SPECIAL 32-PAGE FEATURE—PERSONAL COMPUTING

$1.00 ■ JUNE 1978

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

easy to build
BAR-GRAPH DISPLAY
uses discrete LED's

roundup for hobbyists
CASES AND CABINETS
for your projects

telephone accessory
BUILD DIGI-TOLL
computes cost of calls

special feature
PERSONAL COMPUTERS
1 what they can do and how to select your own
2 peripheral devices and accessories
3 programming languages and how to use them
4 roundup of who makes what

PLUS:
- ★ Build A HI-FI Graphic Equalizer
- ★ MATV Switching System
- ★ All About Audio Oscillators
- ★ Hobby Corner
- ★ State-Of-Solid-State
- ★ Service Clinic
- ★ 8080 Computer Corner

A GERNSBACK PUBLICATION

06
0 70989 34 40

NOW **YOU** CAN AFFORD
THE WORLD FAMOUS
Diablo Printer Terminal

IPSI PROUDLY ANNOUNCES A PRICE BREAKTHROUGH ON DAISY WHEEL PRINTER TERMINALS

The IPSI Model 1622

Featuring: RS 232 compatibility at 110, 150, 300, and 1200 baud: **Print speed** of 45 char/sec: **Graphics** capability: Over 30 **print wheels** from 10 to 15 char/inch: 5 ribbons in color, cloth, film or two color: **Form length** adjustable: **Spacing** adjustable from 120 pitch to .1 pitch: Line spacing adjustable from 48 lines/in. to .4 line/in.: Identical in every respect to it's high priced sister the **Diablo HyTerm II*** model 1620.

Price: $2,595.00 each in single units, quantity discounts available.

Service: Major cities in the U.S. and Canada.

You have probably waited a long time to purchase your computer printer at a reasonable price. Wait no longer! The Diablo 1620 lists for $3,240.00 we sell it for $2,595.00; save well over $600.00. For immediate action phone in your order collect and we will ship your terminal the same day.

We also stock Diablo 1345A (Hytype II*) mechanisms for immediate shipment at the low price of $1,150.00. Order one now and build your own terminal using your own CPU, or do-it-yourself by buying our 1622 kit and assemble your own terminal within 10 hours for $2,295.00

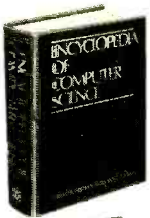
If you've always wanted to turn your computer onto word processing, this is the only way to go. Ask for our free word processing software.

IPSI
INTERNATIONAL PERIPHERAL SYSTEMS, INC.
4982 E. UNIVERSITY AVE.
FRESNO, CALIFORNIA 93727
CALL (209) 252-3635

*Hyterm and HyType are registered trademarks of Xerox Corp.

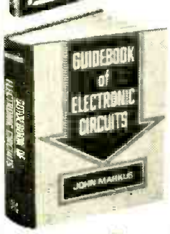
CIRCLE 94 ON FREE INFORMATION CARD

Introductory offer to new members of the ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB



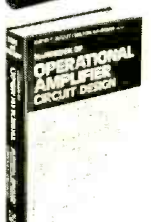
769/01X
ENCYCLOPEDIA OF COMPUTER SCIENCE
by A. Ralston and C. L. Meek
Pub. price, $60.00
Club price, $39.95

286/051
OPTOELECTRONIC APPLICATIONS MANUAL
by Hewlett-Packard
Pub. price, $19.25
Club price, $14.50



404/453
GUIDEBOOK OF ELECTRONIC CIRCUITS
by J. Markus
Pub. price, $29.50
Club price, $21.50

772/622
SEMI-CONDUCTOR ELECTRONICS DESIGN
by F. K. Manasse
Pub. price, $21.95
Club price, $18.25



617/97X
HANDBOOK OF OPERATIONAL AMPLIFIER CIRCUIT DESIGN
by D. E. Stout & M. Kaufman
Pub. price, $29.65
Club price, $17.50

491/380
MICROCOMPUTER-BASED DESIGN
by J. Peatman
Pub. price, $23.00
Club price, $17.50

any one
of these great professional books
for only $1.89
values up to $60.00

Special $1.89 bonus book comes to you with your first club selection

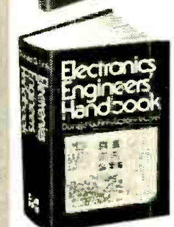
162/468
INTEGRATED CIRCUITS AND SEMICONDUCTOR DEVICES: Theory and Application, 2/e
by G. J. Deboo & C. N. Burrous
Pub. price, $17.95
Club price, $13.95

353/670
MICROPROCESSORS AND SMALL DIGITAL COMPUTER SYSTEMS FOR ENGINEERS AND SCIENTISTS
by G. A. Korn
Pub. price, $24.50
Club price, $18.95

629/218
DIGITAL INTEGRATED ELECTRONICS
by H. Taub and D. Schilling
Pub. price, $23.50
Club price, $16.95

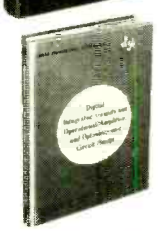
231/494
ELECTRONICS DESIGNERS' HANDBOOK, 2/e
by L. J. Giacoletto
Pub. price, $47.50
Club price, $37.50

255/342
MANAGEMENT OF ENGINEERING PROJECTS, 2/e
by V. G. Hajek
Pub. price, $15.95
Club price, $12.50



209/804
ELECTRONICS ENGINEERS' HANDBOOK
by D. G. Fink
Pub. price, $45.50
Club price, $33.50

571/384
ELECTRONIC COMMUNICATION, 3/e
by R. L. Shrader
Pub. price, $16.95
Club price, $12.50



637/539
DIGITAL INTEGRATED CIRCUITS AND OPERATIONAL-AMPLIFIER, AND OPTOELECTRONIC CIRCUIT DESIGN
by Texas Instruments
Pub. price, $16.50
Club price, $12.50

save time and money by joining the

ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB

Here is a professional book club designed to meet your on-the-job engineering needs by providing practical books in your field on a regular basis at *below publisher prices.* If you're missing out on important technical literature—if today's high cost of reading curbs the growth of your library—here's the solution to your problem.

The Electronics and Control Engineers' Book Club was organized for you, to provide an economical reading program that cannot fail to be of value. Administered by the McGraw-Hill Book Company, all books are chosen by qualified editors and consultants. Their understanding of the standards and values of the literature in your field guarantees the appropriateness of the selections.

How the club operates: Every month you receive free of charge *The Electronics and Control Engineers' Book Club Bulletin.* This announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the Club, you save both money and the trouble of searching for the best books.

MAIL THIS COUPON TODAY

ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB
P.O. Box 582, Princeton Road, Hightstown, New Jersey 08520

Please enroll me as a member and send me the two books indicated. I am to receive the bonus book at the introductory price of $1.89 plus my first selection, plus tax, postage and handling. If not completely satisfied, I may return the books within 10 days and request that my membership be cancelled. If I keep the books, I agree to take a minimum of three additional books during the next two years at special Club prices (guaranteed 15% discount, often more). I will receive the Club Bulletin 13 times a year. If I want to examine the featured selection, I need take no action. It will be shipped automatically. If, however, I want an alternate selection—or no book at all—I simply notify the Club by returning the convenient card always enclosed. I will always have a minimum of ten days in which to return the card and you will credit my account fully, including postage, if this is not the case. Membership in the Club is continuous but cancellable by me at any time after the four-book purchase requirement has been filled. *This order subject to acceptance by McGraw-Hill. Orders from outside the continental U.S. must be prepaid. All prices subject to change without notice. Offer good for new members only.*

Write Code # of $1.89 bonus book selection here ______

Write Code # of first selection here ______

NAME ______

ADDRESS ______

CITY ______

STATE ______ ZIP ______

EXTRA SAVINGS: Remit in full with your order, plus any local and state tax, and McGraw-Hill will pay all postage and handling charges. **E33350**

CIRCLE 38 ON FREE INFORMATION CARD

Radio-Electronics®

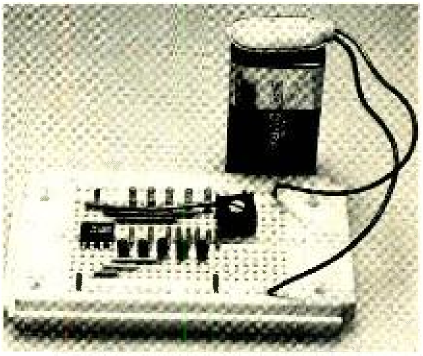
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

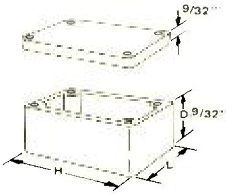
JUNE 1978 Vol. 49 No. 6

ON THE COVER

When you want to keep track of long-distance phone charges, the first thing you need is a record of how long you've been talking. Digi-Toll does just that. It also reminds you, with a bright red digital readout right at your phone, of how long you've been talking. See construction details starting on page 69.



LED BAR GRAPH is a nifty substitute for an analog meter . . . and it's easy to read. Turn to page 78



CABINETS FOR PROJECTS helps answer that problem question of "What cabinet should I use?". Five pages of listing start on page 73.

Radio-Electronics, Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Second-class postage paid at New York, NY and additional mailing offices. One-year subscription rate: U.S.A. and U.S. possessions, $9.98, Canada, $12.98. Other countries, $14.98. Single copies $1.00.

Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Box 2520, Boulder, CO 80322.

looking ahead

Computers go retail: First mass-market push for the computer as a consumer product is under way, and as of early spring there was heavy activity on several fronts. In some cases, big retailers were testing the waters to see if the buyers and the product were ready for one another. In other cases, the results were already in and dealers were highly pleased with early sales.

Macy's chose the San Francisco area for a market test in 13 of its stores, with a promotion campaign for the $500 VideoBrain home computer. A store spokesman said some two dozen computers were sold during the first day of the promotion, about one-third going to consumers who weren't technically oriented and "didn't even know what a home computer was" before Macy's broke its ad campaign. Other department stores understood to be handling VideoBrain include Macy's and Bloomingdale's in New York, Maas Brothers in Florida, Dayton's in Minnesota and May Co., Broadway Stores, Bullock's and Robinson's in Los Angeles.

Radio Shack held a special heavily advertised computer promotion in its Phoenix stores, offering the TRS-80 for same-day delivery. Its other stores had been taking orders, promising six-to-eight-week delivery. Radio Shack has also established a new retail division called Tandy Computers, which has issued its first mail-order catalog, and opened its first store in Fort Worth. Apple Computers has been successfully marketing at retail through about 50 Team Electronics stores and is adding other outlets, including traditional hi-fi and camera retailers.

Meanwhile, Magnavox is introducing a new product called "Odyssey Mark II Computer Video Game System." It's actually more a game than a computer and will sell for less than $200—but it will have both joy-stick controllers and a full alphanumeric keyboard. It uses an Intel microprocessor, and will be programmed by ROM cartridges at about $20 each. Retail sales will begin in the fall.

New from Sony: Sony has been making plenty of news with new and revamped products, some for delivery soon, others later. The company demonstrated in Japan a CCD color camera using three MOS chips measuring 9.1 × 10.3 mm, each with 226 horizontal and 492 vertical elements for a total of 111,192 picture elements. Sony said the camera uses a proprietary "special offsetting technique" which effectively doubles horizontal resolution, claiming that more than 280 lines of horizontal resolution can be attained. The camera's size and weight are claimed to be about the same as a super-8 home movie camera. Sony officials said the color camera will sell for $835 to $1,250 when it's marketed in Japan in fall 1979, but that they ultimately hoped to be able to sell a CCD color home video camera for less than $500. RCA recently demonstrated its own CCD color camera and said it would take commercial orders in 1979 (see **Radio-Electronics**, April, 1978).

Sony also is introducing in the United States for the first time its three-tube projection television system. It uses special 9-inch monochrome tubes as the picture source, with two lenses and a mirror system to throw a bright picture on a screen mounted atop the one-piece fold-up cabinet. The projector will be available this fall in 50- and 72-inch diagonal screen sizes in the $3,000 range. Brightness is claimed to be 60 footlamberts with the smaller screen and 30 with the 72-inch screen.

At the same time, Sony is updating both its Betamax home videocassette recorder and its color TV line. A new-model Betamax will have built-in LED electronic clock-timer and remote pause control. Unlike the former model, which could record and play in both fast and slow speeds, it will be a single-speed unit, designed for the L-500 tapes, which have a two-hour recording time, or the new L-750, which step this up to three through the use of thinner tape.

Sony's TV line wil feature new, brighter Trinitron tubes and a new chassis designated "I2" and said to be designed for "ease of accessibility and service." When two screws are removed, the chassis slides out of the set into an accessible service position with the circuits still connected and operable. The chassis may be turned on its side without tilting the set.

Service complaints down: TV servicing complaints received by the National Better Business Bureau declined in 1977 from 1976. Television service companies in 1977 ranked ninth in number of complaints received by local Better Business Bureaus, down from eighth in 1976, complaints dropping from 9,394 to 9,113. In 1977, some 74.8% of complaints were settled as opposed to 72.4% in 1976. Analyzing 1977 television servicing complaints, the National Better Business Bureau said 61.9% of the complaints involved unsatisfactory repair, 16.9% unsatisfactory service, 5.9% guarantee or warranty, 5.6% credit or billing, 2.8% delayed delivery, 2.7% product quality or performance, 1.3% selling practices, 1.2% advertising practices, 0.9% failure to provide refunds and 0.7% discontinued business.

Varactors & remotes: Electronic tuning is gradually taking over American television. According to EIA figures, 31.1% of all color sets produced or imported last year contained varactor tuners—including 57.5% of consoles and 20.9% of portables and table models. At the same time, remote control finally became an important TV feature, included in 12.7% of new sets last year, as compared with 10% in 1976.

In black-and-white, the growth trend continued to be toward AC-DC portables, but their share of the market increased only slightly from 1976—to 16.5% of all monochrome sets, up from 15.6%. Incidentally, 11- and 12-inch sets accounted for 57.4% of black-and-white production last year. In color, 19-inch was by far the most popular size, representing 44.2% of production.

Want to know what color sets sell for at the factory? The International Trade Commission makes quarterly studies in connection with the color quota on imports from Japan. Its latest tally represents average factory prices of color sets made in the United States by screen size during the fourth quarter of 1977: A 13-inch averages $225.56, the 16- and 17-inch bracket $299.10, 19-inch sets $297.35, and larger screen (20 inches and up) average $456.67. All sizes together average out to $349.23.

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

District of Columbia communications system links city ambulances with hospitals

A major communications network between the District of Columbia ambulances and 15 participating hospitals in the area will soon be complete, according to Albert P. Russo, director of the Department of Human Resources.

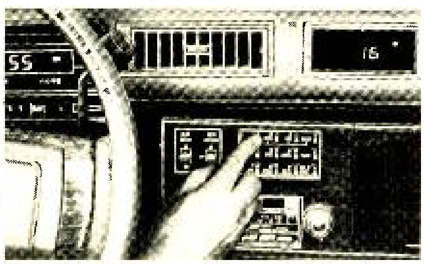
This network is a vital element in the D.C. Emergency Medical Services System, which will not only provide city ambulances with a direct communication line to the hospitals, but, Mr. Russo adds, also allow for interhospital communication, thus paving the way for future linkage with emergency medical communications systems in other surrounding areas.

The system consists of a transmission console at the District Fire Department Communications Center, in addition to receiving consoles at the hospitals. The signals are transmitted via a 180-foot tower at the center, which handles all voice and telemetry communications between ambulances and hospitals. When the system is complete, all 15 participating hospitals will be able to avail themselves of voice communications, while seven hospitals will be equipped to receive medical data telemetry (i.e., electrocardiogram data).

Fire Department ambulances are equipped with 10-channel two-way radios, plus patient-side portable radios, so that physicians can relay vital information on patient treatment.

General Motors trip computer system is option in '78 models

General Motors has developed a trip-computer system called the *TripMaster* that can be had as an option in their 1978 Cadillac Seville models for $875.



GENERAL MOTORS TRIP COMPUTER is available in 1978 models. Pushbutton-controlled, dash-mounted system provides 11 pieces of information, from estimated and actual fuel consumption to estimated time of arrival based on remaining fuel and driving range in miles.

The *TripMaster* (with which the car owner also receives a digital speedometer and digital fuel readout gauge) is pushbutton-controlled, providing such information as amount of fuel remaining; average speed; average and actual miles-per-gallon; total elapsed trip time; miles car can be driven on remaining fuel; miles to destination; estimated arrival time; time of day; the engine RPM; temperature; and system voltage. The heart of the system is a M6800 microcomputer. The digital display is a gas-discharge readout for maximum daytime visibility.

The *TripMaster* is envisioned as only the first step in what will eventually be a completely computerized automobile. Computers will soon control such operations as the carburetor system, fuel injection, exhaust gas recirculation, air conditioning, cruise control and theft-alarm systems.

24-hour electronic "beeper" protects the elderly or ailing

Heart patients, disabled or elderly persons living in isolated conditions can now avail themselves of a 24-hour electronic "beeper" device that can be worn around the neck or carried in a pocket for help in emergencies. It has an effective range of only 300 feet, because Federal regulations prohibit greater distances.

The device is a battery-powered transmitter and weighs about an ounce. Pressing a button or squeezing the device activates a transistorized unit hooked up to a telephone in the home. This unit then dials a pre-recorded message (giving name, address and type of emergency). This message is sent either to a centralized computer, which translates the coded beep for a private operator who contacts the necessary party, or dials the call directly to a preselected list of numbers—police, fire department, physicians, hospitals, friends and neighbors.

There are several systems on the market, among them the *Lifeguard* (Life-Guard Systems, Inc. Kenilworth, OH), *Safeguard* (ADT Security Systems, Inc., of Ohio) and *Microlert* (Microlert Systems, Toms River, NJ). Their cost is high: The *Microlert* pocket transmitter costs $695, and the pendant transmitter, $995; rental costs run from $30 to $50 a month. (A Life-Guard Systems spokesman says the *Lifeguard* can be rented for $20 a month, less installation costs and telephone line rental.) At present, no Medicaid or Medicare funds are available to help defray these costs, although some people have been able to list the devices as a tax deduction if they are doctor-recommended. Presently, more than 1000 people are using such systems in the United States.

New York organization for the blind tapes best sellers

In New York City, the Jewish Guild for the Blind has gone into the "best seller" business. They have developed a cassette library of current fiction and nonfiction that is recorded almost as soon as the books themselves hit the market. Bruce Massis, Guild librarian, cites the fact that the classics are already available on records, and adds that the Guild is the only organization that does the best sellers "hot off the press." And about a year and a half ago, different sound effects were added to the recordings, greatly adding to their popularity.

It takes both sides of about 10 cassettes to record a complete book. The cassettes are marked in Braille so that the blind person is able to play them in sequence. The average recording time for a book is approximately a month, depending on how much time the volunteer reader can devote to it. Copies of a given book can be made by machine, producing nine cassettes on both sides in about nine minutes.

The cassettes are mailed free anywhere in the U.S., the cost of mailing being underwritten by the U.S. Library of Congress. To date, the Guild claims 950 steady customers; however, many more are able to hear the recordings via special network programs for the blind. Printed catalogs are available that are updated four times a year with supplementary listings sent out to regular readers. Special Braille catalogs are also available for those who prefer them. For information, contact the Jewish Guild for the Blind, 15 West 65th Street, New York, NY 10023.

Top 1977 vocational students compete in '78 vocational Olympics

In February, 1978, a week-long competition was held in Dayton among last year's top vocational students. The young contestants were vying for selection to the 1978 U.S. International Skill Olympics, to be held in Pusan, Korea, in September.

The 28 contestants were all high scorers in the 1977 U.S. Skill Olympics, sponsored by the Vocational Industrial Clubs of America (VICA), the national organization for students enrolled in trade, industrial, technical and health education studies.

The individual selected to represent the *electrical trades* in the International Olympics is Mark Agee, Spokane, WA. The field of *industrial electronics* will be represented by Neal Sedell, Vancouver, WA, and Erik W. Wolfner, Miramar, FL (alternate). For *radio and TV repair*, the participants will be Richard A. Lomax, Camden, DE, and Terry M. Williams, Wheelersburg, KY (alternate).

Hams invited to participate in Enterprise space launch

The Kennedy Space Center Amateur Radio Society (SCARS) once again will invite amateur radio stations around the world to call the SCARS station to participate in the

continued on page 12

NRI BRINGS "POWER-ON" TRAINING TO YOUR HOME... FOR QUICKER, EASIER LEARNING AND FASTER EARNING

NRI FIRSTS

You get trouble-shooting experience from the chassis up . . . with NRI's unique training equipment.

The "firsts" described here are typical of NRI's over 63 years of leadership in electronics home training. When you enroll as an NRI student, you get the technical knowledge and the priceless confidence of "hands-on" experience sought by employers in communications, TV-audio servicing, computers, and industrial and military electronics. NRI training is designed for your education . . . from the educator-acclaimed Achievement Kit sent the day you enroll, to bite-size, well illustrated, easy-to-read lessons programmed with designed-for-learning training equipment.

NRI Firsts make learning at home fast and fascinating. More than a million have come to NRI for home training. Professional TV/Audio technicians who learned their profession through home training rate NRI as first choice by far, over any other school.

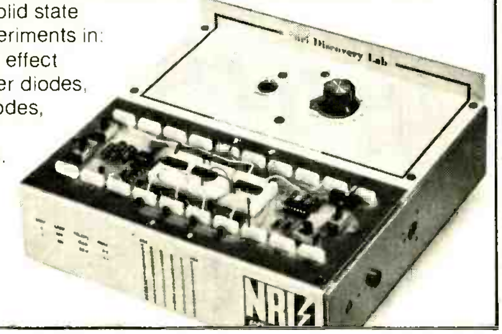
SEND FOR THE FREE FULL-COLOR CATALOG . . . for full details on NRI home training. There is no obligation . . . *no salesman will call.*

First and only school with designed-for-learning Quadraphonic Audio Center with four SP14 speaker systems. This solid state SQ™ system is designed so that you perform meaningful experiments at every stage of assembly . . . for thorough training in audio technology.

™Trademark of CBS, Inc.

First with an electronics Discovery Lab™. This self-contained advanced solid-state lab gives you fast, hands-on access to fully-powered semiconductor circuitry. NRI is the only school with all these modern solid state component experiments in: bipolar and field effect transistors, Zener diodes, light-emitting diodes, SCR's and phototransistors.

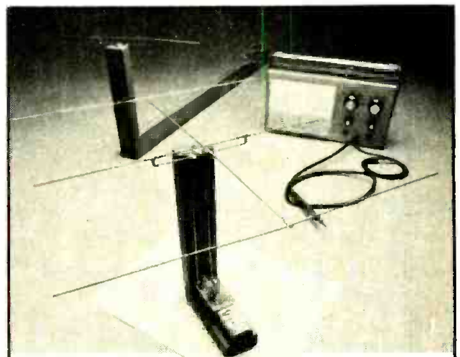
™McGraw Hill CEC.



First and only school with new Optical Transmission System engineered to allow you to analyze digital and analog signal transmission via light beam. Systems you build use LED and phototransistor technology, simulating basic principles of laser communications as used in video disc home entertainment systems.

First and only school with designed-for-learning 25" diagonal solid state Color TV complete with cabinet. This solid state set was designed by NRI's own engineers from the chassis up so that students can perform over 25 in-set experiments during construction, including valuable "Power-On" trouble-shooting.

First and only school with a portable CMOS digital frequency counter engineered by NRI to give you experience in the newest types of digital systems coming into expanded use in consumer electronics.

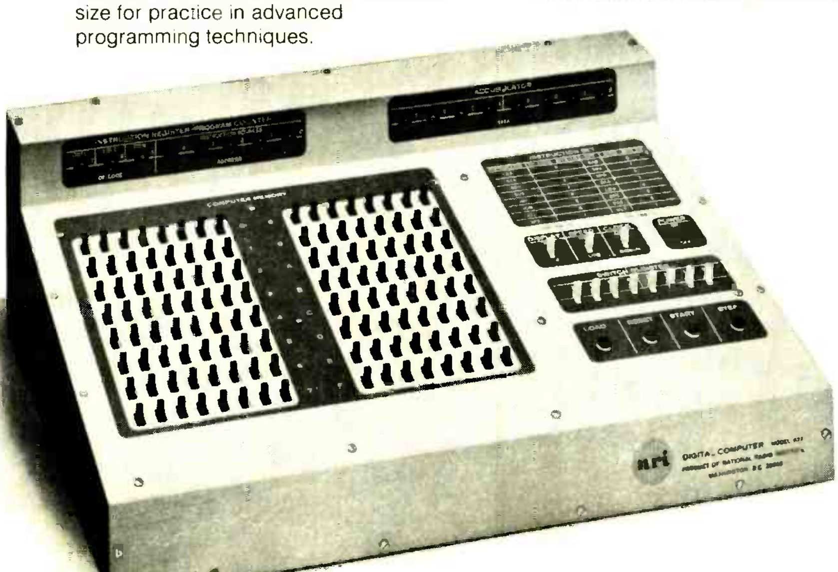


First and only school with an Antenna Applications Lab engineered to give you a thorough understanding of practical communications antenna requirements. You assemble and test several different types of antennas and matching sections, measuring gain and radiation patterns.

First and only school with a solid state regulated power supply engineered by NRI to give you experience with modern power supply designs; to give you a premium power supply for your NRI Transceiver, or to use in trouble-shooting mobile equipment.

First and only school with designed-for-learning, 400-channel, digitally-synthesized VHF Transceiver to give you the only fully-up-to-date 2-meter equipment for complete training in commercial, amateur, and CB communications. The design incorporates circuitry and components representative of the latest state of the art. Circuitry is on five plug-in circuit cards to take full advantage of NRI "Power-On" training.

First and only training with an actual programmable digital computer to give you the only home training in machine-language programming . . . essential to trouble shooting digital computers. Extra Memory Expansion Kit doubles memory size for practice in advanced programming techniques.



If card is missing, write to:

NRI Schools
McGraw Hill Continuing
Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016

new & timely

continued from page 6

first launch of U.S. space shuttle *Enterprise.* Those hams that successfully contact the station will receive a Special Event Commemorative Certificate showing the space shuttle.

For this special event, the station plans to operate on three separate modes: single sideband, radio telegraphic and novice code, all timed to coincide with lift-off operations. Those amateur operators who wish to participate in this event should contact the Space Center Amateur Radio Society, Box 21073, Kennedy Space Center, FL 32815, or call Carl Zelich (305) 867-2194 or (305) 452-6410.

Vanadium disulfide—adds new life to lithium battery

Bell Laboratories have developed an experimental rechargeable high-energy lithium battery cell that can operate at room temperature without any noticeable physical change or deterioration. What has added new life to the lithium battery is previously undiscovered material, *vanadium disulfide*, that provides the stability lacking in other battery materials, such as nickel cadmium.

The Bell studies of "layered compounds"—materials resembling mica and graphite—led to the discovery of vanadium disulfide's special properties. In the Bell battery, vanadium disulfide makes up the basic positive electrode terminal, while lithium forms the negative electrode. During battery operation, electrons leave the lithium electrode and pass through the layers of vanadium disulfide; simultaneously, lithium ions in the electrolyte flow into the spaces between the layers of vanadium. This results in minimal physical changes; thus, when the battery is recharged the electrons and lithium ions are expelled and the structure returns to its original condition.

The new lithium battery is lightweight and provides 2.5 volts, or almost twice the voltage of NiCad cells, used in most modern electronic devices.

Radio Shack microcomputer system rated leading contender in field

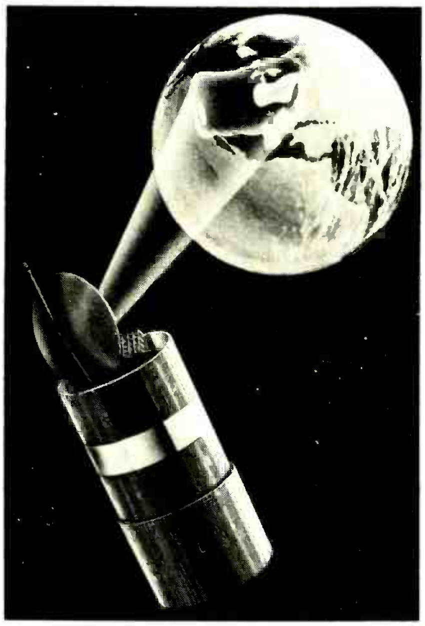
Speaking before a meeting of the Morgan Stanley first annual Personal Computer Conference, Radio Shack president Lewis Kornfeld expressed his confidence that Radio Shack's TRS-80 Microcomputer System will be one of the leading systems in the field. He underscored this by asserting that it was Radio Shack's intention to "explore and enter the market for computers in order to serve small business . . . professionals, students and hobbyists."

The TRS-80 system was introduced in 1977. It is completely prewired and tested and consists of a 53-key professional keyboard and microcomputer, power supply, data-cassette recorder, video display monitor, plus a comprehensive owner's manual—the whole system selling for $599. Prerecorded cassette programs are available for small business payroll and personal finance management and educational courses such as math, algebra and a programming course.

Mr. Kornfeld also announced a new expansion interface and ROM converter, a mini-floppy disc drive, a line printer, new software, as well as complete TRS-80 expanded systems.

Domestic satellites to provide large-scale telecommunications services

Satellite Business Systems (comprising Aetna Life & Casualty, Comsat General and IBM) and Hughes Aircraft have joined forces to build three domestic satellites, the first designed to provide large-scale telecommunications services to both commercial and government users in the U.S.



SATELLITE BUSINESS SYSTEMS spacecraft will transmit high-frequency signals to be received by roof-mounted earth antennas. The solid white beam represents area of U.S. covered by spacecraft's strongest signals.

The SBS satellite system will permit installing unmanned, automatic earth antennas in urban areas without interfering with other terrestrial signal systems or spacecraft. The 12-gHz signal output will be 20 watts, rather than the normal 5 or 6 watts, and the stronger signals will enable roof-mounting the antennas, or installing them in office parking lots. All 48 states will be served by the system, with the strongest signals beamed to 5-meter dish antennas in densely populated east-central and west coast areas; the rest of the country will be served by 7-meter parabolic earth antennas.

It is expected that the satellites will be launched via space shuttle to an eventual orbit at an estimated altitude of 36,000 kilometers (22,300 miles). The projected date of launch is 1981.

New executive director for IESA

As of February 1, 1978, Leon F. Howland, CET, will be the new executive director of the Indiana Electronic Service Association (IESA). Mr. Howland will take the place of retiring Tom Bertrand.

Mr. Howland has served as IESA director, as well as a legislative lobbyist whenever the state of Indiana enacts legislation concerning the electronic service business and technicians. He has also served as chairman of the TV-Radio licensing board; as a past president of IESA (twice); and as an officer in NEA. He is presently also director of ITTA, an Indianapolis association of more than 100 trade firms.

Cable TV subscribers to get computer-controlled alarm systems

A new computer-controlled alarm system in Dayton, OH, connects the area's cable TV subscribers with a central computer-controlled alarm panel that is monitored for 24 hours.

In this system, the fire, smoke or burglar alarm detectors are installed at the subscribers' home entrances, and are connected both to the central alarm panel and to the TV cable. Triggering the detector flashes a set of programmed instructions to the central video screen at the monitoring station. At his end, the subscriber, if he is home, can press a pushbutton to show what specific emergency aid he needs—medical help, an emergency squad, or the assistance of a nearby relative.

Although no rates or installation charges have yet been determined, it is estimated that a complete cable TV alarm system could cost several hundred dollars.

SCTE elects 1978 slate of officers

The Society of Cable Television Engineers (SCTE) recently announced its new officers and board for the 1978-1979 term:

Robert Bilodeau, president for the second term; Harold Hull of Sarasota, FL, Eastern vice president; Gayheart C. Kleycamp, San Angelo, TX, Western vice president; Judith Scharf, Denver, CO, secretary; and Edward Horowitz, NY, treasurer.

The following regional directors were also elected: Frank J. Bias (Region 1); Glenn Chambers (Region 2); Bruce Uerling (Region 3); William Ellis (Region 4); John Weeks (Region 5); James Grabenstein (Region 6); and John Morovich (Region 7).

READY for BUSINESS

We've got it all together—the cost effectiveness and reliability of our 6800 computer system with a high capacity 1.2 megabyte floppy disk system. . . PLUS—an outstanding new DOS and file management system.

1 MEGABYTE DISK SYSTEM

DMAF1 introduces a new level of capability to small computer systems. This disk system features two standard size floppy disk drives using the new double sided disk and two heads per drive. Usable storage space of over 600 kilobytes per drive, giving a total of over 1.0 megabyte of storage on line at all times. Ideal for small business applications, or for personal "super" systems.

DMA CONTROLLER

The controller occupies one main memory slot in an SS-50 bus and uses the Motorola MC-6844 DMA controller. The combination of a DMA type controller and double sided disks give the system speed of data transfer unobtainable with smaller drives.

OPERATING SYSTEM

To compliment this outstanding hardware we are supplying equally superior software. The disk operating system and file management system is called FLEX. It is one of the most flexible and complete DOS's available for small systems, but just as important; it is easy to use.

No one can match the variety of compatible peripherals offered by Southwest Technical Products for the SS-50 bus and the 6800 computer system. Now more than ever there is no reason to settle for less.

DMAF1 Disk System (assembled) $2,095.00
DMAF1 Disk System (kit). $2,000.00
68/2 Computer with 40K of memory (assembled) $1,195.00

SWTPC

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216

editorial

Where have all the designers gone?

The integrated circuit has done a lot of good things. Actually, it has *caused* a lot of good things. Complex electronic devices grow smaller. Prices of electronics devices seem to manage to hold their own in the face of inflation. And electronic equipment steadily grows more reliable.

But what seems to be missing is the designer. Oh sure, there's still an engineer around who takes a bunch of IC's (black boxes) and wires them up to form a "new device". The only trouble with this is that this is not really designing . . . or is it?

We have our ideas on this subject, and would like to compare them with yours. We want to know what you think about the state of electronic design today. What exactly is electronic design? What does an electronic designer do? Is he designing when he takes IC's and connects them together to make a circuit? Is the only designer left, the man who devises those IC's we all use?

Most important of all, do you think that the integrated circuit has slowed down the development of new electronic devices or has the integrated circuit shortened development time? Remember! Making a device smaller or less expensive is not the same as coming up with an entirely new device.

The subject is interesting and important. Let's have your comments.

Larry Steckler

LARRY STECKLER
Editor

Radio-Electronics®

Hugo Gernsback (1884-1967) founder
M. Harvey Gernsback, editor-in-chief and publisher
Larry Steckler, KTX-3644, CET, editor
Arthur Kleiman, KTZ-3288, managing editor
Robert F. Scott, CET, W2PWG, KXK-8533, technical editor
Sonia Greenbaum, copy editor
Jack Darr, CET service editor
Leonard Feldman contributing high-fidelity editor
Karl Savon, semiconductor editor
David Lachenbruch, contributing editor
Earl "Doc" Savage, K4SDS, hobby editor
Vincent P. Cicenia, production manager
Harriet I. Matysko, circulation director
Sheila Wertling, circulation assistant
Arline R. Bailey, advertising coordinator

Cover design by Louis G. Rubsamen
Cover photo by Mel Small

Radio Electronics is a member of the *Institute of High Fidelity* and is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature.*

Gernsback Publications, Inc.
200 Park Ave. S., New York, NY 10003
(212) 777-6400
President: M. Harvey Gernsback
Vice President: Larry Steckler
Treasurer: Carol A. Gernsback
Secretary: Bertina Baer

ADVERTISING SALES
Paul McGinnis
Director of Marketing

EAST
Stanley Levitan
Radio-Electronics
200 Park Ave. South
New York, NY 10003
(212) 777-6400

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
The Ralph Bergen Co.
540 Frontage Road—Suite 361-A
Northfield, Illinois 60093
(312) 446-1444

PACIFIC COAST
Mountain States
Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd.,
4th Floor,
Los Angeles, CA 90069
(213) 659-3810
Sales Mart Building
1485 Bayshore Blvd., Box 140
San Francisco, CA 94124
(415) 467-0125

SOUTHEAST
J.E. Publishers Representative Co.,
214-387-2424

NTS trains you on tomorrow's equipment. Today.

