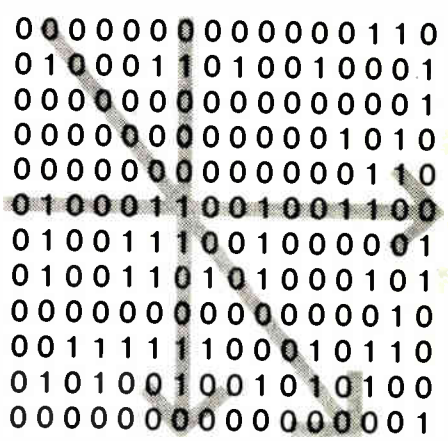
The application programmer need only identify the node where the printer is located, and DS/1000 forwards the information from node-to-node until it reaches that address.

Microcoded Driver

DS/1000 takes advantage of the microcode-ability of the HP 1000 in its Communications Access Method driver. CAM allows simultaneous requests on multiple communications lines between HP 1000's to be serviced concurrently. For example, a DS/1000 node can handle four concurrently active 9600 baud lines, or two active hardwired lines with a combined effective throughput of up to 20K-bytes/second.

Tri-Directional Error Check

To ensure data transmission integrity, DS/1000 has powerful microcoded error checking. Data blocks, when received,



are checked simultaneously for vertical, longitudinal, and diagonal parity.

Obtain full details by checking D on the HP Reply Card.

A new computing data acquisition component for OEM's

If you are an OEM and interested in low-cost computing components for your measuring instruments for scientific research, clinical analysis, or industrial applications, you should know about the HP 97S I/O Calculator. A fully programmable printing calculator, with BCD interfacing, the HP 97S just may be the solution to the problem of how to automate your products at an affordable price.

Based on the HP-97 Programmable Printing Calculator, the HP 97S incorporates BCD interfacing so that data can be efficiently gathered from a wide range of instruments including: electronic balances, photometers, densitometers, thermal conductivity measurement devices, strain gauge systems, calorimeters, devices for measuring ion activity, titrators, pH meters, coordinate measurement equipment, physical measuring equipment, or any BCD output device.

Your customers will appreciate the HP 97S with your product, not only for its low cost, but also for its many computational features. The HP 97S features include:

- 244 steps of program memory, a magnetic card reader for storing programs and data,
- three levels of subroutines,
- labelling,
- indirect and relative addressing,
- RPN logic,
- built-in printer, and
- a large, bright display, tilted for easy reading.

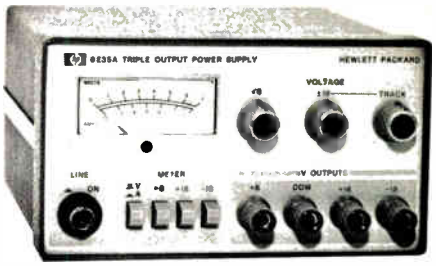
Programming power and simple interfacing also make your job easier. Getting the 97S up and running with your instruments will require two simple steps—interfacing and programming. To get you started, HP provides detailed documentation. The installation and operation manual includes detailed technical specifications and clear instructions for simple interfacing, as well as helpful diagnostics and service information.

The programming guide gives step-by-step explanations for programming and the Standard Application Pak includes 15 pre-recorded programs and 24 blank cards.

For more details on how you can add intelligence and hard-copy output to your products, check H on the HP Reply Card.

Whether you are an OEM manufacturer of electronic balances, photometers, calorimeters, pH meters—or any BCD output device—this calculator can make your instrument "smart" at a price you can afford.

New, compact power supply features triple outputs



Convenient power for circuit breadboards is yours with this new three-in-one lab bench power supply.

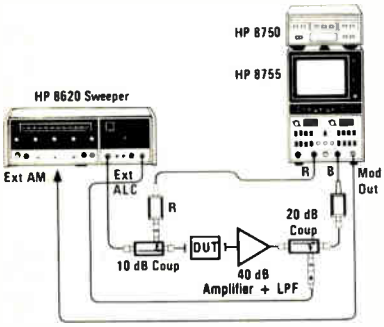
This low-cost, compact, three-in-one power supply is a handy addition to the lab bench where single or multiple voltages are needed for designing and testing breadboards and prototypes. The HP 6235A Triple Output DC Power Supply delivers three adjustable DC output voltages: 0 to 6 V at 1 A, 0 to +18 V at 0.2 A, and 0 to −18 V at 0.2 A. A single 0 to 36 volt output at 0.2 A can also be obtained by connecting across the −18 V and +18 V terminals. The +6 V and +18 V outputs can be adjusted independently. The −18 V output is adjusted with a tracking ratio control, after which it will proportionately follow the +18 V output as the +18 V control is adjusted. The +18 V and −18 V tracking outputs are especially useful for powering operational amplifiers and other circuits requiring symmetrical operating voltages.

The supply is a constant voltage/current limit type, with each voltage continuously adjustable over its range, while the maximum current available is automatically limited to prevent overloading. You can quickly select and monitor voltage or current for each output with the pushbutton meter switches.

Weighing only 2.3 kilograms, (5 lbs.), the new 6235A is small enough to pick up with one hand. It can be powered from 115 V or 230 V, 47-63 Hz AC input.

Check I on the HP Reply Card for more information about this triple output power supply for your lab bench.

New note describes 100 dB microwave measurements



Microwave swept measurement setup uses RF amplifier within leveling loop to achieve >100 dB dynamic range.

"100 dB Dynamic Range Measurements Using the HP 8755 Frequency Response Test Set", a new HP application note (AN 155-2), will be of interest to people making RF and microwave swept measurements. Expanded dynamic range is achieved by using the associated sweep oscillator's leveling/modulation element as an "automatic RF substitution" device by configuring it within the system's power leveling loop. The note discusses the factors that determine and limit measurement dynamic range. Equipment cited in the note covers from 10 MHz to 18 GHz.

For your complimentary copy of AN 155-2, check J on the HP Reply Card.

Application Note describes 1 MHz to 18,000 MHz synthesized source

The third application note from the Microwave Synthesizer Series, AN 218-3, is now available.

It describes how the HP 8672A and HP 8660A/C Synthesized Signal Generators can be combined with programmable signal switching to yield a signal generator with one output connector covering from 1 MHz to 18.000 MHz. In addition, the frequency resolution of the 8672A generator is improved from its usual 1, 2, and 3 kHz, to 1, 2, and 3 Hz. Such a programmable source is excellent for automatic test systems.

Some sample desk-top computer software sub-routines are given to aid the user in programming the system.

For your complimentary copy, check K on the HP Reply Card.

Troubleshoot three-state data buses conveniently, quickly, economically

Troubleshooting three-state data buses in digital circuitry, computers, and data communications systems can be challenging under the best of circumstances, but imagine yourself in this situation: a stuck data bus line with RAM's microprocessor and I/O devices attached to it, all of which appear the same electrical potential. Since the board is too expensive to toss away and you don't have the hours of time needed to use analog troubleshooting techniques, consider the HP IC troubleshooters.

The IC troubleshooters allow you to isolate quickly and conveniently the bus problem outlined here by giving you a combination of three tools you need to determine if the bus line is shorted, open, or has a bad driver. The troubleshooters you need first are the handheld HP 545A Probe and the 546A Pulser. Just pulse and probe the stuck line to see if its logic state can be taken to a HIGH. If not, then there is a short to ground on the line. To find it, keep pulsing the bus line while you use our 547A Current Tracer to follow current pulses directly to the shorted bus element.

Detecting stuck bus lines often requires a combination of voltage and current information. The HP IC troubleshooters provide stimulus and response capability in both the voltage and current domains for more complete, economical digital troubleshooting.

For more information, check L on the HP Reply Card.

HP's 545A Probe, 546A Pulser and 547A Current Tracer help pinpoint logic faults on three-state buses.

Speed transceiver, audio or broadcast testing with HP's new distortion measurement set

In addition to the time-saving convenience of auto set level and auto null, a built-in tracking oscillator for audio measurements gives you a low-distortion source for testing high quality audio equipment and allows you to tune one instrument instead of two.

Whether you're testing transceivers, professional audio equipment or broadcast performance, the HP 339A Distortion Measurement Set can help you make quick and accurate measurements.

Automatic frequency nulling and auto set level of the 339A speed your total harmonic distortion measurements (THD), while true-rms detection provides accurate measurements to as low as 0.0018% (−95 dB) from 10 Hz to 110 kHz. Just select the frequency of the built-in −95 dB low distortion oscillator and the 339A's front panel "turn signal" indicators show you how to make the proper range settings.

In transceiver testing, automatic setting of the 100% reference level over a 10 dB input range means fewer critical adjustments, saving you a considerable amount of test time. True-rms detection lets you accurately determine thermal noise and harmonic components in making SINAD measurements.

Broadcast compliance testing is easy with the 339A's built-in AM detector, 30 kHz low-pass filter, switchable VU meter ballistics, and a +2 to −12 dBm (600 Ω) meter scale. You can quickly isolate the causes of out-of-limit readings and reduce set-up time when checking equipment for compliance with government regulations.

Contact your local HP field engineer for further details or check M on the HP Reply Card.

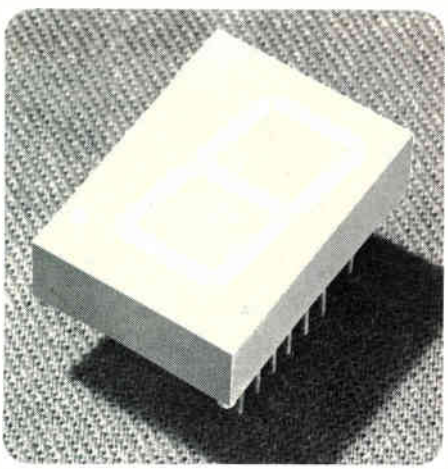
Low R_S beam lead PIN diode switches in less than 2 ns

The HPND-4050 offers 1.3 Ω typical (1.7 max) series resistance at only 10 mA for high frequency performance in shunt. This low resistance reduces power requirements and makes it suitable as a shunt switching element in stripline and microstrip circuits. The low current requirements are of interest to designers for portable, airborne or shipboard applications including switching, attenuating, phase shifting and modulating at microwave frequencies. Reverse recovery time of two nanoseconds meets or exceeds requirements for fast switching in high frequency modulator and attenuator component applications in ECM systems. The capacitance of the HPND-4050 is 0.15 pF maximum and breakdown voltage is 30V minimum. Nitride passivation of the HPND-4050 provides immunity from environmental contaminants.

The HP mesa process with glass backfilling is responsible for the performance of this beam lead PIN. The mesa construction constrains the minority carriers, thereby enhancing switching speed.

For details, check N on the HP Reply Card.

HP introduces its largest 7-segment red LED display



The new HDSP-3400 Series red LED numeric display is the largest in Hewlett-Packard's seven-segment product line, which ranges in size from 2.59 millimetre (.10 inch) to the new 20.32 millimetre (0.8 inch) display.

Readable in bright light at distances of up to 10 metres (33 feet), the HDSP-3400 is designed for use in electronic instruments, point-of-sale terminals, television sets, weighing scales, digital clocks, and a number of other applications requiring low power consumption in a large, easy-to-read display.

The gallium arsenide phosphide displays are in a standard 15.24 millimetre (0.6 inch) dual-inline-package that permits mounting on PC boards or in standard IC sockets for easy use.

Models in the new series are: HDSP-3400, common anode left hand decimal; 3401, common anode right hand decimal; 3403, common cathode right hand decimal; 3405, common cathode left hand decimal; 3406, universal overflow (±1) right hand decimal.

The HDSP-3400 Series displays are available from stock of Hewlett-Packard's franchised distributors.

For greater details about this new product, check O on the HP Reply Card.

Microprocessor enhances capability and lowers cost of a new microwave counter

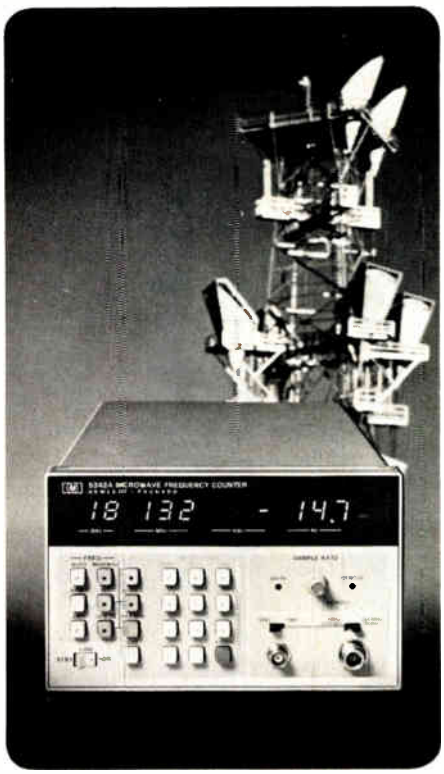
On the basis of its cost reduction alone, a full capability, automatic, 10 Hz to 18 GHz microwave frequency counter priced 20% less than any other in its performance class would be interesting news to people doing microwave work. But add to this lower price the other features of HP's 5342A and you have what is perhaps the best value and most significant development in microwave counters for many years. With these features your bench, systems or field measurement tasks can now be performed faster, more conveniently and more economically over a wide range of input parameters:

- Measure input signal level at the same time you measure frequency without switching input connectors (option 002); 10 MHz to 18 GHz frequency coverage with ±1.5 dB accuracy.
- >50 MHz FM tolerance lets you measure heavily loaded communications carriers on-line with active traffic.
- Microprocessor supervised measurements and front panel keyboard make set-up faster, more convenient, more error-free...lets you enter frequency/amplitude offsets, to be added to or subtracted from the measured results.
- Automatic amplitude discrimination measures only the highest signal in the input spectrum.
- Hewlett-Packard Interface Bus (option 011) provides systems control for all measurement capabilities and access to measured results.
- Optional, built-in digital-to-analog converter (option H01), allows high accuracy plots of frequency or amplitude changes, via strip chart recorder.
- Compact half-rack module size makes the 5342A convenient for field use.

This blend of high performance, unmatched versatility and low price was achieved by a new harmonic heterodyne converter technique with microprocessor based calculations and control. This reduces the need for expensive components to a single hybrid, thus lowering the cost significantly. The 5342A shines in other specifications too. Sensitivity is −25 dBm, 500 MHz to 12.4 GHz and −20 dBm...to 18 GHz. Time base crystal aging rate is $<1\times10^{-7}$/month ($<5\times10^{-10}$ /day in option 001). Dynamic range is 30 dB, 500 MHz to 12.4 GHz, and 25 dB to 18 GHz (42 dB and 35 dB, respectively, if you order amplitude measurement option 002 or extended dynamic range option 003.)

For more information, check P on the HP Reply Card.

HP-IB



The new 5342A's great FM tolerance allows heavily loaded communications carrier frequencies to be measured on-line and with active traffic. This plus optional amplitude measurement gives you two of the most often needed communications measurements in a single, compact package. HP-IB option offers full systems capability too.

Europe-Central Mailing Dept., P.O. Box 529, Amstelveen-1134, Netherlands. Ph.(020) 47 20 21
Japan-Yokogawa-Hewlett-Packard Ltd., Ohashi Bldg., 1-59-1 Yoyogi, Shibuya-ku, Tokyo 151. Ph. 03-370-2281/92.
Elsewhere outside the U.S.A.-1507 Page Mill Rd., Palo Alto, California, 94304, U.S.A.

HEWLETT hp PACKARD

hp MEASUREMENT COMPUTATION news
product advances from Hewlett-Packard

March/April 1978

New product information from

HEWLETT-PACKARD

Editor: Bojana Fazarinc-Bitencourt

Editorial Offices:
1507 Page Mill Road
Palo Alto, California, 94304 U.S.A.

00882

If you are located

IN EUROPE

please use this card for fastest response

MEASUREMENT COMPUTATION news Mar/Apr 1978

product advances from Hewlett-Packard

Check the **circle** below if you wish to receive literature only.
Check the **box** below if you wish to be contacted.

- ○ A. HP-19C/29C solutions books
- ○ ☐ B. 7245A printer/plotter
- ○ ☐ C. 8160A programmable pulse generator
- ○ ☐ D. DS/1000
- ○ ☐ E. 1350A graphics translator
- ○ F. Guide to electronic counters
- ○ G. HP Journal, February 1978
- ○ ☐ H. HP 97S calculator
- ○ ☐ I. 6235A triple output DC power supply
- ○ J. Application Note 155-2
- ○ K. Application Note 218-3
- ○ ☐ L. 545A/546A/547A IC troubleshooters
- ○ ☐ M. 339A distortion measurement set
- ○ ☐ N. HPND-4050 beam lead PIN diode
- ○ ☐ O. HDSP-3400 Series displays
- ○ ☐ P. 5342A microwave counter

40B

PLEASE PRINT

Name

Title

Department, Building, Mail Station, Etc.

Company

Post Office Box or Street No.

City Country

Telephone Number

If you are located

ELSEWHERE

this card will bring fastest response

MEASUREMENT COMPUTATION news Mar/Apr 1978

product advances from Hewlett-Packard

Check the **circle** below if you wish to receive literature only.
Check the **box** below if you wish to be contacted.

- ○ A. HP-19C/29C solutions books
- ○ ☐ B. 7245A printer/plotter
- ○ ☐ C. 8160A programmable pulse generator
- ○ ☐ D. DS/1000
- ○ ☐ E. 1350A graphics translator
- ○ F. Guide to electronic counters
- ○ G. HP Journal, February 1978
- ○ ☐ H. HP 97S calculator
- ○ ☐ I. 6235A triple output DC power supply
- ○ J. Application Note 155-2
- ○ K. Application Note 218-3
- ○ ☐ L. 545A/546A/547A IC troubleshooters
- ○ ☐ M. 339A distortion measurement set
- ○ ☐ N. HPND-4050 beam lead PIN diode
- ○ ☐ O. HDSP-3400 Series displays
- ○ ☐ P. 5342A microwave counter

40B

PLEASE PRINT

Name

Title

Department, Building, Mail Station, Etc.

Company

Post Office Box or Street No.

City Country

Telephone Number

Due to individual government and import regulations, the prices of the products featured in this edition may vary from one country to another.

For pricing information, please contact the Hewlett-Packard sales and service office nearest you, or write to any of the regional offices listed on the preceding page.

We look forward to serving you.

DIRECT RESPONSE SYSTEM

For fast response, use the above reply cards. Please note that you can choose two types of HP response.

- ☑ Literature. (You will receive more information on a product.)
- ☑ Please contact me. (You will receive product information *and a follow-up* call from a Hewlett-Packard representative.

If both reply cards on this page have been used, contact your nearest HP field office or one of the regional offices listed on the preceding page. Or, write directly to the Hewlett-Packard Company, 1820 Embarcadero Road, Palo Alto, California, 94303, U.S.A.

HEWLETT hp PACKARD

Place
Postage
Here

HEWLETT-PACKARD
Central Mailing Department
P.O. Box 529
Amstelveen-1134, Netherlands

Place
Postage
Here

HEWLETT-PACKARD
1820 Embarcadero Road
Palo Alto, California 94303

Intel announces 32K and for EPROM and micro

Check Pin 18 on our new 2332. It's the key to compatibility with high performance microcomputers and EPROMs.

Now's the time to get samples or place your order for the 2332 or 2364. They're our new 32K and 64K ROMs that will change the way you design your system. Here's how.

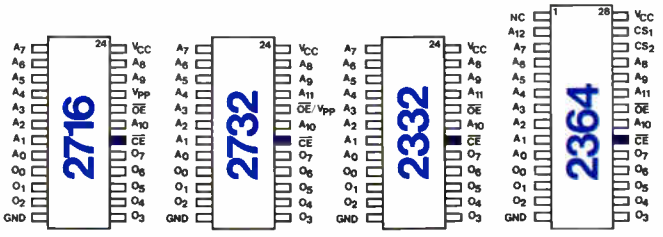
Microcomputer system components—EPROMs, ROMs and microprocessors—need to be designed as an integral unit, not piecemeal. That's the only way to provide maximum design flexibility and ensure a longer life cycle for your system. We've looked ahead at your future design requirements to provide you with components today that will enable you to take advantage of tomorrow's advances. The result is a family of compatible 5V EPROMs and ROMs for microcomputer systems.

Intel's new 2332 and 2364 are the latest members of that family. They provide system compatibility in three important ways.

First, these new ROMs have a guaranteed access time of 300 ns—fast enough to take full advantage of new, advanced microprocessors. To achieve 300 ns speed with low power dissipation, our parts are Edge-Enabled. That's where Pin 18 comes in. It provides the Chip Enable function necessary for the internal clock circuitry.

64K ROMs designed computer compatibility.

Second, the 2332 and 2364 are compatible with our 2716 industry-standard 16K EPROM and will be compatible with our 32K EPROM when it is introduced. Again, Pin 18 is the key. Note that Pin 18 performs the same power control function on all devices. So you can prototype with EPROMs and go directly to high density ROMs for production.



	16K EPROM	32K ROM/EPROM	64K ROM
Organization	2K x 8	4K x 8	8K x 8
Active Icc (max)	100 mA	40 mA	40 mA
Standby Icc (max)	25 mA	15 mA	15 mA
Access Time (max)	350-450 ns	300 ns	300 ns

Engineering the 2332 and 2364 for microcomputer system compatibility led us to the third important advance—the end of bus contention problems. In new multiplexed microprocessor systems, such as the MCS-85 and MCS-86, the Output Enable (Pin 20) needs to be independent of the Chip Enable (Pin 18) which is the power control and selection function. So the 2332 and 2364 have an Output Enable ($\overline{OE}$) for independent control of the data bus, with no possibility of multiple device selection. And input latches on all Edge-Enabled devices allow direct interface with new multiplexed microprocessors.

Low power is essential to meet today's design requirements. We've achieved low power in our 32K and 64K ROMs that can't be matched by fully static parts. Active current of the 2332 and 2364 is 40 mA (maximum). And Intel's Edge-Enabled devices have the added benefit of using Pin 18 for the power control function. So standby current is automatically reduced to 15 mA (maximum).

To get complete details on this important and complex subject, send for our 2332/2364 applications note AP-30, "Applications of Intel's 5V EPROM and ROM family for microcomputer systems." It provides board layout recommendations, system design applications, timing diagrams, function explanations and discusses PL/M modular software compatibility. Write: Intel Corporation, Literature Dept., 3065 Bowers Avenue, Santa Clara, CA 95051. Or for samples of these new parts, contact your local Intel representative.

intel® delivers.

Visit us at the Hanover Fair '78
April 19 through 27, 1978. Cebit-West,
Hall 18, Booth 1503.

Europe: Intel International Corporation S.A., Rue du Moulin a Papier, 51-Boite 1, B-1160, Brussels, Belgium. Telex 24814.
Japan: Intel Japan Corporation K.K., Flower Hill-Shinmachi East Building 1-23-9, Shinmachi, Setagaya-ku, Tokyo 154. Telex 781-28426.

Circle 29 on reader service card

Meetings

Annual Meeting, U. S. Metric Association (Boulder, Colo.), Portland Motor Hotel, Portland, Ore., April 21–22.

Communications Satellite Systems Conference, American Institute of Aeronautics and Astronautics, Town and Country Hotel, San Diego, Calif., April 23–27.

Electronic Components Conference, IEEE, Disneyland Hotel, Anaheim, Calif., April 24–26.

National Relay Conference, National Association of Relay Manufacturers and Oklahoma State University, Stillwater, Okla., April 25–26.

National Aerospace Symposium, Institute of Navigation, Howard Johnson's Regency Motor Hotel, Atlantic City, N. J., April 25–27.

Microwave Power Tube Conference, IEEE, Naval Postgraduate School, Monterey, Calif., May 1–3.

Newcom '78, Electronic Industry Show Corp. (Chicago), Las Vegas Convention Center, Las Vegas, Nev., May 2–4.

Symposium on Offshore Technology, IEEE, Astrohall, Houston, May 8–11.

Intermag Conference, IEEE, Palazzo dei Congressi, Florence, Italy, May 9–12.

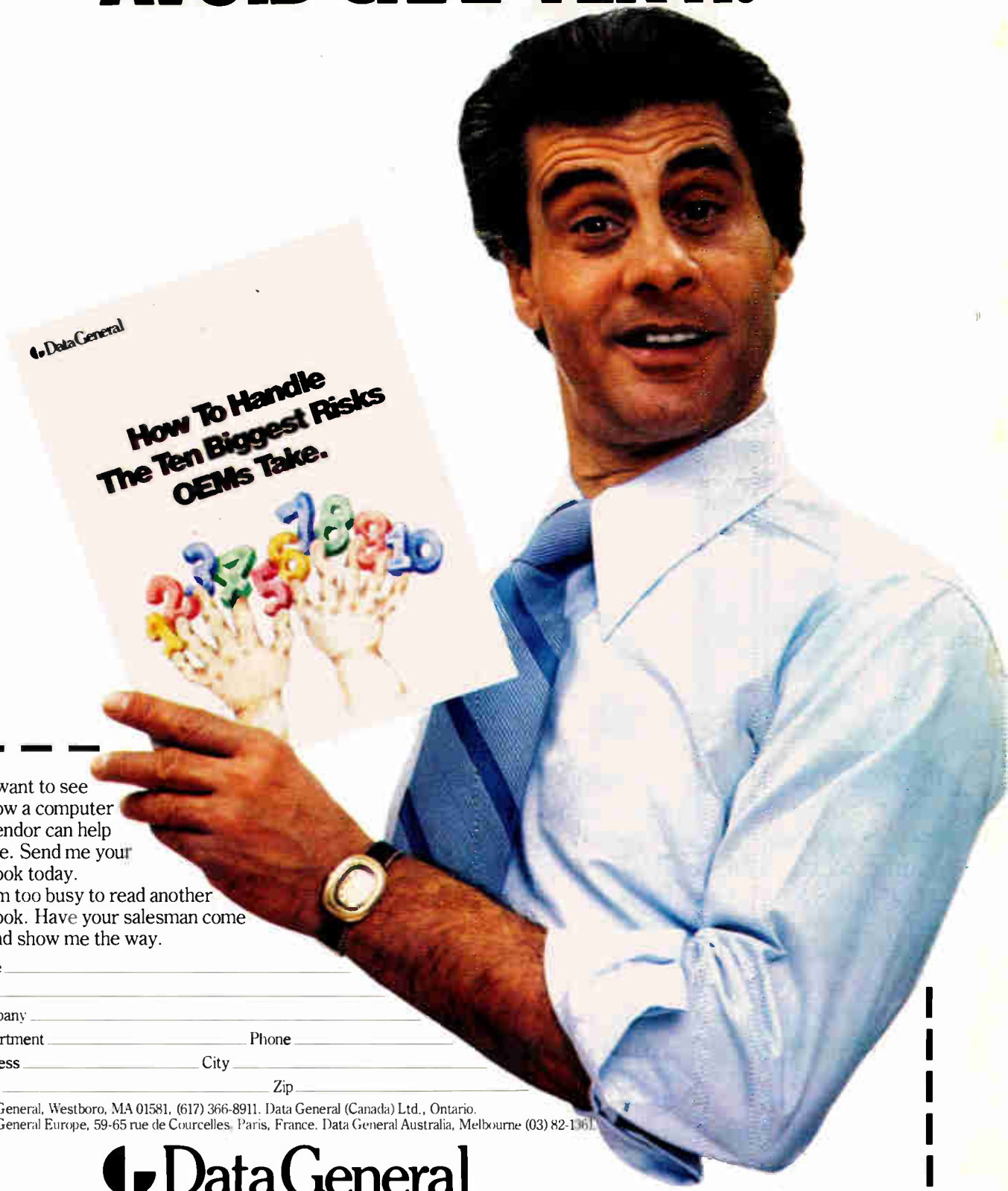
Electro-Optical Warfare II Symposium, Naval Ocean Systems Center (San Diego), Fleet Anti-Submarine Warfare Training Center, San Diego, Calif., May 10–11.

Conference on Software Engineering, IEEE, Atlanta Hyatt Regency Hotel, Atlanta, May 10–12.

Naecon—Aerospace and Electronics Conference, IEEE, Dayton Convention Center, Dayton, Ohio, May 16–18.

International Symposium on Circuits and Systems, IEEE, Roosevelt Hotel, New York, May 17–19.

READ THESE TEN CHAPTERS. AVOID CHAPTER 11.



☐ I want to see how a computer vendor can help me. Send me your book today.

☐ I'm too busy to read another book. Have your salesman come and show me the way.

Name _____

Title _____

Company _____

Department _____ Phone _____

Address _____ City _____

State _____ Zip _____

Data General, Westboro, MA 01581, (617) 366-8911. Data General (Canada) Ltd., Ontario.
Data General Europe, 59-65 rue de Courcelles, Paris, France. Data General Australia, Melbourne (03) 82-1361

Data General

We make computers that make sense

EX413

Intel delivers the micro components designers

There's no more efficient way to solve your interface and control requirements for microcomputer-based systems than our peripheral components.

They're single-chip solutions to even the most complicated operations, integrating up to 22,000 transistors per chip to replace circuit boards full of discrete logic with a single component. Result: you cut parts cost, reduce package count and board space, and simplify both development and operating software.

We've designed each of these peripheral chips to be an intelligent, programmable component in your system and to perform most functions with minimal cpu supervision. The resulting decrease in cpu overhead provides your system with higher performance and increased throughput.

"I can accomplish almost any I/O function with one chip using Intel's versatile peripheral interfaces and dedicated device controllers."

The dedicated function components below are available now, with more on the way. Here's a brief description of their versatility.

8271 Programmable Floppy Disk Controller. Provides full control of up to four standard or minifloppy drives. (Available early 1978.)

8273 SDLC/HDLC Protocol Controller. For SDLC and HDLC communications.

8275 Programmable CRT Controller. Provides fully buffered interface and control of almost any raster scan CRT display.

8278/8279 Programmable Keyboard/Display Interfaces. Keyboard/sensor array input scan, and output scan for LED, incandescent and other displays. 128-key or 64-key input.

8251A Programmable Communications Interface. Industry standard USART for synchronous or asynchronous serial data transmission, including bisync.

8253 Programmable Interval Timer. Contains three independent 16-bit counters, programmable modes from dc to 2MHz.

8255A Programmable Peripheral Interface. General purpose I/O interface with 24 individually programmable I/O pins.

8257 Programmable DMA Controller. Provides four-channel, high speed direct memory access independent of CPU.

8259 Programmable Interrupt Controller. Handles eight levels of vectored priority interrupt. Expandable to 64 levels.

computer peripheral are talking about.

UPI-41™ is Intel's Universal Peripheral Interface, bringing distributed intelligence to microcomputer systems for the first time.

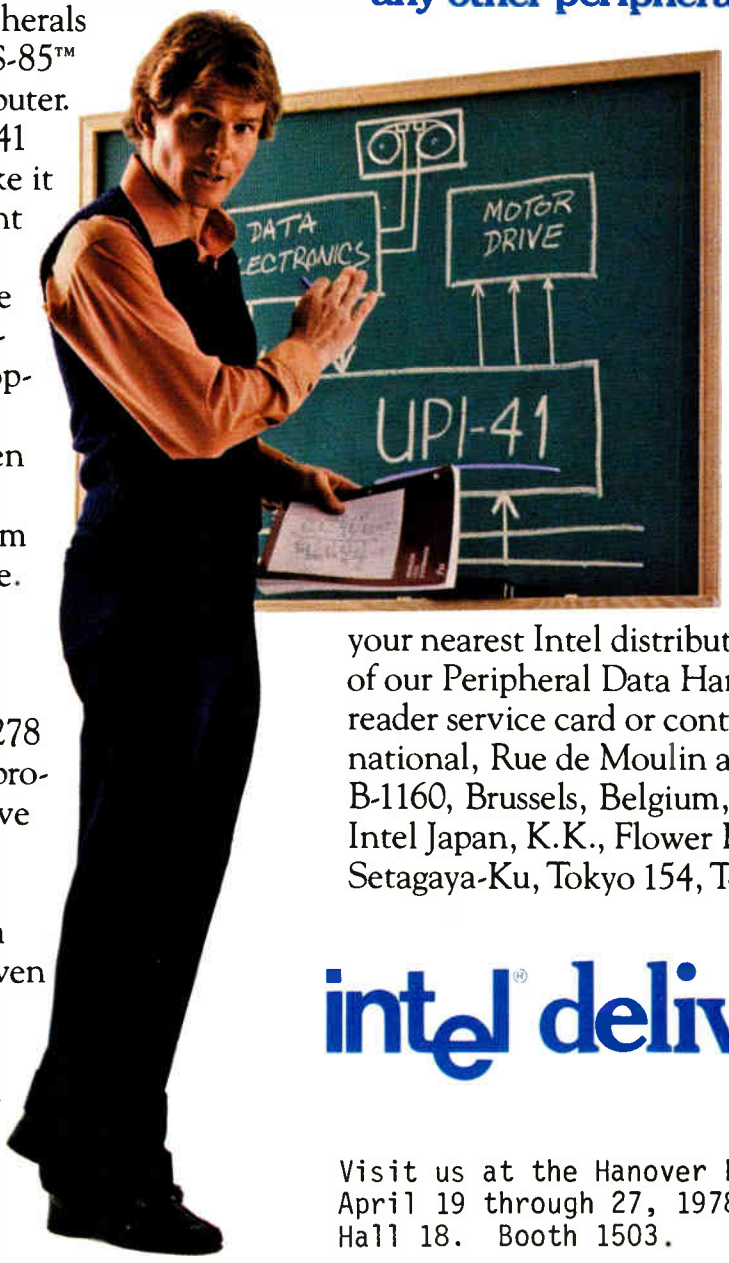
Actually a highly integrated, user-programmable microcomputer, UPI-41 is a new solution that obsoletes custom LSI and specialized discrete designs for interfacing most low and medium speed peripherals with an MCS-80,™ MCS-85™ or MCS-48™ microcomputer.

Intel delivers UPI-41 in two versions that make it easy for you to implement your own designs. The 8741 includes an erasable and reprogrammable 1K-byte EPROM, for development, testing and low volume production. Then the 8041, with masked ROM, provides maximum economy in high volume.

We've taken the UPI-41 concept a step further with the 8278, described at left. The 8278 is the first of several preprogrammed 8041's that we've adapted to specialized applications.

Because UPI-41 is a microcomputer, we've given it the same high level of support we give all our microcomputers. UPI-41 is supported by our Prompt™ 48 Design Aid, the Intellec® microcomputer development system with resident UPI-41/MCS-48 Macro Assembler. Plus applications assistance worldwide, full documentation, training classes, design seminars and a rapidly expanding users' software library.

"And, for my special I/O requirements, Intel's UPI-41 Universal Peripheral Interface is user programmable to control nearly any other peripheral device."



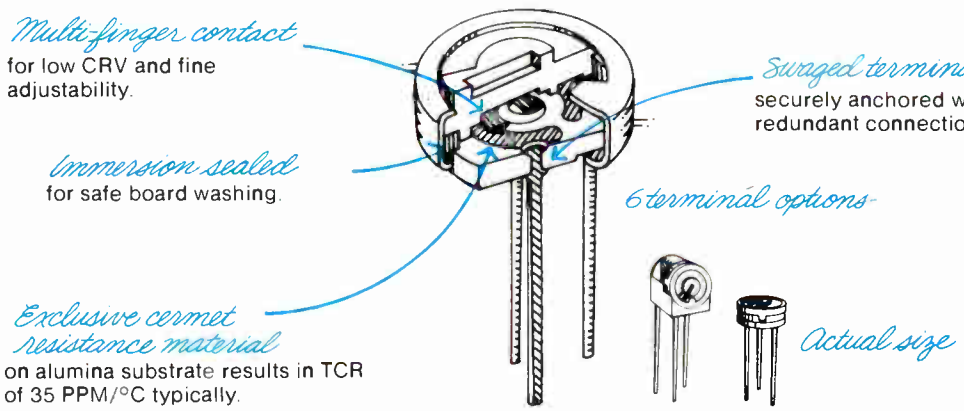
Intel's peripheral components, and the MCS-80, -85 and -48 microcomputers they support, are available through your nearest Intel distributor. For your copy of our Peripheral Data Handbook use the reader service card or contact: Intel International, Rue de Moulin a Pápier, 51-Boite 1, B-1160, Brussels, Belgium, Telex 24814; or Intel Japan, K.K., Flower Hill-Shinmachi, Setagaya-Ku, Tokyo 154, Telex 781-28426.

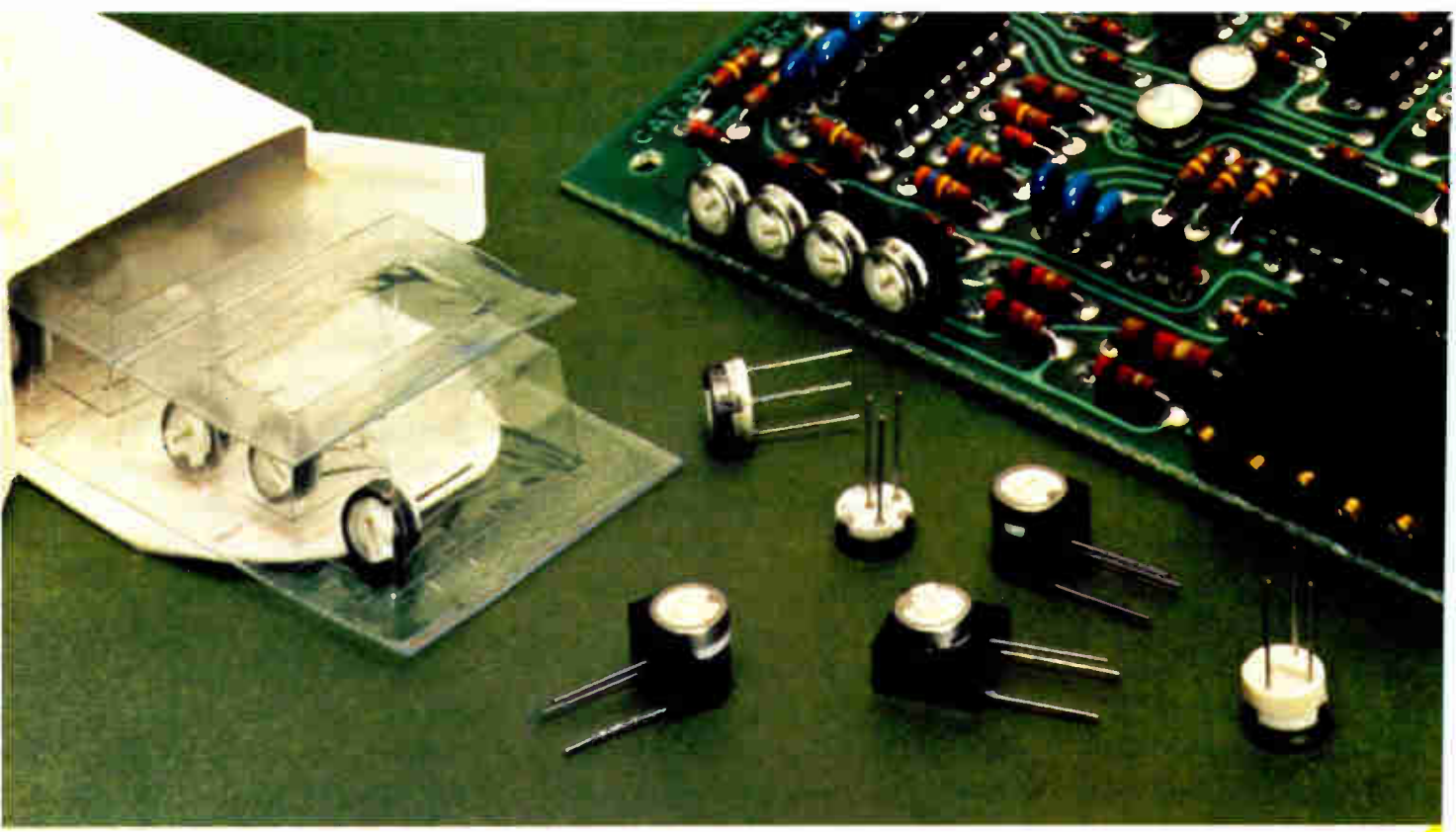
intel® delivers.

Visit us at the Hanover Fair '78
April 19 through 27, 1978. Cebit-West,
Hall 18. Booth 1503.

Type A ¼" trimmers. A reliable cure for cramped PCB's.

Our Type A ¼" cermet trimmer gives you low profile, lowest TCR for a tiny package of high performance... and an ideal solution for cramped printed circuit boards. 10 ohms to 2.5 megs. 0.5 watt at 85°C. -55°C to +150°C temperature range. You get great variety plus greater savings, too. $0.96 each—1000 piece lot. We have what you need; our distributors have it when your need is now. Ask for Publication 5238.





Quality in the best tradition.

ALLEN-BRADLEY
Milwaukee, Wisconsin 53204

CONTACT YOUR ALLEN-BRADLEY DISTRIBUTOR OR WRITE TO ELECTRONICS DIV.

EC159

Circle 34 on reader service card

Electronics newsletter

GE to market projection TV in one cabinet

General Electric Co. plans to start shipping in June a $2,700 television set with a 45.7-inch-diagonal screen—actually, a projection system that is enclosed in a single cabinet. Although the receiver cabinet is 50 in. high and 70 in. long, **it is only 24 in. deep as a result of an L-shaped rear-projection system using a mirror.** The color picture is produced by a 13-in. picture tube with in-line electron guns mounted on a 32-kv solid-state, modular chassis. The 1,003-in.^{2} picture is then projected through a three-element f1.6 acrylic lens developed for GE.

Crystal oscillators from Motorola to sell for $3.75

Motorola Inc. is about to crash through the $5 barrier for crystal clock oscillators with a trio of thick-film hybrids it plans to start shipping in June. Noting designers' growing tendency to use a single master frequency to clock all elements of their systems, the firm's component products department in Franklin Park, Ill., **has chosen three frequencies to introduce as "standards."** The three—16,000, 18,432, and 19.6608 megahertz—can be divided down to provide the different clocking signals needed by both the system's microprocessor and its baud-rate generator. In lots of 1,000, the parts will be tagged at $3.75 each in an attempt to create standards for the industry and thus attract the volume orders needed to support that low price. Frequency drift will be rated at ±0.05%.

Micro Networks to add analog I/O boards

Add the name of Micro Networks Corp. to the growing list of companies making analog input/output boards for microcomputers. The Worcester, Mass., company, best known for its hybrid data-converter products, **will introduce its first plug-in microcomputer board, probably in June.** Called the MN7300, it is designed to mate with the Intel SBC 80/20 and will offer a variety of options. The unit has 16 single-ended (8 differential) input channels, with the option of going to 32 or 16, respectively, if the board contains a Micro Networks multiplexed expander circuit. The price will range from about $600 to $1,200, depending on options. The company expects the 7300 to compete with the RTI-1200 from Analog Devices Inc.

Environmentalists oppose PAVE PAWS as health peril

The Air Force has run into strong environmentalist opposition to the PAVE PAWS radar that it is building at Otis Air Force Base on Cape Cod for early detection of sea-launched missile attacks against the U. S. An organization called Cape Cod Environmental Coalition Inc. is suing the Air Force in hopes of obtaining an injunction to prevent the phased-array system at Otis on Cape Cod from being completed or tested. The group alleges, among other things, **that its operation would subject residents near the facility to harmful levels of microwave radiation.** It also wants the Air Force to prepare an environmental impact statement.

Raytheon Co. is prime contractor for the system to the Air Fore Electronic Systems division at Hanscom Air Force Base, Mass., and has been awarded contracts totaling more than $80 million for its two installation, the other being at Beale Air Force near Sacramento, Calif. Air Force officials maintain that an environmental assessment done prior to construction at Otis shows that there would be no harmful results from the radar's operation.

Electronics newsletter

Multiuser MDS to bow at Electro 78

The Boston Systems Office Inc. and Tektronix will demonstrate at Electro 78 (May 23–25) a microprocessor development system featuring simultaneous multiuser capability. "This system concept allows several simultaneous users **to develop several microprocessor-based designs, even where the designs use different families of** CPUs," Michael Rooney, Boston Systems president, says. These include the 8085A and 8080A, 9900, 6800, and Z80 families. Instead of spending $35,000 for the two Tektronix 8002 development systems, a user can buy a $28,650 version of the new system and get the same functional capability, says Theodore W. Gary, a Tektronix market development specialist.

Switching supplies feature power in small package

Switching power supplies are beginning to give linear supplies a run for their money at low-power levels. The latest company with switchers at 25 w is Computer Products Inc. of Fort Lauderdale, Fla., with two series to be introduced later this month **that probably deliver more power in a smaller package than any other encapsulated switching power supply.** The series differ only in configuration—one is for chassis mounting and the other for printed-circuit-board insertion. Both series have identical output models, ranging from 5 V at 5 A to 15 V at 1.8 A, have 80% efficiency at full load, and are epoxy-encapsulated to withstand vibration. Prices for the chassis-mountable models range from $105 to $110 singly, but prices for 100 or more drop to $89.25 for some models. Prices for the pc-board style are $99 to $104, with 100-and-up priced as low as $84.25.

Mysterious radio signals are neither mystery nor radio

Mysterious radio signals in the Eugene, Ore., area have been reported to be everything from extraterrestrial in origin to Soviet experiments. But the signals are neither mysterious nor radio, says Clifford Schrock, a Tektronix engineer who has privately quantified them. **They appear to be electrostatic, he says.** "The phase varied identically with Bonneville Power Administration line variations," he says, "indicating the source is connected to that grid." Therefore, Schrock continues, the signal with its 300 ns spikes—with peaks at 4.7 and 7.5 MHz—is probably caused by a high-power-consuming industrial facility in southeastern Eugene with rectifier stack problems or by a large electrical rotating machine with commutator problems.

Addenda

After warning buyers that they may have inadvertently purchased thousands of substandard 1702A 2-K erasable programmable ROMs. Advanced Micro Devices has slapped **a $1 million lawsuit alleging trademark infringement against two southern California independent distributors.** The two distributors, A-OK Electronics of Los Angeles and Gentronix of Hawthorne, have been temporarily restrained from selling 1702As with apparent AMD markings. . . . . A 32-bit minicomputer capable of operating from the huge existing base of IBM 370 software at a much lower price tag bows this week from Two Pi Co. of Hayward, Calif. Aimed at commercial data-processing and distributed data-processing applications, **the Two Pi/V32 operates in the same performance class as the 370/138 but without some of the IBM machine's features.** It can directly address up to 4 megabytes of memory, however, and operates in full virtual mode. With 1 megabyte of memory and four input-output channels, it costs about $190,000.

1024 (One Thousand Twentyfour) Instructions with the New Infrared Remote Control System from ITT Semiconductors

We have always considered it essential to apply our worldwide know-how to trend-setting developments.

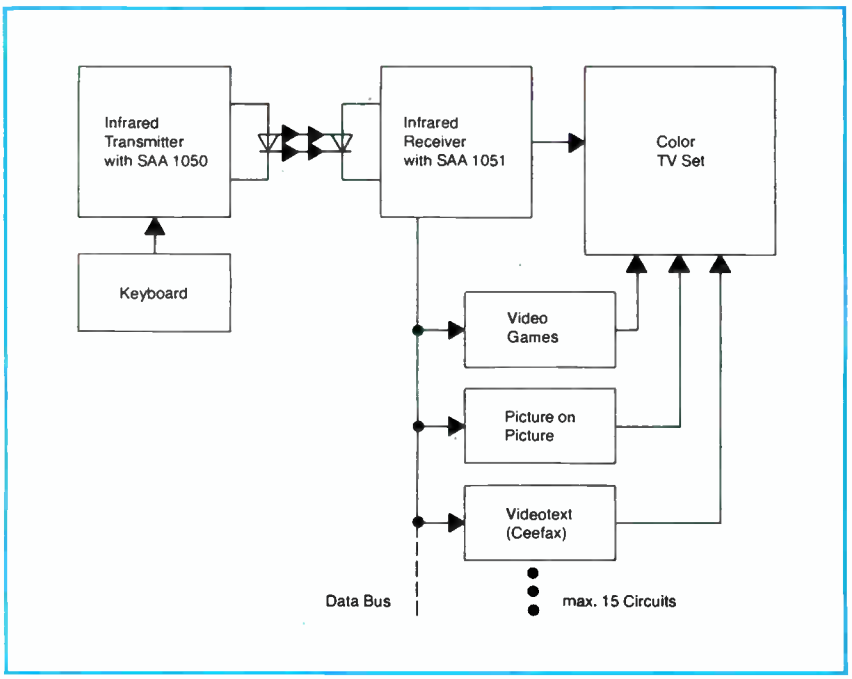
In the early 1970s it was already known that a color TV set could best be adjusted for an optimum picture from only the right viewing distance. The first remote controls using heavy cables appeard on the market. And then came the wireless but expensive and delicate controls.

We found the ideal solution... thanks largely to our expertise gained in developing those now legendary tuning diodes for controlling analog and digital signals in a TV set. (Meanwhile, a diode tuner fitted with our integrated circuit SAA 1021 can be used also for fully electronic channel selection.)

In those days we started looking for new control concepts... and we developed our 30-channel ultrasound remote control system SAA 1024/25, a system that has become the most popular in Europe today and has propelled INTERMETALL, our German based activity, to the top position among European producers of MOS devices for consumer applications. Together with our partners in the TV Industry we have continually expanded our knowledge and refined our technologies so that we can now present our highly flexible and long lived

Infrared Remote Control System SAA 1050/51

Technical Features:
- transmission system for 64 individual instructions, all assignable to 16 different addresses, giving a total of 1024 instructions
- transmitter IC SAA 1050 in CMOS technology
- receiver IC SAA 1051 in silicon-gate P-channel technology, a specialized microprocessor
- signal transmission by pulse-code modulated infrared light
- long transmission distance
- high noise immunity through integrated interference suppression circuit
- long life of transmitter battery
- four operation options for the receiver IC
- only one transmitter for 16 pieces of equipment or addresses



Block Diagram of the new Infrared Remote Control System with the Integrated Circuits SAA 1050 and SAA 1051

The dialogue and cooperation with our customers has borne fruit; our new transmission system is just what the industry wants.

The ongoing know-how exchange with our partners has shown that a revolutionary control system such as ours must also be capable of controlling features in the audio and video field that are still in the early stages of development, for example intelligent TV games, teletext, viewdata, remote programming of high-fidelity equipment, etc.

We will gladly give you more details. Ask for our data sheet 6251-110 and for the application consultants in your country.

Production and Marketing Centers: **U.S.A.:** ITT Semiconductors, 500, Broadway, Lawrence, Mass. 01841, Tel. 617-688-1881, Telex 7103420764, **U.K.:** ITT Semiconductors, Footscray, Sidcup, Kent, Tel. 3003333, Telex 21836, **W. Germany:** INTERMETALL GmbH, P.O.Box 840, D-7800 Freiburg, Tel. (761) 5171, Telex 07-72716, **Japan:** ITT Semiconductors, P.O.Box 21, Shinjuku-ku, Tokyo 160-91, Tel. 3478881-5, Telex 22858.

semiconductors ITT

At last. The 2901A, one upped.

Announcing a faster, fully spec'd 2901A 4 Bit microprocessor slice.

It's a unique blend of ECL and Schottky, fully pin-compatible, and faster than any other 2901A in the world.

Here are the numbers.

	Typical	Commercial	Military
Our data:	25° C (5V)	0°-70° C (4.75-5.75V)	−55-+125° C (4.5-5.5V)
A, B Inputs —> Y Output	37ns	65ns	80ns
C_n —> Y Output	18	30	35
D Input —> Y Output	20	40	45
Clock —> Y-Output	35	60	65
Minimum Clock Period	45	60	75
Read-Modify-Write Cycle	45	60	75

And if you think those are hot specs, wait'll you see our 2901A-1 coming soon.

Specs like this really shouldn't come as a big surprise to you.

After all, we're the industry leader in bipolar technology. And we invented Bipolar Tri-State™ (which is used with the 2901A).

And another nice thing is all the parts we support the 2901A with.

First off, a family of 16 products, all fully spec'd.

Our family:

IDM2901A	4-Bit Microprocessor Slice
IDM2902	Carry Look-Ahead Generator
IDM2909A	Microsequencer
*IDM2911A	Microsequencer
IDM29702	16 x 4 Bit RAM (open collector)
IDM29703	16 x 4 Bit RAM (Tri-State)
IDM29750	32 x 8 Bit PROM (open collector)
IDM29751	32 x 8 Bit PROM (Tri-State)
IDM29760	256 x 4 Bit PROM (open collector)
IDM29761	256 x 4 Bit PROM (Tri-State)
IDM29803	16 Way Branch Controller
IDM29811	Next Address Controller
*IDM29901	Octal Tri-State
IDM29902	Priority Encoder
IDM29903	16x4 Edge-Triggered Register (Tri-State)
*IDM29908	Quad Gated Flip Flop (flag control)

*Available soon.

Also, we supply a complete line of low-power Schottky MSI, MOS static and dynamic RAM's, as well as all the other parts you need to build a complete, high-performance processor.

So if you need to know who to go to for everything you need, now you know.

E 4/13

National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10
West Germany
Gentlemen:

☐ Please send more information on your 2901A and its support products.

Name _____ Title _____

Company _____

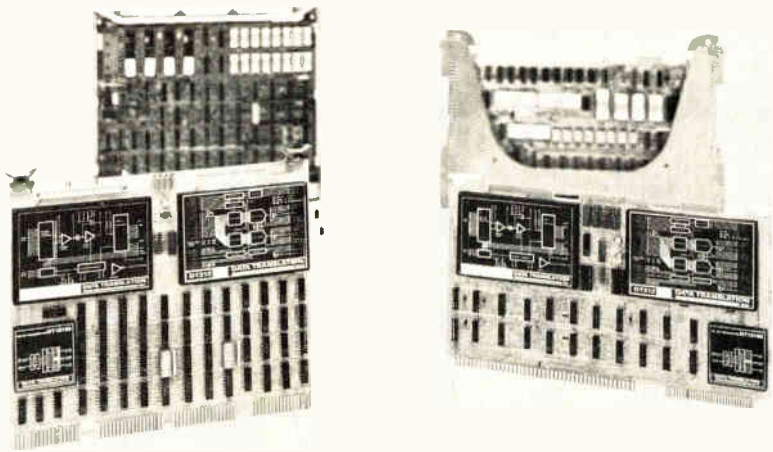
Address _____

City _____ State _____ Zip _____

National Semiconductor

5 DAY DELIVERY

Microcomputer Analog I/O Systems with extensive software diagnostics



For:

INTEL SBC-80 Series (8080A)
ZILOG MCB Series (Z-80)
DEC LSI-11 & LSI-11/2
Computer Automation LSI 2,3 & 4 Series
National Semi IMP/PACE & BLC-80 Series

PLUS the widest selection of Data Acquisition Modules anywhere. Concentrate on the Software and other key system Requirements... and let us take care of Your Analog Problems.

SEND for Full Technical Data or Call us.

GSA Contract No. GS-00S-64219

DATA TRANSLATION INC
4 Strathmore Rd., Natick MA 01760
(617) 655-5300 Telex 94-8474

INTERNATIONAL SALES OFFICES: ARGENTINA, Buenos Aires, 89-4594; AUSTRALIA, N.S.W. (02) 747-2731; BELGIUM, Brussels 02-352135; ENGLAND, Cheshire (061 23 2321; FINLAND, Helsinki, 90-357457; FRANCE, Buc 956.31.30; GERMANY, Puchheim (089) 80 60 61-62; INDIA, Bombay 298686; ISRAEL, Ramat Hasharon; ITALY, Milan 34.93.041; JAPAN, Tokyo (03) 355-1111; NETHERLANDS, Rijswijk 70-996360; NEW ZEALAND, 814 9385; NORWAY, Olso 0269 44 90; PORTUGAL, Lisboa 4 53 13; SPAIN Barcelona (93) 301 78 51; SWEDEN, Vallingby 08 38 00 65; SWITZERLAND, Zurich 01/54 70 60

Circle 40 on reader service card

RCA to make Intel parts using SOS

Agreement gives RCA right to design Intel microcomputers with silicon on sapphire; Intel gains SOS know-how

The semiconductor industry is apt to take a harder look at building complementary-MOS circuits with the silicon-on-sapphire process in the wake of last week's technology- and product-exchange accord between RCA Corp. and Intel Corp. And RCA, for one, couldn't be more pleased.

"We got what we wanted," says Carl R. Turner, vice president for integrated circuits at RCA's Solid State division in Somerville, N. J., which has been working on SOS for some five years. "We were looking for someone to acknowledge what we've been telling our customers about the virtues of SOS and to get additional products. This agreement does both."

Although instrument and computer manufacturer Hewlett-Packard Co. of Palo Alto, Calif., has its own SOS process and uses some of RCA's SOS parts, Turner notes: "When you're in the automobile industry, it's nice to be acknowledged by General Motors. We're in the microprocessor business, and Intel is the General Motors of that industry."

Pact details. Terms of the three-year nonexclusive pact enables RCA to design high-density SOS versions of Intel's high-performance 8-bit microprocessor, the 8085A, and the 8048 single-chip microprocessor, both of which are n-channel metal-oxide-semiconductor devices. Further, Intel will provide RCA with know-how for developing C-MOS-on-sapphire versions of its 8155 random-access memory with input and output ports and 8355 read-only memory with I/O, as well as supply support hardware and software.

In return, Intel's Microcomputer Components division in Santa Clara, Calif., is to get technical information on RCA's SOS technology and the design of RCA's SOS versions of the Intel parts. Thus, if it chooses, Intel may alternate-source the SOS versions of its chips.

With the information provided by RCA, Intel can evaluate the trade-offs between further squeezing n-MOS and shifting to another technology for future large-scale and very-large-scale integrated devices. And SOS is worth considering as a hedge for the future: it not only offers high speed and low power, but also may prove to be competitive with other advanced MOS processes in terms of density and cost.

However, Leslie L. Vadasz, vice president and general manager of Intel's Microcomputer Components division, scotches any thought that the company is going into the SOS business. "We're committed to n-channel," he says, "because it is the mainstream LSI of the future." As for any eventual involvement in SOS, he says Intel will continually evaluate its position.

Low power. The reason that Intel went for the RCA deal, Vadasz stresses, is that it enhances the 8048 and 8085 family in low-power applications. "The realization of Intel's 8085 and 8048 microcomputers incorporating RCA's C-MOS-on-sapphire technology," he states, "will allow many customers to whom power considerations are paramount to use these industry-standard product families."

In hand. RCA's Carl Turner holds key element in the agreement: a 40-mil-thick ribbon of sapphire, 3 ft long and 3 in. wide.

Just as Intel is pledged to its n-MOS program, RCA is fully committed to continue its CDP1802 C-MOS microprocessor program and to its plans to introduce the 1804 single-chip SOS microcomputer later this year, Turner says. "The signing of the agreement with Intel in no way decreases our thrust to expand our Cosmac family."

But why offer two types of microcomputer? Because the 1804, for example, is register-oriented to provide easy I/O access and "is a natural

pairs for push-button dialing. It is also readying a tone receiver, a part that should push its tone dialers into applications beyond the telephone.

But Mostek reserves most of its enthusiasm for pulse dialers. Now that the Federal Communications Commission lets consumers buy phones from firms other than telephone operating companies, the company sees a much larger near-term market for pulse dialers that can be used on the older rotary-dial networks. In February it unveiled a chip that converts push-button keyboard inputs to pulse signals that simulate those from a rotary telephone dial.

Pulse dialers grow. To date, the largest telephone maker to turn to the integrated-circuit approach for dual-tone multifrequency dialing is GTE Automatic Electric Co. Mostek reportedly supplied that manufacturer with more than 1 million parts last year. Overall, the market for monolithic tone dialers is growing more than 20% each year, with about 5 million units expected to be shipped worldwide this year, according to James M. Garrett, marketing manager for industrial products at the Carrollton, Texas, firm. In contrast, the demand for pulse dialers should grow to 15 million units by 1980, up from this year's 2 million, he says.

The reason for the difference in growth rate is obvious. "There are many places in the U. S., and especially in Europe, where tone dialing is not installed yet, and won't be for several years," points out Robert J. Paluck, manager of Mostek's Industrial Products department. "But button-to-pulse dialing will work on both pulse and tone networks." Further, each telephone operating company has different sets of specifications for tone dialing, whereas pulse timing on the two networks is standard. The upshot is that consumer telephone makers are building push-button phones with pulse dialers that are compatible with all phone systems in order to limit the number of phone types they must turn out.

Moreover, there are signs that the traditional telephone manufacturers will drop rotary dials and make push-button phones with pulse outputs instead, Paluck adds. That is because the $2 pulse-dialer chip will operate from a single-contact, calculator-type keyboard—a cheaper, more reliable assembly than either the dial mechanism now used in rotary phones or the two-of-seven-tone sliding matrix keyboards in today's mechanically implemented tone dialers.

Although Mostek's new pulse dialer, joining one- and two-chip approaches already on the market from General Instrument Corp., Motorola Inc., and Siliconix Inc., will be able to tap immediately into the gigantic market for individual telephones, that is not the case with its upcoming tone receiver. But the part will dramatically simplify the $90 to $200 tone-receiver assemblies now sold for private-branch-exchange and telephone central-office switching equipment: the assembly's price should fall to under $15 within two years, Paluck estimates.

That price will open up markets beyond telephone equipment. "We see a new market that we call 'interactive communications' that utilizes the tone dialer and tone receiver together," Garrett says. "It allows the user, over telephone lines or radio waves, to control some type of device," he adds, citing credit-verification terminals, security systems, push-button telephone order-entry systems, and remote control of oil field pumps. A major application will be in home computer systems that could allow control of lights, heating, appliances, and security—all from a pay phone booth, he says.

Eventually, tone receivers will be built into telephones as well. "We foresee intelligent telephones with the ability not only to dial but also to receive digital information," he says. Such a phone could, for example, display the phone number of people trying to call a busy line. □

Avionics

Air Force finds new gyroscope for F-4 that is cheaper, more reliable

The Air Force is equipping its F-4 fighters with new rate gyroscopes from a somewhat surprising source: Timex Corp., the manufacturer of low-cost watches. True to the company's reputation in watches, its gyros are much less expensive than those they replace. They will also last much longer.

The gyro project is being managed by George Britton of the Productivity, Reliability, Availability, and Maintainability program office. With headquarters at Wright-Patterson Air Force Base, near Dayton, Ohio, PRAM is a joint organization of the Air Force Systems and Logistics Commands. Its charter is to lower operating and support costs of Air Force weapons systems.

Britton calculates that the substitution—the new fluid-damped gyros are to replace magnetically damped units developed close to 20 years ago—will save the Air Force at least $2 million over the next five years.

It is a matter of catching up with the development of technology, Britton says. The KR-7 gyros in the F-4 stability-augmentation system were state-of-the-art devices when first built by General Electric, he points out, but their mean time between failure of 500 hours has been considered low for some time and the cost of a replacement has climbed to $1,800 each. The Timex gyro costs about $900 and has an MTBF of 3,000 hours.

The way the Air Force decided to substitute a gyro like Timex's is an example of the serendipity with which the PRAM office often carries out its task. Britton, the office's chief engineer with 20 years spent at Wright-Patterson, had been called in to consult on another Air Force program—the Pave Penny target-

SCIENCE/SCOPE

The concept for an air-to-air missile half the size with twice the performance of the AIM-7F Sparrow has been proved feasible in a recent program conducted by Hughes under contract to an Air Force/Navy joint system program office. Using new technology and improved state-of-the-art, AMRAAM (Advanced Medium Range Air-to-Air Missile) will provide a "launch and leave" capability plus the option of launching several missiles at multiple targets. The Hughes design features a patented solid state power combiner, which is the key to the active radar seeker, and takes full advantage of the latest digital technology and micro-miniaturization of electronics. It will be compatible with the F-14, F-15, F-16 and F-18. AMRAAM also features a low-smoke, high-impulse rocket motor which reduces the chances of an enemy pilot sighting either the launch or the oncoming missile and taking evasive action.

The highest TOW missile first-fire hit ratio yet recorded by a U.S. unit has been earned by the Marine Corps at Camp Pendleton, CA. where Marines scored a 96.6% hit rate -- 143 out of 148 tries -- on stationary targets. Developed by Hughes for the U.S. Army, TOW (Tube-launched, Optically-tracked, Wire-guided) today is deployed in the air and ground forces of more than 20 nations worldwide. The airborne version of TOW also is used as an anti-tank missile system by U.S. Army and Marine Corps helicopter units. The missile in flight is 117 cm long, 15 cm in diameter and weighs 19 kg. Its maximum range in the air is 3,750 meters.

An off-the-shelf compact digital tracker for airborne targets is available now from Hughes. Only 45 pounds and shelf- or rack-mounted, the electro-optical tracker is employable in a TV tracking system which includes a TV camera, gimbal platform and servo amplifier.

The tracker features automatic acquisition of valid targets within the TV field of view and automatic gate-sizing to conform with target dimensions. Its digital and analog processors, optimized for airborne targets, generate the azimuth and elevation air signals that drive the gimbal servo and keep the TV camera pointed toward the tracked object.

Hughes Electron Dynamics Division in Southern California has opportunities for: physicists, mechanical engineers, electronic engineers, materiel and process engineers to work in the design and development of microwave traveling wave tubes, traveling wave tube amplifiers, materiel and solid state research and development. For immediate consideration, please send your resume to: Hughes Aircraft Company, Electron Dynamics Div., Professional Employment, P.O. Box 2999, Torrance, CA 90509.

The Satellite Business Systems Corporation has completed negotiations with Hughes to build three communications satellites for its domestic system. (Its members: Aetna Life & Casualty, Comsat General, IBM.) SBS is designed to provide fully switched private networks to businesses, government agencies and others with varied, large volume needs. SBS service will be all-digital, transmitting voice, high-speed data, facsimile and video-conference information in a Time-Division Multiple-Access mode. The SBS spacecraft will be the first to offer point-to-point service within the U.S. using the K frequency band (12 to 14 Gigahertz.) It can be launched either by Space Shuttle or the veteran Delta rocket booster.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

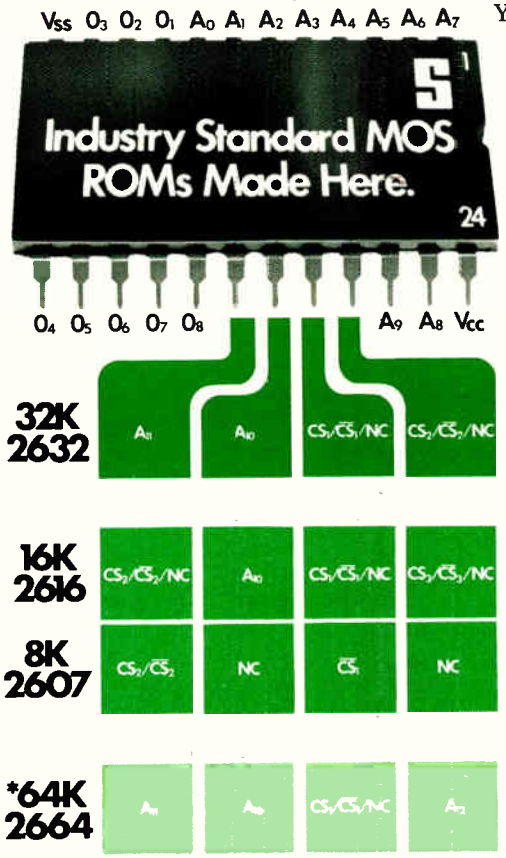
Our dedicated MOS processing line can make our ROMs into your ROMs a lot faster than you might think.

When we give you a promise on ROM delivery, you can consider it a commitment.

Ordering ROMs is easy. Getting your ROM order when you need it is not so easy. ROM production is a custom business filled with variables. Your program mask is unique. ROM quantities vary widely. Your parts must be handled separately—and carefully—through all stages of fab, QC, assembly, test and, lastly, shipment. These factors can snowball to cause problems.

Except at Signetics.

Dedicated Processing Means Predictable Delivery. At Signetics, we maintain a completely separate production line for MOS ROMs. This dedicated processing means efficiency, process uniformity, and predictability. It also means faster turnaround from mask design to finished product. And it enables us to tell you—in advance—when your order will be shipped. Dedicated processing is our guarantee to you that your custom mask ROM order won't be bumped by someone else's requirement for a standard memory product.



All Signetics MOS ROMs Have Standard Pin-Outs. When you design with our ROMs, regardless of the initial density specified, memory expansion is automatically built in. All Signetics ROMs are socket-compatible, and are designed to the industry-standard 24-lead pin configuration. They're also compatible with the 2708 and 2716 EPROMs. You can design future systems now, upgrading density as required in the same socket.

A Fully Static ROM Family—Single +5V Power Supply Optimizes Design. Ordering your ROMs from Signetics can produce a lot of other benefits. We can offer you everything you need in fully static MOS ROMs from 8K to 32K.* They're TTL-compatible, require a single +5V power supply, and feature state-of-the-art access time.

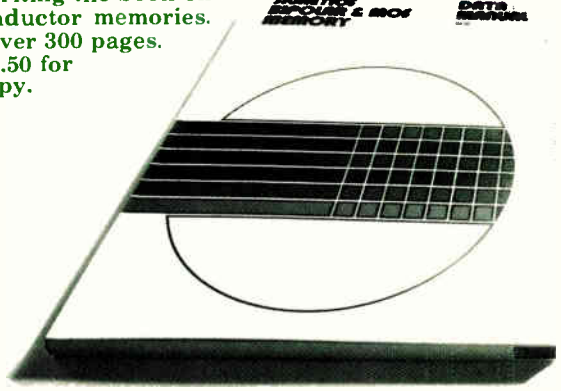
Our recent history as a ROM supplier will tell you something, too. In 1977 our ROM sales tripled. This year, we expect to triple again.

Call your local distributor today or use the coupon below to order your technical data on Signetics' growing family of high-performance MOS ROMs and EPROMs.

signetics
a subsidiary of U.S. Philips Corporation

Signetics Corporation
811 East Arques Avenue
Sunnyvale, California 94086
Telephone 408/739-7700

We're writing the book on semiconductor memories. It has over 300 pages. Send $3.50 for your copy.



*You can expect an industry-standard 64K ROM from Signetics in the third quarter.

To: Signetics Information Services, 811 East Arques Avenue
P.O. Box 9052, MS 27, Sunnyvale, CA 94086

Please send me technical data on the following products:
☐ 8K ROMs ☐ 16K ROMs ☐ 32K ROMs ☐ Denser ROMs
☐ 8K EPROMs ☐ 16K EPROMs ☐ 32K EPROMs ☐ Denser EPROMs

I have an urgent requirement. Please have a ROM specialist phone me at once: (_____) _____, Ext._____

Name _____ Title _____

Company _____ Division _____

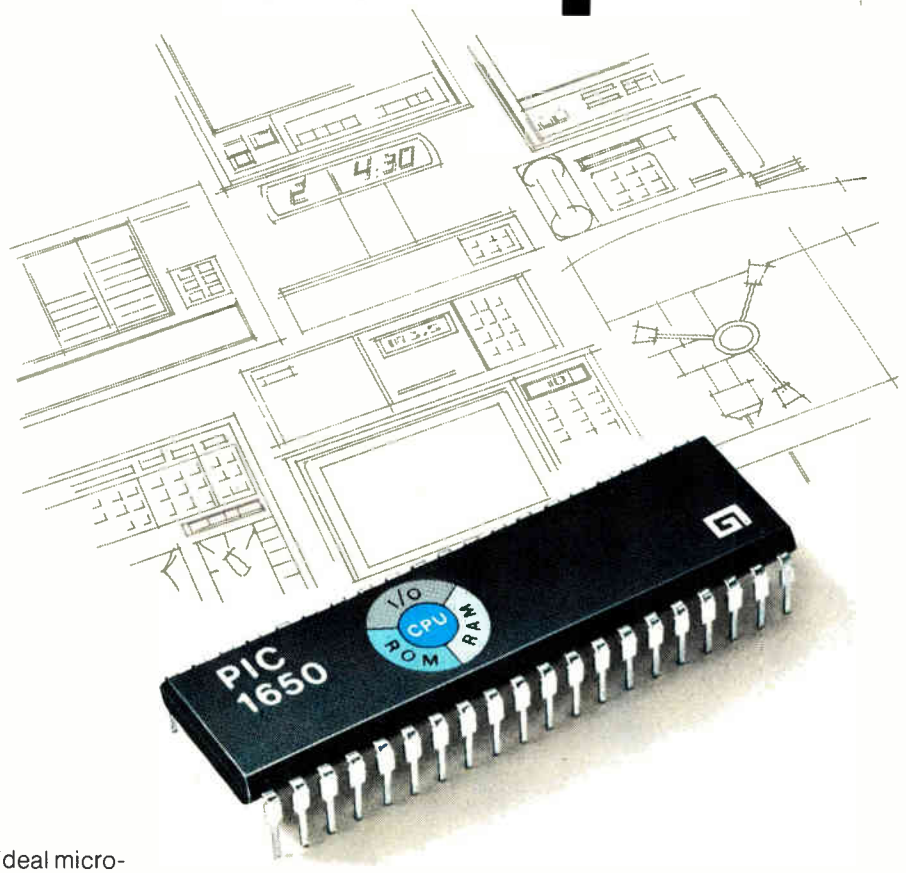
Address _____ MS _____

City _____ State _____ Zip _____

☐ Enclosed is my check for $3.50. Please send me your Memory Data book.

EM-413

The GI single-chip microcomputer.



GI's PIC 1650 series are the ideal microcomputers for low cost, high volume applications. These 8-bit single-chip stand alone controllers will add new dimensions to your appliance, automobile, vending machine, home entertainment unit or any number of other products. Emphasis is on versatile control.

GI Microelectronics has put more on its PIC 1650 chip. There is no other low-cost microcomputer that matches its performance. This allows you to include many features beyond the capability of other low-cost microcomputers. So you have less to buy, inventory, test and assemble.

The PIC 1650 has a 512 by 12-bit ROM and a 32 by 8-bit register for read/write memory. Four sets of eight TTL compatible I/O lines and on-chip clock are other characteristics of this chip, all in a single 40 lead DIP.

If you're pressed for space (and can live with less I/O) try the PIC 1655, available in a space-saving 28 lead DIP.

GI engineers stand ready to assist in your important move to "microcomputerization." They've got software and development systems. And they have the ROM-less PIC 1664 for plug-in circuit emulation—using a choice of programmable ROM or RAM. Call or write the low-cost, single-chip microcomputer system experts. General Instrument Microelectronics Ltd., Regency House, 1-4 Warwick Street, London W1R 5WB, England, Telephone: 01-439-1891.

We help you compete.

GENERAL INSTRUMENT CORPORATION
MICROELECTRONICS

out a power supply will sell for $1,350 in quantities for original-equipment manufacturers.

The standard machine will come with two typefaces of 96 characters each that are stored in read-only memory. Additional typefaces can be stored—up to 20 of them—in the 56,000 bytes of read-only memory provided for in the machine. □

Micros handle network protocols

Adding to the many chores they already do for large computers, microprocessors are catching on at the computers' front ends, as an interface to telecommunications networks. The hard part of this job is to reconcile the myriad protocols the many different computer firms have evolved for allowing their own computers to communicate.

This is where Computer Automation Inc., the Irvine, Calif.-based minicomputer maker, comes in. It is using a Zilog Z80 microprocessor to sort out the protocols so that its computers can talk with other manufacturers' machines.

The Z80 is the brain in the company's so-called Distributed Data Base Processor—a pair of printed-circuit boards that fits into the firm's minicomputers. This processor in turn is the key element in the company's ambitious Virtual Network, to be introduced later this month.

Tied together. This new distributed-processing network allows up to 31 of Computer Automation's SyFa minicomputers and 992 terminals to be linked by one control computer. An unlimited number of these networks can be tied together, along with equipment built by other manufacturers, because of the protocol-handling capability of the Distributed Data Base Processor.

The Virtual Network depends on the Z80 processor to go into action on an incoming protocol transmission. As extra cards are added for different protocols, which is what the company expects customers to do and has provided space for, the Virtual Network can support a profusion of computer equipment.