Microcomputers, digital systems and more... from the first name in home study.

Simulated TV Reception

Now NTS training programs include an even wider choice of solid-state digital equipment than ever before offered in any electronic home study course. Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath digital computer, digital test equipment, digital stereo receiver (70 watts per channel) plus much more state-of-the-art equipment to make your training exciting and relevant. Learn servicing and maintenance easily with step-by-step Project Method lessons and kits.

An all-new full color catalog shows you exactly what each of the fourteen courses cover, and every piece of equipment you receive.

Send for it today and see for yourself what's really happening in electronics training technology at NTS. It's free. Just send the coupon.

NO OBLIGATION. NO SALESMAN WILL CALL. APPROVED FOR VETERAN TRAINING.

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 South Figueroa St., Los Angeles, Calif. 90037

NATIONAL TECHNICAL SCHOOLS Dept. 206-068
4000 South Figueroa Street, Los Angeles, California 90037

Please send FREE Color Catalog and Sample Lesson.

- ☐ Color TV Servicing
- ☐ B & W TV and Radio Servicing
- ☐ FCC License Course
- ☐ Electronic Communications
- ☐ Electronics Technology
- ☐ Audio Electronics Servicing
- ☐ Digital Electronics
- ☐ MicroComputers/MicroProcessors

Name ____________________

Address ____________________

Apartment Number __________ Age ______

City ____________________

State __________ Zip ______

☐Check if interested in G.I. Bill information.
☐Check if interested ONLY in classroom training in Los Angeles.

letters

IN DEFENSE OF AMERICAN TV'S

I would like to answer some points raised by Mr. Kubilus in the Letters column of the January 1978 issue.

I have been associated with the TV industry for 11 years as an electronics engineer, and for two of those years operated a TV service business. I am also English, and during visits across the Atlantic have taken a natural curiosity in TV sets over there.

Mr. Kubilus questions the large number of screws used to secure the backs of U.S.-made TV sets. In this country, manufacturers voluntarily subscribe to Underwriters Laboratories, and meet or exceed all the safety specifications laid down by that independent organization. These specifications apply to the back of the set as well as to the rest of it. For example, the maximum slot size, distance of back material from chassis parts and back security are all specified. After all, removal should not be so simple a child could do it!

U.L. has also determined the type of wall plug to be used: polarized for a "hot" chassis and, if desired, nonpolarized for sets with an isolation power transformer. I am sure no one would disagree with this elementary safety precaution.

Mr. Kubilus may be a competent "do-it-yourself" expert, but many are not. Experience in the TV repair business has amply demonstrated to me that "a little knowledge can be a dangerous thing." A schematic diagram invites the attention of such people into an area that is potentially very dangerous. Special techniques must often be used, particularly with today's solid-state technology.

In many states, the law requires an itemized receipt for repair work be given the customer together with the return of old parts. In Utah, for example, the state requires samples of shop tags, etc., and checks they meet quite extensive legal requirements. So, if a previously repaired set does not have the repair information attached, the customer should have his copy. However, I doubt if such information is of much use to service technicians.

It is my opinion that TV sets produced in the U.S. within the last five years are very serviceable indeed. Plugs and sockets are widely used, and, in many cases, only two screws have to be removed to take off or slide back the chassis. Plug-in modules have been used extensively by some manufacturers and are easily replaced. Tuners can usually be removed by loosening either two or four screws.

I do not share Mr. Kubilus' concern for parts standardization. Several parts suppliers in this country make it their business to analyze TV sets as they come on the market. They produce extensive cross-reference manuals and cover everything from transformers to IC's. Besides, an experienced technician will know what available part he can use with safety when faced with a faulty original.

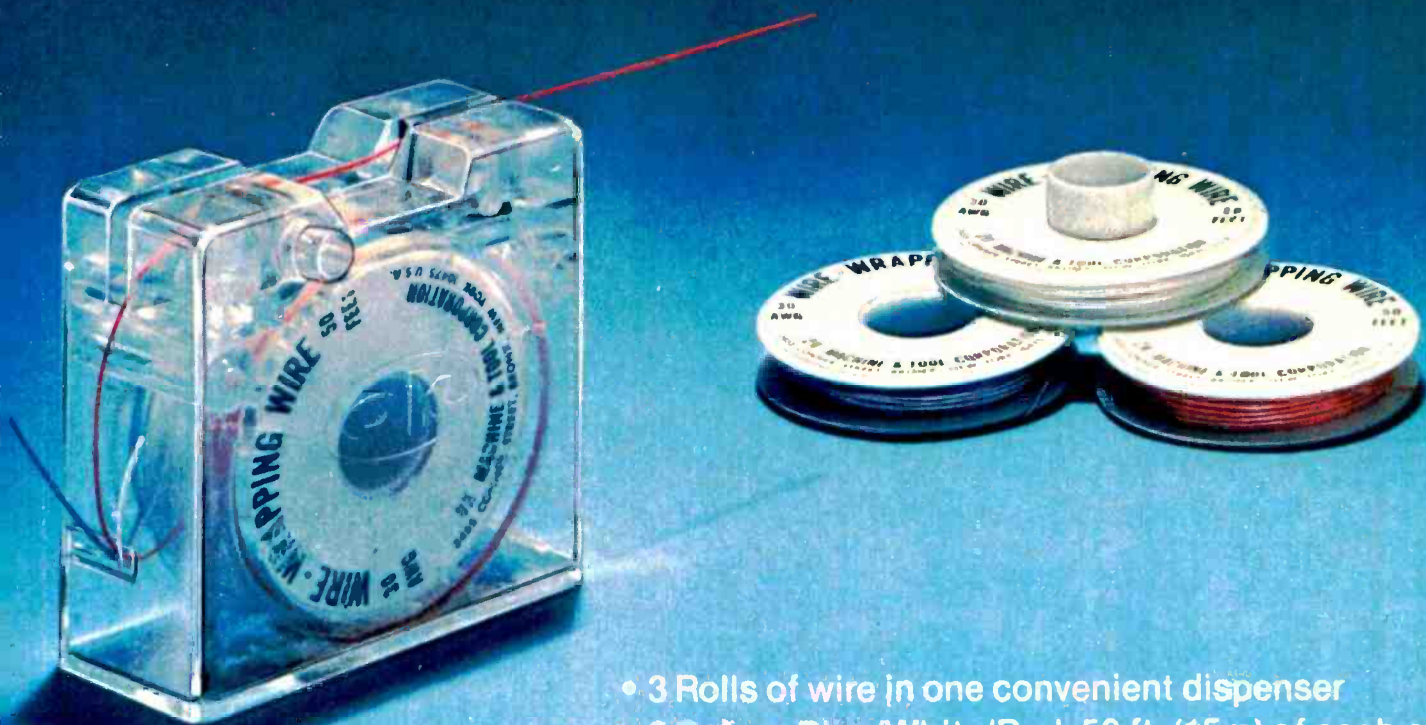
U.S. consumers are very fortunate. They have a considerable selection of good-quality TV sets available at very reasonable cost. To purchase a medium-priced 25-inch color console model represents an investment of about 4½% of the average wage-earner's yearly salary. In Europe the investment is closer to 12%.

DAVID J. H. APPLEBY
El Paso, TX

continued on page 22

TRI-COLOR

WIRE CUTTING AND STRIPPING DISPENSER



Model No. WD-30-TRI
Patent Pending

- 3 Rolls of wire in one convenient dispenser
- 3 Colors, Blue/White/Red, 50 ft. (15m) of each color
- AWG 30 (0,25mm) KYNAR® insulated wire
- Built-in cutting plunger cuts wire to desired length
- Built-in stripper strips 1" of insulation
- Easily refillable
- For wire-wrapping and other applications.

WD-30-TRI	DISPENSER WITH WIRE	$5.95
R-30-TRI	TRI-COLOR REPLACEMENT SPOOLS	$3.95

Kynar® Pennwalt

MINIMUM BILLING $25.00 / ADD SHIPPING CHARGE $1.00 / NEW YORK STATE RESIDENT ADD APPLICABLE TAX

OK MACHINE & TOOL CORPORATION 3455 CONNER ST. BRONX, N.Y. 10475 (212) 994-6600/Telex 125091

CIRCLE 42 ON FREE INFORMATION CARD

At CIE, you get electronics career training from specialists.

If you're interested in learning how to fix air conditioners, service cars or install heating systems – talk to some other school. But if you're serious about electronics, come to CIE – The Electronics Specialists.

John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

But if you think you have the cool – and want the training it takes – to make sure that a sound blackout during a prime time TV show will be corrected in seconds – then answer this ad. You'll probably find CIE has a course that's just right for you!

At CIE, we combine theory and practice. You learn the best of both.

Learning electronics is a lot more than memorizing a laundry list of facts about circuits and transistors. Electronics is interesting because it's based on some fairly recent scientific discoveries. It's built on ideas. So, look for a program that starts with ideas – and builds on them.

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson uses world-famous "programmed learning" methods to teach you important principles. You explore them, master them completely . . . before you start to apply them!

But beyond theory, some of our courses come fully equipped with the electronics gear to actually let you perform hundreds of checking, testing and analyzing projects.

In fact, depending on the course you take, you'll do most of the basic things professionals do every day – things like servicing a beauty of a Zenith color TV set . . . or studying a variety of screen display patterns with the help of a color bar generator.

Plus there's a professional quality oscilloscope you build and use to "see" and "read" the characteristic waveform patterns of electronic equipment.

You work with experienced specialists.

When you send us a completed lesson, you can be sure it will be reviewed and graded by a trained electronics instructor, backed by a team of technical specialists. If you need specialized help, you get it fast . . . in writing from the faculty specialists best qualified to handle your question.

People who have known us a long time, think of us as the "FCC License School."

We don't mind. We have a fine record of preparing people to take . . . and pass . . . the government-administered FCC License exams. In fact, in continuing surveys nearly 4 out of 5 of our graduates who take the exams get their Licenses. You may already know that an FCC License is needed for some careers in electronics – and it can be a valuable credential anytime.

Find out more! Mail this card for your FREE CATALOG today!

If the card is gone, cut out and mail the coupon.

I'll send you a copy of CIE's FREE school catalog, along with a complete package of independent home study information.

For your convenience, I'll try to arrange for a CIE representative to contact you to answer any questions you may have.

Remember, if you are serious about learning electronics . . . or building upon your present skills, your best bet is to go with the electronics specialists – CIE. Mail the card or coupon today or write CIE (and mention the name and date of this magazine), 1776 East 17th Street, Cleveland, Ohio 44114.

Patterns shown on TV and oscilloscope screens are simulated.

CIE Cleveland Institute of Electronics, Inc.
1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

☐ **YES . . .** John, I want to learn from the specialists in electronics – CIE. Send me my FREE CIE school catalog – including details about troubleshooting courses – plus my FREE package of home study information. **RE-36**

Print Name ____________________

Address ____________________ Apt. ______

City ____________________

State ____________________ Zip ______

Age ________ Phone (area code) ____________

Check box for G.I. Bill information: ☐ Veteran ☐ Active Duty

Mail today!

LETTERS
continued from page 16

TEXAS COMPUTER GROUP

Your readers in the Permian Basin area of Texas might be interested to know about the Permian Basin Computer Group.

Our group has monthly meetings in the cities of Midland and Odessa. (In Midland, the meetings are held on the second Monday of the month, and in Odessa, on the second Saturday of the month.) Everyone is invited to attend the meetings, regardless of educational background, and no dues are collected.

For further information, write Permian Basin Computer Group, John Rabenaldt, Ector County School District, Box 3912, Odessa, TX 79760, or phone (915) 332-9151, Ext. 43.

JOHN RABENALDT
Odessa, TX

CAPACITORS & BATTERIES

Hurray! I was sure glad to read your February 1978 Service Clinic on the solid-state horizontal-output stage that uses those four-legged capacitors. I have replaced several of these and didn't really know why they opened up. However, you should have told your readers never to bypass the open link between capacitors. It doesn't work! It can blow those output transistors faster than you can think!

Your Hobby Corner advice, also in the February 1978 issue, on avoiding battery troubles was right in line with my thinking. If one has several pieces of battery-operated equipment, one low-cost AC or DC adapter can be used. I prefer using the 12-volt AC adapter, and in each piece of equipment install a bridge rectifier and suitable resistor to limit the battery-charging current to the recommended level. All equipment has the same input jack. Now you can use the inexpensive adapter for all your equipment and never worry about polarity. Even if someone plugs a DC adapter in, no harm will be done.

STUART SJALUND
Ontario, Canada

WIRE AND CABLE

Your article on "Coping with Wire and Cable" in the January 1978 issue was disappointing to me. I'm sure the article will be of some information and benefit to those who are uninformed. However, when an article excludes the most prominent people in the wire-stripping industry, as well as their tools, it seems that even the people who are supposed to be informed, are not.

I would like to bring the following to your attention:

1. Ideal Industries manufactures more different types of wire strippers for more different applications than anyone else.

2. On page 36 in Table I, Wire Stripping Tools & Crimpers, you list the name "Ideal" along with the part numbers, but you show the address as Great Bend, PA. Ideal Industries is located in Sycamore, IL.

3. Under the cut on page 36, the caption indicates: "Wire splices can be made with wire-nuts." I'm sure Ideal Industries appreciates your using its registered trademark of *Wire-Nut*; however, this should only be used with proper trademark recognition of Ideal Industries.

I'm very happy to see that you are making an effort to be of service to the market and the industry by showing the various tools, what they should be used for and the benefits of using them. I'm sure Ideal Industries would appreciate the opportunity to help you enlighten the professional and the hobbyist.

P.V. MALL
I D I Electric (Canada) Ltd.
Ajax, Ont.

FREE ENERGY

Apparently Mr. Ecklin (Letters, February 1978 issue) believes that the laws of physics were made up by humans and, like speed limits, can be ignored. These laws have always been with us, and we are just beginning to understand them. We can't break the laws, or even bend them by intent or inadvertance.

I want to know where Mr. Ecklin is going to find the lossless spring that generates no heat as it is flexed.

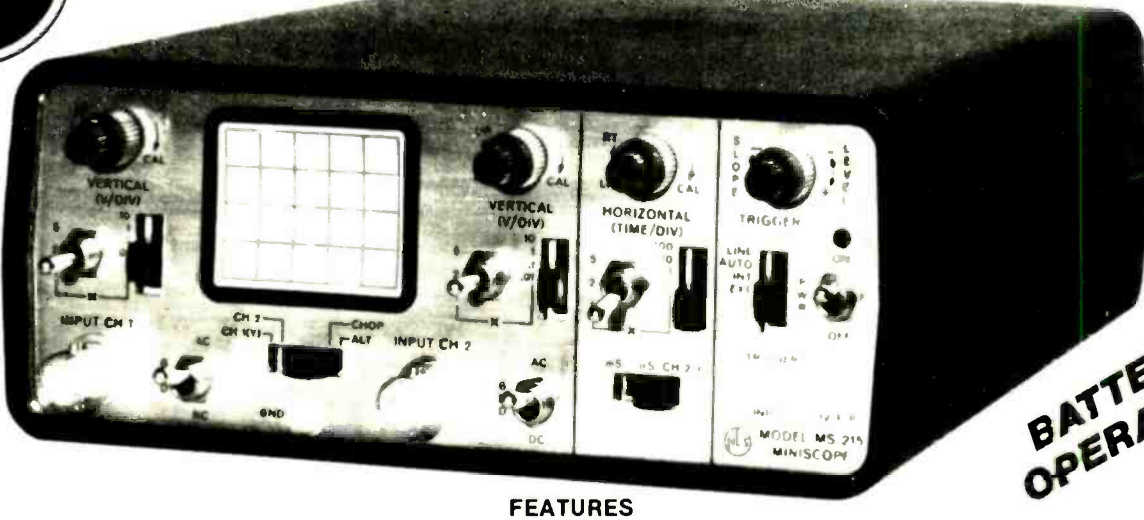
Something he might try that will bring the point home would be to ride a really well-balanced 10-speed bike around for a while and then fit it with one of those little generators that light the lights for "free." I think he may go back to buying batteries when he finds out how much work is required to move those coils of wire past a magnet to generate 6 volts at a few hundred milliamps.

W. COCHRAN
Chalfont, PA

R-E

DUAL TRACE 15 MEGAHERTZ PORTABLE MINISCOPE

$395.00



MADE IN THE U.S.A.!

BATTERY OPERATED!

FEATURES

- Dual Trace- 2 channel: separate, chopped or alternate modes.
- 15 megahertz bandwidth.
- External and internal trigger.
- Time Base - 0.1 microseconds to 0.5 Sec/div - 21 settings.
- Battery or line operation.
- Automatic and line sync modes.
- Power consumption less than 15W.
- Verticle Gain - 0.01 to 50 volts/div —12 settings.
- Weight is only 3 pounds.

From the originator of the Digital Voltmeter, Non-Linear Systems comes the MS-215 Miniscope. It is a fine electronic instrument with a great deal of measuring capability and excellent accuracy. Its design is modern, utilizing the latest in low-powered integrated circuits, and it is packaged into the smallest practical size. The instrument fits into many briefcases and tool boxes with room to spare.

Operating characteristics have been chosen so that the MS-215 will make all of the measurements needed in servicing most electronic equipment. It is field-portable so its use is not restricted to the bench.

SPECIFICATIONS:

Vertical

Mode: CH1, CH2, CH1 & CH2 (Chopped) & CH1 & CH2 (Alt.)
The Following Specifications apply to each channel

Y Axis

Verticle Input: 10mV/div to 50V in 12 Calibrated ranges, as follows:
x1-10mV/div to 10V/div in four ranges, each continuously variable.
x2-20mV/div to 20mV/div in four ranges, each continuously variable.
x5-50mV/div to 50mV/div in four ranges, each continuously vairiable.
Accuracy is 3%

Input Impedence: 1M ohm shunted by 50 pF.

Bandwidth: DC/DC to 15 Mhz ±6 db (DC to 8 Mhz ±3 db). AC, same as DC down to 3Hz.

Rise Time: Approximately 23 nS @ 1 division deflection.

Input Voltage: 250 maximum (DC and Peak AC).

Horizontal

Mode: Internal Time Base or External Horizontal, switch selectable. In the XY mode, vertical input is through CH1 and horizontal input is through CH2

Bandwidth: DC to 200 KHz (±3 db).

Coupling: AC, DC or ground, switch selectable. Low frequency point on AC is 3 Hz.

Input Impedence: 1Meg ohm shunted by 50 pF.

Deflection Factor: 10mV/div to 50V/div in 12 calibrated ranges.
The ranges can be calibrated with the CH2 gain control

Input Voltage: 250V maximum (DC and Peak AC)

Time Base: 0.1uS/div to 0.5 Sec/div in 21' calibrated ranges, as follows:
x1, uS-0.1uS/div to 100 uS/div. x2, uS-0.2uS/div to 200 uS/div.
x5, uS-0.5uS/div to 500 uS/div. x1, mS-0.1mS/div to 100 mS/div
x2, mS-0.2mS/div to 200 mS/div. x5, mS-0.5mS/div to 500 mS/div.
all in four ranges, each continuously variable. (Range increments ar .1, 1, 10, 100.) With vernier in full clockwise position, calibrated time measurements are possible. Accuracy is 3%.

Triggering

Internal: Sweep triggered from internal trigger source (In the dual trace modes, the internal trigger source is CH1).

Automatic: Trigger source is internal calibrater frequency. To be used if there is no other trigger source available to synchronize the sweep.

Line: Trigger is derived from line frequency when using the battery charger.

External: Controls function as for internal triggering (1 Megohm input impedence).

Slope: Selects sync to positive- or negative- going waveform.

Coupling: AC

Sensitivity: Less than 1 div for internal trigger and less than 1 volt for external trigger.

Level: Trigger Level control permits continuous adjustment of trigger point in all modes except Auto.

Internal Calibrater: A square-wave signal of 1 volt p-p ± 5% is provided. Frequency is approximately 1KHz.

Display

Graticule: 4x5 div, each division is 0.25 inch. Viewing area 1.1"Hx1.35"W

CRT: Bluish-white phospher, medium peristence. CRT uses low power filament for low battery drain. Instant on!

Power

On-Board Batteries: Three sealed, rechargeable lead acid "D" Cells

Operating Time: Typically 4 hours.

Charging Time Scope Operating: Will run indefinitely but not reach full charge.

Non-operating: Sixteen hours

External Power: Battery charger 115 vac (220 vac on request), 50-400Hz, less than 15 watts.

Dimensions: 3.1"Hx6.4"Wx8.0"D.

Weight: Three pounds.

Environment

Operating Temperature: 0° to 40°C

Shock and Vibration: Designed to with stand normal shock and vibration encountered in commercial shipping and handling.

Accessories

Furnished: Tilt stand, battery charger, 2 input cables, and 3 miniature banana plugs.

Optional: Leather carrying case and probes

Warranty: One year parts and labor. Made in the U.S.A.

MS-215 with Rechargeable Batteries and Charger
$395.00

Leather Carrying Case

The leather case has 2 separate compartments. One to hold the scope, the other to hold the charger, probe, shoulder strap, etc. The case can be worn on the belt, or over the neck.

The snaps used on the case are "one way", thus accidental striking of the case against an object will not undo the snaps or let it be pulled off your belt.

41-140 ***$30.00***

Probes

10 to 1 probe with 10 megohm input.

Probe uses spring hook tip for sure connection. Compensation network is located at the connector rather than at the probe, so as to keep size and weight to a minimum.

41-141 ***$24.50***

Deluxe Combination Probe

Switchable 10to1/1to1 probe with an assortment of probe tips to suit any situation.

41-3495 ***$34.95***

MS-15 Single Trace version of MS-215

$289.00

$40.00 OFF
On Any Accescries Purchased with **MS-215 MINISCOPE**, Just Send or Mention the **COUPON** and **Radio-Electronics** *Magazine*

PRIORITY ONE ELECTRONICS©

10031 S Woodley Ave. Sepulveda CA. 91343

Terms VISA, MC, BAC, check, Money Order, C.O.D. U.S. Funds Only. CA residents add 6% sales tax. Minimum order $10.00. Orders less than $75.00 include 10% shipping and handling, excess refunded. Just in case please include your phone no. **"Sorry, no over the counter sales"** Good thru July 15, 1978

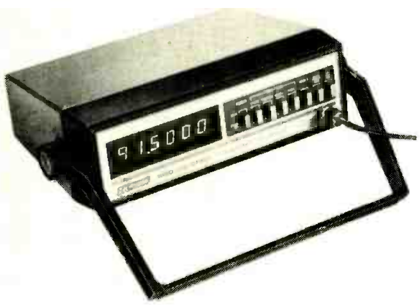
Send for our latest brochure

phone orders welcome (213) 893-8202

OEM and institutional inquiries invited

equipment report

B&K-Precision Model 1820 Universal Frequency Counter



CIRCLE 102 ON FREE INFORMATION CARD

B&K-PRECISION (6460 W. CORTLAND STREET, Chicago IL 60635) have brought out a new frequency counter, the *model 1820 Universal*, which sells for $260. It counts frequencies from 5 Hz up to 80 MHz. Besides this, it will perform tricks that I'd never thought of, and there are full instructions for doing all of them.

The 6-digit *model 1820* has eight pushbutton controls. It's housed in a plastic cabinet with an adjustable bail that serves as a benchrest (you can set it at any angle needed) or a handle. It's AC-powered, and the total drain of only 15 watts makes it easy to use in the field, with a DC/AC converter.

The gate time is pushbutton-controlled. Set in the AUTO position, the pushbutton automatically selects the correct range and place the decimal point to display the maximum number of digits without overranging. Indicator LED's tell you the display is reading in kHz or MHz. Set to the 1-SEC position, the counter reads out the frequency to the nearest Hz. For example, on a CB transmitter, this will push the "27" off to the left, and the frequency is read to 6 digits to the right of the decimal point.

An internal 10-MHz clock oscillator is crystal-controlled, with a ±0.1-PPM stability. By replacing this oscillator with a TCXO (temperature-controlled crystal oscillator) the stability can be raised by a factor of 10! The substitution is very simple. Just unsolder the original oscillator and drop the TCXO into the holes.

Now, for the instrument's handy tricks: pressing the PERIOD pushbutton displays the period (the elapsed time for one complete cycle) of the input signal. This is very useful on low frequencies, since it provides much better resolution. To convert the reading to frequency, just take the reciprocal number, using the period vs. frequency tables so thoughtfully included in the Appendix to the instruction manual.

This procedure can be used for telephone touch-tone frequency pairs; modem frequencies; both U.S. and CCITT frequency standards; CTCSS (Continuous Tone-Controlled Squelch System) frequencies used in two-way radio; all the TV sweep frequencies; the multiplex pilot carrier, power-line frequencies; amateur radio RTTY; and slow-scan TV frequencies. There is even a full-page frequency vs. period table for a complete "equally tempered scale" for pianos and organ tuning! For example, the key of low C has a 16.351-Hz frequency, but you can read the period and get one more digit of accuracy—it's 61.1583 ms.

continued on page 26

"The Sansui AU-717 is a superb amplifier. We like it with no ifs, ands, or buts." (Julian Hirsch) It offers "as much circuitry sophistication and control flexibility as any two-piece amplifying system."

(Len Feldman)

Everyone says great things about the new Sansui AU-717, but the experts say it best.

The Sansui AU-717 DC integrated amplifier is "Sansui's finest .... It incorporates a fully direct-coupled power amplifier section whose frequency response varies less than +0, −3dB from 0Hz (D.C.) to 200 kHz. The amplifier's power rating is 85 watts per channel (min. RMS) from 20 to 20,000Hz into 8-ohm loads, with less than 0.025 per cent total harmonic distortion ..... If any amplifier is free of Transient Intermodulation Distortion (TIM) or any other slew-rate induced distortion, it is this one .... The slew rate ... was the fastest we have measured on any amplifier, an impressive 60 V/usec.

"The preamplifier section of the AU-717 .... has very impressive specifications for frequency response, equalization accuracy, and noise levels ... The AU-717 has dual power supplies, including separate power transformers, for its two channels ... [and] exceptionally comprehensive tape-recording and monitoring facilities .... Good human engineering .... separates this unit from some otherwise fine products....


Julian D. Hirsch, Contributing Editor Stereo Review

"The Sansui AU-717 is a superb amplifier. We like it with no ifs, ands, or buts." [Reprinted in part from Julian Hirsch's test report in **Stereo Review**, February, 1978.]

"One clear advantage of DC design is apparent. Even at the low 20Hz extreme, the amplifier delivers a full 92 watts – the same value obtained for midfrequency power – compared with its 85 watt rating into 8 ohms....


Leonard Feldman, Contributing Editor Radio-Electronics

"The equalization characteristic of the preamplifier was one of the most precise we have ever measured, with the deviation from the standard RIAA playback curve never exceeding more than 0.1dB......

"Sansui claims that this unit has reduced transient intermodulation distortion – a direct result of the DC design, and, indeed, the model AU-717 delivered sound as transparent and clean as any we have heard from an integrated amplifier....

"... worth serious consideration – even by those who prefer separate amplifiers and preamplifiers." [Reprinted in part from Len Feldman's test report in **Radio-Electronics**, January, 1978.]

Listen to the superb sound of the Sansui AU-717 at your Sansui dealer today. And be sure to ask him for a demonstration of the matching TU-717 super-tuner.

SANSUI ELECTRONICS CORP.
Woodside, New York 11377 • Gardena, California 90247 • SANSUI ELECTRIC CO., LTD., Tokyo, Japan
SANSUI AUDIO EUROPE S.A., Antwerp, Belgium • In Canada: Electronic Distributors

Sansui

CIRCLE 73 ON FREE INFORMATION CARD

EQUIPMENT REPORT
continued from page 24

Finally, the table contains a listing for the Kansas City Standard Cassette Interface used by computer hobbyists. The frequency counter can also be used to test TV ultrasonic remote control systems. The transmitters can be set right on the button for each function, and the receivers checked with equal ease.

The ACCU pushbutton stands for accumulate and reads the total number of cycles or events (switch opening or closing, etc.) occurring at a given time. This reading is set to zero by pushing the RESET button, and stopped by opening the input circuit at the end of the desired time.

When you press the pushbutton marked TIME, the display starts counting instantly in hundredths of a second. The reading can be returned to zero by pressing the RESET pushbutton. This function can also be used as a electronic stopwatch. A control cable with a pushbutton switch or electronic actuator on it is plugged into the rear-panel jack. Press the TIME button and then the RESET button. To start the count, the control switch is opened (or the electronic actuator is driven to a logic-high level, not more than 5 volts). When the switch is closed, the count stops (to a logic-low level), and is retained on the display until the RESET button is pressed.

Next to the RESET button is the gate TIME pushbutton mentioned before, for higher resolution. Finally, the last pushbutton on the far right is a ×1–×10 attenuator selector for reading signals at a higher level than the input limit: up to 200 volts (DC + AC peak) to 500 Hz, and 100 volts on higher frequencies. The input is a standard BNC jack and has a 1.0-megohm input impedance. Therefore, standard 10:1 oscilloscope probes can be used where circuit loads must be kept low.

The instruction manual gives complete details of all the tests that can be made by the *model 1820*. It even includes schematic diagrams of the electronics needed to make this kind of control possible, mostly debouncing circuitry for greater accuracy. Practically any kind of electrical transducer can be used with it to make many measurements. **R-E**

Hickok Model 517 Dual-Trace Oscilloscope

CIRCLE 103 ON FREE INFORMATION CARD

THE HICKOK ELECTRICAL INSTRUMENT COMPANY, 19514 Dupont Avenue, Cleveland, OH 44108 has just released two triggered-sweep oscilloscopes; the *model 515* (a single-trace scope) and the *model 517* (a dual-trace version, shown here). The specifications are identical, except for an added channel on the *model 517*, which was the one tested.

This scope is an impressive instrument. The cabinet is a "laydown" style with the cathode-ray tube (CRT) at the top on the left-hand side, and controls placed below and to the right. The controls for the two input channels are side by side at the bottom, making them easy to get at. All panel controls are grouped into two color-coded areas: Blue for the vertical inputs, for the level control and for all switches used with these. All the triggering controls, the level set, etc., are contained in the green area at the top of the panel on the right. The case has a locking bail-handle that can be used to set it at any desired viewing angle.

Each channel has a calibrated step attenuator with a 12-step range from 10 mV-per-centimeter to 50 volts-per-centimeter. This control serves a dual function. The center knob is a variable attenuator; turning it fully clockwise and clicked puts it in the CALIBRATE position. A full turn counterclockwise extends the vertical range down to 5 mV-per-centimeter. Channel amplifiers A and B are identical, and can be AC- or DC-coupled; the center position grounds the input for positioning of the trace. The bandwidth is given as up to 15 MHz in either channel. Our tests proved this rating is quite conservative, since we observed signals up to 27 MHz with readable deflection.

The TIME/CM (horizontal sweep speed) switch can be varied from 0.5 μs-per-division down to 0.2 seconds-per-centimeter, in 18 calibrated steps. A ×5 sweep-multiplier extends the upper limit to read only 100 ns-per-centimeter. The *model 517* can be triggered by internal sync, or by an external trigger pulse. An AUTO-NORMAL switch triggers the sweep so that you can see the baseline for setup and adjustments. A selector switch marked "+/−" lets you select either positive or negative polarity for triggering. All these controls are widely spaced pushbuttons. A continuously variable trigger level gives positive trigger control. Other pushbuttons display only the Channel A, Channel B or DUAL (both channels at once) modes; the ADD mode displays the Channel A signal added to Channel B, with the resultant waveforms.

Both *model 515* and *model 517* are meant to be general-purpose scopes for any industrial/lab/radio/TV application. For TV work, a special TV-V/H switch selects a sync-separator circuit so that the pattern locks on either horizontal or vertical signals. Whether horizontal or vertical sync is used depends on the position of the TIME/CM switch, which automatically selects the correct sync, depending on the sweep speed. We gave the *model 517* our pet "acid test": display a color-bar signal from a generator at horizontal rate. This is a beast to lock onto, since it consists of a whole row of sharp pulses of the same amplitude. The *model 517* grabbed it and held it firmly.

The resolution is very good. In this same test (using the sweep expander) we were able to count the number of cycles (10 in all) in one bar of the color-bar pattern! Actually, the expanded sweep wasn't needed; we just used it to verify our count in normal operation. The risetime is very good. We fed it patterns from a digital color-bar generator having an excellent squarewave output, and the risetime was almost unmeasureable. A good squarewave probe-calibration signal (7.5 volts P-P) is provided via a jack on the panel. This is used for setting frequency-compensating trimmer in the ×10 probes.

The *model SP-17 Probe Kit* contains two special probes. One probe is the *model SP-7*, a
continued on page 28

EQUIPMENT REPORT
continued from page 26

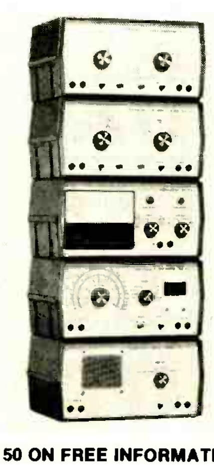
×10 low-capacitance probe, and the other is the *model SP-6*, a combination ×1/×10 probe. A slide switch on the probe handle selects either mode; the center switch position grounds the input for setup. The basic probe has a very sharp tip. There are four slip-on adapters: a spring-loaded hook; an insulator cap that covers everything but the sharp probe tip; a special adapter with two small guard insulators that have a sharp tip between them, for checking one pin of an IC without shorting; and a BNC adapter. A tiny insulated screwdriver adjusts the trimmer in the probe. The *model SP-17 Probe Kit* comes in a sturdy plastic pouch with a zipper, so you can't lose those little adapters in your kit. The cables are 1.5 meters long or about 5.5 feet.

Unlike some early triggered-sweep scopes, the *model 517* can perform sweep alignment. The last TIME/CM switch position is labelled EXT HORIZ. The horizontal sweep signal is fed into the external trigger jack; the variable control on the TIME/CM switch then acts as a horizontal-gain control. A vertical input signal is fed into the Channel A input. The *model 517* has one feature I used to like on my old scopes, but haven't seen lately: a trace-invert switch. This switch can "make the curve go the right way," if you're like me, and want the curve to go *up*. The switch has other uses: In normal operation, in the ADD mode (Channel A + Channel B), flipping the switch to the INVERT position displays the *difference* signal, or Channel A − Channel B. For best triggering on video signals, this switch should be set so that the sync-tips point down.

The CRT is a rectangular 5DEP31 with a built-in graticule. For vectorscope analysis, you can slip in a vector graticule over this graticule; this, too, comes with the instrument. The INTENSITY, FOCUS and ASTIGMATISM controls are grouped out of the way at the top left-hand corner of the panel.

This is a good, versatile instrument, and it should prove of great value to anyone who needs a reliable and accurate oscilloscope. Its price tag is $695. **R-E**

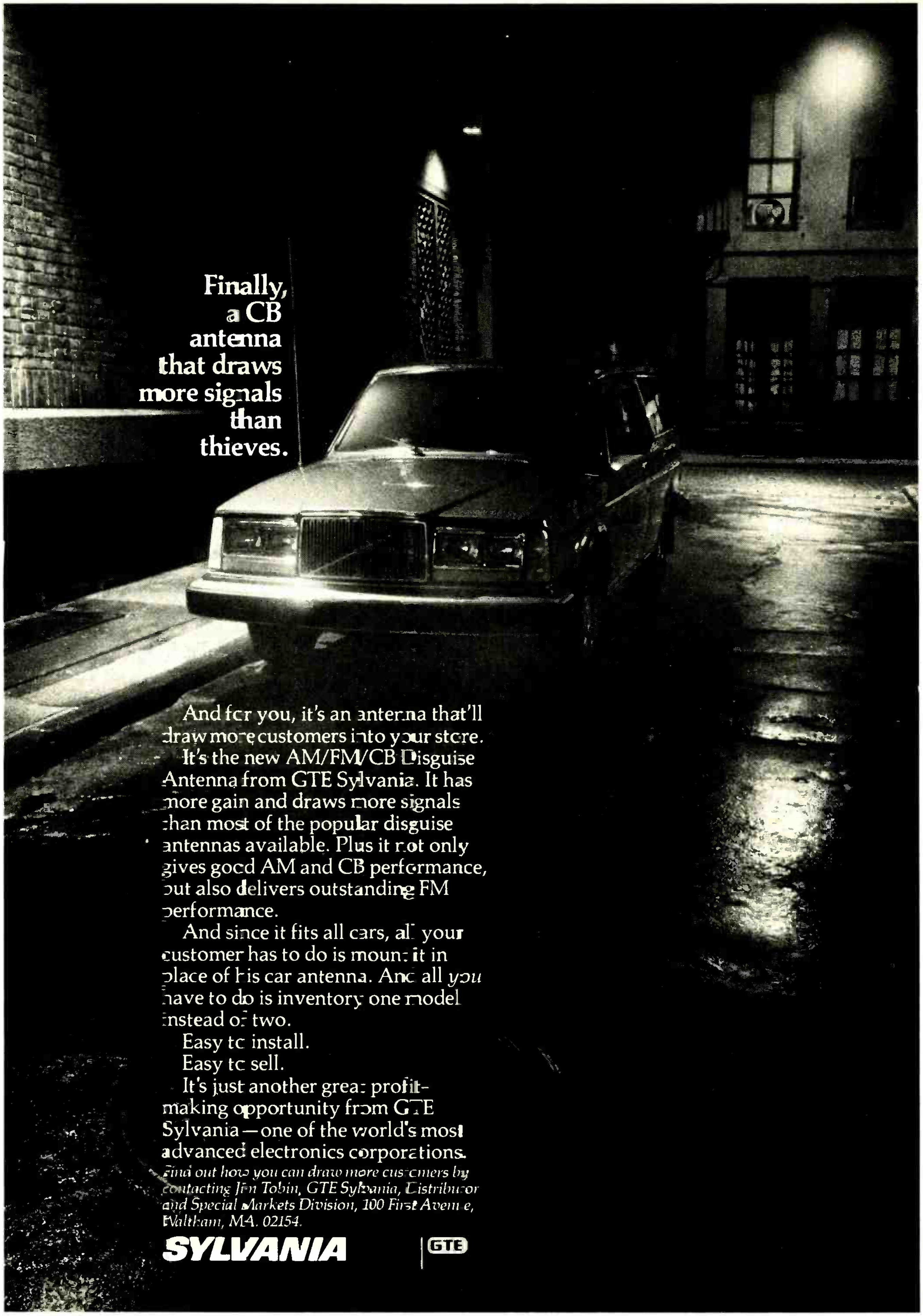
Heathkit Series 5280 Test Instruments



CIRCLE 50 ON FREE INFORMATION CARD

THE HEATH COMPANY HAS JUST RELEASED its Series 5280 test instruments. There are five instruments, all in identical plastic cases that can be stacked for a neat test-center layout. The cases are 11 inches wide, 5¾ inches high

continued on page 30


Finally, a CB antenna that draws more signals than thieves.
And for you, it's an antenna that'll draw more customers into your store.
It's the new AM/FM/CB Disguise Antenna from GTE Sylvania. It has more gain and draws more signals than most of the popular disguise antennas available. Plus it not only gives good AM and CB performance, but also delivers outstanding FM performance.
And since it fits all cars, all your customer has to do is mount it in place of his car antenna. And all *you* have to do is inventory one model instead of two.
Easy to install.
Easy to sell.
It's just another great profit-making opportunity from GTE Sylvania—one of the world's most advanced electronics corporations.
Find out how you can draw more customers by contacting Jim Tobin, GTE Sylvania, Distributor and Special Markets Division, 100 First Avenue, Waltham, MA. 02154.
SYLVANIA
GTE

EQUIPMENT REPORT

continued from page 28

and 7¾ inches deep. Typical weight is 3¼ pounds. All solid-state, the instruments can be powered either by two 9-volt batteries or by an AC power supply having five plugs that fit sockets on the back of each unit.

First, in numerical order, is the *model IG-5280* RF Oscillator. It has an RF output from 310 kHz to 110 MHz on fundamental frequencies, in five overlapping bands. An extra band is calibrated on the scale, 110 to 220 MHz on harmonics. The AF modulation is 1 kHz, and can be used as an audio test signal. Both RF and AF outputs have variable controls; the AF control serves as a modulation-percentage control for RF. Our test sample showed excellent accuracy.

Next, the *model IB-5281* Inductance-Resistance-Capacitance Bridge. It uses a Wheatstone circuit that is AC-driven so that capacitors and inductors can be checked. The instrument's resistance is from 10 ohms to 10 megohms; inductance is from 10 μH to 10 H; and a capacitance from 10 pF to 10 μF, all on three ranges. The panel meter shows the null, and parts can be checked against an external standard for matching. A special scale shows matching and the percentage of error. We checked several known components with good results.

The *model IG-5282* Audio Oscillator has a range from 10 Hz to 100 kHz, and has separate sinewave and squarewave outputs. For sinewave operation, only the sinewave section need be switched on; for a squarewave, both sections must be on. This confused me at first, but after taking my usual drastic step (reading the manual!) the problem cleared up. Sinewaves are clean and the squarewave has excellent risetime. Sample waveforms for checking and identifying both sinewave and squarewave distortion are shown in the manual.

The *model IT-5283* is an RF/AF Signal Tracer. This instrument follows RF-IF signals through any radio, as well as AF signals from the detector on. Switching is performed in the test-probe tip; a diode symbol shows you the RF reading. A novel feature is used in the third switch position: it becomes an audible volt-ohmmeter! The input goes to a relaxation oscillator using a unijunction transistor. You can read resistance from 0 up to 5 megohms. You hear an audible tone, and as resistance goes higher, the frequency goes down. The *model IT-5283* can also be used as a DC voltmeter, from −3 volts to +20 volts; as the voltage goes down, the frequency goes down. This instrument can also be used for checking logic states. You soon learn to identify the tone produced by a logic high (1) and a logic low (0).

Last, but not least, the test instrument you should build first (if you plan to obtain them in kit form) is the *model IM-5284* Multimeter. The AC or DC voltage ranges are from 1.0 volt up to 1000 volts. On the DC range, the input impedance is 10.0 megohms; on the AC range, the impedance is 1.0 megohm. The ohmmeter reads from R × 1 to R × 1.0 megohm. The analog panel meter is a 4.5-inch rectangular unit. There are four separate scales and four ranges, 0–1, 0–10, 0–100 and 0–1000, are used. Also provided are an ohms scale and a special scale for the 0–1.2-volt AC range. The ZERO ADJUST and OHMS ADJUST controls are located on the front panel along with the RANGE and FUNCTION switches and the input jacks.

This instrument was checked on all ranges against a high-accuracy digital meter. All the AC and DC voltage ranges read right on the nose. The AC voltage ranges have a good frequency response, accurate up to 100 kHz. The resistance ranges, which were checked against our lab standards, were also accurate. The drift was almost undetectable over a fairly long test.

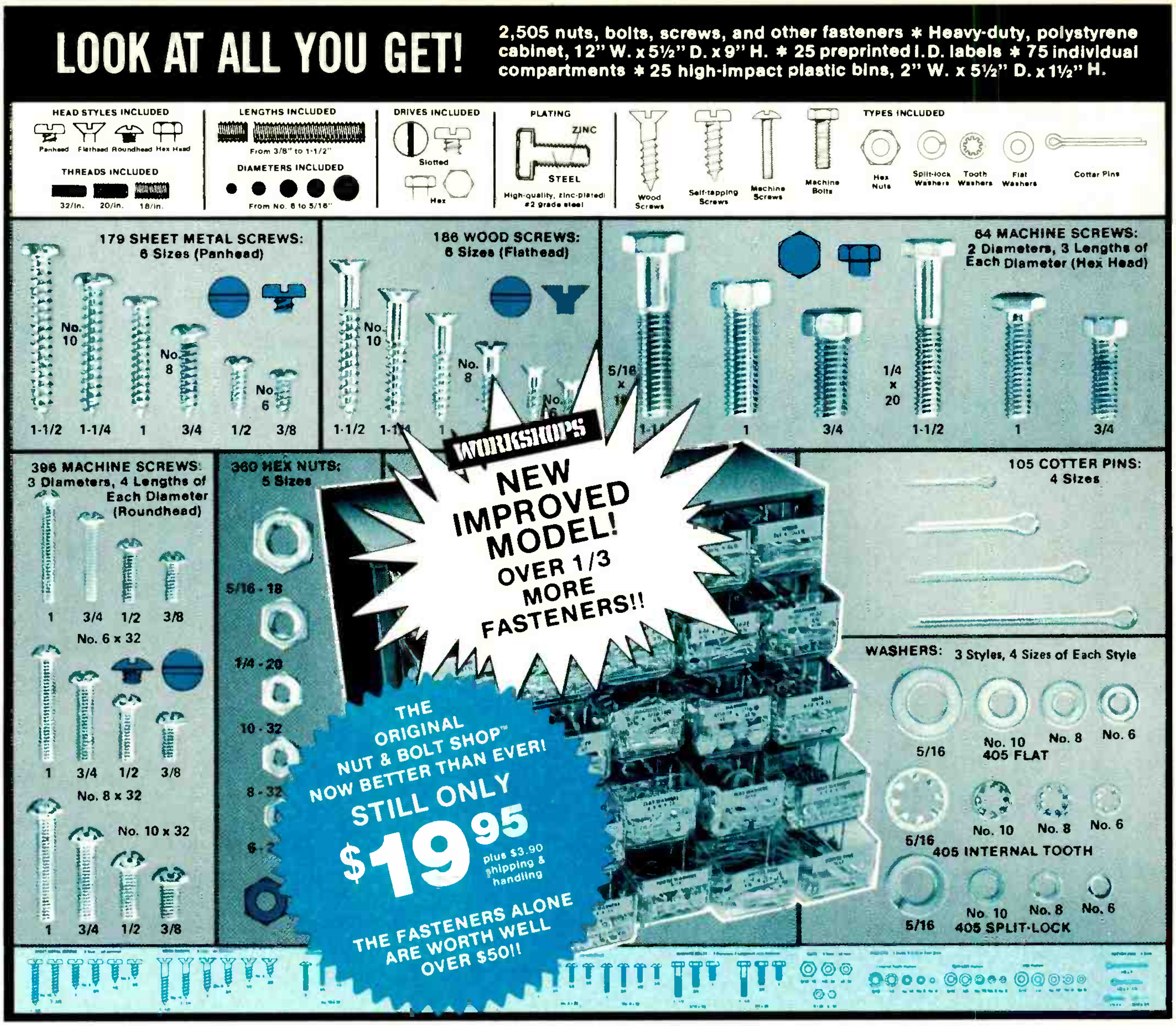
The operating power supply for all five Series 5280 instruments can be provided by the *model IP-5280-1* AC Power Supply. This has a +9- and −9-volt output, each regulated by its own IC regulator; currents up to 100 mA can be drawn. There are five cables, each with plugs, that are long enough to reach all the instruments even if they are stacked one on top of the other. This compact power supply can be tucked away anywhere. It has an isolating fuse-protected power transformer. No special switch is needed; you just use the on-off switches of the individual instrument.

The Series 5280 can provide the beginner or advanced experimenter with low-cost, accurate and versatile test instruments that are available in kit form or fully built and tested. They should be ideal for use in electronics and electrical schools, or for servicing any kind of equipment. And the stacking feature makes it possible to create some neat and useful layouts for any kind of work. **R-E**

Spyderco Company Portable Hand

LET'S SUPPOSE YOU WANT TO SOLDER TWO resistors together for a test. You hold one resistor in one hand, and the soldering iron in

continued on page 35



Just about every nut, bolt, screw, washer, and cotter pin you'll ever need — over 2,500 pieces — all organized & labeled in a multi-bin cabinet.

- Now . . . your own hardware store for home, shop, or office!
- 2,505 fasteners total — all high-quality, zinc-plated (rust-resistant) steel.
- No more piece-at-a-time trips to the hardware store.
- Heavy-duty, polystyrene cabinet, high-impact plastic bins and bin dividers, printed I.D. labels.
- Truly a $50-plus value.
- Unconditional 30-day, money-back guarantee.
- The most important "tool" in your workshop.
- As featured by the editors of: MECHANIX ILLUSTRATED, POPULAR SCIENCE, WORKBENCH, FAMILY HANDYMAN, HOT ROD, AND OTHERS.

FREE 17½" x 24" wall-size Specifications Chart — a $2.50 value. Tells you everything you need to know for a quick professional job every time. What thread types, and head styles are available. What size nut and wrench to use. What size "starting" and "tapping" holes to drill. When to use what kind of washer. Instantly measures sizes. And much, much more. Yours FREE just for trying the Nut & Bolt Shop!

Now you can have just the right nut, bolt, screw, washer, or cotter pin at your fingertips . . . whatever the job! And for an almost unbelievable low price!!

With the NUT & BOLT SHOP — a complete size range of just about every kind of hardware you'll ever need. All organized in one 25-tray, 75-bin cabinet. Perfect for auto repair. Home projects and hobbies. Office maintenance. And industrial shop use. Great as a gift, too!

No more time-consuming trips to the hardware store. No more less-than-professional looking repair jobs. No more searching through old coffee cans of odds and ends.

OUR CUSTOMERS ARE AMAZED AT THE VALUE!

"I don't see how you make a profit at such a low cost! I found it much more than I expected!!"
M. D. Dorsette, Rockville, Maryland

"An excellent buy. At retail prices, would have cost far more . . . usually a minimum of 3c to 5c a piece!"
G. L. Steiger, Enfield, Connecticut

"Quality is excellent. Great for do-it-yourselfers . . . and convenient!"
G. R. Dalmadge, Sunnyvale, California

"I've priced these items separate — it would have cost far more for them (at a hardware store)."
J. D. Russell, Cicero, Illinois

Order today! Send check, money order, or company purchase order for just $19.95 (plus $3.90 shipping and handling) to D.R.I. Industries, Inc., 6864 Washington Ave. So., Eden Prairie, MN 55344. If you're not completely satisfied — if you're not truly amazed at all you get — return it within 30 days for a full refund. No questions asked! And keep the FREE $2.50-value wall chart for your trouble!

— 24-HOUR SERVICE —

CREDIT CARD BUYERS
Call our 24-hour toll-free number for immediate service 800-331-1000
(In Oklahoma, call 918-664-8300 collect).

30-DAY UNCONDITIONAL MONEY BACK GUARANTEE

D.R.I. Industries, Inc. Dept. RE-68
6864 Washington Ave. So., Eden Prairie, MN 55344
I WISH TO ORDER_____(QTY.) NUT & BOLT SHOP(S).
☐ I have enclosed my check, money order, or company purchase order for $19.95 plus $3.90 ea. (MN residents add 4% sales tax).
☐ I wish to charge it to (check one): ☐ American Express ☐ VISA ☐ Diners Club ☐ Master Charge ☐ Carte Blanche
CARD NO. ____________ EXP. DATE ___/___
SIGNATURE X ____________
NAME ____________
ADDRESS ____________
CITY ____________ STATE ______ ZIP ______

04697

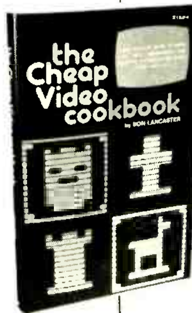
TM "The Workshops" and "The Nut & Bolt Shop" are trademarks of D.R.I. Industries, Inc., Eden Prairie, MN.

CIRCLE 71 ON FREE INFORMATION CARD

Foggy about computers?

Sams new library of computer books provides your clear course

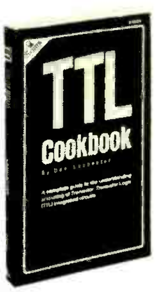
You've counted on Sams for years to bring you clear, concise information about many subjects. Now obtain explanations and data you need to work with and enjoy the fascinating computer world — written by experts.



The Cheap Video Cookbook

By *Don Lancaster*

A complete guide to super low cost alphanumeric and graphic microprocessor-based video displays. Contains complete construction details on a seven IC circuit that dramatically slashes the cost of getting words, op-code, and graphics out of a microcomputer and into a television set. Includes thoroughly documented and debugged software. Enables you to produce virtually any alphanumeric format, including scrolling 24 lines by 80 characters, and virtually any graphics format, including high resolution 256 X 256 mode and four-color graphics. Also contains complete details on transparency techniques that let you compute and display at the same time with high throughput. 288 pages; 5½ X 8½; softbound. No. 21524 $8.95



TTL Cookbook

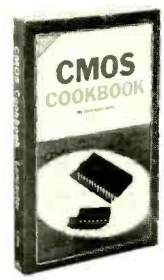
By *Don Lancaster*

You'll discover what Transistor-Transistor Logic is, how it works and how to use it. Discusses practical digital applications. You'll learn to build TTL systems that entertain, test and train. 336 pages; 5½'' X 8½'' softbound. No. 21035 $9.50

TV Typewriter Cookbook

By *Don Lancaster*

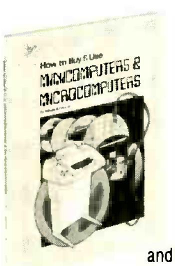
Your comprehensive guide to low cost television display of alpha-numeric and graphics data for microprocessor systems, word processing, TV titling and video games. Covers configurations, memories, keyboards, techniques and much more. 256 pages; 5½'' X 8½'' softbound. No. 21313 $9.95



CMOS Cookbook

By *Don Lancaster*

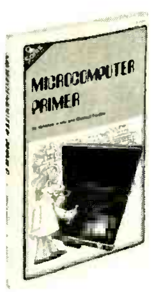
Your complete guide to the understanding and use of Complementary Metal-Oxide-Silicon integrated circuits. Gives usage rules; power supply design examples; applications; information on breadboards, testing, tools, and interface. Detailed coverage of logic and more. 416 pages; 5½'' X 8½'' softbound. No. 21398 $10.50



How To Buy & Use Minicomputers & Microcomputers

By *William Barden, Jr.*

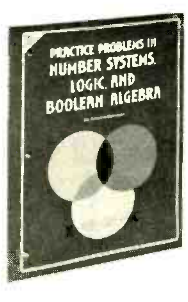
This manual gives you the basics of minicomputers and microcomputers. Explains their hardware and software, the peripheral devices available and various programming languages and techniques. Allows you to decide which system is best for your needs. 240 pages; 8½'' X 11'' softbound. No. 21351 $9.95



Microcomputer Primer

By *Mitchell Waite* and *Michael Pardee*

Written for the beginner in the computer field. All the basic concepts and characteristics of microcomputers are explored. The easy to understand language prepares you for further study. 224 pages; 5½'' X 8½'' softbound. No. 21404 $7.95



Practice Problems in Number Systems, Logic, and Boolean Algebra (2nd Edition)

By *Edward Bukstein.*

This workbook is a 64-lesson introduction to digital computer mathematics. Problems designed for classroom or individual use. Pages are removable. Includes answers for all exercises. 144 pp. 8½ X 11; softbound. No. 21451. $6.50

Z-80 Microcomputer Handbook

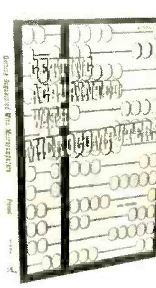
By *William Barden, Jr.*

The Zilog Model Z-80 represents a microprocessor that is extremely sophisticated and attractive to many computer users. Provides essential informtion on Z-80 technology. Organized into three sections: hardware; software; microcomputers; built around the Z-80. 304 pages; 5½ X 8½; softbound. No. 21500 $8.95

Your Own Computer

By *Mitchell Waite,* and *Michael Pardee*

An introduction for the novice to the fascinating world of home computers. Reveals the potential of these technical marvels. Tells how personal computers will soon be used to regulate energy in the home, regulate spending habits and even to provide entertainment for the family. 80 pages; 5½ X 8½; softbound. No. 21483 $1.95



Getting Acquainted With Microcomputers

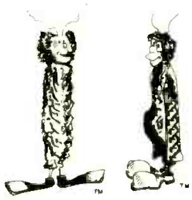
By *Louis E. Frenzel*

Learn about microcomputers in an effective, lowcost manner. The essential information contained in this book has been compiled especially for engineers, technicians, scientists, but it will also prove invaluable to those who want to learn more about hobby and personal computing. 288 pages; 5½ X 8½; softbound. No. 21486 $8.95

How To Program Microcomputers
By *William Barden, Jr.*
Explains assembly-language programming of microcomputers based on the Intel 8080, Motorola MC6800, and MOS Technology MCS6502 microprocessors. Basic concepts, number systems and operations, computer operation and computer codes are examined. Microcomputer architecture and operation are discussed. The author concludes with a number of useful precanned operations. 256 pages; 5½ X 8½; softbound. No. 21459 $8.95

Using The 6800 Microprocessor
By *Elmer Poe*
Acquaints the reader with the hardware and the software of the 6800 "fun" machine. No special background in digital electronics is necessary. Guides the reader through all phases of programs that demonstrate the practical use of a 6800 system. Fifteen information packed chapters. Appendix includes a programmer's card. 176 pages; 5½ X 8½; softbound. No. 21512 $6.95

The Blacksburg Continuing Education Series™



It has long been the objective of the "Blacksburg Group" to develop timely and effective educational materials and aids that will permit students, engineers, scientists and others to quickly learn how to apply new technologies to their particular needs. The members of this group have long been involved in digital electronics, minicomputers and microcomputers. Since 1974 they have collaborated as a group in the development of textbooks, short courses, magazine columns and hardware. *The Blacksburg Continuing Education Series* is an easy to read format consisting of 15 titles. Subjects range from basic electronics through microcomputers, operational amplifiers and active filters. Each title in the series includes detailed experiments, "hands-on" learning experiences, and examples to reinforce basic concepts. Book Size 5½" X 8½", softbound.

8080 A Bugbook: Microcomputer Interfacing And Programming
By *Peter H. Rony, David G. Larsen,* and *Jonathan A. Titus*
Teaches the skills needed to use an 8080-based breadboard microcomputer system. Covers the principles, concepts and applications of an 8-bit microcomputer based on the 8080 microprocessor IC chip. Presents the four fundamental tasks of computer interfacing: (1) generation of device select pulses; (2) latching of output data; (3) acquisition of input data; (4) servicing of interrupt signals. 416 pages No. 21447 $10.50

NCR Data Communications Concepts
By *NCR Corporation*
Explores the various concepts, techniques, and limitations of data communications. Written mainly for telephone-based communications, but just as applicable to other forms of data communication. Basic carrier systems, transmission lines, modems, and more. 192 pages No. 21548 $6.95

Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing
By *Peter R. Rony, David G. Larsen,* and *Jonathan A. Titus*
A combined approach to digital electronics and 8080-based microcomputers covering basic gates through microcomputer interrupts, with hardware and software examples. Experiments teach digital logic breadboarding, circuit design and microcomputer interfacing. Two books: 512 pages each;
Book 1 No. 21550 $12.95
Book 2 No. 21551 $12.95
Two Volumes No. 21552 $23.95

Microcomputer-Analog Converter Software and Hardware Interfacing
By *Jonathan A. Titus, Christopher A. Titus, Peter R. Rony,* and *David G. Larsen*
Covers the microcomputer hardware and software necessary to interface A/D and D/A converters to 8080-based microcomputer systems. Also discusses sample-and-hold and multiplexer circuits. With experiments and completely documented computer programs. 320 pages;
No. 21540 $9.50

DBUG: An 8080 Interpretive Debugger
By *Jonanthan A. Titus* and *Christopher A. Titus*
Describes DBUG, a software debugging package for 8080-based microcomputers, and how it can be applied to program development and testing. Complete with hexadecimal and octal listings. 112 pages. No.21536 $4.95

NCR Data Processing Concepts Course
By *NCR Corporation*
Here is a general introduction to data processing, computers, and logic for those interested in how a computer works. Includes sections on digital logic and mathematical operations. Also covers Input/Output devices, memories, and computer control. 320 pages. No. 21547 $9.50

Microcomputer Software
By *David G. Larsen, Peter R. Rony, Jonathan A. Titus,* and *Christopher A. Titus*
A detailed approach to assembly language programming for 8080 or 8085-based computers. Covers basic and advanced instructions, mathematical manipulations, number-base conversions, command decoders, arrays and tables, interrupt programming, and more. With complete, tested programs in standard mnemonics. 304 pages No. 21541 $9.50

Logic and Memory Experiments Using TTL Integrated Circuits
By *David G. Larsen* and *Peter R. Rony*
A "hands on" introduction to the use of 7400-series devices, memories, display and arithmetic elements. The emphasis is on experiments that are used by the reader to explore and use digital circuits. Two books.
Book 1; 384 pages No. 21542 $10.50
Book 2; 352 pages No. 21543 $9.95
Two Volumes No. 21544 $18.95

Interfacing and Scientific Data Communications Experiments
By *David G. Larsen* and *Peter R. Rony*
Describes the use of UAR/T and USAR/T "chips" for serial data communications between instruments and computers. The operation of teletypewriter interfaces and serial transmission circuits are explored. With experiements and circuit details. 160 pages;
No. 21546 $5.95

Send Your Order TODAY!

Send books checked below, $__________ enclosed (please enclose check of money order).* I understand that, if not completely satisfied, I may return my order within 10 days for a full refund.

*Include sales tax where applicable. Canadian prices slightly higher.

☐ 21035	$ 9.50	☐ 21404	$7.95	☐ 21486	$8.95
☐ 21313	$ 9.95	☐ 21451	$6.50	☐ 21500	$8.95
☐ 21351	$ 9.95	☐ 21459	$8.95	☐ 21512	$6.95
☐ 21398	$10.50	☐ 21483	$1.95	☐ 21524	$8.95

Howard W. Sams & Co., Inc.
4300 West 62nd Street/Indianapolis, Indiana 46206

NAME ______________________
(Please print)
ADDRESS ______________________
CITY ______________ STATE ________ ZIP ______

THE BLACKSBURG CONTINUING EDUCATION SERIES™

☐ 21447 $10.50 ☐ 21536 $4.95 ☐ 21547 $9.50

The following books will be available during the month specified.

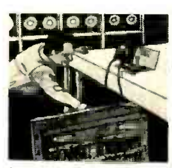
☐ 21548	June 1978	$ 6.95	☐ 21541	Sept. 1978	$ 9.50
☐ 21550	July 1978	$12.95	☐ 21542	Oct. 1978	$10.50
☐ 21551	July 1978	$12.95	☐ 21543	Oct. 1978	$ 9.95
☐ 21552	July 1978	$23.95	☐ 21544	Oct. 1978	$18.95
☐ 21540	August 1978	$ 9.50	☐ 21546	Oct. 1978	$ 5.95

TKG42

Available in Canada: Lenbrook Industries Ltd., Scarborough Ontario M1H 1H5.

For field or lab work, Dynascan has a quality scope to fit your needs. B&K-PRECISION has taken a no-nonsense, cost-effective approach to oscilloscope design. Our scopes are rugged dependable instruments, designed to match the features and performance of far more expensive scopes, without matching their high prices. Typical of this approach is our Model 1474 30MHz dual-trace lab scope and our new Model 1432 15MHz portable dual-trace scope.

The B&K-PRECISION Model 1474 is the most cost-effective dual-trace scope available. No compromise features include a built-in signal-delay line, 5mV/cm sensitivity, switchable high- and low-pass triggering filters and a TTL compatible Z-axis input. Vertical response is typically down only −6dB at 49MHz. The 1474 is excellent for microprocessor work, as signal delay and the 30MHz minimum bandwidth allow you to examine short pulse waveforms.



The new Model 1432 portable dual-trace scope is one of our best values. This compact portable offers optional rechargable battery pack and full lab-scope features. An automatic battery charger is built-in as a standard feature. Sensitivity is 2mV/division over a DC to 15MHz range. Bandwidth response is typically down only −6dB at 25MHz. Special features include algebraic addition and subtraction of two input signals, 19 calibrated sweep ranges and front-panel X-Y operation.

Off-the-shelf delivery is another of our features, and it's the one you can take advantage of first. We're so sure that B&K-PRECISION scopes will fill your needs, that we can offer a no-obligation, ten-day free trial. Contact your local B&K-PRECISION distributor for immediate delivery or a demonstration.

B+K PRECISION DYNASCAN CORPORATION

6460 West Cortland Street, Chicago, Illinois 60635 · 312/889-9087

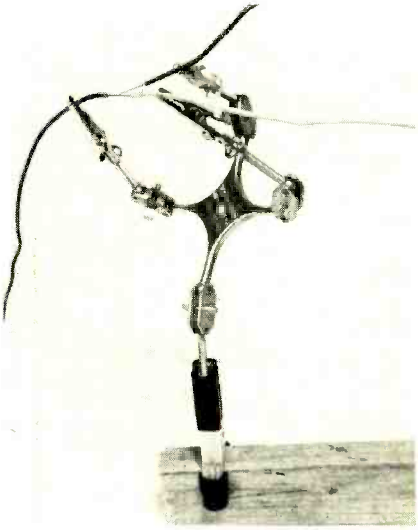
In Canada: Atlas Electronics, Ontario · Intl. Sls: Empire Exporters, Inc., 270 Newtown Road, Plainview, L.I., NY 11803

CIRCLE 80 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 30

the other. Then, you chase the loose resistor all over the bench, solder it, and then you move just as the solder sets! What you need at times like this is another hand.

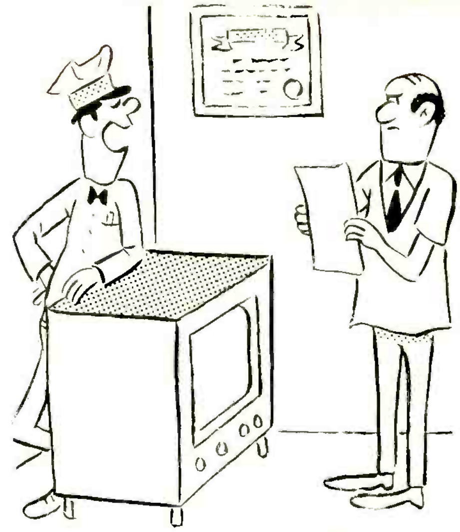


CIRCLE 105 ON FREE INFORMATION CARD

The Spyderco Company, Box 3517, Redding, CA 96001 has one for you called *The Portable Hand.* It has four arms, each with an adjustable ball-socket joint with a thumbscrew. The arms can be set to any position or angle you wish, and are mounted on a stamped metal star that can be placed on the bench as a base, or fastened with a screw through the center. Three of the arms end in standard Mueller Series 60 alligator clips. These clips are secured by a brass collar with a set-screw, which makes them easy to replace if damaged. The clips will hold the leads of any small components. If necessary, they can be padded by slipping a piece of spaghetti wire over the jaws.

The fourth arm has a larger Mueller *Hippo-Clip* with rubber-padded jaws and grips. You can use this clip to fasten *The Portable Hand* to the bench edge, a shelf, or the top of a TV cabinet, and then just use the other three arms.

This is the kind of handy timesaving device that I love! An illustrated folder comes with it that shows 18 possible things you can do with it. It is definitely not a toy or a cheaply made gadget to play with. It's very well-built, strong and should withstand long and hard use on the bench. *The Portable Hand* sells for $9.95, and it should pay for itself soon. **R-E**



"Of course you're welcome to get a second opinion, doctor! But this first one is still going to cost you $47.00!"

This 8-bit machine, by itself, is as versatile as a lot of systems that include peripherals

Skeptical? For starters, because of its unique design the H8 is the only machine in its price class that offers full system integration yet, with just 4K of optional memory and using only its "intelligent" front panel for I/O, may be operated completely without peripherals!

Memory Display

Register Display

I/O Port Display

In addition, by using the features of its built-in PAM-8 ROM panel control program, the H8 actually allows you to dig in and examine machine level circuitry. Responding to simple instructions, the "intelligent" panel displays memory and register contents and lets you inspect and alter them even during operation. And for greater understanding, the front panel permits you to execute programs a single instruction at a time. The H8's memory is fully expandable, its 8080A CPU extremely versatile, and with the addition of high speed serial and parallel interfacing you gain the added flexibility of I/O operation with tape, CRT consoles, paper tape reader/punches, and soon floppy disk systems! The H8 offers superior documentation including complete step-by-step assembly and operation manuals, and comes complete with BASIC, assembler, editor, and debug software that others charge over $50 for. H8, simplicity for the beginner, sophistication for the expert and at $375* just right for you.

*Prices are mail order net FOB, Benton Harbor, Michigan. Prices and specifications subject to change without notice.

HEATHKIT COMPUTERS

System Engineered for Personal Computing

H8

Computers, peripherals and nearly 400 exciting, easy to build electronic kits all in your

FREE Heathkit Catalog

HEATH
Schlumberger

Heath Company, Dept. 020-420
Benton Harbor, MI 49022

Please send me my FREE Heathkit catalog.
I am not on your mailing list.

Name ______________________

Address ______________________

City ______________ State ________

CP-150 Zip ________

CIRCLE 100 ON FREE INFORMATION CARD

YOUR OWN

JUNE 1978

Computer

Personal Computers

Ever wonder what you would do with a
possibilities are limited only by your imagination.
plus a look at what a computer system consists of and

WILLIAM BARDEN

Buying a personal computer system today is somewhat similar to choosing a wife. Rather than evaluating the field qualitatively and making the choice based on logic, a lot of emotion is involved. This article decribes currently available microcomputers and attempts to give the reader some selection guidelines.

Why buy a microcomputer?

Personal computers are essentially composed of logic circuitry. Unlike complicated special-purpose circuitry

BYT-8 microcomputer from Byte Incorporated has toggle switches and LED indicators on the front panel.

that performs only one dedicated function, however, the microcomputer can be rapidly and easily changed to perform a variety of functions by reprogramming. The circuitry is "told" how to perform each specific job demanded of it by its owner. Using any of the many microcomputers available today it is possible (at reasonable cost) to:

- Play a variety of games from Star Trek to involved combat games.
- Create and play synthesized musical selections
- Understand human voice commands.
- Speak with a Scots brogue.
- Set up an energy conservation system for your home with the computer controlling the heating and cooling, and possibly even opening and closing windows automatically.
- Prepare your income tax.
- Set up a weight-loss program that is specifically tailored to the amount of weight you want to lose, how fast you want to lose it and how much work you want to put into it.
- Compute your payroll; figuring tax deductions, health insurance, social security, etc.
- Act as a bill collector; automatically preparing collection letters that are individualized for each customer and reporting back to you on the status of each customer and the total of your unpaid accounts.
- Balance your checkbook and estimate your net worth.
- Inventory parts for your small business.
- Decipher and generate Morse code for an amateur radio transceiver.
- Provide a burglar and fire alarm for home or business.
- Provide automatic telephone dialing and decode remote telephone commands.
- Control lights, sprinklers and heating.
- Tutor yourself, spouse and children.
- As more software is developed (more instructions), your computer system can grow to accomplish additional tasks. It is never limited to a specific set of tasks. Whenever you come up with a new job for your machine, a little programming will make it possible for the computer to add still another job.