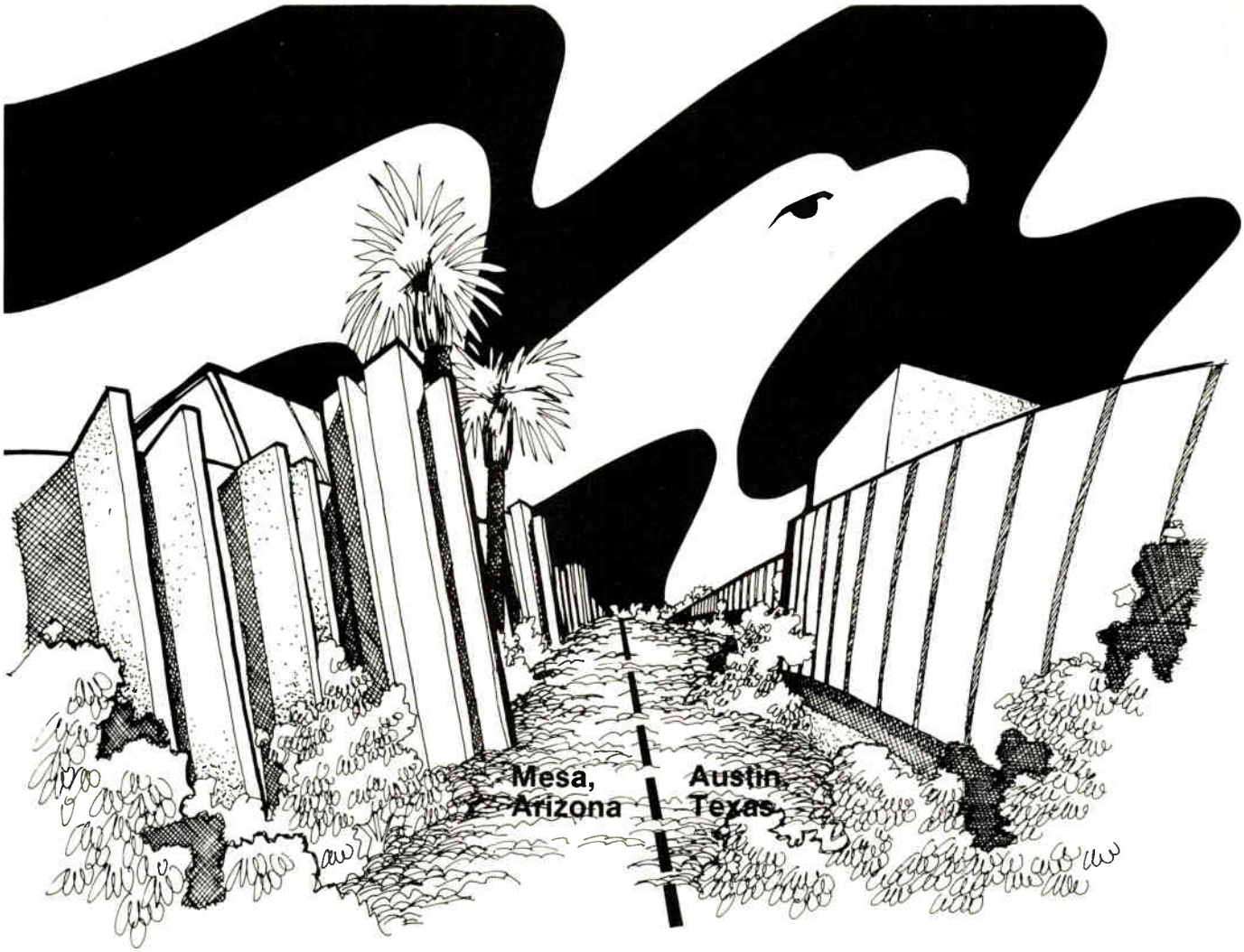
With either one or a cluster of protocol processors in each minicomputer, users can avoid the delay of going through a central host computer by directly accessing any other terminal or data base. This is expected to be a major advantage for such customers as multi-branch banks and insurance firms.

Making the project economically feasible is the use of the Z80 processor for protocol control, instead of a complete minicomputer or a discrete-device implementation. Right now, the Z80 sells for less than $10 each in 1,000-lot quantities, and with bigger buys a $3 price is in sight by 1980, according to the company. "This compares with $40 for discrete circuit components, which don't begin to have enough performance to handle all the protocol chores efficiently," says Richard A. Davis, principal engineer for advanced programs.

The Distributed Data Base Processor is actually two half-circuit cards (7.5 by 15 inches) that fit into each SyFa minicomputer. The Z80 and 16 kilowords of random-access memory sit on one card, called the distributed microprocessor unit. This controls the communication line adapter card, on which sits the receiver circuitry that actually handles the protocols.

Similar units. All the distributed microprocessor units are alike, programmed by their host computer. But the line adapters differ according to which communications protocol is used, Davis says. Altering them offers maximum flexibility, since current debate centers on which protocol will eventually prevail in Government standards. These include the IBM 3790 SNA/SDLC, and Bell Systems X.25.

Accepting an incoming signal at up to 56 kilobits per second, the adapter makes sure that it conforms fully to the required protocol format by deleting or inserting data bits. "A character-oriented message in bisync



Still No.1 in all the world.

The industry's No. 1 source for ıi-rel ICs and discretes continues to announce an ever-growing list of military qualified circuits.

The leader in TTL...

Motorola offers more JAN TTL ɔarts than anyone else in the world. And with our recent dedication to LS ve've already qualified 17 of these ɔarts with more in the works.

Coming on strong n NMOS Memories and CMOS.

Our entire Austin facility has)ESC 38510 line certification, exclu- ive of memory boards. You can get ıe MC14000 and MC14500 series 383, Class B units off-the-shelf—over 10 high-quality, standard parts for your hi-rel requirements. And we've received /05503BEC qualification on our MC14049 series hex buffers. Several key MOS memories, like the MCM4027 4K RAM, also are processed to Level B and Level C standards.

No.1 in Mil MECL...

If you're looking for 10K QPL parts, it's Motorola. Only Motorola. No one else can run up a battle flag in high speed digital logic except us.

Hi-Rel M6800 families.

MC6800 data for QPL has been submitted to DESC.

There are now well over 2 dozen MPUs, I/O chips, RAMs, ROMs, EPROMs, MODEMs, timers, controllers, interface adapters and other M6800 family functions processed to /883 standards. With and without 100% burn-in. Motorola is totally committed to supplying the highest quality, highest reliability microprocessor components.

Motorola. Flying high in Hi-Rel. Contact us about your needs:

Bipolar Logic: (602) 962-2011.
CMOS/NMOS MPU: (512) 928-6200.

MOTOROLA
Semiconductor Group

form, for example, would be altered into the more easily processed bit-oriented SDLC protocol," explains Davis.

A failure of any one processor affects only itself, not others in the network, he says. He acknowledges his company is not alone in its approach, pointing out that Fairchild Semiconductor's recent 9440 16-bit microcomputer can be used for similar applications. But his firm has a lead in actually designing front-end processors into hardware, he feels. □

Data 100 moves in with IBM appeal

The company has 35% of the installed base of batch terminals, estimates International Data Corp., the market researchers of Waltham, Mass. That alone makes Data 100 Corp.'s entry this week into the distributed processing market well worth studying.

As expected, the Minneapolis maker of IBM-compatible terminals and peripherals continues to focus on IBM customers. Its new system resembles the IBM System/34, the computer giant's newest minicomputer system geared to distributed processing. Also in keeping with its practice, Data 100 will sell its wares 15% to 20% below IBM's pricing, says Robert S. Bernstein, director of product-line management.

Easy move. The main concern of Data 100 is to make the move to distributed processing easy for its many terminal-system users. "Customers have wanted lots more functions at the terminal," says Bernstein. "They want to use high-level languages and do file management as well as simple data entry. The easiest way is to add a processor."

The processor that Bernstein has in mind is essentially a minicomputer, called the Attached Applications Processor. Added to a terminal, the model 85 gives each terminal the processing power of a local computer while not tying up the host mainframe. It works with Data 100's existing terminals, including its model 82, introduced last year and emulating IBM's 3271 information display system.

With the 82 system, users could

News briefs

Storage Technology developing advanced telecom system
Storage Technology Corp. has formed a new wholly owned subsidiary, STC Communications Corp. of Broomfield, Colo., to develop what it calls the first small-scale digital telephone voice multiplexer and concentrator offering normal voice quality. Designated the COM2, the system is based on Intel Corp.'s new 8086 16-bit microprocessor and can multiplex 31 conversations onto 16 private lines. Available in July, COM2 configurations will be priced typically from $60,000 to $80,000.

Siemens acquires line of floppy-disk drives
In a move aimed at broadening its computer peripherals product offering, Siemens AG of Munich, West Germany, has acquired the flexible-disk drive product line of General Systems International Inc. of Anaheim, Calif., for an undisclosed amount of cash. Key products from the U. S. firm are the FDD110, for single- or double-density storage on a removable diskette, and the FDD200, which expands data storage to 1,600 kilobytes per diskette.

Rapicom formed to develop high-speed fax products
Rapifax Corp. of Fairfield, N. J., and its Dacom Inc. subsidiary in Santa Clara, Calif., have been combined into a new company, Rapidcom Inc., that is to continue development and marketing of a wide range of high-speed facsimile equipment. Based in Fairfield, the new company will continue to market the existing product line under the Rapifax and Dacom trademarks. It also plans to explore and develop advanced communications systems.

What do you do for printed circuits and hybrid microelectronics when your traditional suppliers can't meet your needs?

Sometimes your traditional suppliers are too loaded with big orders to tool up right away for your custom electronics needs.
Sometimes their prices for small or medium-sized quantities make your own production costs too high.
Sometimes you have to wait a long while until they're free to handle your special design.
Elta is the solution

We make:
Single and multilayer printed circuit boards, hybrid microelectronics modules and microwave components. Transformers, chokes and filters.
All produced to customer or military specifications.
All incorporating Elta's renowned high standards — the highest standards — of Quality Assurance.

We tailor size, shape, and electrical characteristics to buyer requirements.
We are sensitive to the needs of our clients, and react quickly to their problems.
We are flexible in approach, highly competitive in price, prompt in delivery.
Try Elta.
We're there when you need us.

ELTA Electronics Industries Ltd.
A Subsidiary of
Israel Aircraft Industries Ltd.
A foundation to build on

Ashdod, Israel: Tel: 055-31155.
Telex: ELTA IL 031807.
Cables: ELTASHDOD.
Brussels: 50, Ave des Arts. Tel: 5131455.
New York: Israel Aircraft Industries International Inc.
50 West 23rd Street, N.Y. 10010.
Tel: (212) 620-4400.

IAI ELTA

National and Lambda prove Fairchild regulators give you more for your money.

Compare our high current voltage regulators to the leading competitors.

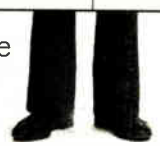
You'll see we come out on top across the board.

Our unique Hybrid technology allows us to overcome the limitations of monolithic designs. Which means you get better specs at a lower cost.

3 AMP, 5 VOLT REGULATORS

PARAMETER	CONDITIONS*	FAIRCHILD SH323SC	LAMBDA** LAS1405	NATIONAL** LM323K
Available Peak Current (typ)	V_{IN}-V_{OUT}= 10 V V_{IN}-V_{OUT}= 20 V	6 A 6 A	4.2 A 2.3 A	4.2 A 3.2 A
Available Average Output Current (typ)	V_{IN}-V_{OUT}= 10 V V_{IN}-V_{OUT}= 20 V	5 A 2.5 A	3 A 1.5 A	3 A 1.5 A
Minimum Input Voltage (typ)	I_{OUT}= 3 A	V_{OUT}+ 1.8 V	V_{OUT}+ 2.2 V	V_{OUT}+ 1.9 V
Max Power Dissipation	—	50 W	30 W	30W
Price	100 pieces	$5.00	$6.75	$5.35

*T_C = 25°C
**Based upon published data sheet specifications



see by this chart, one leading competitor doesn't even offer the part. And the one that does isn't much competition.

For more details on our voltage regulators, just contact your Fairchild distributor or representative. Or, for more immediate results, call your nearest Fairchild sales office.

France: Fairchild Camera & Instrument S.A., 121 Ave d'Italie, 75013 Paris. Tel: 00331 584 55 66. Telex: 0042 200614. **Italy:** Fairchild Semiconduttor S.P.A., Via Rosellini, 12 20124 Milano. Tel: 02 6887451. Telex 36522. **Germany:** Fairchild Camera & Instrument (Deutschland) GmbH, 8046 Garching Hockbruck, Daimlerstr. 15, Munchen. Tel: 089 320031 Telex: 52 4831 tcrd. **England:** Fairchild Camera & Instrument (UK) Ltd., 230 High St., Potters Bar, Hertfordshire EN6 5BU. Tel. 0707 51111 Telex: 0051 262835. **Sweden:** Fairchild Semiconductor AB, Svartengsgatan 6, S-11620 Stockholm. Tel. 8-449255 Telex: 17759.

HI-CURRENT REGULATORS

5 AMP, 5 VOLT REGULATORS

PARAMETER	CONDITIONS*	FAIRCHILD μA78HO5ASC	LAMBDA** LAS1905	NATIONAL
Available Peak Current (typ)	V_{IN}-V_{OUT}= 10 V V_{IN}-V_{OUT}= 20 V	7 A 7 A	5 A 1.5 A	NO PART AVAILABLE
Available Average Output Current (typ)	V_{IN}-V_{OUT}= 10 V V_{IN}-V_{OUT}= 20 V	5 A 2.5 A	5 A 1.5 A	
Dropaut Voltage (typ)	C I_{OUT}= 5 A	2 V	2.4 V	
Price	100 pieces	$5.50	$11.25	

*T_C = 25°C
**Based upon published data sheet specifications

How our 3 Amp regulators stack up.

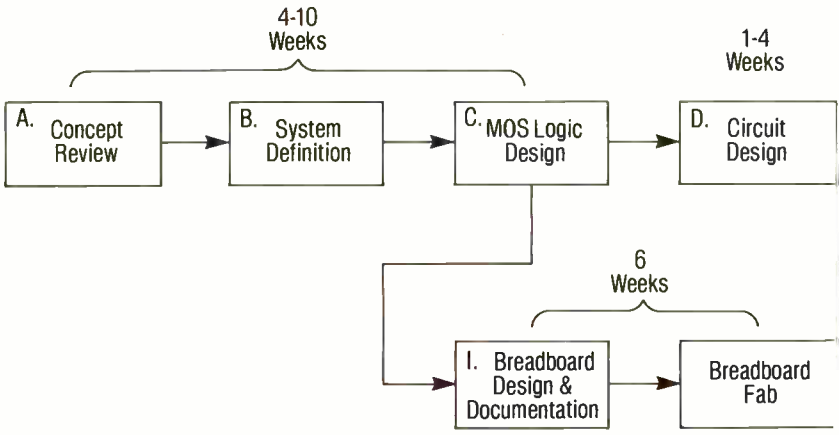
Our SH323SC 3 Amp, 5 Volt regulator is a perfect example of the value of applying Hybrid know-how to regulator designs.

This side-by-side comparison based on published data sheets should leave no doubt.

How our 5 Amp regulators stack up.

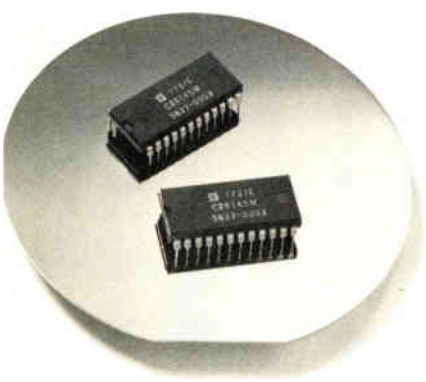
Our μA78HO5ASC is a new, enhanced 5 Amp, 5 Volt regulator that's pretty much in a class by itself. As you can

Everything you need making custom



When to go custom. When a single custom circuit can replace hundreds of individual components, the benefits are obvious. But the cost of developing that single custom circuit is high, and only becomes practical if the volume you will actually use is significant. At Synertek, the first stage in custom circuit evaluation is a cost-versus-volume analysis.

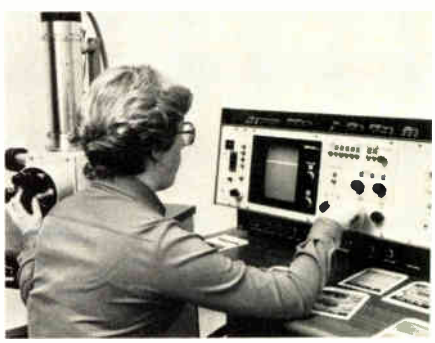
Some applications, such as digital watches, would be impossible without a single custom circuit. In other cases, the performance and reliability advantages may outweigh the initial higher cost considerations. In any case, it's a simple matter of economics. With fewer parts, lower assembly and inventory costs, smaller size, less weight, less heat to dissipate, greater reliability and a competitive edge to help build that crucial volume requirement, savings are enormous in a successful custom program.



Getting there on time. You can't afford to wait the normal 26 weeks development time, and then find the end product doesn't do the job. At Synertek, we have

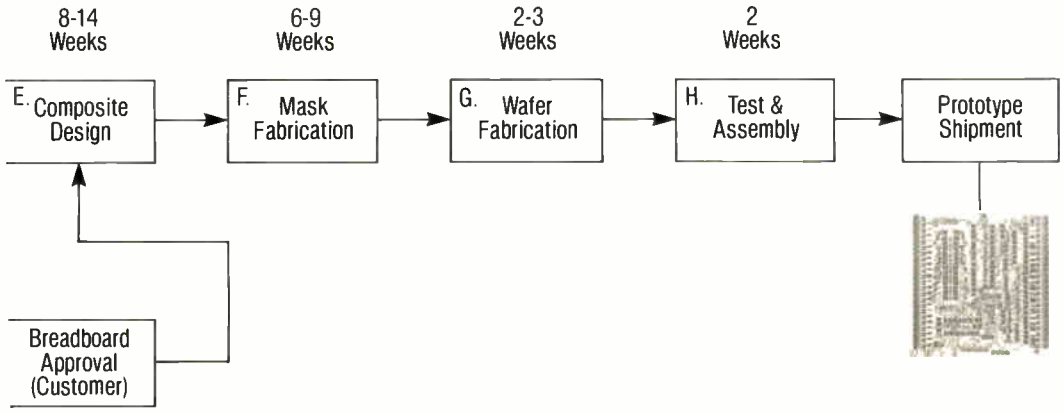
the development stages down to a science. We provide complete working level interface between your product development group and our custom circuit specialists. Every step of the way.

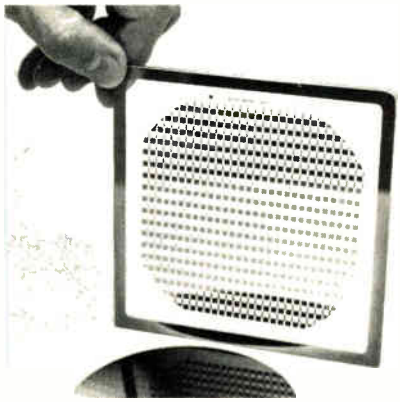
Our customers participate in design meetings and are urged to attend the periodic design reviews. A fully functional breadboard is built for each custom circuit. Where any possible doubt is felt about the original specifications, the customer is urged to work with the breadboard in his own systems for



Syn

to know about circuits.





ıands-on review by his own product levelopment and marketing people.

To date, we've produced over 200 ustom circuits for advanced electronic roducts covering an incredible array f applications. Our record of deliver- ıg on time, in specification, is excellent. Ve will gladly provide customer refer- nces on request.

Which process to specify. Whichever does the job best, and most economically. Our standard product lines are implemented in N-Channel, P-Channel, CMOS, Ion Implanted Silicon Gate with or without Depletion Loads. All are available *now* for your custom circuit from Synertek.

It's your circuit, and your circuit alone. You need that confidence. And Synertek provides it. Our expertise is in MOS circuitry. We guarantee the proprietary nature of your Synertek custom circuit.

How we do it. We possess one of the outstanding custom circuit groups in the country, and one of the very few completely dedicated to custom work. Our custom group draws on resources and experience gained in producing a tremendous volume of standard MOS circuits and duplicates every facility and resource applied to our standard line. In spec, in production, at the right price.

Synertek, 3001 Stender Way, Santa Clara, California 95051. (408) 988-5600. Call collect and give your immediate requirements to Frank Rittiman, Custom Circuits Product Manager.

ertek.

Synertek
3001 Stender Way
Santa Clara, California 95051

I'm interested:

☐ Please send me your Custom Capabilities brochure for an in-depth look at Synertek's facilities, capabilities, and more.

☐ Attached is a schematic with specifications. We anticipate a volume of _____ first year and _____ second year.

Package requirements are _____.

Name _____

Title _____

Company _____

Street _____

City _____

State/Zip _____

Phone _____

EDUARD RHEIN PRIZE 1978

US $ 50.000 FOR TELEVISION RESEARCH

In agreement with the Advisory Council of the Eduard Rhein Foundation, the Board of Governors has issued the following guidelines for the Eduard Rhein Prize 1978:

1.

The Eduard Rhein Prize is awarded each year for outstanding achievement in furthering television technology.

The special topic for the Eduard Rhein Prize 1978 is:

a significant contribution to the improvement in the performance of the total television system (picture quality or capability) that can be appreciated by the general viewer. This contribution can be both the improvement or development within the scope of present television or pointed to the future.

2.

The Eduard Rhein Prize 1978 is endowed with DM 100.000,-- (approx. US $ 50.000) at time of going to press.

3.

Applicants for the Eduard Rhein Prize 1978 may only be put forward by experts, organizations or institutions actively engaged in televis'on research. Papers may be submitted from anywhere in the world.

4.

a) Closing date for entries (date of postmark) is 15 August 1978.

b) Applications to be addressed to the Board of Governors, Eduard Rhein Foundation, Kloepperstieg 3, 2000 Hamburg 67, Federal Republic of Germany.

c) Applications may be: research report, internal laboratory report, paper submitted for publication, already published paper.

5.

a) The applications must be in German or English.

b) Papers must be submitted with six copies and must be typewritten or printed.

c) Papers should not exceed 30 typewritten pages. If the contents call for lengthier explanation, enclose a summary of no more than 20 typewritten pages. Each paper must also be accompanied by a summary of no more than one typewritten page clearly stating the essential results of the research.

d) Applicants must also enclose a brief curriculum vitae of their scientific or engineering career.

6.

The Board of Governors of the Eduard Rhein Foundation will decide upon the awarding of the Prize following the recommendations by the Advisory Council.

The decision is final and cannot be contested in law.

7.

For the complete guidelines and rules applying to the Prize, write to the Board of Governors, Eduard Rhein Foundation, Kloepperstieg 3, 2000 Hamburg 67, Federal Republic of Germany.

The members of the Advisory Council of the Eduard Rhein Foundation are: Prof. Dr. Ing. E.h. Walter Bruch (Chairman) Hannover; James Hillier, Princeton, N. J.; Joseph Polonsky, Paris; Prof. Karl Tetzner, Munich; Dr. Frederik W. de Vrijer, Eindhoven.

Washington newsletter

Solar satellites get new lobby to push for demonstration

Solar-power satellites have their first lobby, a group formed by 25 major U. S. industrial and scientific organizations. The group's first target is passage of H. R. 10601 **to create an SPS research and demonstration program** with an initial appropriation of $25 million in fiscal 1979 [*Electronics*, Feb. 16, p. 60]. Called the Sunsat Energy Council, the nonprofit group is headed by Peter E. Glaser, vice president of Arthur D. Little Inc., Cambridge, Mass., who first advanced the solar-power satellite concept. Ten of the 15 council directors are key executives in the aerospace and electronics industries. Its Washington counsel is the law firm headed by former Sen. Frank E. Moss, the Utah Democrat who was chairman of the Aeronautics and Space Sciences Committee.

Cincinnati, ITT named finalists for Singcars radio

The Army has named two finalists in its proposed $1.3 billion program to develop and produce the next generation of battlefield radios for use by all U. S. military services and possibly by the North Atlantic Treaty Organization. Under 40-month contracts awarded to Cincinnati Electronics Corp. ($6.4 million) and ITT ($5.4 million), **each company will build 43 prototypes** of the jam-resistant, automatic frequency-hopping radios, called Singcars V for single-channel ground and airborne radio system. Losers in the competition were GTE Sylvania Inc. and a joint proposal by RCA Corp. and Britain's Racal Tacticom.

U. S. consumer imports up 23% to $3.6 billion

U. S. consumer electronics imports climbed 23% to nearly $3.6 billion last year, **with Japan's share of more than $2 billion accounting for more than half the total.** At the same time, American exports dropped 7% from the 1976 level to $463 million. These changes increased the 1977 consumer electronics trade deficit by 29% over 1976, according to Commerce Department figures.

Separate data from the Electronic Industries Association of Japan indicates that 1977 U. S. imports of Japanese consumer electronics alone accounted for 8.7% of that nation's total electronics production in all categories for the year. The EIA-J estimates that Japan's 1978 electronics output will rise more than 7% from last year to $25.17 billion despite a forecast 4.5% drop in color TV production. That results primarily from the Orderly Marketing Agreement between the U. S. and Japan, reached last year, which puts a ceiling on such shipments to America. Commerce Department figures for 1977 imports show TV receivers, chassis, and tuners totaled $1.13 billion, up 23% from 1976, while radios, excluding citizens' band, rose 17% to $729 million. Microphones, amplifiers, speakers, and parts accounted for $285 million, up 40%.

New EIA unit for fiber optics headed by Wilson

The expanding use of fiber optics has prompted the formation of a new subdivision for companies in the field within the Electronic Industries Association's Parts division. Leroy Wilson of Corning Glass Works and ITT Cannon's William O'Hirok have been named chairman and vice chairman, respectively, of the new subdivision. IBM Corp.'s Philip Dann will become chairman of the newly organized fiber optics committee. The EIA's interest in fiber optics previously was limited to a section of the electromechanical devices subdivision and an engineering committee working group.

Postal Service hit on electronic mail test plans

An $895,000 noncompetitive award to Communications Satellite Corp. by the U. S. Postal Service for the first international test of electronic mail next year is drawing fire from industry and members of Congress. Critics of the month-long test scheduled for next February are concerned that Comsat's selection **was based on an unsolicited proposal and that the Postal Service's legal monopoly on mail service may impinge on the market's development by private services.** Postmaster General William Bolger says a subsequent year-long trial of the new service under the $2 million program will be put out for competitive bids if the Comsat test using Intelsat IV-A's 6,000 circuits is successful.

CB price hikes follow increase in tariff to 21%

Domestic citizens' band radio manufacturers are raising prices. Their action follows President Carter's one-year increase in tariffs to 21% from 6% on all CB imports except hand-held models. If approved by Congress as expected, the duty will drop back in the second year to 18%, declining to 15% in the third, and then return to 6%. While the higher tariffs are well below the 36% rate recommended by a divided International Trade Commission [*Electronics*, Feb. 2, p. 57] and the 50% level sought by industry, **company representatives in Washington say they are satisfied.** Since the commission's recommendation, the decline in the value of the dollar relative to Japan's yen in the world money market will make CB imports from Japan more costly. The addition of higher tariffs will make it possible for U. S. makers to raise prices from present depressed levels and still hold a competitive advantage over imports, which captured 95% of last year's market for 8.1 million radios.

FCC ban on linear amps takes effect April 28

The production, importation, and sale of linear amplifiers operating in the 24-to-25-MHz band and used to illegally raise citizens' band radio power levels has been banned as of April 28 by the Federal Communications Commission. At the same time, the FCC says any amplifiers able to operate below 144 MHz also will be subject to a marketing ban unless specific models produced before the cutoff date have been type-accepted by the FCC's Laboratory division and proven unable to operate, even with "minor modification," at 24 and 25 MHz. The FCC says its action comes after a study showing that use of linear amplifiers by CBers **was responsible for 46% of the complaints of interference with reception of TV and other home entertainment signals.**

Competition scores Inmarsat proposals favoring Comsat

Proposals to name Communications Satellite Corp. as the sole "designated entity" for U. S. participation in the new international maritime satellite organization called Inmarsat are meeting strong opposition in Congress from other maritime carriers and at the FCC. Early April testimony before the House Communications subcommittee on H. R. 11209—a bill that would give Comsat a U. S. monopoly on provision of maritime satellite services—**generated opposition from such carriers as ITT World Communications Inc.** Senior vice president and counsel Howard White typified the opposition, which saw no reason for favoring Comsat and proposed amendments that would permit participation by other carriers.

INTERFACE POWER*

Device	Input	Drivers per package	Dutput Current	BV_{CEX}	$LV_{CE\ (SUS)}$ @ 100 mA	Gain Stages	Clamp Diodes	Package
ULN-2061M	TTL	2	1.75A	50V	35V	2	Yes	8-pin DIP†
ULN-2062M	TTL	2	1.75A	80V	50V	2	Yes	8-pin DIP†
ULN-2064B	TTL	4	1.75A	50V	35V	2	Yes	16-pin DIP
ULN-2065B	TTL	4	1.75A	80V	50V	2	Yes	16-pin DIP
ULN-2066B	MOS	4	1.75A	50V	35V	2	Yes	16-pin DIP
ULN-2067B	MOS	4	1.75A	80V	50V	2	Yes	16-pin DIP
ULN-2068B	TTL/MOS	4	1.75A	50V	35V	3	Yes	16-pin DIP
ULN-2069B	TTL/MOS	4	1.75A	80V	50V	3	Yes	16-pin DIP
ULN-2070B	MOS	4	1.75A	50V	35V	3	Yes	16-pin DIP
ULN-2071B	MOS	4	1.75A	80V	50V	3	Yes	16-pin DIP
ULN-2074B	TTL/MOS	4	1.75A	50V	35V	2	No	16-pin DIP
ULN-2075B	TTL/MOS	4	1.75A	80V	50V	2	No	16-pin DIP

† Mini-DIP, .375" long

*Only Sprague can supply dual and quad 1.75A, 50/80V Darlington Switches

Sprague Series ULN-2060 and ULN-2070 offer the highest power ratings available. They are 1.75 amp 50/80 volt Darlington switches and have guaranteed $LV_{CE\ (SUS)}$ minimums of 35/50 volts. No other IC manufacturer offers voltage-current combinations of this magnitude.

A pioneer in both high-current interface and copper alloy DIP lead frames, Sprague possesses extensive experience with plastic DIPs which offer greatly improved thermal characteristics. All quad switches in this series utilize the webbed-pin "B" DIP package. Lower thermal resistance ratings offer increased device limits, reduced junction temperatures, and improved reliability.

Many high-power interface problems are simplified and solved with Sprague Darlington Switches. Typical uses include interface with solenoids, relays, motors (dc and stepping), LEDs (MUXed numeric or matrix), lamps, and other applications in search of 1.5 A IC hardware.

For application engineering assistance, write or call George Tully or Paul Emerald, Semiconductor Division, Sprague Electric Company, 115 Northeast Cutoff, Worcester, Mass. 01606. Tel. 617/853-5000.

For Engineering Bulletin 29305A and WR-172 'Quick Guide to Interface Circuits', write to: Technical Literature Service, Sprague Electric Company, 35 Marshall Street, North Adams, Mass. 01247.

4SS-7113R3

SPRAGUE WORLD TRADE CORPORATION · 19 CHEMIN FRANÇOIS-LEHMANN · 1218 GENEVA SWITZERLAND

SALES OFFICES **AUSTRIA:** ELBATEX GMBH, WIEN, TEL 02?2-869158 **BENELUX:** SPRAGUE BENELUX, RONSE, TEL 055-215302 **DENMARK:** SEMICAP, KØBENHAVN, TEL 01-221510 **FINLAND:** FIELD OY, HELSINKI, TEL 90-6922577 **FRANCE:** SPRAGUE FRANCE SARL, BAGNEUX, TEL 01-6551919 **GERMANY:** SPRAGUE ELEKTRONIK GMBH, FRANKFURT, TEL 0611-439407 **GREECE:** EMITRON SA, ATHINAI, TEL 021-3242188 **IRAN:** UNITEC CO LTD., TEHRAN, TEL 021-665782 **ISRAEL:** RACOM ELECTRONICS CO LTD., TEL-AVIV, TEL 03-453151 **ITALY:** SPRAGUE ITALIANA SPA, MILANO, TEL 02-479121 **NORWAY:** HEFRO TEKNISK A/S, OSLO, TEL 02-380286 **PORTUGAL:** DITRAM COMPONENTES E ELECTRONICA, LDA., LISBOA, TEL 019-45313 **SOUTH AFRICA:** ALLIED ELECTRIC (PTY) LTD., DUNSWART, TEL 52-8232 **SPAIN:** BIANCHI SA, SAN SEBASTIAN, TEL 943-362045 **SWEDEN:** INTERELKO AB, ENSKEDE, TEL 08-492505 **SWITZERLAND:** TELION AG, ZURICH, TEL 01-549911 **TURKEY:** KAPMAN KOMANDIT, ISTANBUL, TEL 457625 **UNITED KINGDOM:** SPRAGUE ELECTRIC (UK) LTD., WEST DRAYTON, TEL 44627 **YUGOSLAVIA:** BELRAM SA, BRUXELLES, TEL 02-7342619.

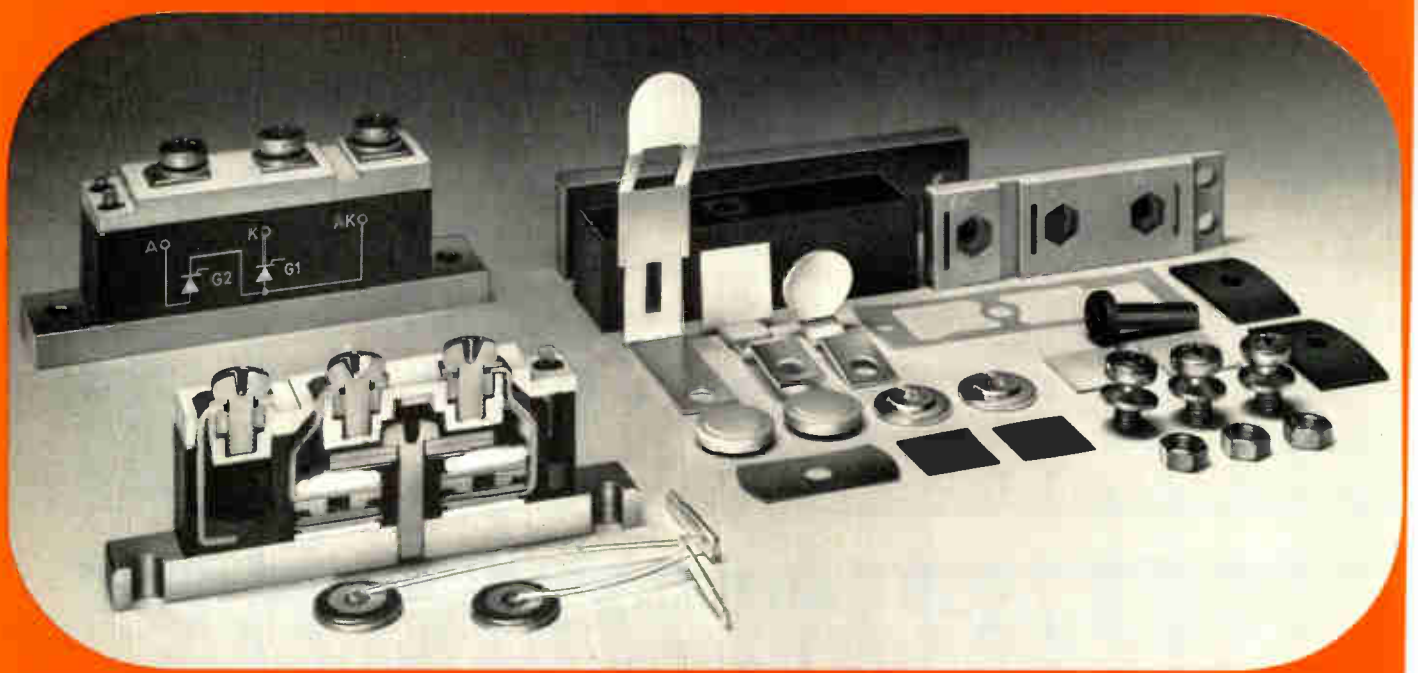
SPRAGUE
THE MARK OF RELIABILITY

a General Cable subsidiary

... and you thought we only make great capacitors.

SIEMENS

So many parts to reliably interconnect two thyristors?



More than 30 parts made from twelve different materials – these are the constituents of a ready-to-install THYodul®, a twin-thyristor module from Siemens. Of course, two thyristors can be interconnected in a less complex manner, but THYoduls make the design of space-saving converters a good deal simpler and more economic:

- The module is extremely compact and fully insulated, it can be installed without additional insulation parts.
- A copper bar carrying no voltage provides for optimum heat dissipation and guarantees permanently problem-free screw-mounting.
- The proven pressure contacting ensures absolute reliability; thermal stresses at contact points, as are customarily associated with changing loads, no longer pose any problems.

THYoduls from Siemens are available for fully and half-controlled and forced-commutated converter circuits, for currents up to 2 x 75 A and peak off-state voltages up to 1650 V. And at a price that will soon dispell any thoughts you may have of designing your own devices.

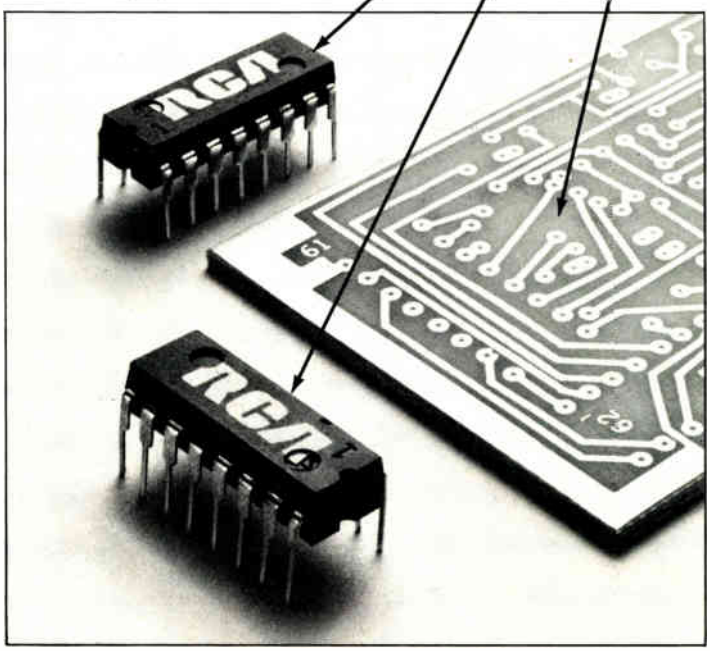
B 7811.101

THYodul from Siemens – the new compact module for converters

Circle 255 on reader service card

RCA. Newsmaker in Linear.

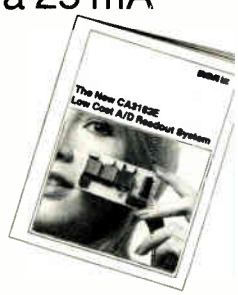
New A/D makes low-cost readout as easy as 1 2 3



Our new CA3162 A to D converter lowers the cost of three-digit readout. So you can go digital in more places. Or in new places. Our new driver (CA3161) and our circuit layout make it easy as well as economical.

1 Super accurate A/D Converter.
Our CA3162 uses dual slope integration, which means high noise rejection. Freedom from long-term drift and changes due to temperature. It has an ultra-stable on-chip bandgap reference. On-chip clock. And much more.

2 Companion driver IC.
The CA3161 BCD to 7-Segment Decoder from RCA has a 25 mA current per LED segment for brighter, larger displays.



3 Circuit board layout.
The whole circuit design is right there, ready for you to drop in the actual components for a complete 3-digit readout.

Send for our new brochure on the 3162 A to D system.

For more information, contact your local RCA Solid State distributor. Or contact RCA Solid State headquarters in Somerville, N.J.; Sunbury-on Thames, Middlesex, England; Quickborn 2085, W. Germany; Ste. Anne-de-Bellevue, Quebec, Canada; Sao Paulo, Brazil; Tokyo, Japan.

RCA Linear IC experience is working for you.

RCA

Circle 64 on reader service card

International newsletter

China plans research in microelectronics and computers . . .

Microelectronics and computer technology are to be important parts of an ambitious eight-year program for scientific research unveiled recently in Peking. The country hopes to make "a breakthrough in the technology of ultra-large-scale integrated circuits" and to create "a comparatively advanced force in research in computer science and build a fair-sized modern computer industry" by 1985, the minister of the state science and technology commission, Fang Yi, told the first national science conference since the 1950s. **He said China must lose no time in mastering large-scale IC production and must make extensive use of microcomputers.** China is known to have budding electronics industries [*Electronics*, March 3, 1977, p. 78], which clearly will be given a big role in the country's major economic development program announced in February.

. . . with satellites and lasers also due for development

Also announced at the Peking science conference was a new space program that calls for research in satellites, space laboratories, space probes, and basic science. Fang Yi, a well-known scientist in his own right, called for the "study and manufacture of a variety of scientific and applied satellites." China has launched and brought back on target at least three satellites, but Western observers believe that country's scientists cannot yet retrieve satellite data electronically, as do Russia and the U. S. **The conference also heard that a big push will be made in lasers, a field intimately connected with China's high-energy physics research** that is a keystone of the eight-year plan. Laser-induced nuclear fission is listed as a research target, along with development of new types of lasers and study of new mechanisms of laser generation and of optical-fiber communication.

Magnetofluids appear in full range of German loudspeakers

AEG-Telefunken is about to introduce a family of loudspeaker systems whose tweeter and woofer portions operate with magnetofluids between the poles of the speaker's permanent magnet. The new series consists of the 75-w TLX1, on the market since February, and the 120-w TLX2 and the 200-w TLX3 to come this month. **Basically liquids containing minute iron-oxide particles, magnetofluids can improve a hundredfold the magnetic conductivity of the gap in which the coil vibrates.** This makes for notes of higher fidelity and brilliance than can be obtained with conventional speakers. What's more, the fluid acts like a damper, thereby reducing ringing effects and hence signal distortion. Prices for the new loudspeakers are about the same as for conventional versions.

BPO pushes work on codec modulator and new exchanges

The British Post Office is letting a contract to Ferranti Semiconductors for development of a delta-sigma modulator microcircuit to be teamed with the BPO's single-channel coder-decoder chip. **The resulting two-chip unit will be first used in the BPO-developed CDSS 1** (customer digital switching system number 1). This 100-line all-digital microprocessor-controlled exchange is to be manufactured by Plessey and General Electric Co., with preproduction models slated for this year. The all-digital codec chip is to be made by Ferranti and General Instrument Microelectronics Ltd. (see p. 77), and the new modulator will work with the bipolar Ferranti version and the MOS model from GIM.

The BPO also says it will place first production orders for its long-awaited System X digital main exchange before the year's end with GEC Telecommunications, Plessey Telecommunications, and Standard Tele-

phones & Cables Ltd. These first trunk, junction, and local exchanges are slated to be operational before the end of 1981, months earlier than scheduled. While the BPO will eventually buy $400 million worth a year, System X also carries British hopes for major export sales.

Swiss joint venture to turn out semi-custom chips

Complementary-MOS semi-custom chips will be coming from a Swiss joint venture established by Heuer-Leonidas SA of Bienne and Eurosil GmbH of Munich. The wafers and the technology will come from Eurosil, with Heuer setting up an end-processing facility. **The chips will be sold all over Europe, and instrument makers are expected to be major customers.** The new firm, Heuer Micro-Technik AG, is 60% owned by Heuer, which specializes in production of stop watches, chronographs, and other time-measuring devices. The rest is owned by Eurosil, a major manufacturer of integrated devices for timepieces.

France ready on bipolar aid, but MOS pacts unsettled

Although the French government has made up its mind what to do on bipolar technology in its five-year $130 million IC plan, it still is having trouble putting together the essential MOS side. It is ready to sign bipolar agreements with Thomson-CSF and RTC, the Philips group's major components-producing unit in France. These pacts would help pay for development of mostly linears and fast microprocessors at Thomson and fast logic circuits at RTC. **Still unsettled are the teamings in the two MOS-making firms that the government wants to set up.** For custom circuits, Thomson and EFCIS presumably will join forces, possibly with an American partner. For standard circuits, the government hopes to persuade a major U. S. firm to take a minority position in a new company whose French shareholders chiefly would be equipment makers.

Toshiba offers home video camera for less than $1,000

The $1,000 barrier on color video cameras for the home is no more: Toshiba is selling its new model for a basic price of around $985 in Japan. Designed to work with the video cassette recorders of many manufacturers, **the IK-1300 features an improved stripe filter integrated into the single pickup tube and two camera-tube ICs,** one for the synchronization generator and one for the color-processing amplifier.

Addenda

Ferranti Semiconductors is doubling the complexity of its semi-custom Uncommitted Logic Array **from 225 cells, each roughly equivalent to 1½ gates, to 484.** It will be offering a range of performances corresponding to high-speed, medium-speed, and low-power Schottky-TTL devices. . . . Signetics, the Sunnyvale, Calif., subsidiary of Philips, is planning another offshore plant. **To be near Manila, the facility will eventually turn out some 45 million ICs a year** for export to the U. S., Thailand, and Western Europe, but with perhaps as much as 15% of the output staying in the Philipines. . . . In Greenock, Scotland, **National Semiconductor has finished a crash program to rebuild its diffusion and assembly operation,** which burned to the ground a year ago. There are three production lines, for MOS, bipolar, digital and linear circuits, all on 4-in. wafers. . . . The **move from discrete-component to surface-acoustic wave filters is gaining momentum:** Thorn Industries, Britain's largest TV-set maker is readying new models with SAW filter sections from Plessey and Mullard.

New AM/FM signal generator for long - medium - shortwave

1978 will see SSB introduced on a wide scale for international maritime and aeronautical radio, meaning high demands on the purity and stability of the signals used in testing the equipment – and making the SMLH the ideal signal source for producers of and workshops servicing marine and aero radio sets, HF direction finders, antennas and amplifiers.

The SMLH covering 10 kHz to 40 MHz is a precision generator offering optimal price/performance, high spectral purity and frequency stability plus excellent modulation characteristics. Expandable to a power signal generator and power sweeper, its output ranges from 0.05 µV through 10 V.

The SMLH is economical and easy to operate – use it for all measurements on active and passive components, subassemblies and whole units. With its negligible AM distortion it's just right for measuring receivers. The low frequency drift – typically 25 Hz/5 min after one-hour warmup – and linear frequency response (±0.2 dB) enable measurements on highly selective filters and receivers working on narrow channel spacings. A 6-digit counter shows the output frequency with maximum resolution of 1 Hz. Its high output voltage makes the SMLH an obvious choice for multisignal measurements and for checking very high intermodulation margins. IM is 50 dB down in multitone AM.

Options (simply add on without any trimming):
crystal oscillator for higher counter accuracy (2×10^{-6}/year), **2-W amplifier** for boosting the output power, **sweep oscillator** covering 100 kHz through 40 MHz, **overload protection.**

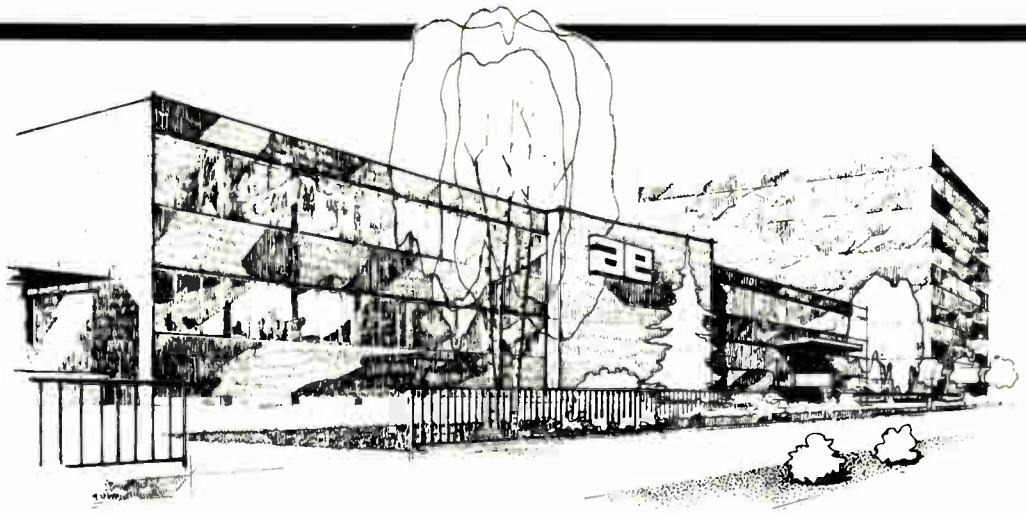
For more information quote
SMLH AM/FM signal generator

Rohde & Schwarz
Postfach 80 14 69
D-8000 München 80
Fed. Rep. of Germany

Electronic Measurements and Radio Communications. Development, manufacture, sales and service. Known for "electronic precision".
Independent concern (establ. 1933), represented in 80 countries.

ROHDE&SCHWARZ

Circle 66 on reader service card

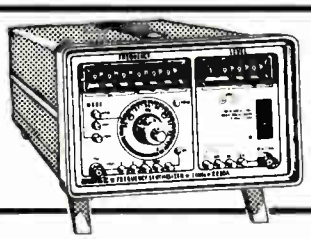


ADRET ELECTRONIQUE

presents

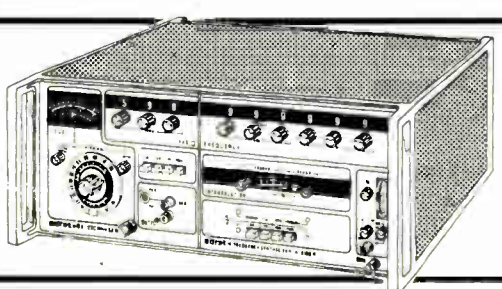
Its new line of synthesizers
from 50 Hz to 1.2 GHz
all IEEE bus 488 compatible

THE SERIE 2000
Includes three frequency and level generators, covering the range 50 Hz/18.6 MHz with various output impedances and heterodyne frequencies for selective measurements.



THE SERIE 3000
Two versions, from 300 Hz to 60 MHz, one general purposes with AM/FM modulation, the other for system application with programmable frequency and level.

THE SERIE 3100
Very low and low frequency applications, from 0,01 Hz to 200 kHz for structure vibration tests, N.M.R., stimuli generator, provided with wired options such as high resolution programmable phase shift, wobulation, programmable attenuation.



THE SERIE 6000
Universal serie covering with three output plug-in units, a range of 300 Hz/1.2 GHz fully programmable, frequency, level, search, AM-FM-PM modulation.

adret electronique

ADRET ELECTRONIQUE

12, AVENUE VLADIMIR KOMAROV • 78192 TRAPPES CEDEX FRANCE • TELEX ADREL 697821 F

Voice-recognition unit for data processing can handle 120 words

With three microprocessors, Japanese terminal permits a user input of five words at a time without pause

Speaking a few words needs no special skill, unlike dancing one's fingers rapidly across a keyboard, so voice-recognition units appeal to industrial and commercial users of computers and other data-processing equipment. One that shows how their manufacturers are beginning to take advantage of microelectronics is the new Voice Data-Input Terminal that Nippon Electric Co. will put on sale in September.

The first such Japanese unit, the three-processor terminal can recognize as many as 120 words, spoken without pause in groups of up to 5 words. Most systems now on the market recognize only one word at a time and in standard form have capacities to recognize considerably fewer words.

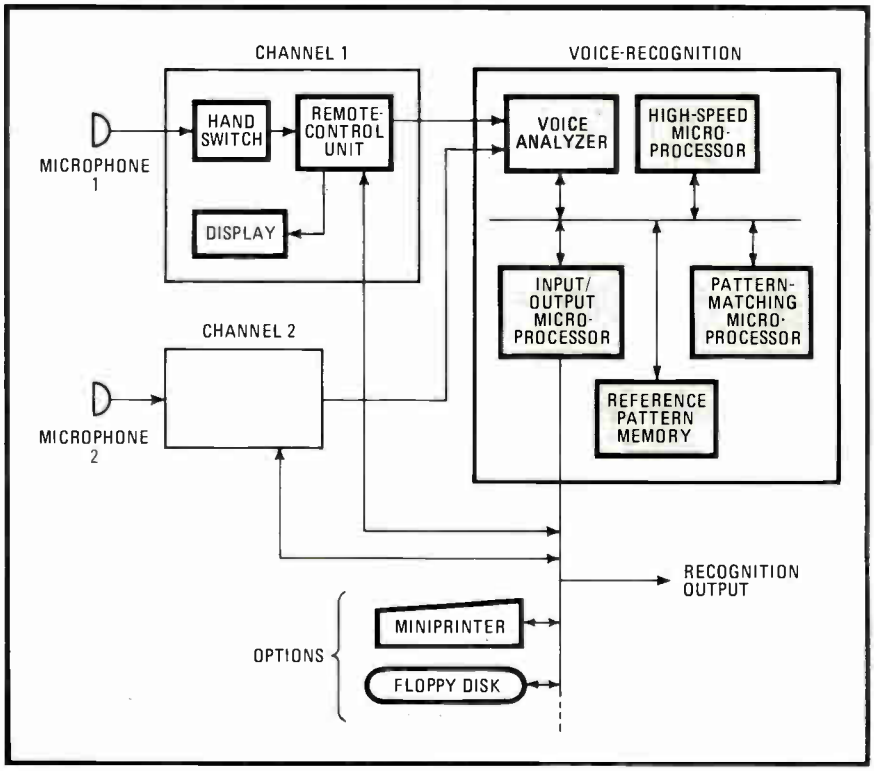
While voice-recognition units have been on the market for a while, it is only recently that they have begun to incorporate microprocessors. One of the U. S. leaders in the field, Threshold Technology Inc. of Delran, N. J., has been using the LSI-11 16-bit microcomputer in its models for some time [*Electronics*, July 22, 1976, p. 8]. Such units are self-contained, requiring no programming of voice-associated functions in a mainframe or host minicomputer, points out E. Joseph Simmons Jr., marketing vice president for Threshold. Like the Japanese unit, the New Jersey firm's model 600 can recognize groups of words without pause.

The NEC voice-recognition system includes a voice analyzer, a reference pattern memory, and three microprocessors performing programming, input/output, and control functions (see diagram below). The voice analyzer, which is composed of nonrecursive digital filters, breaks down incoming speech between 120 and 5,900 hertz into 16 separate channels.

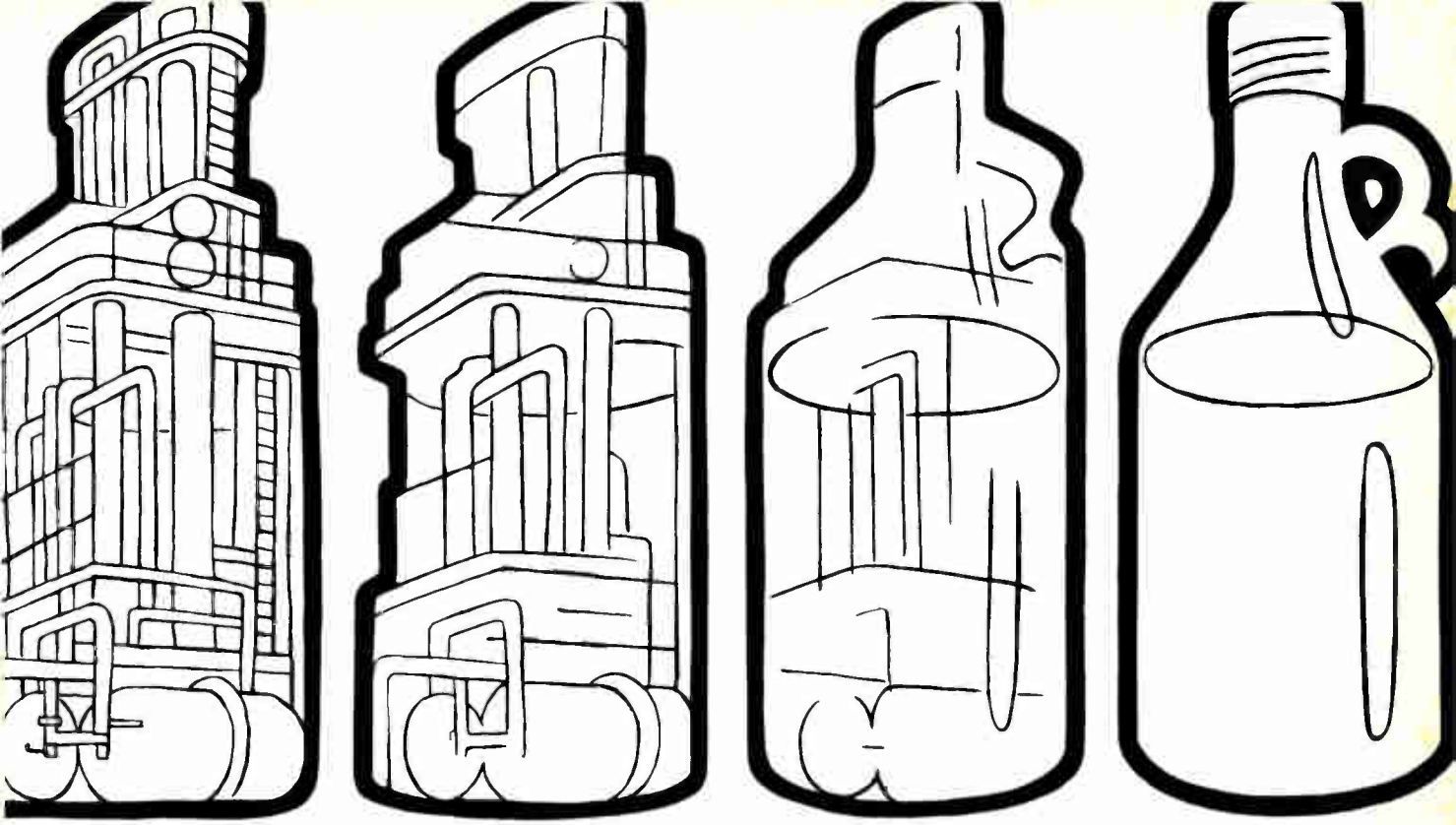
TTL for matching. The pattern-matching processor, a high-speed bipolar assemblage of mostly transistor-transistor-logic devices, matches patterns of incoming speech with those in the reference pattern memory. Its programming is considered dynamic because it can be changed by the control processor, for example to modify the time scale.

The I/O processor is the interface between the voice-recognition system and the remote-control units that serve two operator positions. It also handles the input from the tape reader that provides the words to be stored in the pattern memory, and it can handle the interfacing with the optional floppy disk and miniprinter. It is NEC's version of the 8080A processor, the μcom-8.

A high-speed 16-bit bipolar micro-



Well-equipped. NEC's voice-recognition unit includes a bipolar processor for pattern-matching programming, an 8080A type for I/O duties, and a bipolar control processor.



synthesis... in bottles

The reproducibility of processes in the manufacture of semi-conductors depends upon the pure chemical products having constant properties. Rhône-Poulenc, being itself a producer of the base molecules, controls all the stages product development and thus ensures constant quality

- ACS and MOS acids and mixtures
- ACS and MOS solvents
- products for epitaxy
- mineral products of high printy

firm _____

ess _____

I like to receive information on the pure products for use in electronics.

e-poulenc (CF/PSP) 21, rue J. Goujon F. 75360 PARIS CEDEX 08 Tél. (1) 256.40.00

CF/G-8-26

rhône-poulenc

Circle 256 on reader service card

from Siemens

Circle 275 on reader service card

tenuator, and adding read-ins.

The frequency may be keyed to seven digits or set manually, and the level is displayed on a 3½-digit readout or an analog meter scaled to 0.6 decibel. When fitted with the optional general-purpose instrument bus, both instruments are fully programmable, thus allowing keyboard entry for automatic frequency stepping and level incrementing over selected ranges.

For troubleshooting digital lines, HP's South Queensferry, Scotland, production unit has come up with an instrument that can be used to measure level, phase jitter, weighted noise, noise with tone, and frequency shift, as well as three-level impulse noise, phase hits, gain hits and dropout transients.

Data-line analysis. Versions of their 3771A data-line analyzer have been developed for CCITT and Bell standards. They can be used as stand-alone test instruments or as part of an automatic test system, controlled externally via the HP interface bus. The 3771A is a companion instrument to the 3770A amplitude-delay distortion analyzer and the 3770B telephone-line analyzer, which are used for routine line measurements and for characterizing a line before equalization.

A receiver. Typifying the new generation of communications receivers is Redifon Telecommunications Ltd.'s R1000, which bowed at the show. The London firm's new offering uses frequency-synthesis techniques over a range of 15 kilohertz to 30 MHz.

To meet a growing requirement for simple operation, channel selection and service mode—including continuous wave, a-m, upper sideband, and lower sideband—can be made by illuminated push buttons, as can the choice of bandwidths between 0.3 and 8 kHz. Alternatively, the frequency can be set by a flywheel tuning control.

The 20-channel C-MOS memory permits frequency, service, and bandwidth data to be stored for 19 stations while the 20th holds the channel in use. □

France

Broadcast switching matrix/automatic mixer, uses MOS logic for up to 10,000 connections

Controlling the variety of inputs that make up the final modulation fed to the transmitter for a radio broadcast is tricky enough. Yet, while broadcast engineers mix the inputs and fade them in and out, they must ship signals to a number of other places—for example, broadcast signal to the transmitter and warning of an impending switchover to a live studio feed to the personnel there.

Fortunately for the harried engineer, there are several electronic aids to ease his job, one of the latest being a modular frequency-switching matrix designed by Télédiffusion de France, the government agency that handles the technical side of broadcasting. Built of analog metal-oxide-semiconductor switches controlled by digital signals from complementary-MOS logic, the matrix is combined with an automatic mixer.

Designated the SN3300 by the firm, the system can offer switching matrixes of as many as 100 by 100 points. The 10,000 connections would suffice for all but the largest central studios while limiting operator-addressing effort to four digits: two for the input and two for the output. Paris-based TDF says the system is less costly and complicated than a computer-aided switching and programming system.

With the new system, the operator retains complete control of what is going on without having to know about computer operations—despite the enormous number of permutations available. Also, no computer programming knowledge is necessary to give it instructions.

The module that is the basis for the switching matrix has 10 inputs and a triple output. The triple output furnishes signals for the outgoing broadcast, for an additional transmission of that broadcast to the studio, and for remote-control operations—for example, switching on the red light in the on-the-air studio. Each module is made up of analog MOS circuits (MEM855P), which are switched on selectively by binary-coded-decimal signals that come from a digital control.

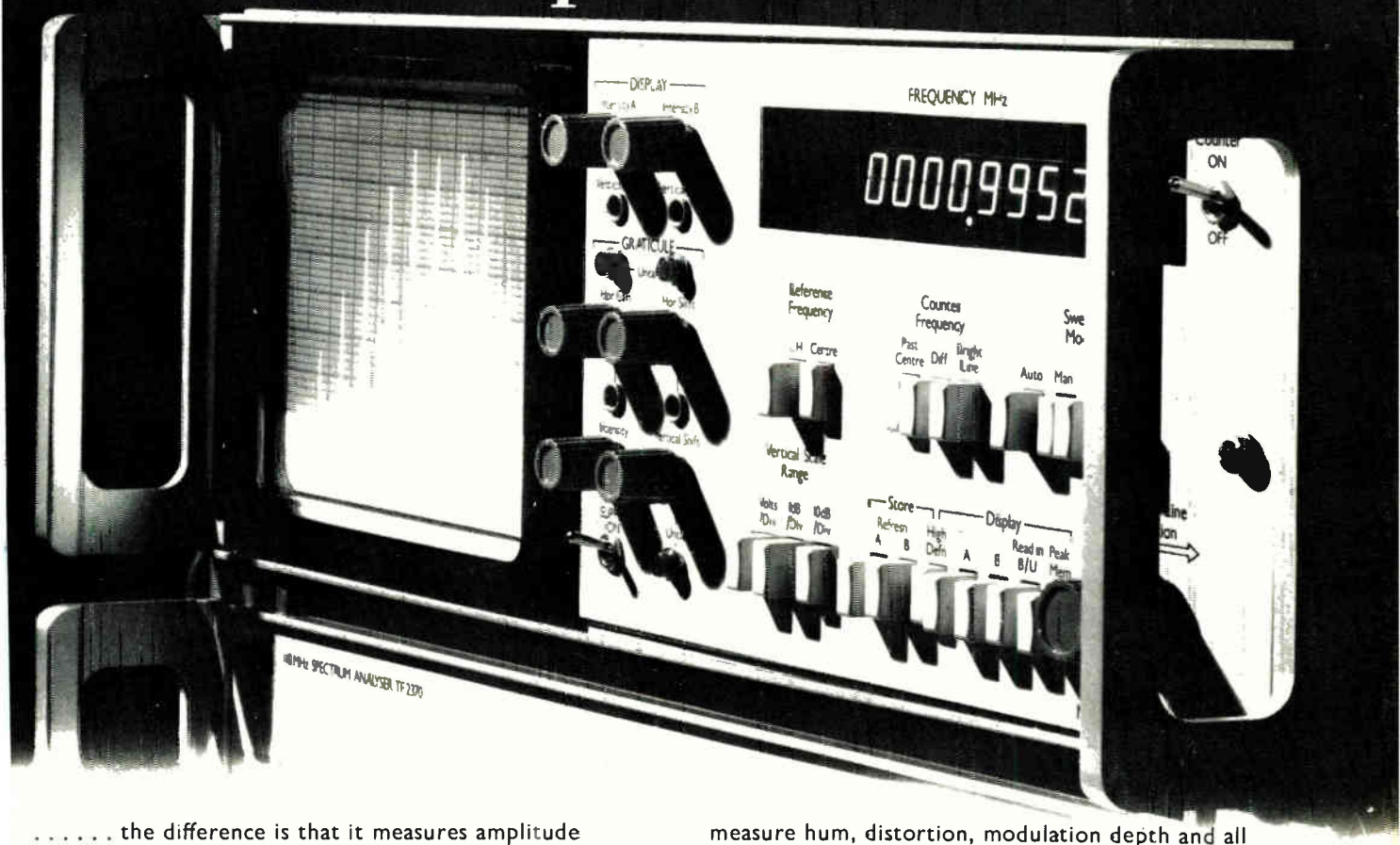
The control unit decodes the operator's keyboard inputs and applies the resulting signals to a logic unit. Composed mostly of 4000-series C-MOS packages, the logic unit in turn controls the switching modules. It also controls the automatic mixer, which is built around voltage-controlled amplifiers, one for each of the two input channels. The voltage ramps that fade out one channel while bringing up the second can be programmed for rise and fall times of 0.2, 1, 2, or 4 seconds.

Three modes. The operator can punch in switching instructions as they are needed. Also, he can put switching sequences into a random-access memory. Then he can call up the sequences with the keyboard, or he can instruct the control unit's quartz clock to automatically trigger them at designated times.

The big advantages of the MOS technology over relay switching and other methods are reliability, low power consumption, and high immunity to noise, say the TDF engineers. The signal-to-noise ratio is above 88 decibels, while power consumption at 50/60 milliamperes is reckoned to be some 20 times less than, say, that of transistor-transistor logic. The relative slowness of MOS is no disadvantage because there is no need for submicrosecond switching. Maximum switching time is less than 2 μs; crosstalk attenuation is about 100 dB.

The first SN3300 went live last month on France-Culture, one of the country's four official radio networks. Though developed by TDF, the new system is being built and sold by SAF (Société Artistique Française) of Paris. □

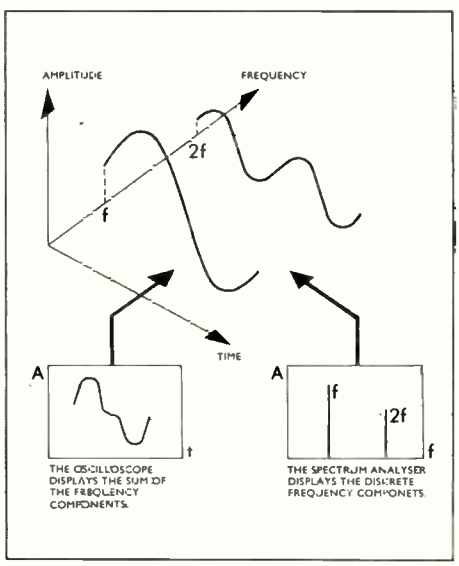
The oscilloscope with a difference...



. . . . . the difference is that it measures amplitude against frequency (instead of time). This comparatively small change has led to our instrument being called a "Spectrum Analyser" which, in turn, has caused oscilloscope users to believe it's for a completely different job, "they are complicated things used only by boffins and people concerned with light waves or something".

But – excuse us – that's where they're wrong. Our TF 2370 is easier to use than many oscilloscopes, it has a frequency range from 30 Hz to 110 MHz and gives much, much more information about waveforms of nearly all types than does a 'scope. And it has a built-in digital frequency meter and sweep (tracking) generator of its own so you can check amplifiers and filters too.

Signals are displayed with the fundamental, harmonics, sidebands and spurious content all clearly indicated and quite distinct from each other. You can see the waveform as it really is and measure hum, distortion, modulation depth and all sorts of things to an accuracy impossible on a 'scope – even on signals which 'scopes show as being 'pure'.



Our special digital store and television display system gives you a steady 'infinite persistance' picture on which you may also compare your ideal waveform with your actual live image. The graticule is electronically generated – so no parallax errors – and you can move it up and down, or sideways, or expand it, all at the twist of a knob or two.

Whether you are involved in design, production, calibration, maintenance or indeed virtually any application where oscilloscopes are used, you will find that the TF 2370 Spectrum Analyser will provide a faster, easier, more informative and accurate answer to nearly all your questions.

If you're still a sceptic ask us for literature or, better still, ring us for a demonstration.

mi MARCONI INSTRUMENTS

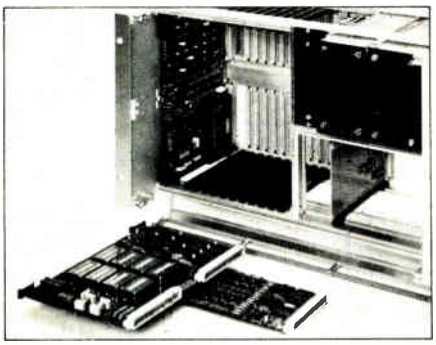
Marconi Instruments Limited · Longacres · St. Albans · Hertfordshire · England AL4 0JN · Tel: (0727) 59292 · Telex: 23350
Marconi Electronics Inc · 100 Stonehurst Court · Northvale · New Jersey 07647 **USA** · Tel: (201) 767-7250 · Twx: 710-991-9752
Marconi Instruments · 32 avenue des Ecoles · 91600 Savigny-Sur-Orge · **France** · Tél: 996.03.86. · Télex: 600541.F
Marconi Messtechnik GmbH · 8000 München 21 Jörgstrasse 74 · **West Germany** · Tel: (089) 58 20 41 · Telex: 5 212642

Meet DIN, IEC and VG standards

Eurocard

Quality connectors from a big connector user

As a big connector user, Philips have long recognised the need for International, interconnection standards. But as a user, we also recognise that there's more to a connector than the

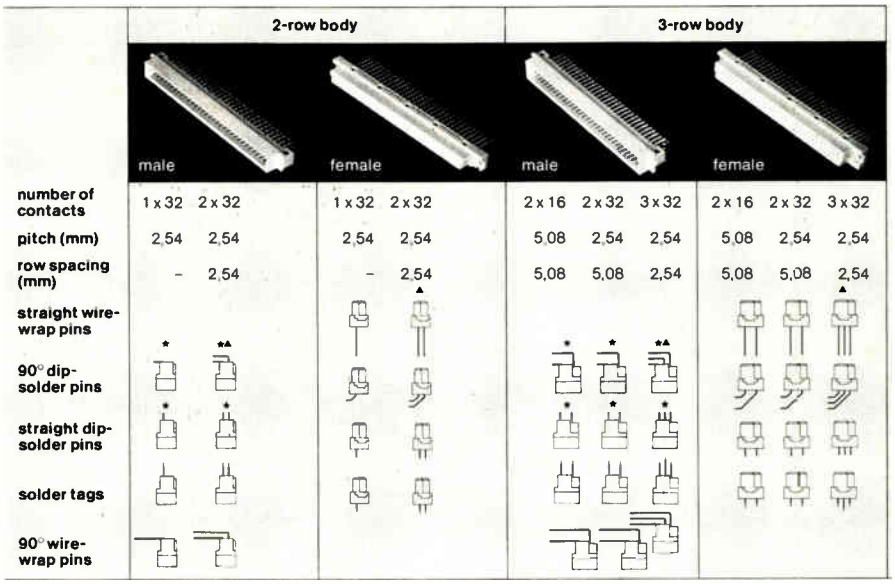


dimensions and format of the Eurocard system.
In connectors there's a vital parameter called quality. So don't look just to DIN and IEC, look also for a supplier who can meet the critical, German Military (VG) standards. Because even if you don't need these high-quality standards, it's important to know that your connectors were made to the same quality levels, on the same equipment, by the same people. People like Philips.

A comprehensive range

As illustrated in the table above, Eurocard connectors are available in two series for 2 A and 5,5 A applications and in 2-row, 3-row and 4-row configurations. The series are designated F068-I and F068-II respectively and are available with a wide range of accessories.

F068-I 2,54 mm 2 A at 20°C IEC 130-14 / DIN 41612 / VG 95324

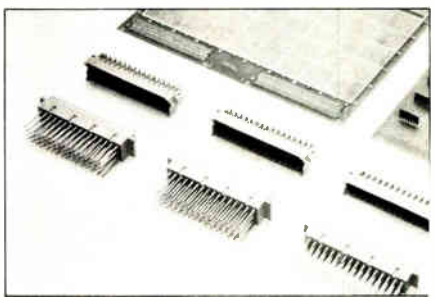


★ available with protruding ground contacts
▲ available to German MIL Spec VG 95324

Contacts and terminations

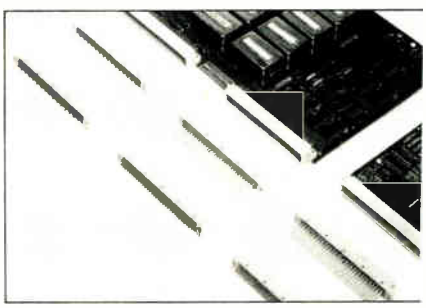
The main specification points are given in the table below. In addition it should be noted that F068-I male connectors with dip-solder pins and all male F068-II connectors can be supplied with protruding earth contacts. Use of these contacts ensures that electrostatic effects do not damage sensitive components, such as some IC types, when the connector halves are separated.

		F068-I		F068-II	
		male	female	male	female
material for metal parts		brass	phos. bronze	brass	phos. bronze
contact finish (gold on nickel)					
IEC and DIN:	nickel	2 µm	2 µm	3 µm	2 µm
	gold	1,3 µm	1,3 µm	1 µm	2 µm
VG 95324:	nickel	2 µm	2 µm	–	–
	gold	2,5 µm	3 µm	–	–
termination finish		gold flash on 1 µm nickel		6 µm tinned	
reinforced contacts		–	no	–	yes
non-reinforced contacts		–	yes	–	yes
removable contacts		no	no	yes	no
mechanical endurance		400 insertions: IEC 512-5 500 insertions: VG 95324		400 insertions: IEC 512-5	



Above, male F068-II connectors on single- and double-format Eurocards for mating with female connectors with wire-wrap pins

Below, male F068-I connectors mate with female connectors having either wire-wrap or dip-solder pins.



PHILIPS Electronic Components and Materials

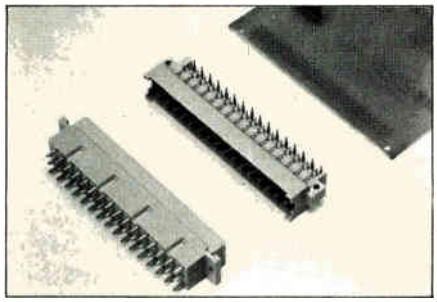
Connectors

Developed and made in Europe

F068-II 5,08 mm 5,5 A at 20°C IEC 130-1 / DIN 41612

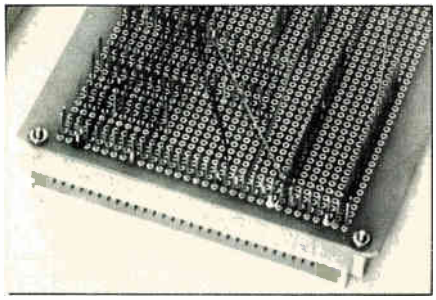
	3-row body		4-row body	
	male	female	male	female
number of contacts	2x16 3x16	2x16 3x16	4x16	4x16
pitch (mm)	5,08 5,08	5,08 5,08	5,08	5,08
row spacing (mm)	5,08 5,08	5,08 5,08	5,08	5,08
straight wire-wrap pins				
90° dip-solder pins				
straight dip-solder pins				

all connectors use even numbered pins only.
all male connectors available with protruding ground contacts.
all female connectors available with reinforced contacts.



Above, male F068-II connector on single-format Eurocard for mating with female connector having dip-solder pins.

Below, male F068-I connector with right-angled wire-wrap pins to obviate the use of intermediate pins.

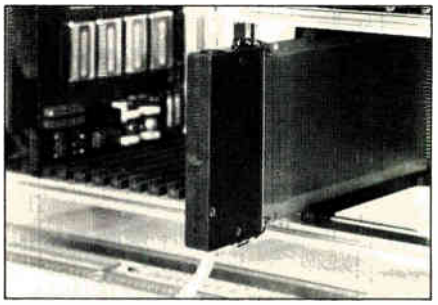


All female F068-II connectors are supplied with contacts reinforced by metal springs. This ensures reliable operation under severe conditions such as vibration.

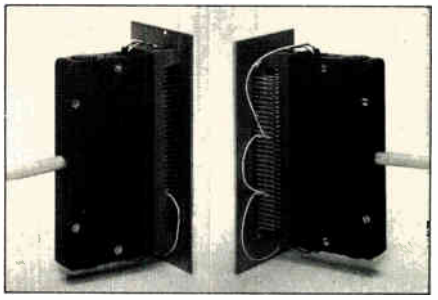
Accessories

A comprehensive range of accessories is available including cable hoods for use with both male and female F068-I connectors. The hoods are manufactured in two parts and are provided with a cable clamp and three cable entry positions, which allow cable feedthrough.