Now it is possible to design individual, special-purpose circuits so that they can provide most of these functions, but what other design can perform *every* one of these functions and at such a low cost?

pdp 11/03 MINICOMPUTER from digital shows how information is displayed on a CRT.

Several years ago, a properly equipped minicomputer would have cost about $40,000. Now, all the functions described above can easily be implemented on a $2000 microcomputer system, and many can be performed on a $600 system. If you're ready to spend what you'd pay for a new TV set or stereo system, just take a look at what your money will buy.

Microcomputer components

Figure 1 shows typical microcomputer components. The logic components are grouped into *hardware*, *software* and *firmware*.

Hardware consists of the cabinetry that contains the circuitry, necessary power supplies, a real or imaginary bus representing system logic signals, memory, a central processing unit (CPU) and firmware. The bus is the master wiring system of the computer. It can most conveniently be

Are They Right For You?

computer if you had one in your home? The
Here's a look at a few of the many possibilities,
what you should look for when selecting your own.

thought of as a wide ribbon cable consisting of as many as 100 separate wires.

In the S-100 bus, for example, there are 100 wires. Each one carries a specific signal. Each circuit board in the computer is set up with a connector that matches the bus. Lead number 1 is always the same in that system, as is lead number 2, and 3 and so on. All bus systems are not compatible. Each one has its own set of connections. This can be both an advantage and a disadvantage.

The good side is that several companies can make products that fit a particular bus. As the computer owner you can then buy plug-ins from a variety of suppliers. However, in practice, there are multiple suppliers for only a small number of the available bus systems. For the others, the only source of add-ons is the original system manufacturer. Don't forget this point. It could cost you dollars when you want to expand your system.

Software is the instructions that enable the computer to follow your directions and accomplish its task. Again, there are options, mostly in terms of the "language" you use. (For more information on language and programming, see the following article in this special section.) There is also available for almost all personal computers, prepared software on magnetic tape or paper tape that can be used to tell the computer how to do a specific job. Firmware is hardwired software and cannot be easily changed.

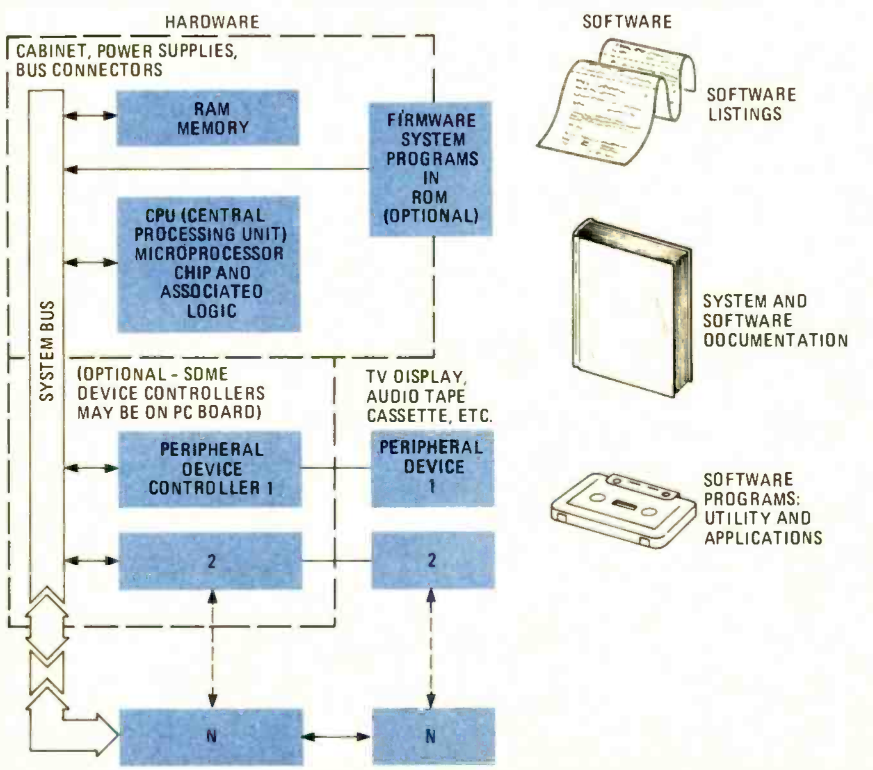
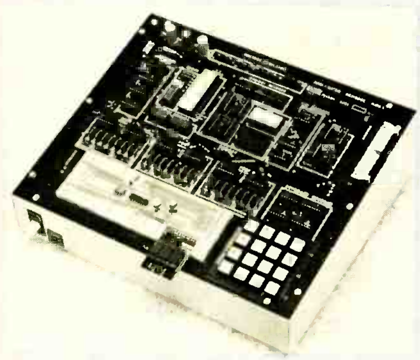


FIG. 1—A MICROCOMPUTER SYSTEM consists of RAM memory, a central processing unit plus system programs stored in ROM memory. Peripheral devices, such as a CRT terminal, printer, or additional external memory are connected to the system via peripheral device controllers. Signals to the various parts of the system are carried along the system bus.

The cabinet in many cases is quite unimpressive. The Apple II and Radio Shack TRS-80 systems are of this type; they contain a minimum of controls and switches. Other microcomputers have a cabinet with a control panel, as is the case with the MITS 8800b and IMSAI 8080 microcomputers; however, a control panel's usefulness is debatable.

XITAN MAINFRAME from Technical Design Labs has an S100 bus structure.

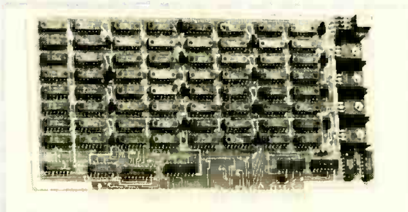
Within the cabinet are the power supplies and system bus. If the microcomputer is similar to the Byte Incorporated BYT-8, it contains a discrete physical bus. You can look into the cabinet and observe a series of 100-pin connectors mounted on a PC board with 100 etched lines representing the bus. If the microcomputer is a Commodore PET, the bus may be represented only by external connectors and various etched lines on a single large PC board. The bus of a microcomputer is usually similar to the pinout (the diagram that shows where the individual pins on the microprocessor connect and shows their functions) of the microprocessor itself. A microcomputer built around the 8080A microprocessor



MINI-MICRO DESIGNER from E & L Instruments is a breadboarding system for prototyping computer circuits.

has 8080-type signals, one constructed around the 6800 microprocessor has 6800-type signals, etc.

If the microcomputer has a bus with plug-in connectors (as in the MITS 8800b), the microprocessor and associated circuitry will be on a plug-in board called the CPU board. (The CPU is the central processor unit. It is the brain, the control center, of the computer.) If the microcomputer is an integrated single-board type (PET), the CPU forms part of the logic IC's on the board itself.



STATIC RAM MEMORY from Vector Graphic is designed for the S100 bus structure.

The CPU consists of the *microprocessor* IC and any TTL or MOS IC's required to interface the microprocessor to the rest of the system. Almost all personal computers use either the 8080, 6800, 6502, or Z-80 microprocessors as a base around which the microcomputer is built. A comparison of the four types is beyond the scope of this article, but, in general, the current versions of these microprocessors are approximately equal in speed, instruction set and efficiency—much more so than, for instance, the differences between an 8080 microprocessor and its predecessor, the 8008.

(Time out for some definitions. The instruction set is the set of built-in instructions that the microprocessor can inherently perform. Every microprocessor type has its own specific instruction set. Speed relates to how quickly the microprocessor can complete a step in its operation. This time is usually measured in microseconds.)

In many applications, the actual microprocessor IC used will be *transparent* (transparent means that the user will not be aware of the microprocessor and will not know what type is in the machine unless he checks the manual to find out) to the

H9 CRT TERMINAL from Heathkit has CRT display plus alphanumeric keyboard.

system user. The differences in speeds and efficiency between the

TABLE I—Peripheral Devices For Current Microcomputers

Device	Explanation	Availability On System Type			
		I	II	III	IV
Keyboard	Similar to typewriter keyboard	BC	A	AB	A
Video display	Alphanumeric and/or graphic	BD	A	AB	A
Teletype	ASR-33 series	BD	A	AB	CD
Audio cassette tape	Secondary storage	BD	A	AB	A
Floppy disc	Secondary fast storage	DE	A	AC	AB
Printer	High-speed hard copy	CE	A	AC	BD
Paper tape equipment	Auxiliary storage	CE	A	BC	CE
A/D, D/A	Analog-to-digital input, D/A output	CE	A	AC	CE
Music synthesizer	Better than a MOOG	CE	A	AC	CE
Speech input/output	Actually sound input/output	CE	A	BC	CE
Relay drivers	For control applications	CE	A	AC	CE

Notes:
I. Microcomputer on a board; II, S-100; III, non-S-100; IV, turnkey system.
A. Readily available.
B. Sometimes available.
C. May be connected with some difficulty or design work.
D. May be connected with more difficulty or design work.
E. A major effort.

microprocessors themselves will be secondary to other system attributes such as the efficiency of the software, the design and the bus structure.

Memory will also be contained on separate plug-in modules in a bus-oriented microcomputer (8800b), or on a portion of the motherboard (PET). All current microcomputers can address up to 65,536 bytes of

RADIO-SHACK'S TRS-80 microcomputer system has memory and keyboard.

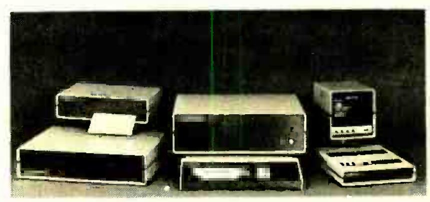
memory directly (sixty-four 1024-byte segments, or 64*K*). In practice, this memory range is divided between user-accessible memory and firmware memory. If 10K bytes are used for firmware, for example, only 54K bytes are available to the system user.

COMPUCOLOR offers microcomputer and full-color graphics terminal in single enclosure.

The firmware portion of memory consists of read-only memory, physically represented by ROM, PROM, or EPROM (*R*ead-*O*nly *M*emory, *P*rogrammable *R*ead-*O*nly *M*emory, or *E*rasable PROM). Generally, the firmware includes the manufacturer's systems software programs to provide file manage, an operating system and a BASIC interpreter. Firmware is included with such microcomputers as Radio Shack's TRS-80 and Commodore's PET, and can be added to virtually any other microcomputer. Firmware programs are nonvolatile, that is, turning off the computer will not destroy the program burned into the PROM.

Firmware is an easy way to add specific functions to a computer. Unlike entering a program into memory, firmware does not consume any memory space and it cannot be erased (with the exception of EPROM's which can be erased and reprogrammed after being removed from the computer). One way to think of firmware is as a plug-in program—the program is in the form of an integrated circuit.

The remaining portion of memory is RAM (*R*andom *A*ccess *M*emory or *R*ead-*W*rite *M*emory) and is user-accessible for program storage. Naturally, the more memory, the more flexible and powerful the system. A small system can have 4K of RAM, while a larger configuration might have 32K or more.



COMPUTER SYSTEM from The Digital Group shows the various peripheral devices.

Peripheral devices and controllers for the devices are connected to the microcomputer either directly through the bus or through input/output (I/O) ports and connectors.

The peripheral devices shown in Table I are available for use with current microcomputers. Not every device, however, is available for every microcomputer. Many devices can be connected to virtually any bus by simple interfacing-design work.

A minimum workable system consists of a keyboard (to enter alphanumeric characters), a video display (to display characters or graphic lines), a CPU and memory. Each peripheral device needs a controller, essentially an interface between the bus and device. Since the peripheral devices operate much more slowly than the CPU's hundreds of thousands of instructions per second, the controller buffers the data to match the CPU and device speeds and per-

TABLE II—Current Microcomputer Types

Company	Computer	Type	Microprocessor
Apple Computer	Apple II	I	6502
Central Data	2650 Computer	I	2650 (Signetics)
E&L Instruments	MMD-1	I	8080A
Iasis	ia7301	I	8080A
IMSAI	IMSAI 8048	I	8048 (Intel)
MOS Technology	KIM-1	I	6502
Alpha Digital Systems	Alpha Z-80	II	Z-80
Byte Inc.	BYT-8	II	8080A
Cromemco	Various	II	Z-80
Equinox	Equinox System	II	8080A
IMSAI	8080	II	8080A
IMSAI	80/30	II	8080A
MITS	Altair 8800b	II	8080A
North Star	Horizon	II	Z-80A
PolyMorphic Systems	POLY 88	II	8080A
Processor Technology	Various	II/IV	8080A
Vector Graphic	Vector 1	II	8080A
Vector Graphic	Vector 1+	II	8080A
Digital Group	Various	III	Z-80, 8080, 6800, 6502
Heathkit	H8	III	8080A
Heathkit	H11	III	LSI-11 (DEC PDP-11)
Intelligent Systems	Intecolor 8001	III	8080A
Midwest Sci. Instr.	MSI-6800	III	6800
MITS	Altair 680B	III	6800
Ohio Scientific	Challenger II	III	6502A
Southwest Technical	SWTP 6800	III	6800
Apple Computer	Apple II	IV	6502
Commodore	PET 2001	IV	6502
Ohio Scientific	Challenger IIP	IV	6502A
Radio Shack	TRS-80	IV	Z-80

I—Microcomputer on a board.
II—S-100 type.
III—Non-S-100 type.
IV—Turnkey system.

forms handshaking (a constant back-and-forth verification of the transmission of data) between the CPU and the device. The controller logic again may be contained on a portion of the single-board microcomputer (represented as dashed lines in Fig. 1), or it may be a separate module. Generally, for each new peripheral device that is added to the system, a new controller board must be attached to the bus or to an I/O port.

ACT-IV CRT TERMINAL from Micro-Term has alphanumeric keyboard.

Two general types of software are available: *system* (or *utility*) *software* and applications *software*. System software includes programs to help develop other programs, debug or troubleshoot other programs, or manage data in memory or in secondary memory storage, such as a floppy disc or audio cassette tape. System software can be supplied in firmware or on an easily *loadable* program medium, such as audio cassette tape or paper tape. Applications programs range from game packages to accounts-receivable programs, in fact, any program for which the microcomputer system will be used.

Although system software may be supplied in firmware as part of the system, application programs generally come separately in the form of audio cassette tapes, listings and documentation. Not all microcomputer manufacturers supply huge quantities of applications programs. For this reason and for the fun involved, you can write your own applications (or systems!) programs. There are three types of programming available to the user—*machine language, assembly language* and *higher-level languages*.

ALTAIR 680 FROM MITS has toggle switches and discrete LED indicators on front panel.

Machine language is the most basic, tedious and (although some will disagree) least enjoyable of the three methods of programming. Rarely necessary on today's systems, it requires you to enter strings of binary data to program the computer. *Assembly language* allows you to automatically assemble the instructions for the microprocessor being used in the microcomputer, thus eliminating the manual machine language method. Although machine language and assembly language programs can be executed much faster than other higher-level languages, they are more time-consuming to write. *Higher-level languages* such as BASIC let you program statements that resemble the English language. BASIC is by far the easiest language to learn and the most readily available for microcomputers. Other languages that are offered are FORTRAN, COBOL or APL. Figure 2 compares the three programming types used for a simple program. For more details on the three major programming methods, see "How To Program A Computer" elsewhere in this special section.

MACHINE LANGUAGE
As input on hexadecimal key pad:
```
A8
0E
0A
81
OD
C2
00
01
```
ASSEMBLY LANGUAGE
As input on keyboard:
```
        XRA  A
        MVI  B, 10
LOOP    ADD  B
        DCR  B
        JNZ  LOOP
```
HIGHER-LEVEL (BASIC) LANGUAGE
As input on keyboard:
```
350  LET S=0
360  FOR I=1 to 10
370  LET S=S+I
380  NEXT I
```

FIG. 2. ADDING 1+2+3 . . . +10 in three languages

Available microcomputers

Currently, four basic personal microcomputer types are available: The *microcomputer on a board*, the *non-S-100 modular microcomputer*, and the *turnkey* system. Table II lists the lower-cost systems of the four microcomputer types.

The *microcomputer on a board* format is exemplified by such systems as MOS Technology's KIM-1. Other microcomputers of this type

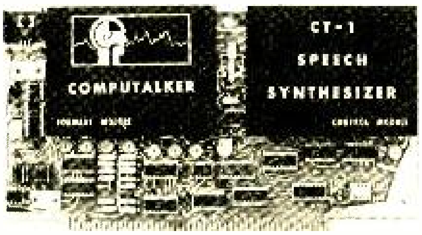
SYSTEM 8813 from Polymorphic has three floppy disk drives.

are offered by microprocessor manufacturers as single-board evaluation modules. These are designed primarily for the engineer who will either evaluate the microprocessor or integrate the module in a production system.

This type of module (available either as a kit or fully assembled) may include an LED display, a small numeric keyboard, a small systems software program in the firmware and a small user-accessible RAM memory. In some cases, additional memory or I/O devices are added to the basic system. Programming is generally possible only by using machine language.

The advantages of this system are its low cost, hardware simplicity, small size and low power drain. Its disadvantages are its lack of expandability (there are few add-ons available) and its less-sophisticated software. This type of microcomputer is probably ideal for an experimenter who wants to obtain the most basic hardware and software in order to learn and understand how both aspects of a personal computer function.

The *S-100 modular microcomputers* started with the MITS 8800.



MODEL CT-1 from Computalker Consultants is a speech synthesizer board.

MITS defined the MITS (or S-100) bus, and many other manufacturers copied it in their microcomputer designs. There are literally dozens of memory boards, I/O devices and special-purpose interfaces that plug directly into the S-100 bus. Most are compatible with each other, even if they are produced by different manufacturers. A control panel may or may not be offered. Firmware is not stressed but may be provided. In general, the S-100 microcomputers cannot simply be plugged in and operated. Kits or fully assembled systems are available.

VECTOR 1 MICROCOMPUTER from Vector Graphic.

This system's advantages are its low cost, a wide range of add-on peripherals and sophisticated hardware and software. The chief disadvantage is the lack of good general-purpose firmware (preprogrammed plug-in PROM's to take care of things like programming language).

The third group of microcomputers do not use the S-100 bus and provide a modular, rather than a turnkey, system. Since the S-100 bus is not used, additional modules or peripheral devices that are compatible with the system are probably provided only by the manufacturer of the system—for example, the Southwest Technical Products SWTP-6800. As with S-100-type microcomputers, systems in the non-S-100 group are available as kits or fully assembled. The primary advantage of this group is their somewhat lower cost. The greatest disadvantage is their reliance upon the manufacturers' own add-on devices.

The last group of microcomputers are the *turnkey* (plug it in and turn it on) systems, as for example, the Radio Shack TRS-80. These systems are fully assembled, warrantied and ready to operate. Firmware includes an operating system and a BASIC interpreter; a keyboard, video display and audio cassette interface are usually provided.

The advantages of this group are the low cost, the "plug it in and turn it on" configuration, the integrated systems software, and a wide range of user-developed application programs. The disadvantages are the possible limited expandability and the reliance upon manufacturers' own add-on modules and peripheral devices.

This represents a rather brief summary of the current personal computer marketplace. Although there are many factors involved in selecting a microcomputer, unlike choosing a wife, the purchaser won't be rejected if he has the cash! **R-E**

Peripherals-arms and legs

To perform useful functions, a computer needs peripheral devices. These devices interface between man and machine and greatly expand a computer's capability.

KARL SAVON
SEMICONDUCTOR EDITOR

PERIPHERALS ARE THE ARMS, LEGS, mouth and ears of the microcomputer. Without them, the computer is no more than a theoretical curiosity. Peripherals perform two basic functions: First, they interface between man and machine. They appear in the form of terminals, graphic displays and printers. Second, they expand the computer's capability from theoretical to highly practical applications through the use of such devices as cassette recorders, floppy-disk drives and analog interfaces.

Terminals

The most basic peripheral needed for a microcomputer is a terminal that lets you talk to the machine, program it, enter data into it and receive answers from it. Toggle switches and LED displays are adequate for a learning system, but once past basics it is vital to be able to move information in and out at conversational and at higher rates. Program-development cycles require an efficient link between you and the assemblers, compilers, interpreters and file management software. Even though there are diverse forms of data terminals, the most generally used is a keyboard-display combination.

A terminal, unlike a typewriter, consists of two electrically separate parts that are actually *physically* separated in some systems. The keyboard-driven transmitter usually has a standard typewriter key arrangement, plus several control keys. Often, only upper case letters are implemented and separate numeric keypads are built-in for convenience. On the receive end of the terminal, the most common devices are impact ribbon printers and video display.

For the computer and terminal to understand each other, they must speak the same language. Several standard formats have been composed so that system components from different manufacturers can work together:

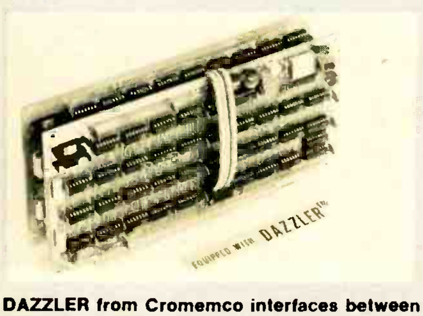
- The predominant format in use is the **American Standard Code for Information Interchange (ASCII).** It is a 7-bit code plus a parity bit with a particular combination of bits corresponding to each character in its vocabulary.
- Some older equipment use a five-level **Baudot code** that was developed for telegraphic purposes. Its basic set of 2^5 or 32 codes is nearly doubled in keyboard characters, using letter and number keys that precede characters in one of two sets. Although similar in function to a typewriter shift key, these keys are not depressed simultaneously with other keys.
- The **EBCDIC code** is an eight-level language used by IBM and others that has twice the characters of ASCII (2^8 = 256 vs. 2^7 = 128), and is suited for more complex control and graphic applications.

Diode or IC encoders convert key closures into ASCII or other codes. These relatively slow, operator-limited terminals use serial data flow over one or two wires (plus ground). Parallel-to-serial conversion in the transmitter converts the parallel output of the keyboard-encoder into the serial bit stream, and corresponding serial-to-parallel conversion and decoding are performed in the receiver. UART integrated circuits have been designed that perform the conversion and the related tasks of parity-checking and start-and-stop bit generation.

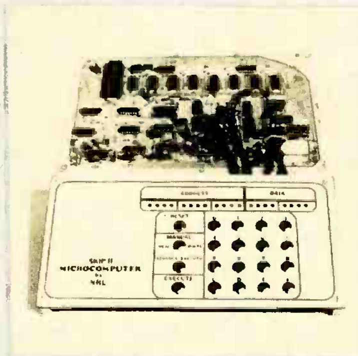
When the ASCII code is combined with start-and-stop bits, sequences of 10 or 11 bits represent each transmitted or received character. Transmission is asynchronous, which means it does not require a transmitted clock signal.

The ones and zeroes of the data stream on the wires that connect the terminal and computer are distinguished by two DC levels. Several different voltage or current levels are used for compatibility with TTL, RS232C (bipolar) or 20- or 60-mA current-loop equipment.

The terminal receive-and-transmit sections are independent of each other. It is only by electrical interfaces in the terminal or through the computer that the printer mechanism or CRT screen displays the keyboard data entries. In a full-duplex system, the computer and terminal communicate in both directions simultaneously. The computer is programmed to echo back what is transmitted to it. Control characters would normally produce nonprinting codes, but the computer can return intelligent responses; for example, "control C" or "↑C" when the control-C combination is typed on the keyboard. In half-duplex systems, communication takes place in one direction at a time. In most cases the terminal is wired so that the printer or display responds directly to the keyboard because the computer does not have time to echo the response. Otherwise, after you typed a letter you would then have to wait for the computer to return the character before you could type a second letter. Inadvertently hooking a half-duplex terminal to a full-duplex system produces strange results—typically, the double-printing of pressed keys. Many terminals can be switched between half-duplex and full-duplex modes.



DAZZLER from Cromemco interfaces between S100 bus and TV set to add graphics.



SKIP II MICROCOMPUTER by NBL has hexadecimal keyboard and LED indicators.

IBK-1 MICROCOMPUTER from IMSAI has built-in card cage, CRT terminal and power supply

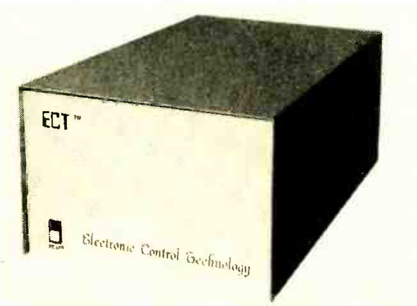
Terminal data rates are from 10 to 30 characters-per-second for strictly manual keyboard devices. Those keyboards having built-in paper tape or magnetic tape storage have data rates of 30 to 480 characters-per-second and even higher.

Keyboards may have 64 or 128 ASCII characters, and may have such features as numeric pads, tactile feedback and rollover. During an entry sequence, a fast typist, or a slower one with an uneven technique, may depress more than one key at any given instant. N-key rollover (NKRO) recognizes the key closures in the time order in which they are entered, and does not become confused when more than one key remains depressed. Two-key rollover (2KRO) is a less-sophisticated method that only recognizes two key closures simultaneously. The third and subsequent closures are ignored.

Keyboards are classified as *contacting* and *noncontacting*, depending on how the electrical current path is interrupted. Key pressure sensing may be performed mechanically, capacitively, photoelectrically, or by using reed switches, saturating cores, Hall-effect devices or elastomers.

Hard-copy printers are classified as *impact* and *nonimpact*, each with its own particular advantages and drawbacks. Impact printers use mechanical hammers, wheels or dot-matrix pins that strike the paper through an inked ribbon, and one column or one line is printed at a time. Impact printers are low-cost and can make copies, but they are generally noisy, may have poor print quality and are not as reliable as well-designed nonimpact printers.

Nonimpact printers are fast and quiet. One type uses ink jets that are sprayed onto the paper and controlled electrostatically. *Electrolytic printers* pass an electric current through chemically treated paper with wires or pins. *Electrostatic printers* use precharged dielectric-coated paper that is passed through a toner. The toner has ink particles that are oppositely charged to the printed charges on the paper. *Thermal printers* use transistor dot-matrix printheads that move across temperature-sensitive paper. Character fonts are electrically stored in read-only-memories (ROM's).



ECT MICROCOMPUTER FROM Electric Control Technology has S100 bus structure.

Some stand-alone computer systems have a keyboard and video display or printer built right into the main housing. Sometimes a video or RF output is provided so a video monitor or TV receiver can be used as an economical display.

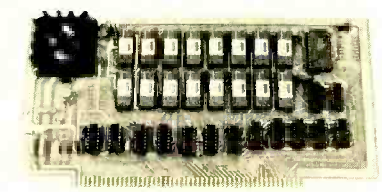
The video terminal is expected to become the main home-computer peripheral because of its low cost and graphic capability. Video terminals have editing options that allow corrections before the characters are fed to the computer. Other options include page and scrolling formats, character accents, selectable baud rates and cursor controls. Video terminals do not make hard copies. A preferred arrangement is a video terminal backed up by a printer that can generate a permanent record of the data that must be saved.

There is an intermediate class of terminals that use a TV display and a low-cost hex keypad. Primarily used in learning systems, they are adequate and even preferred for special applications where the input is mainly numeric.

The final choice of terminal must be made on the basis of cost, multiple-copy capability, speed, interface requirements, printing-vs.-plotting characteristics, font, print quality and color, noise, ease of operation, serviceability, type of paper, and reliability.

Tape cassettes and cartridges

As system and user programs grow in length and number, you must find a sensible way to store them. Virtually all microcomputer manufacturers have recognized the advantages of using standard audio cassette recorders for program storage. Interfacing hardware and software are important resident or optional parts of their systems. Frequency shift keying (FSK), pulse-width modulation (PWM), phase encoding (PE), nonreturn-to-zero (NRZ), biphase encoding, group-coded recording (GCR), Manchester coding and the Kansas City Standard (KCS) are some methods used to both store data on audio tape and retrieve it. Phase encoding is popular because it is self-clocking, making it tolerant of speed variations and has good noise performance. Manchester coding is a type of phase-transitional encoding in which positive signal transitions represent ones and negative transitions represent zeroes. The KCS method is a variation of Manchester code that represents zeroes as 1200-Hz tone bursts and ones as 2400-Hz bursts.



RAM MEMORY BOARD from Electronic Control Technology mates with the S100 bus.

Although at one time paper tape was very popular, it is being gradually displaced by digital magnetic-tape cartridges and cassettes that offer much greater reliability than either paper tape or audio cassettes. Lower-performance machines use drives that have evolved from audio recorders. In these systems the tape is caught and held between a capstan drive shaft and a free-wheeling pinch roller. At higher tape speeds and data densities, direct servomotor drives are used. Two motors drive the cassette hubs in a very clean mechanical arrangement.

Digital recorders use phase encoding with typical tape densities of 800 bits-per-inch. They have versatile control functions including write, stop, reverse one block or line, read one block or line, read continuously, erase, rewind for cassette removal and wind past tape leader. Extensive error checking is performed for dropouts, bit timing and character parity. The unformated capacity of a cassette is about 720 kilobits and data transfer rates are 24 kilobits-per-second.

Cartridge drives provide improved performance and are used wherever higher operating speeds (48 kilobit-per-second transfer rate) and greater storage capacity (2.9 kilobits) are needed. Quarter-inch tape is recorded with densities of 1600 bits-per-inch on up to four tracks. Cartridge-drive manufacturers plan to compete with floppy disks by reducing access times. But for the present the tape heads and system mechanics limit search speeds to about 30 inches-per-second.

Floppy disks

Given enough financial resources, there are very few computer enthusiasts who would not invest in a large-capacity, floating-head, magnetic disk system. Random-access addressing of large amounts of stored data makes such a system look almost like a huge chunk of RAM. Some advanced computer systems exchange segments of disk memory with main computer memory to give the computer the *virtual* appearance of a machine with a very large main memory. Real-life budgets have forced computer manufacturers alike to find an economical compromise. The floppy disk does not have the data capacity of cassettes and cartridges, but is a random-access device with almost 500 times faster access. The *Mylar* disk is 9 inches in diameter and 0.003-inch thick, coated with a mag-

RADIO SHACK TRS-80 microcomputer shown with video monitor.

netic oxide and protected in an 8-inch-square jacket. The jacket has holes through which the spindle rotates the disk at 360 RPM, the head contacts the disk, and (on hard-sectored disks) the index holes are exposed. Hard-sectored disks use photoelectrically sensed index holes to locate data; soft-sectored disks rely on reading the block headings recorded on the disk.

FLOPPY DISC DRIVE from Mits adds additional memory to microcomputer system.

On IBM-compatible disks, data is recorded on 77 concentric tracks that are numbered 00 to 76 from the outside of the disk in. Track 00 holds labels and system and disk information, two tracks are reserved as alternates, leaving 73 tracks for data. Each track has 26 sectors, and each record or sector stores 128 bytes. This calculates to a total of $73 \times 26 \times 128 = 242,944$ bytes. There are double-sided, higher-density floppy disks and other non-IBM-compatible disks with greater capacity.

In a step to reduce costs even further, the *minifloppy* disk was created, packaged in a 5¼-inch-square jacket. Hard-sectored *minifloppy* disks have 16 records-per-track and soft-sectored 18 records-per-track. The record length remains 128 bytes, with either 35 or 40 tracks. Maximum storage capacity is then $18 \times 40 \times 128 = 92,160$ bytes (one byte = 8 bits). Data transfer rates are about 125 kilobits-per-second. It is rumored that a $100 *minifloppy* drive will soon appear on the market.

Floppy disks also have their difficulties, the main problem being much higher wear than their floating-head big brothers. Disk life is typically specified in the millions of passes-per-track.

Other equipment

Having deliberately skipped over terminals different than the keyboard-printer, it is time to backtrack a little. A terminal is any device that reads in and writes out information; it can be equipment that handles punched paper tape or cards, magnetic cards and tape, bar codes, and so forth.

Paper tape is useful if you own an ASR *Teletype* machine with its built-in paper-tape reader and punch. With no additional expense except for the paper tape, you have a readily available storage medium. Unfortunately, this system is also slow and noisy. More sophisticated photoelectric readers and high-speed punches are available but they are fairly expensive. Low-cost optical readers eliminate some of the complexity and expense: The tape is pulled manually through the reader. This type of equipment is attractive if you have quite a lot of paper-tape software available.

Card readers and punches are not very popular. They are most familiar in the 80-column by 12-row format. One of their peculiar advantages is the ease with which a single program statement or data line can be modified without upsetting the rest of the program.

The line printer is an extension of the terminal printer or display, except it tends to be a high-speed device (for example, 125 lines-per-minute with each line having 132 characters) used when there are many pages of data to be printed.

Plotters use servocontrolled coordinate positioning arms to produce permanent graphic records. They differ from chart recorders in that the stylus can draw complex patterns back and forth over the stationary paper.

If a terminal is situated far away and telephone lines or radio waves are used as the connecting medium, some type of communications interface or modem (modulator-demodulator) is needed. Tone and phase-modulation schemes are used, and error-correcting codes are added to enhance reliability. Acoustic couplers and modems are either built into terminals or are separate entities. The coupler connects to a telephone handset and converts the received telephone tones into an electrical output signal. It also converts an electrical input signal from the modem into sound that drives the phone's transmitter element. A portable terminal can be taken anywhere and the computer called up for field access. The modem performs the phase or frequency encoding to condition the digital bit stream for the communications channel.

Charged-coupled mass memories may become competitive with cassettes, cartridges and disks in the near future. Access is completely electronic and about 50 times faster than a high-speed disk. There are some devices already on the market with capacities of 1 million bytes.

If your application is highly scientific or mathematic and you perform such operations as evaluating matrices, you may find that your BASIC interpreter or other software is much too slow. Peripheral floating-point hardware solves such problems with their high-speed parallel computation methods.

Interfaces

Interfacing between the computer and the peripheral device is an essential consideration. The interface can be as expensive as the peripheral itself. Unless the peripheral is directly compatible with the computer's voltage levels and timing, a controller will be necessary to match up the two. A widely adopted technique minimizes hardware modification by using software drivers stored in ROM or RAM to produce the signals needed by the peripheral. Software or firmware (ROM) approaches may adversely affect the performance of the peripheral or the entire system. Before rushing out to purchase any peripheral device, it is best to know exactly what other hardware and software components are needed to make it work (and at what performance level) with a particular computer system. **R-E**

how to
Program A Computer

To get a computer to do what you want it to, you must communicate with it. Here's a look at three different levels of programming and how to use each one.

ART KLEIMAN
MANAGING EDITOR

THERE'S NOTHING DUMBER ON THE face of this earth than a computer. Oh boy, are they ever stupid! Go ahead, make one perfectly human mistake when writing or entering a program, hit "go" and. . . . . nothing! A pathetic 20th-century staring match between man and machine. So, instead of finding out the winner of that match, let's grab the latest computer catalog.

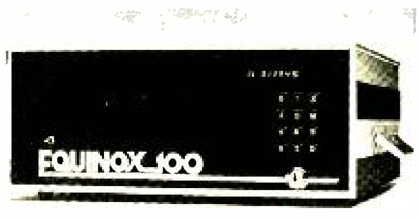
What are we looking for in the catalog? Don't be silly, we're looking for help. Help comes in the form of a higher-level language. So, we scan past the paragraphs describing the CPU boards, memory, I/O, peripherals, etc., and go right to the software section. Here, we're bombarded with terms like machine code, assembly language, interpreter, compiler, BASIC, FORTRAN, APL, EMPL. . . . . . . .whew! Before you blow a human fuse, let's take a look at what these terms mean, and what they mean to the computer. To get a better understanding, however, let's first get back to basics.

How a computer is programmed

Digital computers are digital because they're built using digital logic IC's. And digital logic IC's eat, chomp and spit out binary numbers (zeroes and ones). That's it! It doesn't matter whether we're discussing the data base at the Pentagon or the most simplistic single-board microcomputer trainer. The only things flowing through those circuits are zeroes and ones.

The heart of the computer is the CPU, or microprocessor. This nifty device performs many functions, such as adding, subtracting, comparing, etc., in response to instructions. In other words, it can do many things, but it must be told what to do by giving it an instruction. Remember, this is a digital device, so when it adds or subtracts, it adds and subtracts binary numbers (zeroes and ones) and the instruction given to it must be in the form of a binary number.

If the microprocessor has one thing going for it, it's speed. It can perform many operations in a very short time. If we wanted to perform just one operation, we wouldn't need a computer. So, to perform many operations (hundreds, thousands, or even hundreds of thousands) very fast, we must feed the instructions to the microprocessor just as fast. To do this, we connect the microprocessor to a memory. The instructions and the necessary data are stored in the memory and called a program.



EQUINOX 100 computer from Parasitic Engineering has an octal keyboard.

Inside the microprocessor is a register (a device for the temporary storage of a binary number) called a program counter. After storing the program in the memory, the program counter is set to the beginning address (location) of the program. Then, you hit GO (instruct the microprocessor to begin execution). The program counter addresses the first memory location and the memory responds by feeding the first instruction to the microprocessor. After the microprocessor does its thing by executing the instruction, the program counter is incremented (advances) by one and addresses the next memory location. Again, the memory responds by feeding the next instruction to the microprocessor. The microprocessor executes this instruction and again increments the program counter by one. This process continues until the entire program is executed.

So, programming a computer means that you have to store the program in the memory. This is done by writing and then entering the program in the computer's memory. This can be done at three different levels—machine language, assembly language and higher-level language.

Machine-language programming

You could write the program in digital form and then enter the program into the memory one digit at a time. This is machine-language programming. Figure 1 shows a simple program for adding two numbers together. The program is written for the 8080 microprocessor, one of the more popular 8-bit microprocessors. (A bit is a binary digit and a byte is 8 bits.) The 8080 is an 8-bit microprocessor because it physically has eight data lines. These data lines are used to input instructions and data and also to output the results. The 8080 also has address lines for addressing memory. However, eight address lines aren't enough. Eight bits would enable the 8080 to address only 256 memory locations, hardly enough program space to do anything except add two numbers together. So, internally, the 8080 gangs two bytes together and feeds them out on 16 address lines. Sixteen address lines enable the 8080 to address 65,536 memory locations—quite a lot! To feed a memory location to the microprocessor on the eight data lines, however, requires two operations. First, the low-order address byte (the eight least significant bits of the memory address) is input and then the high-order address byte (eight most significant bits of the memory address) are input. This idea is implemented in the simple addition program shown in Fig. 1. Let's take a look at it and see what happens at each step of execution.

The addition program occupies 15 memory locations starting at location 0 (represented by the 16-bit binary number 0000000000000000). Basically, the program takes the binary number stored in a specific memory location, adds it to the binary number stored in another memory location and stores the result in a third memory location. For discussion purposes, the left-hand column in Fig. 1 numbers each program step the way you're used to seeing numbers—in decimal form. This will make it easier for us to refer to each program step.

The very first memory location (program step 1) contains an instruction that tells the microprocessor to load the HL register pair with the immediately following two data bytes. Both the H and the L registers are 8-bit registers located inside the microprocessor IC. When told to do so by the instruction, the microprocessor gangs these two registers together to form a single 16-bit register, called the HL register pair. The 16-bit HL register pair is used to specify a 16-bit memory location. The microprocessor instruction is also called the *op-code*.

Now, back to the program. The next memory location (program step 2) contains the low-order 8-bits of the memory address, which is to be loaded into Register L of the HL

SOL TERMINAL COMPUTER has computer and alphanumeric keyboard in a single enclosure.

register pair (by program step 1). Program step 3 contains the high-order 8-bits of the memory address, which is to be loaded into Register H of the HL register pair. After the microprocessor completes program step 3, the HL register pair contains the memory address 0000000000001100. This memory location, coincidentally, contains the first number of our addition problem. Program steps 4, 5 and 6 do the same things that program steps 1, 2 and 3 do but with the DE register pair. Here, the DE register pair is loaded with memory address 0000000000001101. This memory location contains the second number of our addition problem. So far, we've got the HL and DE register pairs loaded with two memory addresses, each one of the memory locations containing one number of our addition problem.

Program step 7 contains an instruction that tells the microprocessor to load the accumulator with the contents of the memory location specified by the DE register pair. The accumulator is another internal register within the microprocessor. This register is the working register. It is used to manipulate data, perform math and logic operations, store results, etc. The accumulator is involved with just about every operation the microprocessor performs. So far, we have the accumulator loaded with the first number of our addition problem.

Program step 8 is where the two numbers are actually added. This instruction tells the microprocessor to add the contents of the accumu-

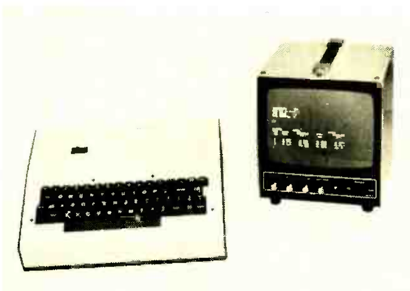
Program Step	Memory Location		Instruction Data	Comment (Meaning of Instruction)
	High-Order	Low-Order		
1	00000000	00000000	00100001	Load the HL register pair with the two immediately following data bytes
2	00000000	00000001	00001100	Memory address, low-order byte
3	00000000	00000010	00000000	Memory address, high-order byte
4	00000000	00000011	00010001	Load DE register pair with the two immediately following data bytes
5	00000000	00000100	00001101	Memory address, low-order byte
6	00000000	00000101	00000000	Memory address, high-order byte
7	00000000	00000110	00011010	Load accumulator with contents of memory location specified by DE
8	00000000	00000111	10000110	Add accumulator contents of memory location specified by DE. Store results in accumulator.
9	00000000	00001000	00110010	Store accumulator in memory location specified by two following data bytes
10	00000000	00001001	00001110	Memory address, low-order byte
11	00000000	00001010	00000000	Memory address, high-order byte
12	00000000	00001011	01110110	Halt
13	00000000	00001100	XXXXXXXX	First number of addition problem
14	00000000	00001101	XXXXXXXX	Second number of addition problem
15	00000000	00001110	XXXXXXXX	Result of addition

FIG. 1—MACHINE-LANGUAGE PROGRAM for adding two numbers together. The actual program consists of the instruction/data that is stored in the corresponding memory locations.

lator with the contents of the memory location specified by the HL register pair. The result of the addition operation is stored in the accumulator. We could leave the result of the addition in the accumulator if we wanted to, but in actual practice this is hardly ever done. The result is either fed to an output port that is connected to a CRT terminal, a printer or something similar, or it can be stored in another memory location. Since we don't have any peripheral equipment connected to our computer, we'd simply store the result in another memory location. Program step 9 does just this.

Program step 9 contains an instruction that tells the microprocessor to store the contents of the accumulator in the memory location specified by the immediately following two data bytes. Program step 10 contains the low-order byte of the memory address, and program step 11 contains the high-order data byte of the memory location. Now, we have the result of the addition operation stored in memory location 0000000000001110.

Program step 12 is a HALT instruction. This tells the microprocessor that the program is finished and to stop execution. Program step 13 is



ACT-I TERMINAL has alphanumeric keyboard. Monitor shows how information is displayed.

the memory location containing the first number of the addition problem, program step 14 is the second number in the addition problem and program step 15 is the result of the addition operation.

To run the program, we would simply load program steps 13 and 14 with the two numbers and set the program counter to 0000000000000000. Then hit GO. You could examine the contents of memory location 0000000000001110 to obtain the result.

Entering a machine-language program

Now that you know what a machine-language program is and what

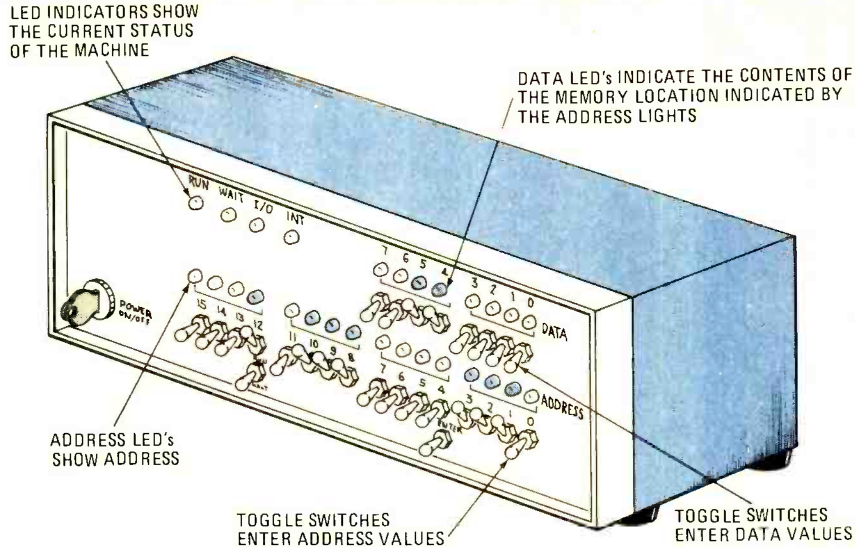


FIG. 2—TYPICAL FRONT PANEL of computer showing toggle switches and LED indicators.

it looks like, let's take a look at how we load it into the machine. The program isn't fed to the microprocessor; it's stored in the memory. This means that we would have to address the right memory location and store the data/instruction at that location. We could do this by using toggle switches on the front panel of the computer—16 toggle switches connected to the address lines and eight toggle switches connected to the data lines (see Fig. 2). We would also need another toggle switch to instruct the memory IC's to store the data on the data lines. This switch could be labeled STORE, WRITE, ENTER, or anything appropriate. An example of how one such toggle switch is connected is shown in Fig. 3. One position of the toggle switch would be labeled 0 and would ground the line, the other position would be labeled 1 and connect the line to +5 volts.

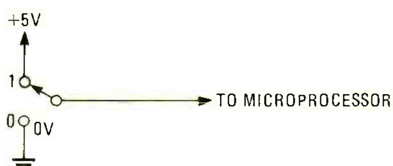


FIG. 3—FRONT PANEL TOGGLE SWITCHES apply +5 volts to microprocessor in one position, and ground in the other position.

Now, we're set. Well, almost. The toggle switches permit us to enter the program, but there is no way we can check the data stored in the memory to see if we entered it correctly. So, we connect eight LED's to the data lines and install them on the front panel along with the toggle switches; a lit LED signifies 1. Now we are set.

To load the program into memory, set the address switches to the first memory location, set the data switches to the first instruction and then hit ENTER. Then, set the 16 address switches to the next memory location, set the eight data switches and again hit ENTER. Continue this procedure until the entire program is loaded. Be careful, though, don't make any errors. If you do, the program won't run. Make a mistake entering just one bit, just one, and the program won't run.

As you see, entering a program this way can be quite tedious. Of course, with short programs such as the one shown in Fig. 1, the procedure isn't too bad. But with longer programs that really do something, the situation becomes more complicated. Some programs can run 2000, 5000, 10,000 program steps or longer, and the situation gets a lot worse. With patience and diligence, however, you can become quite good at entering programs this way. With a lot of practice, you can whiz your fingers across those toggle switches so fast that you will dazzle your family and friends. However, those toggle switches may grow limp with fatigue, not to mention your fingers.

This type of front panel was common in the early microcomputers. One of the very first hobbyist computers was the Mark 8 and it had a similar front panel. It was a construction project published in the July 1974 issue of **Radio-Electronics.** The first commercially available microcomputer was the Altair, which also had a similar front panel. Another early microcomputer was the Im-

Program Step	Memory Location		Instruction Data
	High Order	Low Order	
1	00	00	21
2	00	01	0C
3	00	02	00
4	00	03	11
5	00	04	0D
6	00	05	00
7	00	06	1A
8	00	07	86
9	00	08	32
10	00	09	0E
11	00	0A	00
12	00	0B	76
13	00	0C	XX
14	00	0D	XX
15	00	0E	XX

FIG. 5—HEXADECIMAL MACHINE-LANGUAGE program is identical to the program shown in Fig. 1, except the binary numbers are represented by their hexadecimal equivalents.

sai, again with the same type of front panel. Both the Altair and the Imsai are popular microcomputers, still going strong in the marketplace. That's because they can be programmed using higher-level languages. You'll discover what these languages are later on in this article, but now let's get back to the front panel.

It's obvious that using toggle switches is no way to enter a machine-language program. There must be a better way, and there is. Let's sit back for a moment and take a look at that 8-bit data word we are entering. Is there another, shorter way to represent those same 8 bits? If we split these 8 bits up into two groups of 4 bits, we could represent each 4-bit group by a *hexadecimal* digit. A group of 4 bits provides 16 possible combinations of zeroes and ones. If

Binary	Hexadecimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

FIG. 4—FOUR-BIT BINARY WORD and corresponding hexadecimal value.

we want to represent each of those 16 combinations with a single digit number, we need a numbering system to the base 16. Figure 4 shows the 4-bit group and the corresponding hexadecimal digit. Don't be confused—here A, B, C, D, E and F represent numbers, not letters. Now, if we recombine those two 4-bit groups back into a single 8-bit group, we can represent those 8 bits with 2 hexadecimal digits. For example, 00000000 would be represented as 00, and 11111111 would be represented as FF.

CONNECT A TV SET to the Apple II computer and you have a computer and CRT terminal.

Now we can construct a front panel using a hexidecimal keypad rather than toggle switches. Instead of the discrete LED's, we can use a 2-digit LED alphanumeric display for the data. (Remember in hexidecimal we count 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, and so on. So we need 2 digits of readout, each one capable of counting from 0 through F.) We'll also have to include some circuitry to decode the hexadecimal digits into the corresponding 8-bit word. Since the memory address requires 16 bits (2 bytes), we can represent it by using 4 hexadecimal digits.

To use this type of front panel, first switch to the MEMORY mode and enter the starting memory address. Figure 5 shows the simple addition program shown in Fig. 1 but in hexadecimal format. If you wanted to enter the program shown in Fig. 5, you would select the MEMORY mode and enter 0000. You would then select the ALTER mode and enter the first instruction, which is 21. Memory location 0000 would automatically be loaded with 21, and the memory address would be advanced by 1. The next data byte would then be entered by simply hitting 0 followed by a C. This process is continued until the entire program is entered. If while you were entering the program, you came across a memory location that you did not want to alter, you would simply hit the MEMORY INCREMENT switch and the contents at the memory location would remain intact. Or you could re-enter the contents at that memory location. In any event, entering machine-language programs in hexadecimal form is easier, both on the eyes and on the fingers, and there is much less of a chance of making a mistake.

Are binary and hexadecimal the only two ways to enter a machine-language program? No. There is a third way being used by a few manufacturers. The 8-bit data word is again split up but this time into three groups instead of two. The first group contains 2 bits and the last two groups contain 3 bits each. Since the maximum number of bits in any group is 3, we could use the octal number system to represent the binary number contained in each group. Figure 6 shows the 3-bit groups and the corresponding octal number. Since the first group contains only 2 bits instead of 3 bits, this group will have a maximum octal number of 3. Since the other groups contain 3 bits, they will have a maximum possible octal number of 7. We then recombine the groups to form a single 8-bit data word, just like we did with the hexadecimal system. The octal numbers will range from 000, corresponding to the data byte (a binary number) 00000000, to 377 (equivalent to decimal 255), corresponding to binary 11111111.

Binary	Octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

FIG. 6—THREE-BIT BINARY WORD and corresponding octal value.

We can now build a front panel just like we did for the hexadecimal system. But this time instead of using a hexadecimal keypad, we would use an octal keypad. Instead of using a 2-digit LED display for the data, we would use a 3-digit LED display. The memory address requires a 6-digit LED display instead of a 4-digit LED display. Otherwise, the front panel remains basically the same. Even the way we enter the programs remains basically the same. To see what an octal-based machine-language program looks like, the simple addition program already discussed is shown in Fig. 7 in octal format.

One final note on front panels: Front panels from different manufacturers differ in their features and therefore in the way programs are entered. Some front panels have automatic incrementing features while others may not. Some front panels are octal while others are hexadecimal. The Heath H8 and the Equinox from Parasitic Engineering are examples of full-featured octal front panels

Program Step	Memory Location		Instruction/ Data
	Low Order	High Order	
1	000	000	041
2	000	001	014
3	000	002	000
4	000	003	021
5	000	004	015
6	000	005	000
7	000	006	032
8	000	007	206
9	000	010	062
10	000	011	016
11	000	012	000
12	000	013	166
13	000	014	XXX
14	000	015	XXX
15	000	016	XXX

FIG. 7—OCTAL MACHINE-LANGUAGE PROGRAM is identical to the program shown in Fig. 1, except the binary numbers are represented by their octal equivalents.

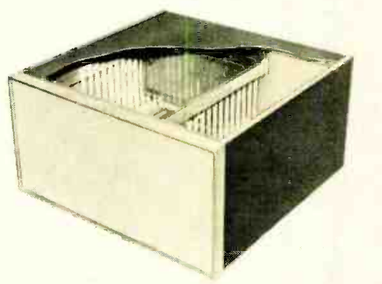
(with display and keyboard). In any event, since the exact sequence of pushing buttons to enter a machine-language program does vary from computer to computer, do take a close look at the front panel before you buy your computer. Some computers are completely devoid of front-panel controls. This means that they have no switches or displays on the front panel other than a reset and/or a power ON-OFF switch.

The Alpha computer from TDL and the 6800 from Southwest Technical Products are examples of this type. To program this type of computer in machine language or any other language requires a keyboard connected to the computer's input port. Even though the nitty-gritty may be different, entering a machine-language program is basically (and I mean basically) the same no matter which computer you use.

Now you know what a machine-language program is and what it looks like. As you probably already guessed, it's no fun programming in machine language. The 8080 microprocessor has no less than 78 instructions, while the Z-80 microprocessor has 158. This means that if you were to program in machine language, you would need a list of the instructions and the corresponding op-code (the binary form of the instruction). Then, depending on the computer, you might have to convert the op-code into octal or hexadecimal. If you were lucky, you might even find an instruction list with the op-code already in hexadecimal or octal. In any case, having to look up the op-code for each instruction is slow and tedious. If you were ambitious, you could get around this by memorizing the entire instruction list and corresponding op-code for each instruction. But I, for one, do not relish the prospect of having to commit such a list to memory. There must be a better way, and there is.

Assembly language

Let's suppose that we were able to program the computer using alphanumerics instead of just plain numbers. We could code the instructions



VECTORS VP2 enclosure permits you to design your own microcomputer.

into a 3- or 4-letter group very similar to the original instruction, and the computer would translate this code group into the machine-language instruction. We could use a hexadecimal keyboard to speed the process. Certainly, a group of meaningful characters are much easier to commit to memory than a group of 8 zeroes and ones. Also, if we wrote this "translator" program so that it takes care of all the memory addresses, programming would be much easier.

YOUR OWN **Computer**

The translator program is called an assembler program and the 3- or 4-letter groups that stand for the instruction are called a mnemonic (*nee-monik*—an easy-to-remember code word). A mnemonic is an abbreviated word that is intended to remind us of the original word. Let's take a closer look at mnemonics.

Program step 7 in Fig. 1 is an instruction that loads the accumulator with the contents of the memory location specified by the DE register pair. The corresponding mnemonic for this instruction is LDA (*LoaD Accumulator*). Program step 9 contains a store accumulator instruction. The mnemonic for this is STA (*STore Accumulator*). Another instruction is the halt instruction, and the corresponding mnemonic is HLT (*HaLT*). As you can see, mnemonics are definitely easier to remember than the binary op-code. In fact, we really don't even have to memorize the mnemonics. It's enough just to become familiar with them.

Let's take a look at what an assembly-language program is. Programming in assembly language is a little more difficult to grasp at first than machine language, but stick with it. We'll try to walk it through one step at a time. For discussion purposes, let's suppose you were writing the program down on a piece of paper. The assembly-language program is divided into four vertical columns. Each column is referred to as a field. The four fields are, from left to right, the LABEL, OPCODE, OPERAND and COMMENT fields.

So far you have a piece of paper divided into four columns. The LABEL field is always the first column. A label is a letter, or a group of letters, that reference a memory location. For example, suppose you assigned the first line of your assembly program with the label START. Then, if at any place in the program you had to refer to the starting address of the program, you could simply use the word START. The assembly program would automatically translate the word START into the starting address of the program. Or, suppose you wanted to store the result of a calculation in a memory location. You could assign a label to that memory location. Then, if you wanted to fetch the result from memory, you could simply use that label. You don't have to label every memory location when you write the assembly program if you don't want to. In fact, you don't have to use any labels at all. To avoid labeling, simply leave the first column (label field) blank.

The second column (the OPCODE field) contains the mnemonic abbreviation of the instruction. Some instructions, however, require more information than just the mnemonic. For example, suppose you wanted to store the contents of the accumulator in a memory location. You would use the STA mnemonic in the opcode field, but you would also have to specify the memory location where you want the accumulator stored. This information would go in the OPERAND field. Depending on the particular assembler you were using, you could specify the memory location as a 16-bit binary number, or an octal number, or hexadecimal, or even good old decimal. If you don't want to, you don't even have to worry about keeping track of memory locations. Remember the label field? If you assigned a label to the memory location, you could specify that memory location by using the label in the operand field. The operand field contains necessary information other than just memory locations. For example, suppose you used a mnemonic (instruction) that involved a register pair. The operand field would specify which register pair the instruction would operate on. In other words, the operand field contains any additional information that the particular instruction requires.

The last column, the COMMENT field, is not used by the computer at all. It contains documentary information that you, as a programmer, can add to help you understand the program. You can add whatever alphanumeric information you desire in this column.

Now that you have at least a basic understanding at what an assembly language is, let's look at an actual program written in assembly language. The simple addition program that was discussed throughout this article appears in Fig. 8 in assembly language.

The first line of the assembly-language program contains the *label* START. The first line also contains the first instruction of the program in the form of the mnemonic LXI. This LXI mnemonic instructs the microprocessor to load the register pair with the immediately following data bytes (X's in the mnemonic stand for register pairs.) The operand column leads off with an H. This defines the register pair as the HL register pair. Next comes the hexadecimal data that is to be loaded in the HL register pair. A comma separates the two pieces of information in the operand field. The second line of the program contains another LXI instruction, but this time, as you can see from the operand field, it operates on the DE register. The comma again separates the hexadecimal data that is to be stored in the DE register pair.

The third line of the program con-

Label	Opcode	Operand	Comment
START	LXI	H, 000C	Load HL register pair with 000C
	LXI	D, 000D	Load DE register pair with 000D
	LDAX	D	Load accumulator with memory specified by DE
	ADD	M	Add accumulator and contents of memory specified by HL
	STA	000E	Store accumulator in 000E
	HLT		Halt
	END	START	Assembler directive, load program counter with starting address

FIG. 8—ASSEMBLY-LANGUAGE PROGRAMMING involves using mnemonics to represent machine-language instructions.

tains the mnemonic LDAX, which instructs the microprocessor to load the accumulator with the contents of the memory location specified by a register pair. The operand field specifies the DE register pair. In the next line of the program, the combination of the mnemonic and operand instructs the microprocessor to add the contents of the accumulator and the contents of the memory location specified by the HL register pair. The next line stores the contents of the accumulator in the memory location specified in the operand field. The next-to-last instruction is the HLT mnemonic, which instructs the microprocessor to stop execution.

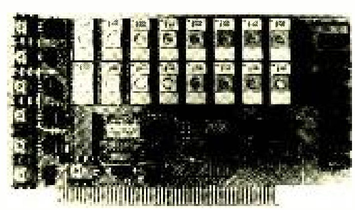
SOUTHWEST TECHNICAL'S 6800 system has optional floppy disc, printer and CRT terminal.

So far, as you can see, the assembly-language program is exactly the same as the machine-language program, but written differently in a much easier format to look at and understand than just binary numbers. The last line in Fig. 8 contains a mnemonic that is not a microprocessor instruction. The assembler program, in addition to understanding a mnemonic for each microprocessor instruction, understands several additional mnemonics called *assembler directives*. These are used to direct the assembler itself to do something. The mnemonic END tells the assembler that the program is complete and to stop assembling the program. The operand field contains the label START that loads the program counter with the starting address of the program. This means that after the program is assembled and loaded into the computer in that machine language, the program counter is set to the memory address that contains the first LXI instruction.

That is basically what assembly language looks like. Incidentally, the program shown in Fig. 8 is called a *source program*. It is in its raw form, it hasn't been translated into machine language. The assembler will translate into machine language, and Fig. 8 is the source for the assembler. However, thus far you only have the source program written down on a piece of paper. Now, you'll have to put it into a form that the assembler can use. This requires some additional equipment for your computer.

Since assembly language is written in alphanumerics, you'll need an alphanumeric keyboard and an alphanumeric display; both of these are contained in a CRT terminal. To connect the terminal to your computer, you'll need a parallel interface board if your computer doesn't already have one. You'll also need an external device to store your source and assembler programs, and then load them back into the computer when needed at a later time. The most common storage device used in personal computing is the audiocassette tape recorder. This device is inexpensive and surprisingly reliable. To interface the cassette recorder to your computer, you need a cassette interface.

You also need a program to drive the cassette interface. This software is a program that directs the microprocessor to transfer the contents of memory, one location at a time, to the cassette interface when you want to store a program on a cassette tape. It also contains a routine that takes the digital data stored on the cassette tape and transfers it to sequential memory locations. This software is called a *bootstrap program*. You'll also need software to drive the CRT terminal. If you're lucky, your computer contains both these programs, as well as several additional systems programs, stored in a permanent memory called a ROM. The system software is called a monitor program. If your computer doesn't contain a monitor ROM, then you'll first have to load the bootstrap program into the computer through the front-panel switches. Once the bootstrap program is loaded, you can then load the rest of the programs using the cassette tape recorder.

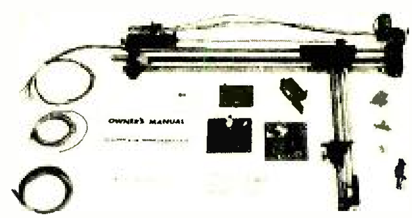


COMBINATION RAM AND ROM memory board mates directly with the S100 bus.

Now that you have the necessary equipment, you can write your source program in assembly language.

Assembly-language programming

To write your source program on the CRT terminal requires an additional program called a *text editor*. The text editor makes it much easier to write text on the terminal. It provides you with various edit functions in case you make a mistake, it has a tab function for setting up columns on the terminal, and it even has a cassette file routine that enables you to transfer several source programs to the same cassette tape.



X-Y PLOTTER connected to computer permits hard copy drawings.

The text editor is loaded into the computer via the cassette tape recorder. Once this is loaded, you can write your source program on the terminal. The keyboard on the terminal is very similar to a typewriter keyboard. It has all the letters and numbers, and it even has a shift key, space bar and carriage return. So to enter the source program, you merely type it out as if you were entering it on a typewriter.

The source program is entered by typing it one line at a time. The four fields are separated by spaces. For example, to designate the end of the opcode field and the beginning of the operand field, you enter a space by hitting the space bar on the keyboard. There will be times when you run across a column with nothing in it. To get around this, you again hit the space bar. For example, if the first column, the label field, is to be left blank, simply hit the space bar and you'll automatically start the next field, which is the opcode field.

The technique of using just a single space to separate the various fields results in a CRT display with the four fields appearing slightly shifted on each line. This may be confusing when you want to analyze the source program on the CRT display. I get around this by using the tab function associated with the text editor to automatically insert the correct number of spaces so that the four fields appear in four vertically aligned columns. Figure 9 shows what the source program in Fig. 8 would look like on the CRT display after you enter it. You'll notice that Fig. 9 looks exactly like Fig. 8 but without the names of the four fields. I also left out the comment field in Fig. 9.

START	LXI	H, 000C
	LXI	D, 000D
	LDAX	D
	ADD	M
	STA	000E
	HLT	
	END	START

FIG. 9—ASSEMBLY-LANGUAGE source program as it would appear on a CRT terminal.

Once the source program is entered on the terminal, you then transfer the source program to a cassette tape. This is done by using the various commands provided us by the text editor.

You're now ready to use the assembly-language program to translate the source program into machine language. For the sake of discussion, let's assume that you're using a two-pass assembler. It gets its name because the source program is loaded into the computer twice. The first thing you do is load the assembler program into the computer using the cassette tape recorder. Then, the source program is loaded into the computer, again using the cassette recorder. Next, rewind the cassette tape containing the source program and load it into the computer a *second* time. The CRT display will then tell you if there are any mistakes in the source program as the computer compares the two programs. If there are no mistakes, you can then store the machine-language program on another cassette tape.

If there was a mistake, the source program will have to be corrected. To make a correction, first load the text editor back into the computer. Then load the source program. The corrections are easily made using the various edit commands available with the text editor. The corrected source program is then stored on the cassette tape and the whole assembly procedure is repeated.

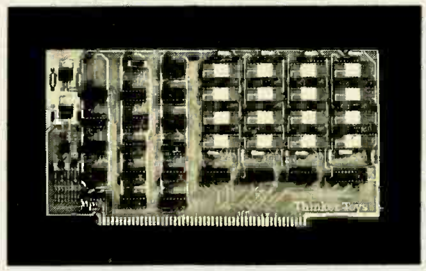
Assembler programs are different

Not all assembler programs are the same. Before you buy an assembler program, make sure that it is intended to be used with the micro-

UC-2000 from Infinite Systems contains computer, CRT terminal, and floppy disc drives.

processor you have in your computer. Since assembler programs generate machine language, the machine language must be compatible with the particular microprocessor in your computer. For example, if you have an 8080 microprocessor in your computer, you must use an 8080 assembler program.

There are two types of assembler programs available; the most common type used in personal computers is the *two-pass assembler.* The other type of assembler program is called a *one-pass assembler.* Without going into the details of how an assembler program works, let's take a look at what the differences between these two types mean to you as a programmer. First, the two-pass assembler requires less memory to assemble the exact same source program than a one-pass assembler requires. So, with the same amount of memory in your computer, you could assemble larger programs using a two-pass assembler than with a one-pass assembler. However, using a two-pass assembler requires more time since the source program must be loaded into the computer twice. As fast as cassette tape recorders seem for loading programs, they're still relatively slow. So, the trade-offs for the two types of assemblers are speed and memory requirements. Since memory is still quite expensive, the two-pass assembler is most commonly used in personal computers. The total memory requirements for using either type of assembler depends on the length of your source programs.



8K RAM memory board from Thinker Toys mates directly with the S100 bus.

Higher-level languages

So far, this article has been discussing machine language and assembly language. When you program in machine language, you communicate with the computer on the same level as the microprocessor. When you program in assembly language, you communicate with the computer by using mnemonics, and the assembler program translates the mnemonics into machine language. Is assembly language considered a higher-level language? The answer is no. The mnemonics are just another form of microprocessor instructions. One mnemonic is translated into one microprocessor instruction by the assembler program. A higher-level language translates one instruction into many microprocessor instructions.

The most common higher-level language for personal computers is BASIC. This language uses English-like statements and commands. For example, let's look at your addition program again, but this time written in BASIC. The program is written so it will add the numbers 2 and 3 together:

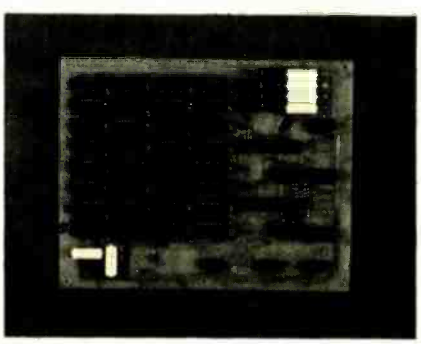
```
10 A = 2 + 3
20 PRINT A
30 END
```

The numbers preceding the statements are called *line numbers.* These tell the computer which statements to execute first. The computer merely executes the statements in numerically ascending order. The line numbers are also used for reference by a few other commands in the BASIC repertoire. The first statement sets the value of the variable A equal to the sum of 2 and 3. The PRINT A statement outputs the result to either the CRT display or a hard-copy printer if you have one. The last statement tells the computer that the program is finished and to stop execution. As you can see, writing programs on this level frees you from worrying about such things as memory locations, microprocessor registers, etc. You simply tell the computer what to do and the BASIC takes care of the rest.

MICROCOMPUTER CONTROL of AC appliances is possible with AC controller boards.

To program in BASIC, you again need a CRT terminal and a cassette tape recorder. First, you load the BASIC software into the computer using the cassette tape recorder. Then, you write the BASIC program on the alphanumeric keyboard. The program is written one line at a time. When you're finished, the CRT display will look exactly like the simple addition example. To execute the program, simply type RUN and hit the return key on the keyboard.

There are many, many variations of BASIC available. First, there's BASIC, and then there's EXTENDED BASIC. EXTENDED BASIC adds more features and commands to the BASIC repertoire. Also, there are variations between



WWW ENTERPRISES memory board uses Texas Instruments TMS-4060 memory IC's.

BASIC's written by different software suppliers. A program written using one kind of BASIC may not run under another BASIC without some minor modifications. The use of semicolons, colons, commas, quotation marks, etc., in the program is called *syntax*. Some BASIC's are very flexible in the use of syntax while others are quite rigid . . . a point you should investigate before purchasing a BASIC.

Other higher-level languages are also available, including APL, EMPL, FORTRAN and others. However, these languages are not in common use in personal computers for various reasons. For example, APL requires the use of additional symbols not found on a standard alphanumeric keyboard. So, to use APL requires a special APL keyboard.

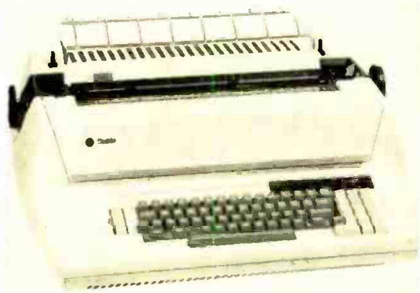
Higher-level languages are also classified as either *compilers* or *interpreters*. A compiler is very similar to an assembler program. That is, a compiler translates a source program into machine language, except that the source program is written using the statements associated with the higher-level language instead of mnemonics. The higher-level compiler resides in a high-speed external memory, such as a floppy disc. The source program is written and the compiler

HEATH H8 computer has an octal display and keyboard on the front panel.

translates it into machine language. Then the machine-language program is loaded into the computer and executed.

An interpreter, on the other hand, resides within the computer's internal memory. The source program is written using the higher-level statements, just as you did with the simple addition program. The interpreter translates the source progam *one statement at a time* into machine language, the computer executes the machine-language statements and then the interpreter translates the next statement in the source program.This process continues until the entire source program is translated *and* executed.

The disadvantage of using any higher-level language is the additional memory requirements. For example, even a BASIC interpreter is also classified by the additional internal memory it occupies. There are 4K, 8K and 12K BASIC's available. The



DIABLO PRINTER is offered by International Peripheral Systems for personal computer systems.

4K and 8K usually signify a standard BASIC, while 12K usually signifies an extended BASIC. If you have a computer with 16K of internal memory and you use a 12K BASIC, you only have 4K of memory left to write your programs in.

The disadvantage of using an interpreter is lack of speed, since each

COMPUTER BOARDS from Processor Technology mates with the S100 bus.

time a source program is executed, it must be translated. A compiler, on the other hand, translates the source program only once. Each time the program is executed, it is the machine-language program that is executed. A compiler, therefore, is much faster than an interpreter.