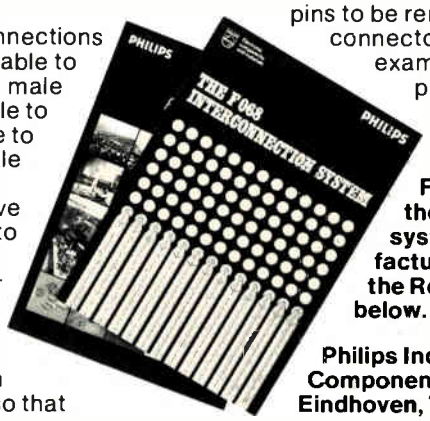
Three basic connections can be made: cable to panel-mounted male connector; cable to cable and cable to board-edge male connector. The illustration above shows a cable to rack-mounted female connector via an extender board. The F068-I connectors can also be coded so that the male connectors will only mate with females having the same code. A set of coding parts is available for this purpose.



Testing sometimes requires that temporary connections be made to the wire-wrap pins of rack-mounted female F068-I connectors. As shown below, a set of parts is available for this purpose.



A useful accessory for the F068-II series is the simple tool that allows the pins to be removed from the male connector. This can be used, for example, to relocate a protruding earth contact.



For a detailed brochure on the F068 interconnection system and our manufacturing facilities please use the Reader Service Number below.

Philips Industries, Electronic Components and Materials Division, Eindhoven, The Netherlands.

PHILIPS

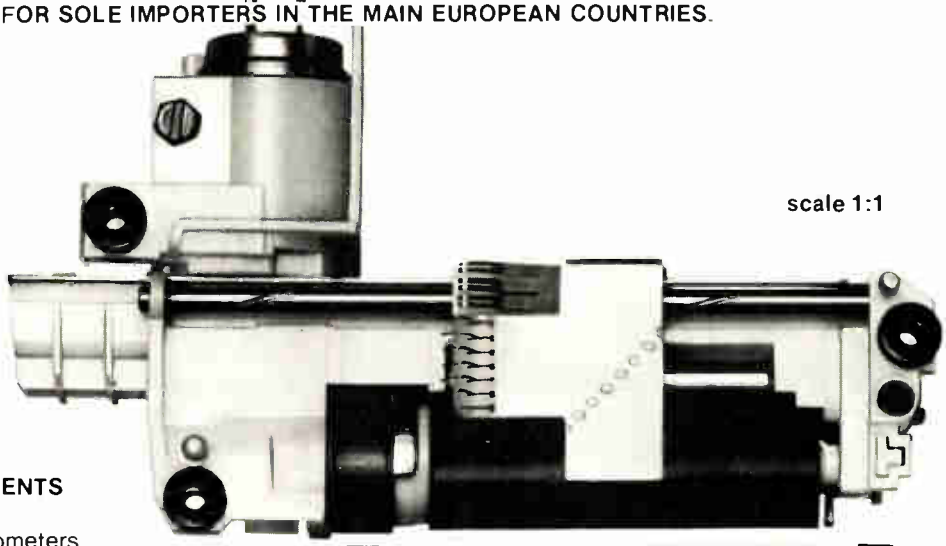
olivetti nip 18

non impact printer

SOLE AGENT: SIME BRONDI P.O. Box 344, 10100 Torino - Italy - Tel. 011/800.5630/5654/4616, telex 22466 Brondi

WE ARE LOOKING FOR SOLE IMPORTERS IN THE MAIN EUROPEAN COUNTRIES.

COMPACT SIZE
HIGH RELIABILITY
LOW PRICE
EASY CONNECTION
QUIET OPERATION
LOW POWER CONSUMPTION
NO INKED RIBBON
NO LUBRICATION
BATTERY OPERATED



scale 1:1

APPLICATIONS

MEASURE AND CONTROL INSTRUMENTS
Digital voltmeters - Frequency meters - Electronic counters Electronic thermometers

ELECTROMEDICAL INSTRUMENTS
Function control devices

AUTOMATIC WEIGHING SYSTEMS
Digital scales - Industrial scales

INDUSTRIAL PROCESSING CONTROL
Microprocessor output units - Numeric control - Automation monitoring

TELEPHONES
Telephone charge checking systems - Data transmission

OTHER APPLICATIONS
Data loggers - Emergency vehicles - Fire engines - Mobile communications - Police cars

SPECIFICATIONS

DOT MATRIX SERIAL PRINT ON ELECTROSENSITIVE PAPER
7 electrode mobile head - Prints numerals, letters of the alphabet and symbols - Max capacity: 25 characters per line

CHARACTER SIZE
Height: 3 mm - Width: variable

PRINTING SPEED
Up to 2 lines per second

VERTICAL SPACE
Mechanically controlled, 5 mm step

ASSEMBLING AND POSITIONING
Directly on printed circuit - Works in any position

MAX. DIMENSIONS
Width: 175 mm - Height: 45 mm - Depth: 80 mm

WEIGHT
190 gr

ENVIRONMENT CONDITIONS
Temperature: −10 °C ÷ +50 °C - Relative humidity: 90%

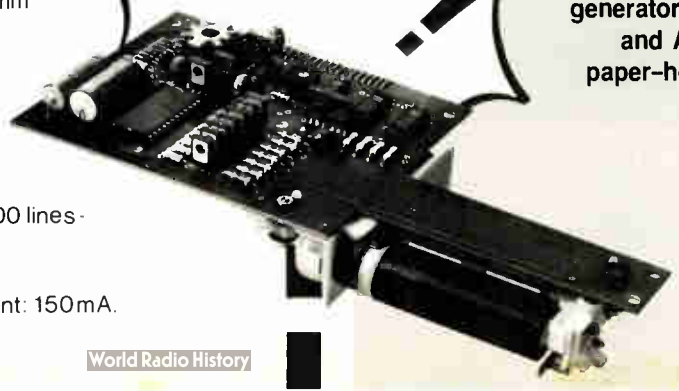
OPERATING LIFE
Printer: › 2.000.000 lines - Head: › 700.000 lines - Easily interchangeable head

POWER
Motor: 4,5 nominal Volts, max. 6 Volts. Current: 150 mA. At start peak 1,2 A for 1 millisecond.
Pins: 35 Volts with negligible consumption.

Circle 103 on reader service card

```
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
```

NEW!



Now available also in an O.E.M. version including the electronic circuit for motor and print control. Complete with character generator BCD and ASCII, paper-holder, etc.

Touch & Trigger

Automatic displays to 25 MHz at 2 mV

As illustrated, the PM 3212 has an impressive combination of features that add up to unbeatable all-round performance.

Bandwidth, sensitivity, triggering facilities, weight and dimensions are all what you need and what you might expect for this price class.

"Auto" triggering on the PM 3212 is more than a trace finder – much more. In this mode not only is a zero line displayed when there is no input signal, but in the presence of a signal the trigger level is derived from the peak-to-peak amplitude of the signal. This gives instant and unambiguous triggering for a wide variety of measurement conditions.

But we give you more. A brighter trace, a sharper display, a double insulated supply, battery operation and versatile X-Y facilities. And the usual Philips plus: the unbeatable front panel layout.

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

Continuously variable timebase for easier measurements of phase, for timing comparisons and to avoid "double writing" problems in digital applications.

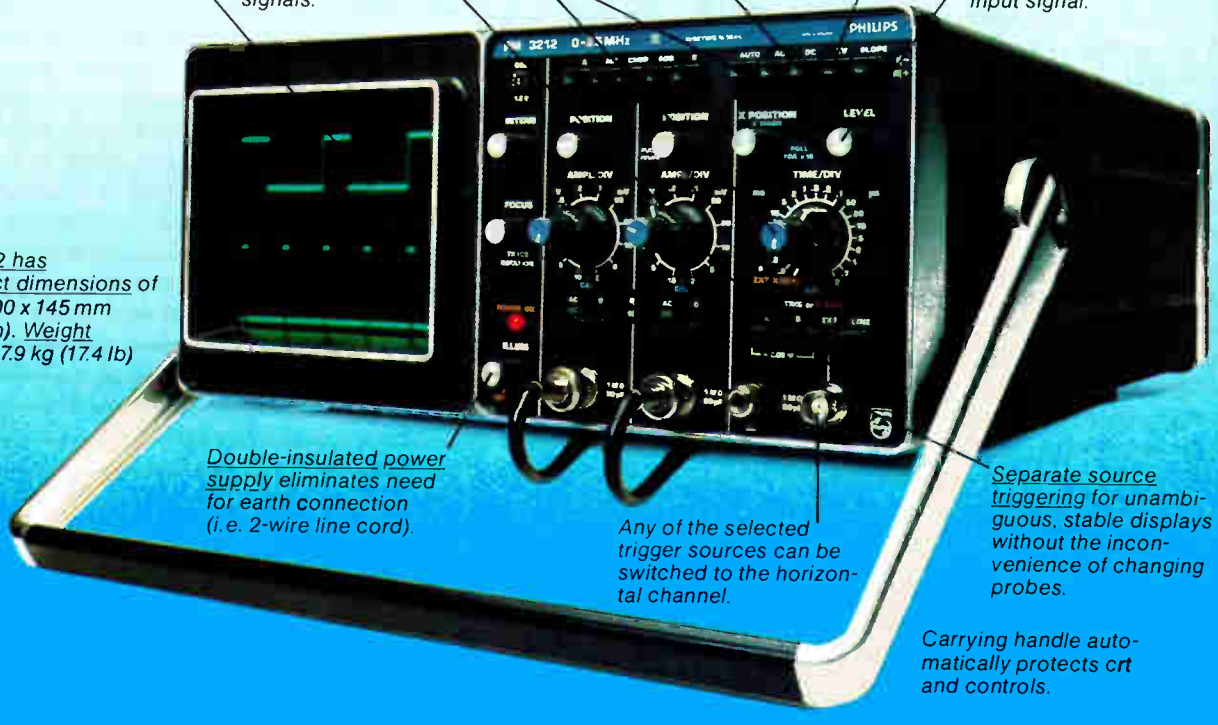
Automatic TV triggering at the touch of a button. Frame triggering occurs in the lower sweep speeds, changing over automatically to line from 200 µs/div upwards.

High light output displays through 10 kV tube. Small spot size. Continuously variable illumination of fine-line internal graticule.

Composite triggering when both buttons are depressed. When used in the alternate mode this gives a stable display of two unrelated signals.

DC coupled triggering without which variable duty cycle waveforms cannot be handled. This is a vital feature for digital measurements.

Level control can be used instead of "Auto" when the instrument needs to be triggered at an exact point in the input signal.



PM 3212 has compact dimensions of 445 x 300 x 145 mm (l x w x h). Weight approx. 7.9 kg (17.4 lb)

Double-insulated power supply eliminates need for earth connection (i.e. 2-wire line cord).

Any of the selected trigger sources can be switched to the horizontal channel.

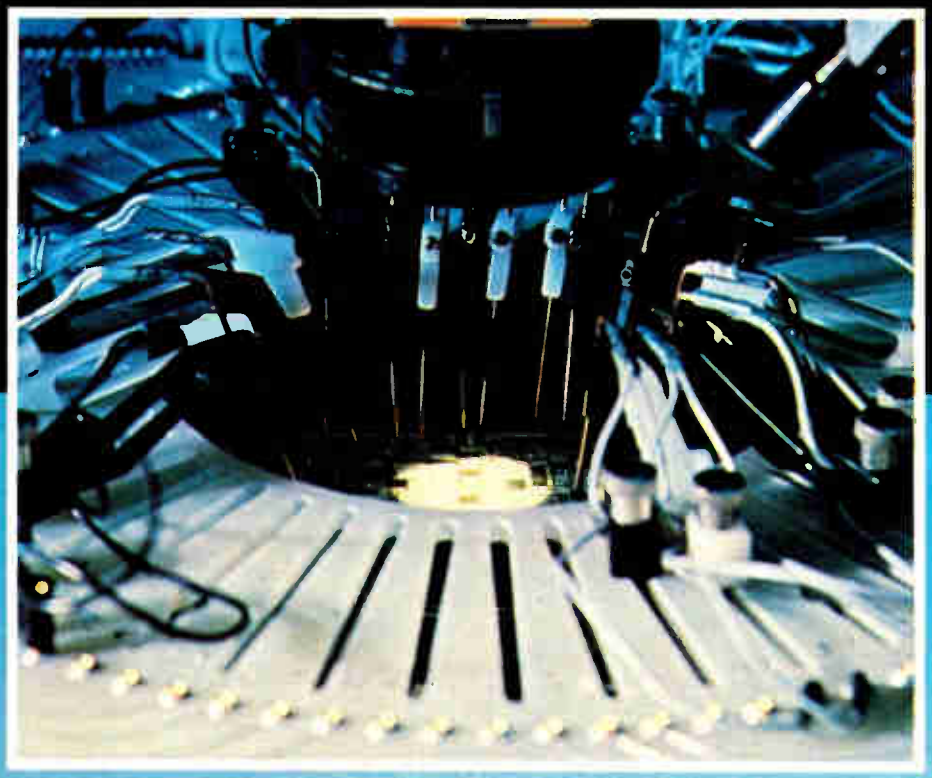
Separate source triggering for unambiguous, stable displays without the inconvenience of changing probes.

Carrying handle automatically protects crt and controls.

PHILIPS Test & Measuring Instruments

PHILIPS

Circle 104 on reader service card



We know how

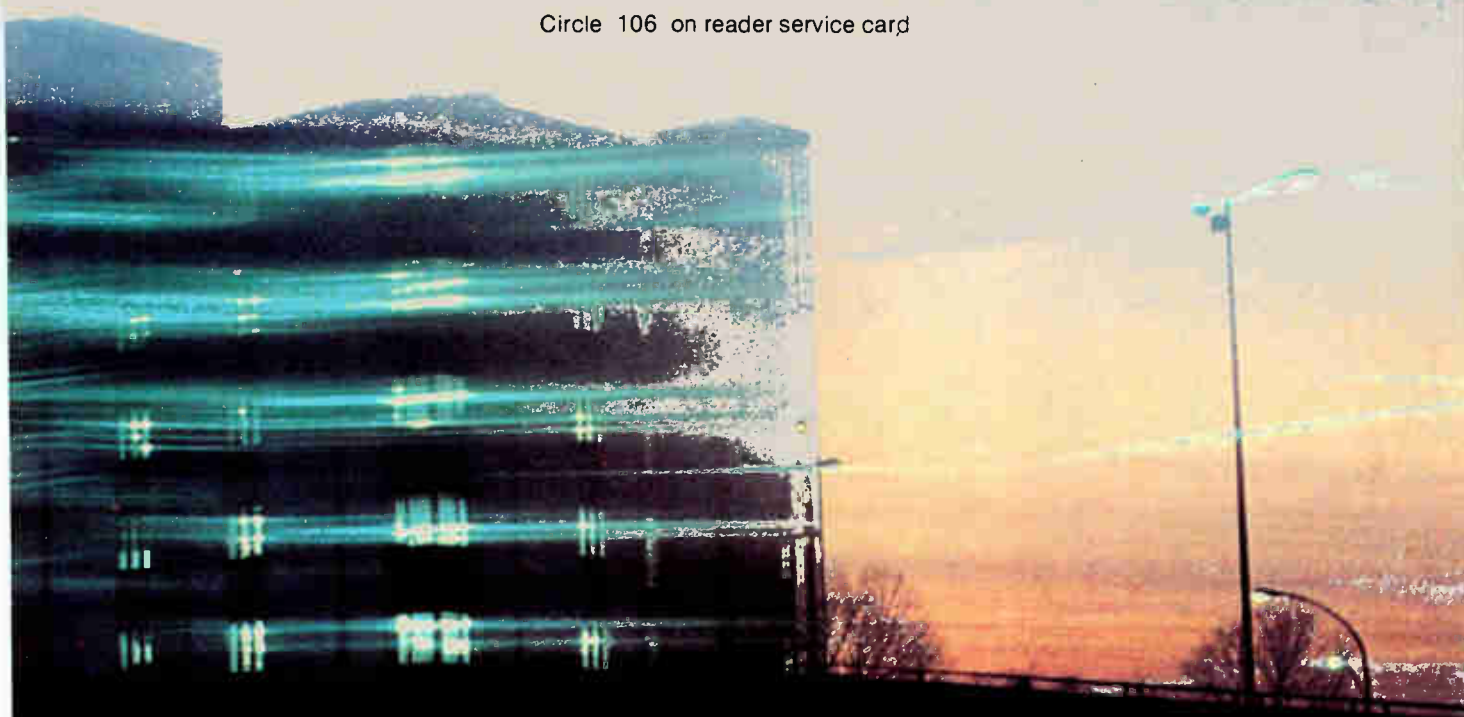
to make ourselves heard

through our 2,000 researchers
our 30,000 workforce
building telecommunications equipment and systems
in 9 factories.
Exporting worldwide.

ITALTEL

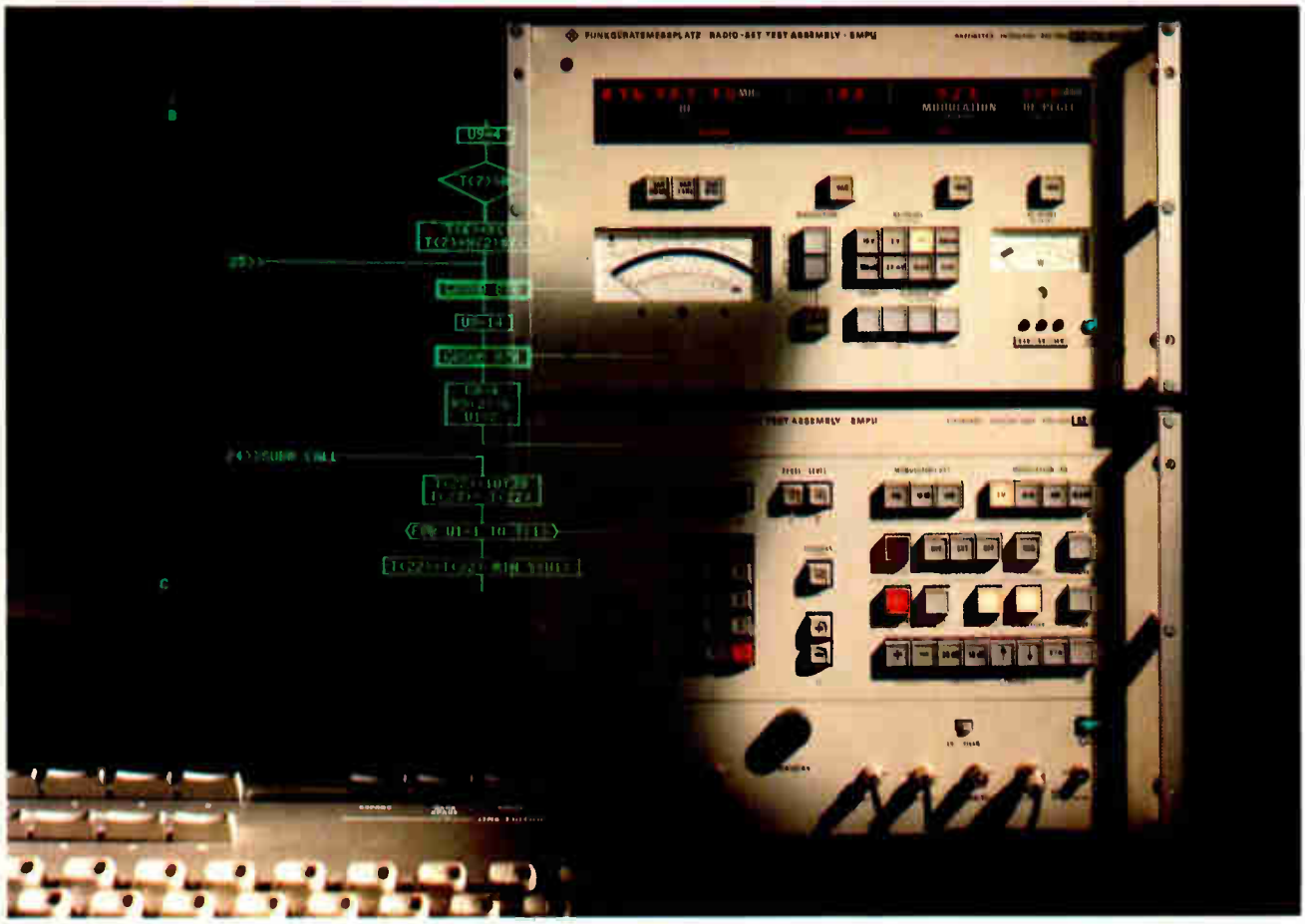
Telecommunications is our business

Circle 106 on reader service card



20149 Milan (Italy) - 12, Piazzale Zavattari - phone (+ 392) 4388.1

Calculator-controlled radio-set test assembly



Smart test assembly SMPU using IEC interface bus and inbuilt microprocessor for executing fast and reproducible measurements, no matter how complicated, in production and service – without external controls and extremely simple in use.

The accuracy of the integrated devices enables measurements in line with CEPT requirements. All devices are also individually accessible for testing subassemblies. Programming to IEC-bus standard, meaning straightforward adding on of extra measuring and controlling units, e.g. for analyzer and SSB chores. Combination with IEC-bus-compatible calculators, e.g. Tektronix 4051, brings all the advantages of a fully automated, calculator-controlled test system:

- no limitation to fixed programs
- extremely simple program setup and alteration
- high intelligence: true-value measurement with tolerance, fault diagnosis or interactive program
- peripherals: printer, plotter, floppy disk, magnetic tape or disk, hard-copy unit and card reader

No need to learn a programming language – comprehensive library of programs is available and constantly being added to.

For more information quote **SMPU calculator-controlled**

Rohde & Schwarz
Postfach 80 14 69
D-8000 München 80
Fed. Rep. of Germany

Electronic Measurements and Radio Communications. Development, manufacture, sales and service. Known for "electronic precision".

Independent concern (establ. 1933), represented in 80 countries.

ROHDE&SCHWARZ

Circle 107 on reader service card

Solder coater eliminates steps, reduces costs

by Charles Cohen, Tokyo bureau manager

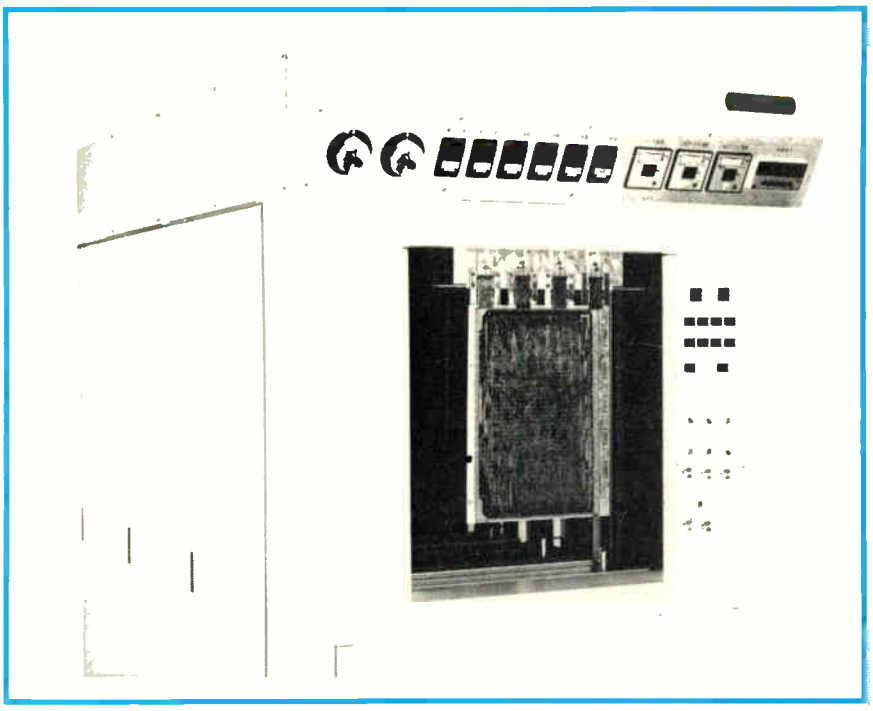
In new process, only through-holes and pads are solder-coated by compact Japanese unit

By eliminating unnecessary coating, a solder coater developed by Dai Nippon Screen Manufacturing Co. promises to solder-coat printed-circuit boards with higher quality yet lower cost than conventional electrolytic methods. Since only the areas that need it are coated, the DS HSC-224-A also eliminates environmental problems associated with the disposal of unwanted solder.

The new unit coats only the through-holes and surrounding pads with solder, rather than the entire wiring area. This approach increases reliability, since there is no solder on the traces to interfere with the epoxy-resin solder-resist mask that is applied before the dip-solder step.

With the DS HSC-224-A, the operator can process up to 100 boards an hour. Maximum board size is 550 by 600 mm, minimum is 150 by 200 mm. Still smaller layouts may be fabricated several at a time on a board that is later cut apart. Generally the coater handles glass-epoxy boards with copper traces on both sides, of the kind used in industrial equipment, but it can also process paper-phenolic boards, including one-sided types with through-holes.

Fabrication starts conventionally,



with a board typically having a 35-μm-thick copper foil laminated to each side. It is drilled and given an electroless copper plating, typically 1 to 3 μm thick, and electrolytic copper plating, typically 10 to 15 μm thick, on both sides and in the holes. Then sensitized film, typically Du Pont Riston T-113S or T-116S, is laminated onto both sides. At this point the process diverges from the conventional electrolytic method.

In the solder-coater process, the sensitized film is exposed and developed so that it remains only over the pads, the holes in the pads, and where the printed wiring will be, to serve as a resist while the wiring pattern is etched out of the copper on the board. Then the film is stripped, and solder resist is applied over the entire board except the holes and pads. Processing in the solder coater consists of a 2-to-6-second dip in a 230°C solder bath and a 2-second leveling process in which air heated to 230°C removes solder from holes and levels it on the pads. The board is then ready for parts insertion and dip-soldering.

In the conventional electrolytic process, the sensitive film is exposed, developed, and removed from the pads and wiring pattern, which are then plated with a solder film about 20 μm thick. Next, the Riston film is stripped, and solder is used as a resist while copper foil is etched from the areas around it to give the desired wiring pattern. Areas other than the pads are then coated with epoxy solder resist, and the boards are heated in ovens by radiant heat to fuse the relatively porous plated coating into a denser coating similar to that acquired by dipping. The resist may shift during the fusing, turning the board into a reject.

In both processes, terminals that fit into sockets are plated with gold or other contact material, and the boards are cut to desired shape when necessary. The price in Japan for the compact new coater is 13 million yen, or about $56,522 at the exchange rate of 230 yen equals $1.

Dai Nippon Screen Manufacturing Co. Ltd., Horikawa Kurumaguchi, Kamikyo-ku, Kyoto 602, Japan [441]

Opening new frontiers with electro optics

Just what the doctors ordered: RCA-developed PMTs that allow whole-body CT scanning in only 2 seconds.

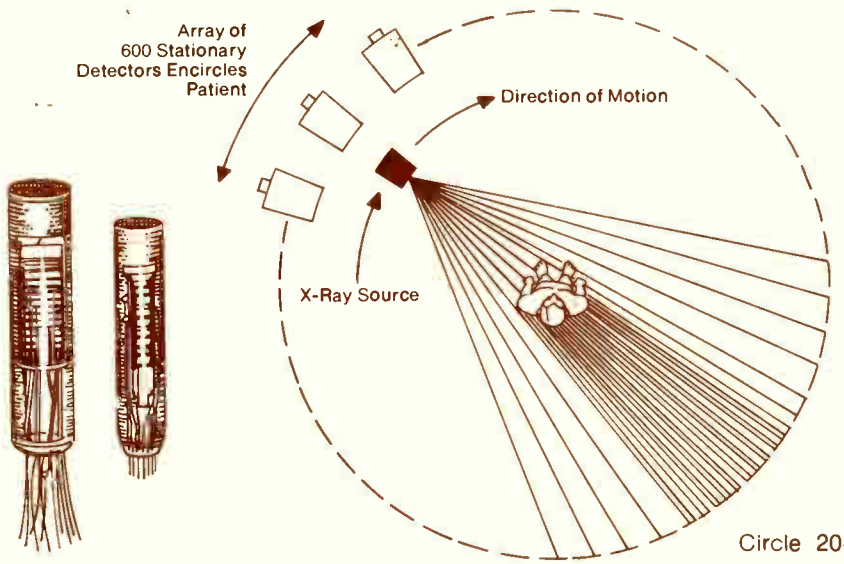
Computerized tomographic (CT) X-ray scanners are creating a lot of excitement in medical circles. Unlike conventional X-rays, where a dense object can block out something important such as a tumor, a CT scan from hundreds of directions produces a highly revealing, complete cross-sectional view of the patient.

Vital links in this process are the hundreds of photomultiplier tubes which measure light scintillations caused by X-ray beams passing through the body and striking individual crystal detectors. RCA, of course, has a long background in the design and manufacture of PMTs. So we've been able to provide extremely reliable tubes with the performance required for critical measurements at ever-faster scanning speeds—users report as fast as 2 seconds.

These PMTs feature a wide dynamic operating range due to a highly conductive cathode surface and low anode dark current characteristics. Cathode currents of several nanoamperes and anode dark current in the picoampere range are possible when using the PMTs at operating voltages around 600 volts, characteristic of most CT scanning systems.

Two sizes of RCA 10-stage head-on tubes are being used in scanners. The 4886 has a 3/4" diameter and the S83001E a 1/2" diameter bialkali photocathode.

They represent a clear case where RCA saw a need and applied years of PMT experience to meeting it. Now, what can we do for you?

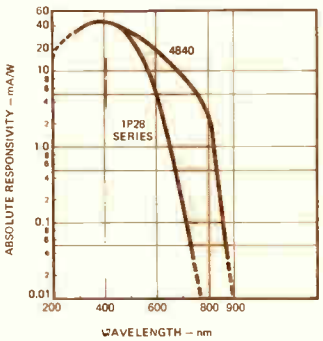


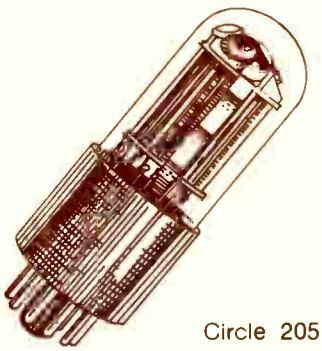
Circle 204

For spectroscopists: PMT with improved responsivity out to 850 nanometers.

The popular RCA 4840 1-1/8" dia., 9-stage PMT has been improved again. Its high responsivity now extends over a broader spectral range—to 850 nm typical. And there are some other benefits from buying this RCA tube. The assurance that comes from domestic manufacture. Prompt delivery. Price—about $55. And in-depth application support from people who really know how to help you get the most from a PMT.

So if you're involved in broadband spectroscopic analysis or low-level light detection systems—analyze the extra benefits you get from buying your PMTs from RCA.



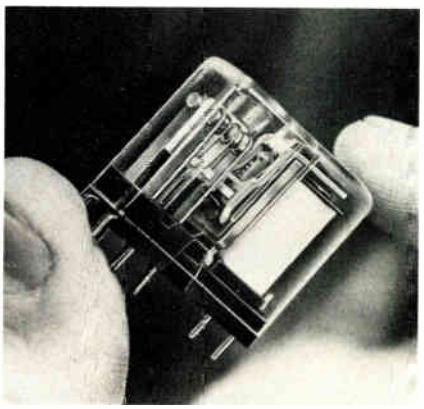


Circle 205

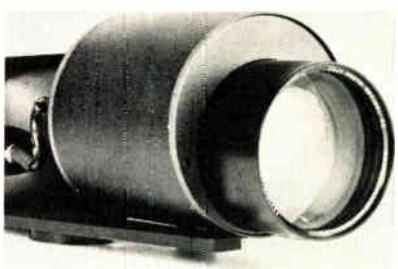
If electro optics can solve your problem, remember: EO and RCA are practically synonymous. No one offers a broader product spectrum. Or more success in meeting special needs. Call us for design help or product information. RCA Electro Optics, Lancaster, PA 17604. Phone 717-397-7661. Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste.-Anne-de-Bellevue, Quebec, Canada; Sao Paulo, Brazil; Hong Kong.

RCA

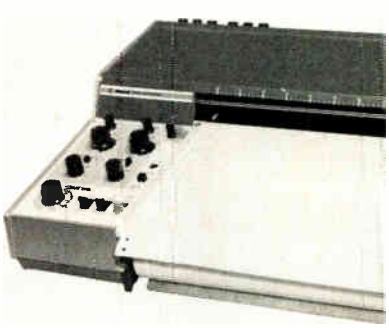
New products international



Series 265 relays are available with a range of pin spacings that provide interchangeability with various European types. The relays have dimensions of 25.9 by 28.8 by 12.1 mm. Pye Electro-Devices Ltd., Controls Division, Exning Road, Newmarket, Suffolk CB8 0AX, England [443]

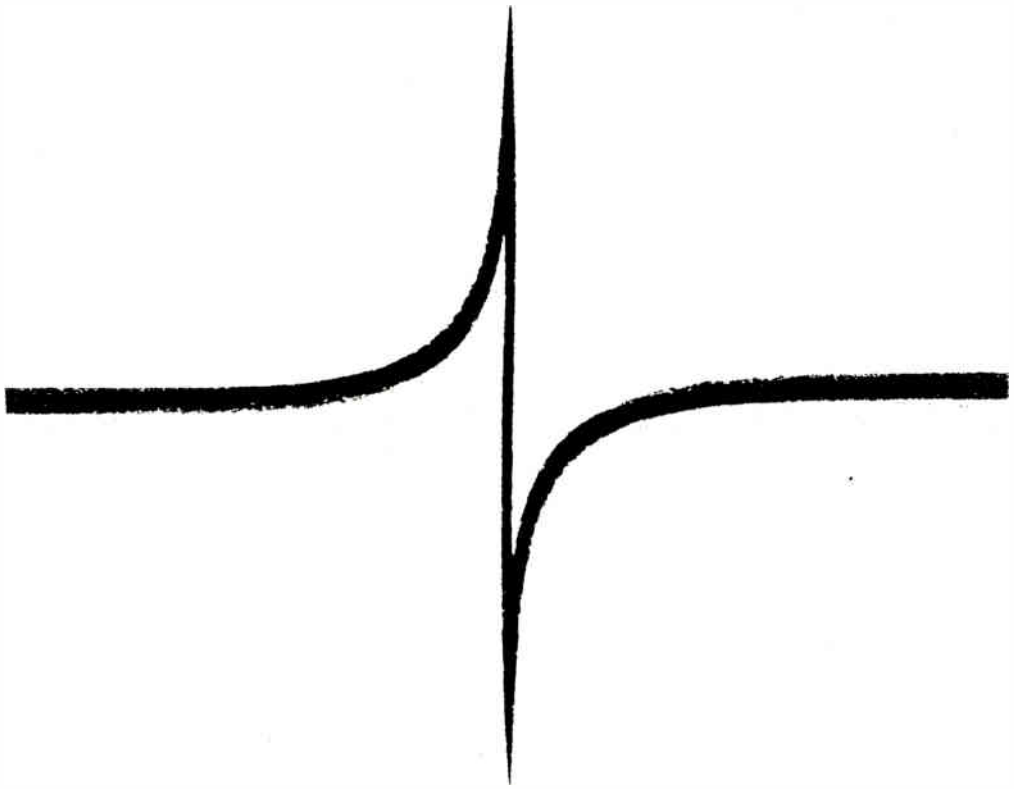


A low-light TV camera produces high-resolution signals of full video amplitude with scene highlight brightness of only 0.05 lux. Usable signals are obtained at brightnesses down to 0.02 lux. Cotron Electronics Ltd., Rockland Works, Eagle Street, Coventry CV1 4GJ, England [444]



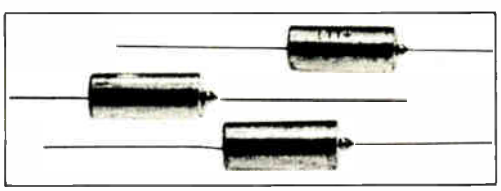
The VP-6621A (two-pen) and VP-6611A (one-pen) flatbed chart recorders have writing speeds of more than 100 cm/s. Input ranges are 1 mV to 5 V in 12 steps. Matsushita Communications Industrial Co., 4-3-1 Tsunashima Higashi, Kohoku-ku, Yokohama 223, Japan [445]

new performances



doped tantalum capacitors

L.T.T. offer new performance with doped tantalum capacitor type CTS 31 (PASI 85).
This capacitor, in addition to excellent standard characteristics:
- low leakage current.
- high capacitance.
- stability with both temperature and time



displays improved performances to surge current and reverse voltage in low impedance circuits.

These new performances are tested by Qualification and Group C life test of 2000 hours / 85 °C with 20 % AC 50 Hz Rated Voltage (without DC polarization), under low impedance conditions. AC voltage for A and B size may be 30 % Rated Voltage.

The CTS 31 from L.T.T. is the first high volumetric efficiency electrochemical capacitor to withstand this test.

L TT

89, rue de la Faisanderie 75782 Paris Cedex 16 télex 620356 Gralifil Paris tél. 504-45-50

Please send me more information on the CTS 31 doped tantalum capacitor.

name _____ address _____
title _____ city _____
company _____ state _____ zip _____

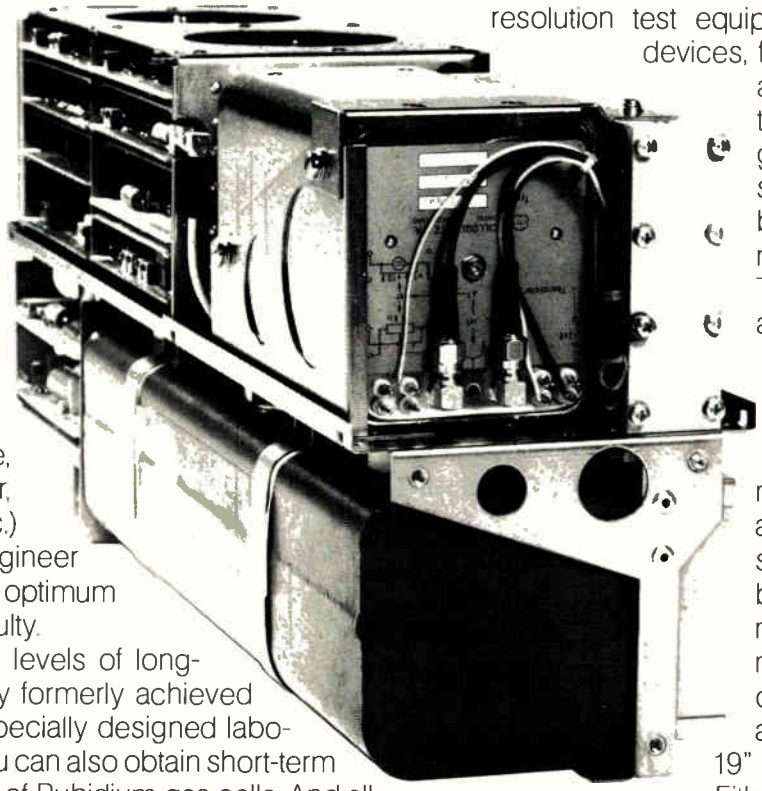
New products international

An option for the 1041 and 1051 digital voltmeters—compatibility with the IEC standard bus system—allows them to be installed with only simple software changes. Datron Electronics Ltd., Meteor Close, Norwich Airport Industrial Estate, Norwich NR6 6HQ, England [446]

The model TH 7501A is a self-contained video-signal store, which will hold a single television image for later examination or processing or to integrate several TV images. Thomson-CSF, Division Tubes Electroniques, 38 rue Vauthier, 92100 Boulogne-Billancourt, France [447]

The BH 604-7 automatic continuity tester is the first standard system to be released that is based on the BH 604 computer. It is inexpensive, fast, and easy to use. Errors are listed on a display and/or printer. Burnt Hill Electronics Ltd., 19 Holder Rd., Aldershot, Hampshire GU12 4RH, England [448]

If you want a Cesium frequency standard without the frills Oscilloquartz has developed a unique OEM module



Now you can obtain a primary frequency reference that gives you access to Cesium standard performance but leaves you free to apply it as you wish, choose your own peripherals and package. And you don't need in-depth knowledge of the complex resonance technology. Oscilloquartz has designed their OEM module (Cesium beam tube, 5MHz crystal oscillator, microwave multipliers, etc.) so that any competent engineer can install it and achieve optimum performance without difficulty.

You can obtain the same levels of long-term stability and accuracy formerly achieved by only a few large and specially designed laboratory set-ups. And now you can also obtain short-term stability comparable to that of Rubidium gas cells. And all this without any need for calibration on your part.

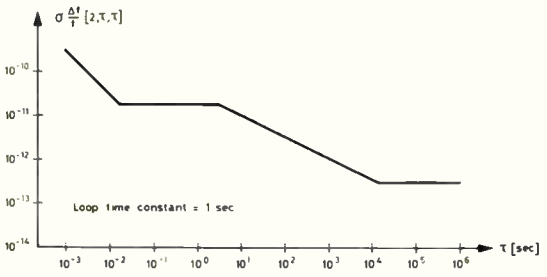
Developed specifically for OEM application, this Oscilloquartz compact 5MHz frequency source offers the stability, reproducibility and accuracy needed for high-resolution test equipment and timing devices, fail-safe navigation and communications systems, geophysical survey systems, very long base-line interferometer arrays, etc.

Then, if you prefer a self-contained Cesium beam frequency standard, we offer our basic OEM module along with a mains power supply, stand-by battery, controls, monitoring instruments and indicators — all packaged in a standard 19" rack.

Either way, you get the best in technology, quality, accuracy and technical service that built the name and reputation of Oscilloquartz. Run through the specification ... then contact us for more details.

Technical data	
Accuracy:	$\pm 1.10^{-11}$ over temperature range (without calibration)
Reproducibility:	$\pm 5.10^{-12}$
Settability:	$\pm 5.10^{-13}$, total range $\pm 4.10^{-11}$
Output:	5 MHz, 1 Vrms/50 Ω
Power supply:	22 to 30 VDC, 25 W
Dimensions:	height 190 mm (7.5") width: 120 mm (4.75") depth: 466 mm (18.37")

Stability



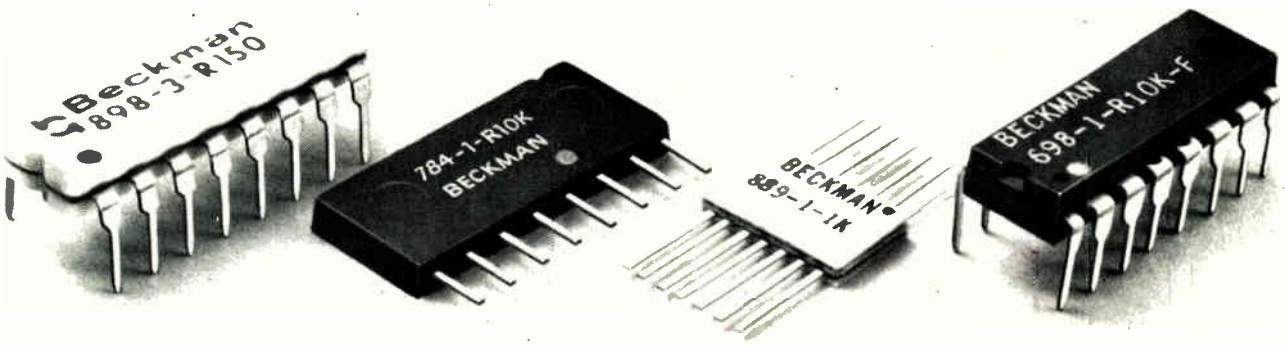
OSCILLOQUARTZ SA

Member of the Ebauches group
CH-2002 Neuchâtel 2 Switzerland
Tel. 038 25 85 01 Telex 35315

Pathfinders in Precision

Circle 114 on reader service card

The Beckman alternative



One Piece Money Savers that save Time and Space, too.

The logical alternative to discrete resistors.

Beckman resistor networks do the same job—quicker, easier, cheaper—and in less space, whether inserted automatically or by hand.

Use the Beckman Alternative to reduce inventory and handling costs, lead bending, QC and other factors in manufacturing cost.

Beckman are pioneers in resistor network technology. It was they who developed thick film processes back in 1955 and since then they've led the field. Their range of DIPs and SIPs, Flatpacks or Customs, thick or thin film Resnets, is the best in the world. Beckman means reliability, consistency of quality, off-the-shelf service and quick delivery. It means an ability to meet you on price as well as performance—it means experience. A wealth for you to draw on.

If you want the best, use the Beckman name.

For further details contact—
The Sales Department
Beckman Instruments Limited
Queensgate
Glenrothes
Fife SCOTLAND KY7 5PU
Tel: 0592 753811
or your local Beckman Helipot Distributor.

Beckman Subsidiaries
Beckman Instruments Italiana S.p.A., Via Arese 11, 20159 Milano, Italy. Tel. 6888951. Telex 36484.
Beckman Components GmbH, 8 Munchen 40, Frankfurter Ring 115, Munich. Tel. No. 38871. Telex 5216197.
Beckman Composants S.A.R.L., 52 Chemin Des Bourdons, Gagny 93220, France. Tel. No. 9278295. Telex 6921.

BECKMAN® 1975

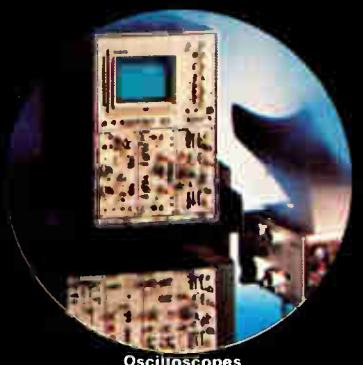
ENERTEC

measurement is our vocation

function generator 4415

2 generators in 1 instrument

Frequency range: 0.1 Hz to 2 MHz
Waveforms: ∿, ∿, ⊓, DC, TTL, ⩘
Vobulation: internal, external ratio 1000: 1
Output level: 20 V peak to peak
Distortion factor: 0.15 %


Oscilloscopes


Voltmeters

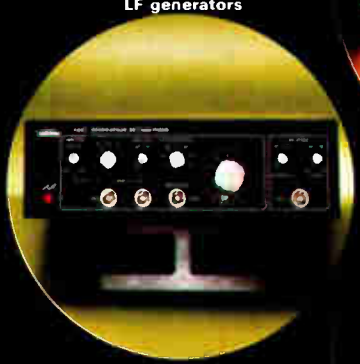

DC powers


Counters


HF generators


A.T.E.


Selective levels


LF generators

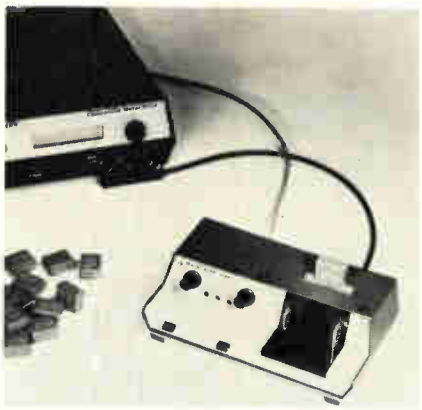
ENERTEC
Schlumberger

ENERTEC
DEPARTEMENT INSTRUMENTS
5, RUE DAGUERRE 42030 SAINT-ETIENNE
CEDEX FRANCE TEL. (77) 25.22.64
TELEX 330696 CIRCE STETN

New products international

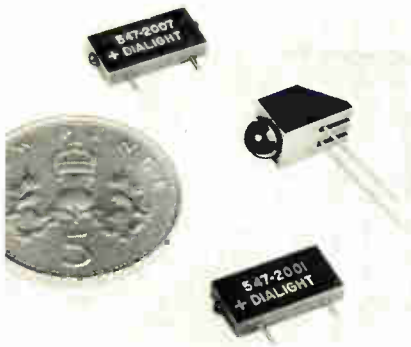
The NSG226 interference simulator for data-transmission systems simulates interference pulses with a 5-ns rise time. For two-wire data lines, the interference may be coupled capacitively to the line in either the common or differential mode. Schaffner AG, 4708 Luterbach, Switzerland [455]

The TR-4114 spectrum analyzer covers a 50-Hz to 120-MHz frequency range. Its noise sidebands are more than 95 dB down at frequencies more than 50 kHz from the carrier for a 1-kHz i-f bandwidth. Takeda Riken Industry Co., 1-32-1 Asahi-cho, Nerima-ku, Tokyo 176, Japan [456]

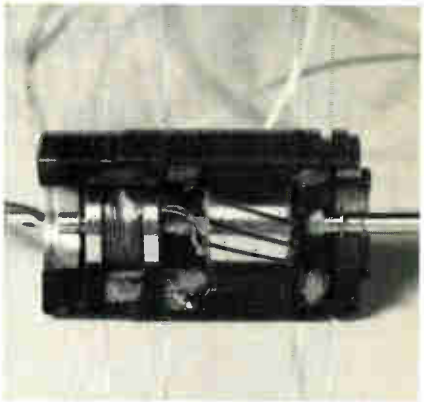


The B 424 is an automatic tester that reads out component values with no more than 0.25% error on a liquid-crystal display. Resistance, capacitance, and inductance are read with 2,000-count resolution. Wayne Kerr, 442 Bath Rd., Slough SL1 6BB, England [457]

The Maxireg 761.1 and 762.1 power supplies both deliver up to 60 watts. The 761.1 offers ranges of 0-15 V at up to 4 A and 0-30 V up to 2 A, while the 762.1 ranges from 0-30 V up to 2 A and 0-60 V up to 1 A. Weir Instrumentation Ltd., Durban Rd., Bognor Regis, Sussex, England [458]



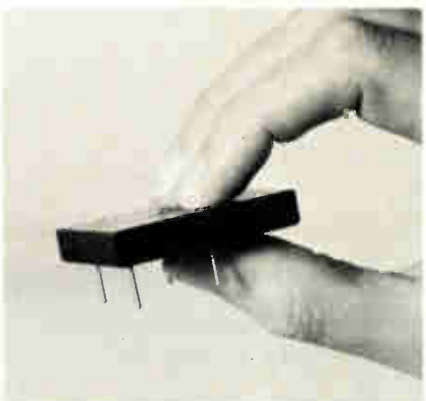
For logic and fault indication, the 547 and 555 series of LEDs mount easily on printed circuit boards, have integral resistors, and can be directly driven from TTL and DTL circuits. Range is from 3 to 20 mA and 3.6 to 14 V dc. Pye Electro-Devices Ltd., Newmarket, Suffolk, England [459]



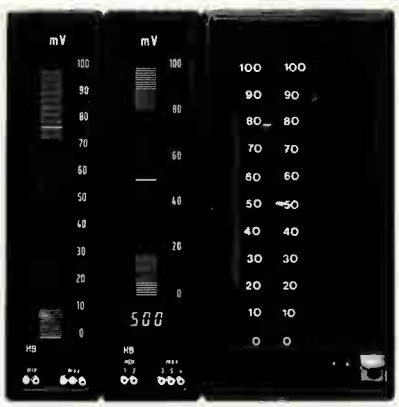
A range of brushless resolvers with accuracies to within ±3 minutes of arc over a range of from 400 Hz to 10 kHz are suited to applications as shaft angle encoders with electronic resolver to digital converters. Moore Reed and Co. Ltd., Walworth Industrial Estate, Andover, Hamps., England [460]

New products international

A monolithic timer-counter, the model XR-2242, produces ultra-long time delays from microseconds to days. Its two timing circuits can be cascaded to generate delays or timing intervals up to one year. Rastra Electronics Ltd., 275-281 King St., Hammersmith, London W6 9NF, England [461]



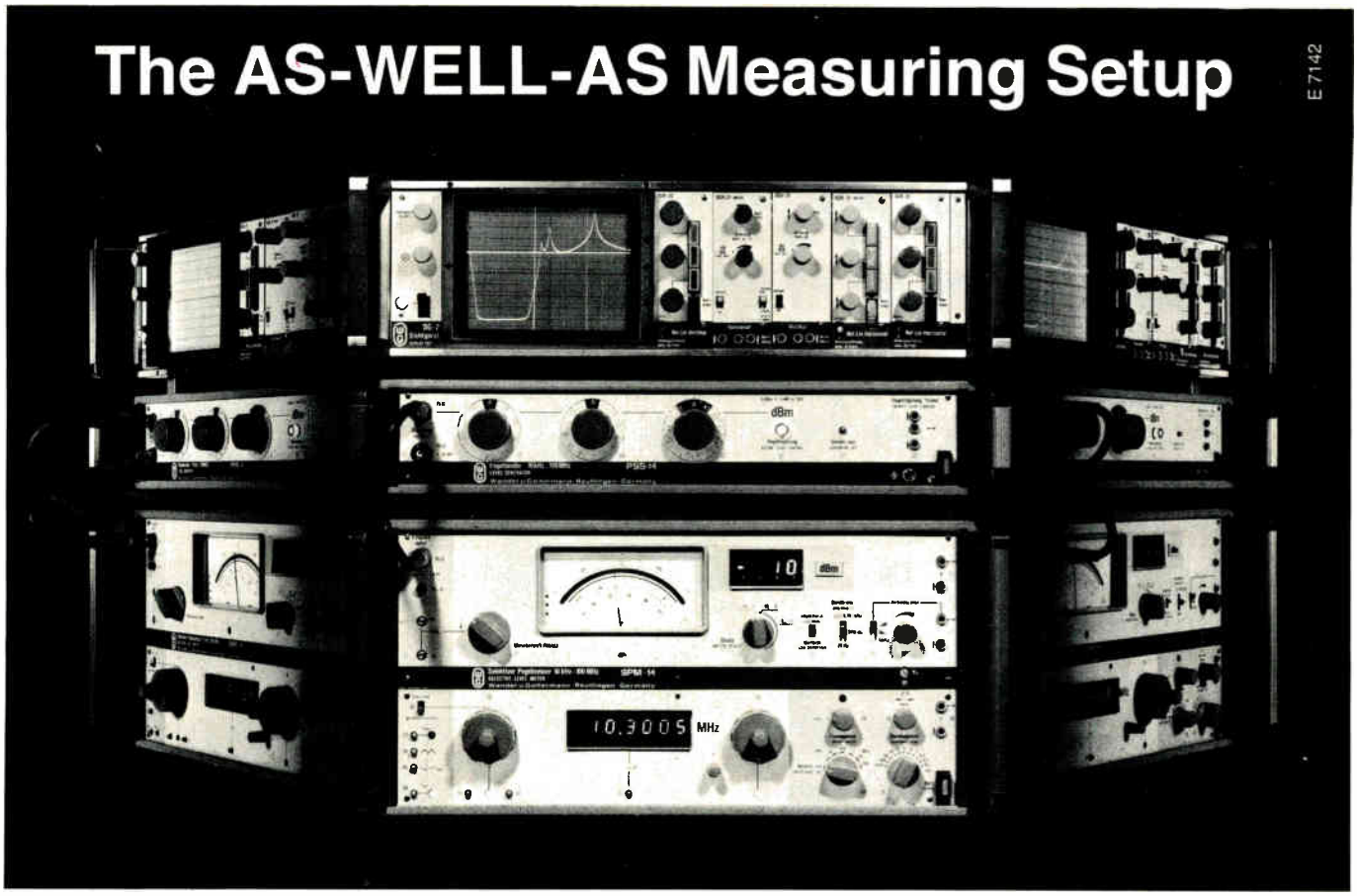
The model FEPS2 is a very-low-profile linear voltage regulator, which supplies high current peaks without shutting down. Regulated outputs range from 5 to 24 volts either positive or negative. Roband Electronics Ltd., Charlwood Works, Charlwood, Surrey RH6 OBU, England [462]



The A-2000 series optoelectric measuring-display system uses flat fluorescent elements, which are bright green. An indicator shows the direction of measured results as well as their value. Hartmann & Braun, 6 Frankfurt 90, P. O. Box 900507, West Germany [463]

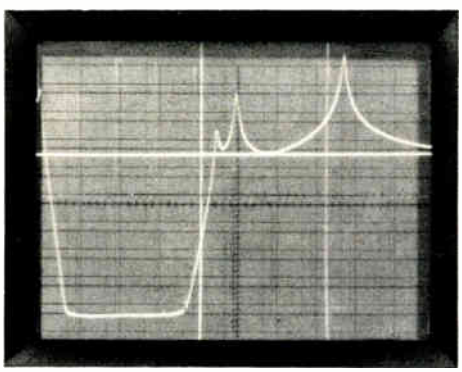
The AS-WELL-AS Measuring Setup

E 7142



for level and sweep measurements from 10 kHz to 100 MHz

A measuring setup for all who are not satisfied with EITHER-OR. For instance: **either** high level resolution **or** wide level measuring range? The PSM-14 has both. It has one **as well as** the other: a ±1 dB scale expander and a 100 dB indication range.
Continuous frequency setting or high frequency stability? Wide frequency-range or high frequency-resolution? Narrow sweep width or panoramic reception over complete frequency range? The PSM-14 offers both... AS-WELL-AS. It unites the advantages which other sets exclude, and is a perfect all-round setup. Also it is economical: the measuring setup PSM-14 is also available as an independent Sender/Receiver combination PS-14/SPM-14 providing the same characteristics.



The SG-2 or SG-3 Display Unit plus the SPM-14 becomes the Sweep Measuring Setup WM-14.
The most important features:
* Crystal slave-locked frequencies give increased accuracy * 7 digit frequency readout, 10 Hz resolution * Linear scales for voltage and level * Measures levels 130 dB +3 dB bandwidths: 2.3 (1.74) kHz, 360 Hz, 25 Hz if requested * Fast signal detector to simplify finding narrow-band signals * Any frequency deviation between 100 Hz and 100 MHz * Sweep time to 100 s for X-Y recorder connection * Vertical and horizontal reference traces on swept display.
The only thing remaining is: EITHER you are already measuring with the PSM-14/WM-14 OR you should immediately request detailed free information.

Wandel & Goltermann
Postfach 45 · D-7412 Eningen · F. R. o. Germany
Tel. (07121) 8441 · Telex 07 29833/wug d

Representatives in more than 50 countries. Affiliates in:
BR Wandel & Goltermann L. A. · RIO DE JANEIRO, Tel. 275-7799
CDN R-O-R Associates Ltd. · SCARBOROUGH Ont., Tel. 416-291-7121
F Wandel & Goltermann France · 94-RUNGIS, Tel. 687 32 70
GB Wandel & Goltermann U.K. Ltd. · LONDON W 3, Tel. 992 6791
S Wandel & Goltermann AB · STOCKHOLM, Tel. 08/188345
USA W & G INSTRUMENTS Inc. LIVINGSTON N.J. Tel. (201) 994-0854

Circle 129 on reader service card 25E

erbatron®

IT'S NOT JUST A CHEMICAL WE SELL

we also offer our know-how as reagent manufacturers, gained over decades of work in this field.
It is from this experience that we have built up the purification and sophisticated analysis methods which enable us to guarantee you highest purity levels from both the physical and chemical aspects.

Packaging materials are studied and selected with great care, too, to ensure they do not cause deterioration with time, and offer maximum safety in handling.

Our bottle of IPA is not just plain ISO-PROPYL ALCOHOL.

MONTEDISON GROUP
CARLO ERBA

CHEMICALS DIVISION
P.O. Box 3996/20159 MILANO/Via Imbonati 24 (Italy)
Telex Erba Mi 36314/Tel. 6995

Circle 197 on reader service card

ALL UNITRODE MAKES ARE POWER SEMICONDUCTORS.

WE HAVE TO MAKE THEM BETTER.

Unitrode makes power semiconductors. Period.

And when a company's income relies totally on only one area of semiconductors, it better make them better than anyone else.

We do.

Take ultra-fast rectifiers. Our UES series gives you the lowest forward voltage drop in the industry: .7V at rating. Plus 15ns forward recovery, 30ns reverse. Plus thermal resistances of 0.6°C/W for the DO-5, 0.8°C/W for the TO-3, and 1.2°C/W for the DO-4. And operating junction temperatures of 175°C. All this performance is available in ratings from 2.5-70A and up to 150V.

Take our unique PIC600 switching regulator power output circuits. A whole power circuit – already designed and built – for less than the price of its individual parts. To save you time in design, breadboarding, and debugging – as well as money.

Take our Barrier™ NPN power switching transistors. Ours give you half the fall times of conventional designs. And three times better $E_{S/b}$ with ratings up to 400V.

Take our exclusive ChipStrate® thyristors. The revolutionary packaging concept for power SCRs and Triacs that bettered the form factor and lowered the cost. The line covers 3 to 55A and up to 800V.

Take power PIN diodes. Ours can withstand up to 1000V, with the power to switch up to 5KW thanks to thermal resistance as low as 4°C/W and series resistance as low as 0.2Ω.

Take our JAN-qualified 2N5660 series of state-of-the-art power switching transistors. They give you the best combination of high voltage, fast switching, and low leakage in the industry.

But a better product isn't enough in this business. We have to do a better job of getting it to market.

So with Unitrode you'll never have to pay state-of-the-art prices for state-of-the-art semiconductors. We have one of the most competitive pricing policies you'll find.

Come to Unitrode for your power semiconductor needs.

And find out just how good a power semiconductor company can be.

For our "Semiconductor Selection Guide", circle the reader service number. For a free copy of our 496-page "Semiconductor Databook", just call or write: Unitrode Corporation, 580 Pleasant Street, Watertown, MA 02172.

Barrier™ is a trademark of Unitrode Corporation

UNITRODE

IN SEMICONDUCTORS, UNITRODE MEANS POWER.

Circle 198 on reader service card

Unitrode Electronics GmbH, Hauptstr. 68, 8025 Unterhaching, W. Germany, Tel.: 089-61 90 04 to 06, TELEX: 05-22 109.

Also available in Munich, EBV, 089-64-40-55; London, Walmore, 01-835-1228; Brussels, J.P. LeMaire, 02-478-48-47; Capetown, Electrolink, 45-7656; Copenhagen, A.F. Pedersen, 01-19-4500; The Hague, Koning en Hartman, 67-83-80; Helsinki, Nores & Co., 13-360; Madrid, Comisa Ing., 254-29-01/04; Milan, Microel Italia, 02-47-94-87; Oslo

RF automatically now."

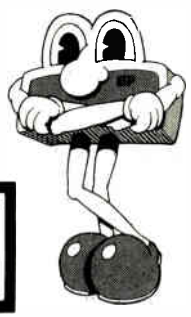
"Until EIP invented the Model 451, measuring the frequency of my radar signals was about as easy as finding Atlantis with a snorkel. I had to use narrow band cavity wavemeters with 0.1 to 0.2% accuracy. Or I had to use a transfer oscillator with its infernal zero beat. Both these techniques required a lot of auxiliary equipment. Not to mention being difficult and time consuming, particularly for narrow pulses and low repetition rates.

"EIP's Model 451 Automatic Microwave Pulse Counter is the first and only counter around that automatically and directly measures pulse modulated signals from 0.3 to 18 GHz.

"Even unskilled operators can use it. All that you need to do is connect a signal to the counter input. The pulsed signal's frequency immediately appears on a bright 7 digit LED display with resolution to 10 kHz. I can measure pulse widths as narrow as 100 nanoseconds. And there's no minimum or maximum frequency limits on pulse repetition.

"It's also a whiz for doing frequency measurements in the time domain—VCO post tuning drift measurements for instance.

"The EIP engineers have put together an informative app note explaining how the 451 works. To get your copy, phone or write EIP. Tell them you're ready to retire your snorkel."



EIP

EIP, Inc. / 3230 Scott Boulevard, Santa Clara, California 95051 / Phone (408) 244-7975.
In Europe: EIP International, Brussels, Belgium / Phone 2/660 48 70.

Circle 199 on reader service card

SEE US AT - I.M.78, STOCKHOLM 24-28 APRIL

MEMBRAIN'S MB7730.

It makes high-speed automatic testing of complex microprocessor circuits an unskilled occupation.

This new-generation automatic test equipment for digital and hybrid sub-assemblies offers a full range of diagnostic facilities for accurate fast fault-finding – without requiring highly skilled operators.

It doesn't cost the earth, either.

And what's more MB7730 options cover a wide range of testing techniques.

It can be a low-cost, easy-to-use system for small-scale production testing; a high-speed system with parallel test patterns for testing boards with microprocessor, static and dynamic LSI circuits; or a general purpose tester handling a range of assemblies.

Powerful software aids minimise time and effort required for programming.

Up to 8 MHz.

Pattern rates of up to 8 MHz across the entire field of pins permit circuit testing at full speed, closely emulating the behaviour of boards when installed.

The test system, computer and peripherals are all made by Membrain, using far fewer components than most systems, to give exceptional reliability and across-the-board support from a single, specialist supplier.

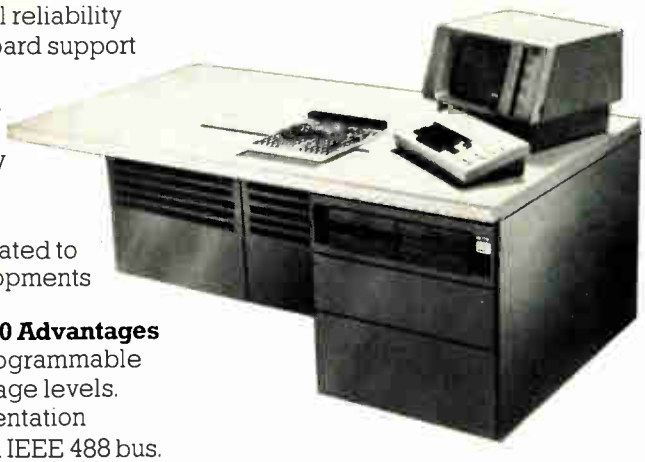
Your MB7730 system will not only cope with today's circuits, it can be expanded and uprated to handle new developments as they arise!

More MB7730 Advantages

Fixed and programmable driver/sensor voltage levels. Analogue instrumentation controlled through IEEE 488 bus. Matrix switching. Advanced operating system for ergonomic programming. ASSET logic-simulation software. MENTOR known-good-board programming software. HYPOINT guided-probe/clip for fast fault isolation... and compatibility with common operating procedures and programming languages of the entire Membrain MB7730 series.

How are you testing your microprocessor boards?

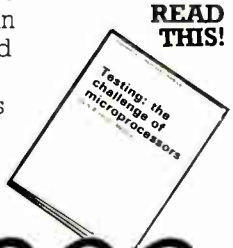
Contact Membrain or your local representative – or use the reader service card for further details of the remarkable MB7730, and what it can do for you.



Free on request

Reprinted from 'New Electronics' Nov 15 '77. This topical article by N. B. Vernon of Membrain covers the state of the art in microprocessor testing. And points to the future of ATE in this field. Send for your copy to the address below.

READ THIS!



MEMBRAIN LIMITED,
Ferndown Industrial Estate, Wimborne, Dorset, England.
Tel: Ferndown (0202) 893535 Telex: 41436

MEMBRAIN TEST SYSTEMS GmbH Munich
Tel: (089) 376363 Telex: 5215014

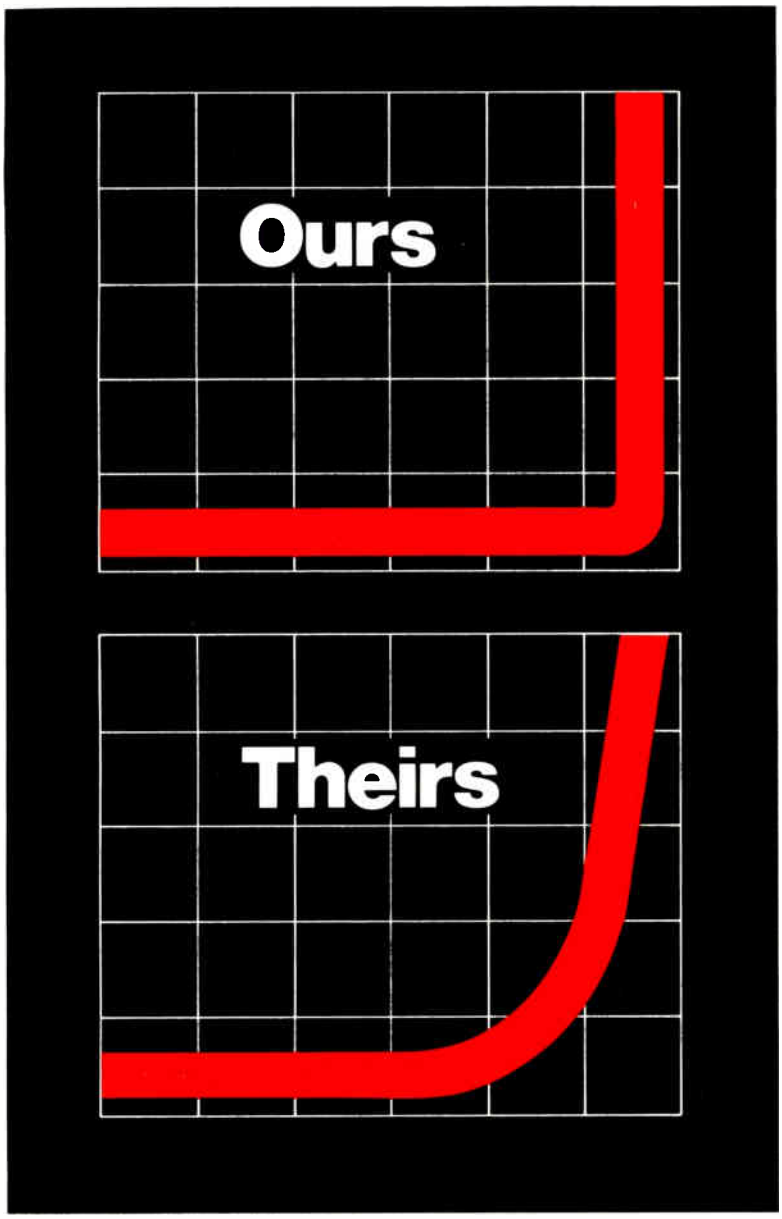
MEMBRAIN SARL Paris
Tel: (1) 687 0193 Telex: 202973

MEMBRAIN
European leaders in Automatic testing

The Teledyne Zener Report

At 100 nanoamps...

Our knee makes their knee look sick



If your logic circuit needs an extremely constant reference voltage, but you want to draw as little current as possible, *our new LVA zener is your only choice.*

That's right. Your only choice. Other zeners can give you a stable voltage at 50 microamps. Only we can do it at 100 nanoamps.

Teledyne low voltage avalanche zeners are available in a range of voltages from 4.7V to 10V at your tolerance requirement. Let us know what you need, and we'll give you exact specs. And the most pleasant surprise of all may be the price.

For complete information and/or evaluation samples, contact Jerry Kramer at (415) 968-9241.

TELEDYNE SEMICONDUCTOR

1300 Terra Bella Avenue, Mountain View, California 94043 • (415) 968-9241

SALES OFFICES: DOMESTIC: Salem, N.H. (603) 893-9551; Stony Brook, N.Y. (516) 751-5640; Des Plaines, IL (312) 299-6196; Los Angeles, CA (213) 826-6639; Mountain View, CA (415) 968-9241
INTERNATIONAL: Hounslow, Middlesex, England (44) 01-897-2503; Tiengen, West Germany 7741-5066; Kowloon, Hong Kong 3-240122; Tokyo, Japan 03-403-8141

Teradyne finds the practical solution.
No. 4 in a series.

The testing of ECL propagation delays

In the subnanosecond world, any mistake is a big one.

In the mainframe computer business, victory belongs to the swift. So computer designers have turned from fast TTL devices to faster ECL ones, as they attempt to outcycle-time one another. The battle lines are currently drawn somewhere on the short side of a nanosecond, as ECL devices with propagation delays of 700 picoseconds come on stream. Of course, a 700-picosecond propagation delay isn't of much use unless it is *known* to be 700 picoseconds. That means that test systems that take on ECL must resolve tens of picoseconds, which is difficult enough in the laboratory but murder on a production or incoming-inspection line.

The first commercial system dedicated to the ECL problem is Teradyne's S357 Pulse Parametric Subsystem, designed to offer (in conjunction with a J325 Digital IC Test System) single-socket testing of an ECL device's dynamic, functional, and dc parametric properties. Some of the techniques that enable this system to operate reliably in the subnanosecond domain illustrate both the magnitude of the testing challenge and the ingenuity of the design team assigned to the project.

One of the toughest problems, for example, is what to do about pin-to-pin skew caused by unavoidable variations in signal paths and in the propagation delays of the test system's own level detectors.

In the S357, an automatic deskew routine is used to measure the system's variables and to correct for them in software. To handle signal-path variations, the system uses built-in time-domain reflectometry to measure the actual distance between detector and socket, and programmed values are then adjusted in software. Level-detector variations fall into several classes, and an error reduction routine has been developed to deal with each. For example, the voltage offset of each detector varies with slope. The automatic deskew routine measures this variation and corrects programmed voltages accordingly.

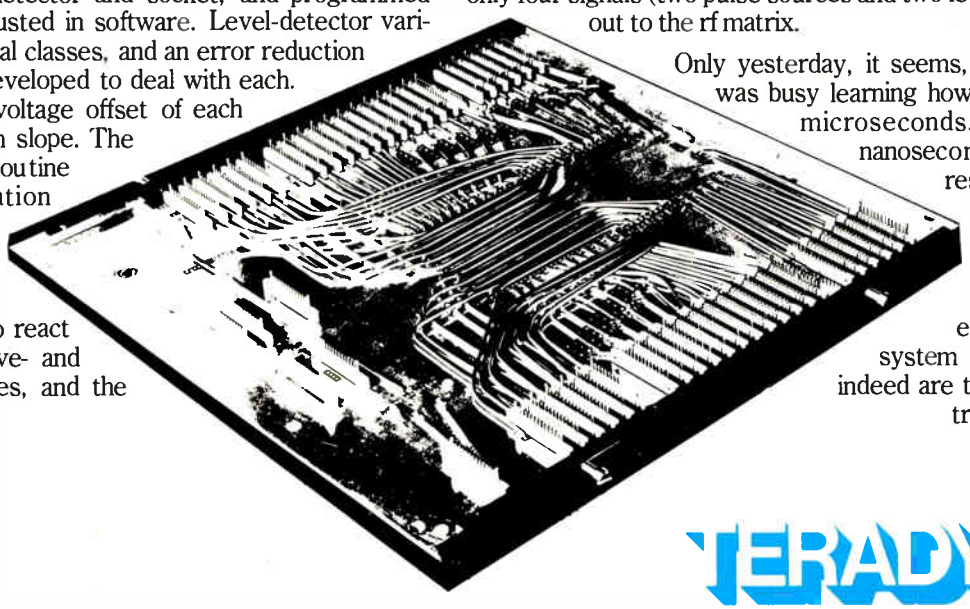
Level detectors also react differently to positive- and negative-going slopes, and the automatic deskew routine has an answer to that one, too: An inverting rf transformer flips the pulse, the variation in response is automatically measured, and a software time-skew correction is applied.

The entire deskew routine takes only about four minutes, so there is little reason not to perform the operation regularly.

Once the system has been deskewed, only drift stands between the user and complete confidence in system timing. To erase that last trace of uncertainty, the S357 verifies its time measurement unit against one of several built-in, NBS-traceable delay lines, the fastest of which is 500 picoseconds ±10 picoseconds.

With the system deskewed and calibrated, one still needs good programmable pulse sources. The trouble here is that just about every pulse parameter interacts with every other: Change rise time and the amplitude shifts; change duration, and the fall time gets away. Solution? Calibrate not pulse parameters, but whole pulses, as to delay, width, rise time, fall time, and amplitude. Once a pulse is defined and calibrated, it is locked safely in software for recall when it is needed in the test program.

All this software ingenuity is backed up by hardware engineered to carry low-level ECL signals from point to point with a minimum of degradation. A 50-ohm environment is slavishly maintained from the device under test through the rf matrix to the detectors and pulse sources, via special relays and carefully routed runs of semi-rigid coaxial line. Signal integrity is further enhanced by the design decision to confine all critical electronics to the mainframe and to bring only four signals (two pulse sources and two level detectors) out to the rf matrix.



Only yesterday, it seems, our industry was busy learning how to measure microseconds. Then came nanoseconds. Now we resolve tens of picoseconds, but not without agonizing attention to every detail of system design. These indeed are the times that try men's souls.