The disadvantage of using a compiler is the high-speed external memory requirements. This high-speed external memory is expensive. It is for this reason that interpreters are in far more common use than compilers. **R-E**

computer corner

How to prepare programs for microcomputers.

PETER RONY, CHRIS TITUS, DAVID LARSEN AND JONATHAN TITUS*

DEFINITIONS

Editor—Allows edit functions such as addition of a line or character to a program, insertion, deletion, etc. It permits you to alter your program. The input could be anything from programs or reports to raw instrument data.

Assembler—Converts the assembly language code into machine code, accepting mnemonics and symbolic addresses instead of actual binary values for addresses, instructions and data.

Monitor—Controls the operation of the various programs available. The monitor can access the editor, assembler or other programs.

Debugger—Allows a step-by-step observation of the program flow and the results of the program's operation. A debugger can be used to change data or instructions, alter registers, etc.

Breakpoint—A special instruction that can be inserted in a program to break off the normal program control and return control to a debug-type program. When a breakpoint is executed, the debug program indicates what the computer was doing at that point.

Cross Assembler—An assembler program that generates the program binary code for a computer other than the type it is being used with. For example, an 8080 cross-assember could operate on a PDP-8 minicomputer.

ONE OF THE PROBLEMS MANY MICROCOMPUTER users face is preparing software for their particular applications. The software examples that we have provided in past columns are short enough to be put together or *assembled* by hand; that is, we translated each mnemonic into its octal, hexadecimal or binary equivalent. Addresses for jumps, calls and input/output devices are easily added or changed since the computer programs are short and the addresses are probably listed in sequential order on the rough draft. Unfortunately, not all software preparation is this easy. Many application programs can be many thousands of steps long. This column will discuss the aids that are available for microcomputer program development.

One difficulty in software development is a clear, concise statement of the problem and how it is to be solved. All the desired results, inputs, outputs and the complete program flow, including all decision-making, must be considered before starting to program. An outline or block diagram can be used, but a flow chart is much easier to follow. Figure 1 shows a typical flow chart.

After the problem has been well thought out and a solution put in flow-chart form, a decision must be made. Is the program short enough to be easily translated by hand? In many cases, particularly with simple programs, hand assembly makes sense. In other cases, software development aids called *editors* and *assemblers* are faster and more efficient. To understand how editors and assemblers work, consider the process we used to put together this column.

We first outline the subject so that it can be covered well in short-column format. A handwritten copy is then typed, corrected, retyped and perhaps corrected and typed a final time. The illustrations and examples are formulated and drawn separately. This is the *editing* process. When writing a column, avoid references such as, ". . . the example below" or "the table on the following page." When the column is composed or *assembled*, references to tables, figures, etc., are much easier to follow.

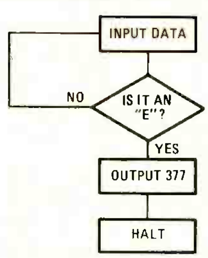


FIG. 1

Computer software is similarly developed. An editor program is used, either on a microcomputer or a timesharing system, to edit the individual program steps. The editor can correct, change, insert and delete steps in the program, just as with a manuscript. The editor program is generally unaware that you are writing a computer program, since you can use most editors to write a letter, prepare mailing lists, etc. When an editor is used to prepare a mnemonic program, *symbolic addresses* are often assigned to software tasks within the program. In this way, the actual value of the addresses for subprograms or subroutines is not needed. Just as in a column we refer to Fig. 4, the program refers to the letters, LOOP, as the starting address of a time-delay loop. Allowing the use of symbolic addresses for program steps means that the program can be changed without regard to the actual numeric values of addresses.

The assembler program must accept information from the editor and generate an output in a form that is compatible with your computer. Just as you assemble short programs one step at a time, so does the assembler. The assembler contains a table of mnemonics and their equivalent values. For example, an 8080 assembler would translate an MVIA instruction into 076 octal. The assembler also assigns real, 16-bit addresses to your symbolic addresses, such as LOOP. When using symbolic addresses, be sure to have a program step for each symbolic address and assign an address if you use a symbol. You cannot assign the same "name" to more than one address. Most assemblers will recognize a *redefined symbol* or an *undefined symbol*, and will produce an error message to let you know what needs to be corrected.

The final assembler output will be in punched paper tape, cassette or disc form ready to run on your system. Most assemblers will also produce a program listing showing the address of each step, the date in each successive location, a symbolic address name and the mnemonic plus any comments.

After a program has been assembled it will probably have to be debugged. The program checkout and debugging can be difficult without additional software "tools." Computer control panels are useful, but reading binary codes can become tedious, and there are many computers without external controls and readouts. There are *debugging programs* for most microcomputers that allow you to change instructions, list blocks of data or instructions and single-step through a program.

Many debug programs can establish a *breakpoint* in the software being tested. When the computer reaches a breakpoint, the instruction at that address is executed and an output device, such as a teletypewriter, lists the contents of important internal CPU registers. Breakpoints indicate not only that the computer reached a certain point in the software, but also what the computer did when it got there. If a breakpoint is set in the normal program flow and it is not reached, there is something wrong with the program. In this case, the breakpoint is moved closer and closer to the start of the program until the error is found. When the error is found, it can be corrected by using the debug program to change an instruction, data, etc.

Once the program operates correctly, the debug program should be able to save it on paper tape, a cassette, or some other medium. It should also be able to read such programs back into memory. In any case, when errors are found you should re-edit and reassemble the software to produce a complete, error-free documented listing. **R-E**

* This article is reprinted courtesy of American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Mr. Jon Titus is president of Tychon, Inc., a microcomputer consulting firm in Blacksburg, VA.

Integer multiplication and division routines for the 8080 microprocessor.

SINCE MICROPROCESSORS LIKE THE 8080 and 6800 do not have multiplication and division instructions, subroutines (containing addition and subtraction instructions) must be written to perform these operations. A typical paper-and-pencil decimal and binary multiplication for two different number sets is shown in Fig. 1.

Multiplication

Figure 1 shows that the mechanics of multiplication in the two number sets are

```
    1024                  00100110
  × 596                 × 00011011
   6144                   00100110
   92160                 001001100
+ 512000                0000000000
  610304               00100110000
                      001001100000
                     0000000000000
                    00000000000000
                 + 000000000000000
                   000010000000010
```

FIG. 1—MULTIPLICATION EXAMPLES shown in decimal and binary.

very similar. As the multiplicand is multiplied by larger and larger powers of 10 or powers of 2, the result of the multiplication must be shifted to the left by one, to increase the significance of the result. For instance, when 1024 is multiplied by the 9 in 596, the result (9216) is shifted to the left by one place, because the multiplication is really 90 × 1024 and the result is really 92,160.

To multiply two binary numbers, the 8080 must examine the multiplier one bit at a time. If the bit is a logic 1, the multiplicand is added to the *partial sum* (initially 0). If the bit examined is a logic 0, then the multiplicand is not added to the partial sum. Regardless of whether or not that addition takes place, the partial sum *must* be shifted one bit position, after each bit in the multiplier is examined.

To keep the 8080 multiplication software example (see Table 1) as simple as possible, we write a subroutine that multiplies two 8-bit numbers. These two numbers must be stored in registers D and E of the 8080, and the 16-bit result is stored in registers B and C (register pair B). When the subroutine is called, register pair B is cleared because it will be used to store the *partial sum* and finally the 16-bit result of the multiplication. Register L is loaded with the number of bits in the multiplier, octal 010, hexadecimal 08 or decimal 8. At NXTBIT, the multiplier that is contained in register D is moved to register A, shifted once to the right and saved back in register D. These instructions shift a single bit of the multiplier into the carry so that the state of the bit (logic 1 or logic 0) can be tested with software instructions.

TABLE 1—EIGHT-BIT MULTIPLICATION SUBROUTINE

```
MP88,     LXIB     /SET THE REGISTER PAIR THAT WILL HOLD THE
          000      /RESULT OF THE MULTIPLICATION, TO
          000      /000 000 (HEXADECIMAL 0000)
          MVIL     /LOAD L WITH 8 (DECIMAL), THE BIT COUNT
          010      /OR THE NUMBER OF SHIFTS TO TAKE PLACE
NXTBIT,   MOVAD    /MOVE THE MULTIPLIER INTO A
          RAR      /SHIFT IT ONE BIT TO THE RIGHT
          MOVDA    /THE CARRY IS EITHER 1 OR 0, SAVE THE
                   MULTIPLIER
          JNC      /IF THE CARRY IS 0, JUST SHIFT THE
          NOADD    /RESULT. IF THE CARRY IS A 1, ADD THE
          0        /MULTIPLICAND TO THE RESULT, THEN SHIFT IT
          MOVAB    /GET THE MSBY OF THE RESULT
          ADDE     /ADD THE MULTIPLICAND
          MOVBA    /AND SAVE THE MSBY OF THE RESULT
NOADD,    MOVAB    /NOW SHIFT THE 16—BIT RESULT ONE
          RAR      /PLACE TO THE RIGHT.
          MOVBA    /SAVE THE NEW MSBY
          MOVAC    /NOW SHIFT THE LSBY TO THE RIGHT.
          RAR
          MOVCA
          DCRL     /HAVE ALL 8 BITS OF THE MULTIPLIER
          JNZ      /BEEN TESTED YET? NO, TEST ANOTHER BIT
          NXTBIT
          0
          RET      /YES, THE ANSWER IS IN REGISTER PAIR B
```

If the state of the carry after the shift is a logic 0, this means that the multiplicand is not added to the partial sum, so the JMP to NOADD (NO ADDition) is executed. If the carry is a logic 1, the JMP to NOADD is not executed. Instead, the multiplicand, contained in register E, is added to the partial sum, which is contained in register pair B.

At NOADD, the 16-bit number contained in register pair B is shifted to the right by one bit position. The multiplier's bit count, which is contained in register L, is then decremented by one. When this bit count is decremented to 0, the 8080 will return from the subroutine, with the 16-bit result of the multiplication in register pair B. If the bit count is nonzero, the JMP to NXTBIT is executed, so that another bit in the multiplier can be tested and any additions performed.

Subtraction

The multiplication of the two 8-bit binary numbers was performed by an *add and shift algorithm*. Binary division can be performed by a *subtract and shift algorithm*. An example of binary division is shown in Fig. 2. Binary division is more

```
        00001110
1011 )10011011
      - 1011
        10000
      -  1011
          1011
      -   1011
         00001
```

FIG. 2—BINARY DIVISION example.

complex than binary multiplication. To divide two binary numbers, the divisor is subtracted from a larger and larger portion of the dividend that has less and less significance. If the divisor is larger than the part of the dividend from which it is being subtracted, a borrow occurs. In this case, the divisor is added to the *result of*

TABLE 2—EIGHT-BIT DIVISION SUBROUTINE

```
DIV88,     LXIH      /LOAD THE L REGISTER WITH 010 (DECIMAL 8)
           010       /OR HEXADECIMAL 08 AND LOAD THE H
           000       /REGISTER WITH 000 (THE RESULT WILL BE IN H)
           MVIC      /LOAD THE C REGISTER WITH 000
           000       /THIS REGISTER WILL BE USED FOR STORAGE
NXTBIT,    MOVAE     /MOVE THE DIVIDEND TO A
           RAL       /SHIFT THE MSB OF A INTO THE CARRY
           MOVEA     /SAVE THE SHIFTED DIVIDEND BACK IN E
           MOVAC     /GET THE PARTIAL DIVIDEND STORED IN C
           RAL       /SHIFT THE CARRY INTO THE LSB OF A.
           SUBD      /SUBTRACT THE DIVISOR FROM THIS NUMBER
           JNC       /IF THE CARRY=0, THE SUBTRACTION DID NOT
           NOADD     /PRODUCE A BORROW. THEREFORE, SHIFT THE
           0         /QUOTIENT. OTHERWISE ADD THE DIVISOR BACK TO
                     A
           ADDD      /ADD THE DIVISOR BACK TO THE CONTENT OF A.
NOADD,     MOVCA     /SAVE THE PARTIAL DIVIDEND BACK IN C.
           CMC       /COMPLEMENT THE CARRY.
           MOVAH     /AND SHIFT THE CARRY INTO THE LSB
           RAL       /OF THE H REGISTER. IF A BORROW, C=0
           MOVHA     /IF NOT, C=1
           DCRL      /HAVE ALL EIGHT BITS BEEN SHIFTED YET?
           JNZ       /NO, SHIFT ANOTHER BIT OF THE
           NXTBIT    /DIVIDEND AND TRY ANOTHER SUBTRACTION
           0
           RET       /THE ANSWER IS IN H WHEN THE 8080 RETURNS
```

the subtraction to re-generate the original part of the dividend being tested. A 0 is then entered in the quotient for the bit position being tested. If no borrow occurs when the subtraction is performed, the result of the subtraction is used as the new partial dividend, and a 1 is entered into the quotient since the divisor was successfully subtracted from the dividend. The subroutine listed in Table 2 divides the content of register E (the dividend) by the 8-bit content of the register D (the divisor) and the 8-bit result (the quotient) is saved in register H and the remainder is saved in register C.

The LXIH instruction in the subroutine (Table 2) loads the number of bits in the divisor (octal 010, decimal 8) into register L and register H is loaded with 0. This is done because register H will be used to store the quotient. The MVIC instruction loads register C with 0. Register C will be used to store the *partial dividend.* At NXTBIT, the dividend is shifted one bit to the right. The most-significant-bit (MSB) is shifted into the carry, and the remaining bits of the dividend are saved back in register E. The partial dividend in register C is then moved to register A, and the bit from the dividend is shifted from the carry into the least-significant-bit (LSB) of register A. The SUBD instruction subtracts the divisor from the partial dividend, which was in register A. If the divisor is subtracted from a larger or equal number, the JMP to NOADD is executed. If the divisor is greater than the partial dividend, a borrow occurs, therefore the divisor is added to the result of the subtraction by the ADDB instruction. Register A now contains the original partial dividend.

When the 8080 executes the instructions at NOADD, it must enter a logic 0 or logic 1 into the quotient. Therefore, the state of the carry is complemented by the CMC instruction and then saved in register H. If the subtraction did not generate a borrow, then the carry is a logic 0, but a logic 1 must be entered in the quotient. If a borrow was generated, the carry is a logic 1. This means that a logic 0 must be entered into the quotient. The CMC instruction simply complements the state of the carry to the state needed in the program. Finally, the content of register L is decremented by the DCRL instruction. If more bits within the dividend must be tested, the 8080 jumps back to NXTBIT, otherwise it returns from the subroutine with the quotient in register H and the remainder in register C.

There are a number of *software tricks* that can be used to simplify these two mathematical subroutines. However, unless your microcomputer can execute multiply-and-divide instructions or has special *multiply/divide hardware*, these operations will have to be performed using these or similar algorithms. **R-E**

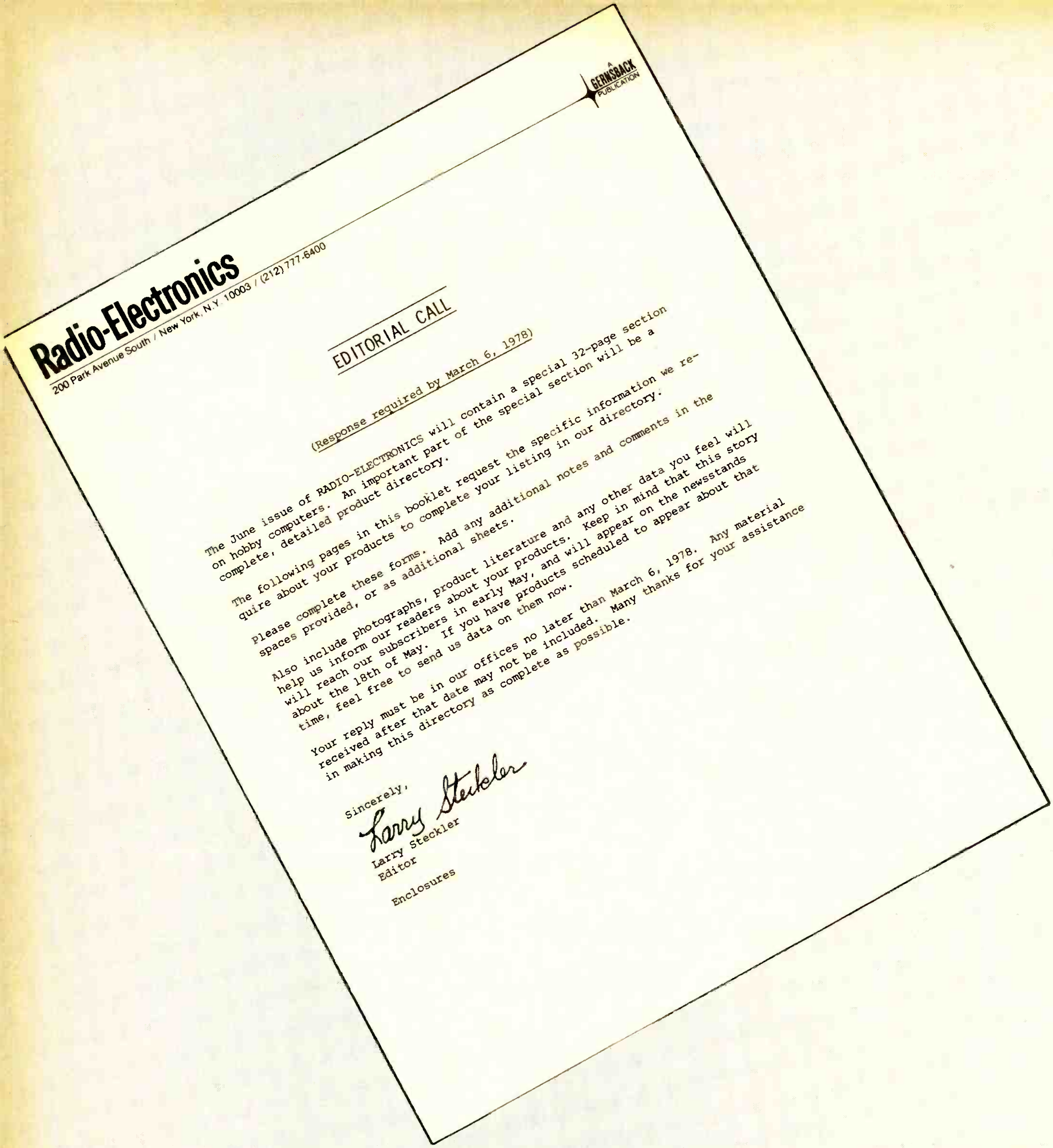
NOT IN THE CHARTS

The following companies provide products of interest to the computer hobbyist, but are not listed in the charts on the following pages.

NAME OF COMPANY	PRODUCT	ADDRESS
COMPUTER FAIRE	Proceedings & Silicon Gulch Gazette—	Box 1579, Palo Alto, CA 94302
COMPUTER PROFESSIONALS	Book Club	P.O.B. 582, Princeton Rd., Hightstown, NJ
CREATIVE COMPUTING	Books	P.O. Box 789-M. Morristown, NJ 07960
HAYDEN PUBLISHING	Books	50 Essex St., Rochelle Park, NJ 07662
HOWARD H. SAMS & CO., INC.	Books	4300 W. 62nd St., Indianapolis, IN 46206
LEXINGTON BOOKS	Books	125 Spring St., Lexington, MA 02173
LOGICAL SERVICES INC.	Microcomputer Programming Course	1080-H E. Duane Ave., Sunnyvale, CA
MCGRAW-HILL PUBLISHING	Books	1221 Ave. of the Americas, New York, NY
O A E	PROM Programmer	676 W. Wilson Ave., Glendale, CA 91203
OSBORNE & ASSOC.	Books	P.O. Box 2036, Berkeley, CA 94702
PRENTICE-HALL, INC.	Books	Route 9W, Englewood Cliffs, NJ 07662
POWER-ONE, INC.	Open frame DC power supplies single dual & triple output models	Power-One Drive, Amarillo, CA 93010
RONDURE COMPANY	IBM Selectric Terminals	2522 Butler St., Dallas, TX 75]35
SHUGART ASSOC.	Floppy & Minifloppy™ Disc Drives	435 Oakmead Pkwy., Sunnyvale, CA 94086
SYLVANHILLS LAB INC.	X-Y Plotter	P.O. Box, Pittsburg, KS 66762
SYSTEX ENTERPRISES INC.	Computer Portrait System	P.O. Box 402, King of Prussia, PA 19406
TAB BOOKS	Books	Monterey & Pinola Aves., Blue Ridge Summit, PA 17214

Personal Computers DIRECTORY

The following pages contain detailed information on the personal computer products made by a large number of manufacturers. We think you'll find it informative



Radio-Electronics
200 Park Avenue South / New York, N.Y. 10003 / (212) 777-6400
A GERNSBACK PUBLICATION

EDITORIAL CALL

(Response required by March 6, 1978)

The June issue of RADIO-ELECTRONICS will contain a special 32-page section on hobby computers. An important part of the special section will be a complete, detailed product directory.

The following pages in this booklet request the specific information we require about your products to complete your listing in our directory.

Please complete these forms. Add any additional notes and comments in the spaces provided, or as additional sheets.

Also include photographs, product literature and any other data you feel will help us inform our readers about your products. Keep in mind that this story will reach our subscribers in early May, and will appear on the newsstands about the 18th of May. If you have products scheduled to appear about that time, feel free to send us data on them now.

Your reply must be in our offices no later than March 6, 1978. Any material received after that date may not be included. Many thanks for your assistance in making this directory as complete as possible.

Sincerely,

Larry Steckler

Larry Steckler
Editor

Enclosures

The letter reproduced at the top of this page was sent as a part of an 8-page questionnaire to all of the personal computer product manufacturers we could locate. We followed up by handing out additional forms at personal computer shows. The resulting tables, on the pages that follow, were compiled from the data we received. For further information on any of the items described, please contact the individual manufacturer. You'll find the name, address and phone number of everyone who participated, on the last page of this special section. When you write or phone for more information please inform the company that you read about their products in this special section. By doing so, you'll help us guarantee a more complete response from all personal computer manufacturers the next time we do this kind of report.

MAIN FRAMES

MANUFACTURER	MODEL	BUS SYSTEM	FRONT PANEL			SLOTS FOR PLUGINS	COMMENTS
			SWITCHES	KEYBOARD	DISPLAY		
APPLE	A250016X	APPLE 50		TYPEWRITER		8	FAN
COMPAL	80	S-100		ARS-33, 37		5	
COMPUCOLOR	II	40-PIN		ASC11	CRT	0	CONVECTION COOLED
COMPUTER SHOP	CS-100	S-100		ASC11 HEX	HEX		FAN BATTERY BACK UP
E & L	MMD-1	E & L		OCTAL HEX	LED		EXPANSION THROUGH SELF-POWERED ADD ONS
ELECTRONIC CONTROL TECHNOLOGY	TT-10	S-100	YES			10	WHISPER FAN
HEATH COMPANY	H-8 H-11	BH-50 38-PIN	YES YES	OCTAL		10 6	CONDUCTION COOLED FAN
INFINITE INC.	UC2000	S-100		ASC11	CRT	8	AXIAL FAN
ITHICA AUDIO		S-100	YES	BINARY			SMART FRONT-PANEL BOARD
JADE COMPUTER PRODUCTS	S-100, SS-50 KIM-1						
MIDWEST SCIENTIFIC INSTRUMENTS	MSI-6800	SS-50	YES	YES	CRT	16	FAN
NBL		SPECIAL		HEX	BINARY		
NETRONICS R & D	ELF II	EEF II	YES	HEX	7-SEG HEX	5	ON BOARD FILTER & REGULATOR
NORTH STAR	HORIZON	S-100	YES			12	FAN
NOVAL INC.	760	44-PIN	YES	ASC11	VIDEO	7	
OHIO SCIENTIFIC	C2-4P C2-S1S C3-S1	48-PIN 48-PIN 48-PIN	YES YES YES	ASC11	VIDEO	4 8 8	INCLUDES AUDIO CASSETTE INTERFACE, 4K RAM, 8K BASIC IN ROM, FAN
PARASITIC ENGINEERING	EQUINOX-100	S-100	YES	12-KEY OCTAL	OCTAL LED	20	CONSTANT VOLTAGE FERRO-RESONANT TRANSFORMER INTELLIGENT FRONT PANEL BOX FAN
QUAY	8000	S-100	YES			12	MUFFIN FAN
REALISTIC CONTROLS	Z1110	S-100		FULL A/N		6	FAN
SEALS ELECTRONICS	PUP-1	S-100	YES		INDICATORS	11	FAN
SOUTHWEST TECHNICAL PRODUCTS	68/2	SS-50	YES			15	7 MAIN PLUG-IN SLOTS 8 I/O PLUG-IN SLOTS
TEI INC.	MCS-112, 122, RM12, RM22	S-100	YES			12 OR 22	FAN
VECTOR GRAPHIC	VECTOR 1, 1+, 1++	S-100	YES			18	FULLY SHIELDED AND TERMINATED MOTHERBOARD WHISTLER FAN
WAVE MATE	JUPITER II, III	72-PIN	YES		4 DIGIT HEX	11	CONVECTION COOLED

MANUFACTURER	CPU: BUS SYSTEM	CPU: MICRO-PROCESSOR	FEATURES: MON. PROM	FEATURES: PARALLEL I/O	FEATURES: SERIAL I/O	FEATURES: OTHER	CPU: RAM (K)	CPU: ROM (K)	MEMORY: BUS SYSTEM	MEMORY: RAM (K)	MEMORY: ROM (K)	MEMORY: EPROM (K)	SPEED μs	DIRECT MEMORY ACCESS	ON BOARD REGULATORS	ADDRESS SELECTION	COMMENTS
APPLE	APPLE 50	6502	●	●	●		48	12	APPLE 50	48	12	12	500	YES	NO	PLUG IN JUMPERS	
CENTRAL DATA									S-100	16 OR 32			450	NO	YES	16K BLOCKS WITH 2K DG SELECT	
COMPAL	S-100	8080	●		●	VECTORED INTERRUPT	512 BYTES		S-100	UP TO 64	UP TO 3	UP TO 3	250 400	YES	YES		
COMPUCOLOR	40-PIN	8080	●	●	●	TIMERS	4, 32	16, 24	40-PIN	16	16	16	450	NO	YES	NO	MEMORY IS ON CPU CARD
COMPUTER SHOP	S-100	Z80	●						S-100	16 TO 64			200	YES	YES	4K	
THE COMPUTERIST									KIM-1	8		8	450	YES	YES		INDEPENDENTLY JUMPERABLE AT ANY 2K BOUNDRY
E & L INSTRUMENTS	E & L	8080	●	●			512 BYTES	512 BYTES	E & L	2		1	450	NO	NO		MOUNTS ON CPU POWERED FROM CPU
ELECTRONIC CONTROL TECHNOLOGY	S-100	8080, Z-80							S-100	2, 16	2	2	450 200	YES	YES	4K BLOCKS	
ELECTRONIC SYSTEMS									S-100	8			450	YES	YES		
FRANKLIN ELECTRIC									S-100	8			450, 250	YES	YES		
GODBOUT									S-100 BH-50	8-16, 12							4K BLOCKS
HEATH COMPANY	BH-50 LSI-11	8080 LSI-11	●				4	1 X 8	BH-50 LSI-11	8 X 8 4 X 16			450 500	YES	YES		
IMSAI MFG.	S-100	8080, 8085	●	●	●	PROGRAMMABLE RAM MODULE	1 TO 4	2	S-100	4, 16, 32, 64	4 16	4 16	475	YES	YES		
INFINITE INCORP.	S-100, CS-100 INFINITE 72, COSMAC	8080, 8085, Z-80, 1802	●	●	●		.5	3									
ITHICA AUDIO		Z-80	●						S-100	8 STATIC 16, 32, 64 DYNAMIC	16/32	16/32	250 OR 450	YES	YES	DIP SWITCH EPROM 1K INCREMENTS	
JADE COMPUTER PRODUCTS	S-100 KIM-1	8080, 6502, Z-80							S-100, SS-50 KIM-1								
MARINCHIP SYSTEMS	S-100	9900															
MIDWEST SCIENTIFIC INSTRUMENTS	SS-50	6800	●				128	4	SS-50	56	56	56	250	YES	YES	SWITCH	
MOUNTAIN HARDWARE									S-100	.5		7.5	500	NO	YES	EVERY 8K	
NBL		SC/MP II		●	●		1			1			500	YES	YES		
NETRONICS	ELF-II	1802					2.56		ELF-II	4			100	YES		4K BLOCKS TO 64K	FULLY BUFFERED & TRISTATE
NORTH STAR	S-100	8080, Z-80	OPT						S-100	16			200	YES	YES	2 8K REGIONS	
NOVAL INC.	44-PIN	Z-80	●	●		32K PROGRAM MEMORY			S-100	32				NO	YES	EACH 8K OF MEMORY CAN BE JUMPERED ON 8K BOUNDRIES	
OHIO SCIENTIFIC	48-PIN	8080, 6502 Z-80	●	●	●		4 16	8	48-PIN	4 16	8 ON CPU		350 250		NO		PIA BASED PARALLED I/O OPTIONAL
PARASITIC ENGINEERING	S-100	8080A	●				512 BYTES	512 BYTES	S-100	4 STATIC			450		YES	DIP SELECTABLE TO ANY 4K BLOCK	

	CPU								MEMORY									
			FEATURES															
MANUFACTURER	BUS SYSTEM	MICRO-PROCESSOR			SERIAL I/O	OTHER	RAM (K)	ROM (K)	BUS SYSTEM	RAM (K)	ROM (K)	EPROM (K)	SPEED μs	DIRECT MEMORY ACCESS	ON BOARD REGULATOR	ADDRESS SELECTION	COMMENTS
QUAY	S-100	Z-80	●	●	●		1		S-100	8 STAT IC		ON CPU	450	YES	YES	4K BLOCKS	
REALISTIC CONTROLS	S-100		●		●		64	2	S-100	64	2	2	250	YES	YES	0000_H-$FFFF_H$	
SD COMPUTER PROD	S-100	Z-80	●	●	●		1	4 8	S-100	4, 8 STATIC 8 TO 64		16 & 32	250/500 STATICRAM 375 EXPANDORAM 450 EPROM	YES	YES	AT ANY LOCATION	
SEALS									S-100 SS-50	8, 16 32, 8	4		250 & 500				
SMOKE SIGNAL BROADCASTING									SS-50	16		8	250 & 400	YES	YES	SWITCH SELECT	
SOLID STATE SALES									F8, KIM, 6800	4			450	YES	NO		
SOUTHWEST TECHNICAL PRODUCTS	SS-50	6800	●				128 BYTES	8 BYTES	SS-50	4, 8 16, 32		UP TO 8 BYTES		YES	YES	ANY 8K BLOCK	
SZERLIP ENTERPRISES									S-100	1		UP TO 32	450	YES	YES		
TEI INC	S-100	8080, Z-80							S-100	16			250		YES		
THINKER TOYS	S-100	8080	●	●	●		256 BYTES	1 BYTES	S-100	8 65			250 250	NO		4K BLOCKS 8K WINDOWS	
VECTOR GRAPHICS	S-100	8080, Z-80							S-100	8, 16		2, 12		YES	YES	SWITCH 8K BLOCKS	
WWW ENTERPRISES									NONE	16			270 DYNAMIC 250 STATIC	YES	NO		
WAVE MATE	72-PIN	Z-80, 6800							72-PIN	UP TO 32		350	350	YES	YES		

I/O BOARDS

	I/O PARALLEL							I/O SERIAL								I/O CASSETTE				
				BAUD						BAUD										
MANUFACTURER	BUS SYSTEM	NO PORTS	HANDSHAKING	RATE	SOFTWARE SELECT	JUMPER SELECT	COMMENTS	BUS SYSTEM	NO PORTS	RATE	SOFTWARE SELECT	JUMPER SELECT	EIA COMPATIBLE	TTY COMPATIBLE	COMMENTS	BUS SYSTEM	BAUD RATE	RECORDING FORMAT	START/STOP CONTROL	COMMENTS
APPLE	APPLE 50	1	●					APPLE 50	1	9600 110	●		●				1500	APPLE ENCODED		
COMPAL		1							2	5600 50	●		●	●			2400 300	PHASE ENCODED	●	
COMPUCOLOR							ON CPU CARD								ON CPU CARD					
COMPUTER SHOP	S-100		●			●		S-100	2	9600 55		●	●	●						
E & L INSTRUMENTS	E & L	3		1750 0			PART OF CPU CARD	E & L	1	110 110					PART OF CPU CARD	E & L	300 300	2-TONE AUDIO VART FORMATTED		

I/OBOARDS

MANUFACTURER	I/O PARALLEL: BUS SYSTEM	NO PORTS	HANDSHAKING	BAUD: RATE	BAUD: SOFTWARE SELECT	BAUD: JUMPER SELECT	COMMENTS	I/O SERIAL: BUS SYSTEM	NO PORTS	BAUD: RATE	BAUD: SOFTWARE SELECT	JUMPER SELECT	EIA COMPATIBLE	TTY COMPATIBLE	COMMENTS	I/O CASSETTE: BUS SYSTEM	BAUD RATE	RECORDING FORMAT	START/STOP CONTROL	COMMENTS
ELECTRONIC CONTROL TECHNOLOGY								S-100	2	19200 50		●	●	●						
ELECTRONIC SYSTEMS								APPLE II		30000 0						S-100	1200 0	VART (FSK)	●	2 DIFFERENT UNITS
FRANKLIN ELECTRONICS	S-100	1				●		S-100	3	9600		●	●	●						
GENERAL MICRO SYSTEMS												●	●			S-100		BIPHASE MANCHESTER	●	1600 BITS/INCH HI-DENSITY DIGITAL 2000 BYTES/SEC
HEATH COMPANY	BH-50 LSI11	3	●					BH-50 LSI-11		9600 110 9600 50		●								
IMSAI MFG	S-100	2 OR 6	●					S-100	2	56000 560		●				S-100	4800 800	TARBELL	●	
IOR	S-100 CUSTOM	6	●																	
JADE COMPUTER PRODUCTS	S-100							S-100								S-100				
MIDWEST SCIENTIFIC PRODUCTS	SS-50	8	●	19200 110		●		SS-50	3	19200 110		●	●	●		SS-50	330 110	KC	●	
NBL		1			●													KC		
NETRONICS	ELF-II	2	●		●			ELF-II				●	●	●		ELF-II	1000	SIMILAR TO KC	●	BOARD ALSO CONTAINS MONITOR PROM
NORTH STAR		1					ON MOTHER BOARD		1	9600 75		●	●	●	ON MOTHER BOARD					
NOVAL	44-PIN						8 8-BIT PORTS ON CPU CARD	44-PIN	1	9600 150		●	●	●			2500	DIGITAL PHASE ENCODED	●	
OHIO SCIENTIFIC	48-PIN	2		1 MHZ SYSTEM																
PARASITIC ENGINEERING	S-100	1	●					S-100	1	4800 110	●		●	●		S-100	300	KC	●	CONTROLS 3 RECORDERS
PERCOM								S-100	1	9600 110		●	●	●		S-100 SS-50	2400 300 1200 300	EXTENDED KC EXTENDED KC	●	
PERSONAL COMPUTING																SS-50	2400 110	KC @ 300 BAUD MANCHESTER @ 2400 BAUD	●	
QUAY	S-100	8	●																	
REALISTIC CONTROLS	S-100	2	●	200000			BUILT INTO FLOPPY CONTR	S-100		56000 110		●	●	●						
RONDURE COMPANY															FOR IBM SELECTRIC					
SOUTHWEST TECHNICAL	SS-50	1	●	9600 110		●		SS-50	1	9600 110		●	●	●			300	KC	●	CONTROLS 2 RECORDERS
TEI	S-100	3		19200		●		S-100	3	19200		●	●	●						
THINKER TOYS																S-100	300	KC	●	CONTROLS 3 CASSETTES INCLUDES 3 SERIAL & PARALLEL PORTS
WAVE MATE	72-PIN	2 OR 4	●					72-PIN	1 OR 2	19200 50	●	●	●	●		72-PIN	1200 300	KC	●	