TERADYNE

The latest buzz word is codecs

Semiconductor makers heed seductive call of new market in U. S. and Europe in belief it has the greatest potential ever for linear ICs

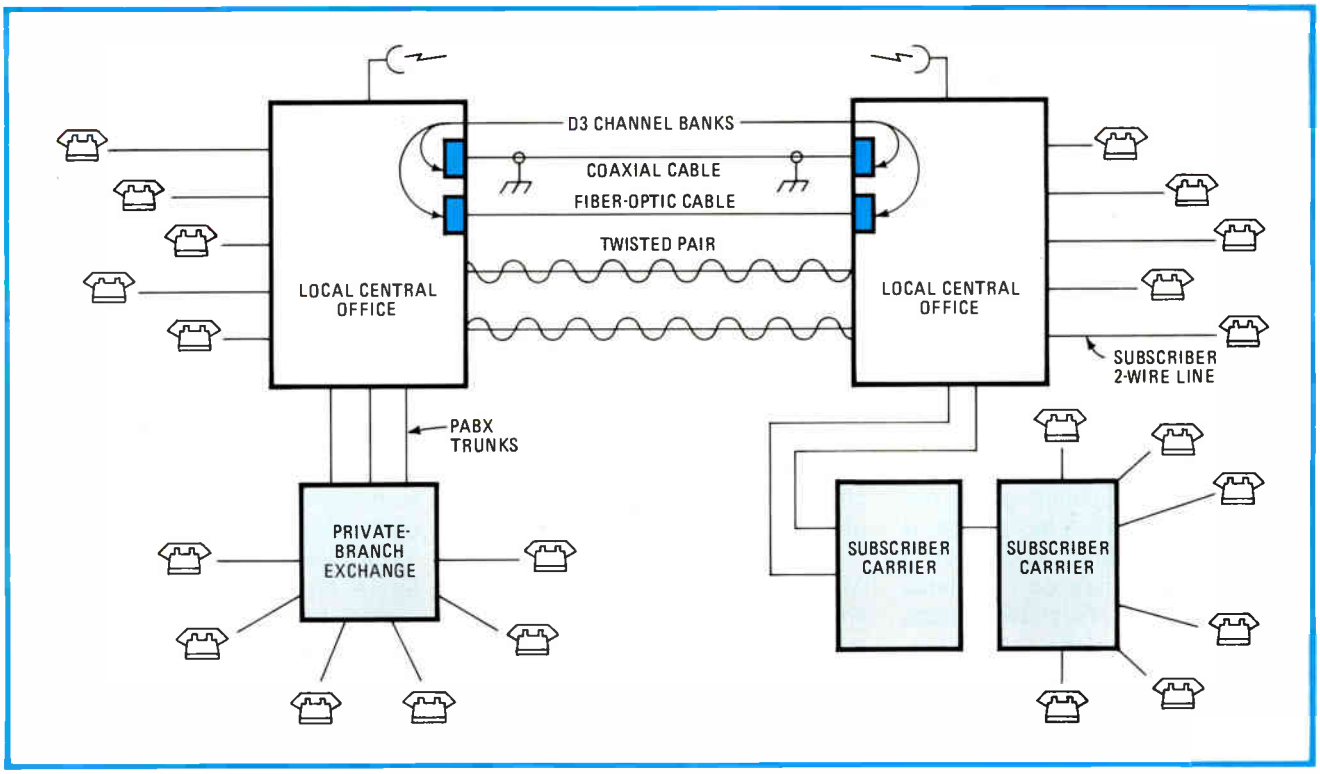
by William F. Arnold, San Francisco bureau manager

Although it is easy for semiconductor manufacturers to wax enthusiastic about new markets, the emerging telecommunications market is especially exciting for them. The reason: as telephone systems around the world go digital, they will need an increasing number of monolithic integrated circuits.

Pacing the market are codecs, coding-decoding devices that convert voice signals into digital bit streams and back again. Just behind are such circuits as filters, pulse-code-modulation switches, and line interface chips. And this comes on top of expanding telecommunications applications for microprocessors and memories.

"Generally, telecommunications is the largest potential market linear has ever seen," declares Steven Thompson, linear IC product marketing manager for Advanced Micro Devices Inc., Sunnyvale, Calif. Agreeing is James Solomon, manager of standard linear IC development at National Semiconductor Inc., Santa Clara, Calif. "It's a consumer business, yet it doesn't have the characteristics of that business that we've all had trouble with." It will not go out of control as calculators did, he says, and compares it more to the computer market.

Naturally, that kind of market has great appeal. Worldwide there are at least 15 chip makers already out with codecs, about to launch them, or in advanced design. To AMD and National, add American Microsystems Inc., General Instrument Corp., Intel Corp., Mostek Corp., Motorola Semiconductor, Precision Monolithics Inc., Siliconix Inc., and Signetics Corp. in the U. S. In Europe, there are EFCIS of France, Britain's General Electric Co., Plessey Ltd., Ferranti Ltd., and Siemens AG of Germany. Industry insiders expect to add Texas Instruments Inc.



Where codecs will be used. A typical estimate of the near-term market for codecs is that 3.5 million units will be sold in 1979, with the total doubling by 1983. Codecs will be used in D3 channel banks, in central office switches, in PBXs, and in the subscriber carrier interface.

systems. Industry, he believes, does not yet fully appreciate that "most of the kids we have on our ships are just that—kids. Most of their formal education stopped at high school."

Aircraft. With its four nuclear-powered engines able to steam for 13 years at classified top speeds in excess of 30 knots, the Eisenhower has ample storage space for aircraft, ordnance, and other supplies that would otherwise be taken up by conventional fuel. As a result, its 4.5-acre flight deck can accommodate up to 100 embarked aircraft of about a half-dozen types, ranging from the F-14A to the A-63 and including propeller craft.

Maintaining that mixture "is something of a job," concedes Cdr. Frank A. Bransom, head of the carrier's aircraft maintenance department. Aircraft maintenance crews rely heavily on the semi-automated system built by Harris Corp.'s PRD Electronics Inc. called VAST—for Versatile Avionics System Test.

Bransom and his team, who have a separate shop for repair and testing of avionics cards with integrated circuits and discrete components, are less concerned with available hardware than with manpower issues. Proficiency is one. An aviation electrician's mate or an aviation electronics technician, for example, can spend between four and six months of his four-year enlistment in training. But, says one of Eisenhower's maintenance officers, "it takes a kid probably 2 to 2½ years of hands-on experience before he is really good at what he does." The benefits of this training may be lost, however, "if he doesn't ship over."

For most electronics and electrical specialty ratings, Navy data shows that between 50% and 70% of enlistment time is spent on assignment to fleet units. Shipboard electronics officers estimate that between 40% and 50% of their crews are on the job for the first time. As a result, the Eisenhower's electronics and avionics maintenance officers are in agreement with Capt. Ramsey that electronics suppliers to CVN-69—and the rest of the fleet as well—need to take a hard look at the documentation they provide with their systems and "put it in plain English." □

Satellites

Battle lines form over satellite types

Meeting in San Diego should see controversy over merits of spinner craft vs body-stabilized platforms

by Rob Brownstein, San Francisco bureau

A smoldering controversy over the design of future communications satellite systems is expected to flare up again in late April at the Communications Satellite Systems Conference sponsored by the American Institute of Aeronautics and Astronautics in San Diego. At stake in the mammoth market is the direction of the technology of future satellites, ground stations, photovoltaic cells, and antennas.

The complex issue centers on one question: should future communications satellites be single-purpose spinner types or large, multipurpose, multiuser body-stabilized platforms? An example of the latter are the "orbital antenna farms" proposed by Burton I. Edelson and Walter L. Morgan of Communications Satellite Corp. Laboratories in Clarksburg, Md. Although the answer will not be clear until the mid-1980s, electronics subcontractors, vendors of photovoltaic panels, and designers of antenna systems anxiously await any signs of any trend so they can prepare long-lead time designs.

The question. Reduced to its simplest arguments, the battle is ease of stabilization vs optimum power. The spinner can be stabilized in relation to the earth more easily than a body-stabilized craft. However, the spinning motion prevents all the photovoltaic cells covering the outer surface from facing the sun simultaneously: only 1/3.14 of the total potential photovoltaic power is produced, says Edelson.

Conversely, the body-stabilized, or three-axis–stabilized, craft is essentially motionless in orbit, and all of its photovoltaic cells can be kept pointed at the sun. Paul Visher of Hughes Space and Communications Group, which makes only spinners, admits that the body-stabilized craft has a power advantage. But he points out that the Space Shuttle has reduced some of the size constraints on future spinners, allowing them to produce more power—up to 6 or 8 kilowatts. The reason is that the shuttle has a large bay that permits it to carry and launch larger spinning-type satellites.

Another point of contention between the proponents of the two approaches is economy. Those favoring antenna farms foresee overall savings because of economies of scale. Edelson and Morgan say these will come because of the more efficient use of the Space Shuttle orbiter and because the various systems will share common power, antenna systems, and orbital housekeeping, such as power budgets and the like.

Over and under. However, Harold Rosen of Hughes Aircraft Co., creator of the spinner satellite concept, disagrees. "I believe the economies are overstated and the problems underestimated," he declares. A large platform "forces needless station-keeping fuel consumption, which is definitely not an economy." Moreover, he foresees compatibility problems among the several systems sharing the platform.

Ford Aerospace and Communications Corp. makes both spinners and stabilized types, and Lewis Cuccia, senior scientist there, supports the latter concept. "The spinner, because of its motion, cannot produce as much electrical power as the body-stabilized satellite can," he says. "Moreover, the spinner cannot support the newer, more complex antenna designs that are being developed." Power and antenna gain can be crucial when a momentary misalignment of satellite and earth-

Communicating bird. This is a scale model of ATS-6, a body-stabilized satellite. Prime contractor for the program is Fairchild.

station antenna occurs.

Antennas. Besides the power advantage, the body-stabilized configuration has an advantage in antenna accommodation. Whereas the spinner has been able to support a multiple-spot-beam antenna array, the body-stabilized version can support more complex arrangements giving greater gain performance.

However, these advantages are blunted by questions of reliability and life expectancy. The spinner has been a largely reliable craft, says Sam Fordyce, NASA's manager of special studies in communications for the director of the Office of Space and Terrestrial Applications, "The ATS-6 [Applications Technology Satellite, a body-stabilized type] developed problems with its thrusters." He sees no clear preference during the next decade and a half for either the spinner or small three-axis stabilized satellite emerging. "A lot will depend on their respective reliability histories and the success of Hughes' Syncom-4 [15-foot spinner] satellite," he believes.

Shifts are key. Life expectancy most affects the time a satellite can remain in a stable orbit. Although electronic failure can kill a satellite, the life-expectancy of the electronics on board far exceeds that of the craft's orbital stability. A satellite's ability to sense orbital shifts and to correct them is key to its longevity.

Since all satellites correct position by firing hydrazine-fueled thrusters, any advantage of increased fuel capacity may be nullified by faulty thruster sensors or servo electronics. And it is impossible to tell whether one type uses more hydrazine than the other until well into the design for a particular communications setup.

There is likely to be a place for both kinds of satellite configurations for at least the next 15 to 20 years, proponents for both agree. However, the large multiuser platform will require a larger capital investment than the spinner. The originators of the idea, Edelson and Morgan, want a governmental agency—like NASA—to undertake the project and prove its viability before a user consortium with the necessary capital would be formed. □

Now you can have the µP-compatible A/D converter you've been waiting for.

Without the waiting.

The newest thing you ought to know about our MP-7570 A/D Converter circuit is its immediate availability. That means you can get it—now!

The circuit itself isn't new. It's been around for a couple of years, initially as an Analog Devices part. Its popularity is well-established, which means demand occasionally exceeds supply.

Micro Power's recently expanded production capabilities now provide a volume second-source supply for the 7570. You can design in its unique characteristics and depend on us for the delivery you need.

Functionally, the 7570 is a CMOS 10-bit A/D converter on a single chip. It uses the successive approximation principle and requires only an external comparator, reference and passive clocking components. Ratiometric operation is inherent in the design, since an extremely accurate multiplying DAC is incorporated in the feedback loop. The 7570 has appropriate control inputs and status outputs for convenient interface with most 8-bit or 10-bit microprocessors.

Micro Power's proprietary High-Density CMOS is employed in producing the 7570. This low-power process features an on-chip network of thin-film resistors and silicon nitride passivation to enhance reliability and long-term stability.

Listed in the table are some of the key specs and prices for the 7570 and *related CMOS converters*. To get more information on these and other linear CMOS products, use the coupon below.

LOW-POWER CMOS CONVERTERS
Three-state Logic

Type	Resolution	Non-linearity	Conversion Time	Price (100+)
7570 JD (A/D)	8-bits	N/A	20µsec	$19.90
7570 LD (A/D)	10-bits	N/A	20µsec	$42.00
7550 BD (A/D)	13-bits	N/A	40msec	$24.90
7522 JN (D/A)	10-bits	8-bit	500nsec current settling time	$13.90
7522 KN (D/A)	10-bits	9-bit		$16.95
7522 LN (D/A)	10-bits	10-bit		$26.10

MICRO POWER SYSTEMS

3100 Alfred Street, Santa Clara, CA 95050, (408) 247-5350

To: Micro Power Systems, Standard Products Division
3100 Alfred Street, Santa Clara, CA 95050

Please send me technical data on these converter products: ☐ MP7570 A/D ☐ MP7550 A/D ☐ MP7522 D/A

☐ I have an urgent requirement. Please have a converter applications specialist phone : ( )_____

Name_____

Title_____

Company_____

Address_____

City/State/Zip_____

☐ Please also send data on your linear CMOS switches and multiplexers.

EM 413

OUR EXPANDING UNIVERSE OF LIGHT-EMITTING ELECTRONICS

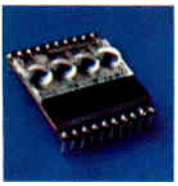
CHOOSE THE DEVICE YOU NEED FROM 310 TYPES

Now Litronix offers an opto-electronic device for virtually every application. Over 300 LED displays, LED lamps, opto-isolators, IR emitters, photo-detectors and photo-voltaic cells. And more are coming every month.

You will find advanced products not available anywhere else. As well as widely-used standard devices at highly competitive prices.

Some highlights:

ALPHANUMERIC LED DISPLAYS.



Character sizes from 0.16" to 0.50" in end-stackable arrays of 1 to 4 red characters — including an intelligent display that interfaces just like a RAM to μP buses.

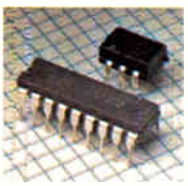
DIGITAL LED DISPLAYS.

Green, yellow and red digits. Nine sizes from 0.1" to 1" high. In DIPs of 1 and 2 digits. On PCBs of to 6 digits with edge connectors. Both light-pipe displays with very wide viewing angle and low-cost reflector displays. 70 different types.

LED LAMPS.

Red, orange, yellow and green lamps. T-1, T-1¾ and axial packages. Arrays of 2 to 10 lamps. With panel mounting clips. Lamps that flash on/off. Constant brightness lamps. Voltage-indicating lamps. 58 different types.

OPTO-ISOLATORS.



One, two and four-channel opto-isolators. Current transfer ratios up to 320%. Isolation voltages up to 5000v. Transmission rates as high as 4 megabits/sec. 15 JEDEC types. 25 different types in all.

IR EMITTING DIODES.

From medium to very high power. Beam widths from 6° to 60°. Hermetic and non-hermetic TO-18 size. Miniature with axial or radial leads. 30 different types.

PHOTO-DETECTORS.

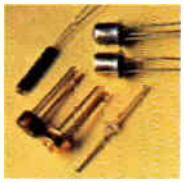


Photo-transistors and photo-diodes with acceptance angles from 6° to 73°. Hermetic high-reliability devices and low-cost non-hermetic devices. TO-18 packages, ceramic packages and miniature radial lead configurations. Arrays of 2 to 10 detectors. 47 different types.

PHOTO-VOLTAIC CELLS.

Silicon solar cells. Sensitivity from .04 microamperes to 2.8 microamperes. Twelve different types available.

SEND FOR FULL CATALOG.

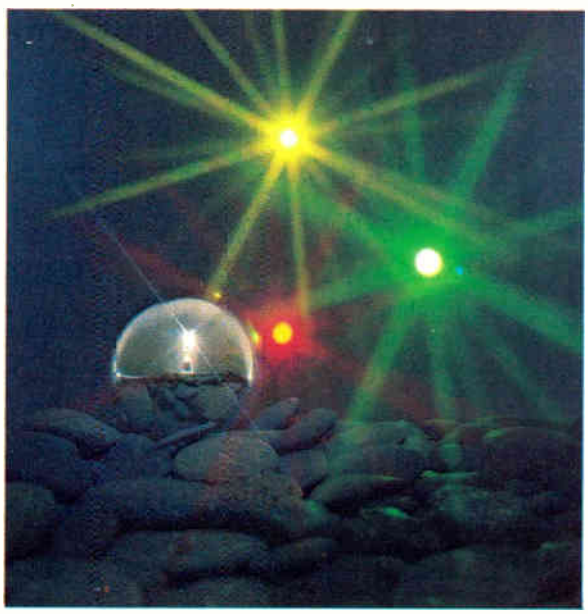
Contains 32 pages on all devices in the product categories above. Phone your local distributor or contact Litronix at 19000 Homestead Road, Cupertino, CA 95014. Phone (408) 257-7910.

Circle 91 on reader service card

litronix

AN AFFILIATE OF SIEMENS

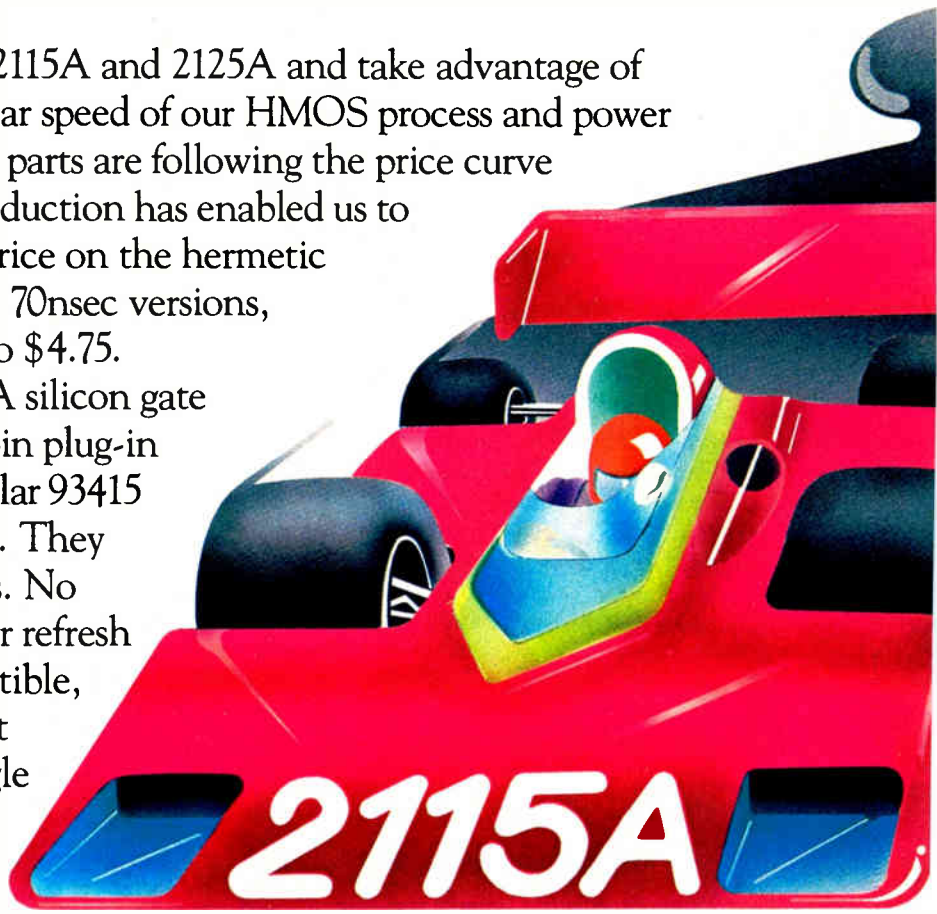
THE LIGHTS FANTASTIC



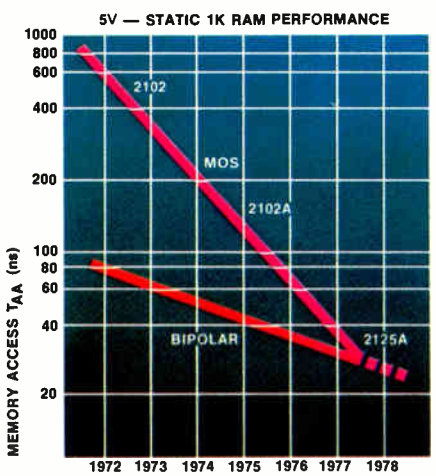
Intel MOS RAMs match 35% price reduction delivers

Convert to the Intel 2115A and 2125A and take advantage of MOS economy, the bipolar speed of our HMOS process and power savings up to 50%. These parts are following the price curve we projected. Volume production has enabled us to reduce the 100 quantity price on the hermetic D2115A-2 and D2125A-2 70nsec versions, for example, from $7.50 to $4.75.

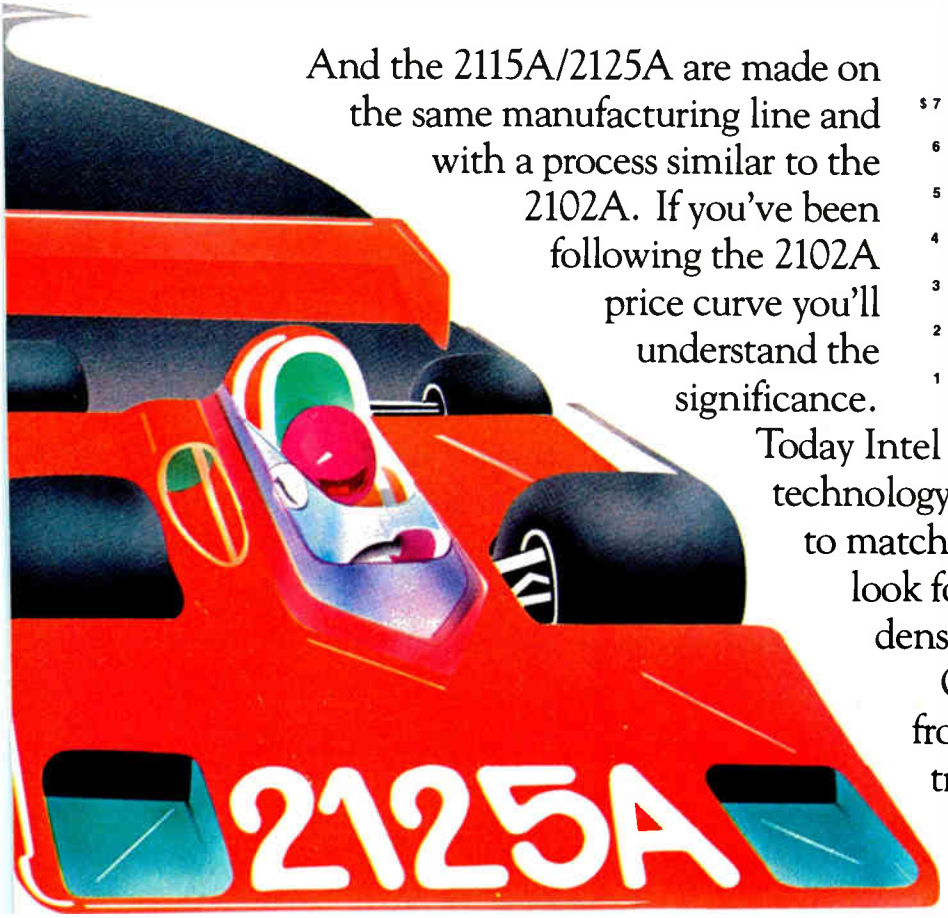
The 2115A and 2125A silicon gate static RAMs are pin-for-pin plug-in replacements for the popular 93415 and 93425 bipolar RAMs. They offer the same advantages. No need for external clocks or refresh circuits, fully TTL compatible, 16mA output sink current and operation from a single +5V supply. Worst case access time on our fastest version is 45nsec.



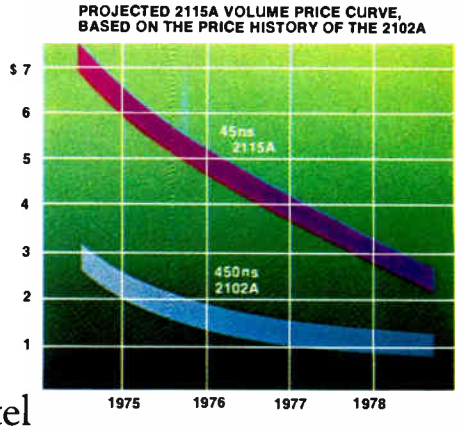
In addition, the 2115A/2125A dissipate 20% less power and the 2115AL/2125AL 50% less power than the 93415/93425. This saves power supply and cooling costs which all adds up to additional savings in the cost of your system. And there's more. Unlike bipolar RAMs, the 2115A/2125A use only a single layer of metalization which means lower manufacturing cost and a more reliable process. So you can look for continued improvement in cost/performance. To put the cost potential in proper perspective, consider this: The 2115A/2125A chip is 35% smaller than Intel's industry standard 2102A.



bipolar speeds. Now our even greater MOS economy.



And the 2115A/2125A are made on the same manufacturing line and with a process similar to the 2102A. If you've been following the 2102A price curve you'll understand the significance.



Today Intel technology delivers HMOS RAMs to match bipolar speed. Tomorrow look for greater speed, higher densities, and even lower cost.

Order 2115A's and 2125A's from your local Intel distributor and take advantage of HMOS economy and bipolar speed.

Contact: Almac/Stroum, Component Specialties, Cramer, Elmar, Hamilton/Avnet, Harvey Electronics, Industrial Components, Liberty, Pioneer, Sheridan, L.A. Varah or Zentronics.

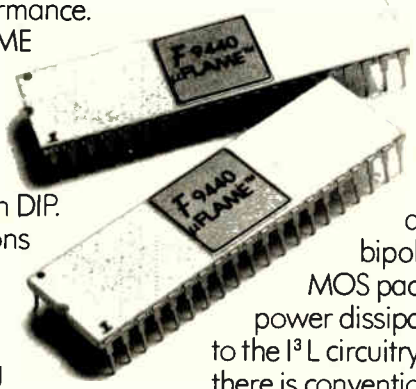
For your copy of our 2115A/2125A Data Sheet, write: Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051. In Europe, contact Intel International Corp. S.A., Rue du Moulin à Papier, 51-Boite 1, B-1160, Brussels, Belgium. Telex 24814. In Japan, contact Intel Japan Corporation, Flower Hill-Shinmachi East Bldg. 1-23-9, Shinmachi, Setagaya-ku, Tokyo 154.

intel® delivers.

Introducing a microprocessor that thinks it's a minicomputer.

Introducing 9440 μFLAME™ — the world's first 16-bit bipolar microprocessor that executes a minicomputer instruction set with minicomputer performance.

The 9440 μFLAME microprocessor is a complete minicomputer CPU on one chip, packaged in a 40-pin DIP.



Major applications for the new device include OEM data processing in a variety of computing control and instrumentation environments; telecommunications PBX and PABX switching installations; and distributed intelligence, distributed multi-processing and front-end (terminal) processing.

Where there's flame there's fire.

Fairchild is also introducing its FIRE™ (Fairchild Integrated Real Time Executive) software. FIRE I is an initial software package for the 9440 that includes the required development aids: diagnostics, a bootstrap and binary loader, and an interactive entry and debugging program.

In addition, the μFLAME microprocessor can execute the Data General NOVA 1200 instruction set. FIRE software such as text editor, symbolic debugger and business BASIC are also available now.

Hot new technology.

The new microprocessor is based on an advanced form of I^2L technology known as I^3L™ (Fairchild's Isoplanar Integrated Injection Logic). It provides the combined advantages of bipolar high speed and MOS packing density and power dissipation. In addition to the I^3L circuitry on the 9440 chip, there is conventional TTL circuitry which allows TTL interface with other logic, PROMs and RAMs.

Build your own.

Fairchild is offering an introductory low-cost kit to familiarize you with the outstanding advantages of the 9440 μFLAME microprocessor. It consists of the 9440, sixteen 4,096-bit TTL dynamic memories, the SSI/MSI components required for memory control, plus FIRE I software manuals and instructions. You get the entire kit for only $750. It will enable you to construct an exercise at the board level in your own format.

Only the beginning.

More sophisticated FIRE software, board level hardware and LSI support circuits will become available throughout the year.

The software will include a floppy disc operating system, disc operating system and a FORTRAN compiler. New LSI circuits will include a 16K TTL dynamic RAM; a memory control with control, refresh and DMA capabilities; an I/O control, and a hardware multiply and divide capability.

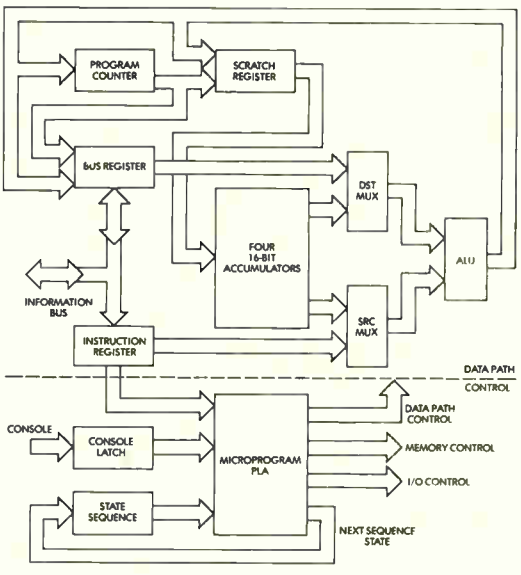
We put the whole 9440 story in a brochure for you. Just write us and we'll send you a copy.

For kits and data sheets, contact the Fairchild sales office in your country.

France: Fairchild Camera & Instrument S.A., 121 Ave. d'Italie, 750013-Paris. Tel: 00331 584 55 66. Telex: 0042 200614. **Italy:** Fairchild Semiconduttori S.P.A., Via Rosellini, 12, 20124 Milano. Tel: 02 6887451. Telex: 36522. **Germany:** Fairchild Camera & Instrument (Deutschland) GmbH, 8046 Garching Hockbruck, Daimlerstr. 15, Munchen. Tel: 089 320031. Telex: 52 4831 fair d. **England:** Fairchild Camera & Instrument (UK) Ltd., 230 High St., Potters Bar, Hertfordshire EN6 5BU. Tel: 0707 51111. Telex: 0051 262835. **Sweden:** Fairchild Semiconductor AB, Svartengsgatan 6, S-11620 Stockholm. Tel: 8-449255. Telex: 17759.

NOVA is a trademark of Data General Corporation

FLAME™ MICROPROCESSOR



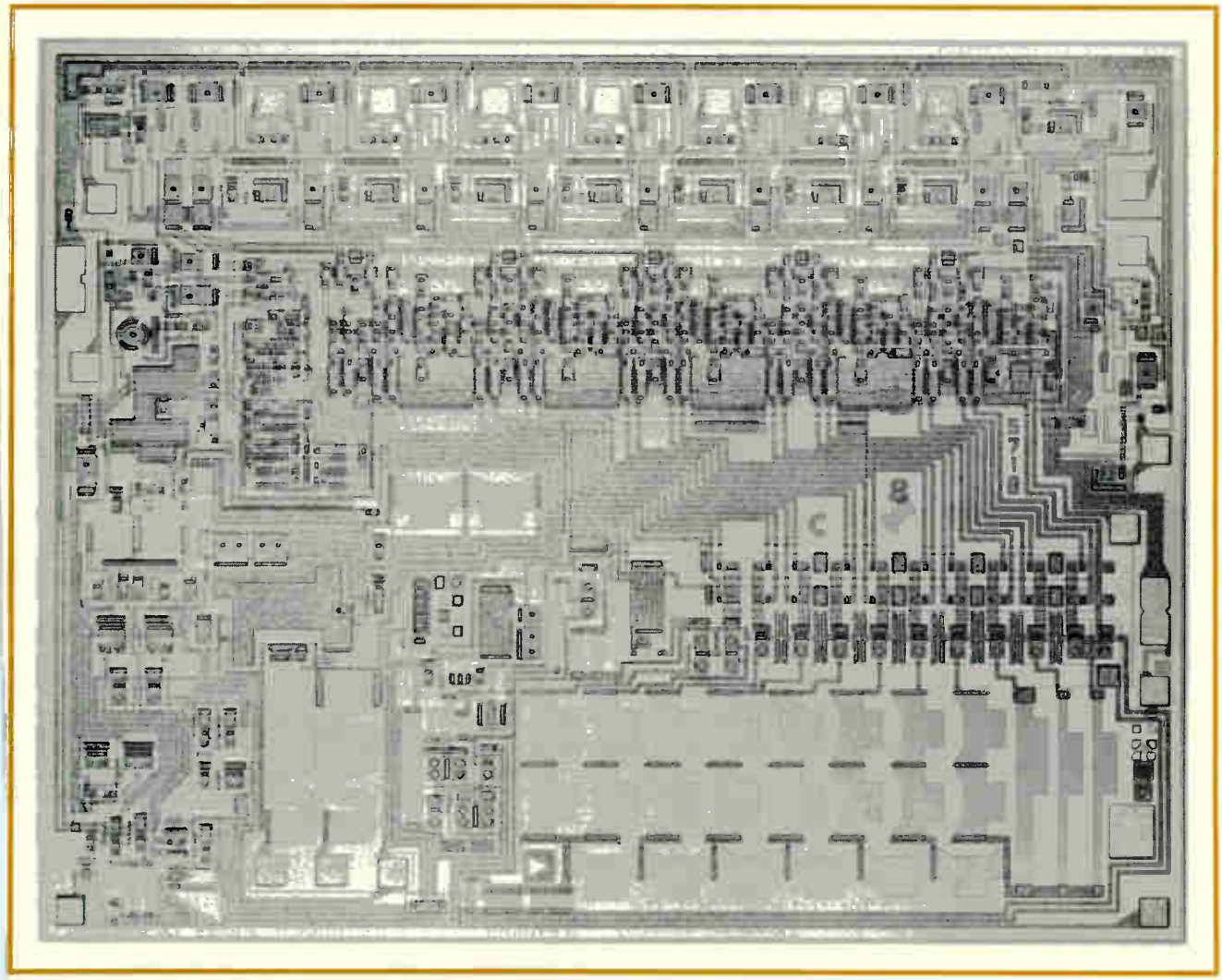
9440 Block Diagram

FAIRCHILD

Circle 94 on reader service card 95

I²L puts it all together for 10-bit a-d converter chip

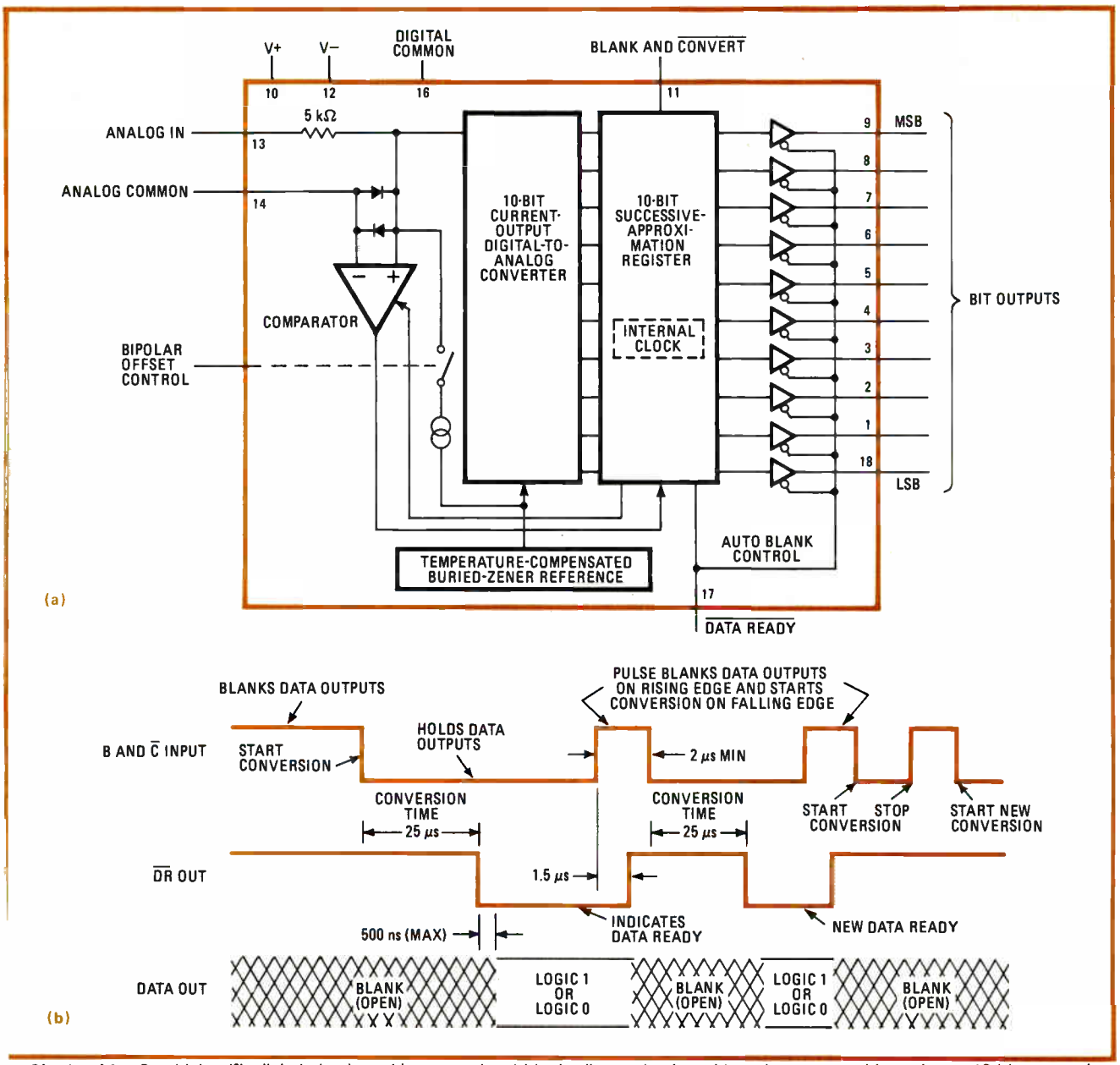
by Paul Brokaw, *Analog Devices Inc., Norwood, Mass.*



☐ Linear-compatible integrated injection logic may well become the technology of choice for fabricating high-performance monolithic analog-to-digital converters. As a bipolar process, it can produce better analog components than any metal-oxide-semiconductor process, and unlike other forms of bipolar logic, it can compete with MOS levels of digital-circuit density.

As a result, I²L is the technology behind a new 10-bit a-d converter, which is also the first chip of its kind to be fully self-contained. Its only external needs are the appropriate power-supply voltages and a convert command. Its on-chip voltage reference and clock save the user both the bother and expense of implementing these functions off chip. Its other elements—a comparator, a digital-to-analog converter, a successive-approximation register, and control logic—handle the successive-approximation conversion.

Interfacing to the AD571, as the chip is designated, is



I. Single chip. Combining I²L digital circuitry with conventional bipolar linear circuitry, this a-d converter chip makes a 10-bit successive-approximation conversion in only 25 μs. The device is fully self-contained, including a clock, comparator, and reference.

surface passivation. Moreover, the zener does not destabilize itself by depositing hot carriers, the result of avalanche breakdown, in the passivating layer.

Operating from supply voltages of +5 to +15 v and −15 v, the AD571 can accept unipolar analog inputs of 0 to +10 v or bipolar inputs of ±5 v. The user makes this selection by simply grounding or opening a single pin. When the device's blank-and-convert line goes high, the output buffers go into the blank (or open) state, and the successive-approximation register resets to a state that prepares it for a conversion. When the blank-and-convert line goes low, the internal clock starts, and a conversion begins. During the conversion, the data-ready line remains high, and the bit outputs remain blanked. At the end of the conversion cycle, the data-ready signal switches low, activating the buffers so that the digital word stored in the register is presented at the bit outputs. Pulling the blank-and-convert line high blanks the outputs and readies the device for the next conversion.

Upon receipt of a conversion command, the successive-approximation register tests the unknown input signal against the successively binary-weighted bits of the internal 10-bit current-output d-a converter. During this test sequence, the input voltage is compared to the voltage developed by the d-a converter output current across the 5-kilohm input resistor. Starting with the most significant bit, which is equal to half of the full-scale weighted signal, the register tests each bit against the input voltage as part of a linear sum. If the comparator signals that this sum is less than the input, the test bit is retained in the sum, or left on. If the sum exceeds the input, the test bit is rejected, or turned off. After testing

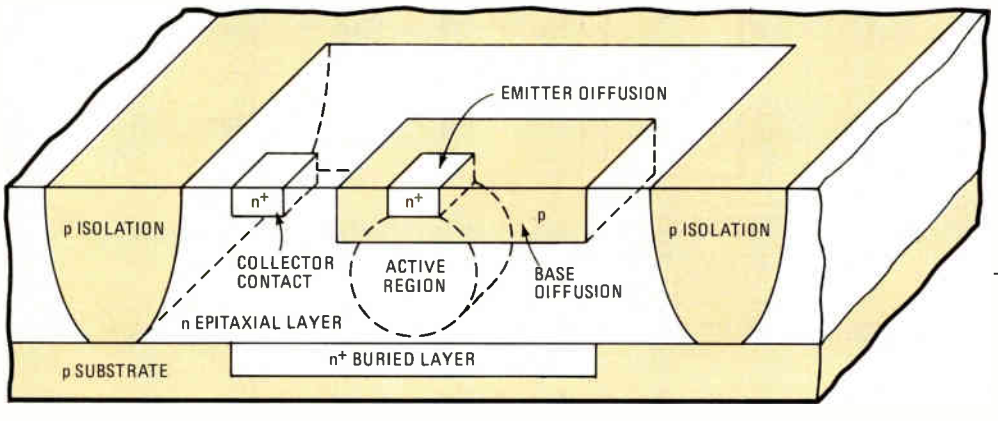
I²L from the linear viewpoint

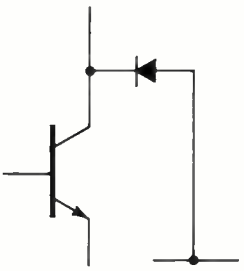
Integrated injection logic differs from conventional logic circuits that have to be made with linear transistors in two important ways. First, though fabricated with the same diffusions, I²L transistors can be made much smaller than the usual junction-isolated linear transistors. Secondly, I²L gates and circuits are simpler than most other logic forms.

In effect, I²L reduces a gate to a single pair of complementary transistors—a vertical npn one having multiple collectors and operating in an inverted mode, and a lateral pnp one with a distributed structure that serves as both a base current source and collector load.

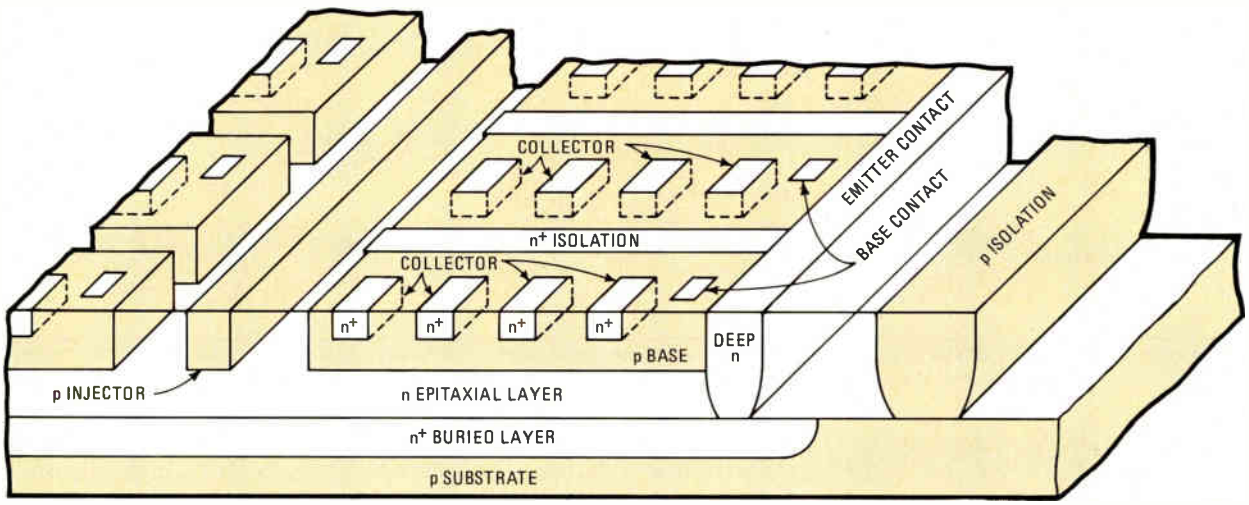
Actually, the active area of a conventional junction-isolated npn transistor (a) is confined to a small region under the emitter. By far the larger part of the device provides the junction isolation and makes contact to the base and collector. The structure is vertical, with the emitter at the top, the collector at the bottom, and the base in between.

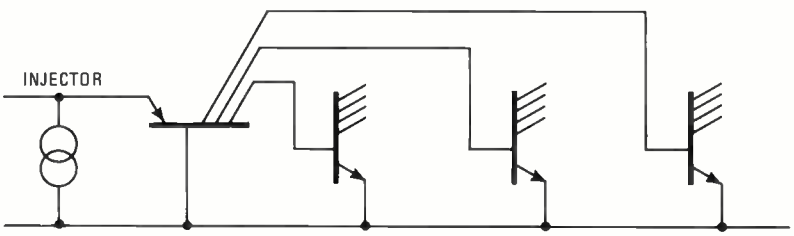
However, this top-to-bottom structure may be operated in reverse—that is, with the collector at the top and the emitter at the bottom—but then the transistor has low beta and a low collector-base breakdown voltage. Even





(a)





(b)

so, it is possible to select the junction depths and doping profile so as to produce high-performance normal-mode transistors, as well as inverted-mode transistors that are adequate for building digital logic circuits.

Indeed, inverted-mode transistors are the key to the effectiveness of I²L. Simply diffusing another base into the n epitaxial region of the npn transistor creates a second inverted-mode transistor, which shares the emitter connection of the first device. This means that inverted-mode transistors may be packed much more densely than conventional junction-isolated transistors, because no wide n areas are needed to contain depletion regions or p isolations.

Inverted operation also lets extra collectors be diffused into each base region, producing a multiple-collector transistor that may be operated as a multiple-term logic gate. Such I²L gates, though, have a single input and multiple outputs, in contrast to the multiple inputs and single output of conventional gates. This variation may entail a slight adjustment in a given design, but need not increase its complexity.

The major processing difference between a conventional bipolar linear integrated circuit and an I²L structure is a deep n diffusion separating the individual gates in the I²L circuit. The other processing steps and their sequence of execution are identical.

I²L combines inverted-mode npn transistors with a distributed lateral pnp transistor, as shown in (b). The emitter of the distributed structure is forward-biased with respect to the n epitaxial region and injects minority carriers into it. Called the injector, this element serves as a current source, injecting base current into each of the npn transistors in the array. The p-type bases of the npn transistors act as the collectors of the distributed pnp.

The additional deep n diffusion separates the gates, and the p-isolation diffusion separates the entire I²L array from other circuits on the monolithic chip. The emitters of all the transistors in any array are joined structurally and are connected in common to a single point in the circuit. The multiple collectors of each npn transistor drive other gates in the array.

Within a logic network, the base of each gate is driven by the collectors of one or more other gates. The current collected by the p-type base enables its associated gate when all the collectors driving it are off. This current acts as the load or pull-up for any or all of the driving gates as they come on. Therefore, in contrast to the traditional operation of IC logic, the application of power turns on I²L transistors, so that they must be turned off to switch their outputs.

Without interconnections, all of the gates collect base current and are turned on. If the beta of each collector of each gate is greater than unity, a single collector can switch more than the base current collected by another gate. As a result, the collector of an on gate can be connected to steal the base current of another gate and hold it off.

Since each injected I²L transistor can be a complete gate and each gate is smaller than a junction-isolated linear transistor, I²L results in very compact logic networks. Furthermore, this efficient bipolar logic structure can be easily combined with conventional bipolar linear structures to produce economical, high-performance analog circuits.

all the bits, the register contains a 10-bit binary code that represents the input signal to within ±½ LSB.

Upon completion of the sequence, the successive-approximation register sends out an active-low data-ready signal that brings the three-state buffers out of their open state. This causes the bit output lines to become active high or active low, depending on the code in the successive-approximation register. When the blank-and-convert line again goes high, the output buffers revert to their open state, and the register is ready for another conversion cycle.

These three-state buffers are made up of conventional diffusion-isolated transistors in circuits similar to transistor-transistor-logic gates. Since these transistors are not gold-doped, as they would be in an all-TTL circuit, they are slower than an ordinary TTL gate, but they can still switch fast enough to multiplex the outputs of several converters onto a common 10-bit bus.

Moreover, since the buffers employ high-voltage linear transistors, they can be operated with supply voltages ranging up to 16 V, so that the converter outputs can directly drive high-level C-MOS logic or high-threshold TTL. In normal operation, the internally generated data-ready signal automatically controls the three-state buffers. This feature saves a control pin, letting the converter be housed in an 18-pin dual in-line package. While the bit outputs are driven by three-state buffers having active pullups, the data-ready output has a resistor-pullup open-collector buffer, which permits data-ready lines from several devices to be wire-ORed.

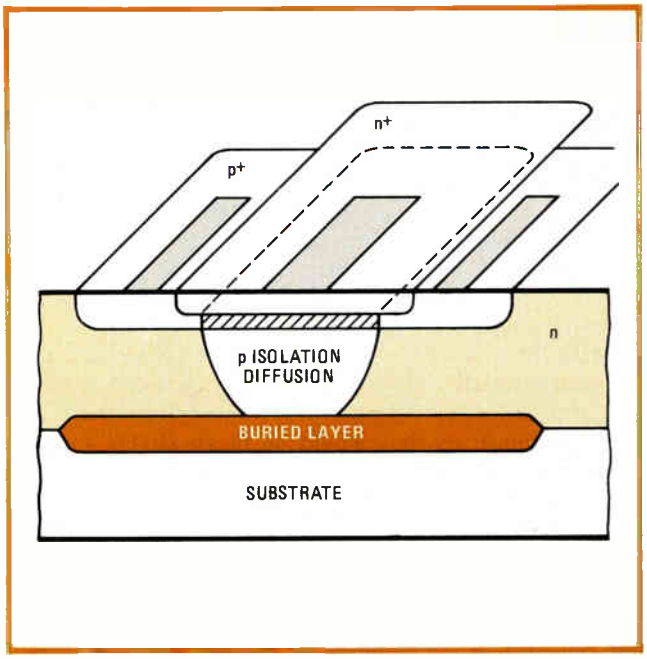
The AD571 also provides a bipolar-offset input to compensate for any offset at the output of the internal d-a converter. This input controls a switch that allows the bipolar offset current, which is equal to the value of the MSB, to be injected into the summing node of the comparator, thereby offsetting the d-a converter's output current. The thin-film 5-kΩ input resistor is trimmed at the factory so that a full-scale input signal will generate an input current that matches the output of the internal d-a converter when all its input bits are on.

To permit more flexible control of system common busing, as well as digital and analog returns, the AD571 offers separate analog and digital common connections. It will operate properly with as much as ±200 millivolts of common-mode voltage between the two commons. To avoid exceeding the maximum ±1-V common-mode-voltage rating when the two commons are joined remotely, they should have a parallel pair of back-to-back diodes connected between them.

The microprocessor hookup

With a minimum of additional components, the unit may operate from standard microprocessor control lines, presenting data to any standard microprocessor bus, whether 4, 8, 12, or 16 bits wide. For example, Fig. 3 shows the AD571 operating with an 8-bit bus and standard 8080-type microprocessor control signals. In this case, the input control circuitry assures that the converter receives a wide enough pulse for its conversion command. When the device is in the standby mode, its blank-and-convert line is low, as is its data-ready line.

To command a conversion, the circuit's start-address-



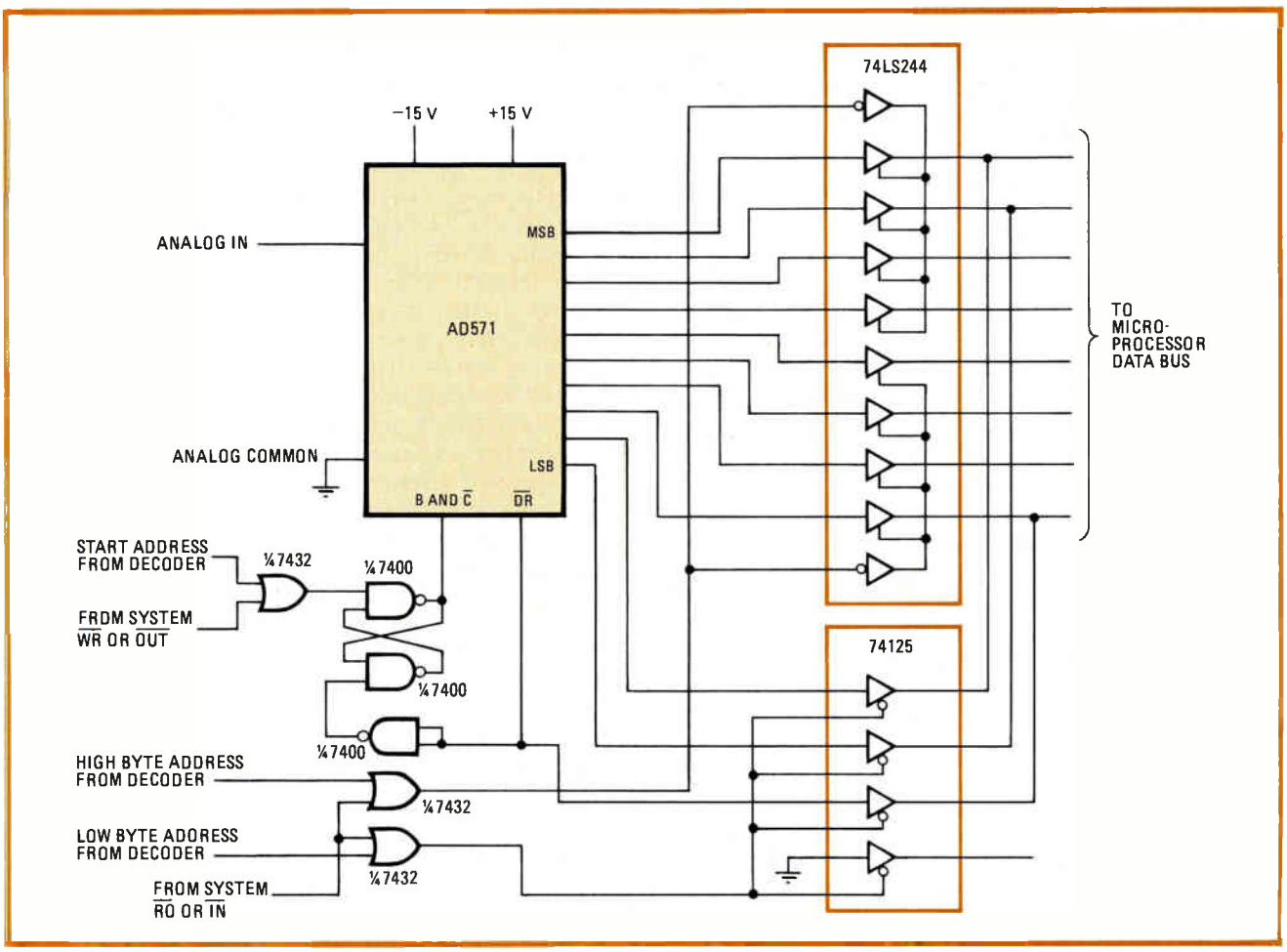
2. For reference. The on-chip voltage reference of the new 10-bit converter is derived from a subsurface (buried) zener diode. Since avalanche breakdown occurs below the surface of the silicon, the zener is immune to adverse charge-carrier effects in the surface layer.

decode line goes low, followed by the $\overline{WR}$ line. The blank-and-convert line will now go high, as will the data-ready line about 1.5 μs later. This resets the external flip-flop, which drives the blank-and-convert line back to low, thus initiating the conversion cycle. When the conversion is complete, the data-ready line goes low, the converter's data outputs become active with the new data, and the control gates return to their standby state. The new data will remain active until a new conversion is commanded.

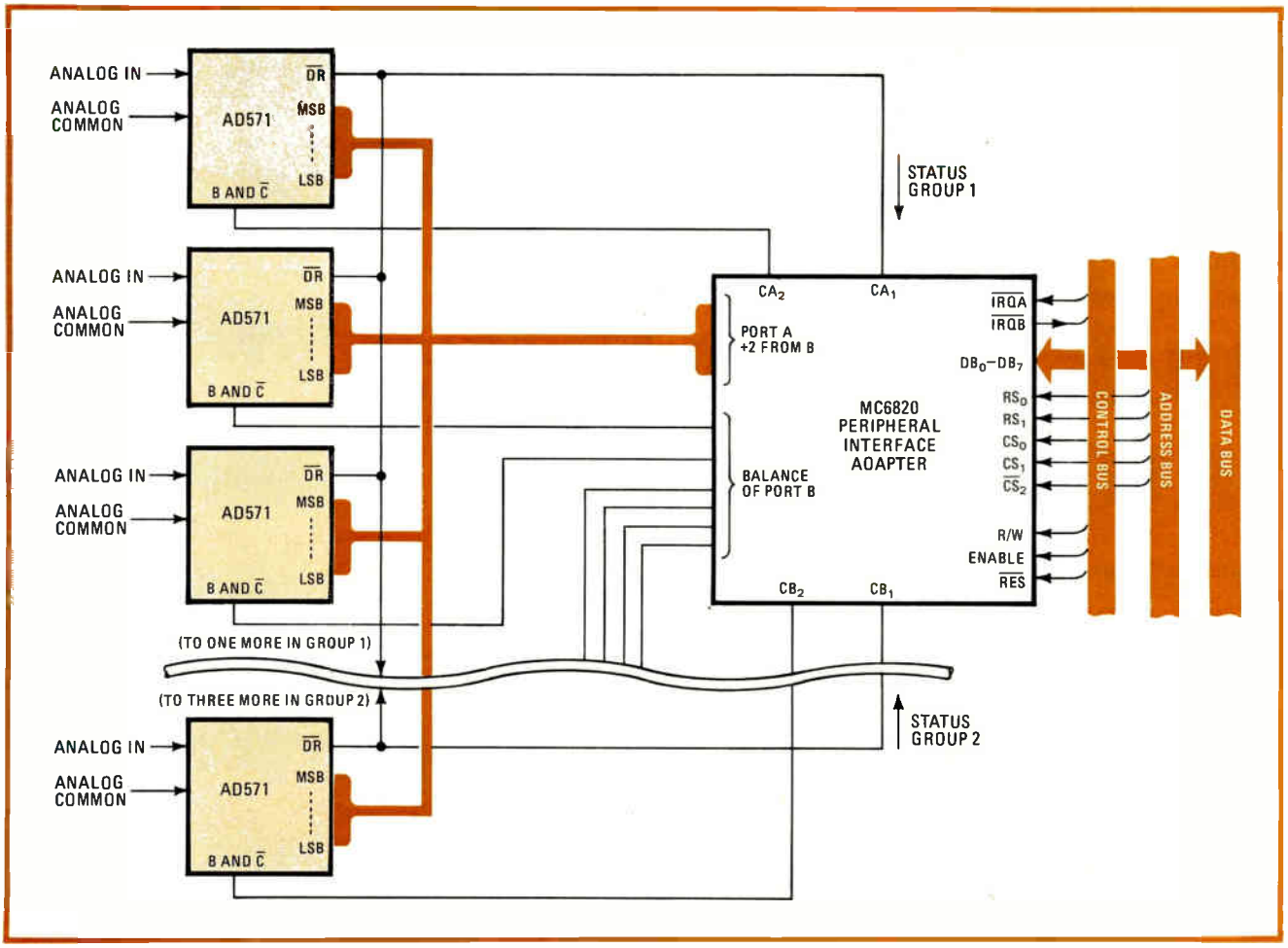
To present this data to the data bus, the user commands the three-state buffers when desired. A data word, either 8 or 2 bits long, loads onto the bus when its decoded address goes low and the system's $\overline{RD}$ line goes low. Such an arrangement presents data to the bus left-justified, with the highest-order bits in the 8-bit word. (A simple rewiring modifies the circuit to a right-justified data arrangement.)

Addressing the gate that buffers the data-ready line polls the converter to determine if a conversion is complete. In this configuration, there is no need for extra buffer-register storage provided that the data may be held indefinitely in the converter itself, since the blank-and-convert line is held low.

Another way of interfacing to a microcomputer bus is to use one of the newer peripheral interface devices, as shown in Fig. 4. This example also demonstrates how



3. Interfacing is a breeze. With just a few external components, the AD571 a-d converter easily interfaces to any standard microprocessor data bus. Data may be stored indefinitely in the converter itself, as long as the device's blank-and-convert line is held low.



4. Multiplexing. The device's three-state output buffers and the wired-OR feature of the data-ready line permit several converters to be multiplexed digitally, often without the need for a sample-and-hold. A peripheral interface chip simplifies the microprocessor hookup.

several converters may be multiplexed together, taking advantage of the AD571's collector-OR feature and its three-state output buffers. With a converter per channel, digital multiplexing eliminates the need for analog multiplexing and often the need for a sample-and-hold circuit as well. The peripheral interface adapter ties eight converters to the microprocessor data bus without the need for any extra logic.

Multiplexing details

The eight converters drive a common 10-bit data bus that terminates at the interface adapter, utilizing its 8-bit port A and 2 bits of its port B. The system reset signal automatically puts these 10 data lines into the input mode. These data lines may be read under software control, and the remaining 6 bits of port B may be programmed as outputs, as may control bits CA_2 and CB_2. The latter eight lines drive the blank-and-convert inputs of the eight converters, so that the devices may be operated in sequence under program control.

Those converters that are to remain inactive are simply held in the blank mode with open outputs as long as their blank-and-convert inputs remain high. The data-ready (or status) lines may be collector-ORed in two groups of four, and these two groups drive the two remaining control bits of the interface adapter. Interrogating these bits tests the status of the conversion in progress. The converters are divided into two groups to minimize the loading effect of the internal pullup resistors on the data-ready buffers.

When a control line is in the logic-1 or high state, its associated converter will be automatically blanked—that is, that unit's outputs will be in the inactive open state. Switching a single control line low starts its associated converter. That converter's outputs will automatically go active when the conversion is complete, and the result can be read from the two peripheral ports. For the next conversion, a different control line can be pulled low, blanking the previously active port at the same time. Subsequently, the cycle may be repeated.

In the future, the AD571 should prove to be just the forerunner of a class of monolithic circuits that efficiently combine complex logic with high-performance linear circuitry. Because of the high degree of circuit complexity it permits, linear-compatible I^2L will mean analog chips that incorporate such features as a standard microprocessor interface, stored-data memory functions, and even possibly an intelligent microprocessor interface. In turn, laser wafer trimming makes it possible to achieve high accuracy at low cost. When combined, these technologies will undoubtedly carve out a sizable niche in the data-conversion field. □

New arrivals in the bulk storage inventory

by Laurence Altman, *Solid State Editor*

TABLE 1: COMPARISON OF MEMORY ATTRIBUTES

Type	Volatile	Mechanical	Methods of data access	Access time	Typical size (bits)	Commercial cost per bit (system level)
TTL RAM	yes	no	random	60 ns	10^3 to 5×10^5	3.0 cents
MOS RAM	yes	no	random	300 ns	4×10^3 to 10^6	1.0 cent
Core	no	no	random	400 ns	10^5 to 5×10^7	0.7 cent
BEAMOS	no	no	random block	30 μs	2.5×10^7 to 6×10^8	0.01 to 0.02 cent
CCD	yes	no	random block	100 μs	10^4 to 8×10^6	0.25 cent
Bubble domain (block-organized)	no	no	random block	1 ms	5×10^5 to 2×10^8	0.03 to 0.05 cent
Floppy disk	no	yes	serial block	100 ms	5×10^5 to 5×10^6	0.05 cent
Cassette	no	yes	serial	10 s	10^6 to 10^7	0.04 cent
Head/track disk	no	yes	serial block	8 ms	10^7 to 2×10^8	0.08 cent
Moving-head disk	no	yes	serial block	100 ms	5×10^7 to 5×10^9	0.0025 cent
Bubble domain (serial organization)	no	no	serial	1 s	5×10^5 to 2×10^8	0.03 to 0.05 cent
Tape	no	yes	serial	20 s	10^8 to 10^{10}	0.0001 cent

Source: Rockwell

The bubble lattice—a new idea

A new concept in bubble memory design increases packing density by an order of magnitude. Recently introduced by researchers at IBM Corp.'s laboratory in San Jose, Calif., the technique packs bubbles into a configuration like a crystal lattice, using the magnetic flux in the lattice walls surrounding each bubble to represent the logic 1s and 0s of computer language.

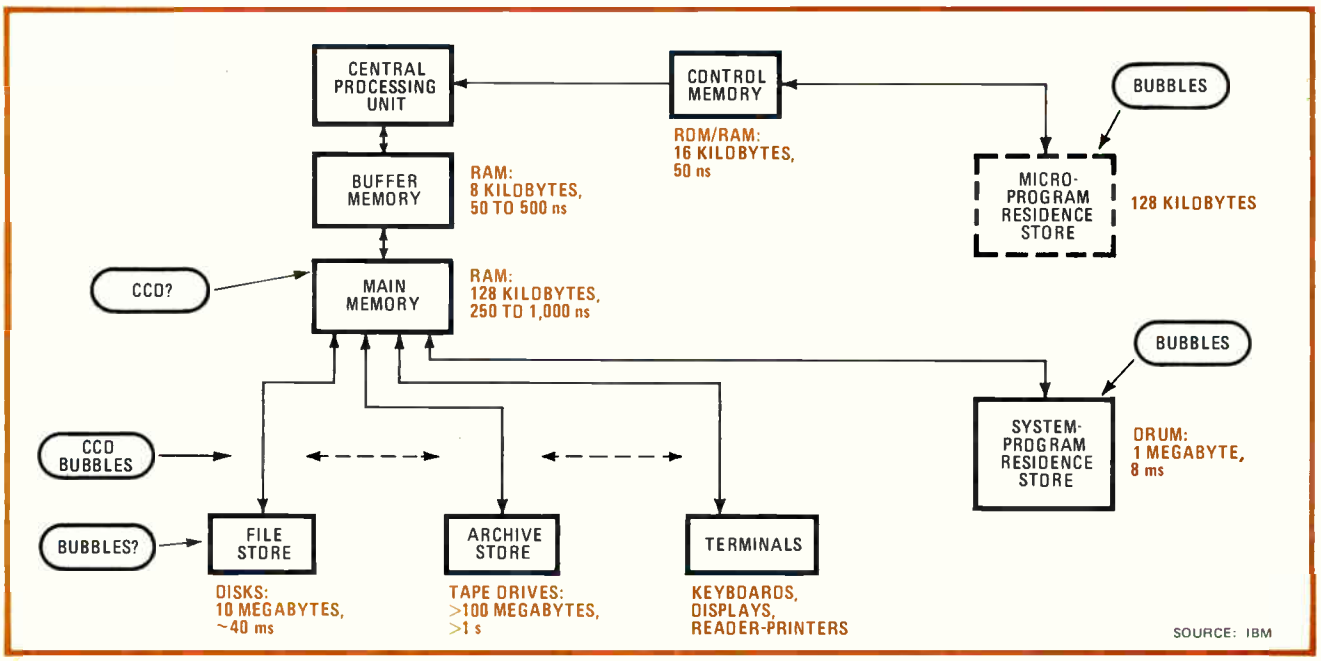
Bubble lattice storage, as it is called, differs radically from conventional bubble memories, in which the presence or absence of bubbles is what counts. In these memories, the bubbles are not static but move about beneath a thin-film Permalloy pattern as directed by a rotating magnetic field. The field constantly reverses the north and south polarity of different parts of the pattern, thus pulling the bubbles along from point to point.

The bubble lattice, on the other hand, squashes the normally cylindrical magnetic-bubble domains so close together that they become hexagonal in cross section, like the cells in a honeycomb, and there is no empty space between them. Storage density increases significantly, but a logic 0 can no longer be represented by the absence of a bubble.

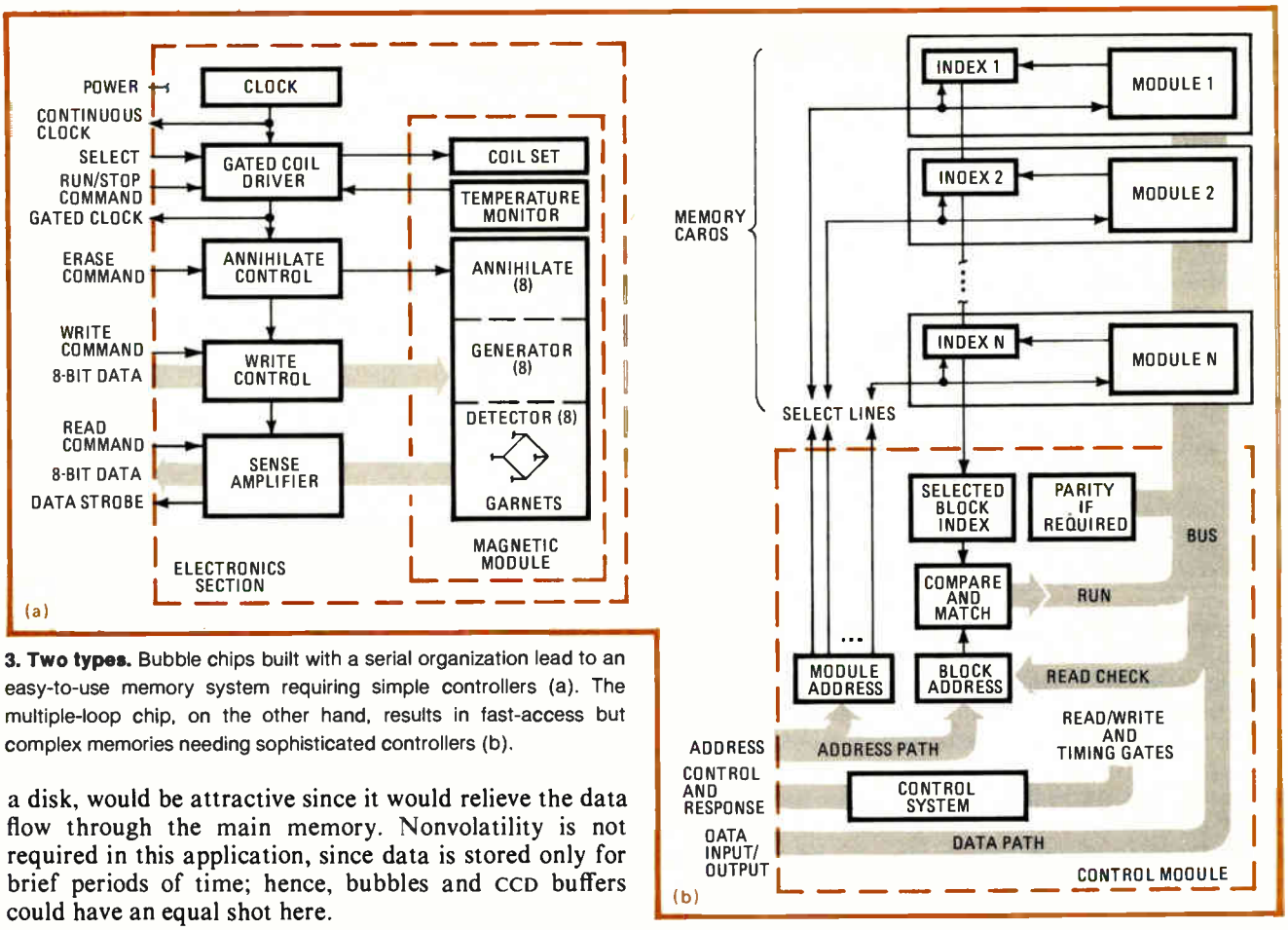
Instead, binary data is represented by a magnetic difference in the stationary bubbles—the direction of magnetization in the boundary or wall that separates the bubble from its surroundings. The magnetization rotates in either a clockwise or counterclockwise direction round the hexagonal perimeter of the bubble. The two directions are used to store 1s and 0s.

performance advantage other than the elimination of moving disk drives. (It should be borne in mind that bubble chips still need Permalloy or conductor patterns covering every bit location, and the attendant processing, yield, and packaging problems are likely to result in higher cost than the manufacture of continuous magnetic-storage media.) CCDs likewise are excluded from this segment because they are nonvolatile. In fact, flexible continuous magnetic media can be expected to cover the archival storage segment of systems for a long time to come, thanks to their inherently reversible, removable, nonvolatile, and low-cost characteristics.

An interesting application can be foreseen for static or quasi-static shift registers like bubbles or CCDs. They could serve as buffers (shaded in Fig. 2) between storage devices that cannot otherwise communicate directly with each other because of a lack of synchronization or a difference in their data ranges. Usually, data passes from tapes to drums or disks and vice versa through random-access main memory. A low-cost shift register, capable of temporarily storing the data of a track (or cylinder) of



2. Finding a place. IBM analysts see targets for charge-coupled devices in main memory (if the price is right) or possibly as an intermediate storage between the main memory and the file and archive storage. Bubbles could serve as resident storage or in mass storage.



3. Two types. Bubble chips built with a serial organization lead to an easy-to-use memory system requiring simple controllers (a). The multiple-loop chip, on the other hand, results in fast-access but complex memories needing sophisticated controllers (b).

a disk, would be attractive since it would relieve the data flow through the main memory. Nonvolatility is not required in this application, since data is stored only for brief periods of time; hence, bubbles and CCD buffers could have an equal shot here.

Bubble system designs

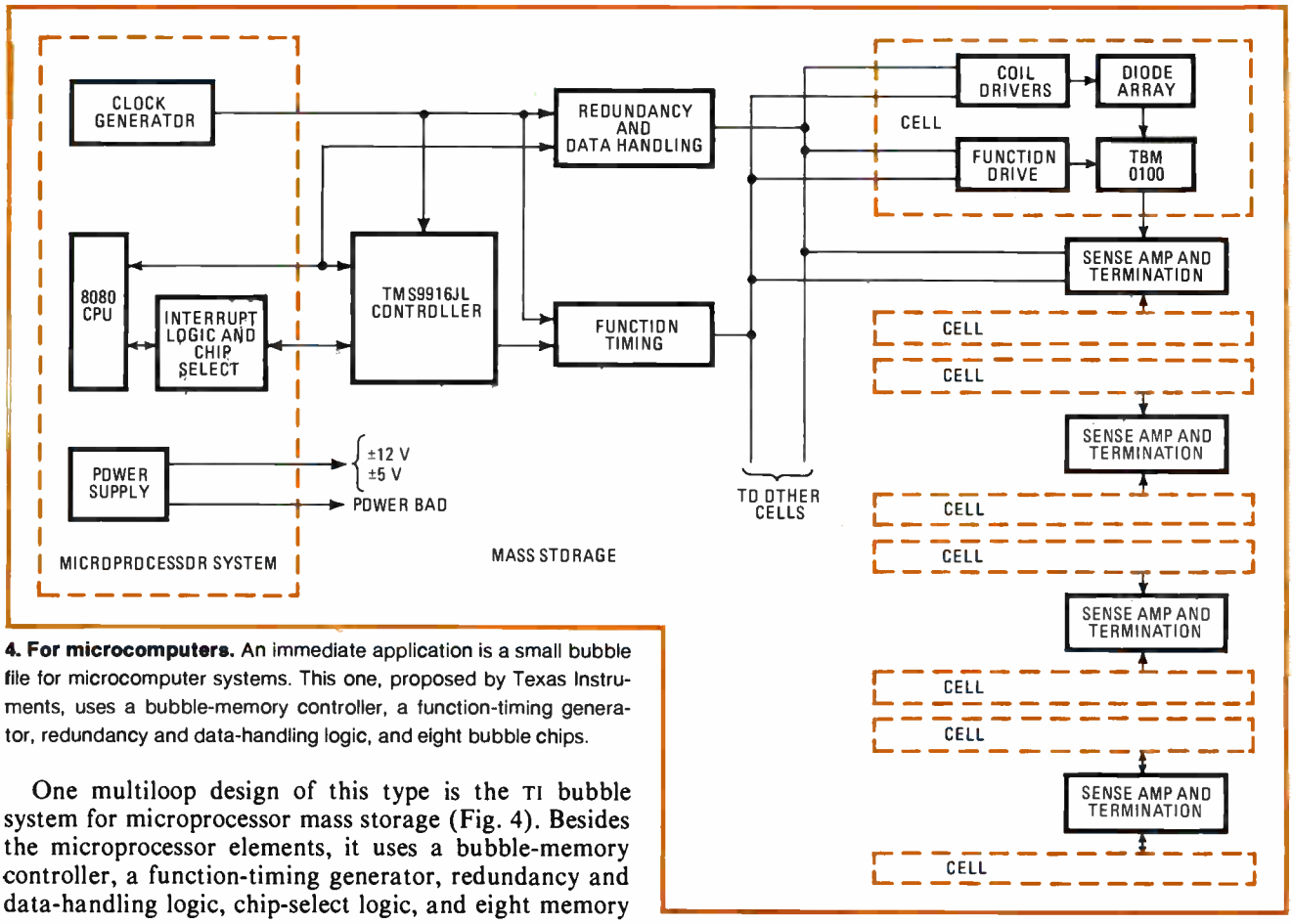
A great deal of bubble-device and -system analysis has been carried out at various Rockwell divisions, where research and development programs have been under way for almost 10 years. At present, there are two types of bubble memory devices. One is organized as a simple serial-data loop, a configuration that yields a family of bubble memories that serve either as data loggers or slow-access program stores. This class of device has characteristics similar to those of cassettes. It gains simplicity of operation at the expense of slow access times of about 100 ms.

The second type of bubble device is built with a series of minor and major loops for data storage. This configuration will be used for systems that require relatively fast, 1-ms access to data blocks.

Using 4-to-6-micrometer bubble chips having capacities ranging from 64 to 100 kilobits, first-generation bubble-memory systems of both types are being introduced or are at the design stage. For instance, there are Bell Telephone's repertory dialer, containing a 1,100-bit serial bubble store; Hitachi's 32-kilobyte serial bubble memory for point-of-sale applications; Rockwell's 102-kilobyte serial bubble memory, also for-point-of-sale systems; Rockwell's 100-million-bit bubble module built for the National Aeronautics and Space Administration for use in a space-borne, four-channel recorder; Texas Instruments' similar project for the Air Force; and, of course, TI's commercially available 92-k bubble-memory-chip subsystem module for data terminals.

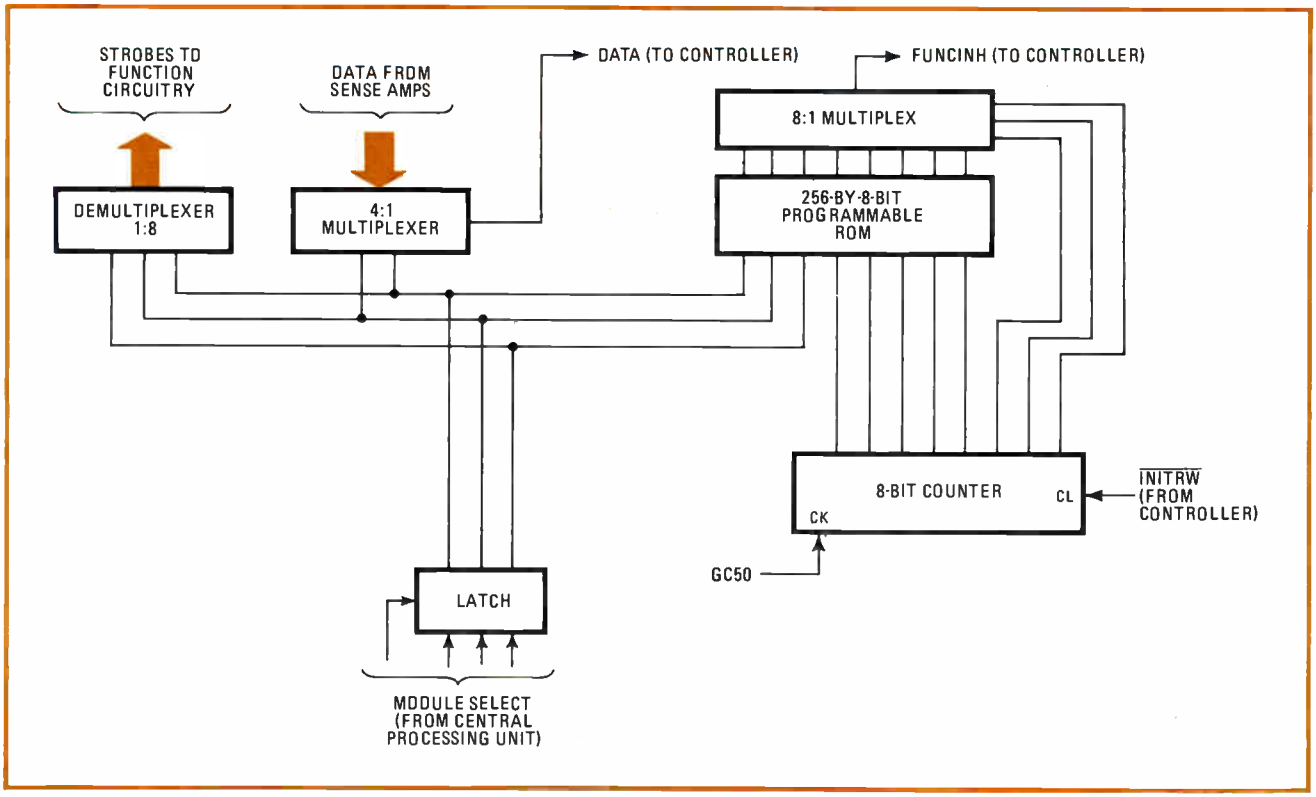
Figure 3a is a block diagram of a characteristically simple system built with eight serial bubble chips. Data is stored in the bubble chips under a single drive coil in a 1-byte-wide data organization similar to that of today's cassettes. Little housekeeping is required since each loop represents data stored in a single device. In fact, a straightforward controller implemented with any standard one-chip microcomputer can start the memory, read through the data searching for the record desired, and then read or write it as necessary. Only four operating commands—run, erase, write, and read—are needed for serial systems of this type.

On the other hand, the minor-loop bubble chips require a much more complex organization, but one with far greater flexibility, speed, and ability to expand. Figure 3b shows a minor-loop system of the kind that might be used to transfer data to a microprocessor main store through a direct-memory-access port. In this system, since block addressing to the memory modules must be combined with some indexing of the location of each record within a module, a complex controller must be implemented. Indeed, minor-loop bubble-memory system controllers will contain most of the features at present found in large disk controllers, including address search logic, parity checking, and error correction. Here, the bubble control may map data away from bad loops and into spare ones in a manner similar to the reassignment provisions of large disks.



4. For microcomputers. An immediate application is a small bubble file for microcomputer systems. This one, proposed by Texas Instruments, uses a bubble-memory controller, a function-timing generator, redundancy and data-handling logic, and eight bubble chips.

One multiloop design of this type is the TI bubble system for microprocessor mass storage (Fig. 4). Besides the microprocessor elements, it uses a bubble-memory controller, a function-timing generator, redundancy and data-handling logic, chip-select logic, and eight memory



5. Redundancy. A bubble-memory system might contain a redundancy system that uses a programmable ROM to prevent bad bits from causing errors. The PROM is programmed to bypass the bad bits from each page read, thus preventing them from reaching the output.

TABLE 2: PRESENT AND FUTURE BUBBLE TECHNOLOGY TRENDS

Present technology		Next 1 to 3 years	5 years from now	10 years from now
Wafers	$100/2-in. wafer	$35/2-in. wafer	$25/3-in. wafer	
Films	YSmCaGe Garnet YSmGe Garnet	YSmCaGe Garnet YSmLuCaGe Garnet	YSmCaGe Garnet (3 layer)? YSmLuCaGe Garnet	amorphous materials Gd Cobalt
Bubble size	4 – 6 μm	2 – 3 μm	1 μm	< 1 μm
Patterns	T-bar using optical contact lithography	gap-tolerant patterns using optical contact lithography	contiguous patterns using electron-beam masks and X-ray lithography	conductor driven or field access?
Bias	permanent magnet	permanent magnet	self-bias	none
Drive	field access 35 – 50 Oe	field access 50 – 65 Oe	field access 75 Oe	current loop
Device bit size	64-K – 128-K	128-K – 256-K	256-K – 1-M	256-K – 1-M
Speed	100 – 500 kHz	0.1 – 1 MHz	1 – 5 MHz	0.200 – 5 MHz
Organization	serial loop or minor loop	major-minor or redundant loop designs	redundant loops only $10^6 - 10^9$	lattice file $10^7 - 10^{10}$
System bit size	$5.0 \times 10^5 - 10^8$	$10^6 - 2 \times 10^8$		
Temperature range	–25 to +75° C	–25 to +75° C	–25 to +75° C	0 to 50° C
System cost	0.1 cent/bit	0.05 –0.03 cent/bit	0.012 –0.005 cent/bit	0.010 –0.003 cent/bit

Source: Rockwell

chips. Four sense amplifiers and their associated termination networks are shared by the eight chips.

This organization restricts the data rate to 10 kilobits per second while reducing parts count, since only one bubble module from each pair sharing a sense amplifier may be accessed at one time. The maximum transfer rate could be increased to 20 kb/s by reconfiguring the data-handling and sense circuitry so that bubble modules might be accessed in parallel.

To read data into this system, the CPU directs the data-handling logic that selects the module to be accessed and then loads the data into the controller with the required page number and read commands. The controller then accesses the proper page and stores the data in its buffer. Finally, the controller sends an interrupt signal to the CPU and commands it to read the data from the controller's buffer.

To write, the process is reversed. The CPU sends the data into the controller buffer and the controller interrupts the CPU when the data entry is completed.

A key advantage that bubble devices have over other memory technologies is the ease with which redundancy can be built into them. Extra minor loops can be included on the chips for use in place of loops containing errors. Thus, false readings and errors are much simpler to correct than is the case with semiconductor chips of the same density.

Redundancy

Redundancy may be handled in several ways. First, the masks for all the bubble modules might be stored in a special programmable ROM. The mask for an accessed module could be read from the ROM and gated with each bit of the page as it is read, preventing bad bits from reaching the controller buffer (Fig. 5). Alternatively, equivalents of the masks could be stored in the CPU ROM. In this case, all the bits in a page would be read and the data reconstructed by CPU software. A third alternative is to store the redundancy map in the bubble device and read it into a RAM during system initialization.

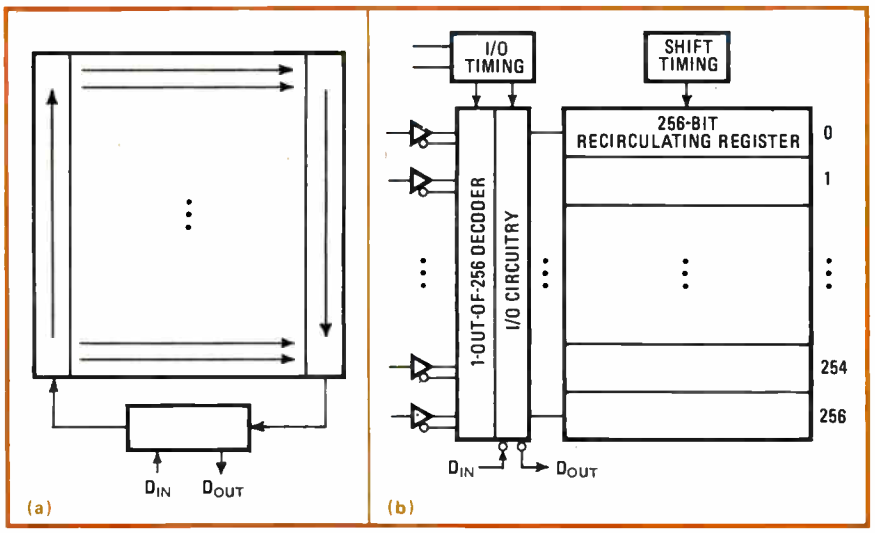
Even as first-generation bubble-memory systems are being designed, continuing research is increasing the capability and reducing the cost of bubble devices. A glimpse of what can be expected is provided by Table 2, an assessment developed by Rockwell researchers. In the near term, finer metalization will improve propagation patterns so that smaller bubbles can be fabricated without aggravating the lithography constraints of device fabrication.

Expected this year are bubbles with diameters of 3 and 4 micrometers, doubling the density and halving the speed of today's typically 5-to-6-μm-bubble devices. As metalization improves in the next one to three years, the chips will rocket to a 256-k density. Such a packing density will favor the minor-loop configurations and make possible systems with a high-level fault tolerance. At the same time, bubble bit costs in the range of 1 millicent will make this technology increasingly attractive for moveable-storage mass-memory replacements.

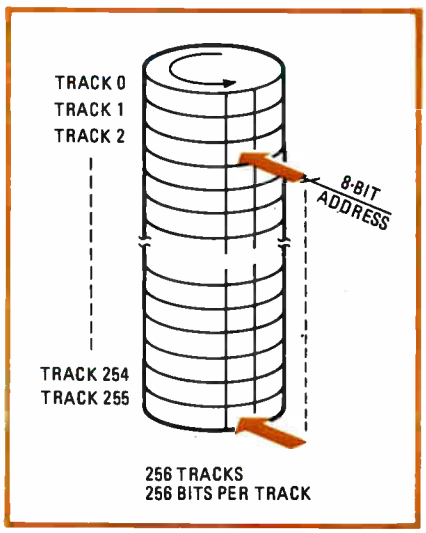
The future of bubbles

Further ahead—perhaps five years off—devices containing 1-μm bubbles are expected. Since the pattern resolutions of 0.25 μm required for this bubble dimension are beyond the reach of optical lithography, a parallel development of electron-beam mask making and electron-beam and/or X-ray lithography will be necessary for achieving these dimensions. The payoff, however, will be well worth the investment: devices with capabilities approaching 1 megabit will be possible.

Packing densities of this magnitude, however, will mandate redundant fault-tolerant and extremely low-power device designs. Nevertheless, these very large-capacity devices will more than amortize the relatively high costs of the raw garnet substrate material used in bubble fabrication and the high cost of the system support that will be required to manage as many bits as this. All in all, a 1-million-bit memory bubble chip will



6. CCD types. Long-loop CCDs (a) are composed of high-frequency input and output serial registers and a relatively slow array of parallel registers. Short-loop types (b) are made up of short straight paths multiplexed together to form the recirculating registers.



7. Power saver. Short-loop device in page-mode operations consists of 256 loops that are accessed by 8-bit addresses.

cause the bit costs to drop below 1 millicent.

Beyond this lie exotic new approaches. The use of a self-biasing film in bubble fabrication could eliminate the dependency of bubble memory systems on bias magnets. Moreover, amorphous materials utilized as lattice files (see "The bubble lattice—a new idea," p. 109) offer of a completely new approach to bubble storage, one that would eliminate all drive coils and yield bubble memories in the range of 10^{10} bits.

The outlook in CCD systems

As for charge-coupled devices, they are being designed into a wide variety of equipment, ranging from block-accessible memories for large computers to look-up files in point-of-sale terminals. CCDs are a good choice for these applications because they are cheaper than semiconductor RAMs and perform better than disks.

All CCD applications have in common the need for low-cost memory storage. Beyond that, the requirements vary according with the design criteria. Hierarchical memories intended for large computers and therefore needing high performance require CCD systems with low latency times and high data-transfer rates. But microprocessor-oriented CCD memories could trade off lower data rates for minimal design-in overhead.

In between there is a full range of applications with varying key requirements. CCD replacements of fixed-head disks, for instance, can get by with low data rates but must be cheap to compete, whereas the reverse is true for CCD data crunchers, main memory extensions, and associative processors. These must be fast, to keep pace with the semiconductor-RAM-based systems that control them, but they need not be cheap since their capacity is small.

Manufacturers of CCDs are experimenting with several device layouts to see which best suit the different applications. The most fundamental parameter they are playing with is the length of the loop in which the CCD's charge circulates. According to designers at Intel Corp., which along with Fairchild and TI have CCD chips either available or soon to be available in sample quantities, a CCD can be made with a few long loops or with several short loops. The choice affects overall device performance and system architecture, since the loop length in essence adds a third dimension to the two (row and column) of RAM design.

Long-loop CCDs generally employ a serial-parallel-serial organization (Fig. 6). A single loop consists of a high-frequency serial-input register, a high-frequency serial-output register, and a low-frequency parallel array between the input/output registers shifting at 1/n of the I/O frequency. The charge packet makes two turns, one at each interface between the parallel array and the serial I/O registers. Since the bulk of the bits reside in the parallel section and move at a significantly lower frequency than the I/O, the SPS organization saves power. A 64-K device typically consists of 16 such loops, and a 4-bit address input selects a specific loop.

Two examples

The device depicted in Fig. 6 is a typical short-loop CCD. Each loop is a short, straight path for the movement of charge. Power is reduced by the use of an internal multiplexing scheme to reduce the actual shift frequency of the array. In the Intel 2464 short-loop device, for example, four 64-bit registers are multiplexed to create one 256-bit loop. For an effective 1-MHz shift rate, the actual array shifts at only 250 kHz. The array comprises altogether 256 identical loops that shift synchronously. Eight-bit address inputs select each loop.

CCD users can reduce power still more in short-loop devices if they use the operating scheme known as page-mode operation (Fig. 7). Since short-loop devices require relatively few shifts between refresh periods, they can stop between shifts for a short time during which several data bits can be accessed. In effect, the data and shift rates are independent. It is entirely feasible to run the fastest possible page-mode data rate while also using the fastest possible shift frequency. In this way, maximum performance may be derived from minimum power. □

Diodes and integrator brake small motors dynamically

by Stephen Wardlaw
Yale-New Haven Hospital, Dept. of Laboratory Medicine, New Haven, Conn.

Alternating-current motors used in position-sensing circuits must be quickly braked and stopped if the system is to retain its positional accuracy. In the case of a small shaded-pole motor, a dc source connected directly to its field winding brakes it dynamically by rapidly dissipating its kinetic energy. But if not turned off in time, the source will overheat the motor.

A safer way is to derive the dc voltage through a silicon controlled rectifier, a diode, and a resistance-capacitance network. Moreover, such a circuit costs less than an electromechanical switch and is simpler than a thermal-delay or momentary-contact switch.

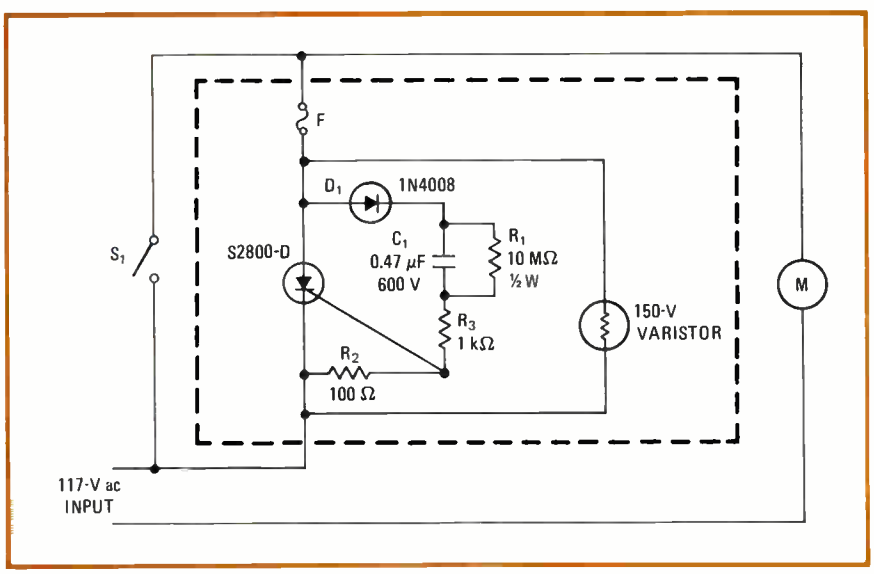
As shown in the figure, the braking unit (within the dotted lines) must be placed in parallel with a manual electronic switch, S_1, that is used to trigger the braking of motor M. With S_1 in the normally closed position, no voltage appears across the braking unit, and R_1 bleeds off any charge being stored in capacitor C_1.

When braking is desired, S_1 is activated and thus opened, so that the positive half-cycle of the line voltage will appear across D_1, C_1, and R_1–R_3 and the SCR will be triggered. This action, in addition to enabling a strong pulse of direct current to flow through the motor windings, partly charges C_1.

When the line current drops through zero and into its negative half-cycle, the SCR turns off and remains in that state until the ac input reaches its positive half-cycle again. The process is repeated until C_1 is charged to near the peak value of the line voltage, at which time direct current will cease to flow. The SCR will not turn on again, because D_1 will be permanently back-biased.

The 150-volt varistor helps to suppress line spikes. The fuse, F, is included as a safety precaution and will open if for some reason the braking unit continues to enable the power line to feed a relatively high direct current through the motor winding. Using the component values shown, the braking unit will enable the line to supply a pulsating dc to the motor for approximately 1 second—more than enough time to completely brake any small motor with a rating of up to ¼ horsepower or so. □

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.



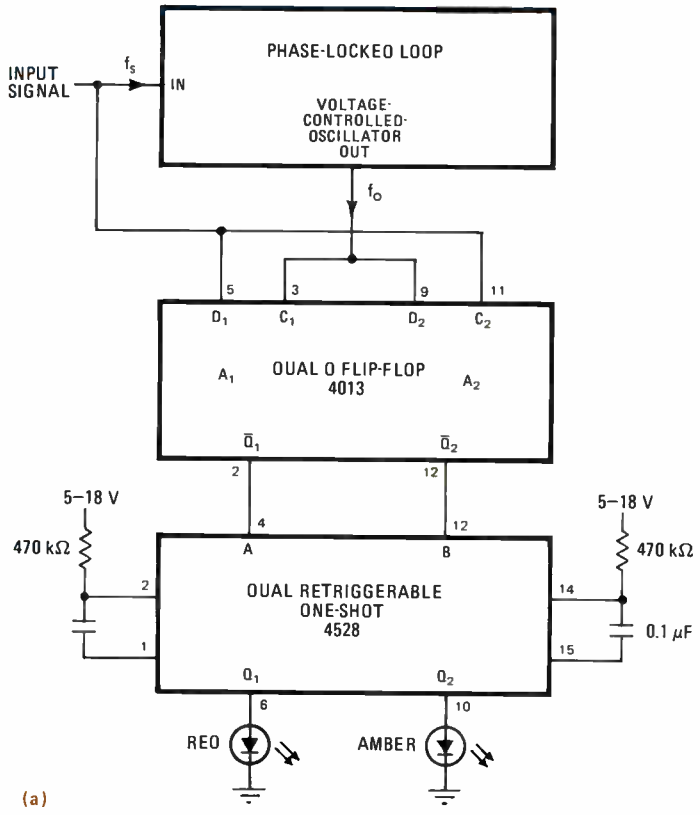
Fast reaction. S_1 initiates motor braking. Positive half-cycle of input voltage appears across D_1, C_1, R_1–R_3, firing SCR and enabling direct current to flow through small shaded-pole motor. C_1 charges to nearly peak value of input voltage during succeeding positive half-cycles, terminating process.

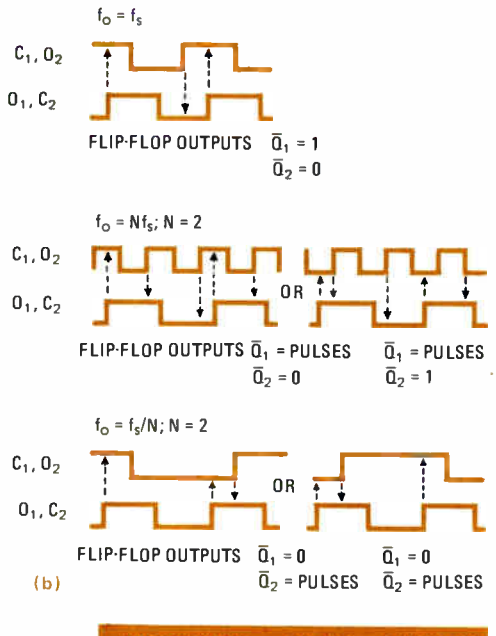
D flip-flops sense locked state of PLL

by L. W. Shacklette and H. A. Ashworth
Seton Hall University, Department of Physics, South Orange, N. J.

This circuit uses a dual D flip-flop to sense the locked state of many popular phase-locked loops, such as the Signetics 562 and 565. By adding a dual one-shot–light-emitting-diode combination to the flip-flops, the circuit visually indicates locking for the conditions where the output frequency, f_o, is locked to the input signal (f_s), to its harmonics (Nf_s) or to its subharmonics (f_s/N).

The circuit shown in (a) determines whether a fixed





LOCKED STATE	RED LED	AMBER LED
OUT OF LOCK	ON	ON
LOCKED ON f_s	OFF	OFF
LOCKED ON Nf_s	ON	OFF
LOCKED ON f_s/N	OFF	ON

(c)

Lock detector. Monitor (a) detects the existence of a phase difference between f_s and f_o and can thus differentiate between three locked conditions, because circuit is also sensitive to ratios f_s/f_o, $f_s/2f_o$, and $2f_s/f_o$ (b). Table (c) summarizes circuit response.

(that is, locked) relationship between f_s and f_o exists by employing both flip-flops in a simple phase detector. The f_s signal drives the D input of flip-flop A_1 and the C input of A_2, and the f_o signal emanating from the voltage-controlled-oscillator output of the PLL drives C_1 and D_2. The design of the phase detector accommodates a PLL having a phase comparator that can generate an upper and lower f_s-to-f_o phase displacement of 180° and 0°, respectively, for the locked condition. The comparator does this by deriving an f_o that is displaced 90° with respect to f_s when the loop is in the center of its range.

The circuit response for a constant f_o and f_s may be understood with the aid of (b). Because the D flip-flops read the data signals (D_i) on the positive edge of each clock (C_i), whenever the data frequency f_{di} equals the clock frequency, f_{ci}, $\overline{Q}_1$ and $\overline{Q}_2$ of the 4013 remain fixed at either logic 1 or logic 0, depending upon whether the signals at C_i and D_i are in phase or out of phase. In either case, the output from the corresponding edge-triggered one-shot in the 4528 will be zero.

When f_c is an integer multiple of f_d, or f_d is an integer multiple of f_c, there will be a pulsed output signal from one of the output ports of the 4013 and a corresponding signal at the 4528 to light the LED. Note that because the one-shot is retriggerable, its output will be constantly at logic 1 for a pulsed input signal. The output (logic 1 or logic 0) from the other port of the flip-flop will be constant. When f_o and f_s are out of lock, each flip-flop reads random 1s and 0s, causing pulsed output signals to appear at both ports of the 4013. The table (c) summarizes circuit operation.

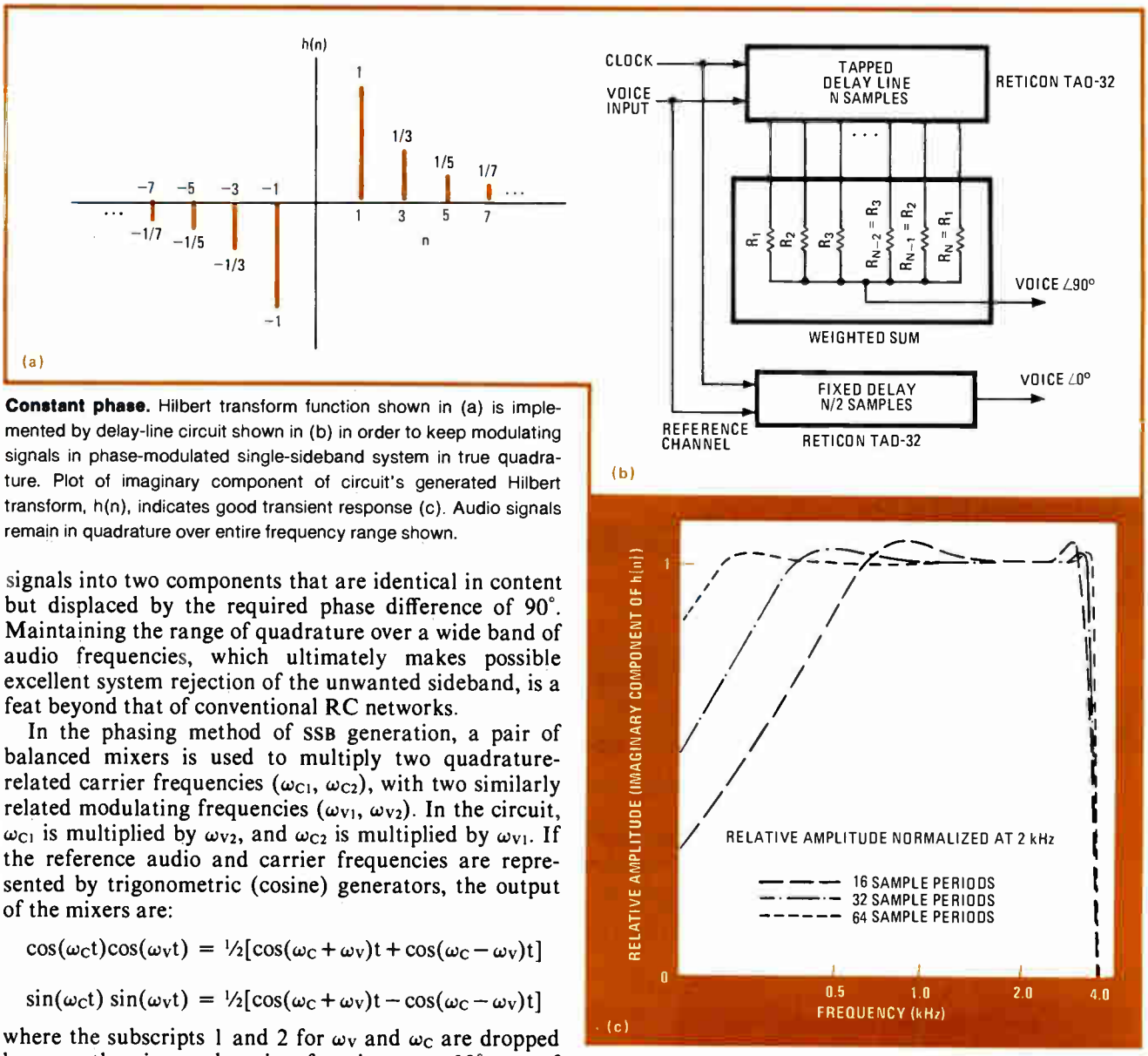
In cases where it is necessary to detect only the condition $f_o = f_s$, a simpler monitor can be constructed using only a single D flip-flop and one LED that is connected to its $\overline{Q}$ output. The LED will light whenever $f_o \neq f_s$. □

Delay lines help generate quadrature voice for SSB

by Joseph A. Webb and M. W. Kelly
University of Canterbury, Christchurch, New Zealand

The major difficulty faced by designers when trying to generate a single-sideband signal by the phase-shift method—that is, obtaining the modulating signals in quadrature over a wide band while achieving good transient response—may be overcome by implementing the well-known Hilbert transform with two clocked analog delay lines and a resistor weighting network.

This simple circuit splits the modulating (audio)



Constant phase. Hilbert transform function shown in (a) is implemented by delay-line circuit shown in (b) in order to keep modulating signals in phase-modulated single-sideband system in true quadrature. Plot of imaginary component of circuit's generated Hilbert transform, h(n), indicates good transient response (c). Audio signals remain in quadrature over entire frequency range shown.

signals into two components that are identical in content but displaced by the required phase difference of 90°. Maintaining the range of quadrature over a wide band of audio frequencies, which ultimately makes possible excellent system rejection of the unwanted sideband, is a feat beyond that of conventional RC networks.

In the phasing method of SSB generation, a pair of balanced mixers is used to multiply two quadrature-related carrier frequencies (ω_{C1}, ω_{C2}), with two similarly related modulating frequencies (ω_{V1}, ω_{V2}). In the circuit, ω_{C1} is multiplied by ω_{V2}, and ω_{C2} is multiplied by ω_{V1}. If the reference audio and carrier frequencies are represented by trigonometric (cosine) generators, the output of the mixers are:

$$\cos(\omega_C t)\cos(\omega_V t) = \tfrac{1}{2}[\cos(\omega_C+\omega_V)t + \cos(\omega_C-\omega_V)t]$$

$$\sin(\omega_C t)\sin(\omega_V t) = \tfrac{1}{2}[\cos(\omega_C+\omega_V)t - \cos(\omega_C-\omega_V)t]$$

where the subscripts 1 and 2 for ω_V and ω_C are dropped because the sine and cosine functions are 90° out of phase. The output of each mixer is then added or subtracted to obtain the upper $(\omega_C+\omega_V)$ or lower $(\omega_C-\omega_V)$ sideband, as desired. Remember, however, that quadrature between the audio and carrier frequencies must be maintained for optimum response.

The discrete Hilbert transform of any signal, that is:

$$h(n) = \frac{1-e^{j\pi n}}{\pi n} = \frac{1-\cos\pi n}{\pi n}$$

corresponds to a 90° phase shift of all its frequency components, and thus by implementing this function the quadrature relationship for the audio channels is maintained. Attaining quadrature for carrier signals is simple, since the ω_C signal has virtually zero bandwidth.

The discrete Hilbert transform is defined from plus to minus infinity, although truncation is needed for physical realization of the function. The truncated impulse response of this function is illustrated in (a).

The required response may be generated with the delay-line circuit shown in (b). A Reticon TAD-32 charge-coupled device is used for the delay line. The weighting resistors are selected so that the circuit will generate the product of the truncated function, h(n), and a smoothing or weighted function, W(n), where $W(n)=\cos^2 n\pi/N$. Each resistor is selected so that $R(n)=h(n)W(n)$. Note that the $\cos^2$ function is defined from $+90°$ to $-90°$, not from plus to minus infinity.

The reference voice channel is delayed by N/2 samples for the audio channels to remain in true quadrature. At a clock frequency of 8 kilohertz, the delay amounts to 4 milliseconds for 64 samples.

The plot of the imaginary component of h(n) in (c) of the figure illustrates the excellent transient response of the circuit. As can be seen, relatively few samples are needed for good performance. In these tests, the clock frequency was 8 kHz. For telephone-quality voice signals, N = 32 is sufficient, and N = 64 represents excellent performance. Since the Hilbert transform is symmetrical, that is, $f(t) = -f(t)$, quadrature is perfect over the entire frequency range shown. □

Say it in a high-level language with 64-K read-only memories

The next generation of ROMs will hold complex, complete software packages, including interpreters and compilers for Basic, Fortran, PL/M, etc.

by Rudy Langer and Thomas Dugan, *National Semiconductor Corp., Santa Clara, Calif.*

☐ A new era is dawning in the world of solid-state memories as very-large-scale integration boosts read-only-memory chips to 64-K size, with 256-K devices standing in the wings. These chip capacities make the ROM a full-blown program-storage medium with a cost, convenience, and durability never before possible. Such silicon software—that is, complex, complete software packages in plug-in ROMs—will change the way memory is used, the way microprocessor systems are designed, and the way software is implemented, developed, and distributed.

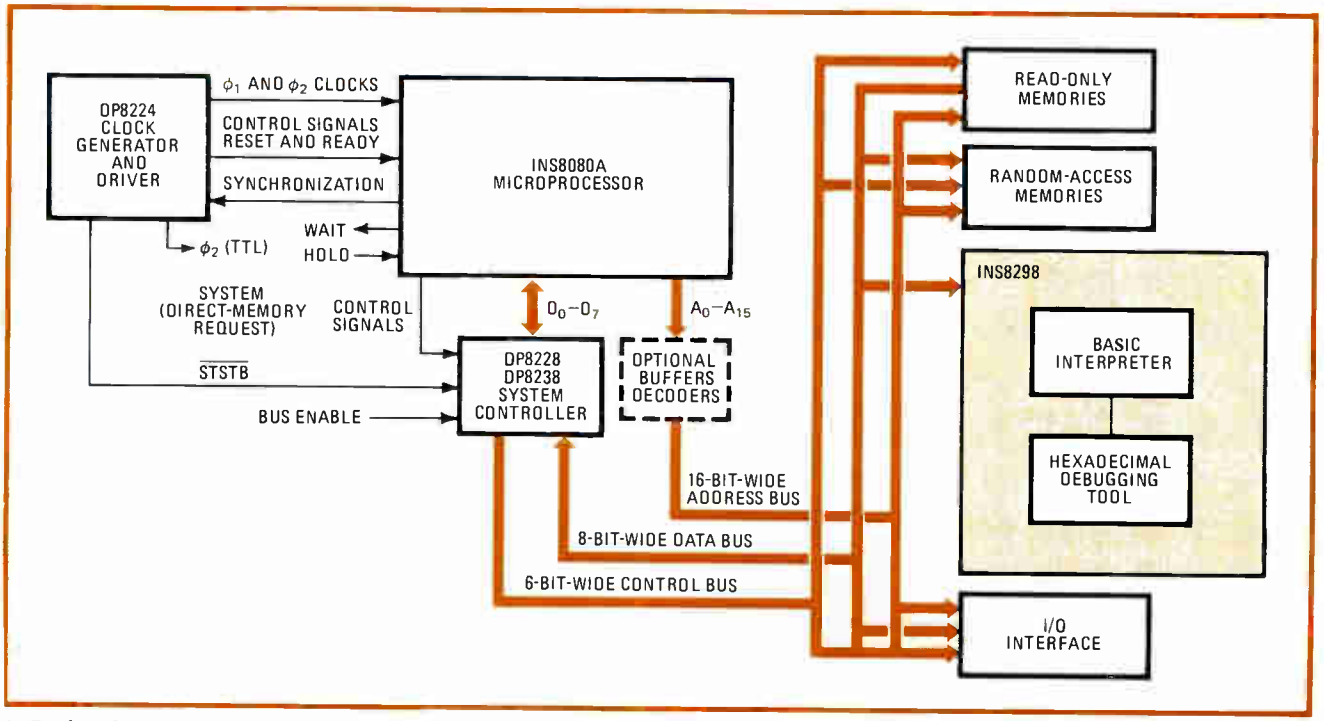
Right on the horizon is the lodestar of this momentous development: the availability to microcomputers of high-level programming languages. Basic, Fortran, and PL/M, which now require expensive disk-based systems for their effective use, will be accessible for no more than the cost of a $15 or $20 integrated circuit.

Indeed, with programmed ROMs, high-level languages will be at last cheap enough for even the smallest microcomputer systems. Moreover, encapsulating software in ROMs means that a large variety of commonly used routines and subroutines can be packaged in readily available off-the-shelf families. Such firmware will be seen as simply a resource of the microcomputer system, nothing more than another peripheral chip.

Bit patterns to programs

Read-only memories have come a long way since their first use as pattern storage on a bit-by-bit basis. Such applications—code-conversion tables like those converting EBCDIC to ASCII, for example—typically require 1,000 to 2,000 bits. As ROM capacity grew, so did its uses. With 4-K chips, it was possible to store a complete font of 5-by-7 dot-matrix characters.

Now, with 65,536-bit ROMs available, extended bit-pattern storage can be achieved. The most immediate



1. Basic microcomputer. Few components are needed to build an 8080-based microcomputer that programs in Basic. Besides the usual ROM, RAM, and system-control chips, the 64-K 8298 ROM is connected to the system's address and data buses. It stores an LLL Basic nterpreter and a handy hexadecimal debugging tool, which allows the user to examine and internal registers and memory location.

TABLE 1: BASIC STATEMENTS AND CONTROL COMMANDS

Statement	Function
CALL	Calls user-written assembly-language routines.
DIM	Declares an array. (Indexing is from zero).
END	Terminates a program and returns control to the Basic subsystem.
FOR	Causes program to iterate through a loop a designated number of times.
GET expression	Reads input data from a specified port.
GOSUB nn	Transfers control to a subroutine beginning at line nn.
GOTO nn	Transfers control to line nn.
IF expression THEN nn	Transfers to line nn if the condition of the expression is met.
INPUT list	Allows the user to supply numeric data to a program directly from the terminal.
LET identifier=expression	Assigns the value of an expression to the identifier on the left side of the equal sign.
NEXT	Signals the end of a loop.
PRINT	Allows numeric data and character strings to be printed on the terminal.
PUT expression	Writes output data to a specified port.
REM	Allows comments to be inserted in the program listing.
RETURN	Returns control to the line after the last GOSUB.
STOP	Suspends program execution and returns.

Command	Function
CONTROL/H (backspace)	Deletes the previous character typed during input.
CONTROL/S	Interrupts program during execution and returns to immediate mode.
DEBUG	Transfers control to the hexadecimal debugger program (HDT).
LIST	Prints out all or part of a program at the terminal.
PACK	Frees memory locations in RAM to allow the user more working space.
PLIST	Punches paper-tape copy of a program.
PTAPE	Reads in paper-tape copy of program using high-speed reader.
RUN	Begins execution of the program currently in memory.
SCR	Erases the program in memory.

impact will be in video games, since the bit patterns for the most part are not programs but actually represent patterns on the screen. Thus they require less development time than computer software. The availability of 1-, 2-, and 4-kilobyte ROMs is largely responsible for the variety of video games, and the development now under way of games using 8-kilobyte memories promises even greater sophistication.

Accordingly, consumer product design is a prime target for silicon software. Advanced general-purpose calculators with basic computation keys and programming capability now require the user to understand both the language of the machine and the detailed mathematical concepts of a particular application. They could be supplanted by special-purpose machines tailored to specific applications by a change of ROMs.

For example, the groundspeed of an airplane may be calculated from windspeed, airspeed, and direction of flight, if one knows the fundamentals of trigonometry and vector arithmetic. Most pilots do not and would not have the time to do it anyway. But anyone could solve the problem using a calculator with appropriately designated input keys and a groundspeed answer key. Such a dedicated machine would be feasible only if the same basic hardware were used for, say, a realtor's, photographer's, or carpenter's calculator, with the personality formed simply by the insertion of a programmed ROM.

A future in computers

Soon ROMs will begin to affect the ways in which computer software is implemented, stored, and distributed. In fact, system software that is exclusively ROM-resident will be the norm in systems of the future.

The benefits of such software are many. First, programs need not be loaded from cassettes, disks, or paper tape. ROM chips will be the cheapest storage medium in the long run, as well as being the smallest. Moreover, they are as indestructible as the machine that uses them, in terms of the nonvolatility of the information they contain.

The advantages a high-level language brings to a microcomputer system using silicon software are many:

- Ease of operation. High-level languages are easy to learn because of their English-like statements and their conversational nature. Compared with assembly language, it takes a relatively short training time to become

```
10   REM "THIS IS A SIMPLE BENCHMARK PROGRAM. IT"
15   REM "MULTIPLIES, DIVIDES, ADDS AND SUBTRACTS."
20   REM
30   INPUT A
40   INPUT B
50   LET C = A + B
60   LET A = A + 1
70   LET E = B/C
80   LET F = A * E
90   LET C = C - F
100  IF A = 1001, THEN 200
110  GO TO 50
200  PRINT "THE LOOP IS DONE AT"
210  END
```

2. Benchmark program. A simple program written in LLL Basic compares run times in compilers and interpreters. The loop in the program carries out addition, subtraction, multiplication, and division, all of which execute 1,000 times. The compiled code runs about 3½ times faster than interpreted code.

proficient in Fortran, and even less time for Basic. Of course, proficiency in the language of a system will simplify the job of operating and maintaining that system.

- Reduced programming time. One high-level statement does the work of about 10 assembly-language statements. Yet, writing a statement in Fortran, for example, takes the same amount of time as writing one in assembly language. High-level languages are also easier to debug, so programs are completed faster.
- Reduced development time. Because the user does not have to convert a high-level development program written for the prototype system into the machine- or assembly-level program for the production unit, development time from concept to market is much reduced.
- Reduced documentation costs. It is easier to write out explanations of high-level programs because they are more natural in their syntax and hence more straightforward in their expression of what is being done.
- Program-language commonality. Assembly language statements vary from computer to computer, but a high-level language can provide a common way of encoding programs for use with different types of computers.
- Elimination of the specialist. Programming in a high-level language lessens the need for a highly trained programming specialist. This brings the system's operation closer to the people who understand the application, not necessarily the computer. With assembly language, the opposite is often true: programs end up adjusting the application to the computer's convenience.

To use high-level languages on a microcomputer system requires either interpreters, which translate and execute each source (high-level) statement into machine language, or compilers, which translate entire high-level programs into machine language before execution. Compilers are much larger programs than interpreters, but generate native machine code that executes significantly faster, having substantially less lines.

TABLE 2: MEMORY MAP FOR BASIC INTERPRETER

ROM Address (hexadecimal)	Function
1000 – 1047	Basic entry points for initialization
1048 – 1291	Basic I/O (standard for INS8251 at ports EC and ED)
1292 – 12CC	PACK routine
12CD – 27FF	Basic interpreter
2800 – 2EFF	Hexadecimal debugging tool and loaders
2F00 – 2FFF	I/O jump routines
RAM Address (hexadecimal)	**Function**
3D00 – 3DFF	Basic RAM scratch area (printers, stack, etc.)
3E00 upward	Basic user program space

Since an interpreter translates and executes individual statements essentially in their source form, the programmer can make immediate alterations to the source programs during checkout. Many interpreters also can detect programming syntax errors as statements are being typed in. With assembly-level programs, errors often go undetected as far as the prototype system.

High level for microcomputers

With lots of program space in the new large ROMs, extremely space-efficient code need no longer be written for every microprocessor application. Although high-level languages may produce four or more times as much assembly code when compiled, they can now filter down to production-level microcomputer systems—unless the execution-speed requirement demands a tightly written assembly program.

With a high-level language running directly in a final production system, the designer may pay penalties in execution time of as much as 10 times over that obtained by using optimized machine languages. But of the range of microprocessor applications, the vast majority are not very time-critical. Most instrumentation, data-acquisition, and process-control jobs can be done by a microprocessor configuration that operate at just a tenth the speed of an 8080A.

Already, several versions of Basic interpreters are available that take up less than 8 kilobytes of memory and could fit in a single integrated circuit. One version, for example, is LLL Basic, developed at the Lawrence Livermore Laboratory in Livermore, Calif., and tailored for data-acquisition and process-control applications. The LLL Basic interpreter requires 6 kilobytes of memory, and therefore fits comfortably in an 8-kilobyte ROM.

Nearly all interpreters, and even some compilers, will be accommodated by the 16-kilobyte ROMs under development, and forthcoming ROMs as large as 64 kilobytes will be large enough for a whole family of compilers and compiled programs that are already in the public domain. Thus the era of silicon software is well on the way to being launched.

Software packaged in ROMs has additional benefits of its own. Immediately apparent is the impetus it adds to

ASSEMBLY-LANGUAGE PROGRAM

```
ORG 37400Q
   SCR E QU 30Q
   PAG EQU 4400Q
   PRESS EQU 4Q
   TEMP EQU PRES +4
   VOL EQU 0Q

                    ; READ VOLUME
LXI H, PAG          ; PAGE 11 LOC 0
MVI C, SCR          ; SCRATCH AREA
CALL INPUT          ; READ VOLUME FROM TTY TO
                    ; MEMORY BUFFER
MVI L, PRESS        ; READ PRESSURE
MVI C, SCR          ; SCRATCH
CALL INPUT          ; READ AND STORE IT
MVI L, TEMP         ; READ TEMP
MVI C, SCR          ; SCRATCH
CALL INPUT          ; READ AND STORE IT
MVI L, TEMP+4       ; CALCULATE STD PRESSURE
MOV B, L            ; SAVE IN B
MVI M, 276Q         ; LOAD 760 INTO MEMORY
INR L
MVI M, 000Q
INR L
MVI M, 110Q
INR L
MVI M, 012Q
MVI I, PRES         ; DIVIDED
MVI C, TEMP+8       ; RESULT
CALL LDIV
MVI L, TEMP+4       ; STORE 273.15
MOV B, L            ; SAVE IN B
MVI M, 210Q
INR L
MVI M, 223Q
INR L
MVI M, 063Q
INR L
MVI M, 0111Q
MVI L, TEMP
MVI C, SCR          ; SCRATCH
CALL LADD           ; ADD TO GET DEGREES KELVIN
MOV C, L            ; STORE RESULT PTR IN C
MOV L, B            ; 273.15 IN B
MOV B, C            ; TEMP IN DEGREES K
MVI C, TEMP+12      ; RESULT
CALL LDIV           ; DIVIDE THEM
MOV B, C
MOV L, TEMP+8       ; PRESSURE
MVI C, PRES         ; TEMPORARY RESULT
CALL LMUL
MOV L, C            ; RESULT PTR TO L
MOV B, VOL
MUI C, TEMP+12      ; FINAL VOL AT STD PARD GING
CALL LMUL
MVI L, C            ; FINAL RESULT
MVI C, SCR
CALL CVRT           ; WRITE ANSWER TO TTY
END
```

(a)

LLL BASIC PROGRAM

```
10REM "THIS IS A TEST TO COMPARE PLM
      ASSEMBLY AND"
20REM "BASIC LANGUAGES FOR WRITING FAST AND
      EASY"
30REM "TO DEBUG PROGRAMS FOR MICROPROCESSORS."
35REM
40REM "CALCULATE VOLUME USING THE IDEAL GAS
      LAW"
45REM "VOL2=VOL1*(P1/P2)*(T2/T1)"
50REM
60PRINT "ORIGINAL VOLUME"
65INPUT V1
75PRINT "ORIGINAL PRESSURE"
80INPUT P1
85PRINT "ORIGINAL TEMPERATURE"
90INPUT T1
100REM "NOW THAT THE VALUES ARE INPUTED LET'S
      DO THE CALCULATION."
105LET A=T1+273.15
115REM "T1 IS IN DEGREES C"
116REM "A IS IN DEGREES KELVIN."
120LET B=P1/760.0
125REM "P1 IS IN MM OF HG."
127REM "P2=760.0 WHICH IS 1 ATM."
130LET C=273.15/A
135REM "C IS T2/T1"
136LET E=C*B
137REM "E=(T2/T1)*(P1/P2)"
140LET V2=E*V1
150PRINT "THE VOLUME AT STD PRESS AND TEMP IS";V2
200END
READY
```

(b)

3. Assembly vs Basic. A program that performs the ideal-gas-law calculation is written in assembly language (a) and in LLL Basic (b). While the Basic-generated code occupies 2½ times as much memory, the program took only an hour to write and debug; the assembly language program took more than four days.

program modularity. A concept widely used in computing circles, application-program modularity is just coming into vogue with microcomputers. It allows the design of software packages or modules that can eliminate redundant programming efforts.

Such modules are at present sold, rented, and swapped in paper-tape, magnetic-tape, and disk form and are ready-to-go application packages designed so that the user merely specifies which options or special requirements are needed and what particular values must be used. If designed and inserted into ROMs, these packages become truly modular, since small plug-in units incorporate the program function.

Interchangeable languages

Another ROM software advantage is in language interchangeability. Using silicon software, a microcomputer-system designer can change the language of his system by simply swapping chips. A single-board computer could be turned into a Basic machine by dropping a ROM-resident interpreter into the proper socket. The board could subsequently be changed to an APL, Fortran, Pascal, or Cobol machine merely by substituting the

proper plug-compatible programmed device.

An example of silicon software is the INS8298 Basic interpreter for the 8080A microprocessor. Few additional components are needed with the microprocessor and the 8-kilobyte ROM interpreter to build the complete Basic microcomputer system shown in Fig. 1.

The LLL Basic interpreter in the 8298 can translate, debug, and execute ASCII-coded programs written into random-access memory by the user. Each statement is interpreted from its basic ASCII format and then executed line by line. Since the interpreter works directly from user-written source statements in memory, the user can easily manipulate source code and instantly revise the program when errors are detected. If the application needs more efficient assembly code than can be generated by an interpreter, a Fortran program that compiles LLL Basic programs is available in the public domain.

Basic interpreter in action

The 8298 accepts both the program statements and control commands listed in Table 1. Program statements describe operations to be performed on program data, while control commands specify actions that alter the status of the user's program by directing the execution, saving, and retrieval of programs.

All program statements, except those preceded by a line number, are executed immediately and then discarded. Called the immediate or direct mode, this is especially valuable for program checkout. Those statements preceded by a line number are inserted into the program for later execution at a spot determined by the line number.

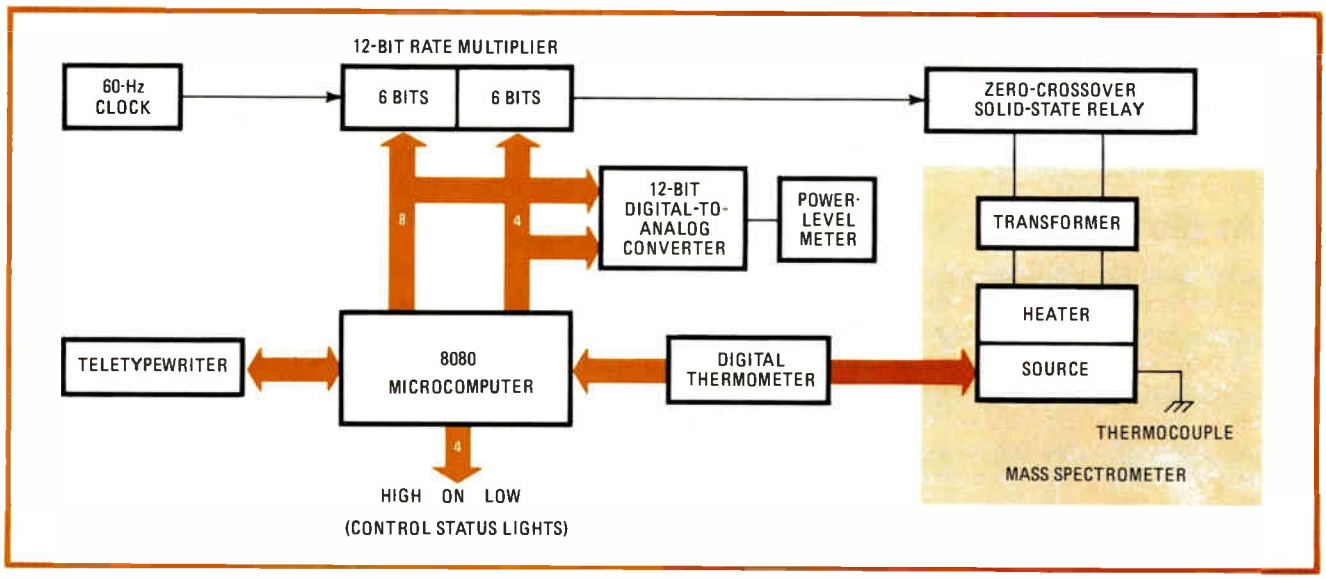
The memory map for the Basic interpreter is shown in Table 2. Hexadecimal ROM addresses cover from 1000_{16} to $2FFF_{16}$, and the interpreter assumes its working RAM starts at $3DOO_{16}$. All input/output routines used by the 8298 are in the upper 256 bytes of address space so that a simple address-decoding circuit can allow the substitution of special user-supplied input/output packages if necessary. As an alternative scheme allowing the user to tailor I/O to his own needs, entry points to the interpreter are provided that allow the page-0 initialization program to route all Basic input/output through its own routines by preinitializing the RAM I/O jump table used in all 8298 programs.

A hexadecimal debugging and utility tool (HDT) is also included in the 8298. The HDT allows the user to examine internal registers and memory locations and to modify their contents. It is called from the Basic interpreter to help debug user-developed software. Input and output data representation is in hexadecimal format. In addition, HDT also has commands that test a specified range of memory locations, load programs in hexadecimal, NSC, and LLL binary formats, and save the contents of a specified range of memory locations.

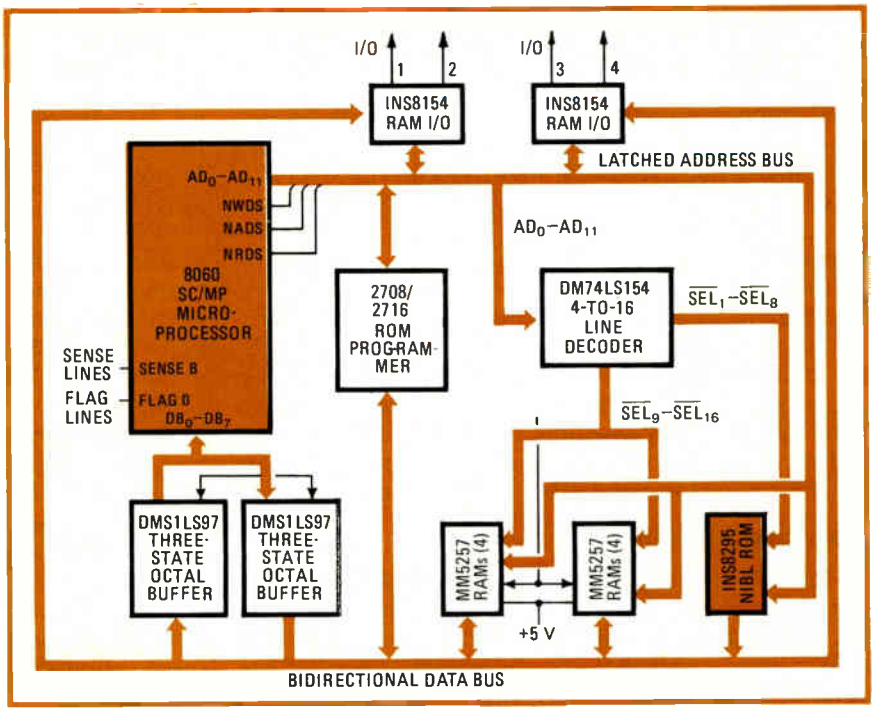
The benchmark program shown in Fig. 2 was used to compare the Basic interpreter with a compiler. Running the program took 75 seconds with the interpreter. When it was compiled into 8080 machine code, it ran in 22 seconds. Thus, an application that calls for stringent speed requirements may warrant the extra effort required to program in assembly code rather than in a high-level language.

Gas-law program

For comparative purposes, a program that performs simple mathematical routines—the ideal gas-law calculation—has been written in both LLL Basic and assembly language (Fig. 3). The assembly language routine is 100 bytes long and took four to five days to program and debug on an 8080-based system. The LLL Basic version occupies an estimated 250 bytes, exclusive of comments. But it took only one hour to program and debug into a state suitable for input into a compiler. Of course, an 8298-based system, using the capabilities of its HDT package, could immediately punch the program



4. Temperature controller. A microcomputer-based temperature controller for the inlet probe of a high-resolution mass spectrometer is programmed in LLL Basic. The system hardware took 1½ months to complete, while the Basic programming required just 1½ weeks. If the program were implemented in assembly language, a period of at least three months would be needed for to carry out the tasks of writing and debugging. In operation, the Basic program calls a small assembly-language routine that performs calculations quickly.



5. Nibl Board. The 9295 32-K read-only memory contains an intepreter for the National Industrial Basic Language (Nibl), which is evaluated in this SC/MP-based microcomputer system. Hooking a teletypewriter to the input/output line, the user can develop his application program in Nibl in on-board random-access memory and then burn it into the PROM once it is debugged.

out in a format suitable for a programmable ROM.

A typical application using LLL Basic is for temperature control of the inlet probe of a high-resolution mass spectrometer (Fig. 4). A digital temperature is obtained from a thermocouple, which is connected to a digital panel meter with a binary-coded-decimal output.

In operation, the LLL Basic program calls a small assembly-language routine to read the temperature. The program then operates on the reading, calculating the deviation of the actual temperature from the desired temperature variation curve, and applies an appropriate amount of heat to keep the inlet temperature tracking correctly.

The hardware for the system took about six weeks to design and debug, and the software effort took about half as long. If assembly language had been used, the software would have taken about twice as long as the hardware. This example shows how high-level languages can greatly reduce the time required for overall system development.

Nibl on a chip

Another example of silicon software is an 8060 SC/MP-oriented interpreter for Nibl—National Industrial Basic Language—which is implemented in a single 32,768-bit ROM called the INS8295. Nibl, aimed at industrial control applications, is a relative of Tiny Basic, a limited version of the standard Basic developed by Robert Albrecht and James Warren as a general-purpose game and educational language for microprocessors.

Since Tiny Basic was intended for adaptation with many different types of microprocessors, it was written in a highly interpretive language designed expressly for the construction of translators. It requires, therefore, only a simple interpreter for the 8060 microprocessor. Since Nibl is intended for industrial applications, significant improvements have been made over Tiny Basic in the areas of I/O, program control, and device control.

The interpreter is broken into two blocks: a program written in the intermediate language that does the actual interpretation, and a collection of 8060 machine-language subroutines invoked by the intermediate language.

The organization of a prototype Nibl-evaluation board is shown in Fig. 5. Its purpose is to aid users of the 8060 in assessing the usefulness of Nibl in their particular applications. The board contains the 8295 Nibl ROM, two random-access memory I/O chips, eight 4-K static RAMs, an 8060, and two PROM sockets, one of which may be used as a 2708 ROM programmer and the other as a 2716 programmer during program development. Once the user programs are developed, both sockets can be used to run them.

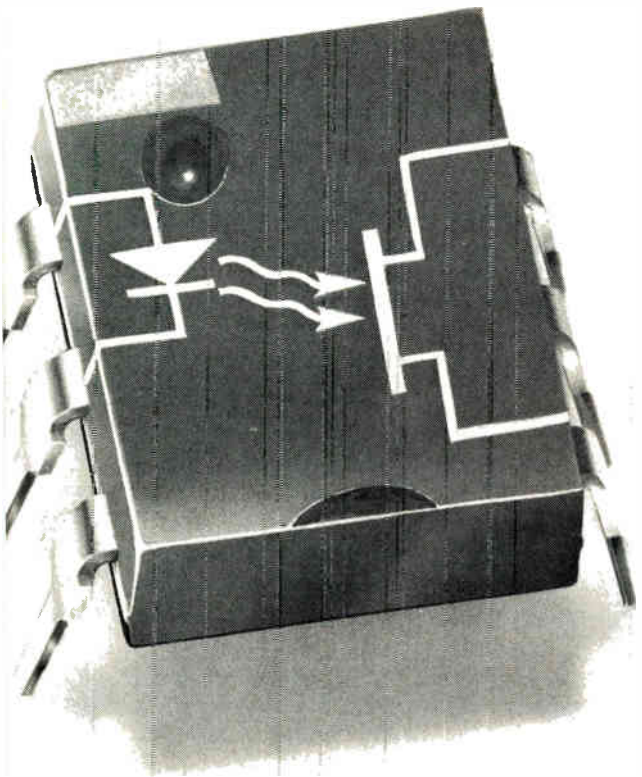
A roughly equivalent system—the 8060 low-cost development system—typically requires at least four boards: a central-processing-unit board, a 4-kilobyte ROM/PROM programming board, a 2-kilobyte RAM board, and a special Nibl board containing eight 4-K programmed ROMs.

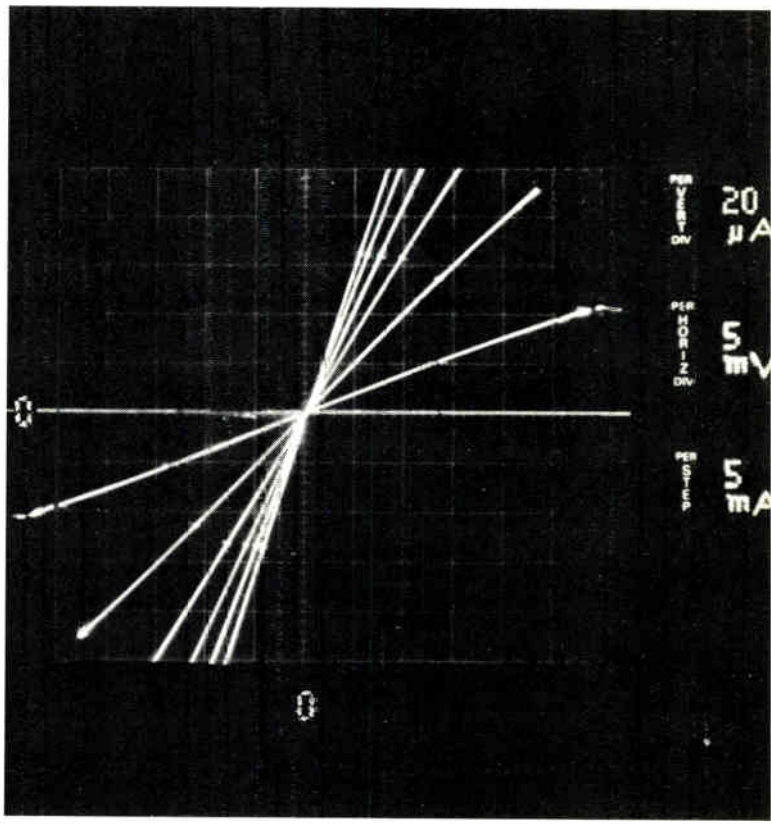
With the board, users can enter Nibl programs with a teletypewriter or some other RS-232-C link into the on-board ROM. Once developed and debugged, the programs may be loaded into the ROM programmer for burn-in. When the same board is plugged into a user system, the Nibl-based program stored in ROM or PROM is executed directly through the 8295.

The 4 kilobytes of RAM user space allow a minimum of about 120 average Nibl statements, more than adequate for most operator interfacing and for a variety of industrial-control applications. And although Nibl does not have the speed to handle video interfacing or direct control of fast peripherals, the algorithms can easily be proved out in Nibl and translated into 8060 machine code for installation in the final system. □

What's new about GE's Optically Isolated Bilateral FET?

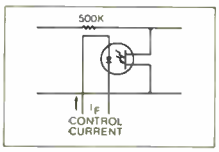
Linear low level output.



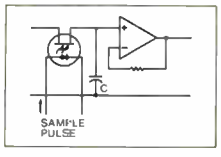


General Electric continues to innovate in Optoelectronics with the new H11F, that optically combines the dependable, efficient GaAs IRED with a Silicon Bilateral Analog FET. The H11F can be used either as a linear variable resistor output with <200Ω "on" resistance, >300 MΩ "off" resistance—or as a fast (<15µ sec) bilateral analog switch featuring 60-volt peak-to-peak output and extremely low offset voltage.

A typical application of the H11F as a variable resistor yields distortion free attenuation of low level 10KHz signals over a 70 db range.



Another unique application of the H11F is in an isolated sample and hold circuit where signal polarity is undefined and cost is critical. H11F series coupler prices start at 98¢ in 1,000 lot quantities.



Other applications include automatic gain control, active filter fine tuning, multiplex A/D conversion.

The H11F series, like other General Electric opto couplers, features patented glass dielectric isolation for uniformity, performance and reliability.

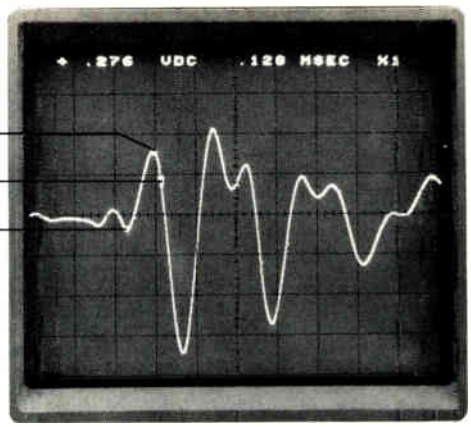
The H11F is another example of GE innovative leadership in Optoelectronics. For a design specification sheet and free sample, write to General Electric, Electronics Park 7-42, Syracuse, N.Y. 13221, (315) 456-2715 or contact your authorized distributor.

In Europe, contact Electronics Trading Company, Dundalk, Ireland. (042) 32371, TELEX: 6500. 222-09

There's more to any GE semiconductor than meets the eye

GENERAL ELECTRIC

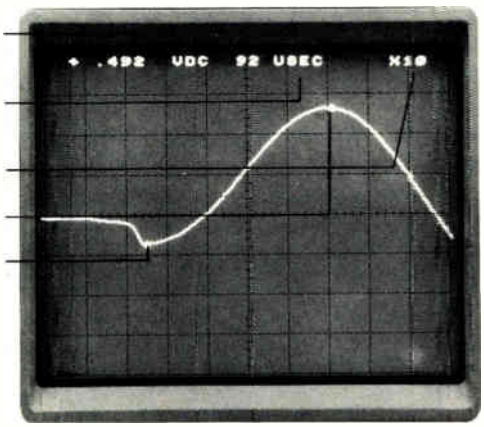
Three ways digital storage makes our 820 a super scope.



1 Capture one-time analog events.

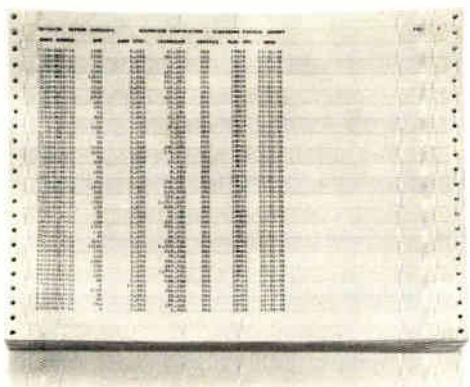
There's no better way to record one-time events than our 820 Digital Storage Oscilloscope. It captures analog signals, converts them to digital data, then stores that data in semiconductor memory.

Digital storage techniques enable us to give you "pre-trigger" recording, a Biomation exclusive. You can actually begin recording a random signal before you know it's going to occur, and apportion the 820's memory to record data both before and after the trigger. And set the trigger level to prevent false triggers.



2 Expand the display for detail analysis.

When you need to analyze the event in detail, you can expand the display 2, 5, 10, 20 or 50x. Movable cursors let you pinpoint the portion of the waveform you want to study. And on-screen digital readout of time and voltage is automatic.



3 Perform computer data analysis.

Digital storage gives you maximum analysis flexibility. You can transfer the data, already digitized, to mag tape, disc or other permanent storage. Or you can read the data out directly to a programmable calculator or computer system.

The 820 is the latest product in our six-year history of using digital storage techniques to help you capture and analyze analog signals. Other Biomation products enable you to convert your scope to a "super scope" by adding digital storage. For more information, or to arrange a demonstration in your lab, call Don Dedinas, (408) 988-9600. Or write us: 4600 Old Ironsides Drive, Santa Clara, CA 95050.

GOULD biomation

Components meeting reflects growing IC compatibility

On the bill at the 28th ECC are new optical devices, improved fiber-optic connectors, superdense LSI packages, screenable capacitors

by Lucinda Mattera, *Components Editor*

☐ Components are tracking integrated circuits more closely than ever before. In size, shape, packages, and even processing, the two areas are becoming increasingly compatible. This trend will be readily apparent at the 28th Electronic Components Conference, which will begin on April 24 in Anaheim, Calif. In particular, the program will reflect advances in optical components, packaging techniques, and both capacitor and resistor technologies.

Among the highlights in optical and packaging developments are: an optical potentiometer for high-speed servo systems, a transformerless double-balanced ring modulator for telecommunications equipment, connectors for terminating single-fiber optical cables, and a new hybrid packaging technique for squeezing close to a quarter of a million logic gates into a single module.

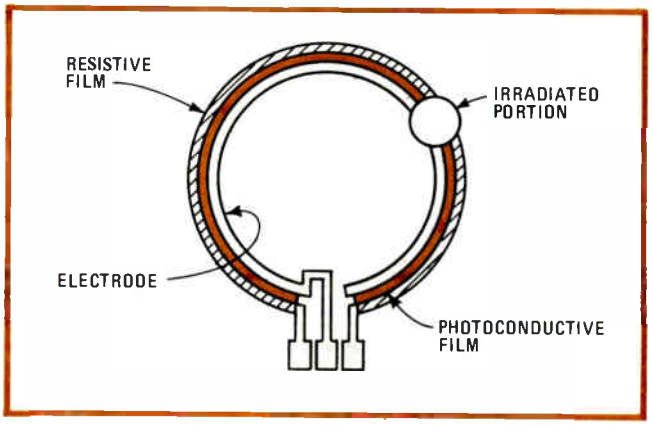
Among passive components, some of the more notable advances include: a high-stability aluminum electrolytic capacitor for long-delay timing circuits, a leadless construction for tantalum chip capacitors, a thick-film materials system for printing hermetic high-value capacitors, and another base-metal thick-film resistor system. Finally, there is a new technique for putting thermistors with a negative temperature coefficient on thin plastic backings so as to permit their use at frequencies up in the audio range.

Lighting the way with optics

Without a doubt, optical techniques are playing an increasingly important role in components technology. Optical methods are resulting in both discrete and integrated components that are faster, smaller, and simpler than their earlier counterparts. And the transmission of data over optical fibers is leading to a new generation of special connectors.

Take the optical potentiometer designed by Japan's Fujitsu Laboratories Ltd. The new device, say its developers, eliminates such shortcomings as chatter and wear common to conventional mechanical-contact units. It holds nonlinearity to less than 1% and provides an output smoothness of within 0.3% at an operating speed of 2,000 revolutions per minute. Such a contactless design will most likely find use as a feedback sensor in high-speed servo systems.

At the heart of the optical potentiometer is its element (Fig. 1), which consists of a photoconductive film sandwiched between a resistive film and an electrode. Made from tellurium-doped cadmium-selenium, this photoconductive film makes continuous contact with the resistive film and the electrode, and when illuminated at a specific point, electrically connects the resistive film and the electrode at that point.

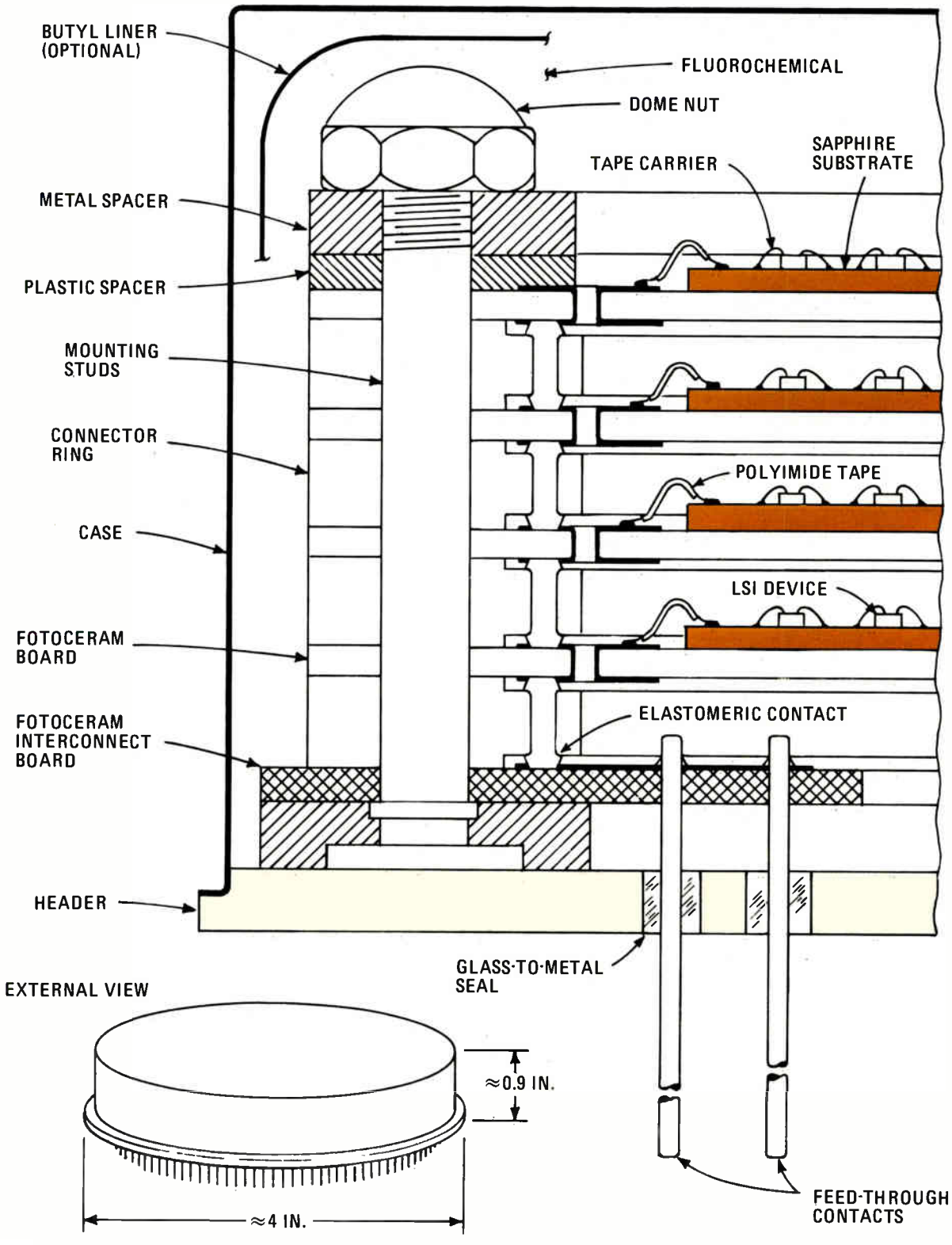


1. Photopot. Utilizing tellurium-doped cadmium-selenium photoconductive film, Fujitsu Laboratories is building an optical potentiometer that can operate at 2,000 revolutions per minute. The device will likely find use as a feedback sensor in high-speed servo systems.

A slit rotary disk, a shaft, and a light source make up the rest of the potentiometer. The disk, which has a hole with a diameter of 2 millimeters, mounts on the shaft, resulting in a space between the disk and the element of 0.3 mm. The lamp housing contains a spherical mirror in order to irradiate the photoconductive film uniformly.

Optical techniques are also behind the new transformerless ring modulator for telecommunications being proposed by Japan's Tottori University and the University of Osaka Prefecture. The researchers are using optical couplers to build a double-balanced ring modulator that should help to miniaturize telecommunications equipment. Such smaller equipment would replace comparatively bulky conventional modulators, which contain at least two transformers. Also, because it is transformerless, the optical modulator may be integrated easily.

Essentially, the modulator consists of two symmetrical phototransistors, an amplifier for the carrier signal, and phase-shifting circuits for the input signal. Each symmetrical phototransistor is made up of two photo-



3. Superdensity. Hybrid packaging technology developed by Raytheon's Missile Systems division allows up to 200,000 logic gates or 4 million memory bits to be packed into a single module measuring only about 30 in.^{3} Utilizing large-scale integrated devices mounted on tape carriers, the company puts the latest packaging innovations to work. Sapphire substrates carry the LSI devices, while polyimide tape makes the interconnections between these substrates and the boards to which they are attached. A fluorochemical fill provides adequate cooling.

Despite these advantages, the use of screen-printed capacitors has been limited. Existing thick-film compositions have relatively low dielectric constants, and they are inherently porous, even when fired at high temperatures of 950°C to 1,000°C. The absence of a reliable method for encapsulating these porous structures and their high processing temperatures have hindered their widespread use.