	FLOPPY INTERFACE								OTHER BOARDS				
MANUFACTURER	BUS SYSTEM	MINI 5"	FLOPPY 8"	NO. DRIVES	HARD SECTORED		OPERATING SYSTEM	COMMENTS	BUS SYSTEM	SPEECH	MUSIC	CONTROLLERS	OTHERS
APPLE		●		2		●	YES			●	●	●	
CALIFORNIA INDUSTRIAL													MOTHER BOARD
CANDA SYSTEMS						●	YES		S-100			●	REAL TIME CLOCK AC POWER SWITCH
COMPAL	S-100	●		4	●		MICROPOLIS						4-SLOT EXPANDER
COMPUTALKER									S-100	●			AUDIO AMPLIFIER AND SPEAKER REQUIRED
COMPUCOLOR		●				●	IN ROM						
COMPUTER SHOP	S-100	●		1 TO 3	●		NORTH STAR						
E & L									E & L				EPROM & 8K RAM
ELECTRONIC CONTROL TECHNOLOGY													CARD CAGE, MOTHER BOARD, EXTENDER
ELECTRONIC SYSTEMS													VART & BAUD-RATE GENERATOR TV TYPERWRITER MODEM
HEATH COMPANY	BH-50	●		2	●								
IMSAI	S-100	●	●	7		●	ENHANSED CP/M						
INFINITE	S-100	●		3			NORTH STAR						
ITHICA AUDIO	S-100	●	●	8	●							●	A/D-D/A-8 BIT A/D-D/A-12 BIT
JADE COMPUTER PRODUCTS									S-100	●	●		
MICRONICS									S-100				BUG TRAP
MIDWEST SCIENTIFIC INSTRUMENTS	S-100 SS-50		●	4	●		YES		SS-50				CALENDAR CLOCK OPTO ISOLATOR
MOUNTAIN HARDWARE									S-100 APPLE-II			●	REMOTE CONTROL CLOCK CALENDAR
NETRONICS													PROTOTYPE
NORTH STAR	S-100	●		3			2.5K DOS						HARDWARE, FLOATING POINT
NOVAL	44-PIN	●		2		●	YES		44-PIN				PROM BURNER 2ND DISPLAY DRIVE COLOR SELECTOR
OBJECTIVE DESIGN									S-100				PROGRAMABLE CHARACTER GEN 512 X 256
OHIO SCIENTIFIC	48-PIN	●		1 2		●	YES		48-PIN				GRAPHICS 128 X 128 4 COLOR ALPHABETICS
PAIA											●		
PARASITIC ENGINEERING	S-100	●	●	4		●	CP/M						

FLOPPY INTERFACE / OTHER BOARDS

MANUFACTURER	FLOPPY INTERFACE: BUS SYSTEM	MINI 5"	FLOPPY 8"	NO. DRIVES	HARD SECTORED	SOFT SECTORED	OPERATING SYSTEM	COMMENTS	OTHER BOARDS: BUS SYSTEM	SPEECH	MUSIC	CONTROLLERS	OTHERS
PERCOM	SS-50	●					IN IK ROM						
PERSONAL COMPUTING	SS-50	●	●	4		●	YES		SS-50				PROTOTYPE
PROCESSOR CONTROL SYSTEM													PROGRAM ORGAN
QUAY	S-100	●		4			QUAY						
REALISTIC CONTROLS	S-100	●	●	8	●		CP/M		S-100	●	●	●	
SMOKE SIGNAL BROADCASTING	SS-50	●				●	YES						
SOUTHWEST TECHNICAL	SS-50	●	●	4		●	YES		SS-50			●	INTERRUPT TIMER CALCULATOR INTERFACE
TEI	S-100	●	●	3 TO 8		●	CP/M						
THINKER TOYS	SS-50	●	●	3 TO 8			CP/M						WUNDERBUS MOTHER BOARD
VECTOR													CARDCAGE S-100 HARDWARE PROTOTYPE
VECTOR GRAPHICS	S-100		●	2		●	CP/M	DUAL STORE					
WAVE MATE	72-PIN		●	2 OR 4		●	YES						

VIDEO DISPLAY MODULES

MANUFACTURER	BUS SYSTEM	RF OUTPUT	VIDEO OUTPUT	GRAPHICS	GRAPHICS RESOLUTION: VERT ELEM	GRAPHICS RESOLUTION: HORIZ ENTS	TEXT CHARACTERISTICS: DOT MATRIX	CHARACT. PER LINE	NO. LINES	PROGRAMMABLE CURSOR CONTROL	BLACK ONLY	WHITE ON BL	SCROLLING	HIGHLIGHT	UPPER CASE	LOWER CASE	COLOR	ON BOARD MEMORY (K)	SYSTEM MEMORY REQUIRED	SERIAL I/O KEYBOARD INPUT	PARALL I/O	COMMENTS
APPLE	APPLE		●		280	192	5 X 7	40	24	●	●	●	●	●	●			UP TO 46 RAM 12 ROM	8K		●	15 COLORS STANDARD 4-COLOR HI RESOLUTION
CENTRAL DATA	S-100		●		640	192	6 X 8	80	16	●		●	●		●	●		2	0			INCLUDES 2650, CASSETTE INTERFACE
COMPAL	S-100		●	●	128	48	7 X 9	64	16	●		●			●	●		1	0		●	
COMPUCOLOR				●	384	256	5 X 7	64	32	●			●	●	●	●	●	4	0		●	COLOR (8 BACKGROUND) (8 FOREGROUND)
COMPUTER SHOP	S-100		●		64	16	YES											16 TO 64	16		●	
ELECTRONIC SYSTEMS	STAND ALONE		●				5 X 7	32	16	●		●	●		●			1	0		●	
IMSAI MANUFACT.	S-100		●	●			5 X 7	80 40	24 12	●	●	●	●		●	●		2 RAM 1 PROM				
INFINITE INC.	S-100		●	●	128	48	7 X 9	64	16			●			●	●		1	2		●	

VIDEO DISPLAY MODULES

MANUFACTURER	BUS SYSTEM	RF OUTPUT	VIDEO OUTPUT	GRAPHICS	GRAPHICS RESOLUTIONS: VERT ELEM	GRAPHICS RESOLUTIONS: HORIZ ENTS	TEXT CHARACTERISTICS: DOT MATRIX	CHARACT. PER LINE	NO. LINES	PROGRAMMABLE CURSOR CONTROL	BLACK ONLY	WHOTE ON BL	SCROLLING	HIGHLIGHT	UPPER CASE	LOWER CASE	COLOR	ON BOARD MEMORY (K)	SYSTEM MEMORY REQUIRED	SERIAL I/O KEYBOARD INPUT	PARALL I/O	COMMENTS
IOR	S-100 CUSTOM		●				7 X 9	64	30	●			●	●	●	●		2	0			
ITHICA AUDIO	S-100		●	●	512	512	5 X 7	64 80	16 24	●	●		●			●		1 2				2 BOARDS
JADE COMPUTER PRODUCTS	S-100		●		128	48	7 X 9	32 64	16	●	●	●	●		●	●		1				
NETRONICS	ELF-II		●	●	128	64																
NOVAL INC.	PART OF CPU		●		256	224	8 X 8	32	28	●	●	●	●	●	●	OPT-IONAL	●					VIDEO IS PART OF CPU
OHIO SCIENTIFIC	48-PIN			●			5 X 7	32 64	32			●	●		●	●		2	0			PROCESSOR CONTROLLED
PERCOM	SS-50		●	●	400	360	7 X 9	80	16 OR 24		●		●	●	●	●		2	0			MEMORY MAPPED
QUAY	S-100		●				5 X 7	64	16	●		●	●		●	●		11				
REALISTIC CONTROLS	S-100						7 X 9	80	24	●	●	●	●	●	●	●	●		2		●	
TEI	S-100		●				7 X 9	80	24	●	●	●	●	●	●	●		2	2	●		
VECTOR GRAPHICS	S-100		●		128	48	7 X 9	64	16	●	●	●	SOFT-WARE	●	●	●		1 X 12 BITS	2		●	
WAVE MATE	72-PIN		●	●	128	96	7 X 13	64 96	32 16	●	●	●	●		●	●		1 2			●	

VIDEO DISPLAY TERMINALS

MANUFACTURER	PARALLEL I/O: NO. LINES	PARALLEL I/O: HANDSHAKING	PARALLEL I/O: COMPATIBILITY	SERIAL I/O COMPATIBILITY	KEYBOARD: NO. KEYS	NO. USER DEFINABLE KEYS	CURSOR	UPPER CASE	LOWER CASE	VIDEO DISPLAY: GRAPHICS	COLOR	RESOLUTION	TEXT: CHAR. PER LINE	NO. LINES	DOT MATRIX	SCROLLING	BLACK ON WHITE	WHITE ON BLACK	HIGHLIGHTING	UPPER CASE	LOWER CASE	COMMENTS
COMPUCOLOR				RS232 EIA	117	16	●	●	●	●	●	384 256	64	32	5 X 7	●			●	●	●	
COMPUTER STORE				RS232M	54	3	●	●	●				64	16	●	●		●		●	●	
E & L INSTRUMENTS				RS232 & 20 MA LOOP	64	0	●	●					64	16	7 X 9	●	●	●		●		REPROGRAMMABLE CHARACTER GENERATOR PARALLEL I/O FOR ASC11 KEYBOARD
HEATH COMPANY			RS-232C 20 MA LOOP	YES	67	67	●	●			●		80 20	12 48	5 X 7	●		●		●		
OHIO SCIENTIFIC				YES	53		●	●	●				64	16		●		●		●		ONLY APPLY TO MICROTERM ACT-1
REALISTIC CONTROLS					70	70	●	●	●	●	●	600 LINES	80	24	●	●	●	●	●	●		
SOUTHWEST TECHNICAL				YES	56	2	●	●	●			600 LINES	64	16	●	●	●	●	●	●		FULL CURSOR DECODING
WAVE MATE	20			SYNC & VIDEO COAX	73	73	●	●	●	●		128 X 96	64 96	32 16	7 X 4	●	●	●		●	●	

LIST OF PERSONAL COMPUTER MANUFACTURERS

Here's a list of names addresses and phone numbers for every company that filled out one of our questionnaires. If a name you are looking for is missing, they did not respond to our request for information.

APPLE COMPUTER INC.
10260 Bandley Drive
Cupertino, CA 95014
(408) 996-1010

CALIFORNIA INDUSTRIAL
15214 Grevill Ave.
Lawndale, CA 90260
(213) 772-0800
T. RYDER

CANADA SYSTEMS, INC.
1353 Foothill Blvd.
La Cañada, CA 91011
(213) 790-7957
KEN FINSTER

CENTRAL DATA CO.
P.O. Box 2484, Station A
Champaign, IL 61820
(217) 359-8010
JEFF ROLOFF

COMPAL
(Computer Power & Light)
12321 Ventura Blvd.
Studio City, CA 91604
(213) 760-3345
IVA KALB

COMPUCOLOR CORP.
5965 Peachtree Corners East
Norcross, GA 30071
(404) 449-5961
RODNEY HUNT

COMPUTALKER CONSULTANTS
P.O. Box 1951
Santa Monica, CA 90406
(213) 392-5230

THE COMPUTER FAIRE
Box 1579
Palo Alto, CA 94302
(415) 851-7075
JIM WARREN

COMPUTER SHOP
288 Norfolk St.
Cambridge, MA
(617) 473-2323
R. RIVERA

THE COMPUTERIST
P.O. Box 3
S. Chelmsford, MA 01824
(617) 256-3649
ROBERT M. TRIPP

E & L INSTRUMENTS
61 First Street
Derby, CT 06418
(203) 735-8774
RICHARD J. VUILLEQUEZ

ELECTRONIC CONTROL TECHNOLOGY
763 Ramsey Avenue
Hillside, NJ 07205
(P.O.B. 6, Union, NJ 07083)
(201) 686-8080
DENNIS P. DUPRÉ

ELECTRONIC SYSTEMS
P.O. Box 212
Burlingame, CA 94010
(408) 374-5984

FRANKLIN ELECTRIC
733 Lakefield Rd.
Westlake Village, CA 91361
(805) 497-7755
FRANK PETERS

GENERAL MICRO-SYSTEMS
12369 W. Alabama Place
Lakewood, CO 80228
(303) 985-3423
BOB SMITH

BILL GODBOUT ELECTRONICS
Box 2355
Oakland Airport, CA 94614

THE HEATH COMPANY
Benton Harbor, MI 49022
(616) 982-3417
V. VIRGIL BENNETT

IMSAI MFG. CORP.
14860 Wicks Blvd.
San Leandro, CA
(415) 483-2093

INFINITE INC.
1924 Waverly Place
Melbourne, FL 32901
(305) 724-1588
BILL HABERHERN

I O R
P.O. Box 28823
Dallas, TX 75228
(214) 358-2671

ITHACA AUDIO
P.O. Box 91
Ithaca, NY 14850
(607) 273-3271

JADE COMPUTER PRODUCTS
5351 West 144th
Lawndale, CA 90260
(213) 679-3313

LEXINGTON BOOKS
D.C. Heath & Co.
125 Spring Street
Lexington, MA 02173
(617) 862-6650

LOGICAL SERVICES INC.
1080-H East Duane Ave.
Sunnyvale, CA 94086
(408) 245-8855

MARINCHIP SYSTEMS
16 St. Jude Road
Mill Valley, CA 94941
(415) 383-1545
JOHN WALKER

MICRONICS, INC.
P.O. Box 12545
Raleigh, NC 27605
LENNY HEATH

MIDWEST SCIENTIFIC INSTRUMENTS, INC.
220 W. Cedar St., Olathe, KS 66061
(913) 764-3273
DR. CHILDRESS

MOUNTAIN HARDWARE, INC.
P.O. Box 1133
Ben Lomond, CA 95005
(408) 336-2495
D. PACE

NBL
Box 1564
Richardson, TX 75080
(214) 231-2703
W.A. KLUCK

NETRONICS R&D LTD.
333 Litchfield Road
New Milford, CT 06776
(203) 354-9375

NORTH STAR COMPUTERS, INC.
2547 Ninth Street
Berkeley, CA 94710
(415) 549-0858
CA GRANT

NOVAL, INC.
8401 Aero Drive
San Diego, CA 92123
(714) 277-8700
AGO KISS

OAE (Oliver Advanced Engineering)
676 West Wilson Avenue
Glendale, CA 91203
(213) 240-0080
DOUGLAS E. OLIVER

OHIO SCIENTIFIC
Box 36
Hiram, OH 44234
(216) 562-3101
DON MUCHOW

OSBORNE & ASSOC.
P.O. Box 2036
Berkeley, CA 94702
(415) 548-2805

PARASITIC ENGINEERING
P.O. Box 6314
Albany, CA 94706
(415) 547-6612

PCS (Processor Control Systems)
Box 544
Celeron, NY 14720
(716) 664-2871
WALTER E. PELTON, Gen'l Mgr.

PERCOM DATA CO., INC.
318 Barnes
Garland, TX 75042
(214) 276-1968
LUCY MAUCH

PERSONAL COMPUTING CO.
3321 Towerwood Drive
Dallas, TX 75234
(214) 620-2776
STEVIE GENTRY

POWER-ONE, INC.
Power-One Drive
Amarillo, CA 93010
(805) 484-2806
STEVE COLE

QUAY CORP.
P.O. Box 386
Freehold, NJ 07728
(201) 681-8700
Mr. ROESSLER

REALISTIC CONTROLS CORP.
404 West 35th Street
Davinport, IA 52806
(319) 386-4400

RONDURE COMPANY
2522 Butler Street
Dallas, TX 75235
(214) 630-4621

SD COMPUTER PRODUCTS
Div. SD Sales
P.O. Box 28810
Dallas, TX 75228
(214) 271-4667
800 527-3460

SEALS ELECTRONICS, INC.
10728 Dutchtown Rd.
Concord, TN 37922
(615) 966-8771
ROBIN CONTENT, Mktg. Dir

SHUGART ASSOC.
435 Oakmead Pkwy.
Sunnyvale, CA 94086
(408) 733-0100
GARY YOST

SMOKE SIGNAL BROADCASTING
6304 Yucca
Hollywood, CA 90028
(213) 462-5652
RIC HAMMOND

SOLID STATE SALES
P.O. Box 74
Somerville, MA 02143
(617) 547-4005
J. HEFFRON

SOUTHWEST TECHNICAL PRODUCTS CORP.
219 W. Rhapsody
San Antonio, TX 78216
(512) 344-9778
DAN MEYER

SYLVANHILLS LAB INC.
P.O. Box 646
Pittsburg, KS 66762
(316) 231-4440
SHARON BELL

SYSTEX ENTERPRISES INC.
P.O. Box 402
King of Prussia, PA 19406
(215) 482-9481
(215) 631-1318

SZERLIP ENTERPRISES
1414 W. 259th Street
Harbor City, CA 90710

TEI Inc.
c/o CMC MARKETING CORP.
5601 Bintliff #515
Houston, TX 77036
(713) 783-8880

THINKER TOYS
1201 10th Street
Berkeley, CA 94710
(415) 527-7548
JEAN MORROW

VECTOR ELECTRONICS CO., INC.
12460 Gladstone Avenue
Sylmar, CA 91342
(213) 365-9661
FLOYD HILL

VECTOR GRAPHIC INC.
790 Hampshire Road A&B
Westlake Village, CA 91361
(805) 497-6853

WWW ENTERPRISES
P.O. Box 548
Harbor City, CA 90710
(213) 835-9417
WARREN WEIMER

WAVE MATE
1015 W. 190th Street
Gardena, CA 90248
(213) 329-8941
DENNIS BROWN

BUILD DIGI-TOLL

Save On Long Distance Phone Calls

A digital timekeeping accessory that displays the time of day and elapsed-time data in step with the Telco billing timer. Use it wisely and reduce toll charges 15%.

FRED BLECHMAN, K6UGT

UNTIL RECENTLY, ONLY THE LARGEST corporations could afford the expensive computerized systems required to effectively manage long-distance telephone call expenses. Now, for less than $50, the *Digi:Toll* (Cerveo, Inc., 211 Mill Creek Drive, Youngstown, OH 44512) solid-state digital clock/elapsed timer makes it possible to control the cost of long-distance and other toll calls *as they are being made*.

The *Digi:Toll* is a digital timekeeping instrument designed specifically for toll-call management applications. Although it is *not* connected to the telephone line, its special circuits continuously display the same time-of-day and elapsed-time data used by the telephone company to calculate toll charges. With this data and an understanding of phone company timing and discount procedures (covered later on in this article) you can reduce the monthly cost of long-distance and timed local calls by 10% to 20% on each phone equipped with a *Digi:Toll*. Table I shows the projected savings possible if the *Digi:Toll* only reduces your toll charges by 15%.

The standard *Digi:Toll* can be operated from a 117-VAC 60-Hz source and functions as a 12-hour time-of-day clock and a 24-minute call timer. Four versions can be built by cutting foil traces and using wire jumpers. The 24-hour-display "T" version is useful for ham operation or for international calls. The "L" (Legal) version can be used by attorneys, accountants, advertising agencies and others who need a long-duration (24-hour) timer for billing, timing conferences, etc., as well as a 24-minute call timer. The "W" (WATS) version *Digi:Toll* is a *totalizing* timer for WATS-line users. This version *totals* (up to 24 hours) each individual call measured on the 24-minute timer. Also, for use in foreign countries at 50 Hz, modification "P," usable with all other versions, can be constructed with only one foil break and one jumper wire.

All *Digi:Toll* versions are also useful for special applications such as in photo and test labs, where they can even be built into other equipment.

Features of the unit

The use of digital display is a significant improvement over past telephone-timing devices, such as stopwatches and hourglasses, since it combines continuous data presentation with ease of interpretation. The *Digi:Toll*'s unique physical design (Patent No. 242,847) contributes to its overall effectiveness. The anodized aluminum enclosure fits conveniently in front of all commonly used desk phones and is held firmly in place, ready for instant use, by the weight of the telephone itself, as shown in Fig. 1. This arrangement encourages continued use of the *Digi:Toll* for cost-reduction purposes. Since no connection to the phone lines is required, no phone company approval or monthly charges are involved.

The extra-bright ½-inch-high LED display and special glare-reducing filter make for easy readability under a wide range of viewing angles and ambient light conditions. Important timing and discount-data tables are prominently located

TABLE I—TYPICAL SAVINGS USING A DIGI: TOLL

Average Long Distance Cost/Month/Phone ($)	Savings/Month at 15% ($)	1st Year Savings ($)	5-Year Savings ($)
25	3.75	45	225
50	7.50	90	450
75	11.25	135	675
100	15.00	180	900
125	18.75	225	1125
150	22.50	270	1350
175	26.25	315	1575
200	30.00	360	1800

above the LED display for easy reference. The proper use of these tables (described later) is a key to the effective use of the *Digi:Toll*.

Operating power is furnished through a Class II, wall-plug enclosed transformer that eliminates batteries. The line cord is thin and unobtrusive. If a power failure or brownout occurs, a flashing display warns

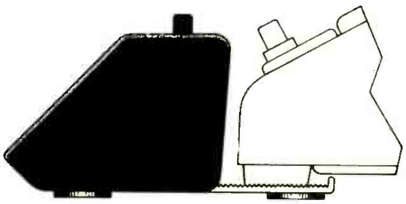


FIG. 1—THE DIGI-TOLL mounts in front of desk telephone and is held in position by its weight.

of possible incorrect time information. Construction is simple and uncrowded, and complete parts kits, with step-by-step instructions, are available, as are preassembled units. See parts list for the various options.

PARTS LIST

All resistors are ¼-watt, 5%, unless noted.
R1–R3—100,000 ohms
R4–22 ohms
R5–47 ohms
R6–33 ohms, 2 watts, wire-wound
C1–1000 µF, 15 volts, electrolytic
C2–0.1 µF, 16 volts, disc
C3–C6—0.01 µF, 16 volts, disc
D1, D2, D6—1N914 signal diode
D3, D4—1N949 germanium diode (no substitutes)
D5—1N4733A 5.1-volt, 1-watt Zener
RECT1—VM08 50 PIV 1-amp bridge rectifier (Varo or equiv.)
IC1—Fairchild 3817 (A or D) digital alarm clock (no substitutes)
T1—11.5-volt, 175-mA Class II wall-plug transformer, 117-VAC, 50- to 60-Hz primary (Dormeyer PS-8514—no substitutes)
DIS1–DIS4—Fairchild FND-500 7-segment LED display, brightness code 08 or 09 or FND-560, any brightness code (no substitutes)
S1—4PDT alternate-action switch (IEE/Schadow F4U-EE)
S2–S4—2PDT momentary-action switch (IEE/Schadow F2U-OA)
Misc.—two 9-pin right-angle header strips (AP Products 929835-01); switch button tops; PC boards; enclosure with end caps and screws; data plate; foam feet; antireflection display filter (Panelgraphic *Chromafilter* Type CF-133 Color: Red 63); hookup wire for jumpers.

The following kits are available from Cervco, Inc., 211 Mill Creek Drive, Youngstown, OH 44512:

KIT DT-1K: Complete kit consisting of all components, PC boards, case, header-pin bending tool, and step-by-step assembly and applications manual, $49.95.

KIT DT-P: Partial kit consisting of all components, including graded displays, switches, transformer and header strips, $29.95.

KIT DT-B: Partial kit consisting of both PC boards; precision-milled, drilled, plated-through (PCB-B), solder-plated and reflowed on black substrate, $14.95.

KIT DT-C: Partial kit consisting of case with hardware, data plate and Panelgraphic display lens, $9.95.

The following assembled and tested units are also available from Cervco, Inc.:

DT-1A: Standard *Digi-Toll*, $79.95.

DT-1A/T, L, W: Modified *Digi-Toll*, $89.95.

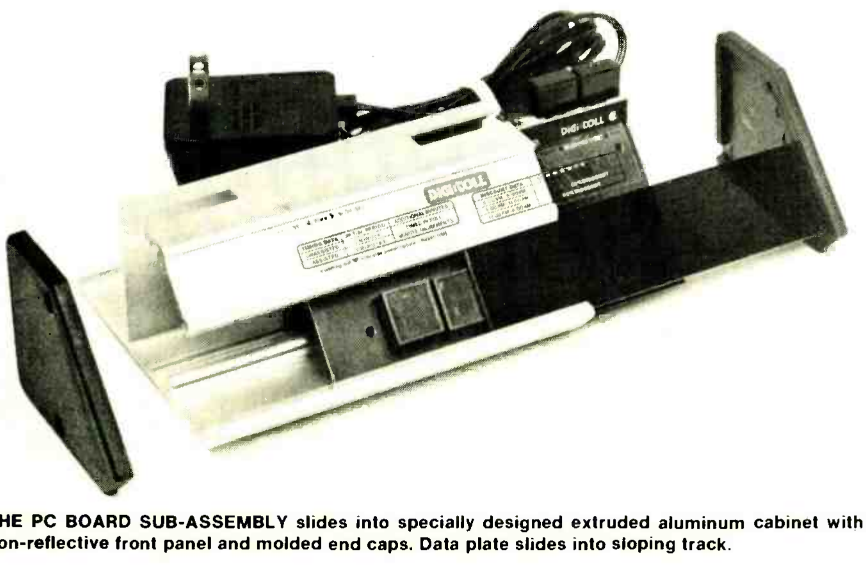
Quantity pricing available on kits and assembled units.

All prices are postpaid in the U.S. Ohio residents add state and local taxes as applicable. For BankAmericard and Master Charge orders, include complete card number and expiration date.

Circuit description

The *Digi:Toll* circuit, shown in Fig. 2, uses only one clock IC to count and display *all* the time-of-day and elapsed-time functions for *all* versions. The IC, a Fairchild 3817 (interchangeable A or D type) is the only IC available that can provide all display-sharing functions without having to provide additional external counter or divider circuits. (Although the 3817 appears identical to the National MM5316 pin-for-pin, some internal functions are not the same.) In addition, several special circuits have been incorporated in the clock/timer's overall design to optimize performance.

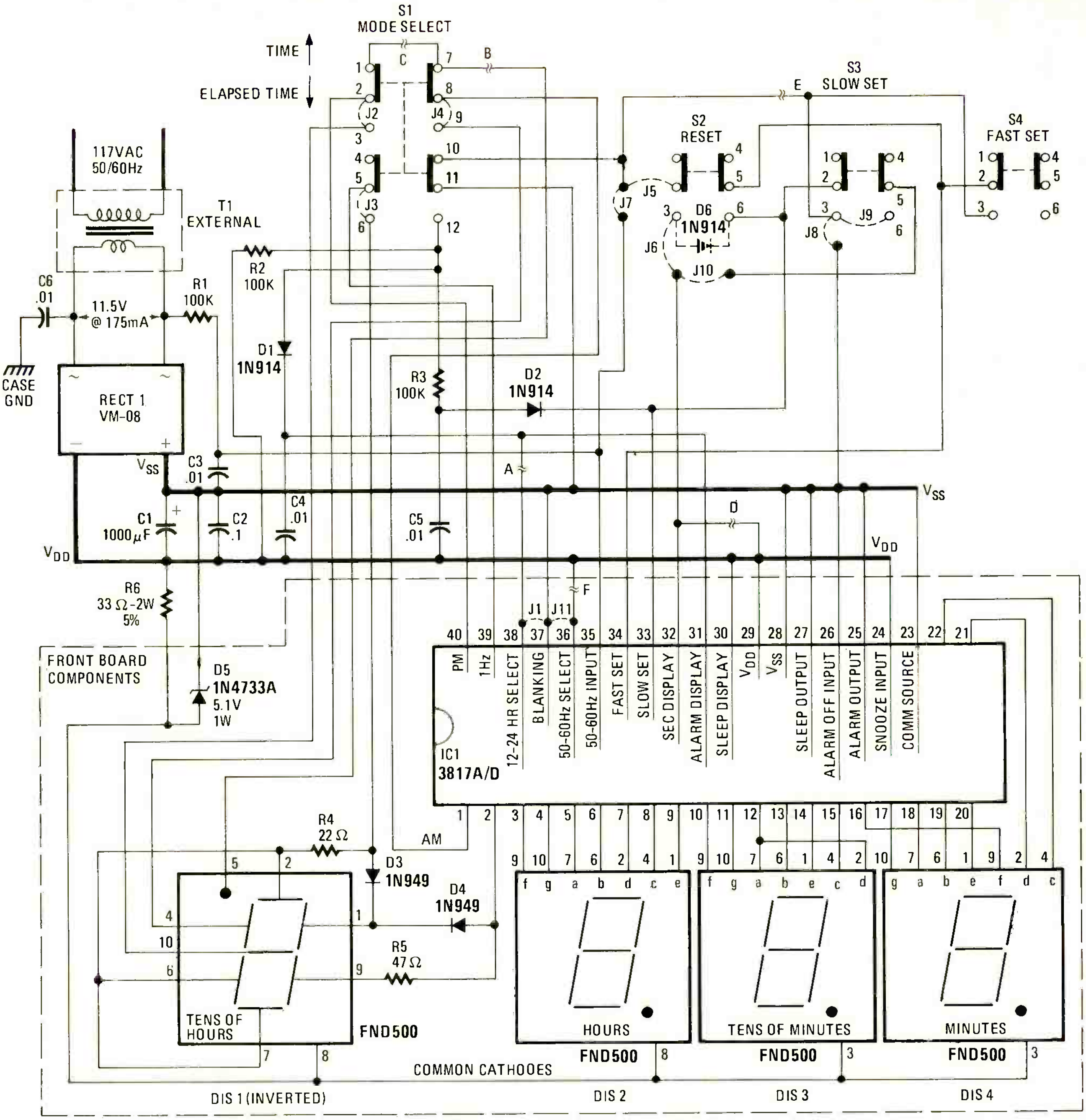
The AC input from wall-plug transformer T1 is converted to DC voltage by bridge rectifier RECT1 and filtered by electrolytic capacitor C1. Extra spurious high-frequency filtering is provided by capacitor C2. Resistor R1 and capacitor C3 shape and feed the AC-input frequency to the clock IC counter circuitry. Capacitor C6, which is connected to the metal case by a PC board trace, helps keep external static discharges (such as that built up from walking on a rug) from affecting the clock IC when you touch the case. Zener diode D5 and a 2-watt resistor, R6, stabilize the variable output from the Class II transformer to keep V_{ss} (positive voltage) at approximately 12 volts. Also, D5 and R6 form a voltage divider that clamps the voltage drop across the IC internal segment drivers and display segments at 5.1 volts. This allows for maximum display-segment drive current without overheating the IC. Without a carefully balanced combination of T1, D5 and R6, the IC could overheat, or the digit displays could flicker with different digit combinations, since a different number of segments would be lighted. Although D5 and IC1 run warm and R6 becomes hot, they all operate within specifications.



THE PC BOARD SUB-ASSEMBLY slides into specially designed extruded aluminum cabinet with non-reflective front panel and molded end caps. Data plate slides into sloping track.

Switches S3 and S4 set the time-of-day display (when switch S1 is in the up position) by connecting V_{ss} to pins 33 and 34 of the clock IC in the conventional manner.

The design lets you use the IC's alarm register as an elapsed timer. This is done by "clocking" the alarm display with the 1-Hz slow time-advance command. Depressing switch S1 locks it down in the ELAPSED TIME position until it is pressed again. When this switch is in the down position, positive voltage V_{ss} at switch terminal 11 flows through terminal 12 and diode D1 to pins 31 and 38 of IC1. This commands the display to show alarm time in the *24-hour* mode. Simultaneously, terminal 12 of S1 (through resistor R3 and diode D2) also provides positive voltage to pin 33 of IC1. This advances the display one count-per-sec-



NOTES

1 - CIRCUIT MODIFICATIONS:

A. BREAKS IN EXISTING PC BOARD TRACES ARE INDICATED BY THE SUMBOL ≈ PLUS A LETTER DESIGNATION.

B. HARDWIRE JUMPERS ARE INDICATED BY A DOTTED LINE PLUS A J DESIGNATION.

C. MODIFICATION DESIGNATIONS:
1. 24 HR CLOCK/24 MIN TIMER - T
2. 24 HR CLOCK-TIMER/24 MIN TIMER - L
3. 24 HR TOTALIZING TIMER/24 MIN TIMER - W
4. 50Hz OPERATION - P

D. ALL FOIL BREAKS EXCEPT D & F ARE ON THE BACK PC BOARD.

E. ALL JUMPERS & D6 ARE ON THE BACK PC BOARD

MODIFICATION TABLE

	FOIL BREAKS						JUMPERS (J)											
MOD	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9	10	11	D6
T	X	X	X				X	X	X	X								
L	X	X	X	X			X	X	X	X	X	X						X
W	X	X	X	X	X		X	X	X	X			X	X	X	X		
P						X											X	

2 - PIN CONNECTIONS FND 500:

PIN	SEG
1	E
2	D
3	COMM CATH
4	C
5	DP
6	B
7	A
8	COMM CATH
9	F
10	G

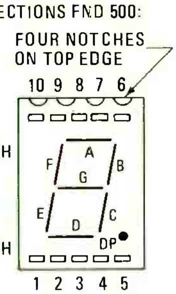


FIG. 2—SCHEMATIC DIAGRAM OF THE DIGI-TOLL. A single clock IC does all the timekeeping and drives the four seven-segment displays. One display is intentionally mounted up-side down. Several versions are made possible by making changes in the circuitry as in the table.

ond. Furthermore, when the last two digits reach "59," the next count advances the *preceding* digit by one.

Although this display is intended to show the alarm-time hours and minutes in a 24-hour format, it is being used here to represent elapsed time in minutes and seconds up to 23 minutes and 59 seconds. On the next count, it goes to 00 00 and continues counting. when switch S1 is pressed again and pops up, this elapsed (alarm) time is held in the clock IC's alarm register. To recall this time, depress S1 to display the last count and the sequence starts advancing again one count-per-second.

To "zero" the elapsed-time display, depress spring-loaded pushbutton RESET switch S2; this feeds a positive voltage to pin 34. Since a positive voltage is already being applied to pin 33, the clock IC is commanded by the internal logic to reset the display to 00 00. Table II shows the operating modes for IC1 in order to clarify the interaction of mode and set functions.

Switch S1 performs another important function. Display DIS1 (the tens-of-hours digit) is normally blank during the time-of-day display (except when it shows a "1" from 10 00 to 12 59) in the 12-hour format. However, for the elapsed-time display, display digit DIS1 must show a "0," "1," or "2" as required. Switch S1's other terminals program this digit with the IC segment-driver outputs. When S1 is in the up (TIME) position, IC1 pins 1 and 40 operate the time-of-day/power-failure indicator dot at the upper left-hand corner of DIS1—a steady "on" display means the clock is showing time in the 12-hour format, while a flashing dot means a power interruption has occurred and the clock may be incorrect. However, when switch S1 is in the down (ELAPSED TIME) position it applies the output voltages of pins 1, 40 and 39 to various *segments* of DIS1. The 3817 clock IC is designed to display the 24-hour format by wiring these pins to the segments shown in Fig. 2.

Two unusual features are worth noting here. First, the dot referred to is simply the decimal point of DIS1, which is mounted in inverted fashion on the PC board for this reason. Second, you may wonder whether pin 39 (the 1-Hz output used as a 24-hour segment driver) would make the segment blink continuously. The answer is (although this information would not be found on the data sheets for the 3817 or MM5316) pin 39 is a 1-Hz output *only* when the clock IC is in the 12-hour mode; in the 24-hour mode, it is a segment driver!