But the new Du Pont system provides hermeticity, and it delivers densities of 20 to 30 nF/cm² with standard processing temperatures of 850°C to 950°C. The system (Fig. 4) consists of silver-bearing conductor electrodes, a two-layer inorganic encapsulant, and a barium-titanate–based dielectric that contains crystalline phases to promote sintering and to optimize electrical properties. The first layer of the encapsulant is a crystal-filled glass having a thermal coefficient of expansion suitable for interfacing with the conductor, the dielectric, and an alumina substrate. The second layer is another glass, but it has a thermal coefficient of expansion that is compatible with the first encapsulant layer and the alumina substrate.

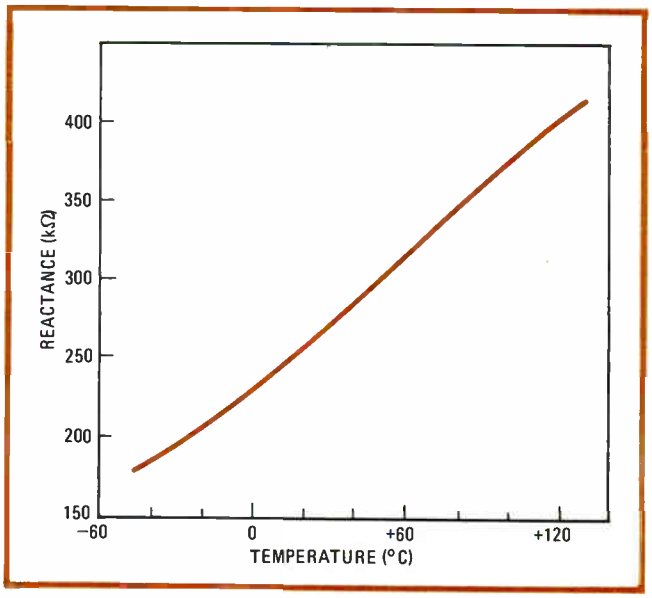
For sensing temperature

Capacitors made with ferroelectric materials exhibit a large temperature dependence—above the Curie temperature of the material, the dielectric constant becomes strongly inversely proportional to temperature. Researchers at Finland's University of Oulu have found a way to put this phenomenon to work, obtaining a capacitive temperature sensor that can be fabricated with standard thick-film processing techniques. The new sensor may be implemented as a discrete or integrated with an oscillator to make a hybrid transducer having an output frequency that is proportional to temperature.

Based on barium-titanate and strontium-titanate powders, the sensor produces a maximum reactance change of 65% over a temperature range of 100°C with a nonlinearity of only 1.5°C (Fig. 5). By varying the ratio of strontium to barium, the Finnish researchers can adjust the minimum temperature of the sensing range between −180°C and +180°C. Such a capacitive sensor offers a number of performance advantages. Its nominal capacitance can be changed by simply altering the device's physical dimensions. Since measurements are made with ac, errors due to contact resistance or potentials are eliminated. Also, self-heating effects are negligible, and no cold junctions or compensating cables are required.

Not to be overshadowed by capacitor developments, resistor technology, both thick- and thin-film, is forging ahead. Another source for a base-metal thick-film resistor system has emerged, as well as ways of fabricating negative- and positive-temperature-coefficient thermistors that promise to open up new applications for these devices.

The base-metal resistor system comes from TRW Inc. in Philadelphia, which has developed thick-film materials that are compatible with both copper and nickel terminations. The system provides a temperature coefficient of resistance of 200 parts per million/°C over a wide range of surface resistivity values—from 1 kilohm per square to 2 megohms per square.



5. For sensing. Fabricated from ferroelectric materials with standard thick-film techniques, capacitive temperature sensor developed by Finland's University of Oulu produces a reactance change of 65% over a 100°C range with only 1.5°C nonlinearity.

Preparation and processing techniques for these base-metal glazes are similar to those for noble-metal glazes. The glaze pastes are printed on ceramic substrates in the desired configuration using conventional thick-film screeners and screens. Optimum performance is achieved when the glazes are fired in standard thick-film furnaces at a peak temperature of 1,000°C on a 30-minute cycle with a nitrogen atmosphere.

Thermistors make gains

As for negative-temperature-coefficient thermistors, applications have been limited to uses involving time constants of just below 1 second because of the heavy substrates these devices usually have. But Sym-Tek Systems Inc. of San Diego, Calif., is putting thermistors on thin plastic backings—like polyimide, Teflon, or Mylar—to obtain time constants as small as 50 microseconds. Thus these devices are now suitable for use in oscillators, modulators, and amplifiers operating at frequencies in the audio range.

The company employs field-emission ion-beam processing to deposit either high-dielectric-constant or high-resistivity materials on various plastics, with little if any heat and at reasonably fast rates. The plastics require no firing after deposition.

Similarly, the future for positive-temperature-coefficient thermistors is also looking brighter. Until now, it has been difficult to establish low-resistance ohmic contacts to these devices, so that at least two processing steps were needed before soldering. However, Du Pont has again come up with a solution, this time from the Photo Products department of its Electronic Materials division in Wilmington, Del. The group has developed a thick-film silver-based conductor that, in a single-step application, provides solderable contacts for positive-temperature-coefficient thermistors on ceramics. □

Two diodes simplify hex-keyboard software

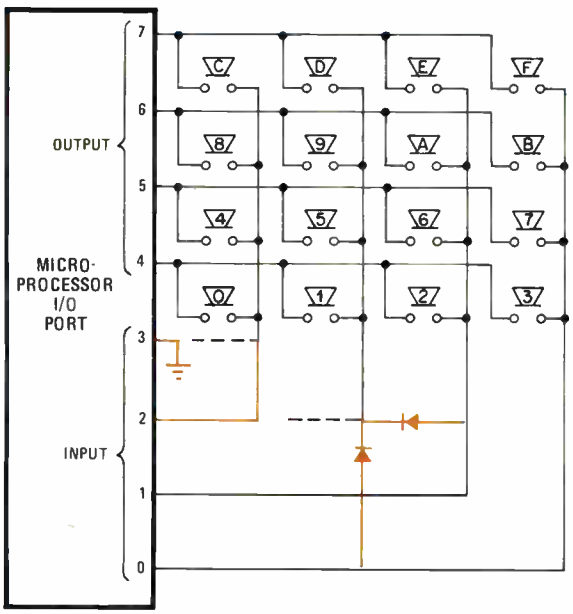
by Neil Heckt
The Boeing Co., Seattle, Wash.

The standard hexadecimal keyboard is a widely used man-to-microprocessor interface even though it has a serious drawback: there is no direct relation between the key number depressed and the binary-coded number read by the microprocessor, and thus complicated and costly software must be written in order to perform this key-to-code transformation. Often, conversion (look-up) tables are used, but if two diodes are connected to the keyboard, as shown in the figure, a few simple instructions can be written to enable the microprocessor itself to easily ascertain the number of the switch depressed.

In this typical switch-port configuration, bits 0–3 of an 8-bit bidirectional input/output port are designated as the input ports, and bits 4–7 as the output ports. Normally, corresponding switch contacts in each row of the 4-by-4-bit array are connected in common, and then in turn to one of the output lines; similarly, the remaining switch contacts are connected in common to one of the input ports. This configuration assumes that each line of the I/O port has active pull-up resistors.

Output lines 4–7 are used to interrogate one or more rows of switches. Normally at logic 1, each line is commanded to a 0 level in sequence; if any switch in the interrogated row is closed, the corresponding input line is pulled low. The data generated is thus sufficient to enable the microprocessor to determine the number of the closed switch, but this keyboard-port configuration yields a poor numerical relation between the data read and the switch number depressed, because the data on bits 0–3 is presented in binary form and the switch array has a decimal base. Moreover, the configuration does not lend itself to an easy base-to-base conversion.

However, by modifying the keyboard-to-I/O-port wiring slightly and adding two diodes to the circuit as shown, the binary data generated by any row, i, will be



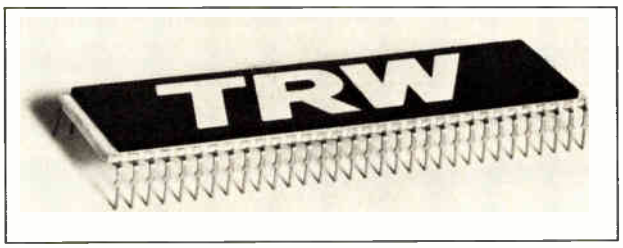
ROW	INTERROGATION OUTPUT	SWITCH NUMBER BIAS
0 – 3	EF (BIT 4 LOW)	1D = –E, 3
4 – 7	DF (BIT 5 LOW)	31 = –D, +1
8 – B	BF (BIT 6 LOW)	55 = –B, +5
C – F	7F (BIT 7 LOW)	99 = –7, +9

Each translation. Modifying keyboard-to-I/O-port connections and adding two diodes (changes shown in color) enable transformation of depressed-switch number to true BCD equivalent for microprocessor without using complex software. Simple software adds a row-dependent bias number to input data during output (interrogation) command for number conversion.

Finally – a cheap

(or rather inexpensive)

Video A/D Converter



Now you can afford to go digital

We've done today what everyone thought was years away. We've developed a Monolithic Video A/D Converter to sell for less than $500—it works just great—and best of all, it's ready for delivery now.

TRW's new 8 bit TDC 1007J costs only $485 (in 100's), features up to a 10 to 1 power reduction over existing converters, is less than ⅓ the size, and converts with unmatched accuracy up to 30MHz (33 ns conversion time).

The TDC 1007J exceeds the standards that networks require for studio equipment, yet is economical enough for field and/or industrial use. If you have a product that is now using one of those expensive Video A/D Converters you can mount the TDC 1007J (and about $30 worth of other components) on a card and start saving a bundle immediately. (Incidentally—we are making available, in small quantities, an evaluation board. It's a fully tested drop-in unit containing everything you need to go digital—just ask for TDC 1007 PCB.)

Let us show you how you can go digital...economically. Available from stock from Hamilton/Avnet or contact your local TRW Electronic Components field sales office or call Willard Bucklen at (213) 535-1831, or send coupon.

TRW LSI Products
An Electronic Components Division of TRW Inc.,
P.O. Box 1125
Redondo Beach, CA 90278

Please send data sheets on the new TDC 1007J Monolithic Video A/D Converter and the TDC 1007 PCB.

Name

Company

Div/Dept Mail Code

Address

City

State Zip

E-4

TRW *LSI PRODUCTS*

...for Digital Signal Processing

Circle 135 on reader service card

made to differ from the next row, i + 1, by only one. The modification allows addition of a software-introduced correction factor—in the form of a bias number to the input bits as a function of the row interrogated—so that the microprocessor may store data numbers equal to the number of the depressed switch.

With the modified circuit, for any row interrogated, switch column 0-4-8-C will generate the binary-coded decimal 3. Similarly, each succeeding column will produce 4, 5, and 6, respectively. A BCD 7 is produced if none of the switches is closed; any other number indicates that more than one switch is closed.

If the software is written so that a bias of −3 is added to the input data when row 0–3 is interrogated, then the microprocessor will translate the data number read (3, 4, 5, or 6) to 0, 1, 2, or 3, which equals the switch number. Similarly, a bias of +1 should be assigned to the data signals emanating from switch row 4–7, +5 for row 8–B, and +9 for row C–F.

Bit position 3 on the I/O port, which is grounded, will always have a data input value of logic 0, of course. However, its corresponding output bit as seen by the microprocessor may have a logic value of 1 because of the carry bit generated by adding the aforementioned bias values to the input data.

Alternatively, the switch number can be ascertained if the interrogation commands emanating from bits 4–7 are read simultaneously when scanning the switch array. The number emanating from these bits may then be subtracted by appending the 2's complement of the interrogation command to the bias value for each row. For example, when interrogating row 4–7, an interrogation byte equal to DF is generated from bits 4–7. This query sets bit 5 low and bits 4, 6, and 7 high. Data read into bits 0–3 will thus be D3, D4, D5, or D6, depending on which switch (0, 1, 2, or 3) is depressed. Assigning a bias of 31 (where D = 3 and 1 = +1) to all lines transforms the input numbers into 04, 05, 06, or 07, respectively. The table gives all the switch-bias codes. □

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.

Subtractor eliminates op-amp offset, common-mode errors

by Akavia Kaniel
Digital Equipment Corp., Marlboro, Mass.

A major problem common to electronic measuring systems employing operational amplifiers—namely, op-amp offset and common-mode and related temperature-dependent voltage errors—will be virtually eliminated if the error components are subtracted from the voltage or current to be measured. The circuits described here will automatically perform the subtraction required.

The op amp's offset voltage will be canceled with a system of the type shown in Fig. 1a. A slight modification to this circuit will enable cancellation of common-mode and temperature-dependent errors as well.

As shown, sensor T_1 converts pressure, temperature, light intensity, and so forth, into a voltage, V_n. When the switches are in position a, the voltage at the output of the op amp is $V_1 = G(V_n + V_{os})$, where G is the gain of the stage, and V_{os} is the offset voltage of the op amp. V_1 is stored in the input memory.

As the switches are moved to position b, the voltage appearing at the output of the op amp will be $V_2 = G(V_{os})$, and this voltage will be stored in the error memory. The subtractor circuit then determines the difference between the contents of the memories, which is $V_o = V_1 - V_2 = GV_n$.

A practical implementation of such an offset-voltage cancellation scheme is shown in Fig. 1b. In this application, the output quantity is a current. When the input voltage is sampled (at a rate determined by particular system requirements), the voltage stored in the sample-and-hold module that serves as the input memory is:

$$V_1 = GR_2(V_n + V_{os1})/R_1 + V_{os2}(1 + R_2/R_1) + I_{da(leak)}R_2$$

Once logic control (dependent on the application) places the circuit into the hold position, the circuit waits for the voltage at V_v to settle to $V_{os\,2}$. At that instant, the input voltage to the operational transconductance amplifier is zero, as is its output voltage, and the logic is instructed to perform an analog-to-digital conversion of the current at V_v, which is:

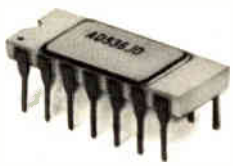
$$I_{da} = V_1/R_2 - V_{os1}G/R_1 - V_{os2}(1/R_1 + 1/R_2) - I_{da(leak)}$$

or:

$$I_{da} = GV_n/R_1$$

There is no error memory as such. The point V_v serves simply as a summing node and subtracts the real-time output of G from the voltage previously stored in the sample-and-hold module. Also, note that the complementary-metal-oxide-semiconductor switches have negligible offset voltage of their own for input frequencies less than 100 kilohertz. Moreover, they have almost zero leakage current and very low source resistance—essentially they add no error to the system.

Fortunately, cancellation of the common-mode voltage error (caused by voltage differences between system ground and transducer ground) and the effect of the transducer-to-measuring system temperature differential may be attained with relatively little modification of the basic offset-voltage circuit, as shown in the block diagram of Fig. 2. The input memory, error memory, and G have the same function as in the circuit first described. The common-mode voltage memory is similar to that of the input memory and is introduced to ensure elimination of all common-mode voltage differentials, including those that are time-dependent. With this configuration, the CMV error will be canceled independently of either the switch-sampling frequency or the elapsed time between the sampling of the input and error



True RMS to DC isn't a big deal anymore.

The AD536 true RMS to DC converter is a monolithic IC in a 14-pin ceramic DIP. Complete and self-contained. Just plug it in and forget about external trims.

The chip is laser wafer trimmed for maximum accuracy and stability. That means an accuracy of ±2mV ±0.2% of reading with high crest factor and excellent bandwidth. And besides the linear DC output, you get a dB output with a 60dB dynamic range for free.

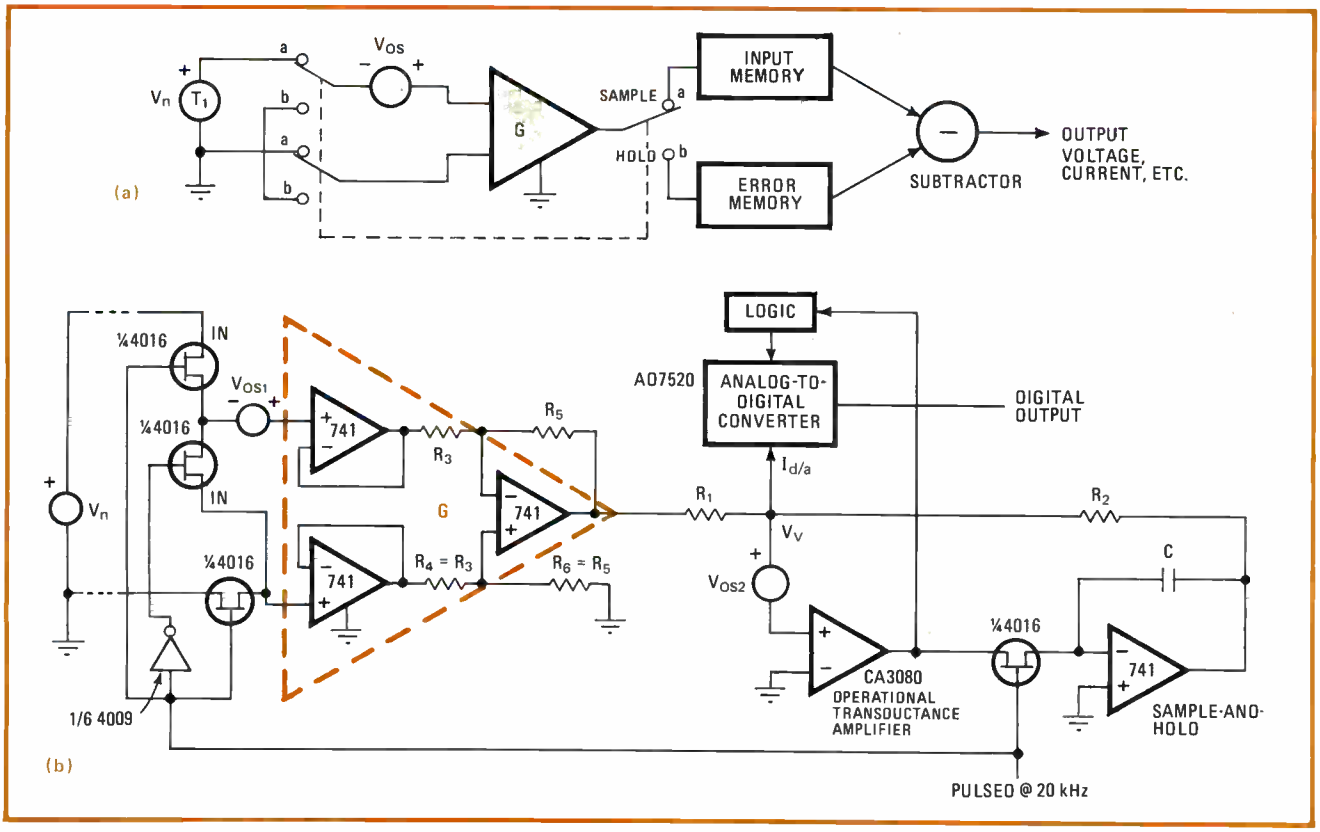
Only $9.95 in 100s. Now that is a big deal.

For specs and samples call Doug Grant at (617) 935-5565. Analog Devices, P.O. Box 280, Norwood, MA 02062.

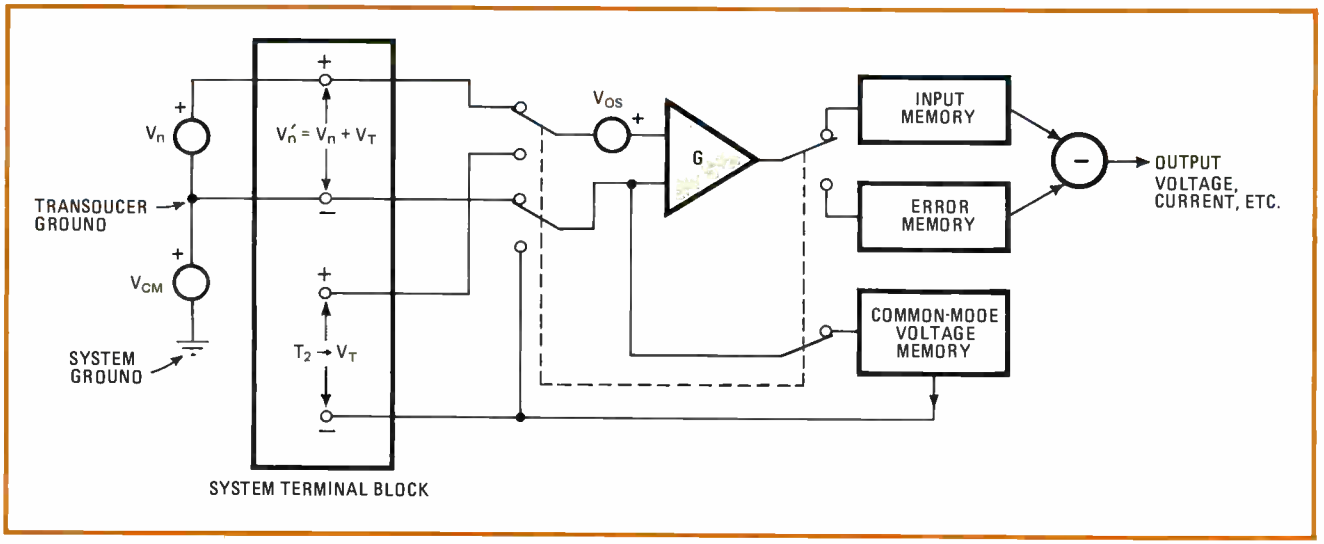
ANALOG DEVICES
The real IC converter company.

Analog Devices, Inc., Box 280, Norwood, MA 02062 East Coast: (617) 329-4700; Midwest: (312) 894-3300; West Coast: (213) 595-1783; Texas: (214) 231-5094; Belgium: 031/37 48 03; Denmark: (02) 845800; England: 01/94 10 46 6; France: 686-7760; Germany: 089/53 03 19; Japan: 03/26 36 82 6; Netherlands: 076/879 251; Switzerland: 022/319704; and representatives around the world.

See us at Electro '78 in Boston, Booths 1235 and 1237.



1. V_{os} cancellation. Circuit eliminates offset voltage of operational amplifier with switches, two memories, and a subtractor (a). Practical implementation of circuit (b) uses C-MOS gates for switches, sample-and-hold module for input memory, summing node V_v for combination error-memory-and-subtractor (b). Sampling rate and logic control constraints are determined by particular system requirements.



2. Total compensation. Common-mode errors and the effect of transducer-to-system temperature differentials are eliminated with small modification of the offset-canceling circuit. Common-mode voltage memory is similar to input memory, eliminates all CMV errors, including those that are temperature-dependent. A second transducer, T_2, is needed to monitor the system temperature (T_s is converted to V_T).

memories when the CMV memory is used.

To cancel the error created by transducer-to-system temperature differences that introduce small voltages to G, a second transducer is used to monitor the temperature at the input port of the system (terminal block) and to convert the system temperature, T_s, to a voltage, V_T. Keeping in mind that V_n also has a temperature-dependent term, the output voltage from the system is:

$$V_o = G[V_{os} + (V_n + V_t) + V_{cm} - V_{os} - V_t - V_{cm}] = GV_n$$

Although logic-control and other timing requirements are not especially critical in this circuit even when the CMV memory is added, the major prerequisite for successful operation is to ensure the input samples are coded at the proper time—that is, when the summing node at which subtraction is performed has settled. □

Engineer's newsletter

What's coming in one-chippers

Designers of microcomputer systems who don't need a lot of processing power should check out the coming crop of one-chip microcomputers. Suppliers of these devices are beginning to trade off processing capacity for such input/output functions as data conversion, manipulation of serial bit streams, increased memory storage, and the like. For example, Mostek's new memory-intensive 3872 one-chipper contains 4 kilobytes of read-only memory for storing large programs, as well as 64 bytes of executable random-access memory for I/O manipulation that doubles the RAM capacity of the firm's popular 3870 machine. Other makers are **close to including analog-to-digital converters in their various one-chip processors.** Also, keep an eye on the new, low-power complementary-MOS versions of popular one-chip microcomputers. Both Texas Instruments and Motorola will be offering C-MOS versions of TI's TMS1000 4-bit unit, and Intersil is designing a C-MOS version of Intel's 8048. Meanwhile, RCA is planning a high-performance, low-power silicon-on-sapphire Cosmac one-chipper.

Read out data from stack registers of TI-58 calculator

Texas Instruments' TI-58 printing calculator has a command series not noted in the owner's manual, points out Wayne K. Spring, who is a major in the United States Air Force. The PC-100A printer decodes 82nn as HIR nn, where nn is an integer between 11 and 19, and HIR apparently refers to hierarchy. **Execution of this code reads out data from the stack registers, which are not normally addressable directly by the user.** This lets you reuse intermediate results from several different labels within the stack without disturbing the stack. Moreover, closing of pending operations with either = or) does not cause loss of the results. Although there does not seem to be a valid key combination for generating this code directly, it may be simulated easily within a program. For example, you can write RCL 82 and then delete the RCL code. The integer codes 11 through 19 are directly available on the A–E and A′–D′ keys.

Careers open up in computer modeling, data communications

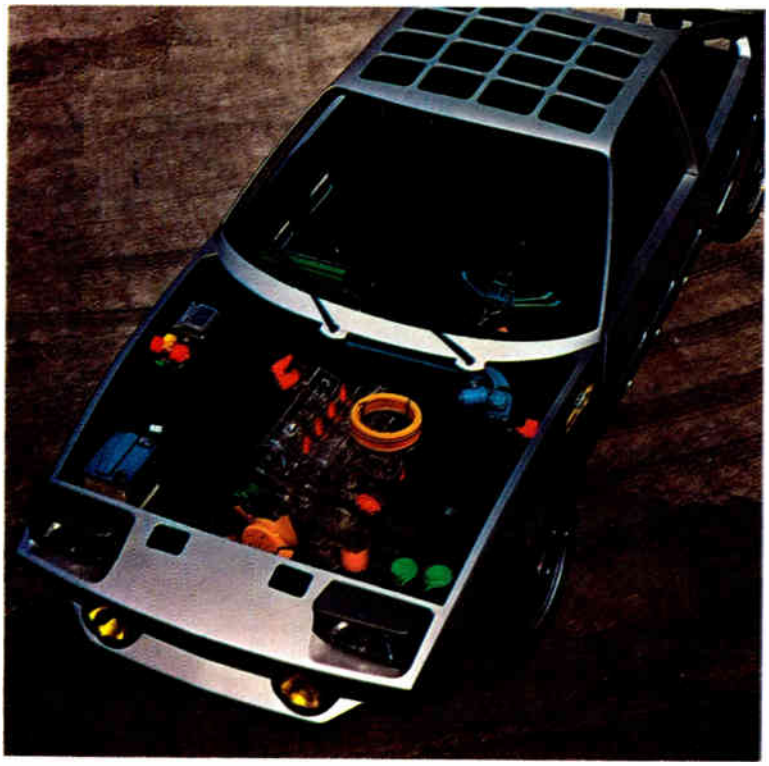
Which electronic engineering disciplines are the hottest? According to several large computer manufacturers, the money is in data communications and computer modeling. Software people are hard enough to find, but data-communications and computer-modeling engineers are a rare breed indeed—there's probably not more than a handful of either in the whole country, says Phil Sakakihara, project manager of networking at Hewlett-Packard. To help meet industry's needs, the University of California in Santa Clara has started **a new masters' degree program in both computer science and data communications.** The program is very applications-oriented, notes Sakakihara, who teaches one of the courses. In fact, he adds, many of the instructors are people right out of industry.

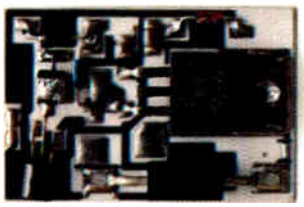
Glossary covers switching supplies

If you're shopping around for a switching power supply or having trouble understanding the data sheet of a unit you've already bought, you'll want to get a copy of Boschert's new glossary of specifications and terms for switchers. In four pages, **the glossary lists over 80 definitions,** among them: common-mode noise, differential-mode noise, centering, soft start, overshoot, peak charging, and transient recovery time. For your copy, write to Boschert Inc., 384 Trinita Ave., Sunnyvale, Calif. 94086, or call (408) 732-2440.

Lucinda Mattera

Instrumenta locomotionis





Hybrid circuits for any automotive electronics application.

Magneti Marelli is one of the largest producers of electric and electronic systems and has been manufacturing standard or custom made thick-film hybrid circuits for over five years.

Magneti Marelli is happy to allow its customers to take advantage of its complete design capabilities and production facilities at competitive prices.

Magneti Marelli can manufacture hybrid circuits for a wide range of applications including:
- data processing systems
- communication equipments
- automotive electronics
- industrial electronics
- medical equipments
- consumer market
- military electronics

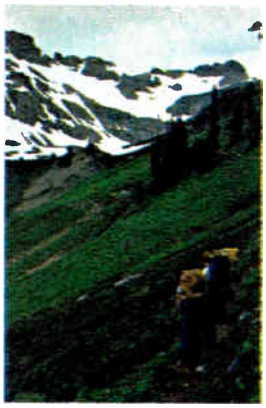
MAGNETI MARELLI
SYSTEM AND ELECTRONICS DIVISION

capability & technology

DNA

MAGNETI MARELLI/DIVISIONE SISTEMI ED ELETTRONICA/SESTO S. GIOVANNI/MILANO/ITALY/V.LE ITALIA 1/TEL. (02) 2490.1/TELEX 31041 MAGNETI










lere's technical achievement for you... etter living for you and your family.

e particularly anxious to meet you if 're a circuit-design, packaging and me- ical, or software engineer—or a spe- it in electron optics, vacuum technol- or materials and processing. But what- your technical strengths, if roll-up-the- es engineering appeals to you, we'd o hear from you.

ktronix you'll find an environment that asizes the individual, and his personal ibution to technical development—by ng on projects, not writing about them. work will benefit advanced engineering ghout the world. Personal professional h comes from working with first-rate people who are experienced in developing state-of-the-art instrumentation, components, and devices.

All Tektronix R & D—financed entirely from our annual sales of approximately $455 million—is directed toward commercial products. Our community is prosperous, with a stability of employment not typical of every industrial center.

Tektronix is located just outside of Portland, one of the nation's most liveable cities. We live in a green land. Mt. Hood and winter sports are a short drive to the east—the Pacific Ocean is just beyond the forested Coast Range to the west.

If you're seeking technical advancement and better living for you and your family, write to us.

An equal opportunity employer.

Tektronix Professional Placement,
Tektronix, Inc.
P.O. Box 500E, Beaverton, Oregon 97077
Please send me an application form.

Name _____

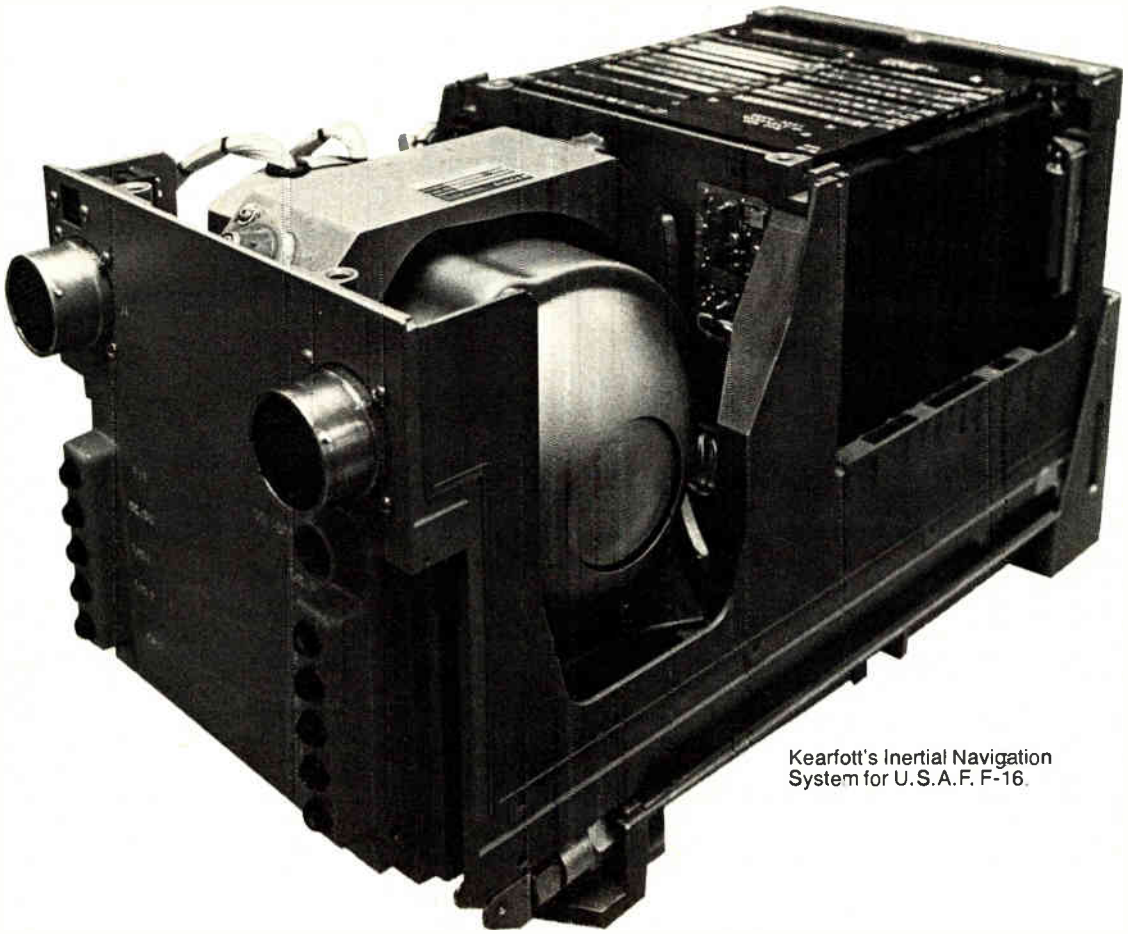
Address _____

City _____

State _____ Zip _____

Tektronix®
COMMITTED TO EXCELLENCE

THE STANDARD FOR INERTIAL NAVIGATION SYSTEMS



Kearfott's Inertial Navigation System for U.S.A.F. F-16.

Kearfott's Inertial Navigation System (INS) for the F-16 consists of two major line replaceable units—Inertial Navigation Unit (INU), and a Fire Control Navigation Panel (FCNP). It is a prime sensor for aircraft velocity, attitude, and heading, and a prime source of navigation information.

Navigational data are developed from self-contained inertial sensors consisting of a vertical accelerometer, two horizontal accelerometers, and two-axis displacement GYROFLEX® gyroscopes. The sensing elements are mounted in a four gimbal, gyro-stabilized inertial platform with the accelerometers, which are maintained in a known reference frame by the gyroscopes, as the primary source of information. Attitude and heading information is obtained from synchro devices mounted between the platform gimbals.

The system provides pitch, roll, and heading in both analog (synchro) and digital form. In addition, the following outputs are provided on a serial MUX channel (MIL-STD-1553):

- Present Position—Latitude, Longitude, Altitude
- Aircraft Attitude—Pitch, roll, Heading (True and Magnetic)
- Aircraft Velocity—Horizontal and Vertical
- Steering Information—Track Angle Error

In order to permit operation in aided-inertial configurations, the INS accepts the following digital inputs in MUX serial format (MIL-STD-1553):

- Position Update—Latitude and Longitude
- Velocity Update—Velocities in INS coordinates
- Angular Update—Angles about INS axes
- Gyro Torquing Update—Torquing rate to INS gyro axes

Significant features:

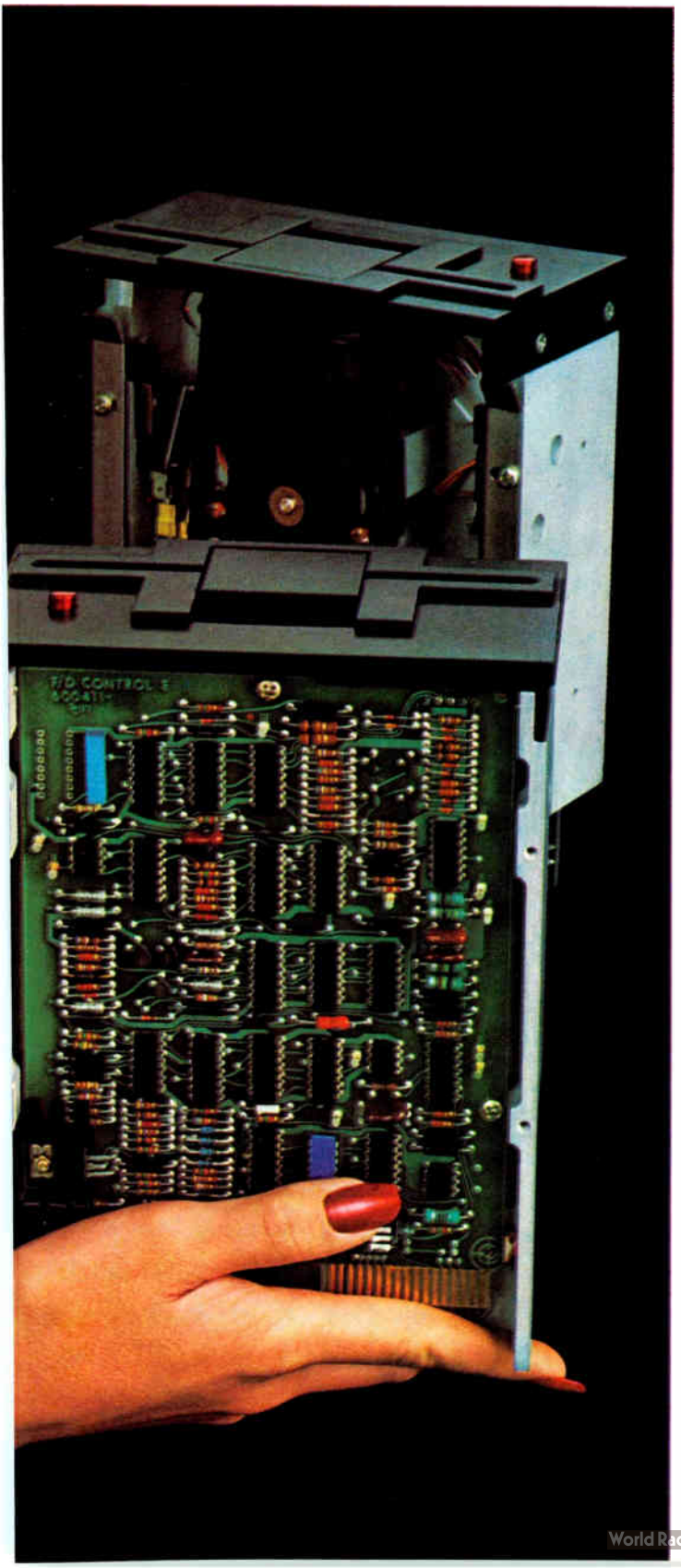
- MUX interface (MIL-STD-1553)
- Lightweight—33 pounds
- Small Size—7.5″h x 15.2″d x 7.5″w
- High Precision—better than 1 nm/h
- Rapid Align—9 minutes at 0° F
- Fast Installation/Removal—rack and panel-type mechanical interface
- Provides Back-up MUX Control in Event of Fire Control Computer Failure

For additional information write to: The Singer Company, Kearfott Division, 1150 McBride Ave., Little Falls, N.J. 07424.

Kearfott

a division of The **SINGER** Company

WORTH FLIPPING OVER:



Pertec's 40-track double density Microfloppy®— compatible with Shugart's 35-track; comparable to no other μC disk drive.

Bottoms up. Here's where a second source leaps to the head of the class. Pertec's FD200 Microfloppy® offers big system performance—with no redesign—to OEMs using 5¼" diskettes. (For 8" applications, our FD514 is interface compatible with Shugart SA800.)

FD200: Fully compatible with Shugart SA400. Same dimensions, same mounting holes, same interface signals, same power connector. But unplug their 35-track drive, plug in FD200...and suddenly you're into the only double density, 40-track recording available to date for μC applications.

Plus flip-side storage. Up to 500,000 bytes per diskette, recording double density both sides. Up to 250 KB on one side—flip it over and store another 250 KB.

Compatible to IBM standard. Through our inventive electronics, it's the same proven read/write head that's built a solid track record for Pertec, in thousands of minicomputer flexible disk drives worldwide.

Easier to use and maintain. Options are switch selectable; power supplies are internationally-standard 5- and 12-volt DC.

And Pertec cuts the number of PCBs in half. Not two, but only one quick-disconnect board—to simplify field maintenance, boost system reliability, reduce spares stocking.

The cost-efficiencies of our FD200 Microfloppy are so indisputable, we expect fast turnovers with microcomputer OEMs. Jump in.

Please send specs for: ☐ FD200 Microfloppy.®
☐ FD514 8" Drive.
Send pricing for: _____(quantities) FD200's.
_____(quantities) FD514's.
☐ Contact us immediately for consultation.
Tel ( )_____ext_____
Name_____
Title_____
Clip coupon to company letterhead and return to Pertec, 9600 Irondale Avenue, Chatsworth, CA 91311.
Or call the Pertec regional sales office nearest you: Los Angeles (213) 996-1333. Ann Arbor, Michigan (313) 668-7980. Hudson, New Hampshire (603) 883-2100. England (Reading) 582115.

PCC PERTEC
a division of Pertec Computer Corporation

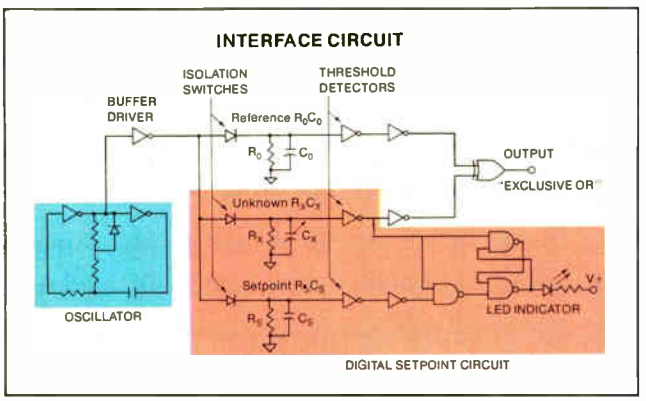
Circle 124 on reader service card

A chip that may someday launch a thousand interfaces.

It started simply enough. Electronics engineers here at the General Motors Research Laboratories set out to devise a highly accurate method of indicating liquid level. And they succeeded.

But then they realized that the heart of their solution, a unique circuit design, had great possibilities for use in all sorts of electrical measuring systems.

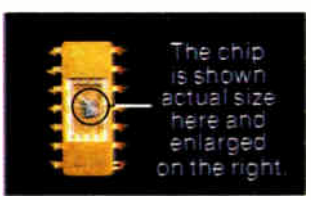
Consider the features. This patented circuit can work in conjunction with any sensor that monitors capacitance, resistance, or inductance



(the three most commonly used measurement parameters). Its outstanding asset, however, is that it converts the analog output of a sensor into a pulse-width modulated, or digital, signal.

As a result, the circuit can serve as the lone interface between a sensor and a microprocessor (minicomputer) in precision control, diagnostic, and other digital systems. Moreover, it is compatible with standard indicator gages.

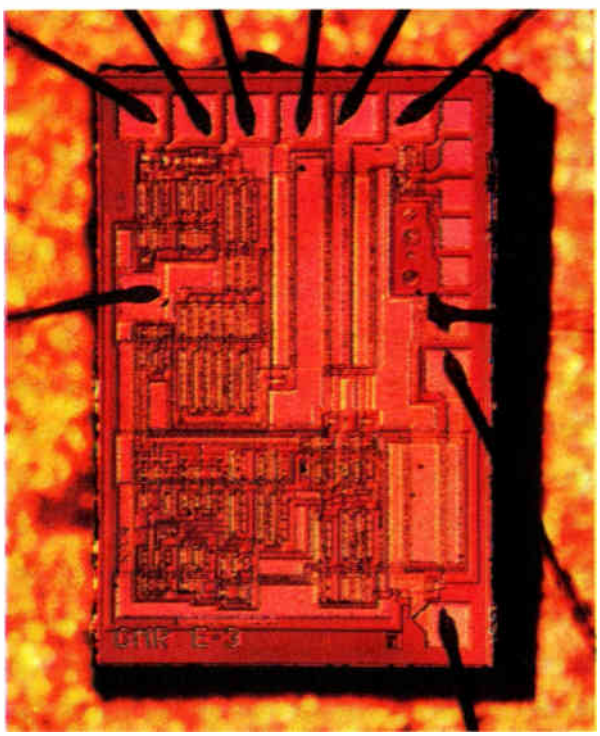
For added ruggedness and versatility, our engineers squeezed the circuit into solid state form. They designed and custom built a prototype complementary metal oxide semiconductor (CMOS) integrated circuit chip.



About a millimeter square, the unit contains 55 transistors and performs seven basic circuit functions — doing a job never before possible with a single IC chip.

Successfully tested in a variety of experimental uses, including a novel alcohol-in-gasoline percentage meter, the chip can be applied in almost any environment to measure position or displacement, liquid level, or pressure.

The universal interface: A promising IC chip off the block of our electronics technology.



GM

General Motors Research Laboratories
Warren, Michigan 48090

Motorola's new direction: subsystems

First product offerings include open-frame linear power supplies, solid-state relays, and input/output interface modules

by Lucinda Mattera, Components Editor

Putting its semiconductor know-how to work in a new direction, Motorola Semiconductor has started up a new product-development and manufacturing unit to produce subsystems with high semiconductor content—specifically those needed by the original-equipment manufacturer serving the industrial control market. Called Subsystem Products, the new unit is a subgroup of the company's Discrete Products division.

According to Bruce McDonald, manager of the group, the OEM subsystem market is big business. "We estimate the market to be $6 billion today and growing to $10 billion by 1982," he says.

Initially, the group is concentrating on supplying subsystems that are peripheral to microcomputer systems. Its first products, now available, are four open-frame linear power supplies. Later this month, a line of solid-state relays will be ready, followed by a series of input/output interface modules. The summer will bring more power supplies, but of the switching-regulated variety, "which will really be our main thrust in supplies," says Nick Freyling, engineering manager.

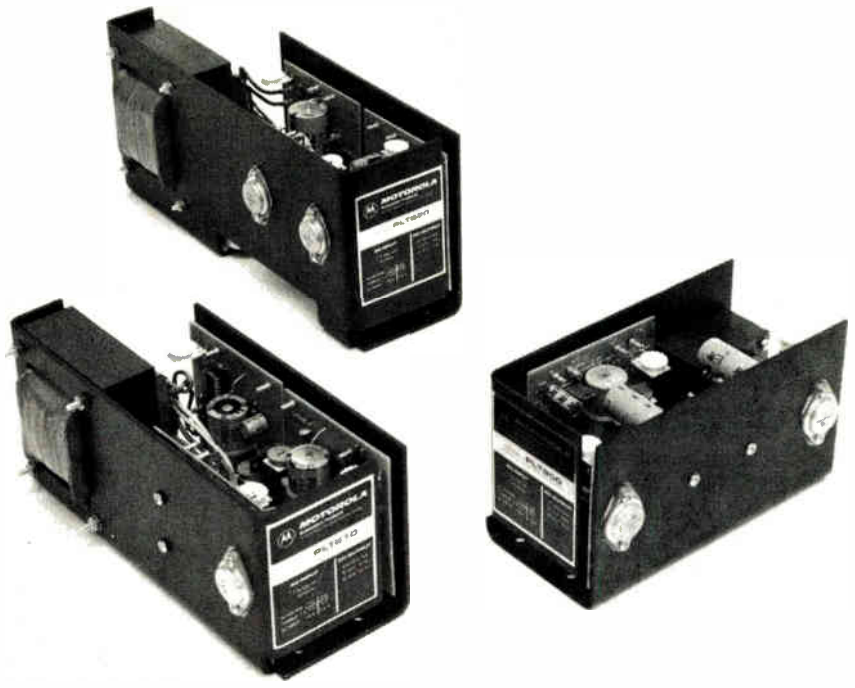
The four linear supplies are all triple-output units intended for low-power microprocessor applications. Three convection-cooled models provide outputs of +5 V at 2, 4, or 6 A and ±12 V at 0.3, 0.7, or 1 A. An air-cooled model offers outputs of 5 V at 15 A, +12 V at 2.5 A, and −12 V at 1.5 A.

Since they have about 50% more heat sinking than competitive designs, the supplies run cooler, Freyling notes. For enhanced reliability, he continues, "we're using hermetically sealed output transistors, and their maximum junction temperature doesn't go above 150°C." Moreover, such features as overvoltage protection and foldback current limiting are standard. Line and load regulation is to within 0.1%. In large quantities, prices are expected to be 10% to 20% below that of the competition.

There will also be four solid-state relays, two in power-block (chassis-mountable) packages and two in printed-circuit-board-mountable packages. The pc-board units can switch 120 or 240 V ac at 2 or 3 A, while the chassis-mountable devices can handle 5 or 10 A. Zero-crossing circuitry and output snubbers are standard. Furthermore, the relays incorporate input current limiting to extend the life of their internal optical coupler. As with the supplies, pricing will be about 20% lower than that of competitive units.

For the I/O modules, Motorola will again be offering four units, two input and two output, with a choice of ac or dc versions in each case. They will be available separately or as assemblies mounted on a board. The initial board, which will measure approximately 11 by 5 inches, will handle any mix of 16 modules and will include status indicators for each of the modules. Future boards will contain 4, 8, or 32 modules.

Motorola Subsystem Products, 2002 W. 10th Place, Tempe, Ariz. 85281 [338]



Codec chip loses British accent

General Instrument is readying its all-digital device, developed for British Post Office, to sell to all comers

by Richard Gundlach, Communications Editor

When General Instrument Corp.'s Microelectronics division began working with the British Post Office to develop a codec chip aimed at use on individual telephone lines in a digital-switching telephone network [*Electronics*, Sept. 1, 1977, p. 3E or 55], the American-based company was very eager to get its product into the world market. Now GI has been licensed to do just that—sell the chip to any user (see p. 77.)

Unlike other coder/decoder chips from semiconductor manufacturers, GI's AY-3-9900 chip is an all-digital system. Except for the Siliconix two-chip codec set, DF-331/2, it is the only one that does not share an analog-to-digital converter between transmit and receive channels.

Because of this design, both channels can be clocked asynchronously. Their total independence of each other is important when the codec is used in satellite communications links and on long local-loop circuits where different delays could cause timing problems if shared-a-d-converter codecs were used. Also, the n-channel, metal-gate codec chip needs no resistor or capacitor ladder networks nor a precision reference voltage source to generate the precise companding steps.

The AY-3-9900 codec chip consists of two separate logic systems for encoding analog signals into pulse-code-modulated bit streams and decoding PCM signals back into analog form.

In the encoding section, the delta-sigma modulator, which is off chip, converts an analog signal from a low-pass filter into a 1-bit-per-sample code. The on-chip circuitry then converts that to a linear PCM signal, which is compressed either into an A-law or into a μ-law PCM serial bit stream.

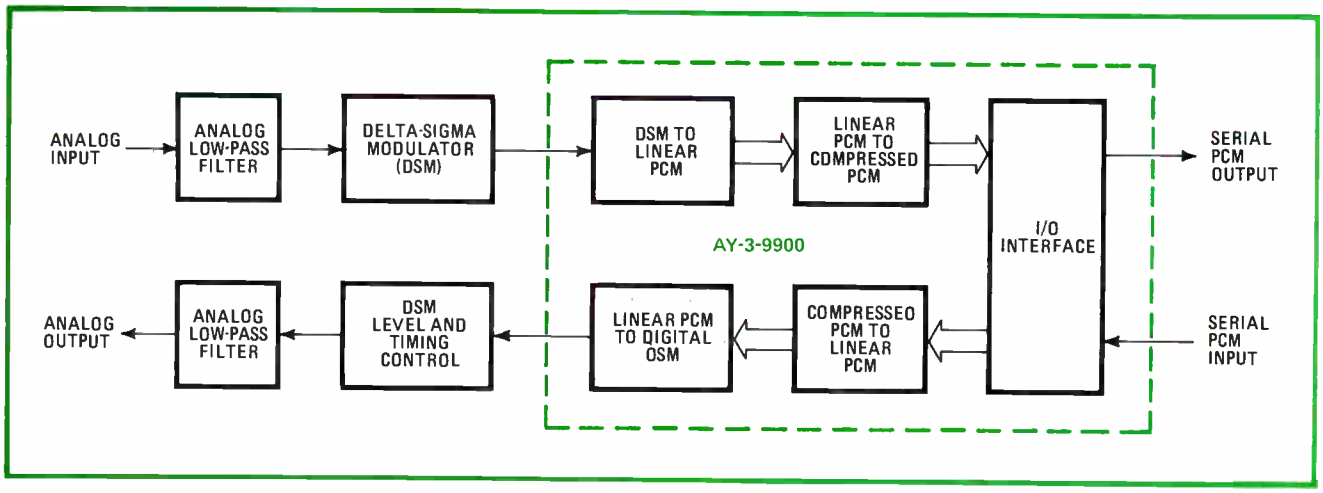
In changing serial PCM signals to analog, the process is reversed. This step is done in the decoding section of the 9900 and the (off-chip) circuit that controls the delta-signal-level modulator and timing, with the audio being recovered from a low-pass filter.

Although developed specifically for telephone PCM carrier equipment, GI expects the codec chip to find application in digital switching, satellite communications links, and in the general area of a-d and d-a conversion.

In June, AY-3-9900 codec chips will be available in plastic packages acceptable to telephone companies. They will cost $2.40 each in 100,000-lot quantities. Initially, GI will supply circuit diagrams for the new off-chip delta-sigma modulator and demodulator. These circuits require only a quad-D flip flop, a dual operational amplifier, and some resistors and capacitors.

Shortly thereafter, the company plans to provide the entire codec function on a single chip for under $10 in large quantities. But since each codec requires a transmit and receive filter, the system cost will be twice that. GI's off-the-shelf filters, the ACF-7270 (transmit) and ACF-7271 (receive) cost $5.50 each.

General Instrument Corp., Microelectronics Division, 600 West John St., Hicksville, N. Y. 11802. Phone (516) 733-3241 [339]



Packaging & production

Bench-top line plates pc holes

Modular system produces two-sided boards with plated through-holes

Construction of two-sided, plated-through-hole, printed-circuit boards is often beyond the capability of small in-house prototype lines. Usually only simple, single-sided boards can be fabricated in these facilities, so that a small company is forced to go outside for any two-sided boards it needs and put up with the wait for delivery.

Now, however, Kepro Circuit Systems has produced an $8,850 tabletop system with which an engineer can produce these boards in about two hours. The holes are first plated, and then a conventional subtractive etch takes place.

In the plating process, the inside of a hole drilled through a copper-clad FR-4 or G-10 glass epoxy laminate is first soaked with a palladium/tin solution, then has 0.01 mil of electroless copper deposited in it. Next, 0.1 to 0.2 mil of copper is electroplated over both the board surface and the electroless copper within the holes. Finally, a resist is put on the copper-plated surface, and conventional subtractive etching takes place.

The plating facility is 21 in. long, 43½ in. high, and 24 in. wide, and a 12-by-12-in. panel is the largest it can process. When combined with a standard Kepro print-and-etch bench-top unit, it makes the complete line for prototyping two-sided boards with plated through-holes. The print-and-etch bench-top line runs in price from $1,935 to $2,795 and includes a dip coater, infrared oven, base, spray developer, rinse unit, spray etcher, water dryer, and fresh water base.

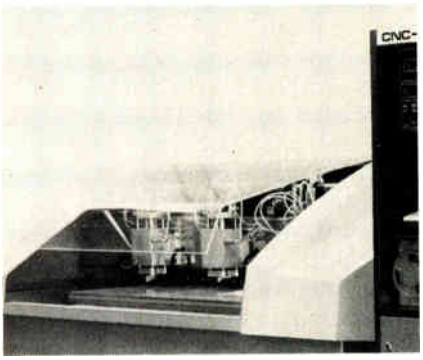
Kepro Circuit Systems Inc., 3630 Scarlett Oak Blvd., St. Louis, Mo. 63122 [391]

Drill and rout machine taken to the PROM

A microprocessor-based control system equips a new drilling and routing machine for printed-circuit boards with many of the capabilities of minicomputer-controlled machines.

In addition to program storage and editing, canned drill cycle, and auto step and repeat, the DSI-4000R controller has computation software stored in nonvolatile programmable read-only memory. This means that the Z-100 machine can be operated without the repeated reloading of software that is required in minicomputer-controlled systems.

When routing, the DSI-4000R offers a feature called precision cornering that is used with both linear and circular interpolation to



reduce errors automatically when small arcs or sharp turns are made.

The Z-100 has high-power spindle motors designed to provide sufficient power and radial force to drill large holes in a single drill cycle and thus extend operating life.

Digital Systems Inc., 232 E. Live Oak Ave., Arcadia, Calif. 91006. Phone (213) 445-6100 [392]

Sputtering system can deposit film on 8-ft substrates

Adaptable to substrates of almost any desired length, the S-3 high-rate sputtering system can lay down a uniform film on 8-foot-wide sub-

Samtec Electronic Hardware

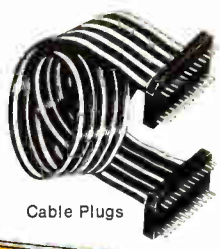
SAM SHINE, PROP.

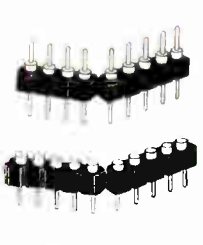
We'll give you old-fashioned personalized service."

he customer comes first at Samtec . . . and our rowing OEM and distributor accounts really ap- reciate it. We believe that service follow-up, de- very and pricing promises are meant to be kept and we work hard to see that they are.

'hy not give us a try and see how trouble-free ersonalized service can be?

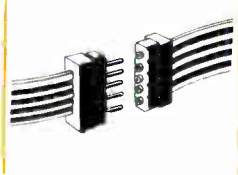
et our New 32-page catalog today—complete ith all specs and ordering data. See what a fference personalized service can make!

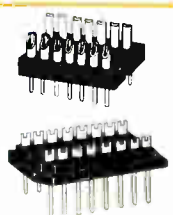

Cable Plugs


Socket/Terminal Strips


DIP Sockets


TO Sockets

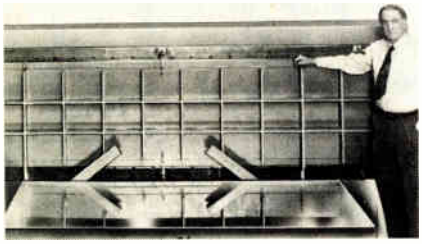

Cable Strip Connectors


Adaptors

samtec

) PROGRESS BOULEVARD, NEW ALBANY, INDIANA 47150
PHONE (812) 944-6733

Circle 149 on reader service card



strates. The planar magnetron deposition sources deposit metallic films at rates up to 20,000 angstroms a minute.

A number of identical sources can be arranged in series for higher throughput, or different sources can be put in series to allow multilayer films to be laid down. Base metals and alloys are deposited in an argon atmosphere at 2- to 5-μm pressure; addition of reactive gases permits deposition of compounds. Thickness uniformities of $\pm 1\%$ are typical.

Denton Vacuum Inc., Cherry Hill Industrial Center, Cherry Hill, N. J. [393]

Wafer probe performs at low and high temperatures

A single temperature-controlled system for probing wafers up to 4.5 inches in diameter has a temperature range of $-10°C$ to $+300°C$. It can go from room temperature to 300°C in 3 minutes and drop from 300°C to room temperature in a mere 90 seconds.

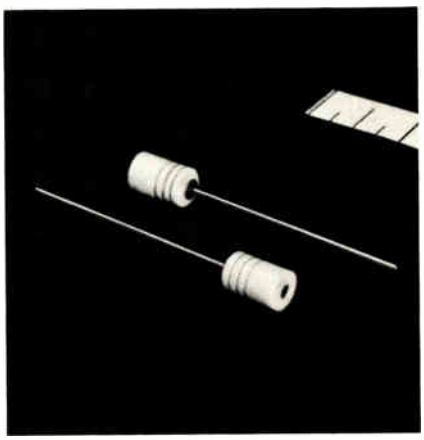
Model TP0316 has a digital readout, cycle timer of 1 second to 60 hours, and $\pm 0.5°C$ stability with negligible gradient across the chuck surface. The unit can be used for wafer, chip, or hybrid-circuit testing and for the temperature characterization of new designs as necessary.

Temptronic Corp., 40 Glen Ave., Newton, Mass. 02159. Phone T. G. Gerendas (617) 965-3420 [394]

Insulated test jack designed for deep holes

A new Teflon-insulated test jack for deep holes is available for castings or thick metal chassis. The test jack, 016-1700, has a lead 1.060 inches long that protrudes below the Teflon insulator.

The top of the jack is designed to accept a probe 0.040 in. in diameter by 0.230 in. long. Special pads and



grooves in the bushing are deflected upward during installation to secure the jack. The insulator is machined from Teflon per MIL-P-19468, and the beryllium-copper contact and brass shell is gold-plated per MIL-G-45204B.

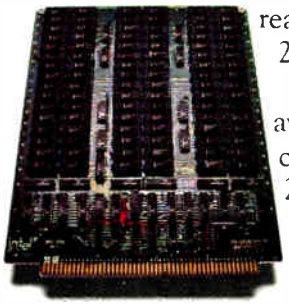
Circuit Components Division, Sealectro Corp., Mamaroneck, N. Y. 10543. Phone (914) 698-5600 [395]

Programmable check added to wafer fabrication line

A microprocessor-controlled programmer adds a programming and process surveillance capability to a system for the fabrication of semiconductor wafers. Designated the model 9502 low-cost programmer, the unit operates with GCA's estab-

Intel's new in-7000 static memory system with Word/Byte Control delivers speed, convenience and design flexibility. It's the easiest way to get our high-density 2114 4K static RAMs into your system.

The in-7000 is a complete static memory with interface and control logic contained on a single 10.8" x 8.175" printed circuit card. The system requires only a +5V power supply, is TTL compatible, and needs no refresh. You can choose from two versions, differing only in speed: the 7000, with a read and write cycle time of 250 ns; and the 7001 (350 ns).



The basic in-7000 card is available in four 16K configurations: 16K x 12, 16, 20 or 24 bits. Two chassis models are also available. The in-Minichassis can house six in-7000 circuit cards, and the in-Unichassis has a 32-card capacity.

A unique feature called Word/Byte Control gives you the design flexibility to standardize on the in-7000 for all your systems applications. Word/Byte Control allows the Byte Control inputs to be used either for reconfiguration or byte data control. In the Word mode, the Byte Control inputs select either or both halves of a word, effectively reconfiguring a 16K x 24 card to 32K x 12; a 16K x 16 card to 32K x 8; and so on. In the Byte mode, any combination of three bytes in a 24-bit word may be selected by the Byte Control inputs.

Get Intel 4K static RAMs into your system now with our in-7000. Phone your local Intel sales office or use the coupon below.

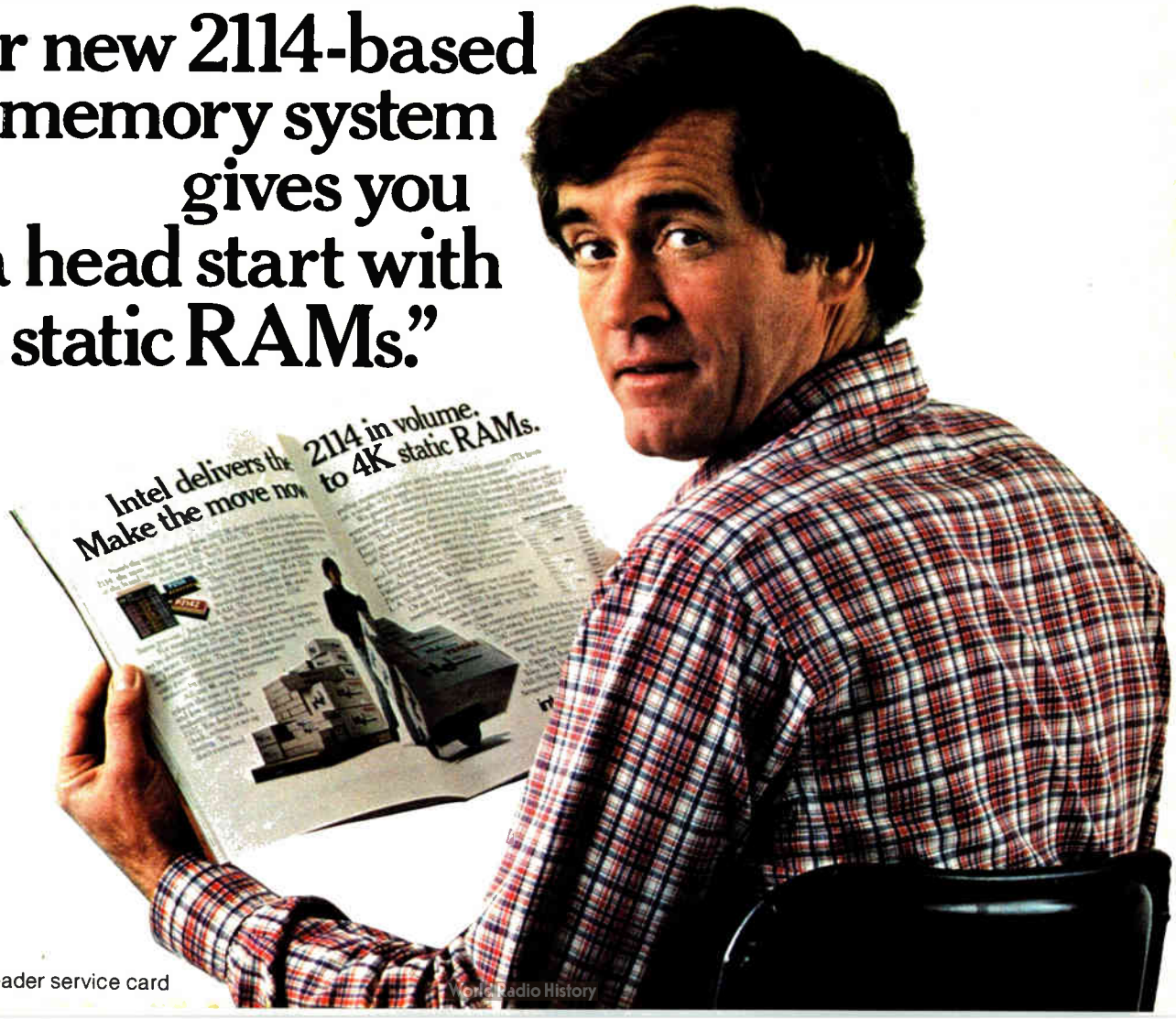
intel® delivers.

Intel Memory Systems EL 4/13/78
1302 N. Mathilda Avenue, Sunnyvale, CA 94086
Phone (408) 734-8102

Send me more information on Intel's in-7000 static memory system.

Name_____
Position_____
Company_____
Address_____
City, State, Zip_____
Call me _____/_____

"Our new 2114-based memory system gives you a head start with 4K static RAMs."



cle 151 on reader service card

THE WIDEBAND RMS VOLTMETER ONLY FLUKE COULD CREATE.

You're probably accustomed to using analog meters for audio-to-rf measurements. Maybe you've given up hope of going digital at a reasonable price.

Good news!

Fluke's new 8920A wideband true rms DMM is loaded with features—some you can't buy anywhere at any price, and it sells at an analog price: $995*!

For starters, 8920A bandwidth is 10 Hz to 20 MHz for sub-audio to video AC measurements. Mid-band accuracy is 0.5%, compliments of an exclusive Fluke designed (and built) micro-electronic rms chip. Accurately measuring noise and non-sinusoidal waveforms is easy since the chip responds only to the heating effect of the waveform. You can select the AC + DC function for non-symmetrical waveforms like pulses that have a DC component.

8921A's Isolated Banana Jack Input.

"Dial-An-Ohm"

We gave the 8920A dynamic range from 180 μV to 700 volts, to measure from low noise levels to the output of powerful amplifiers. And, fast auto-ranging relieves you of the knob twisting chores!

Put the 8920A into dbV mode and measure from −75db to +57db (132db range), with 0.01db resolution. If you want your dbV reference somewhere else beside 1V, Fluke's exclusive *relative reference* lets you store any voltage as the 0-db point. Imagine how simple your gain measurements can be!

To make the 8920A all things to all people, we've included a "dial-an-ohm" feature for dbm measurements. Instead of laboriously correcting each of your readings from a 600 ohm reference, simply dial 50, 75, 300, or one of nine *other* impedances up to 1200 ohms, and be right on every reading. There are several selections for broadcast, telephone, TV and RF applications.

An analog meter is standard, for convenient peaking/dipping/nulling, as is a linear analog output for continuous recording. Optional are logrithmic analog output and an isolated output to drive a counter. Soon, IEEE 488 interface will be available for systems use.

If you prefer an isolated banana jack input with full floating capability, specify the 8921A (also only $995*).

*U.S. Price

For more information, contact one of the more than 100 Fluke offices or representatives, worldwide. In the U.S., CALL (800) 426-0361, TOLL FREE. Residents of the U.S. and all countries outside of Europe, contact: John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043, U.S.A. Telex: 32-0013.

In Europe, contact: Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Telephone (013) 673973. Telex: 52237.

FLUKE®

2504-8018

Circle 153 for literature
Circle 263 for demonstration

New products

horizontal position throughout assembly, eliminating the problem of components falling out before soldering, which occurs with other approaches. Prices for the three carriers range from $42.43 to $89.70.

Multi Tool and Manufacturing Inc., P. O. Box 553, Cape Canaveral, Fla. 32920. Phone (305) 783-2310 [398]

Cleaning equipment is made for small parts

The series 48 line of cleaning equipment includes a vapor cleaner, a two-chamber vapor degreaser, an ultrasonic vapor degreaser, a three-chamber emulsion-cleaning system, a water-displacement drying system, and ultrasonic cleaning tanks with and without heaters for use with water detergents. All have 6-by-8-by-6-inch cleaning chambers for the efficient processing of small parts that require extremely thorough cleaning. Units in the series 48 line are well suited both for production-line and laboratory use.

Lenape Equipment Co., 558 Lincoln Blvd., Middlesex, N. J. 08846. Phone James A. Mastrian (201) 356-5353 [399]

Board mounts can handle wide variety of displays

Display mounts, originally developed for avionics radio use, can be tooled for a number of displays in any combination of digits, decimal points, or other designators. Pins are staggered for easy entry into a printed-circuit board.

Collet sockets have gold-plated beryllium-copper contacts, tin-plated pins, and glass-epoxy base. These multiple display sockets can be supplied for vertical, elevator, or horizontal applications. The high-precision mounts ensure excellent alignment of multiple displays.

Aries Electronics Inc., P. O. Box 231, Frenchtown, N. J. 08825. Phone (201) 996-4096 [396]

+180° with a resolution of 0.1° and 13 bits plus sign. Models SBCD 1753 and 1757 go from 0° to 359.9° with a resolution of 0.1° and 14 bits. Models 1752 and 1753 require input voltages of ±15 v and +5 v; models 1756 and 1757 require only +15 v and +5 v—the −15 v is internally generated.

The converters are housed in the 3.125-by-2.625-by-0.8-inch industry-standard package and are designed to absorb the normal shock and vibration of an industrial or military environment.

The 1752 and 1753 will sell for $420 in quantities of one to nine, and models 1756 and 1757 for $535 in similar quantities. Delivery is from stock.

Analog Devices Inc., Route 1 Industrial Park, Norwood, Mass. 02062. Phone Edward Friedman at (617) 329-4700 [381]

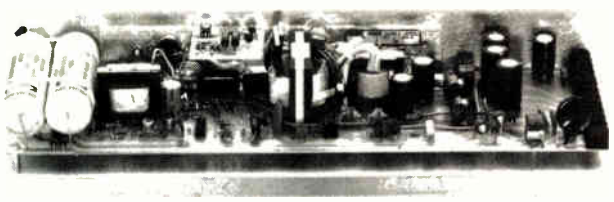
Five-output 400-W switching power supply sells for $395 each for 100 or more

Even though it includes as standard such features as an input electromagnetic-interference filter, a series thermistor that reduces input line surges at turn-on, reverse voltage protection, protection against system shorts, and a thermal cutout switch, the model OL-400 open-frame switching power supply sells for less than a dollar a watt. The five-output supply puts out a continuous power of 400 w and carries a price tag of $395 each for quantities of 100 and up.

The OL-400 puts out up to 45 A at +5 v, ±10 A at ±12 v, and 4 A at −5 v and +24 v. Of course, these current maximums cannot all be realized simultaneously because they would then exceed the 400-w overall limit. On the other hand, each output can deliver three times its rated current to satisfy a transient load. The supply is thus particularly well suited for use in computer peripherals, such as printers and other electromechanical devices, which regularly present transient loads to their power supplies.

A similar supply, the OL-200, has a maximum continuous-power rating of 200 w and sells for $248 each in quantities of 100 or more. It has four outputs: +5 v, −5 v, and ±12 v. It has all of the protective features of the OL-400 except for the thermal cutout switch.

Both supplies can provide 16 ms of continuous power after a complete loss of input—more than enough time



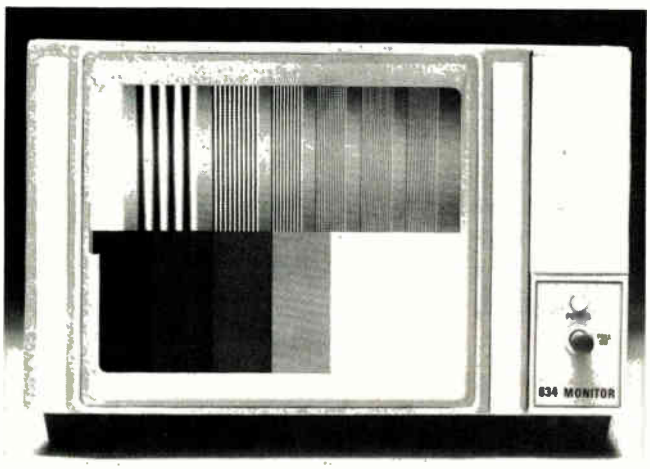
for a computer system to transfer data into a nonvolatile memory. An optional power-fail detector will provide a transistor-transistor-logic signal suitable for initiating such a data transfer.

Boschert Inc., 384 Santa Trinita Ave., Sunnyvale, Calif. 94086. Phone Scott Warner at (408) 732-2440 [383]

6.5-inch display monitor has 1,100-line resolution at a brightness of 100 cd/m²

A flat-screen video-display monitor, the model 634 has a worst-case resolution of 1,100 lines at a brightness of 100 candelas per square meter (30 foot-lamberts). Nominal resolution is 1,400 lines.

As shipped from the factory, with no further calibration, the 634 has a worst-case geometric distortion of 0.5% over a 9-cm circle at the center of the screen. Even at the corners, distortion is held below 1%. Equally important, the display has a guaranteed maximum brightness variation of 20% over the entire screen. According to Tektronix, the model 634 is the only



monitor with a uniform-brightness specification.

Key applications of the monitor will be in the areas of medical imaging, scanning electron microscopes, and security systems.

The 634 sells for $1,125 in small quantities. For applications in which resolution is less critical, a 650-line unit is available for $900. For either version, discounts for original-equipment manufacturers are available on orders of 10 or more. Delivery time is 12 weeks.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [384]

Solid-state voltage reference drifts less than 6 parts per million per year

Two voltage references, the VRS-6 and the VTS-6, are solid-state modules that drift no more than 6 parts per

million per year. The VRS module operates from the ac line; the VTS unit requires a dc supply of 24 v ±10% at 25 mA. Both references, which are being marketed under the trade name Trancell-1, have two outputs: 10.00000 v and 1.08500 v. Both the outputs are protected against short circuits and are accurate to within 10 ppm.

Maximum temperature coefficient is 1 ppm/°C over the range from 15°C to 40°C. The references are extremely insensitive to input-voltage changes: a change of 10% in either direction will cause an output change of less than 1 ppm. Peak-to-peak noise is less than 1 ppm from 0.1 to 10 Hz.

Two additional modules in the Trancell-1 line, the VRS-9 and the VTS-9, are similar to the units just described except that their maximum annual drift is 9 ppm. Prices are as follows: $825 for the VRS-6, $750 for the VTS-6, $675 for the VRS-9, and $600 for the VTS-9. Delivery time for all models is 12 to 14 weeks.

Standard Reference Laboratories Inc., Pollitt Drive South, Fair Lawn, N. J. 07410. Phone John Halgren at (201) 797-3907 [385]

Multidigit seven-segment LED displays stand more than 1 inch high

Numeric display assemblies in the 1000 series have digit heights of more than an inch (actually, they are 27 mm high) and require only 5 to 10 mA of forward current per segment. The seven-segment light-emitting-diode readouts have a typical luminous intensity of 350 millicandelas at 10 mA, a 10-mA forward voltage of 4.4 v, and a

THERE IS NO EASIER WAY TO SAVE.

Join the Payroll Savings Bond Plan and take advantage of America's most convenient method of saving for the future. The interest rate is 6%, and the tax-deferral advantages are extremely attractive.

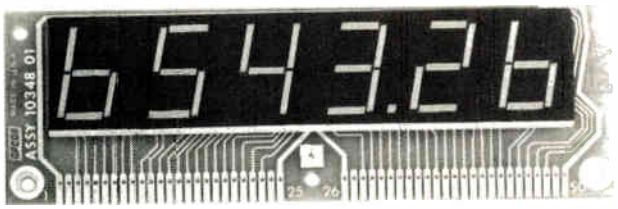
Just contact the payroll department where you work and tell them the amount you want applied toward savings bond purchases. It's as simple as that. And you'll be surprised at how fast your savings accumulate.

Robert T. Campion, chairman and president of Lear Siegler, Inc., and chairman of the 1978 U.S. Payroll Savings Bond Campaign for the electronics industry, urges you to

Buy U.S. Savings Bonds

LEAR SIEGLER, INC.
3171 SOUTH BUNDY DRIVE, SANTA MONICA, CA 90406

Circle 164 on reader service card



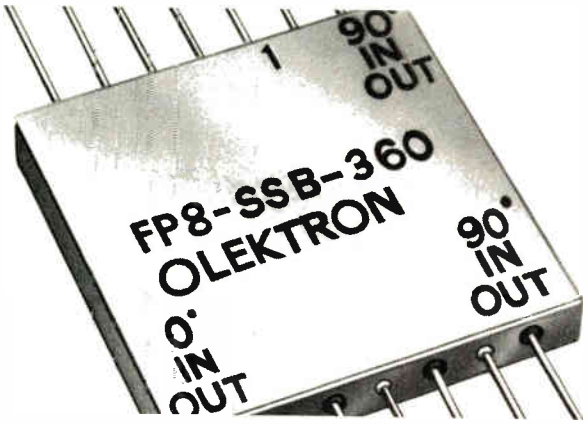
peak emission wavelength of 690 nm. Built on a single printed-circuit board, the assemblies have been designed for applications such as clocks, scales, and large wall displays where easy visibility at 20 feet under typical room lighting is required.

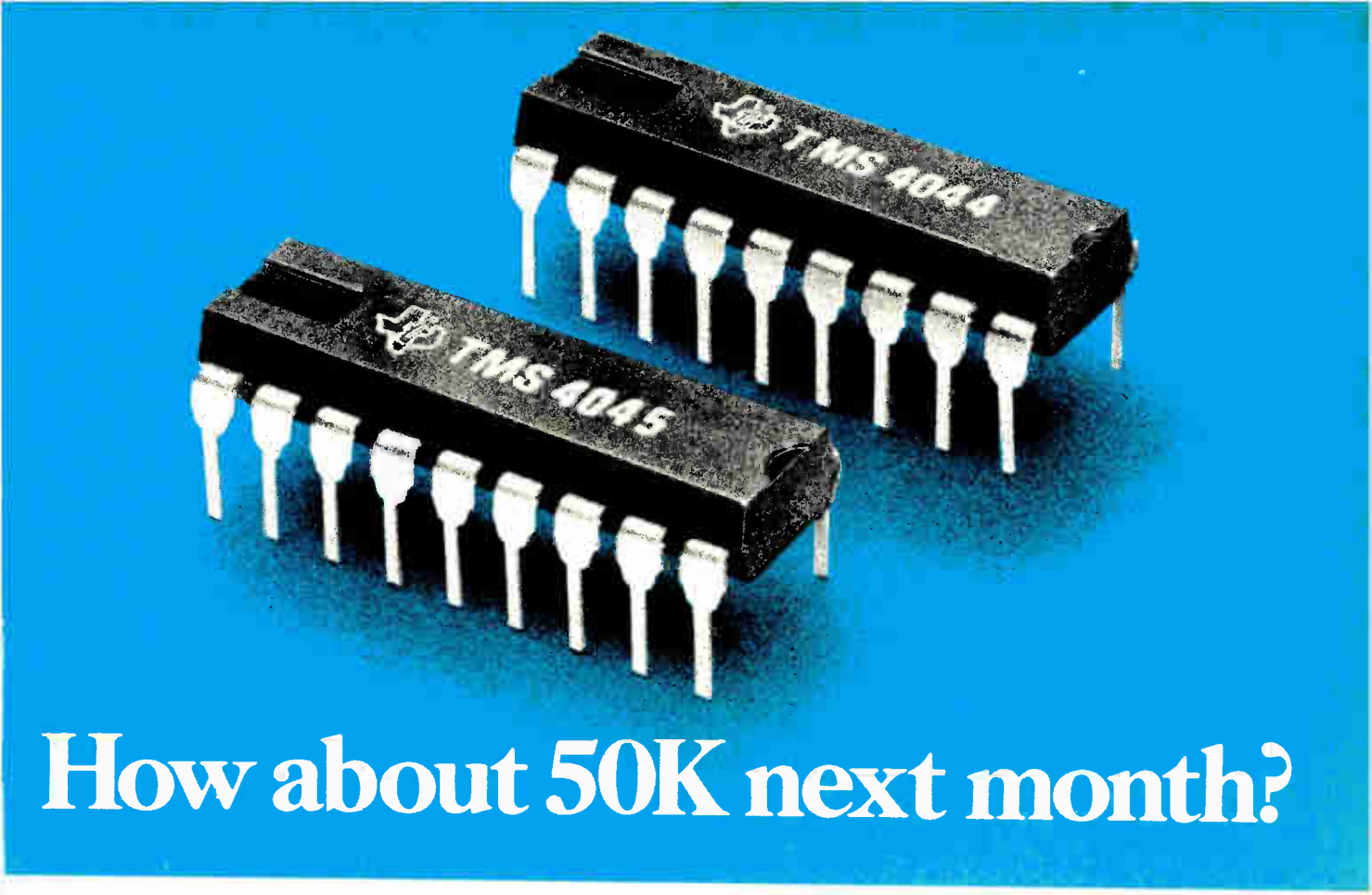
Opcoa Division, IDS Inc., 330 Talmadge Rd., Edison, N. J. 08817. Phone Robert C. Kolts at (201) 287-0355 [386]

Miniature single-sideband modulator has modulation bandwidth of dc to 500 MHz

Housed in a miniature flatpack with dimensions of 0.810 by 0.810 by 0.145 inch, the FP8-SSB-360 single-sideband modulator has a radio-frequency bandwidth of one octave centered at any selected frequency from 10 to 500 MHz. The unit has a conversion loss of less than 10 dB, a carrier suppression of more than 40 dB, a sideband level more than 30 dB below the desired output level, an rf level of up to 0 dBm, and a modulation bandwidth of dc to 500 MHz. The modulator has two modulation inputs that must be driven in quadrature for normal operation. These inputs are compatible with transistor-transistor-logic levels for ease in modulating the carrier with digital signals, as is necessary, for example, in pulse-code modulation. The modulator sells for $115; it has a delivery time of three to four weeks.

Olektron Corp., 6 Chase Ave., Dudley, Mass. 01570. Phone J. Oleksiak at (617) 943-7440 [388]





How about 50K next month?

4K static RAMs from Texas Instruments.

Availability is excellent on TI's popular 4K static RAMs. Off-the-shelf from TI distributors. Or double quick direct from TI.

These are the TMS-4044 and TMS-4045. The Industry Standard 18-pin 4K statics. Choose 4K by 1 or 1K by 4 organizations. They give you everything you ever liked about the 2102. And more:

- Industry Standard 18-pin pin-outs – TMS-4045 equivalent to 2114.
- Low cost – As low as $10.77 (100 pieces)
- ±10% tolerance supply – Less stringent regulation, less cost.
- Simple to use – No clocks, no refresh, simple addressing – minimum system overhead.
- Single +5V supply; full TTL compatibility.
- Fully static – Access and cycle times always the same; no precharge or recovery time.
- Low power – 500 mW maximum.
- Choice of speeds – 250, 300, and 450 ns.
- Unlimited output valid time.
- Complete compatibility with all popular microprocessors.

Don't forget TI's TMS-4046/47 4K static RAMs, too. The ones you use for low standby-power/battery-backup operation. Data is retained down to 10 mW.

Get "no sweat" delivery on TI's 4K static RAMs by calling the nearest authorized TI distributor listed to the left. Or call your nearest Texas Instruments sales office.

TEXAS INSTRUMENTS MOVING AHEAD IN MEMORIES.

TEXAS INSTRUMENTS
INCORPORATED

85107A

Circle 167 on reader service card

OUR OS4000 TAKES OVER WHERE TUBE STORAGE LEAVES OFF.

The Gould OS4000 digital memory oscilloscope extends your capabilities beyond the limits of conventional storage tube technology.

With the OS4000, stored transients do not deteriorate and are clearly displayed at will indefinitely — as long as you choose to keep the data. Stored trigger points allow you to display pretrigger signals as well as the signal itself. You see what actually caused the signal.

Digital storage also offers you four useful options: 1) Fully automatic operation, 2) analog and digital output for hardcopy, 3) higher resolution through expansion of stored traces, 4) the ability to generate complex wave forms.

The OS4000 can enhance the effectiveness of traditional dual trace displays by simultaneously displaying real time and stored traces without the amplitude restrictions of a split beam storage tube. Both signals have optimum brightness to help you draw the critical inferences from close comparisons. At low frequencies there is no irritating flicker or C.R.T. glow.

Rated at 10 MHz for conventional operation the OS4000 utilizes an 8 bit x 1024 word RAM, with a sampling frequency of 1.8 MHz. Normal/refreshed/roll modes are standard.

With a multitude of new applications in general electronics, medical electronics, research laboratories and transducer related measurement situations, Gould's OS4000 simply outclasses every tube storage scope on the market. But even though the OS4000 represents a step forward in storage scope technology, it is both easy to use and extremely affordable.

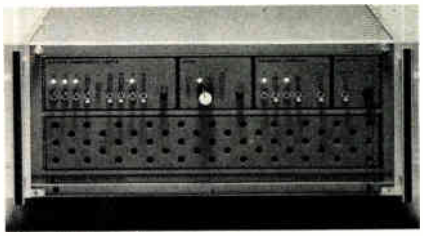
For more information contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, OH 44114. In Europe contact Gould Advance LTD., Roebuck Rd., Hainault, Essex, CB10 1EJ, England.

For brochure call toll free (800) 325-6400. Ext. 77. In Missouri: (800) 324-6600.

Example of expanded output (1:2)

GOULD

New products



System 616 has three plug-in computer interface options as well. Option 01 is plug-compatible with the IEEE-488 interface bus; 02 interfaces a minicomputer through a teletype port using either EIA/RS-232-C or the 20-mA current loop; and 03 interfaces a minicomputer through its buffered I/O card.

Precision Filters Inc., 303 W. Lincoln St., Ithaca, N. Y. 14850. Phone (607) 277-3550 [355]

Pulsed generator has a rise time of less than 10 ns

A general-purpose pulse generator, model 101C, has a 20-MHz repetition rate, a fixed rise time of less than 10 ns, and an output variable to ±18 v from 50 Ω.

Simultaneous auxiliary front-panel outputs are designed for the transistor-transistor-logic level (4-ns rise time) and C-MOS (open-collector output capable of 40 v amplitude or 100 mA). Price is $595, and delivery is in 30 days.

Concord Instrument Division of Systron-Donner Corp., 10 Systron Dr., Concord, Calif. 94518. Phone (415) 676-5000 [357]

Portable counter priced at $295

A portable 225-MHz direct-count, three-function counter is available for communications applications. For $295, the 5725C provides frequency, totalize, and ratio capabilities and is proof against electromagnetic interference.

The 6-digit counter with 0.43-in-high orange light-emitting diodes operates from any 9- to 15-v dc source. Applications include mainte-

Head and shoulders below the competition

DEC RX01
10½″
$4300
Bootstrap $320 extra

DSD 110
5¼″
$3195
Bootstrap included

Data Systems' new, floppy disk system offers performance and storage equal to DEC®'s RX01, but uses half the space and costs 25% less.

Save money, save rack space and increase your system's reliability by selecting the DSD 110 for use with any DEC LSI-11 or LSI-11/2.

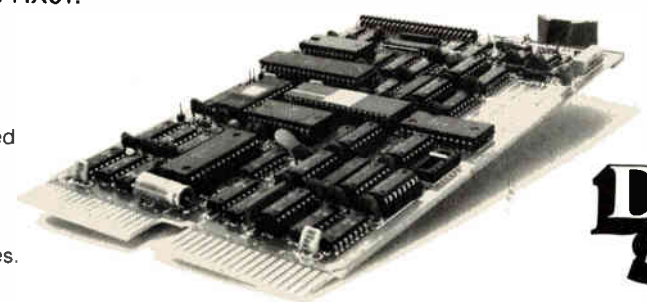
The DSD 110 provides 512K bytes of fully DEC-compatible storage in a 5¼″ cabinet. While the DSD 110 saves you rack space, it also uses one less Q-bus slot than DEC's RX01.

All this is possible because the interface, formatting and controller circuitry, and hardware bootstrap have been combined on a single dual-wide card. This card, which is available separately, eliminates the need for DEC's REV-11 card.

To find out more about the low-cost, low-profile DSD 110, contact Data Systems today. A data sheet and price list will be forwarded to you immediately.

® Registered trademark of Digital Equipment Corporation

Data Systems Design, Inc.
3130 Coronado Drive,
Santa Clara, CA 95051
(408) 249-9353
TWX 910-338-0249



Data Systems has combined interface, formatter, controller, and hardware bootstrap on this single dual-wide card. Available separately in OEM quantities.

Data Systems

Circle 175 on reader service card

New products

circuits. Price is $39.95 with battery. International Instrumentation Inc., P. O. Box 3751, Thousand Oaks, Calif. 91359 [358]

Digital scope adapter kit turns single trace into four

By converting a single-trace oscilloscope into a four-trace unit for viewing transistor-transistor-logic signals, the Four Tracer digital oscilloscope adapter kit provides a low-cost debugging and troubleshooting device for digital circuitry.

The unit provides the user with four inputs with four binding posts on the front panel. Each input is equivalent to a single TTL unit load in parallel with a 6.8-kΩ pull-up resistor. There are gain or positioning controls for any of the traces. These parameters are internally fixed to eliminate the confusion of overlapping traces or traces which have been positioned out of order.

The output—a binding post on the rear panel—carries the composite waveform of the four input signals to the regular vertical input of an oscilloscope. The overall frequency response is such that 100-ns-wide pulses are seen when using a scope with sufficient bandwidth. The unit measures 2⅝ by 4 by 7¼ in., and the price is $70.

Nittany Digital Devices, Box 56 (M), Pennsylvania Furnace, Pa. 16865 [359]

Direct Sinad readings made from combo unit

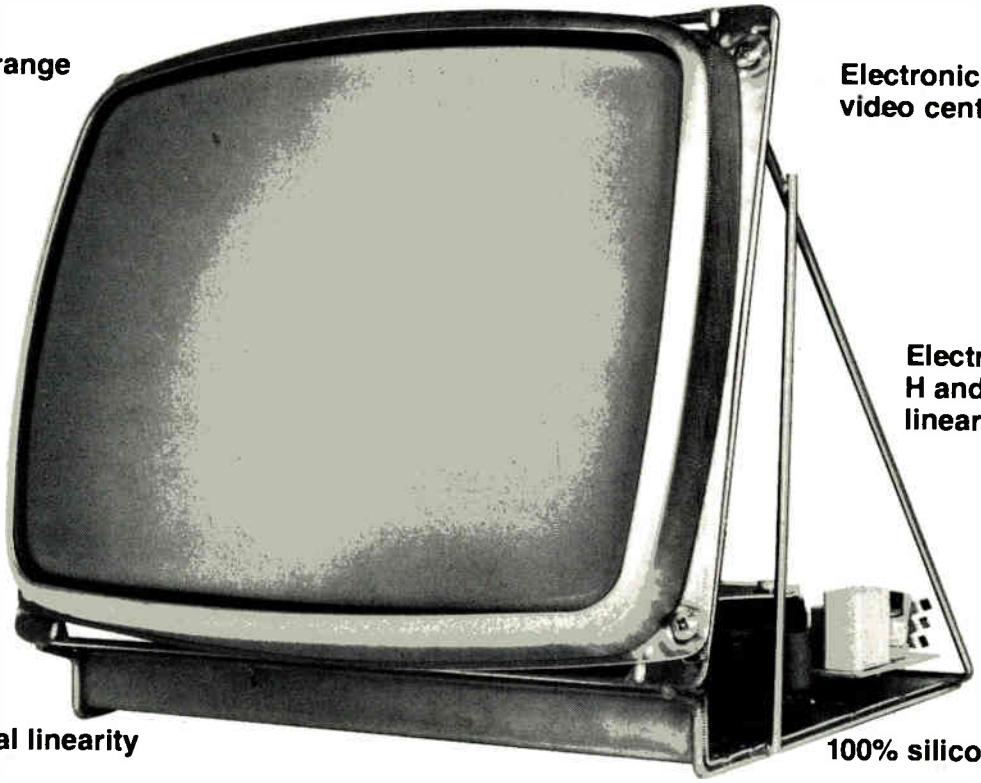
A combination Sinad sensitivity reader, ac voltmeter, and audio signal tracer is available for $249. The Sinadder 3 in the audio mode has an internal 1-kHz generator to provide an accurate tone to modulate a signal generator or monitor audio distortion. As an ac voltmeter, it has nine ranges from 10 mV full scale to 100 V. And as an audio signal tracer it can be used to check telephone control lines by sight and sound.

Helper Instruments Co., P. O. Box 3628, Indialantic, Fla. 32903 [360]

Ball introduces the industry standard in CRT monitors. Again.

Accepts wider range of horizontal input pulse

Electronic horizontal video centering



IC regulated power supply on AC models

Electronic H and V linearity control

Improved vertical linearity

100% silicon circuitry

Now with advanced features you'd never expect in a general purpose data display!

Check out Ball's TV-Series direct drive monitors. The improved performance. The advanced circuitry. The new benefits engineered into our field proven line that's already world famous for high reliability and maintainability.

As before, our specially selected CRT gun and deflection components deliver bright, well defined characters with low geometric distortion. And of course Ball's rugged wire frame and simple subassembly construction offer maximum component cooling and accessibility.

Best of all, our improved TV-Series monitors are completely interchangeable in form, fit and function with first generation designs. You can upgrade right now without interface problems.

Compare life cycle costs. You'll have a Ball.

Call your nearest Ball representative. He'll be glad to introduce you to an old friend. The 2nd generation TV-Series monitors.

Ball Corporation Electronic Display Division
P.O. Box 3376, St. Paul, Mn. 55165 (612) 786-8900. TWX: 910-563-3552

General Sales Offices:

Addison, Illinois (312) 279-7400
Ocean, New Jersey (201) 922-2800
Santa Clara, California (408) 244-1474
Upland, California (714) 985-7110

Ball Electronic Display Division

Circle 177 on reader service card

Microprocessors

8-bit converter has multiplexer

One-chip, six-channel unit lets microcomputer perform control functions

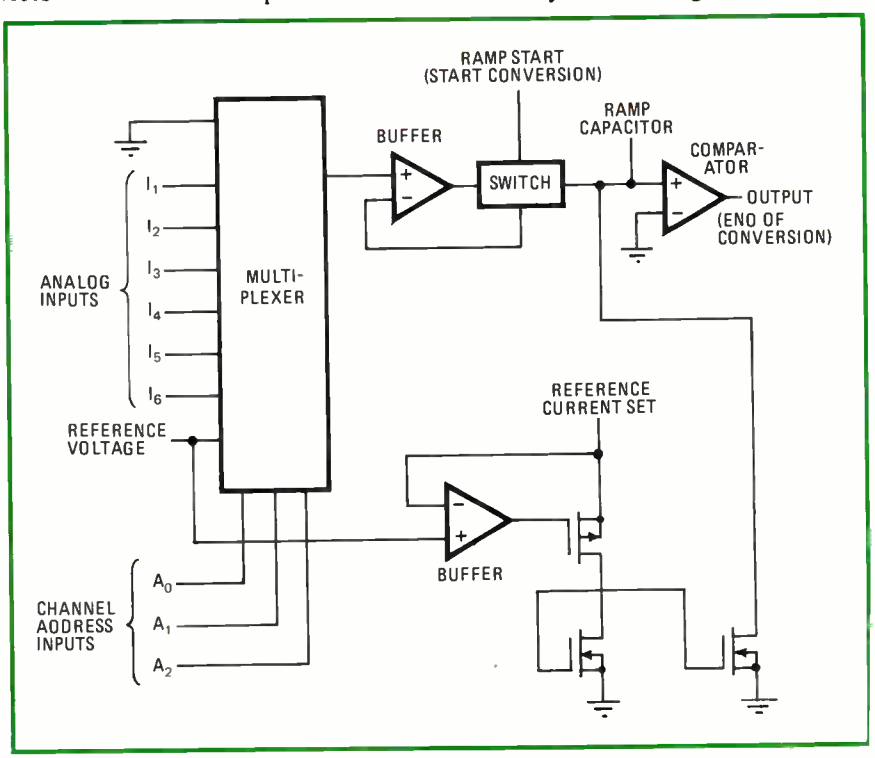
The use of data converters in microcomputer systems is well established. Several converter suppliers are already offering microcomputer-compatible stand-alone parts for use in such systems. But Motorola Inc. is betting that many users will have enough unused processor capacity in their systems to handle the digital portion of the conversion, so it has designed a one-chip analog-to-digital subsystem that relies on the processor for its digital functions.

Clearly aimed at low-end applications, the MC14443 and MC14447 chips are 8-bit single-slope devices that require an external voltage reference and an external ramp capacitor. They are six-channel devices with built-in multiplexers.

Because the calculating, counting, and correction circuitry found in most converters is not needed in the new devices, they sell for a low $3.17 each in lots of 100 or more. That price buys a 16-pin plastic package containing channel-address-selection logic, an analog multiplexer, buffer amplifiers, a voltage-to-current converter, a current-mirror circuit, a ramp-start circuit, and a comparator. The 447 incorporates a standard JEDEC B-Series complementary-metal-oxide-semiconductor push-pull output, while the output driver of the 443's comparator is an open drain that can sink up to 5 mA.

"The chip operates directly with a microprocessor, rather than through a bus line," comments Richard W. Ahrons, C-MOS product planning manager at Motorola's Austin, Texas, MOS facility. Five pins must be connected to the processor's dedicated input/output ports: one to start the converter ramping, one to receive its serial output, and three to address the multiplexer for reference, ground, or one of six analog input signals.

"The converter's speed depends on how the system is designed," Ahrons



The 2114. It's old hat to us

Most 2114s are new products with new product problems. Not ours. The SEMI 2114 is a member of the Royal Family of Static RAMs. It is, in fact, a new pin-out of an 18-pin, 5V, 1Kx4 static RAM that we've been delivering in production quantities for a year and a half.

The SEMI 2114 features low power (only 300 mw), TTL compatible I/O, and all the speed you need for microprocessor applications.

If you'd like complete information on the SEMI 2114, or any other members of the Royal Family of static RAMS, see your local EMM/SEMI distributor, or contact us directly.

Memory at Work

EMM SEMI, INC.

A subsidiary of Electronic Memories & Magnetics Corp., 3883 N. 28th Ave., Phoenix, Arizona 85107 (602) 263-0202

ENGLAND: EMM, Ltd. Tel: (01) 751-1213. **WEST GERMANY:** EMM, GmbH Tel: 6172-6629. **BELGIUM:** EMMSA Tel: (03) 76.69.75. **FRANCE:** EMM c/o Clip. Tel: (01) 754-2319

Circle 272 on reader service card

Knowhow. And where.

"Bussmann can help you choose the right fuse for the right place."

When you do something better than anyone else, people usually take for granted that it's all you *can* do.

Like Bussmann. You probably know us as the electronic industry's most complete source for fast-acting, dependable, state-of-the-art circuit protection. And you're right.

But only half right.

Because Bussmann can also be your most valuable source of expert technical help.

Take your Bussmann salesman, for example. He's more than just a salesman. He's an electrical protection expert.

So he's got the technical know how and experience to simplify and solve your most complicated circuit protection problems.

He can help you decide which fuse from our complete line fits the application you have in mind. Or he can put you in touch with one of our staff engineers for in-depth technical assistance.

Your Bussmann representative can also keep your staff up-to-date on the latest trends in circuit protection. New fusing technology. Or where and how to use the right fuse for the best results.

So call your Bussmann representative today. And trust him for sound technical advice. He'll show you why Bussmann means protection in more ways than one.

McGRAW-EDISON

Bussmann. The Protection Experts.

Bussmann Manufacturing Division
McGraw-Edison Company
P.O. Box 14460
St. Louis, Missouri 63178

Circle 183 on reader service card

One dynamic reason to buy Mostek's 4K static. Delivery.

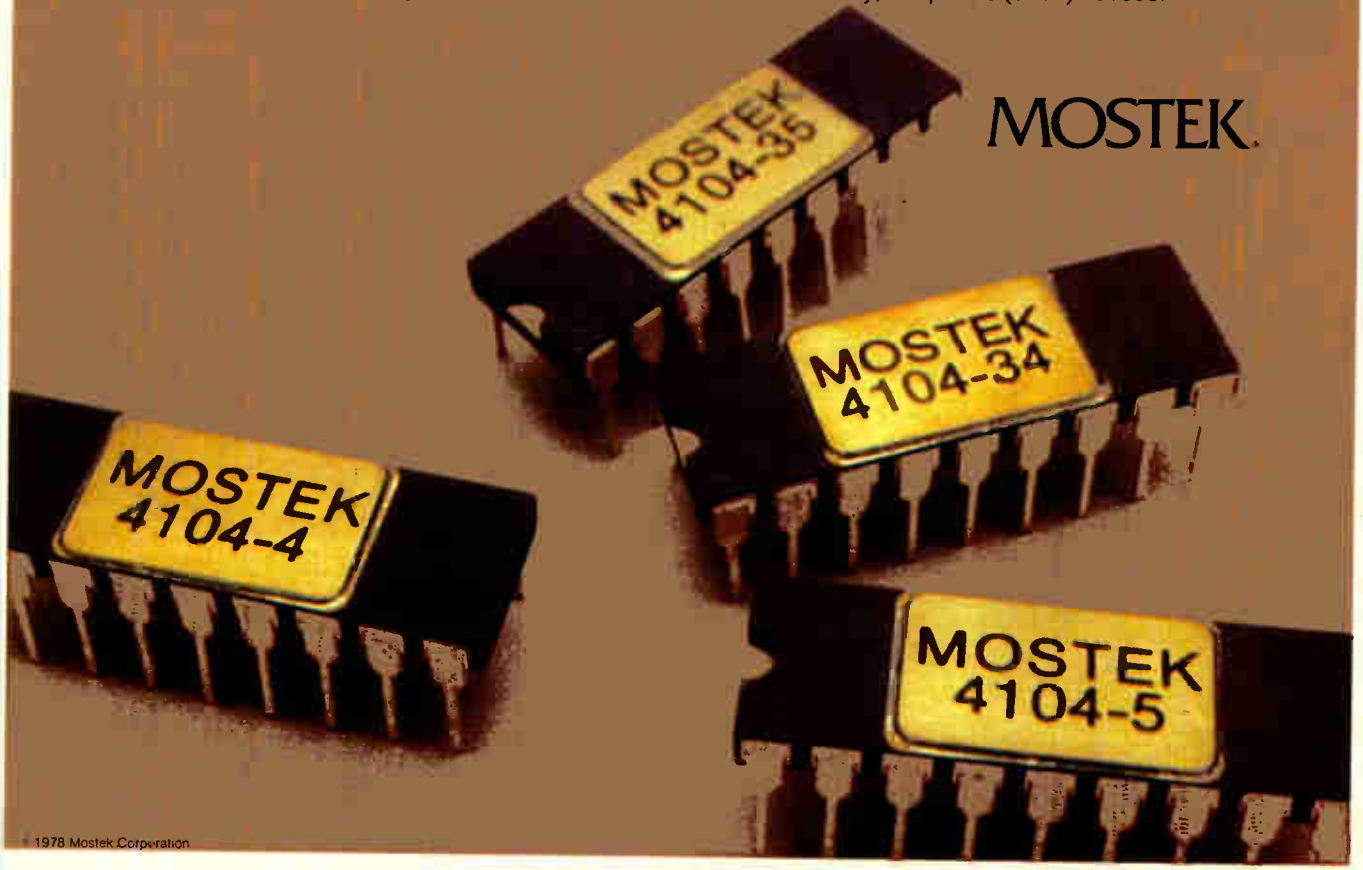
Delivery's fast and that's good news, but there are more dynamic reasons to buy the Mostek 4104 4K X 1 static RAM. For one, it offers the industry's best speed/power product. Using our own widely-copied Edge-Activated™ design concept, Mostek engineers developed the 4104 offering the best features of static and dynamic RAMs. Power is extremely low— just 150mW active and 28mW standby. It's directly compatible with TTL. It operates on a single +5 Volt power supply with a tolerance of ±10%. And you can get it in the industry-standard 18-pin configuration.

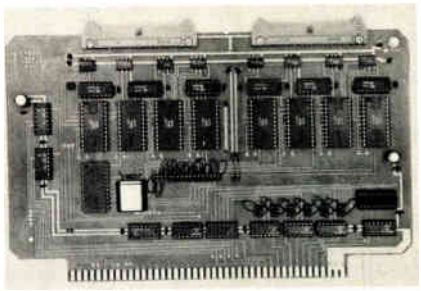
	ACCESS TIME	CYCLE TIME	ACTIVE POWER (MAX)	STANDBY POWER (MAX)	BATTERY BACKUP POWER (3V Supply)
MK4104-4/-34	250ns	385ns			
MK4104-5/-35	300ns	460ns	150mW	28mW	10mW
MK4104-6	350ns	535ns			

The new 4104-3X series offers the capability of retaining data in a reduced power mode. When Vcc is lowered to 3V, maximum power dissipation is only 10mW. This allows complete data retention during battery operation.

There's a lot of dynamic reasons for Mostek's 4104 static RAM. To get the complete story, call a Mostek distributor or sales representative now. Or contact Mostek at 1215 W. Crosby Road, Carrollton, Texas 75006; telephone (214) 242-0444. In Europe, contact Mostek GmbH, West Germany; telephone (0711) 701096.

MOSTEK.





access the control/status registers and the remaining eight access the transmit/receive data registers. This map arrangement allows efficient use of indexed addressing in I/O-intensive systems and permits the use of a tight interrupt polling loop.

The standard eight-channel 9650 sells for $395 in small quantities and $237 each in hundreds. A four-channel version sells for less.

Creative Micro Systems, 6773 Westminster Ave., Westminster, Calif. 92683. Phone (714) 892-2859 [405]

12-bit sequencer controls 4,096 words of instructions

A 12-bit sequence controller for use in microprogrammed computer systems controls up to 4,096 words of microprogram-stored microinstructions. In addition to the capability of sequential addressing, the Am2910 provides conditional branching to any instruction within its 4,096-microword range. An on-chip loop counter keeps track of the number of times a single microinstruction or loop of microinstructions has been executed.

Like its predecessors, the Am2909 and Am2911, the new device is intended for high-speed pipelined microprogrammed systems, especially those built with the manufacturer's Am2901A or Am2903 bipolar microprocessors.

The Am2910 is housed in a 40-pin ceramic dual in-line package; a 42-pin flat package is also available. Prices start at $25.95 in 100-piece lots. Delivery is from stock.

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. Phone (408) 732-2400 [406]

Dialight is your second source to C&K for miniature rockers and toggles...

Come to the people who've always been specialists in having more good ways to solve problems: Dialight. What we've done in indicator lights, illuminated switches, readouts and LEDs, we're doing now in miniature rockers and toggles.

This new Dialight family of switches, which comes in a full range of sizes is, we're proud to point out, all-American made.

When you consider all the configurations of styles, sizes, life and safety ratings, colors and mountings, you'll find there are literally hundreds of thousands of design combinations. Such a number of possibilities can in itself be a problem, except that the new Dialight catalog is specifically designed to prevent confusion and help you quickly and easily find the most advantageous combination of features for your applications.

If you'd like to see what Dialight quality rockers and toggles can do for the looks, durability and economics of your products, contact us today for the Dialight "Meets Your Need" Book. Your free copy will include a list of stocking distributors in the U.S. and Canada.

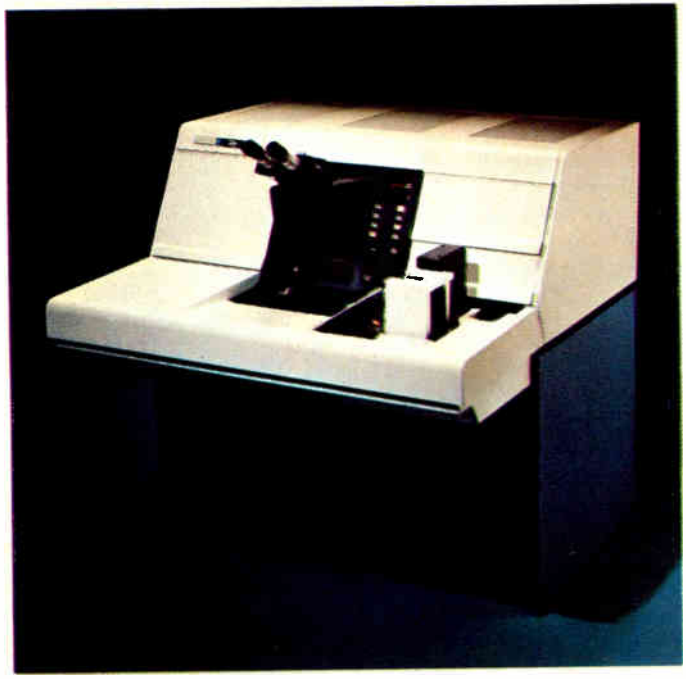
DIALIGHT
A North American Philips Company

American made by DIALIGHT in Brooklyn, N.Y.

Dialight meets your needs.

Dialight, 203 Harrison Place, Brooklyn, N.Y. 11237 (212) 497-7600

Circle 189 on reader service card



The new Perkin-Elmer Micralign Model 140

Perkin-Elmer introduced the Micralign Projection Mask Alignment System over four years ago. Every unit we have manufactured is still in operation and continues to provide the benefits of significantly increased yields and substantially reduced mask costs. The Micralign instrument has become the standard of the semiconductor industry for the manufacture of integrated circuits.

The Micralign instrument has proven to be extremely reliable and we reinforce this reliability with service training seminars and a team of experienced service engineers. In addition, if parts are needed, they are immediately available from our large inventory.

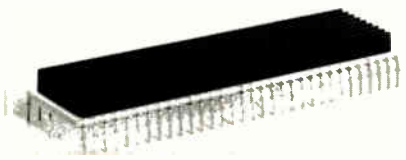
Perkin-Elmer has introduced the third generation of the Micralign Projection Mask Alignment System. These models feature a high performance condenser, which can triple previous light output, automatic wafer loading, and 100-mm wafer capability. These developments can also be purchased as conversion kits for most earlier models.

Perkin-Elmer's policy of protecting your original equipment investment is just one of the extra dividends of being a user of a Micralign instrument.

Learn more about how the Micralign Projection Mask Alignment System delivers the economy and efficiency you need. Write the Perkin-Elmer Corporation, Electro-Optical Division, 50 Danbury Road, Wilton, CT 06897, or call (203) 762-6057.

TODAY, 50 IC MANUFACTURERS RELY ON Micralign™ SYSTEMS AT 75 LOCATIONS WORLDWIDE.

PERKIN-ELMER



accumulator to an improved version of an existing 16-bit multiplier, this division of TRW Inc.'s Electronic Group follows a path similar to one it took with earlier devices, starting in 1976.

Pacing market strategy is "a quantum-level improvement in technology since the first multiplier came out two years ago," says William M. Koral, manager of product applications. "This allows more functions and higher speed at lower power." The new 16-bit TDC-1010J accumulates as well as multiplies in the 115 ns, consuming 3 w, while the older NPY16 only multiplies, taking 160 ns and using 4 w.

Device improvements derive from advances in photolithographic processing, mainly in better projection-alignment equipment and noncontact masks, according to Koral. Line widths are halved to 2 μm, permitting active-device base areas to be reduced by two thirds. For instance, npn transistors are now 1.5 mil^2 instead of 4 to 5 mil^2, he says. Such reductions cut signal transit time, thus leading to the boost in speed and greatly helping in adding the accumulator.

The need for the two-function device became apparent during discusions with buyers of multipliers, who sought sheer speed for such complex digital signal-processing jobs as fast Fourier transform filtering. To accumulate sums of products performed by the multipliers, many were using separate chip sets, TRW marketers found.

"They were holding these sums off board and processing again, but it turns out that integrating an accumulator is not too difficult and [the result] is faster than external components," explains Koral. Since accumulator chips come in 4-bit packages, the TRW combination unit replaces up to nine chips in the popular 35-bit configuration.

In performance, the new device also switches to a subtract function by changing one pin and can be used for only one of the three functions. The TEC-1010J has an operating temperature range of $-55°$ to $+125°$ C. Supply voltage is -0.5 to 7 v, and input/outputs are 0 to 5.5 v. In switching, typical output delay time is 25 ns.

Some 25,000 components are contained in the 250-mil^2 device, which comes in a 64-pin dual in-line package. Because the 115-ns speed is almost at 10 megahertz, it performs nearly 10 million operations per second, says Koral.

Price in 100–499 quantities is $205, against a comparable $175 for the 16-bit multiplier. Volume production is scheduled for late next month.

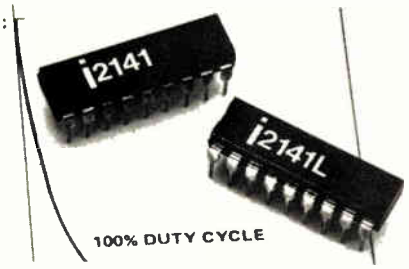
TRW LSI Products, P. O. Box 115, Redondo Beach, Calif. 90278. Phone (213) 535-1831 [412]

4,096-bit static RAM has 120-ns maximum access time

The 2141 family of 4,096-by-1-bit fully static random-access memories comprises seven models with maximum access times from 120 to 250 ns. All seven devices require only a single 5-v power supply, and all are directly compatible with transistor-transistor logic on all inputs and outputs.

The fastest member of the family is the 2141-2 with its 120-ns maximum access time. It has a maximum active current of 70 mA and a maximum standby current of 20 mA.

The remaining six RAMs provide a choice of three access times—150, 200, and 250 ns—each in a standard



If you want to turn tire kickers into car buyers,

find a MOS company that's really up to speed.

Ford Motor Company did.

Anyone who buys a 1978 Continental Mark V has come a long way. And this year, a new option lets him know exactly how much further he can go without running out of gas.

A unique "miles-to-empty" display is controlled by a single 3600-transistor microcircuit, designed specially for Ford by AMI. It processes data from sensors in the car's gas tank and transmission, correlating speed and fuel level to estimate the miles remaining.

For the driver, this means an end to that nervous "can-we-make-it-to-the-next-town" syndrome, and helps him gauge his mpg. Ford, of course, adds another touch of class to a superb automobile—and another selling point to win customers in a highly competitive market.

If you want to get more mileage from your new product, the place to start is AMI. Since 1966, we've developed a variety of ways, using standard or custom circuits, to solve our customers' MOS needs. We have 4, 8 and 16-bit microprocessors ready to program. (The 4-bit S2000 even has a customized I/O.) We can also design a custom circuit for you. Or produce one that you design.

To find out which way is best for you, write AMI Microsystems, Ltd., 108A Commercial Rd., Swindon, Wiltshire, England. Phone (0793) 31345 or 25445. We'll show you how little it takes to make big ideas work.

AMI
MICROSYSTEMS LTD.

Circle 274 on reader service card

FROM LAMBDA

NEW 200 AMP SWITCHING POWER SUPPLY

5 VOLT 200 AMP LGS-G-5-OV-R $1300

THE LGSG PAYS FOR ITSELF WITHIN 18 MONTHS BY CUTTING ELECTRICITY COSTS IN HALF

ONLY THE NEW LGSG HAS THESE EXCLUSIVE FEATURES:

TRUE OVERVOLTAGE PROTECTION

Load protected under any condition of power supply failure

DIGITAL METERS

Switchable voltage or current readout

CONVECTION COOLED

No blowers. No fans

5 YEAR GUARANTEED

LAMBDA ELECTRONICS
DIVISION of Veeco INSTRUMENTS INC

OVER A DECADE OF LAMBDA LEADERSHIP IN MODULAR POWER SUPPLY TECHNOLOGY

NEW IN 1978

200 AMP
SWITCHING POWER SUPPLY

70% EFFICIENCY
LGSG 110/220 VAC
$1300

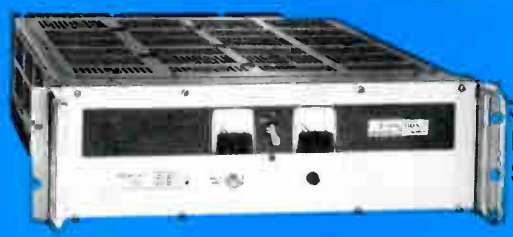
LAMBDA ELECTRONICS
DIVISION of Veeco INSTRUMENTS INC.

1965-66

Silicon modular series

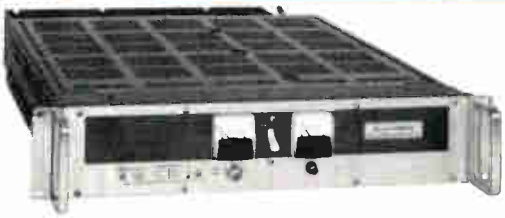
35% Efficiency
$1428

LM-H 110/220 VAC INPUT



35% Efficiency
$899

LM-G 110/220 VAC INPUT



35% Efficiency
$712

LM-F 110/220 VAC INPUT

36% Efficiency
$487

LM-EE 110/220 VAC INPUT

36% Efficiency
$385

LM-E 110/220 VAC INPUT

36% Efficiency
$305

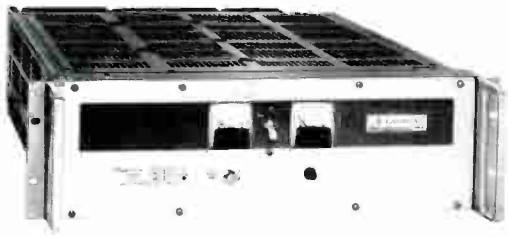
LM-D 110/220 VAC INPUT

36% Efficiency
$193

LMC 110/220 VAC INPUT

1970-71

- regulated power supplies

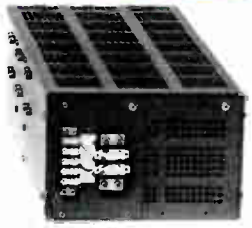


38% Efficiency $1284

LXS-G 110/220 VAC INPUT

38% Efficiency $722

LXS-7 110/220 VAC INPUT



38% Efficiency $599

LXS-EE 110/220 VAC INPUT

38% Efficiency $348

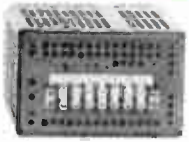
LXS-D 110/220 VAC INPUT

38% Efficiency $300

LXS-CC 110/220 VAC INPUT

38% Efficiency $219

LXS-C 110/220 VAC INPUT

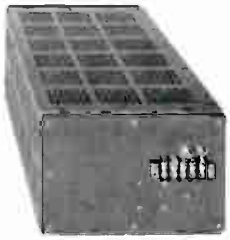


38% Efficiency $182

LXS-B 110/220 VAC INPUT

1976-

Switching power supplies



70% Efficiency $715

LGS-EE 110/220 VAC INPUT OR 44-58 VDC INPUT

70% Efficiency $594

LGS-6 110/220 VAC INPUT OR 44-58 VDC INPUT

70% Efficiency $440

LGS-5 110/220 VAC OR 20.5-32 VDC OR 44-58 VDC INPUT

70% Efficiency $298

LJS-12 110/220 VAC 130-160 VDC INPUT

70% Efficiency $247

LJS-11 110/220 VAC 130-160 VDC INPUT

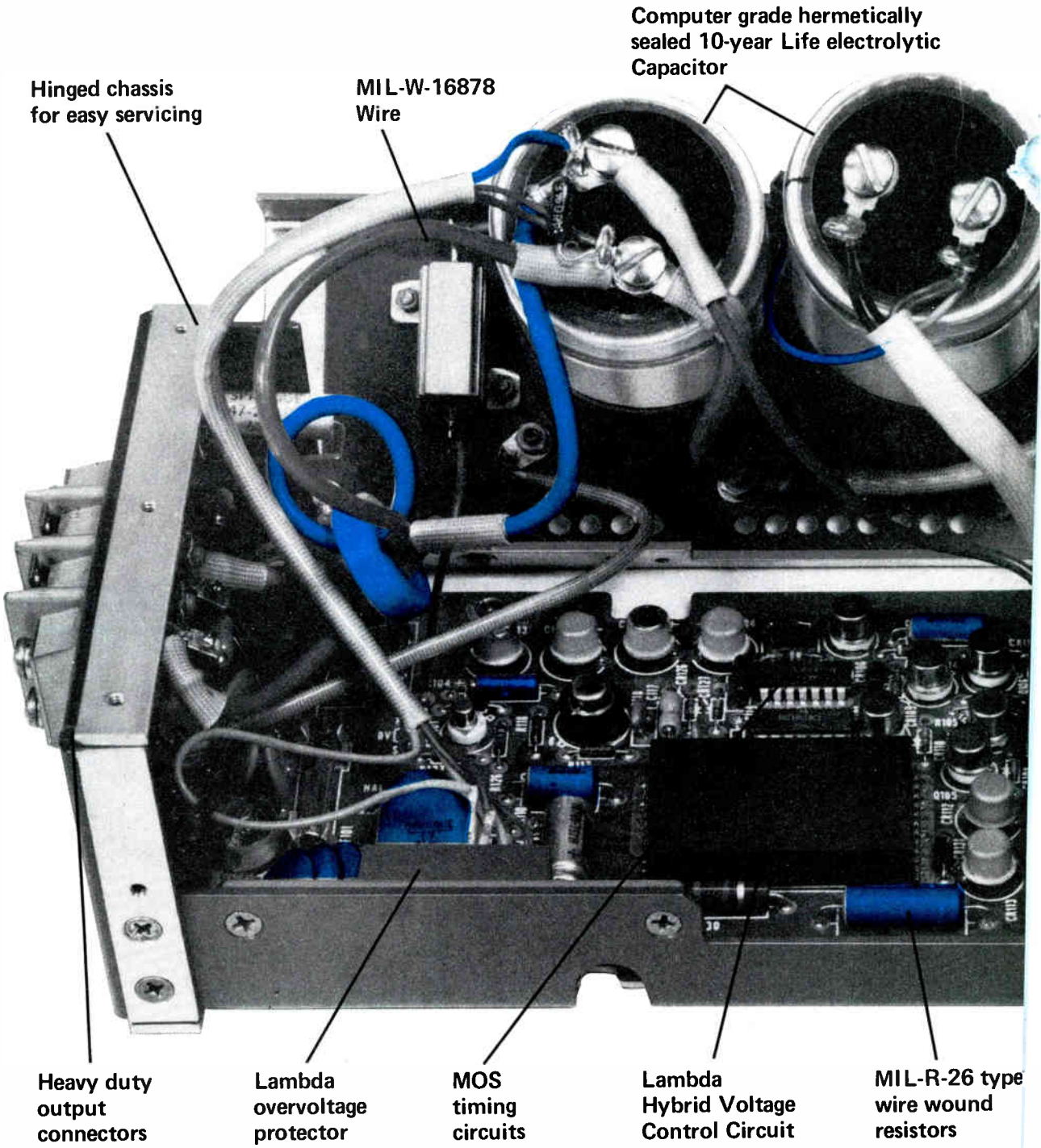
70% Efficiency $202

LJS-10 110/220 VAC 130-160 VDC INPUT

60% Efficiency $157

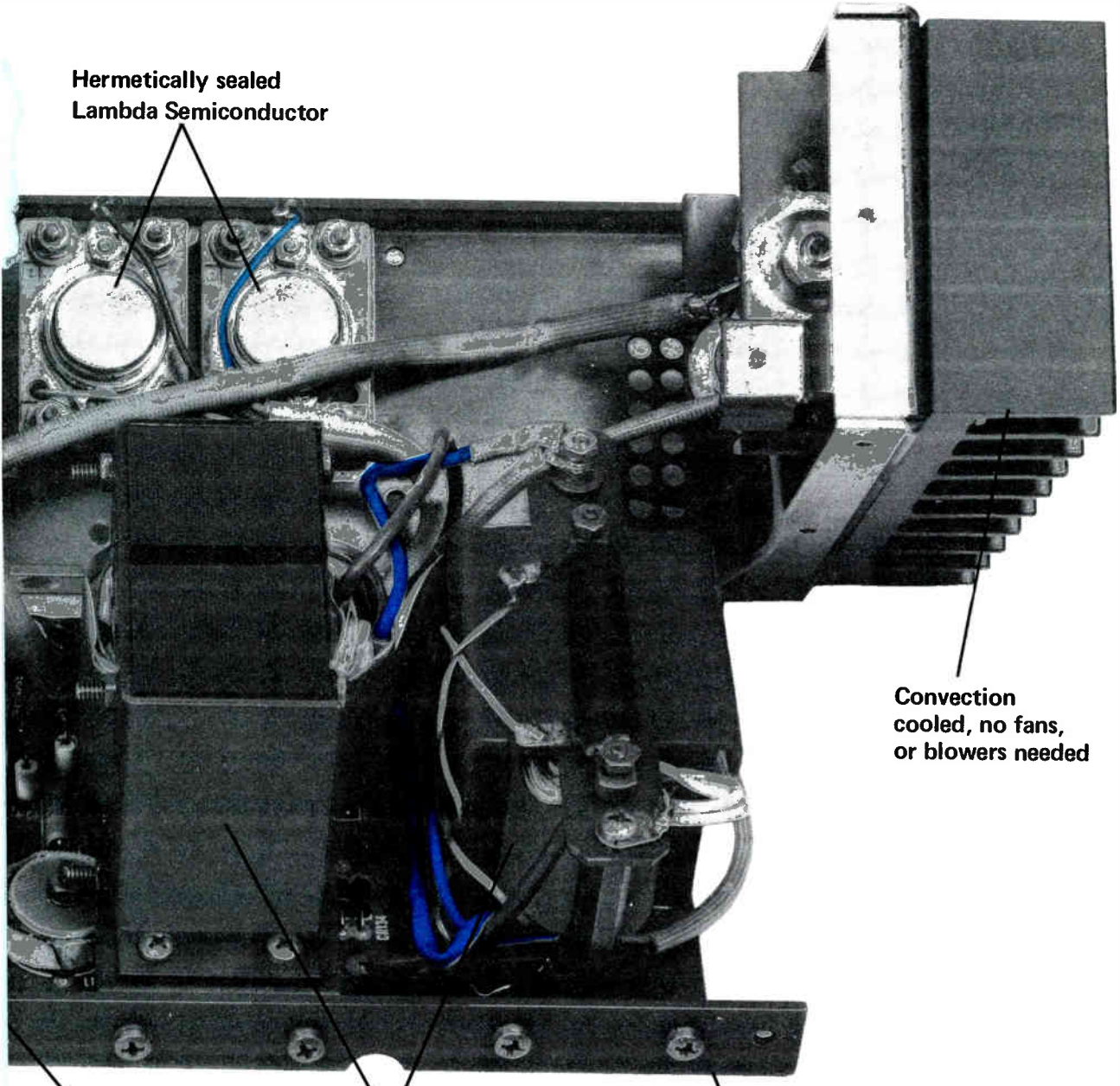
LJS-13 110/220 VAC 130-160 VDC INPUT

Here's why Lambda LG series the most advanced switching



†LICENSEE OF PHOTOCIRCUITS INC.

switching power supplies are power supplies in the world.



Features of LG Series

- 98 models, 4 package sizes
- up to 200 Amps, up to 28 volts
- input 20.5-32, 44-58 VDC as well as 105-132 VAC/187-242 VAC/ 205-265 VAC
- hi-reliability obtained thru new advanced circuitry
- less than 120 components for LGS-5
  less than 140 components for LGS-6
  less than 160 components for LGS-EE
  less than 200 components for LGS-G
- convection-cooled, no fans or blowers needed
- meets mil spec MIL-I-6181D EMI conducted
- designed to meet MIL-STD-810B
- efficiency up to 75%
- density up to 1.2 watts/cu in
- 5 year guarantee
- serviceability—designed for ease of field repair
- built-in 0V shuts down inverter and crowbars output voltage
- power failure hold-up time (see curve)
- fungus proofing standard
- 20 KHz switching
- vacuum varnished impregnated transformer
- hermetically sealed Lambda semiconductors
- listed in UL recognized component index
- CSA certified

Features of LJ Series

- 56 models, 4 package sizes
- up to 30 amps, up to 28 volts
- 20 KHz switching
- built-in 0V shuts down inverter and crowbars output voltage
- efficiency—greater than 70%
- convection-cooled, no fans or blower necessary
- serviceability—designed for ease of field repair
- power failure hold-up time: 16 msec
- AC input 105-132/187-265 VAC
- reg-0.4%
- ripple—10 mV rms
- listed in UL recognized component index
- guaranteed for 5 years

Voltage and Current Ratings

AC INPUT 105-132 VAC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (Inches)	PRICE
LJS-13-5-0V	0.4%, 0.4%	10	5.0	5.0	4.0	2.8	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-5-0V	0.4%, 0.4%	10	10.0	10.0	8.0	5.5	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-5-0V	0.4%, 0.4%	10	20.0	20.0	16.0	11.0	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-5-0V	0.4%, 0.4%	10	30.0	30.0	24.0	16.5	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-5-0V-R	0.1%, 0.1%	10	45.0	38.0	31.0	21.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-5-0V-R	0.1%, 0.1%	10	70.0	61.0	51.0	38.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-5-0V-R	0.1%, 0.1%	10	110.0	100.0	86.0	72.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-5-0V-R	0.1%, 0.1%	10	200.0	180.0	155.0	130.0	G	5 3/16 X 19 X 14	1300

6 VOLTS ± 5% ADJ

LJS-13-6-0V	0.4%, 0.4%	10	4.1	4.1	3.3	2.3	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-6-0V	0.4%, 0.4%	10	8.3	8.3	6.6	4.5	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-6-0V	0.4%, 0.4%	10	16.7	16.7	13.3	9.2	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-6-0V	0.4%, 0.4%	10	25.0	25.0	20.0	13.7	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-6-0V-R	0.1%, 0.1%	10	38.0	33.0	26.0	18.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-6-0V-R	0.1%, 0.1%	10	60.0	56.0	49.0	36.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-6-0V-R	0.1%, 0.1%	10	100.0	90.0	80.0	65.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-6-0V-R	0.1%, 0.1%	10	170.0	151.0	132.0	109.0	G	4 3/16 X 19 X 14	1300

12 VOLTS ± 5% ADJ

LJS-13-12-0V	0.4%, 0.4%	15	2.0	2.0	1.7	1.1	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-12-0V	0.4%, 0.4%	15	4.2	4.2	3.4	2.3	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-12-0V	0.4%, 0.4%	15	8.3	8.3	6.6	4.5	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-12-0V	0.4%, 0.4%	15	12.5	12.5	10.0	6.8	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-12-0V-R	0.1%, 0.1%	15	24.0	20.0	16.0	11.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-12-0V-R	0.1%, 0.1%	15	37.5	35.0	30.5	23.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-12-0V-R	0.1%, 0.1%	15	60.0	53.0	46.0	38.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-12-0V-R	0.1%, 0.1%	15	105.0	95.0	85.0	70.0	G	4 3/16 X 19 X 14	1300

15 VOLTS ± 5% ADJ

LJS-13-15-0V	0.4%, 0.4%	15	1.6	1.6	1.3	0.9	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-15-0V	0.4%, 0.4%	15	3.3	3.3	2.6	1.8	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-15-0V	0.4%, 0.4%	15	6.7	6.7	5.3	3.7	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-15-0V	0.4%, 0.4%	15	10.0	10.0	8.0	5.5	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-15-0V-R	0.1%, 0.1%	15	18.7	16.5	13.2	9.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-15-0V-R	0.1%, 0.1%	15	30.0	28.0	24.5	20.5	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-15-0V-R	0.1%, 0.1%	15	47.0	42.0	36.0	30.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-15-0V-R	0.1%, 0.1%	15	85.0	75.0	65.0	55.0	G	4 3/16 X 19 X 14	1300

20 VOLTS ± 5% ADJ

LJS-13-20-0V	0.4%, 0.4%	15	1.2	1.2	1.0	0.7	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-20-0V	0.4%, 0.4%	15	2.5	2.5	2.0	1.4	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-20-0V	0.4%, 0.4%	15	5.0	5.0	4.0	2.7	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-20-0V	0.4%, 0.4%	15	7.5	7.5	6.0	4.1	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-20-0V-R	0.1%, 0.1%	15	13.5	11.5	9.3	6.3	5	3 3/16 X 4 15/16 X 15	440
LGS-6-20-0V-R	0.1%, 0.1%	15	23.0	21.5	18.5	15.5	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-20-0V-R	0.1%, 0.1%	15	34.0	30.0	26.0	22.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-20-0V-R	0.1%, 0.1%	15	62.0	55.0	48.0	40.0	G	4 3/16 X 19 X 14	1300

24 VOLTS ± 5% ADJ

LJS-13-24-0V	0.4%, 0.4%	15	1.0	1.0	0.8	0.6	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-24-0V	0.4%, 0.4%	15	2.1	2.1	1.7	1.2	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-24-0V	0.4%, 0.4%	15	4.2	4.2	3.3	2.3	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-24-0V	0.4%, 0.4%	15	6.3	6.3	5.0	3.4	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-24-0V-R	0.1%, 0.1%	15	11.5	9.9	7.9	5.4	5	3 3/16 X 4 15/16 X 15	440
LGS-6-24-0V-R	0.1%, 0.1%	15	20.0	19.0	16.0	13.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-24-0V-R	0.1%, 0.1%	15	30.0	27.0	23.0	19.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-24-0V-R	0.1%, 0.1%	15	54.0	48.0	42.0	35.0	G	4 3/16 X 19 X 14	1300

28 VOLTS ± 5% ADJ

LJS-13-28-0V	0.4%, 0.4%	15	0.9	0.9	0.7	0.5	13	4 3/4 X 1 25/32 X 6 5/16	$140
LJS-10-28-0V	0.4%, 0.4%	15	1.8	1.8	1.4	1.0	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-28-0V	0.4%, 0.4%	15	3.6	3.6	2.9	2.0	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-28-0V	0.4%, 0.4%	15	5.4	5.4	4.3	3.0	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-28-0V-R	0.1%, 0.1%	15	9.6	8.2	6.6	4.5	5	3 3/16 X 4 15/16 X 15	440
LGS-6-28-0V-R	0.1%, 0.1%	15	17.5	16.5	14.5	12.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-28-0V-R	0.1%, 0.1%	15	25.0	23.0	20.0	16.0	EE	4 15/16 X 7 1/2 X 16 1/2	715
LGS-G-28-0V-R	0.1%, 0.1%	15	46.0	42.0	36.0	30.0	G	4 3/16 X 19 X 14	1300

Voltage and Current Ratings

DC INPUT 20.5-32 VDC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE (mV RMS)	MAX AMPS AT AMBIENT OF 40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
.GS-5-5-C-OV-R	0.1%, 0.1%	10	35.0	31.0	25.0	16.5	5	3 3/16 x 4 15/16 x 15	$495

5 VOLTS ± 5% ADJ

.GS-5-6-C-OV-R	0.1%, 0.1%	10	29.0	26.0	21.0	14.0	5	3 3/16 x 4 15/16 x 15	$495

12 VOLTS ± 5% ADJ

.GS-5-12-C-OV-R	0.1%, 0.1%	15	15.0	13.5	10.0	7.0	5	3 3/16 x 4 15/16 x 15	$495

15 VOLTS ± 5% ADJ

.GS-5-15-C-OV-R	0.1%, 0.1%	15	13.0	11.0	8.0	5.6	5	3 3/16 x 4 15/16 x 15	$495

20 VOLTS ± 5% ADJ

.GS-5-20-C-OV-R	0.1%, 0.1%	15	10.5	9.0	7.0	4.5	5	3 3/16 x 4 15/16 x 15	$495

24 VOLTS ± 5% ADJ

.GS-5-24-C-OV-R	0.1%, 0.1%	15	8.5	7.5	6.0	3.9	5	3 3/16 x 4 15/16 x 15	$495

28 VOLTS ± 5% ADJ

.GS-5-28-C-OV-R	0.1%, 0.1%	15	7.5	6.8	5.4	3.5	5	3 3/16 x 4 15/16 x 15	$495

DC INPUT 44-58 VDC STANDARD

5 VOLTS ± 5% ADJ

.GS-5-5-D-OV-R	0.1%, 0.1%	10	40.0	32.0	25.0	16.5	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-5-D-OV-R	0.1%, 0.1%	10	60.0	53.0	45.0	36.0	6	3 3/16 x 7 1/2 x 15 1/8	605
.GS-EE-5-D-OV-R	0.1%, 0.1%	10	90.0	85.0	73.0	54.0	EE	4 15/16 x 7 1/2 x 16 1/2	770

6 VOLTS ± 5% ADJ

.GS-5-6-D-OV-R	0.1%, 0.1%	10	35.0	28.0	21.5	14.0	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-6-D-OV-R	0.1%, 0.1%	10	50.0	46.0	41.0	35.0	6	3 3/16 x 7 1/2 x 15 1/8	605
.GS-EE-6-D-OV-R	0.1%, 0.1%	10	78.0	67.0	56.0	42.5	EE	4 15/16 x 7 1/2 x 16 1/2	770

12 VOLTS ± 5% ADJ

.GS-5-12-D-OV-R	0.1%, 0.1%	15	17.5	14.0	10.8	7.0	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-12-D-OV-R	0.1%, 0.1%	15	31.0	28.0	24.0	18.0	6	3 3/16 x 7 1/2 x 15 1/8	$605
.GS-EE-12-D-OV-R	0.1%, 0.1%	15	39.0	33.5	28.0	21.0	EE	4 15/16 x 7 1/2 x 16 1/2	770

15 VOLTS ± 5% ADJ

.GS-5-15-D-OV-R	0.1%, 0.1%	15	14.0	11.0	8.6	5.6	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-15-D-OV-R	0.1%, 0.1%	15	25.0	23.0	20.0	15.0	6	3 3/16 x 7 1/2 x 15 1/8	605
.GS-EE-15-D-OV-R	0.1%, 0.1%	15	32.0	28.0	23.5	17.5	EE	4 15/16 x 7 1/2 x 16 1/2	770

20 VOLTS ± 5% ADJ

.GS-5-20-D-OV-R	0.1%, 0.1%	15	11.5	9.3	7.1	4.6	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-20-D-OV-R	0.1%, 0.1%	15	19.0	18.0	16.0	12.0	6	3 3/16 x 7 1/2 x 15 1/8	605
.GS-EE-20-D-OV-R	0.1%, 0.1%	15	26.0	22.5	18.5	14.0	EE	4 15/16 x 7 1/2 x 16 1/2	770

24 VOLTS ± 5% ADJ

LGS-5-24-D-OV-R	0.1%, 0.1%	15	9.8	7.8	6.1	3.9	5	3 3/16 x 4 15/16 x 15	$440
LGS-6-24-D-OV-R	0.1%, 0.1%	15	16.0	15.0	13.0	10.0	6	3 3/16 x 7 1/2 x 15 1/8	605
LGS-EE-24-D-OV-R	0.1%, 0.1%	15	21.5	18.5	15.5	11.5	EE	4 15/16 x 7 1/2 x 16 1/2	770

28 VOLTS ± 5% ADJ

.GS-5-28-D-OV-R	0.1%, 0.1%	15	8.7	7.0	5.4	3.5	5	3 3/16 x 4 15/16 x 15	$440
.GS-6-28-D-OV-R	0.1%, 0.1%	15	14.0	13.0	11.0	9.0	6	3 3/16 x 7 1/2 x 15 1/8	605
.GS-EE-28-D-OV-R	0.1%, 0.1%	15	19.5	17.0	14.0	10.5	EE	4 15/16 x 7 1/2 x 16 1/2	770

Voltage and Current Ratings

AC INPUT 187-242 VAC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)		PRICE
LGS-5V-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	5	3 3/16 x 4 15/16 x 15		$492
LGS-6V-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2	6	3 3/16 x 7 1/2 x 15 1/8		665
6 VOLTS ± 5% ADJ										
LGS-5V-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	5	3 3/16 x 4 15/16 x 15		492
LGS-6V-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.1	32.4	6	3 3/16 x 7 1/2 x 15 1/8		665
12 VOLTS ± 5% ADJ										
LGS-5V-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	5	3 3/16 x 4 15/16 x 15		492
LGS-6V-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7	6	3 3/16 x 7 1/2 x 15 1/8		665
15 VOLTS ± 5% ADJ										
LGS-5V-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	5	3 3/16 x 4 15/16 x 15		492
LGS-6V-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4	6	3 3/16 x 7 1/2 x 15 1/8		665
20 VOLTS ± 5% ADJ										
LGS-5V-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	5	3 3/16 x 4 15/16 x 15		492
LGS-6V-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9	6	3 3/16 x 7 1/2 x 15 1/8		665
24 VOLTS ± 5% ADJ										
LGS-5V-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	5	3 3/16 x 4 15/16 x 15		492
LGS-6V-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7	6	3 3/16 x 7 1/2 x 15 1/8		665
28 VOLTS ± 5% ADJ										
LGS-5V-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	5	3 3/16 x 4 15/16 x 15	116	492
LGS-6V-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8	6	3 3/16 x 7 1/2 x 15 1/8	116	665

AC INPUT 205-265 VAC STANDARD

5 VOLTS ± 5% ADJ

LGS-5V1-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	5	3 3/16 x 4 15/16 x 15	$492
LGS-6V1-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2	6	3 3/16 x 7 1/2 x 15 1/8	665
6 VOLTS ± 5% ADJ									
LGS-5V1-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.1	32.4	6	3 3/16 x 7 1/2 x 15 1/8	665
12 VOLTS ± 5% ADJ									
LGS-5V1-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7	6	3 3/16 x 7 1/2 x 15 1/8	665
15 VOLTS ± 5% ADJ									
LGS-5V1-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4	6	3 3/16 x 7 1/2 x 15 1/8	665
20 VOLTS ± 5% ADJ									
LGS-5V1-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9	6	3 3/16 x 7 1/2 x 15 1/8	665
24 VOLTS ± 5% ADJ									
LGS-5V1-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7	6	3 3/16 x 7 1/2 x 15 1/8	665
28 VOLTS ± 5% ADJ									
LGS-5V1-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	5	3 3/16 x 4 15/16 x 15	492
LGS-6V1-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8	6	3 3/16 x 7 1/2 x 15 1/8	665

SPECIFICATIONS OF LG SERIES

DC output
voltage range shown in tables

Regulated voltage

regulation line	0.1% for 105 to 132 VAC, 187-242 VAC, 205-265 VAC
regulation load	0.1% for 0 to full load
ripple and noise	10mV RMS, 35 mV p-p for 5 and 6V units 15mV RMS, 100mV p-p for 12 thru 28V units
remote programming resistance	1000 ohms/volt
remote programming voltage	volt per volt

Temperature coefficient
0.03% per°C

AC input

line	105-132 VAC, 47-440 Hz
power	360 watts max. at 0.6 P.F. for LGS-5 750 watts max. at 0.7 P.F. for LGS-6 1100 watts max. at 0.6 P.F. for LGS-EE 1800 watts max. at 0.7 P.F. for LGS-G

DC input
20.5-32 VDC, LGS-5-C packages only. Input voltage specs. comply with minimum usable voltage for lead acid batteries.
44-58 VDC. "D" models only.
145 VDC ± 10%, LGS-5, LGS-6 packages only.

Efficiency
64% minimum except LGS-EE-D and LGS-6-D which are 60% minimum and LGS-5-C which is 55% minimum.

Soft-start circuit: (LGS-6,LGS-6V,LGS-EE,LGS-G only)
limits in-rush current at turn-on.

Overshoot
no overshoot at turn-on, turn-off or power failure.

Ambient operating temperature
continuous duty 0° to 71°C.

Storage temperature range
−55°C to +85°C

Overload protection
Electrical
pre-set electronic current limiting at factory. Internal failure protection by means of line fuse.
Thermal
by self-resetting thermostat on heat sink.

Overvoltage protection
built-in fixed overvoltage protection standard on all units. When a pre-set voltage is exceeded, the overvoltage protector crowbars the output and removes the inverter drive.

EMI
Conducted – conforms to MIL-I-6181D.
Radiated – see graphs for performance.

Cooling – convection cooled.

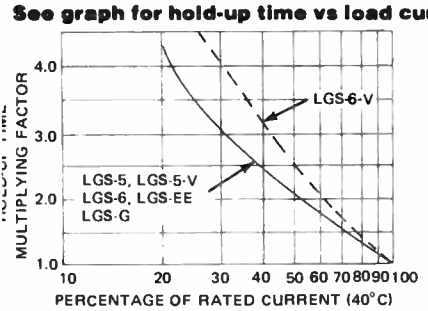
DC output controls
simple screwdriver voltage adjustment over the voltage range.

Metering (LGS-G only)
digital panel meter monitors output voltage/current by means of a Volt/Amp selector switch

Input and output connections
by heavy duty barrier strip; heavy duty studs on all LGS-6 and EE.

Mounting
two mounting surfaces, three mounting positions for LGS-5, one mounting position for LGS-5V, 6, 6V, 6D, EE, EED and G. For LGS-5-C models derate current 10% for mounting positions in which the radiator fins are not vertical.

Power failure
See graph for hold-up time vs load current on all units. (Except LGS-C and LGS-D models).



HOLD-UP TIME AT 100% RATED 40°C CURRENT (IN MILLISECONDS)

MODEL	SERIES LGS-5	LGS-5-V	LGS-6	LGS-EE	LGS-6-V	LGS-G
–5–OV–R		16.5	18.0	16.5	24.0	16.5
–6–OV–R		16.5	17.5	9.4	23.0	16.5
–12–OV–R		5.0	3.0	9.3	7.0	1.0
–15–OV–R		5.0	4.5	8.3	8.0	2.0
–20–OV–R		5.0	6.0	5.0	10.0	6.0
–24–OV–R		5.0	2.0	2.5	8.0	5.0
–28–OV–R		5.0	1.0	7.0	8.0	5.0

Hold-up times as a function of load current.

Remote sensing
provision is made for remote sensing to eliminate effects of power output lead resistance on DC regulation.

Fungus proofing
all units are rendered fungi inert.

Military Specifications
The LGS series has passed the following tests in accordance with MIL-STD-810C.

1) Low Pressure – Method 500.1, Procedure I.
2) High Temperature – Method 501.1, Procedure I & II.
3) Low Temperature – Method 502.1, Procedure I.
4) Temperature Shock - Method 503.0, Procedure I.
5) Temperature – Altitude – Method 504.1, Procedure I. Class 2 (0°C operating)
6) Humidity – Method 507.1, Procedure I.
7) Fungus – Method 508.1, Procedure I.
8) Vibration – Method 514.2, Procedures X & XI.
9) Shock - Method 516.2, Procedures I & III.

MIL-1-6181D – Conducted and radiated EMI with one output terminal grounded.

Physical Data

Package Model	Size (inches)	Weight Net (lbs)	Weight Ship (lbs)
LGS-5	3 3/16 x 4 15/16 x 15	13 1/2	15
LGS-6	3 3/16 x 7 1/2 x 15 1/8	20	23
LGS-EE	4 15/16 x 7 1/2 x 16 1/2	26	31
LGS-G	5 3/16 X 19 X 14	42	45

Options

AC input
For LGS-EE models only

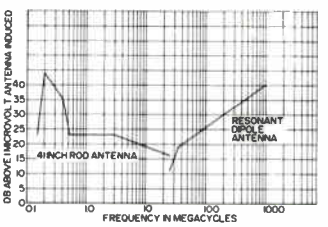
Add Suffix	For Operation at:	Price Qty 1-14	Price Mixed Models Qty 15 & up	Price Single Model Qty 15 & up
–V	187-242VAC 47-440Hz	12% or $30†	12% or $30†	10% or $30†
–V1	205-265 VAC 47-440Hz	12% or $30†	12% or $30†	10% or $30†

*derate 10% for V option only † whichever is greater

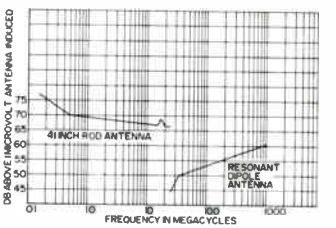
Accessories
overvoltage protection built-in and standard on all models. Rack adapters available.

Guaranteed for 5 years
5 year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

UL/CSA
Listed in UL recognized components index; CSA certified



Narrow band (cw) radiated interference limits



Broadband and pulsed cw radiated interference limits

SPECIFICATIONS OF LJ SERIES

DC output

voltage range: refer to tables

regulation, line	0.4% for line variations from 105-132VAC.
regulation, load	0.4% for load variations from 0 to full load
remote programming resistance	1000 ohms/volt
remote programming voltage	volt/volt
ripple and noise	10mV rms, 50 mV p-p for 5V and 6V models; 15 mV rms, 100 mV p-p for 12V to 28V models.
temperature coefficient	0.03%/°C.
power failure	output will remain within regulation for 16 msec after power failure.

AC input

line	105-132 VAC 47-440 Hz
hold up time	16 msec min at low line and full load, and V_o max.

DC input

145 VDC ± 10%

Overshoot

no overshoot on turn-on, turn-off, or power failure

Efficiency

greater than70% (60% FOR LJS-13) with advanced 20 KHz switching circuitry

Ambient operating temperature range

continuous duty from 0°C to 71°C with load current ratings as shown in tables

Storage temperature range

-55°C to 85°C

Overload protection

Electrical

external overload protection: automatic factory preset electronic current limiting circuit limits the output current thereby providing protection for the load as well as the power supply.

internal failure protection: provided by fuse.

Input and output connections

heavy duty terminal block on front of chassis.

Controls

DC output controls

simple screwdriver voltage adjustment over the voltage range

Remote sensing

provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

Remote shutdown

capability of remote on-off control for either positive ground or negative ground output.

Overvoltage protection

built in fixed overvoltage protection on all model outputs.

Mounting

One mounting surface.

Options

AC input

Add Suffix	For Operation at:	Price Qty. 1-14	Price Mixed Models Qty. 15 and up	Price Single Model Qty. 15 and up
–V	187-265 VAC 47-440 Hz	12% or $30*	12% or $30*	10% or $30*

*whichever is greater

See Physical Data below for sizes of "V" option power supplies — The "V" option supplies sizes are larger than equivalent standard power supplies.

Physical Data

Package Model	Weight (lbs.) net	Size (inches)
LJ-13	1.6	4 3/4 X 1 25/32 X 6 5/16
LJ-13-V	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10-V	3.0	4 3/4 X 1 25/32 X 9 1/16
LJ-11	5.5	4 3/4 X 4 5/16 X 7 15/16
LJ-11-V	7.0	4 3/4 X 4 5/16 X 9 1/16
LJ-12	7.0	4 3/4 X 6 1/4 X 7 15/16
LJ-12-V	8.5	4 3/4 X 6 1/4 X 9 1/16

Finish

gray, Fed. Std. 595 No. 26081.

UL

Listed in Underwriter's Laboratories Recognized Components Index.

Guaranteed for 5 years

5 year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

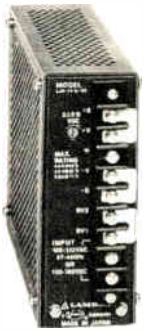
ONLY LAMBDA'S LJ SERIES SWITCHING POWER SUPPLIES

50,000 HOURS MTBF* DEMONSTRATED

LJS-12
30A

LJS-11
20A

LJS-10
10A



LJS-13
5A

*CONDITIONS: FULL LOAD — 40°C RATINGS — 115 VOLT AC INPUT — CONFIDENCE LEVEL: 60%

THE BROADEST LINE OF SWITCHING POWER SUPPLIES IN THE WORLD

⚠Lambda staffed sales and service offices

1
ATLANTIC REGION
Melville, New York 11746
515 Broad Hollow Road
Tel 516 694 4200
TWX 510 224 6484

Long Island, N.Y.; New York, N.Y.; Northern New Jersey
Tel 516-694-4200

Delaware; Eastern Pennsylvania; Southern New Jersey
Tel 215 279 5644

Maryland; Dist. of Columbia; Northern Virginia
Tel 703 451 9340

Southern Virginia; North & South Carolina; Alabama; Georgia; Tennessee; Mississippi
Tel 704 542 1991

Largo, Florida
Tel 813 596 5151

Poughkeepsie, New York
Tel 914 297 4800

2
NORTH-EASTERN REGION
Lexington, Massachusetts 02173
2 Militia Drive
Tel 617 861 8585
TWX 710 326 7558

Rochester, New York
Tel 716 454 6770

3
SOUTH-WESTERN REGION
Dallas, Texas 75231
6950 Winchester
Tel 214 341 5130
TWX 910 861 9048

Houston, Texas
Tel 713 464 6554

Oklahoma
Tel Enterprise 2 183

4
MID-WESTERN REGION
Arlington Heights, Ill. 60005
2420 East Oakton St Unit O
Tel 312 593 2550
TWX 910 222 2856

Minneapolis, Minnesota
Tel 612 935 6194

Cleveland, Ohio; Western Pennsylvania
Tel 216 585 7808

5
FAR-WESTERN REGION
Carson, Calif. 90746
20601 S Annalee Ave
Tel 213-537-8341
TWX 910-346-7649

Denver, Colorado
Tel 303-779-9561

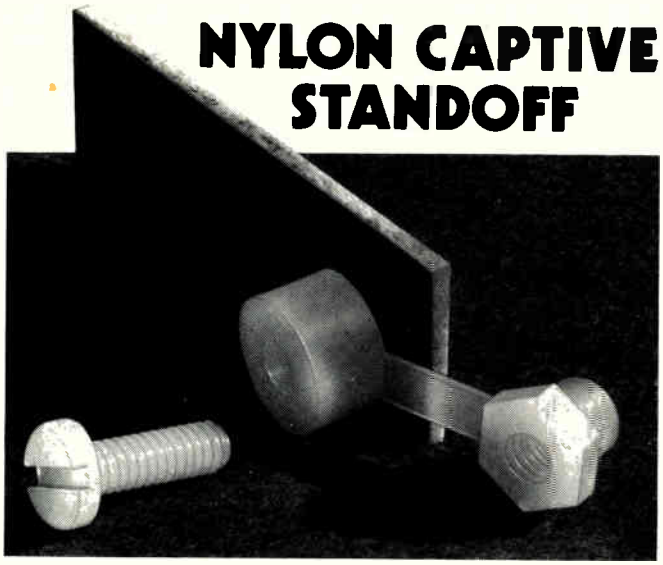
6
NORTH-WESTERN REGION
Sunnyvale, California 94086
599 N Mathilda Ave Suite 210
Tel 408 738 2541
TWX 910 339 9243

LAMBDA MANUFACTURING PLANTS
Melville, N.Y.
Plant I 515 Broad Hollow Rd
Plant II 1770 Walt Whitman Rd
Reynosa, Mexico
Corpus Christi, Texas
121 International Dr

⚠ LAMBDA
ELECTRONICS
DIVISION of Veeco INSTRUMENTS INC

PRINTED IN USA

NYLON CAPTIVE STANDOFF



Designed to eliminate mounting problems in hard-to-reach locations. Especially suited for use as a spacer in separating or stacking PC boards ... also for any type of application requiring components to be rigidly mounted and at same time be electrically isolated. All nylon ... 4 sizes, 1/4", 3/8", 1/2" and 1", for both 6-32 and 8-32 screws.

FREE SAMPLES — write for sample packet, literature and prices.

Weckesser COMPANY, Inc.

4444 West Irving Park Road • Chicago, Illinois 60641 • 312/282-8626

Circle 76 on reader service card

Buzzzz.
(Write for new catalog.)

Solid state electronic MICRO-BUZZER from CITIZEN: High reliability, competitively priced with immediate delivery.

A complete range: **SMB** 1.5, 6, 12, 24, VDC
RMB 3, 6, 12, 24, VDC
IMB (Intermittent) 6, 12, VDC

CITIZEN

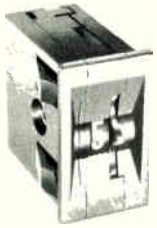
CITIZEN AMERICA CORPORATION
1710 - 22nd St.
Santa Monica, CA 90404
Toll Free (800) 421-6516
In Calif. (213) 829-3541
TWX: (910) 343-6450

Name
Company
Address
City State
Zip Phone

Circle 77 on reader service card

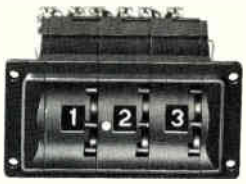
DIGITAL SWITCHES BY EECO

THUMBWHEEL SWITCHES



NEW . . . 8mm WIDE 1800 SERIES

Slim—only .315" (8mm) wide with large .234" high characters. Assemblies snap into panels; no tools or screw holes required. All popular codes. P.C. Board Termination. Front mount.



1776 and 1976 SERIES

1776 series, miniature .500" wide thumbwheel switches offers a selection of over 50 codes, and plastic window dust seal protection. 1976 is a slimmer .350" wide switch with the same advantages. Options include Fast-Mount Hardware, lighting, RFI shielding, stops to limit rotation and notched terminals for direct P.C. Board mounting.

PRINTED CIRCUIT BOARD SWITCHES

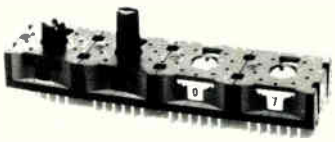
MICRO-DIP

Binary coded dip switch. Solder directly to circuit boards or plug into one-half of a 14-pin socket. 10 and 16-positions, screwdriver setting.

NEW

MINI-DIP

Positive wiping SPST gold contacts give tease-proof reliability. Dust-free design, improved legibility and rocker-locking device. 2-10 stations.



STRIPSWITCHES

Series 21 and 2500 stripswitches mount directly on printed circuit boards. Available in BCD, decimal and other popular 10 and 16-position codes. Screwdriver, thumbwheel and extended knob setting models are available.

One Year Warranty!

EECO

*** FREE** 8-Page Full Color Product Guide

1441 East Chestnut Avenue • Santa Ana, California 92701 • Phone: (714) 835-6000 • TWX 910-595-1550 • Telex 67-8420

Distributed in U.S. by Marshall Industries, Hall-Mark and Schweber. In Canada by R.A.E and Penryn. Agents Throughout The World.

Circle 209 on reader service card

each for the 3.6-to-8-v units. Delivery is from stock to five weeks.

Data Display Products, 303 North Oak St., Inglewood, Calif., 90301. Phone (213) 677-6166 [345]

Dial adjustment eases setting trimming potentiometer

A general-purpose, ½-in.-diameter, single-turn cermet trimming potentiometer has an arrow and dial to indicate the slider position, so that users may specifiy settings and thus reduce tweaking and calibration time during final assembly.

Power of model 93P is rated at 1 w at 70°C. The trimmer is immersion-sealed to maximize stability and

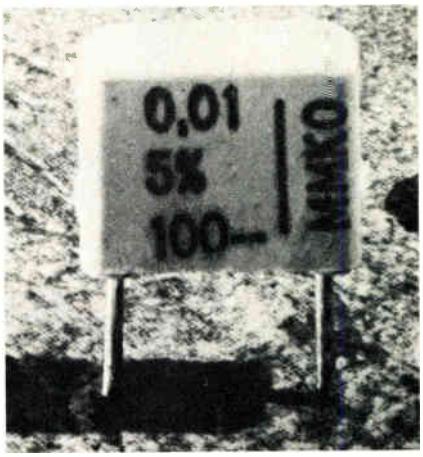
withstand environmental extremes. Temperature range is −55° to 125°C, and voltage adjustability is better than ±0.05%.

Price in quantities of 100 to 199 units is $1.54 each, and delivery is off the shelf.

Beckman Instruments Inc., Helipot Division, 2500 Harbor Blvd., Fullerton, Calif. 92634. Phone (714) 871-4848 [346]

Miniature capacitor line has values from 0.001 to 0.1 mF

A series of radial-lead miniature capacitors, SMMKO, features leads spaced 7.5 mm apart (standard spacing for dual in-line packages) to make them easy to use with printed-circuit boards. The capacitors are constructed of a metalized polyester film and extended foil. They are noninductive as well as self-healing,



and the case is corrosion-resistant and meets Underwriters Laboratory specifications for flammability.

The units are available with capacitance ratings of 0.001 to 0.1 mF in 10% or 20% tolerances. Working voltages are 100 v dc and ture range for this series is −40°C to +100°C.

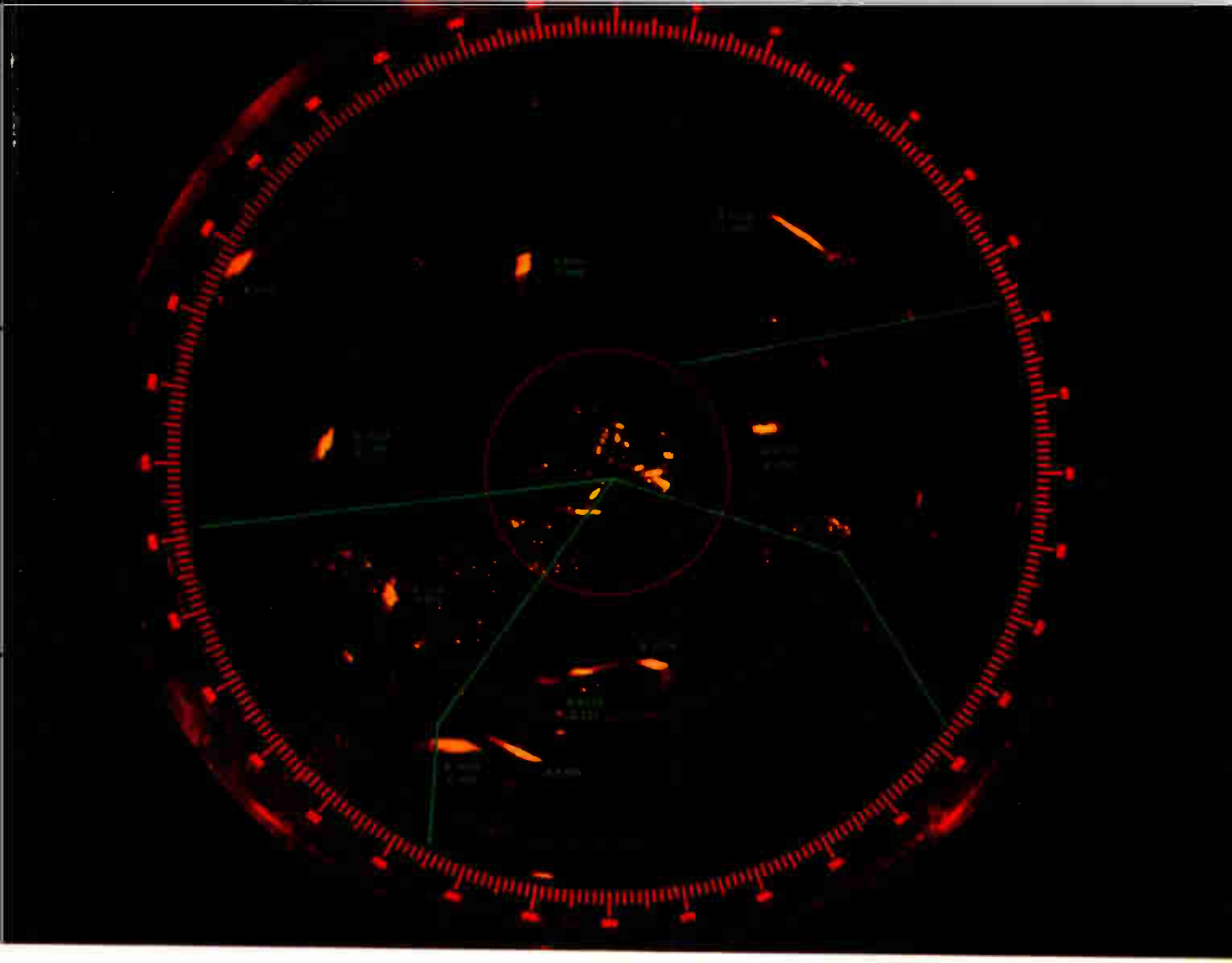
Price is $0.061 each in quantities of 5,000 or more for the 0.01-mF, 20%-tolerance, 100-v dc type. Delivery is from stock to four weeks.

Seacor Inc., 598 Broadway, Norwood, N. J. 07648. Phone (201) 768-6070 [344]

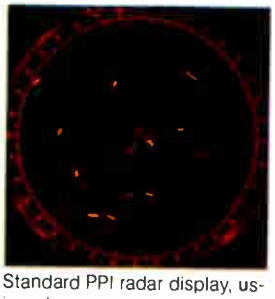
TOPICS

Components

TRW/IRC, Philadelphia, Pa., announces MIL-R-55182 S-level rnc resistors in its thick-film Metal Glaze construction. The move is in response to a recent change in MIL-R-39017, to which ±1%, 100-ppm units were added. . . . **Cornell-Dubilier Electronics, Newark, N. J.,** has gained UL listing for its non-PCB capacitors equipped with an internal protective device. Capacitors contain protective devices designed to prevent the case from rupturing in an internal failure. . . . **TEC Inc., Tucson, Ariz.,** announces compliance with UL specification 1054 and MIL-S8805 for its miniature toggle switches. The switches are made with nickel-plated, brass-toggle handle and threated or plain brass bushings with nickel-plated finish.

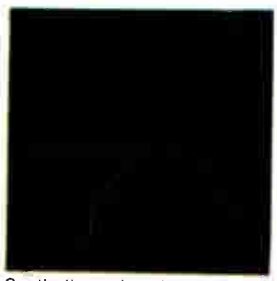


PPI radar + crystal-clear synthetics with THOMSON-CSF's penetration phosphors



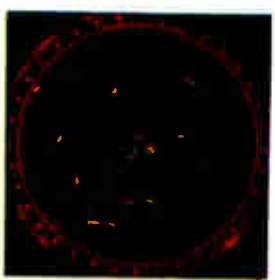
Standard PPI radar display, using long, orange mode of operation (18 kV operating voltage).

+



Synthetic radar data display, using short-persistence, green mode, refreshed at 50 or 60 Hz (9 kV operating voltage).

=



A combined display in which crystal-clear, rapidly changing synthetic data are superimposed on a standard PPI-type display.

me see us at stand 300
SID 78 - April 18-20
YATT REGENCY HOTEL
SAN FRANCISCO

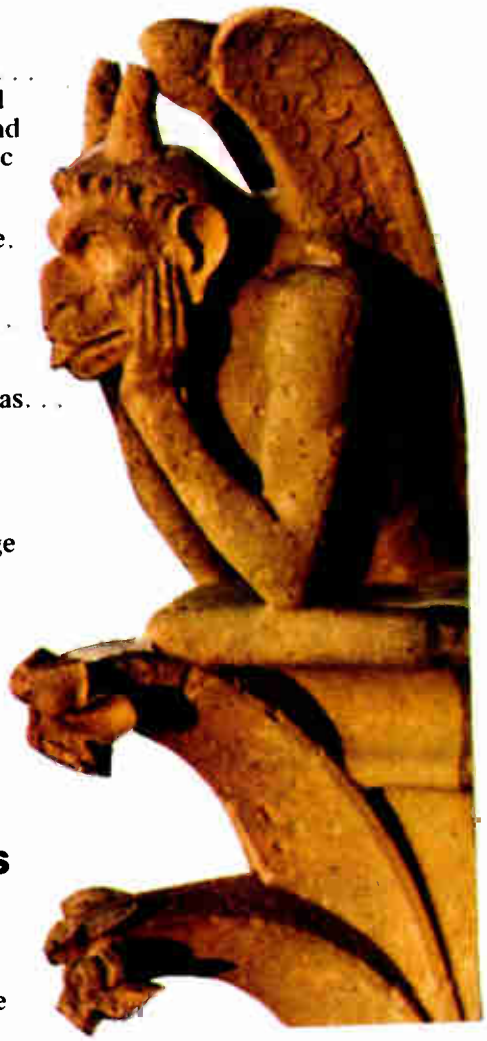
THOMSON-CSF

DUMONT ELECTRON TUBES / 750 BLOOMFIELD AVENUE / CLIFTON NJ 07015 / TEL. : (201) 773.00.00
France - THOMSON-CSF Division Tubes Electroniques / 38, rue Vauthier / 92100 BOULOGNE-BILLANCOURT / Tél. : (1) 604.81.75
Germany - THOMSON-CSF Elektronenröhren GmbH / Leerbachstr. 58 / 6000 FRANKFURT am MAIN.1 / Tel. : (0611) 71.72.81
Italy - THOMSON-CSF Tubi Elettronici SRL / Viale degli Ammiragli 71 / I - 00136 ROMA / Tel. : (6) 638.14.58
Japan - THOMSON-CSF Japan K.K. / TBR Building / Kojimachi 5-7 / Chiyoda-Ku / TOKYO / T 102 / Tel. : (03) 264.63.41
Spain - THOMSON-CSF Tubos Electronicos S.A. / Alcalà 87 / 7° Dcha / MADRID 9 / Tel. : (1) 226.76.09
Sweden - THOMSON-CSF Elektronrör AB / Box 27080 / S 10251 STOCKHOLM 27 / Tel. : (08) 225.815
United Kingdom - THOMSON-CSF Components and Materials Ltd. / Ringway House / Bell Road / BASINGSTOKE RG24 OQG / Tel. : (0256) 29155 / Telex : 858865

3277

"you are today where your thoughts have brought you— you will be tomorrow where your thoughts take you."

(James Allen)



At Northrop, we're thinking about tomorrow. . . and those thoughts are taking us to continued advancements in the research, development and manufacture of highly sophisticated Electronic Countermeasures.

But we know we've only scratched the surface.

In order to maintain our leadership role and achieve new heights in our area of expertise. . . it takes people.

People who are continually exploring new ideas. . . people able to direct their talents toward new discoveries.

If you're an engineer in any of the following areas, and are prepared to accept this challenge and apply your intelligence to creative approaches, consider the key role you can play in advancing the state-of-the-art.

EW SYSTEMS **SOFTWARE**
MICROWAVE **LOGISTICS**
DIGITAL CIRCUIT DESIGN
QUALITY ASSURANCE
RF DESIGN **ELECTRON TUBES**

In addition to an outstanding opportunity with one of the nation's most renowned engineering groups, we offer an excellent salary/benefits program. Qualified individuals are invited to send resume, in confidence, to:

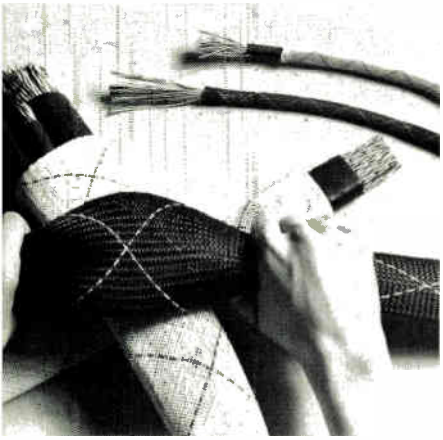
Director of Personnel
Engineering Group
Department E-413
NORTHROP CORPORATION
Defense Systems Division
600 Hicks Road, Rolling Meadows, Illinois 60008

an equal opportunity employer m/f

NORTHROP

New products/materials

A lightweight expandable sleeving protects flat and round cables, wire bundles, and tubes. The open-weave construction of FR-1 makes it flexible and enables it to move easily.



The material has good resistance to degradation by salt water, antifreeze, fuels, and most solvents, which makes it useful for the industrial, marine, and military electronics industries. The polyester material comes in five diameters ranging from ⅛ in. to 2½ in.

Bentley-Harris Manufacturing Co., 241 Welsh Pool Rd., Lionville, Pa. 19353 [476]

High-purity chemicals having a particularly low sodium content can be used in the manufacture of integrated circuits, transistors, rectifiers, and diodes, as well as in etching formulations for silicon. The sodium content of the ammonium fluoride and hydrofluoric acid, for instance, is a maximum of 1 ppm and 0.5 ppm, respectively. The ammonium fluoride sells for $0.55/lb in 1,000-gallon lots, and the hydrofluoric acid sells for $0.58/lb in 1,000-gallon production quantities. A minimum order of $100 is required.

Transene Co., Route One, Rowley, Mass. 01969 [477]

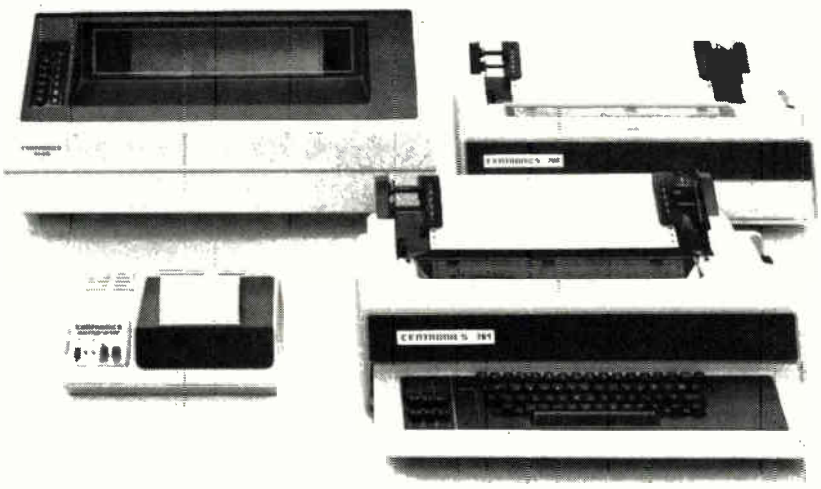
A dry-film adhesive is useful as a temporary mount to hold thin, brittle materials onto a firm backing for dicing, scribing, and slicing. Wafer-Mount 562 can be easily cut to size with a razor or scissors for positioning exactly where the user wants. The material is particularly good

Does "single source" make Centronics better than other printer companies?

NO. Although our 9 model 700 series of matrix printers, 4 model 6000 series of band printers, 760 series teleprinters and new non-impact electrostatic printer give us the most complete line in the industry, it still takes more than breadth of line to be the leader.

Centronics has more. Competitive prices. The largest worldwide service organization of any printer company. Financial stability with a record of growth and strength unmatched in the business. And a track record of superior product reliability and customer support—whether OEM or end-user.

You know the advantages of a single source supply. You know the breadth of Centronics' line. And now you know why Centronics is the better printer company. Write or call today for the complete details of Centronics' full printer line. Centronics Data Computer (U.K.) Ltd., Petersham House, Harrington Road, London. Tel: 01-581 1011. Telex 8951373. Offices in Frankfurt, Paris and Milan.



CENTRONICS® PRINTERS
Simply Better

See us at Hanover Fair Stand C-7107

Circle 223 on reader service card

New literature

Microprogrammed modems. A six-page booklet introduces communications engineers to the features and applications of microprogrammed modems for digital satellite communications. It includes an example of the universal-modem approach for military systems operating in hostile environments. Linkabit Corp., 10453 Roselle St., San Diego, Calif. 92121. Circle reader service number 421.

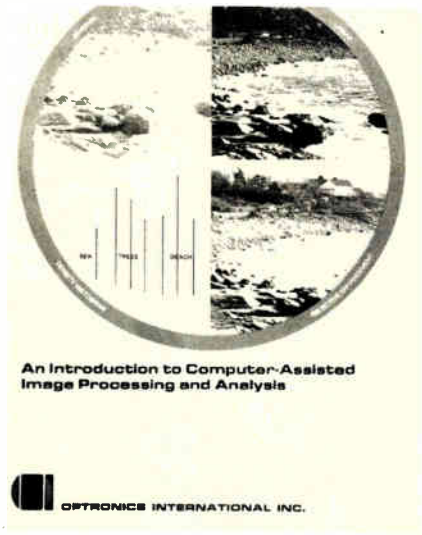
Wire stripping. A 37-page catalog describes wire-stripping machines and hand tools, some of which can be modified to customer specifications. It is being offered by The Eraser Co., P. O. Box 1342, Oliva Drive, Syracuse, N.Y. 13201 [422]

Dc motors. A 10-page four-color bulletin describes a line of dc motors, including enclosure offerings, electrical and mechanical construction features, and motor ratings and dimensions (in both the English and

metric system) for drip-proof and totally enclosed units. The bulletin, which provides examples of typical applications, stresses the laminated-square frame construction. Reliance Electric Co., Motors Division, Marketing Communications Department, 25001 Tungsten Rd., Cleveland, Ohio 44117 [423]

Image processing. A 12-page pamphlet, "An Introduction to Computer-Assisted Image Processing and Analysis," will familiarize the scientist and engineer with the application of image-processing systems in such areas as image enhancement, information extraction, and quantitative restoration. It also contains a

New literature



glossary of terms, criteria for equipment selection, and comprehensive descriptions of techniques used. Optronics International Inc., 7 Stuart Rd., Chelmsford, Mass. [424]

Data communications. The "Data Communications Handbook" will aid program managers and design engineers in achieving a basic understanding of the elements of a data-communications system. The handbook describes data entry and collection, remote batch processing and job entry, information retrieval, and conversational time-sharing examples. It discusses digital vs analog transmission, asynchronous vs synchronous transmission, and modulation techniques, as well as binary serial interfaces and protocols. In addition, there are six appendixes, including "Maximum Capacity of a Channel" and "Integrated Circuits for Data Communications Equipment," a list of places to write for specifications, and a data-communications reference guide. It sells for $3.50 each. Signetics Corp., P. O. Box 9052, 811 E. Arques Ave., Sunnyvale, Calif. 94086

Power semiconductors. Descriptions, parameters, and part numbers for a line of high-power transistors, rectifiers, thyristors, and assemblies, including 30 new products, are given in a 17-page product guide. A service directory at the end gives headquarters, sales offices, sales rep-

CRYSTAL CLEAR CASTING RESINS

ECCOCLEAR casting resins with high optical clarity are used in encapsulations and coatings wherever visual display and inspection of electrical/electronic components is required. Eleven crystal clear epoxies, silicones, urethanes, polyesters and hydrocarbons are described in new ECCOCLEAR folder.

Circle 22 on reader service card

GET PRODUCT DATA FAST BE AHEAD OF COMPETITION

"Product Preview", Emerson & Cuming, Inc's. free news publication is rushed each month to more than 35,000 eager readers. Tells what's new in plastics/ceramics for electronics; makes profitable reading for design & production engineers & managers.

Circle 23 on reader service card

RTV SILICONES FEATURED IN NEW FOLDER

18 ECCOSIL® RTV silicone compounds described in new well-illustrated folder. Pertinent data given in tabular charts on coatings, foams, sealants, adhesives, encapsulants, thick section cure, moldmakers and alloys.

Circle 24 on reader service card

GOOD AS GOLD.

Gold keeps the Motorola 1100 Series crystal clock oscillators on frequency longer.

In our 1100 series, the Motorola hybrid crystal clock oscillator is best in its class because it performs better and lasts longer —from 250 KHz to 70 MHz with a tolerance of ±1.0% to 0.0025%.

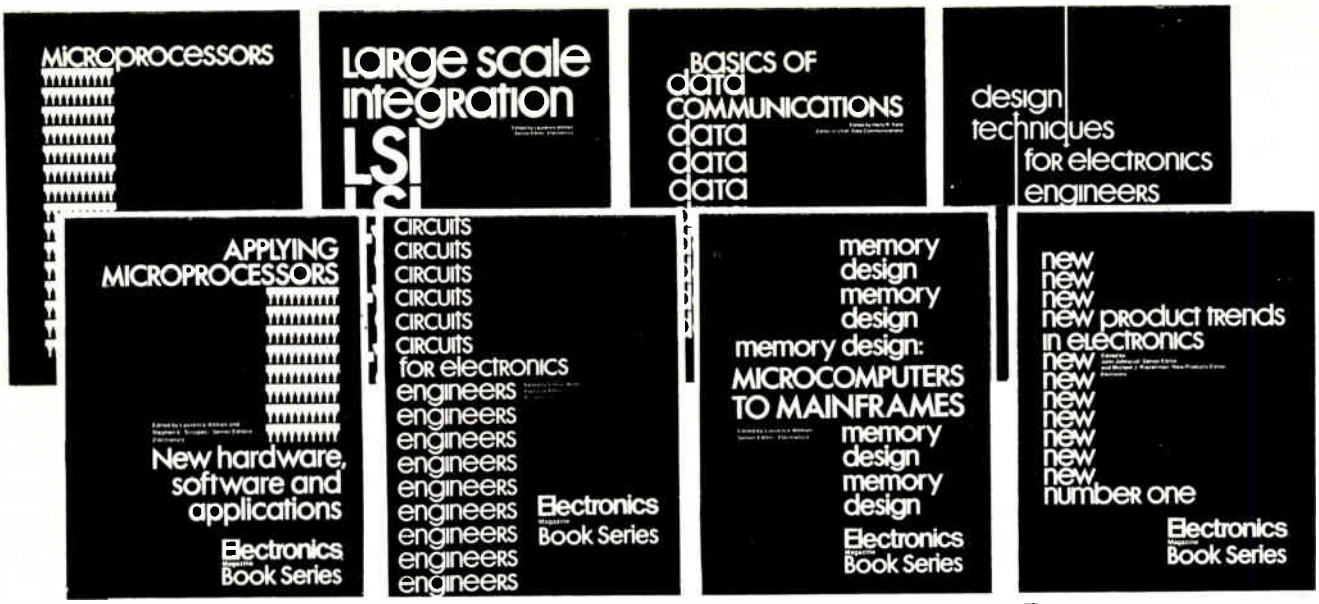
We ensure that our oscillators stay on frequency by using gold plating. Gold doesn't oxidize as rapidly as most other metals, and oxidation changes the mass on the crystals. When the mass changes, the frequency changes. You don't want that. Nor do we.

Because dust on a crystal will change the oscillator frequency, we assemble them in a Class 100 Clean Room. The atmosphere is controlled to keep dust out and hold the temperature and humidity at the correct level. And because we demand perfection, we grow our own perfect quartz. The result is an oscillator that stays on frequency longer. All this at a price that's lower than you'd expect.

If only the best is good enough for you, we'll be happy to send you a price list, rep list, and more data than you'll find on any other oscillator data sheet. Call Barney Ill at (312) 451-1000, or write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, Illinois 60131.

MOTOROLA INC.
Component Products

Circle 231 on reader service card



Electronics Magazine Book Series

1. Microprocessors
What you must know about available microprocessor technology, devices, information, 4th printing. $8.95

2. Applying Microprocessors
2nd and 3rd generation technology. 26 detailed applications from data networks to video games. $9.95

3. Large Scale Integration
Covers the basic technology, new LSI devices, LSI testing procedures, plus system design and applications. $9.95

4. Basics of Data Communications
Includes 47 articles from Data Communications magazine covering more than 11 key areas. $12.95

5. Circuits for Electronics Engineers
Contains 306 circuits arranged by 51 functions from Amplifiers to Voltage Regulating Circuits. Saves design drudgery. $15.95

6. Design Techniques for Electronics Engineers
Nearly 300 articles drawn from "Engineer's Notebook." A storehouse of design problem solutions. $15.95

7. Memory Design: Microcomputers to Mainframes
The technology, devices, and applications that link memory components and system design. $12.95

8. New Product Trends in Electronics, Number One
From "New Products," state-of-the-art materials and equipment, arranged according to function. $14.95

Electronics Book Series
P.O. Box 669, Hightstown, NJ 08520

1. Microprocessors
Send me _____ copies at $8.95 per copy.

2. Applying Microprocessors
Send me _____ copies at $9.95 per copy.

3. Large Scale Integration
Send me _____ copies at $9.95 per copy.

4. Basics of Data Communications
Send me _____ copies at $12.95 per copy.

5. Circuits for Electronics Engineers
Send me _____ copies at $15.95 per copy.

6. Design Techniques for Electronics Engineers
Send me _____ copies at $15.95 per copy.

7. Memory Design: Microcomputers to Mainframes
Send me _____ copies at $12.95 per copy.

8. New Product Trends in Electronics
Send me _____ copies at $14.95 per copy.

Discounts of 10% on orders of 10 or more copies of each book.

If after my 10-day free-trial examination I am not fully satisfied I understand that my payment will be refunded.

☐ Payment enclosed ☐ Bill firm ☐ Bill me

Charge to my credit card:

☐ American Express ☐ Diners Club

☐ BankAmericard/Visa ☐ Master Charge*

Acct No. _____ Date Exp. _____

*On Master Charge only, first numbers above name _____

Name _____ Title _____

Company _____

Street _____

City _____ State _____ Zip _____

Signature _____

That new product... where is it now that you need it?

New Product Trends in Electronics
by the editors of *Electronics* Magazine
333 pages, $14.95

How often do you have to go back through magazines and journals, searching for the specific development that's needed on one of your design projects? You *noticed* it then, but you *need* it now. State-of-the-art products, *arranged by application,* are easy to find in this newest addition to the *Electronics Books Series.*

Compiled from recent issues of *Electronics* Magazine, this reliable reference presents up-to-date, usable information on important materials and equipment. It's more convenient than going back through periodicals . . . more current than textbooks.

From the simple to the complex

Covered here is a wide range of products from simple resistors to sophisticated automatic testing machinery. More than 500 manufacturers are represented from throughout the world—all cross-referenced in an easy-to-use company index.

Functional . . . dependable

The emphasis is on listing products according to function, making this a true problem-solving guide. And all product information was researched by the editors of *Electronics* through direct contact with the people responsible for the product's development.

Find out all about the latest

- amplifiers
- industrial equipment
- semiconductors
- power supplies
- displays
- memory products
- communications equipment
- computers
- components
- instruments
- packaging and production equipment
- data converters

Among the hundreds of manufacturers included . . .

Allen-Bradley
American Microsystems Inc
Analog Devices
Analogic
Bourns
Burr-Brown
Dana Laboratories
Datel Systems
John Fluke
Hewlett-Packard
Intel
International Rectifier
Motorola
National Semiconductor
Philips
Systron Donner
Tektronix
Teledyne
Texas Instruments
TRW

Order today, and don't forget the other valuable books in the Electronics Books Series listed in the coupon below.

Electronics Book Series
P.O. Box 669, Hightstown, NJ 08520

1. Microprocessors
Send me _____ copies at $8.95 per copy.

2. Applying Microprocessors
Send me _____ copies at $9.95 per copy.

3. Large Scale Integration
Send me _____ copies at $9.95 per copy.

4. Basics of Data Communications
Send me _____ copies at $12.95 per copy.

5. Circuits for Electronics Engineers
Send me _____ copies at $15.95 per copy.

6. Design Techniques for Electronics Engineers
Send me _____ copies at $15.95 per copy.

7. Memory Design: Microcomputers to Mainframes
Send me _____ copies at $12.95 per copy.

8. New Product Trends in Electronics
Send me _____ copies at $14.95 per copy.

Discounts of 10% on orders of 10 or more copies of each book.

If after my 10-day free-trial examination I am not fully satisfied I understand that my payment will be refunded.

☐ Payment enclosed ☐ Bill firm ☐ Bill me

Charge to my credit card:
☐ American Express ☐ Diners Club
☐ BankAmericard/Visa ☐ Master Charge*

Acct No. _____ Date Exp. _____

*On Master Charge only, first numbers above name _____

Name _____ Title _____

Company _____

Street _____

City _____ State _____ Zip _____

Signature _____

Classified section FOR ENGINEERING/TECHNICAL EMPLOYMENT OPPORTUNITIES

CLASSIFIED SALES REPRESENTATIVES

Atlanta	Jane Core	404/892-2868	Cleveland	Mac Huestis	216/781-7000	Houston	Mike Taylor	713/659-8381
Boston	Holt Buchanan	617/262-1160	Dallas	Mike Taylor	214/742-1747	Los Angeles	Stan Kassin	213/487-1160
Chicago	Bill Higgens	312/751-3733	Denver	Shirley Klotz	303/837-1010	New York	Larry Kelly	212/997-3594
			Detroit	Mac Huestis	313/873-7410	Philadephia	Dan Ferro	215/568-6161
						Pittsburgh	Dean Genge	412/391-1314
						San Francisco	M.E Kenny	415/362-4600
						Stamford	Holt Buchanan	203/359-2860
						XEROX 400 TELECOPIER		212/997-6800

SENIOR TEST ENGINEER

The individual we seek will have designed in a high technology engineering group working in a small team environment.

Background should include:

- **Design of test fixtures for digital and analog equipment**
- **Some microprocessor design experience**
- **Some automatic test set design experience**
- **Emphasis on hardware design**
- **Experience reviewing and improving basic product circuit and logic design**
- **B.S.E.E. Degree with 5-7 years' related test experience.**

We offer an excellent salary and generous benefits. If you are interested and qualified, please send your resume with salary history/requirement in complete confidence to:

J. R. Walter, Personnel Manager

Databit INCORPORATED

50 Davids Drive
Hauppauge, New York 11787
Equal Opportunity Employer M/F

SYSTEMS ENGINEERS

ESL provides...
TEAMWORK + ATMOSPHERE
as key ingredients of our continuing growth on the San Francisco Peninsula:

ESL has openings for Engineers with 3-10 yrs. exp. in Systems Engineering. Candidates must be familiar with state-of-the-art in antenna systems, receivers and processing hardware for signal acquisition systems. Responsibilities include:

- ★ **Requirements studies**
- ★ **Generating System Specifications**
- ★ **End-to-End System Evaluation**

BS/MSEE or Physics required. Both JUNIOR AND SENIOR-LEVEL POSITIONS AVAILABLE.

Identify with a progressive, employee-oriented Company offering excellent salaries, advancement opportunities and a benefits package including 11 PAID HOLIDAYS (including a full week at Christmas), BONUS PLAN, COMPANY PAID MEDICAL/DENTAL/LIFE INSURANCE . . . and a whole lot more.

Please send resume to Kay Cooper, Professional Employment, ESL Inc., 495 Java Drive, Sunnyvale, CA 94086. An equal opportunity employer. U.S. Citizenship required. (408) 734-2244.

E S L

Trade Opportunities In Sunny New Mexico

Public Service Company of New Mexico, located in Albuquerque, has immediate openings in the following area:

ELECTRONICS JOURNEYMEN

Communications systems experience in microwave, telephone, mobile radio and computer-directed control equipment. Three to five years experience and an FCC second class license required.

We offer good company benefits and career potential, along with an exceptional environment. The Southwestern lifestyle is casual and recreational activities abound. Please submit your resume of experience to: Personnel Department.

Public Service Co. of New Mexico

P.O. Box 2267
Albuquerque, NM 87103
equal opportunity employer m/f

★ FOR MIDWEST ACTION! ★
Computer Professionals
RECRUITING
Computer Professionals
All fees paid by Client Companies.

M H. Wm. Myers & Assoc.
361 Virginia Street
Crystal Lake, IL 60014

Located in the suburban Chicagoland area

ANTENNA INSTALLATION ENGINEER AS PROJECT LEADER

For installation, supervision and acceptance trials as well as management coordinator for broadcasting antenna projects.
An experienced engineer who is prepared to travel to remote sites is required. Location: Canada.
Starting Date: Apr 1/78 or immediately.
Salary: $40,000 dollars per annum.
Applicants on temporary basis are also accepted.
Please apply with references to:

P-6842, Electronics
Class. Adv. Dept., P.O. Box 900
N.Y., N.Y. 10020

We have been placing graduate ENGINEERS in FEE-PAID positions THROUGHOUT THE U.S. since '59. Over 1,000 client companies. We are graduate engineers working full-time for you. Send resume & salary history today or request confidential application.
ATOMIC PERSONNEL, INC.
Suite L 1518 Walnut St., Phila., Pa. 19102
An Employment Agency For All Technical Fields

EMPLOYMENT SERVICE

How To Get A Job Overseas 253 page Book! Only $4. Transworld, Box 90802-HR, Los Angeles 90009.

South?-technical/professional placement network-fee paid. Murkett Associates, Box 527, Montgomery, AL 36101.

EMPLOYMENT SERVICE

M.E.s, I.E.s, E.E.s, Ch.E.s—Let our search firm represent you to our clients nationally and overseas. If you are seeking a more prestigious position with increased responsibilities and a better Future, send a resume or request a position profile and at no charge we will provide you with interview opportunities. Register in our exclusive Executive Search Program. All replies strictly confidential. All Fees employer paid at Management Recruiters, 1900 Point West Way, Suite 281, Sacramento, CA 95815. (916) 920-0441.

Electronic engineering growth positions with clients located nationally. We would be glad to consider your resume. Joe Torcassi (EE), Director, R.J. Bushee & Associates, 1001 Carew Tower, Cincinnati, OH 45202. 513/621-2015.

BUSINESS OPPORTUNITY

Consulting Business: how to start, promote, operate. Reply: Box 831, Glendora, Ca. 91740.

How To Earn Money As A Consultant (including specimen contracts) $25. Business Psychology Int'l, 890/44 Nat'l Press Bldg., Washington, D.C. 20045.

POSITIONS VACANT

Junior Faculty Position—The Department of Electrical Engineering and Computer Science may be in a position to appoint one or more new faculty at the Assistant Professor level, effective September 1, 1978. We are interested in superior candidates who have recently completed their doctorate or who expect to complete it this year. All areas of specialization within the Department's programs in Electrical Engineering and Computer Science will be considered. These areas include: Systems and Control; Computer Science and Artificial Intelligence; Electronics and Digital Systems; Energy Conversion Devices and Systems; Electromagnetics and Dynamics; Electronic Materials and Devices; Communication and Probabilistic Systems; Bioelectrical Engineering. Duties of a faculty member include graduate and undergraduate teaching, research, and thesis supervision. Candidates should supply a resume, a description of their professional interests, and the names and addresses of three or more references. Applications should be sent to Professor F. C. Hennie, Room 38-435. Massachusetts Institute of Technology, Cambridge, Massachusetts 02139. M.I.T. is an equal opportunity/affirmative action employer.

"Because I'm having so much fun!"

That's the response of a senior technical manager. He had been asked why he wasn't at all interested in early retirement.

His feeling is not unusual. The Hughes Aircraft Company is committed to remaining in the forefront of technology. To do so, the engineers must work in an environment which allows them to exercise their creativity. They must be surrounded by stimulating co-workers and with the latest in laboratory facilities. Continuing education must be encouraged and financially supported. In such an environment having fun is not unusual.

We believe that we have data to indicate the high morale of our laboratories. The average tenure of our engineers is over eight years. Our termination rate is less than one-half of the industry average.

Can you push the state of the art in radar, infrared, electro optics, computers, guidance—or related areas? Do you have an accredited degree, or its equivalent?

If so, we would like to hear from you. We have hundreds of openings.

Come and have fun with us.

Please send your resume to: Professional Employment E, Hughes Aerospace Groups, 11940 West Jefferson Blvd., Culver City, California 90230.

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE GROUPS

U.S. Citizenship Required
Equal Opportunity M/F/HC Employer

memo to: ENGINEERING

from: Kazim Ali, Employment Manager
GTE Lenkurt
1105 County Road, San Carlos, CA 94070
(415) 595-3000

Changing jobs; selecting the field in which to employ your talents; and choosing the Company best suited to your potential are critical decisions. I hope you are looking for more than a job . . . and want a career that will bring you personal gratification as well as an opportunity to develop and advance.

GTE Lenkurt, Inc., a part of General Telephone & Electronics Corporation (GTE) and a major manufacturer of video, voice and data communications systems, is a Company with a *Future*, a future that has never looked better and that gives promise for a growth and expansion unsurpassed by any other segment of industry. The outstanding feature in most of the positions offered at GTE Lenkurt is the advancement opportunity that accompanies the job.

GTE Lenkurt also is a Company with a *Challenge*, a challenge to meet the requirements of the ever-growing communications industry, a challenge to meet the expanding requirements of the World's largest industrial community that is only beginning to realize the value of communications in business; and a challenge to supply our customers with the World's finest communications network.

In a generation, GTE Lenkurt has created a tradition normally reserved for Century-old organizations. The tradition is *Excellence*, and the cornerstones that support it . . . quality workmanship, thorough service and intelligent research.

While we are proud of our locations, our plants, our facilities and hardware, we believe GTE Lenkurt is a dynamic, successful and stable organization today because of its greatest resource — *People*. These are people who have devoted a good part of their lives and many millions of hours to building and upholding the Company's tradition of excellence and quality. These are people who represent some of the best minds in the Communications Industry. We need more such people, people who are imaginative, creative and intelligent, and want to grow and expand with a Company that has continuously progressed in the leadership of its industry. GTE Lenkurt is a Leader whose reputation is firmly established both in the world of electronics and also as an equal opportunity employer.

If you have the capacity to accept the challenge, and the ability to answer it, consider the opportunities with our Team in the following areas:

DEVELOPMENT

Electrical Engineers at all levels for projects in subscriber carrier analog and digital microwave radio and PCM carrier and switching. Experience in either linear, or digital circuit, microprocessor control circuit design.

ELECTRICAL

Microcircuit Development

1. Development of Custom Integrated Circuits, Analog and/or Digital Design and computer simulation desirable. Willing to train if solid experience in discrete circuit design. Will work with Bipolar and N-MOS technologies.
2. Development of Automatic programs for high speed laser trim and test of hybrid circuits. Solid background in linear or digital circuit analysis and aptitude in minicomputer programming required.

DIGITAL DESIGN

PCM Transmission & Terminals

For design of PCM digital multiplexers and terminal equipment. 2-7 years experience. Background in high speed digital design utilizing TTL and ECL. Logic, some knowledge of microprocessors desirable, but not required.

FIBER OPTICS

We seek an experienced Engineer knowledgeable in the design and circuit applications of fiber optics components such as laser diodes, light emitting diodes, avalanche photodiode receivers, single fiber connectors and cable-to-cable splicing.

GTE LENKURT

PROFESSIONALS subject: YOU and YOUR CAREER!

POWER SUPPLY DESIGN

Experienced Engineer in power electronics and power processing is required. Basic knowledge of solid state components and power magnetics is desirable.

DESIGN SUPPORT

Electrical Engineers at various levels to maintain, modify and assist the current production of electrical designs in various product lines.

MICROWAVE SYSTEMS

Responsible for defining radio performance specifications and product arrangements including baseband, IF, RF and protection switching. Must have experience in 2-13 gigahertz analog and digital radio development.

MICROPROCESSOR PROGRAMMERS

Openings at all levels. Knowledge of structured programming concepts, telephone circuits and terminology, and basic electrical engineering of particular interest. BS/MSEE desired.

MICROPROCESSOR HARDWARE DESIGN & TESTING

Position requires a BS/MSEE with interest in design and testing of microprocessor system hardware.

DIGITAL SYSTEMS

Responsible for defining characteristics, evaluating new applications and developing customer documentation on evolving multi line PCM subscriber pair gain systems, channel banks, multiplexers and repeatered lines. Should have electrical engineering background and be familiar with Telephone Operating Company switching and digital transmission plant.

INDUSTRIAL

Methods Improvement

Responsibilities include methods improvement, equipment selection, facilities layout and work flow, materials handling and packaging, computer applications to manufacturing problems and solution of production problems during new product introduction. Electronic assembly experience desirable. Minimum BSIE or equivalent with 1-2 years experience desired.

for ENGINEERING POSITIONS, a BS or MS (or equivalent experience) is required.

SYSTEMS ANALYST

Bachelor's degree plus 1-5 years experience in analysis and design of computerized business information systems. Experience in data base/data communications-oriented applications for a manufacturing company desired. Must have sound knowledge of business functions and have strong verbal and written communications skills.

EQUIPMENT DESIGNERS

Equipment Designers must have knowledge of electro-mechanical packaging and/or printed circuit board layout. No degree necessary.

GTE Lenkurt benefits are an outgrowth of a feeling of responsibility toward the Employee that has always prevailed. Some benefits are entirely at the option of the Employee — as they should be. Others are automatic. Taken as a whole, they represent a comprehensive, competitive package that can offer a distinct advantage to the user. Consider the following:

Excellent salaries; paid vacations and Holidays; Medical, Life and Disability insurance; stock purchase; savings and investment program; 100% tuition refund; pension plan; Employee Store, Credit Union and Recreation Center privileges.

For a change, if you wish to join a Company that wants to *work for you*, send your resume, with salary history and requirements, to Professional Employment, GTE Lenkurt, 1105 County Road, San Carlos, CA 94070, or phone our Employment Office Collect 415/595-3000 and request an application. We are an equal opportunity employer.

GTE LENKURT

A Part of General Telephone & Electronics Corporation on the beautiful SAN FRANCISCO PENINSULA

ENGINEERS

The Boeing Company in Seattle, Washington, has a variety of challenging career opportunities for experienced engineers on a wide-range of programs.

Enjoy the relaxed life-styles and unspoiled beauty of the Pacific Northwest in the "Nation's Most Liveable City." You won't find a better opportunity to combine career growth with a pleasing environment. We'd like to hear from you if you have a BS degree or higher in engineering or computer science and experience in any of the following areas:

- ☐ AUTOMATED TEST INSTRUMENTATION-DEVELOPMENT
- ☐ COMPUTER AIDED DESIGN
- ☐ COMPUTERS AND DISPLAYS DESIGN
- ☐ DIGITAL CIRCUIT DESIGN
- ☐ ELECTRICAL/ELECTRONIC TEST
- ☐ ELECTRONIC MATERIALS AND PROCESSES
- ☐ ELECTRONIC PACKAGING DESIGN
- ☐ ELECTRONIC PARTS EVALUATION
- ☐ FLIGHT/MISSION/SYSTEMS TEST
- ☐ GUIDANCE AND CONTROL ANALYSIS
- ☐ NONDESTRUCTIVE EVALUATION
- ☐ OPERATIONAL SOFTWARE DEVELOPMENT
- ☐ SOFTWARE/COMPUTING SYSTEM DESIGN AND ANALYSIS
- ☐ SOFTWARE/COMPUTING SYSTEM TEST AND EVALUATION
- ☐ SOFTWARE QUALITY ASSURANCE
- ☐ TEST SYSTEMS SOFTWARE DEVELOPMENT
- ☐ TEST PROGRAM PLANNING
- ☐ SYSTEMS DESIGN ANALYSIS
- ☐ SYSTEMS REQUIREMENTS DEFINITION
- ☐ WIRING AND CONTROL DESIGN

Candidates must be U.S. citizens. Selected candidates will be offered an attractive salary, comprehensive fringe benefits package, and relocation allowances.

Send your résumé to The Boeing Company, P.O. Box 3707-LMK, Seattle, WA 98124.

An equal opportunity employer.

BOEING

Getting people together

Electronics Engineers LSI Engineers

Design tomorrow's avionics today

... at KING of course.

King Radio Corporation, the world's leading designer and manufacturer of aircraft communications, navigation, and flight control systems for the general aviation industry is on the move. We are expanding into new fields; facing new challenges. Our growth and success have created career opportunities for qualified electronics and LSI engineers.

—**Electronics Engineers:** digital, analog, microprocessor, power supplies, receivers, transmitters, flight controls, radar, etc.

—**LSI Engineers:** CMOS, bipolar, logic, P or N channel design, etc.

We are located in a pleasant, progressive, Kansas City suburb. Full relocation will be provided, and extensive benefits include profit sharing. We invite your confidential inquiry.

Call Dick Johnson collect, at (913) 782-0400.
Evenings and weekends call (913) 782-2290.

Tomorrow's Avionics Today . . . from KING of course

King Radio Corporation / 400 North Rogers Road / Olathe, Kansas 66061

An Equal Opportunity Employer

NON-IMPACT PRINTER ENGINEERING

At Computer Peripherals, the emphasis is on finding innovative people . . . individuals with technical training and ideas. If you can bring us the ability, we can open the door to exceptional opportunity . . . and not just the first door.

We are working in advanced areas of impact and non-impact printer design and development. We have immediate openings for:

- **MECHANICAL ENGINEERS**
- **MANUFACTURING ENGINEERS**
- **QUALITY ASSURANCE ENGINEERS**
- **RELIABILITY ENGINEERS**

Successful candidates will have applicable degree and 3-6 years related experience in non-impact printer development.

These positions offer competitive salaries, comprehensive benefits and generous potential for career growth. Interested candidates please submit letter or resume in confidence with salary history and requirements to:

Bob Brown
COMPUTER PERIPHERALS, INC.
1480 N. Rochester Road
Rochester, Michigan 48063
1-313-651-8810

An Affirmative Action Employer

PROJECT SUPERVISOR

Microprocessor Based
to $37,000

Will supervise engineers and programmers developing this State-of-the-Art electronic systems. Key position with high visibility. Must have previous supervisory experience and a BS/MSEE. The essential technical skills are logic design, systems architecture and microprocessor applications.

We also seek design engineers for this project. Minimum one year experience. Salary to high $20's.

For additional information contact Steve Ford or George Winton at (617) 426-4180. Please include salary history when submitting resume. Our client company assumes all fees.

ROGERS & SANDS

100 Federal Street
Boston, MA 02110
Member of Mass. Professional Placement Consultants

HOUSTON, TEXAS ELECTRONIC DESIGN AND PROJECT ENGINEERS

The automatic control systems segment of our industry is expanding and is currently in need of individuals with analog/digital design capability. Microprocessor experience a major plus on both R & D and product design. Competitive salaries and benefits.

For further information, contact Russell Ballentine or John O'Dell at

(713) 621-9050

All Fees Assumed By Client Companies

M. david lowe
PERSONNEL SERVICES

458 Houston Natural Gas Building
1200 Travis
Houston, Texas 77002

SALES ENGINEER FOR RADIO TEST EQUIPMENT

Must be firm on the measuring techniques of the telecommunications technology. Experience in automatic testing desirable.
Sales experience with government establishments, telecommunications industry and educational authorities highly welcome.
A first class product line and an appropriate first class salary is offered.
Location: Ottawa, Canada
Please reply with references to:
Class. Adv. Dept., P.O. Box 900, NY, NY 10020
P-6843, Electronics

POSITIONS VACANT

Director of Operations—For a $25 million company manufacturing sophisticated electronic instruments. Process includes board and chassis assembly, printed circuit board wiring and wave solder. Additionally, the successful candidate will oversee a test group of designers and a material requirements plan-activity. Candidates must have a proven record of management as well as a sense of urgency and direction. A degree in mechanical or electrial engineering is desirable. This position commands a very attractive compensation incentive, and benefits package. Interested candidates should submit their resumes in confidence, including a salary history to: Executive Search—10B P.O. Box 785 Westport, CT 06880.

Engineer-EE $20K+ Programmer, BPI, 5659 S. Laburnum, Richmond, Va. 23231.

Engineers—Our clients major expansion has created multiple openings for staff engineers. Must have either Electrical or Mechanical background. Midwest location. Salary range $19,000—$37,000. Reply immediately: E. Copeland, Management Recruiters, 2421 Willowbrook Pkwy., Indianapolis, Indiana 46205.

POSITIONS VACANT

Electronic Product Design Specialist—We are looking for qualified designers for existing electronic and electromechanical product designs to meet specific customer requirements. Experience is package design, development of installation hardware and documentation, design and layout of printed circuit boards, would be highly desirable. This is a highly visible position, working closely with manufacturing, purchasing, quality control, marketing and accounting and the individual will maintain product schedules and be accountable for final product performance and documentation. This position requires a sense of urgency and offers a very attractive compensation and benefits package. Please submit your resume and include your salary history, in confidence, to: Executive Search—12F P.O. Box 785, Westport, CT 06880.

OVERSEAS JOB GUIDE

Job Hunting Guide + Directory of 650 Firms. Details on job sources, resumes, taxes. US $6.50—(US & Canada). To foreign address—$7.50. Friar Books—EL, 8956 E. Ardendale, San Gabriel, CA 91775.

FEATURE ARTICLES FROM *ELECTRONICS* AVAILABLE IN REPRINT FORM

No. of copies wanted

New reprints

____ R-801 World market report 1978 24 pp $4.00
____ R-734 Microcomputer families expand 20 pp. $4.00
____ R-730 Special Report—Automotive electronics gets the green light 10 pp $3.00
____ R-728 Flexible circuits bend to designers' will 10 pp $3.00
____ R-724 Special Report—Technologies squeeze more performance from LSI 22 pp. $3.00
____ R-722 Demands of LSI are turning chip makers towards automation 12 pp $3.00
____ R-720 How EEs Feel About Engineering—3-part series 26 pp $5.00
____ R-718 Display makers strive to refine their technologies 8 pp $3.00
____ R-716 Special report—Japanese wave in semiconductor technology 24 pp $3.00
____ R-714 Special report—active filter technology 6 pp $3.00
____ R-713 Electron-beam lithography
____ R-712 Special report—large-scale integration 16 pp $3.00
____ R-710 Personal computers mean business 8 pp $2.00
____ R-708 So you want to be a consultant 6 pp $2.00
____ R-706 Low-cost dual delayed sweep method 6 pp $2.00
____ R-705 Powering up with linear ICs 12 pp $3.00

Charts

____ R-516 Electronic symbols $2.00
____ R-213 Electromagnetic spectrum (updated 1976) $3.00
____ R-326 Optical spectrum (6-page report and chart) $3.00

Books

____ R-803 New product trends in electronics—Electronics Book Series 333 pp $14.95
____ R-732 Memory Design—Microcomputers to Mainframes—Electronics Book Series 180 pp $12.95
____ R-726 Design Techniques for Electronics Engineers—Electronics Book Series 370 pp $15.95
____ R-711 Circuits for electronics engineers: 306 circuits in 51 functional groups—Electronics Book Series 396 pp $15.95
____ R-704 Thermal design in electronics $5.00
____ R-701 Applying microprocessors—Electronics Book Series 191 pp $9.95
____ R-608 Basics of Data Communications—Electronics Book Series $12.95
____ R-602 Large Scale Integration—Electronics Book Series 208 pp $9.95
____ R-520 Microprocessors—Electronics Book Series 154 pp $8.95
____ R-011 Computer-aided Design 135 pp $4.00
____ R-032 Active Filters 88 pp $4.00

Other reprints

____ R-703 Special report—memories 16 pp $3.00
____ R-702 World market report 1977 24 pp $4.00
____ R-616 Special issue—technology update $4.00
____ R-614 Power supply choices for sophisticated designs 8 pp $3.00
____ R-612 Fiber-optic communications special report 24 pp $3.00
____ R-610 Special report on hybrid-circuit technology 19 pp $3.00
____ R-606 Special issue—microprocessors $4.00
____ R-526 How reliable are today's components 16 pp $3.00
____ R-600 World market report 1976 24 pp $4.00
____ R-524 Special report on bipolar large-scale integration 12 pp $3.00
____ R-522 Special report on power semiconductors 12 pp $3.00
____ R-518 Special issue—productivity $4.00
____ R-514 Eight ways to better radio receiver design 6 pp $3.00
____ R-512 Design of circuits for dangerous environments 4 pp $2.00
____ R-510 Bipolar advances with I^2L microprocessor 8 pp $2.00
____ R-508 Designing microprocessors with standard logic 12 pp $3.00
____ R-506 The case for component burn-in 7 pp $2.00
____ R-434 Designing systems with the standard interface 12 pp $3.00
____ R-432 An update on communications satellites 8 pp $2.00
____ R-430 Choosing the right bipolar transistor model for computer-aided design 20 pp $3.00
____ R-428 Designing with low-cost lasers 6 pp $2.00
____ R-424 Microprocessor applications 28 pp $3.00
____ R-422 A microprogramable minicomputer 8 pp $2.00
____ R-420 Computerized text-editing and typesetting 8 pp $2.00
____ R-418 Computer analyses of rf circuits 8 pp $2.00
____ R-414 The ion-implanted n-channel process 6 pp $2.00

Payment must accompany your order

Make check or money order payable to Electronics Reprints. All orders are shipped prepaid by parcel post. Allow two to three weeks for delivery. For additional information call (609) 448-1700 ext. 5494.

Back issues now available:
1960 to 1969, $5.00 each
1970 to 1973, $3.00 each
1974 to 1976, $4.00 each

USE THIS PAGE AS YOUR ORDER FORM

Cost of orders $_____
Plus 10% handling charge $_____
TOTAL AMOUNT ENCLOSED $_____

Mail your order to:
Janice Austin
ELECTRONICS REPRINTS
P.O. Box 669
Hightstown, N.J. 08520

SEND REPRINTS TO

Name_____

Company_____ Dept._____

Street_____

City_____ State_____ Zip_____

Electronics advertisers

Classified and employment advertising

F. J. Eberle, Manager 212-997-2557

■ For more information of complete product line see advertisement in the latest Electronics Buyers Guide
• Advertisers in Electronics International
‡ Advertisers in Electronics domestic edition

Advertising Sales Staff

Advertising sales manager: Paul W. Reiss
1221 Avenue of the Americas, New York, N.Y. 10020
[212] 997-4371
Atlanta, Ga. 30309: Michael Charlton
100 Colony Square, 1175 Peachtree St., N.E.
[404] 892-2868
Boston, Mass. 02116: Frank Mitchell
607 Boylston St.
[617] 262-1160
Chicago, Ill. 60611
645 North Michigan Avenue
Jack Anderson [312] 751-3739
Robert M. Denmead [312] 751-3738
Cleveland, Ohio 44113: William J. Boyle
[716] 586-5040
Dallas, Texas 75201: John J. Uphues
2001 Bryant Tower, Suite 1070
[214] 742-1747
Denver, Colo. 80203: Harry B. Doyle, Jr.
123 Speer Blvd. #400
[303] 837-1010
Detroit, Michigan 48202: Jack Anderson
1400 Fisher Bldg.
[313] 873-7410
Fort Lauderdale, Fla. 33306: Michael Charlton
3000 N.E. 30th Place
[305] 563-9111
Houston, Texas 77002: John J. Uphues
601 Jefferson Street, Dresser Tower
[713] 659-8381
Los Angeles, Calif. 90010: Robert J. Rielly
Robert E. Boedicker, 3200 Wilshire Blvd., South Tower
[213] 487-1160
Minneapolis, Minn. 55435: Robert M. Denmead
4015 W. 65th St.
[312] 751-3738
New York, N.Y. 10020
1221 Avenue of the Americas
Michael J. Stoller [212] 997-3616
Matthew T. Reseska [212] 997-3617
Philadelphia, Pa. 19102: Matthew T. Reseska
Three Parkway
[212] 997-3617
Pittsburgh, Pa. 15222: Matthew T. Reseska
4 Gateway Center
[212] 997-3617
Rochester, N.Y. 14534: William J. Boyle
1175 Pittsford-Victor Rd., Pittsford, N.Y.
[716] 248-5620
San Francisco, Calif. 94111: Don Farris
Dean Genge, 425 Battery Street,
[415] 362-4600
Paris: Patrick Mouillard
17 Rue-Georges Bizet, 75116 Paris, France
Tel: 720-73-01
United Kingdom & Scandinavia: Robert Ghey
34 Dover Street, London W1
Tel: 01-493-1451
Scandinavia: Andrew Karnig and Assoc.
Kungsholmsgatan 10
112 27 Stockholm, Sweden
Tel: 08 51 68 70 Telex: 179 51
Milan: Luigi Rancati
1 via Baracchini, Italy
Phone 86-90-656
Brussels:
23 Chaussee de Wavre
Brussels 1040, Belgium
Tel: 13-73-95
Frankfurt/Main: Fritz Krusebecker
Liebigstrasse 27c, Germany
Phone 72 01 81
Tokyo: Tatsumi Katagiri, McGraw-Hill
Publications Overseas Corporation,
Kasumigaseki Building 2-5, 3-chome,
Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
[581] 9811

Business Department

Thomas M. Egan
Production Manager [212] 997-3140
Carol Gallagher
Production Manager International
[212] 997-2045
Betty Preis
Production Manager Domestic
[212] 997-2908
Roberta Cummings
Production Assistant [212] 997-2044
Frances Vallone
Reader Service Manager
[212] 997-6057

Electronics Buyers' Guide

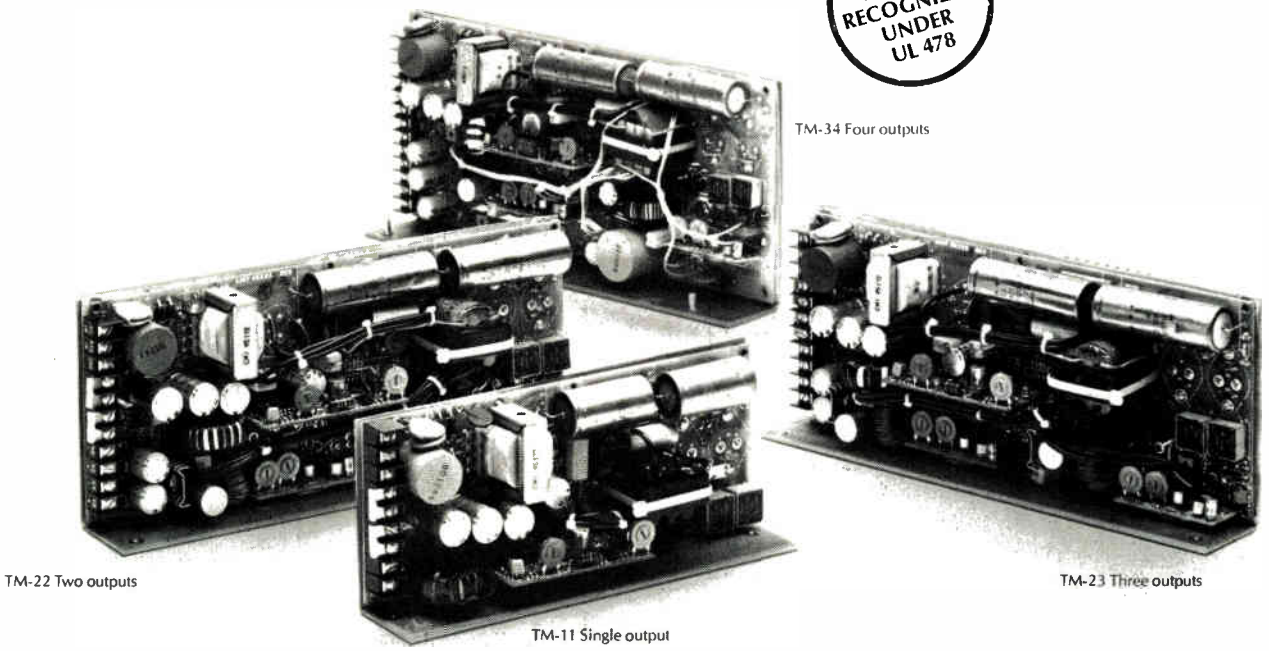
H.T. Howland, General Manager
[212] 997-6642
Regina Hera, Directory Manager
[212] 997-2544
Roberta Cummings Production Manager
[212] 997-2044
Frances Vallone, Reader Service Manager
[212] 997-6057

Classified and Employment Advertising

Frank Eberle, Manager
[212] 997-2557

LH's Tiny-MITE Series Open-Frame Switchers Now UL Recognized!

ALL MODELS RECOGNIZED UNDER UL 478



Designed specifically for high-volume OEM computer and terminal applications.

Now recognized under UL 478, LH's low-cost, single and multiple-output *open-frame* Tiny-MITE (TM) Series switchers are great choices wherever OEM computers and terminals are manufactured in high volume.

Single-output TM-11 units pack 100 watts in 9.5" L x 4" W x 2.5" H packages . . . Two-output TM-22 and three-output TM-23 units pack 150 watts in 12.0" L x 5.15" W x 2.80" H packages . . . Four-output TM-34 units pack 175 watts in 13.0" L x 6" W x 2.75" H packages.

Four models, all open-frame, all UL recognized with the industry's most technically advanced specifications:

- Output voltages — TM-11: 5 V adjustable ± 5% @ 100 W. Other voltages from 2-28 V DC also available. TM-22 main output: 5 V ± 5% @ 20 amps; choice of various voltages on 2nd output. TM-23 main output: 5 V ± 5% @ 20 amps; choice of various voltages on 2nd and 3rd outputs. TM-34 main output: 5 V ± 5% @ 20 amps; choice of various voltages on 2nd, 3rd, and 4th outputs.
- Wide input range — 92-130 or 180-260 V AC, 47-450 hz.
- 1% or 50 mv p-p ripple and noise.
- 75% efficiency (TM-11), 70% efficiency nominal (TM-22, 23, and 34).
- 0.4% line regulation over entire input range.
- 0.4% load regulation from no load to full load.
- 20-msec holdup time if AC power fails.
- All outputs fully regulated and adjustable ± 5%.
- Power fail signal — standard on all models. 1-cycle ride-through (16 msec).
- 200 μsec to 1% response time after 25% load change @ 5 amps/μsec (primary output). Secondary outputs 50 μsec to 1% response time (typical).
- 0°C to 50°C operating temperature.

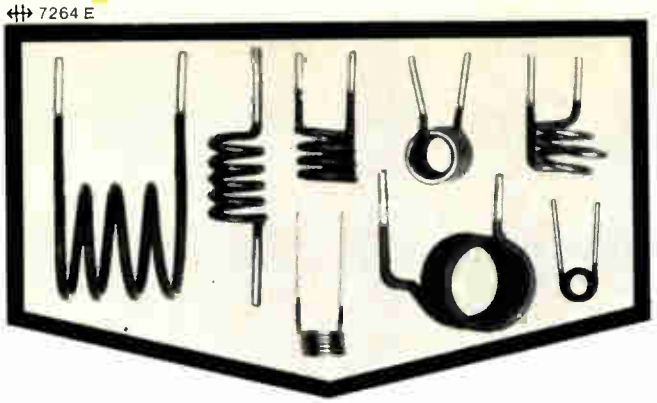
LH RESEARCH

World's largest, most comprehensive standard line of switchers.

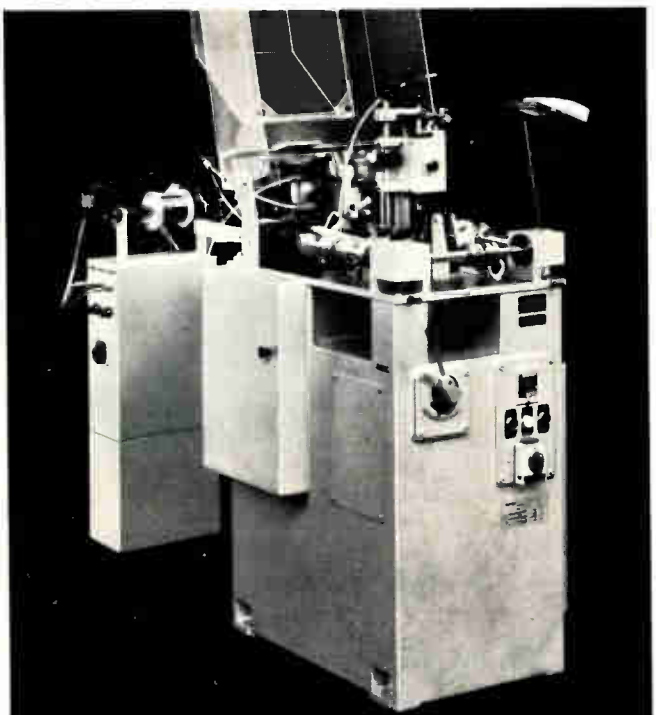
LH's open-frame TM Series of switchers are just one of six standard series based on LH-developed technology and proven in almost 50,000 field-tested units. Nobody packs more power in smaller packages or offers more desirable features including 1 through 7 outputs, up to 2.26w/in., up to 80% efficiency, and a 2-year warranty on all models . . . For price and delivery information on LH switchers, call or write today!

LH RESEARCH, INC.
1821 Langley Avenue
Irvine, CA 92714
(714) 546-5279/TWX 910-595-2540

Circle 247 on reader service card 247



WAFIOS



This automatic machine produces up to

50 coreless coils per minute

including stripping of both shanks

	FTU 0–97	FTU 1–97
wire diameter	0,2–1,0 mm	0,3–2,0 mm
inside diam. of coil	10 mm	15 mm
coil length	35 mm	45 mm
shank length	30 x 30 mm	48 x 50 mm
number of coils	55	70
maximum output	50 coils/min.	40 coils/min.

WAFIOS MASCHINENFABRIK

D-7410 REUTLINGEN 1/W.GERMANY

USA SALES OFF.: WAFIOS MACHINERY CORPORATION

P.O.B. 148 · 25-35 NORTH EAST INDUSTRIAL ROAD · BRANFORD/CONN. 06405 USA

WAFIOS CANADA LTD. 1145 BELLAMY ROAD UNIT N° 19

SCARBOROUGH, TORONTO, ONTARIO M1H 1H5 · TELEX 065-25385

From Electronics Magazine Book Series. Zero-risk trial offer.

New Product Trends in Electronics, Number One

From "New Products," state-of-the-art materials and equipment, arranged according to function. $14.95

Electronics Book Series
P.O. Box 669, Hightstown, N.J. 08520

Send me _____ copies of "New Product Trends in Electronics, Number One" at $14.95 per copy

Discounts of 40% on orders of 10 or more copies.

I must be fully satisfied or you will refund full payment if the book is returned after ten-day trial examination.

☐ Payment enclosed ☐ Bill firm ☐ Bill me

Charge to my credit card:
☐ American Express ☐ Diners Club
☐ Visa ☐ Master Charge

Acc't No._____ Date exp._____

On Master Charge only, first numbers above name_____

Name _____ Title _____

Company _____

Street _____

City _____ State _____ Zip _____

Signature _____

ALCOSWITCH

HIGHEST QUALITY
MINIATURE TOGGLES

Our premium Green Series inherently contain many quality features – all included at no extra cost.

During the past 16 years we've listened to customers. The result is a product that is indisputably the #1 miniature switch line in the industry.

Of importance, our terminals have bonded fine silver contacts which are gold flashed to retard oxidation and facilitate soldering, furthermore, the terminals are Molded-In SE-0 diallyl phthalate cases.

We urge you to call Customer Service at (617) 685-4371. Our sales people would like to tell you why ALCOSWITCH is your best buy.

P.S. Don't forget to ask for our new 76-page catalog and free samples, too!

ALCO ELECTRONIC PRODUCTS, INC.
1551 OSGOOD STREET · NORTH ANDOVER, MA. 01845 U.S.A.
Tel: (617) 685-4371 TWX: 71) 342-0552
A SUBSIDIARY OF AUGAT® INC

Circle 84 on reader service card

Electronics
Reader Service

If the cards below have already been used, you may obtain the needed information by writing directly to the manufacturer, or by sending your name and address, plus the Reader Service number and issue date, to Electronics Reader Service Department, P.O. Box No. 2530, Clinton, Iowa 52734, U.S.A.

Place correct airmail postage here ... for faster service.

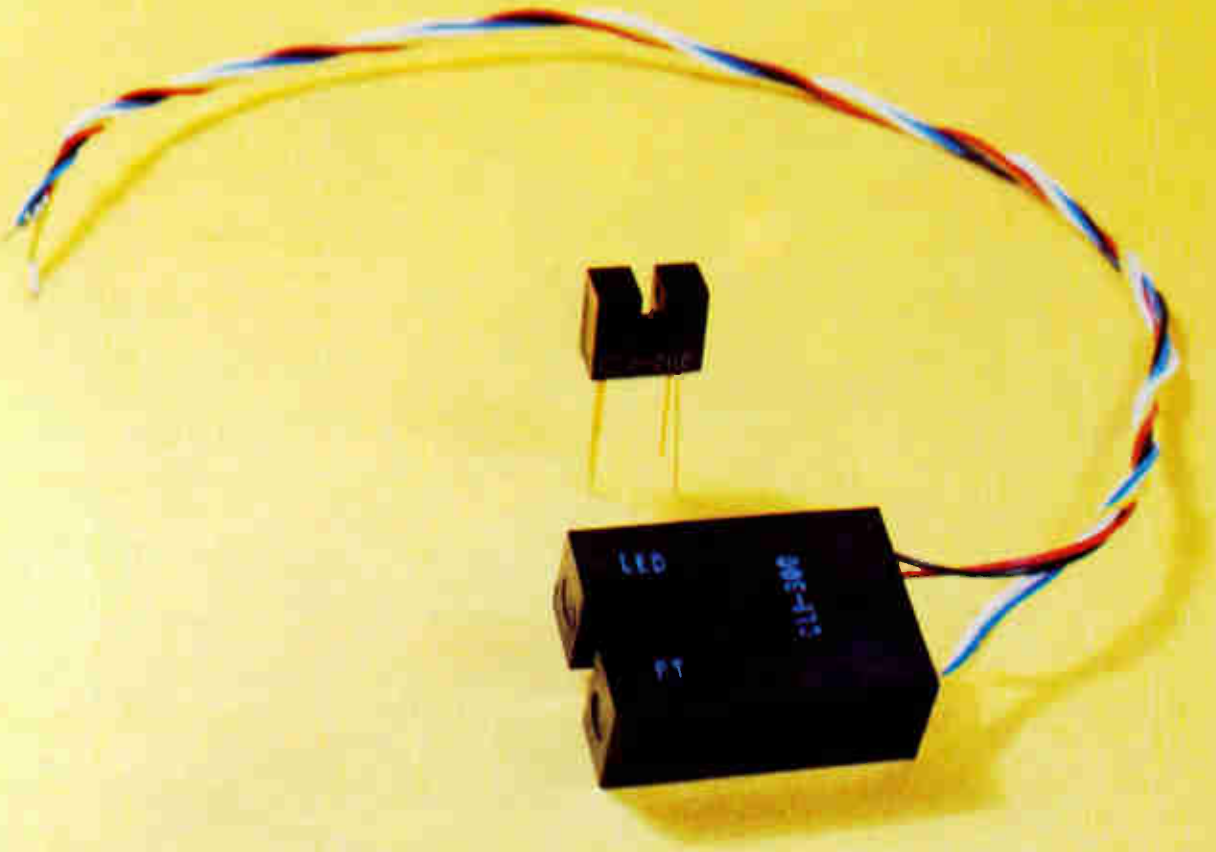
Electronics
P.O. Box No. 2530
Clinton, Iowa 52734
U.S.A.

Place correct airmail postage here ... for faster service.

Electronics
P.O. Box No. 2530
Clinton, Iowa 52734
U.S.A.

OPTICAL SWITCHES from Clairex

Standard Types... Custom Designs



Clairex optical switches are made with hermetically sealed emitters and detectors for maximum reliability. Glass lenses align the light beam to improve target detection, to minimize false triggering from stray light, and to reduce dust pickup.

Clairex offers a line of standard types as well as custom designs to meet your needs and specifications. Remember, our business is providing solutions to optical-electronic problems. Call (914) 664-6602 or write Clairex® 560 South Third Avenue, Mount Vernon, New York 10550.

CLAIREX ELECTRONICS

A Division of Clairex Corporation

Circle 902 on Reader Service Card