If you've followed the explanation thus far, you may be wondering about some of the extra components in the circuitry. For example, D1, D2, R2, R3, C4 and C5 prevent the time-of-day display from being altered if switches S1 and S2 are operated together to simultaneously start *and* zero the elapsed timer. Circuit-shift time within the IC and contact-bounce of the switches could cause the time-of-day circuitry to "see" a fast-forward command before the display is changed to the elapsed-time mode. Time-delay circuits formed by R3–C5 and D1–C4 prevent this from happening. When switches S1 and S2 are pressed together, diode D1's low forward resistance allows capacitor C4 to charge rapidly, quickly commanding the display to show elapsed time. However, the relatively high resistance of R3 slows the charging of capacitor C5, so the positive voltage at the cathode of D2 is delayed at time-advancing command pins 33 and 34 of IC1. Similarly, if S1 and S2 are pressed simultaneously, going from the elapsed-time mode to the time-of-day mode, capacitor C5 discharges rapidly through resistors R3 and R2, while C4 (blocked by D1) is forced to discharge more slowly through the high internal pulldown resistance of the clock IC at pin 31. This removes V_{ss} from pins 33 and 34, (the time-advancing command pins) before the time-of-day is displayed. Diode D2 blocks positive voltage from reaching this whole network when MODE SELECT switch S1 is up (in the time-of-day mode).

Another circuit trick is accomplished by D3, D4, R4 and R5. Diodes D3 and D4 are *special* low-forward-voltage-drop germanium diodes that balance with 5% resistors R4 and R5 to provide uniform brightness to DIS1. Since either a "0," "1," or "2" may be displayed (two, five or six segments are on simultaneously) and the IC-driver outputs are limited to 8 mA on most outputs (16 mA on pins 2 and 12; 24 mA on pin 39), the resistor value and diodes have been carefully selected to minimize segment brightness differences.

You can make circuit modifications by creating foil breaks on the PC board and adding jumpers, as shown in the Fig. 2 table. For example, for modification "T," the 24-hour version, you make foil breaks A, B and C, and add jumpers J1, J2, J3 and J4. Foil break A isolates IC1 pin 38, the 12- to 24-hour select pin, from the switching circuit, and jumper J1 permanently connects it to V_{ss}. Similarly, foil breaks B and C disconnect the decimal-point indicator, and jumpers J2, J3 and J4 permanently wire switch S1 for a 24-hour display. No other functions are affected. This "T" modification is also required as part of the "L" (legal) or "W" (WATS) modifications of the clock/timer.

The "L" version requires one more foil break and two more jumpers, plus adding another diode, D6. Foil break D disconnects pin 32 (the seconds display) from V_{dd} (ground). Jumpers J5 and J6 allow V_{ss} to be applied to pins 32, 33 and 34 simultaneously by pressing switch S2, with switch S1 in the up (time-of-day) mode. Table II shows this resets the time display to 00 00, allowing the unit to be used as a 24-hour elapsed timer. Diode D6 prevents unwanted hold mode when push-button switch S3 is used to slow-set the time.

The "W" version can be chosen instead of the "L" version, but you cannot have both together. The "W" version allows you to totalize or accumulate separate time periods up to 24 hours. The counting is inhibited while S1 is in the time mode (up position) by adding jumper J7, which connects pin 35, the 50- to 60-Hz counting input of IC1, to V_{ss} through terminal 10 of S1. When S1 is in the 24-minute elapsed-time mode (down position), V_{ss} is removed from pin 35, and counting resumes from where it had been stopped. To insure that resetting the 24-hour accumulators to 00 00 is done intentionally and not accidentally, *both* SLOW SET and FAST SET switches S3 and S4 must be pressed. This is done by foil breaks D and E, and by jumpers J8, J9 and J10. When S3 and S4 are *both* pushed, pins 32, 33 and 34 are all connected to V_{ss} and resetting to 00 00 occurs (see Table II).

The power modification to 50 Hz (P) can be done independently of the other options by foil break F and jumper J11. This disconnects IC1 pin 36 from voltage V_{dd} and connects it to voltage V_{ss}. The specified transformer operates at an input of 117 volts, 50 Hz, although it runs warmer than at a 60-Hz input. If your power input is 220 volts, you will need a converter or a different transformer.

In the next article, we'll show the PC boards and discuss construction, testing and *Digi:Toll* applications. **R-E**

TABLE II—DIGI: TOLL OPERATING MODES

Unit Designation	Display Control Pin Connected To V_{ss}	Display Mode	Set Control Pin Connected To V_{ss}: None	33 (slow)	34 (fast)	Both
Standard, T, L, P	None	Time of day	Time of day	Slow time advance	Fast time advance	Fast time advance
L, W, P	32	24-hour elapsed-time (reset)	N/A[1]	N/A[1]	N/A[1]	24-hour display resets to 00 00
All	31	24-minute elapsed time	N/A[1]	Elapsed time run	N/A[1]	24-minute display resets to 00 00

Note:
1. N/A = Not applicable to *Digi:Toll*.

Cases And Cabinets For Your Projects

ONE OF THE MAJOR CONSIDERATIONS FACING THE amateur electronic experimenter and constructor is the physical layout and appearance of the finished project. In the days of vacuum tube and 12 by 16 in.chassis, most projects could be finished off nicely by adding a front panel and slipping the whole thing into a cabinet that could be handcrafted from wood or readily available sheet metals. Today, most electronic projects are assembled on printed-circuit boards or similar materials and are sometimes only one-tenth the size of its old vacuum-tube equivalent.

To select a case or enclosure that is most suitable for your project, you must have a pretty good idea as to what is available. Too, if your make and model specified in a magazine article is not available through your usual supplier, you should be aware of equivalents and possible substitutes. These charts list off-the-shelf enclosures, cases and chassis boxes in various material combinations, colors and sizes.

To find out more about the products or distributors, a list of addresses of each manufacturer follows.

Apollo – Industrial Park, Hauppauge, NY

Buckeye – 555G Marion Road, Columbus, OH 43207 (614) 445-8433.

Bud Electronics – Dept. G., 4605 East 355 Street, Willoughby, OH 44094. (216) 946-3200.

GC Electronics – Division of Hydrometals, Inc., Rockford, IL 61101.

Lafayette Electronics – 111 Jericho Turnpike, Syosset, NY 11791. (516) 921-7700.

LMB Products – 725 Ceres Avenue, Los Angeles, CA 90021. (213) 627-9310.

Premier Metals – C/O Sunshine Mining Co., 337 Manida St., Bronx, NY 10474. (212) 993-9200.

Radio Shack – 2617 West 7th Street, Ft. Worth, TX 76107. (817) 390-3272.

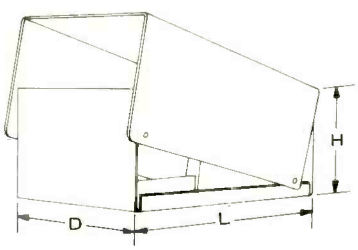
Rose/Stahlin – 500 Maple Street, Belding, MI 48809. (616) 794-0700.

Scientific-Atlanta – Optima Enclosures-2166 Mountain Industrial Road, Tucker, GA 30084. (404) 939-6340.

TenTec, Inc. – Dept. G., Industrial Park, Sevierville, TN 37862. (615) 453-7172.

Vector Electronics Co., – 12460 Gladstone Ave., Sylmar, CA 91342. (213) 365-9661.

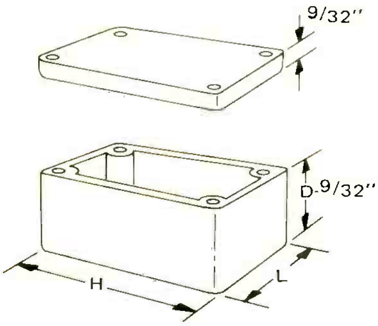
Zero Mfg. – 777 Front Street, Burbank, CA 91503. (213) 846-4191.



INTERLOCKING "U" STYLE

Simple aluminum case available in a wide variety of sizes. Screws that hold the case together are located along the lower edge.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
2-1/4	1-3/8	1-1/2	LMB	C-R-211	Al	–	–	blue
2-1/4	1-3/4	2-1/8	LMB	C-R-221	Al	–	–	blue
2-3/4	2-1/8	2-1/8	LMB	C-R-234	Al	–	–	blue
2-3/4	2-5/8	2-1/8	LMB	C-R-275	Al	–	–	blue
3	5	4	LMB	C-R-345	Al	–	–	blue
3-1/4	1-5/8	2-1/8	LMB	C-R-321	Al	–	–	blue
3-3/4	2-1/8	3	LMB	C-R-332	Al	–	–	blue
4	1-5/8	2-1/8	LMB	C-R-421	Al	–	–	blue
4	2-1/4	2-1/4	LMB	C-R-422	Al	–	–	blue
4	2-3/4	2	LMB	C-R-400	Al	–	–	blue
4	2	4	LMB	C-R-442	Al	–	–	blue
4-1/4	1-1/4	2-1/4	LMB	C-R-425	Al	–	–	blue
5	2-1/4	2-1/4	LMB	C-R-522	Al	–	–	blue
5-1/4	2-1/8	3	LMB	C-R-531	Al	–	–	blue
5-1/2	1-5/8	3	LMB	C-R-532	Al	–	–	blue
6	3	4	LMB	C-R-643	Al	–	–	blue
6	5	4	LMB	C-R-645	Al	–	–	blue
6-1/4	2-1/8	3-1/2	LMB	C-R-632	Al	–	–	blue
7	3	5	LMB	C-R-753	Al	–	–	blue
8	2-3/4	3	LMB	C-R-800	Al	–	–	blue
8	4-1/2	6	LMB	C-R-864	Al	–	–	blue
10	2-1/2	4	LMB	C-R-1042	Al	–	–	blue
12	1-3/4	2	LMB	C-R-1247	Al	–	–	blue

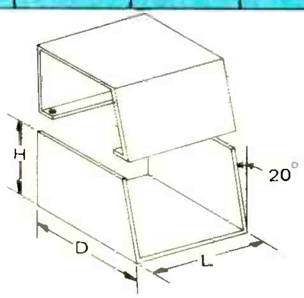


BOX WITH COVER

Rectangular case with front cover available in a variety of materials ranging from plastic, to aluminum to steel. In some units both the front and rear panels can be removed. A few have louvers.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
1-31/32	2-3/64	1-3/8	Rose	90	Lexan	–	90 K for clear cover	grey
2	3-1/8	1	GC	H4-723	Styrene	Al lid; break resistant	–	black
2	3-7/8	1-1/2	GC	H4-724	Styrene	Al lid; break resistant	–	black
2-7/16	4-7/8	1-3/8	GC	H4-722	Styrene	Al lid; break resistant	–	black
2-1/2	2-9/32	1-5/16	Rose	10	Al	die cast body	–	grey
2-1/2	3-55/64	1-5/16	Rose	11	Al	die cast body	–	grey
2-1/2	5-29/32	1-5/16	Rose	12	Al	die cast body	–	grey
2-5/8	3-3/4	1-3/8	GC	H4-725	Phenolic	plastic recessed lid	–	black
2-7/8	5-5/8	2	GC	H4-727	Phenolic	plastic recessed lid	–	black
2-61/64	3-5/32	1-31/32	Rose	305/31	Polyester	impact resistant, flame resistant	–	grey
2-61/64	3-15/16	1-31/32	Rose	305/32	Polyester	impact resistant, flame resistant	–	grey
3-5/32	2-61/64	2-3/64	Rose	25	Al	die cast body	–	grey
3-5/32	3-15/64	2-11/64	Rose	91	Lexan	–	90K for clear cover	grey
3-5/32	4-23/32	2-11/64	Rose	92	Lexan	–	90K for clear cover	grey
3-5/32	4-59/64	2-3/64	Rose	26	Al	die cast body	–	grey
3-5/32	6-19/64	2-11/64	Rose	93	Lexan	–	93K for clear cover	grey
3-5/32	6-57/64	2-3/64	Rose	27	Al	die cast body	–	grey
3-1/8	3-1/4	3-3/8	Rose	911	–	–	–	grey
3-1/8	4-3/4	3-3/8	Rose	M230/921	Lexan	–	–	grey
3-1/8	6-5/16	3-3/8	Rose	M235/931	Lexan	–	–	grey
3-1/4	2-1/8	1-1/8	Lafayette	99-P-80772	Bakelite & Al	recessed inserts	–	black/grey
3-1/2	6	1-7/8	GC	H4-726	Phenolic	plastic recessed lid	–	black
4	2-1/8	1-5/8	Lafayette	99-P-80780	Bakelite & Al	recessed inserts	–	black/grey
4	4	2	Bud	CU-883	Steel	removable front & back panels	–	black/grey
4	4	2	Bud	AU-1083	Al alloy	removable front & back panels	ALL-1083-HG for grey	grey
4-23/32	4-13/16	2-11/64	Rose	82	Lexan	–	82K for clear cover	grey
4-23/32	4-13/16	3-11/64	Rose	821	Lexan	–	821K for clear cover	grey
4-23/32	4-59/64	2-3/64	Rose	26	Al	die cast body	–	grey
4-23/32	6-57/64	2-3/64	Rose	27	Al	die cast body	–	grey
4-23/32	7-7/8	2-61/64	Rose	84	Lexan	–	84K for clear cover	grey
4-23/32	9-29/64	3-15/64	Rose	85	Lexan	–	85K for clear cover	grey

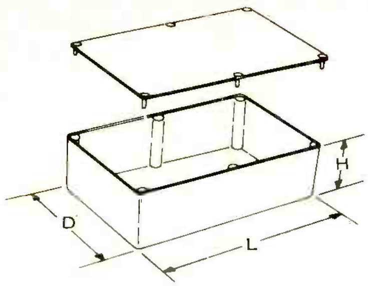
Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
5-1/8	2-1/8	1-5/8	Lafayette	99-P-80758	Bakelite & Al	recessed inserts	–	black/grey
6	6	6	Bud	CU-1098	Steel	removable front & back panels	black	grey
6	6	6	Bud	AU-1039	Al alloy	removable front & back panels	AU-1039-HG for grey	natural
6	–	5	Bud	CU-1099	Steel	removable front & back panels	black	grey
6	9	5	Bud	AU-1040	Al alloy	removable front & back panels	AU-1040-HG for grey	natural
6-1/4	3-3/4	2	Lafayette	19-P-20016	Bakelite	panel sold separately	–	black
6-1/4	3-3/4	4-1/4	Bud	CU-463	Steel	contoured, louvered rear panel	–	grey
6-1/4	5-3/4	4-1/4	Bud	CU-465	Steel	contoured, louvered rear panel	–	grey
6-3/8	3-3/4	1-7/8	Lafayette	99-P-62721	Bakelite/Al	recessed end panel inserts	–	black/grey
6-19/64	6-19/64	3-35/64	Rose	46	Polyester	flame & impact resistant	–	grey
6-19/64	6-19/64	3-35/64	Rose	56	Al	die cast body	–	–
6-19/64	9-29/64	3-35/64	Rose	87	Lexan	–	87K for clear cover	grey
6-19/64	10-1/32	3-35/64	Rose	47	Polyester	flame & impact resistant	–	grey
6-19/64	10-15/64	3-35/64	Rose	57	Al	die cast body	–	grey
6-19/64	14-11/64	3-35/64	Rose	58	Al	die cast body	–	grey
6-3/4	5-1/4	2-1/4	Lafayette	19-P-20024	Bakelite	panel sold separately	–	black
7-3/4	4-7/16	2-3/8	Lafayette	99-P-80764	Bakelite/Al	recessed inserts	–	black/grey
8-1/4	5-3/4	5-1/4	Bud	CU-585	Steel	louvered rear panel, contoured	black	grey
8-1/4	7-3/4	5-1/4	Bud	CU-587	Steel	louvered rear panel, contoured	black	grey
8-3/8	7-3/8	3	Lafayette	19-20032	Bakelite	panel sold separately	–	black
9-1/16	7-7/8	4-11/32	Rose	60	Al	die cast body	–	grey
9-1/16	13	4-11/32	Rose	62	Al	die cast body	–	grey
9-1/16	13-1/16	7-1/8	Rose	621	Al	die cast body	–	grey
9-27/32	10-1/32	4-23/32	Rose	141	Polyester	impact & flame resistant	–	grey
9-27/32	15-3/4	4-23/32	Rose	143	Polyester	impact & flame resistant	–	grey
10	10	8	Bud	CU-880	Steel	removable front & rear panels	black	grey
11	12	8	Bud	CU-881	Steel	removable front & rear panels	–	grey
12-1/4	5-3/4	7-1/4	Bud	CU-7125	Steel	louvered rear panel, contoured	black	grey
12-1/4	7-3/4	7-1/4	Bud	CU-7127	Steel	louvered rear panel, contoured	–	grey
15	9	7	Bud	CU-882	Steel	removable front & rear panels	–	grey



INTERLOCKING "U" WITH SLOPING FRONT

An interesting case where a sloping panel is desired. Aluminum is the material.

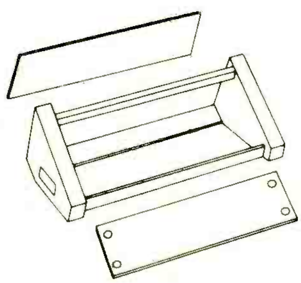
Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
5	4-1/4	5	Bud	SC-12100	Al	single knock-out, 20° slope; 1 piece cover, feet	–	black/white
12	3-1/4	10	Bud	SC-12101	Al	1 piece cover, 20° slope, footed	–	black/white



BOX WITH COVER

These cases are all cast aluminum for applications where durability is important.

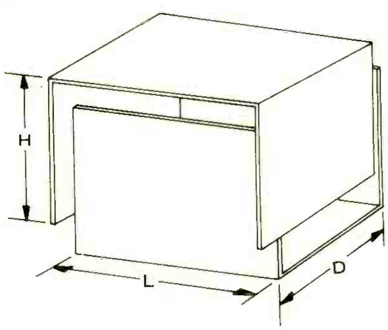
Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
3-5/8	1-1/16	1-1/2	Bud	CU-123	Cast al alloy	1/2 lb.		grey
4-3/8	1-1/16	2-3/8	Bud	CU-124	Cast al alloy	1/2 lb.		grey
4-11/16	2-1/16	3-11/16	Bud	CU-234	Cast al alloy	3/4 lb.		grey
7-3/8	2-1/16	4-11/16	Bud	CU-247	Cast al alloy	1-1/4 lb.		grey
7-3/8	3-1/16	4-11/16	Bud	CU-347	Cast of alloy	1-1/2 lb.		grey



TRIANGULAR SHAPE

An unusual shape for a case but ideal when an unusual appearance for a project is desired. Very pretty when multiple digit readouts are used.

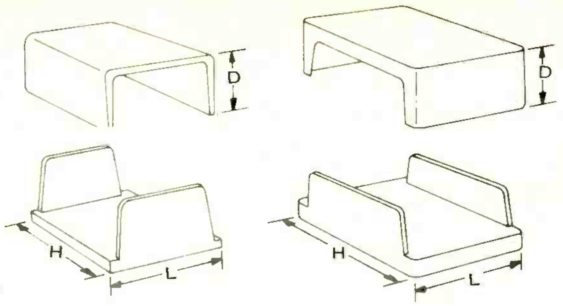
Length	Panel or rear door area		Mfr.	Model No.	Case Material	Comments	Options	Color
16	5-3/4	13-15/16	Bud	MT-214	Steel	9-3/4 lbs; spring latch; handles	Extra door or panel	1–grey
21	5-3/4	18-15/16	Bud	MT-219	Steel	12-1/4 lbs; spring latch; handles	Extra door or panel	1–grey
26	5-3/4	23-15/16	Bud	MT-224	Steel	14-1/4 lbs; spring latch; handles	Extra door or panal	1–grey



ANOTHER INTERLOCKING "U"

One of the most popular types of experimentor cases, overlapping lips on the ends secure the lid.

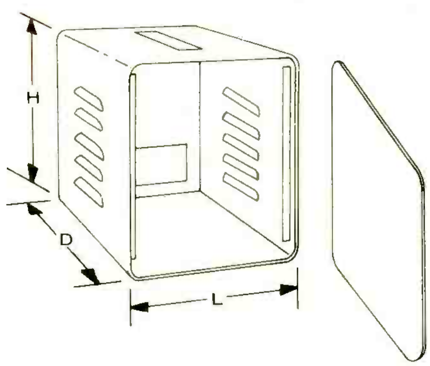
Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
4-1/4	1-7/8	4-1/8	Ten-Tec	TG-24	Al	–	–	grey/black
4-1/4	1-7/8	4-1/8	Ten-Tec	TW-24	Al	–	–	walnut/white
4-1/4	3	4-1/8	Ten-Tec	TG-34	Al	–	–	grey/black
4-1/4	3	4-1/8	Ten-Tec	TW-34	Al	–	–	walnut/white
6	2-3/4	4	Radio Shack	270-260	Al	Rubber feet	–	walnut grain
6-1/4	1-7/8	4-1/8	Ten-Tec	TG-26	Al	–	–	grey/black
6-1/4	1-7/8	4-1/8	Ten-Tec	TW-26	Al	–	–	walnut/white
6-1/4	3	4-1/8	Ten-Tec	TG-36	Al	–	–	grey/black
6-1/4	3	4-1/8	Ten-Tec	TW-36	Al	–	–	walnut/white
9	3-1/2	6	Radio Shack	270-261	Al	Rubber feet	–	walnut grain
11	4	8	Vector	WA1-4V	Al body/plastic	10° slope panel	–	dk. blue/grey
11	4	8	Vector	WA1-12V	Al body/plastic	10° slope panel	–	white/walnut
11	4	8	Vector	WA1-1A	Al body/plastic	10° slope panel	–	clear anodized color
14	4	11	Vector	WA2-4V	Al body/plastic	10° slope panel	–	white/dk blue
14	4	11	Vector	WA2-12V	Al body/plastic	10° slope panel	–	walnut/white
14	4	11	Vector	WA2-1A	Al body/plastic	10° slope panel	–	clear/anodize



INTERLOCKING "U"

Another variation, but one that produces a good looking smooth-seamed case, no case parts overlap.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
1-31/32	3-15/16	63/64	Rose	410	polystyol	impact resistant dust proof	410-K for clear cover	grey
1-31/32	3-15/16	1-37/64	Rose	420	polystyol	impact resistant dust proof	420-K for clear cover	grey
2-9/16	4-23/32	1-37/64	Rose	430	polystyol	impact resistant dust proof	430-K for clear cover	grey
3-5/32	4-23/32	2-23/64	Rose	512	Al	insensitive to heat & cold	512-D0 for front screw mounting	grey & blue
3-5/32	5-29/32	2-11/64	Rose	440	polystyrol	impact resistant dust proof	440-K for clear cover; 440-H for handle	grey
3-5/32	5-29/32	3-5/32	Rose	445	polystyrol	impact resistant dust proof	445-H for handle	grey
4-23/32	7-7/8	2-61/64	Rose	520	Al	insensitive to heat & cold	520-D0 for front screw mount	grey & blue
4-21/64	7-13/32	2-3/4	Rose	450	polystyrol	impact resistant dust proof	450-K for clear cover; 450-H handle	grey
4-21/64	7-13/32	3-15/16	Rose	460	polystyrol	impact resistant dust proof	460-H-handle	grey
6-19/64	9-29/64	3-35/64	Rose	524	Al	dust proof	524-D0 for front screw mount	grey & blue



INSTRUMENT CASE WITH REMOVABLE FRONT PANEL

The kind of case that has been commonly used for all kinds of test instruments. Available in aluminum with louvers.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
6-1/8	8	8	Bud	WA-1540	Al	1/2" recessed ft. panel rubber feet, louvered	–	grey
7	4	5	Zero	ZIC-407	Al	rubber feet	unfinished & unassembled	blue
7-3/4	4-1/2	7	Zero	ZTC-408	Al	rubber feet	unfinished & unassembled	blue
8-1/8	9	12	Bud	WA-1541	Al	1/2" recessed ft. panel rubber feet, louvered	–	grey
9	6	5	Zero	ZIC-409	Al	rubber feet	unfinished & unassembled	blue
11	7	7	Zero	ZIC-411	Al	rubber feet	unfinished & unassembled	blue
11-1/8	11	18	Bud	WA-1543	Al	1/2" recessed ft. panel rubber feet, louvered	–	grey
14-1/8	12	18	Bud	WA-1544	Al	1/2" recessed ft. panel rubber feet, louvered	–	grey

LED Bar Graph Universal Indicator

Bar graphs are replacing analog meters as voltage-level indicators in many instances. Here's how the basic LED bar graph works.

MARTIN BRADLEY WEINSTEIN
WB8LBV, KDT5787*

THE FIRST APPLICATION YOU MIGHT THINK of for the new SN75489 IC (renamed TL489) from Texas Instruments would be as a 0–1-volt LED bar graph. This is because when the IC's five internally biased comparators are fed a 0–1-volt input signal, they will turn on a string of 5 LED's at 200-mV intervals.

Figure 1 shows what's inside of the SN75489. A series of five voltage comparators compare the analog input signal (the input of pin 8, buffered by an internal amplifier with a typical 100K input impedance) with a string of resistors between V_{cc} (pin 7) and ground (pin 1). The resistive ladder turns on comparators 01–05 at 200 mV, 400 mV, 600 mV, 800 mV and 1000 mV, respectively. The comparators turn on open collector transistors at each output (pins 2–6), each capable of sinking up to 80 mA and of handling up to 18 volts. The circuit is intended for use on 10–18-volt supplies, although 9-volt batteries work well.

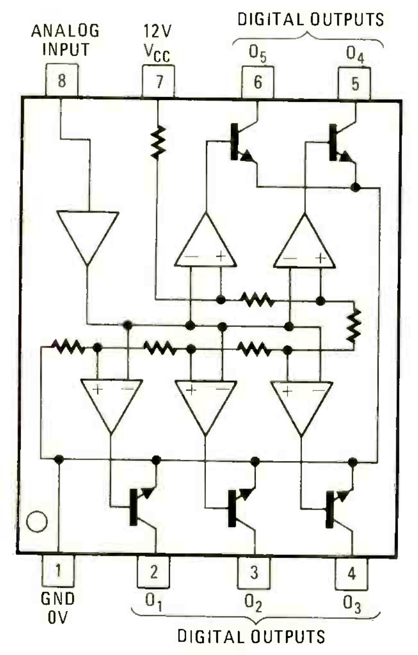
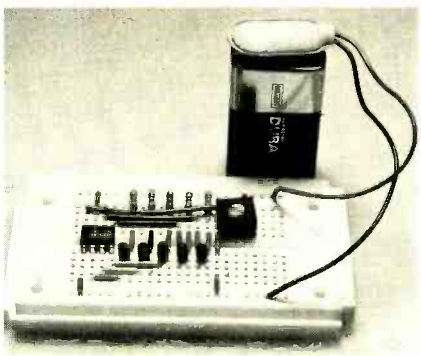


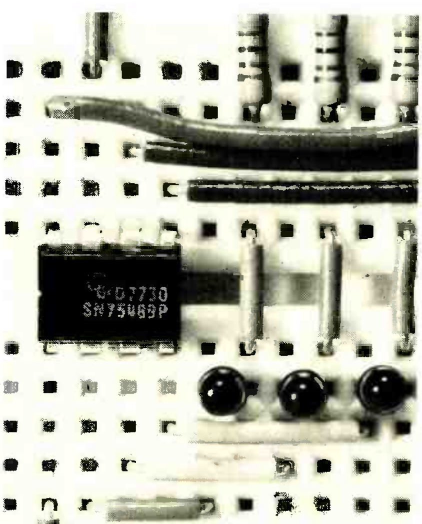
FIG. 1—INSIDE THE SN75489—just renamed the TL489 by the manufacturer.

The comparators feature a built-in hysteresis of about 10 mV to prevent oscillations at the outputs, even with slowly varying inputs. When the input is driven from a high-impedance source, a capacitor should be connected between the high-impedance analog input (pin 8) and ground to prevent undue noise interference.

Figure 2 is the schematic of the simple demonstrator shown in the photo. Resistor R1 varies the voltage at pin 8 and causes the string of LED's, which are arranged as a bar graph, to light up in lines that are successively longer and shorter.



THE DEMONSTRATOR uses Continental Specialties Experimentor 350 breadboarding socket.



CLOSEUP shows board construction and how IC's, LED's and other parts plug right in.

The demonstrator is built on a solderless breadboard (the *model EXP350*

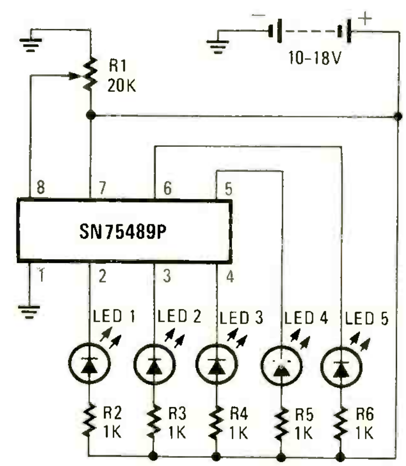


FIG. 2—SCHEMATIC OF DEMONSTRATOR in photo. Number of lit LED's depends on R1.

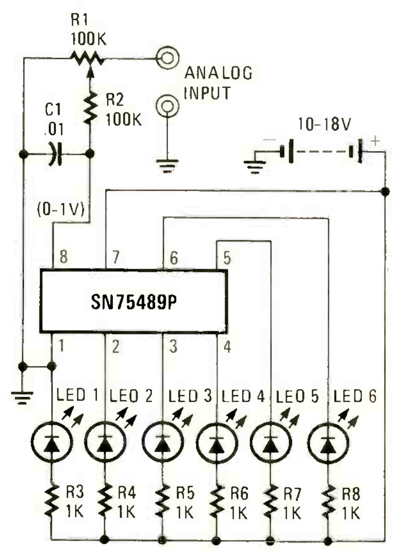


FIG. 3—THE LED ADDED ON LEFT acts as pilot light and lengthens light bar.

Experimentor Socket, Continental Specialties Corp., 44 Kendall St., New Haven, CT 06509; the breadboard is available for about $5.50). It took about the same amount of time to build the demonstrator as to draw the schematic, about a month later.

Figure 3 shows a circuit modification: The first LED in the string of six LED's

* Public Relations Supervisor, Continental Specialties Corp.

TABLE 1. SPECIFICATIONS FOR TEXAS INSTRUMENTS TL489-CP
Five-Step Analog Level Detector/Indicator

TL489-CP
ABSOLUTE MAXIMUM RATINGS

Supply voltage	18 volts (max)
Positive voltage at analog Input	8 volts (max)
Negative current at analog input	10 mA (max)
Current into each output, high level	1 mA (max)
Current into each output, low level	80 mA (max)

RECOMMENDED OPERATING CONDITIONS	MIN	TYP	MAX
Supply voltage V_{cc}	10	12	16.5 V
Voltage on any output, O_{1-5}			18 V

ELECTRICAL CHARACTERISTICS TA = 25°C, V_{cc} = 12 V

PARAMETER	MIN	TYP	MAX	UNIT
(positive-going threshold voltage at input for switching outputs:)				
O_1	160	200	240	mV
O_1, O_2	350	400	450	mV
O_1, O_2, O_3	540	600	660	mV
O_1, O_2, O_3, O_4	730	800	870	mV
O_1, O_2, O_3, O_4, O_5	920	1000	1080	mV
Hysteresis for switching any output		10		mV
Low-level output voltage:				
I_{sink} = 16 mA		0.1	0.4	V
= 40 mA		0.2	0.7	V
High-level output current, V_{OH} = 18 V		5	20	μA
Supply current:				
all outputs high		8	12	mA
all outputs low		15	25	mA
Positive input current (V_{in} = 1 V)		0.5		μA

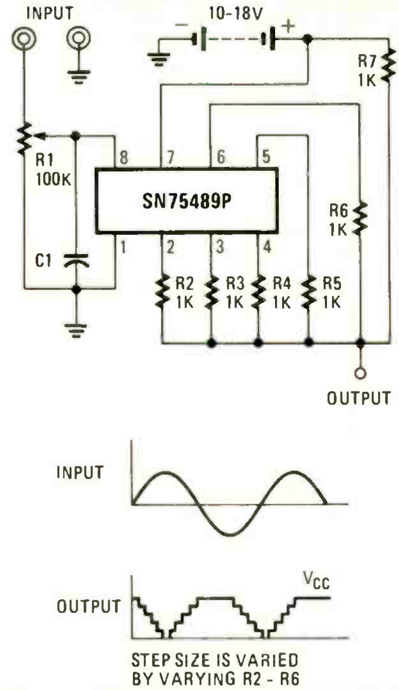


FIG. 6—A STEPPED OUTPUT waveform is developed from a sinewave input signal.

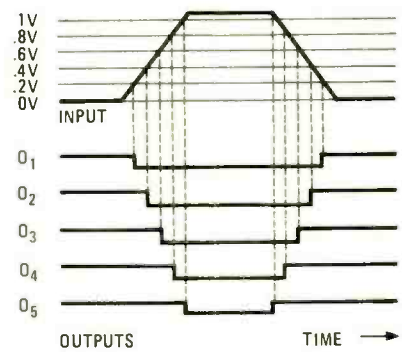


FIG. 7—THE DELAYS between the five outputs depends on the rise and fall times of input

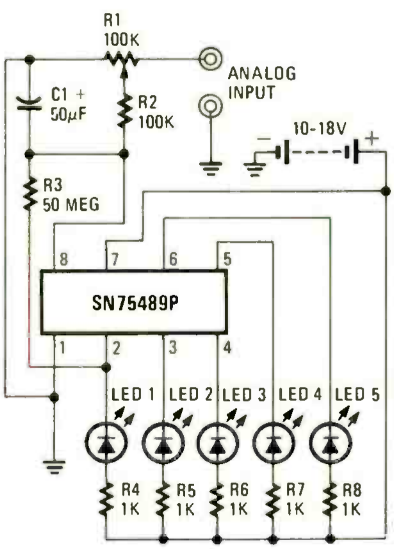


FIG. 4—THE TIME CONSTANT of R3 and C1 cause LED1 to flash with inputs below 200 mV.

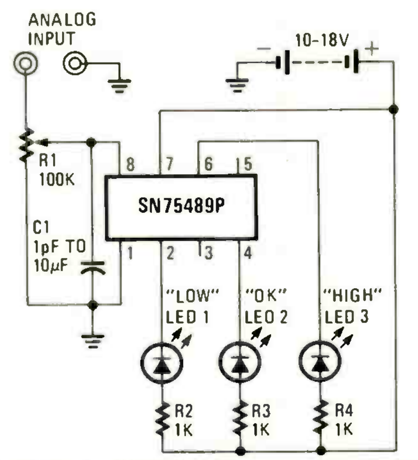


FIG. 5—A THREE-STAGE LEVEL INDICATOR useful in alarm and monitoring systems.

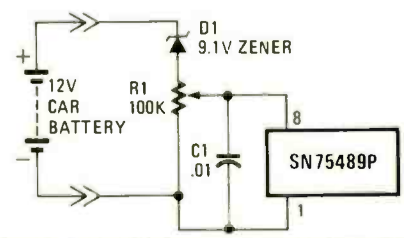


FIG. 8—AUTOMOBILE BATTERY MONITOR. Diode and R1 match voltage to IC's input level.

can double as a bar-graph-lengthener and a pilot light. This scheme is similar to that seen in the solid-state S-meters on some newer CB transceivers. Resistors R1 and R2 scale the input signal to the SN75489's 0–1-volt input range while maintaining high impedance, and capacitor C1 acts as a noise-preventing bypass.

Figure 4 shows the R–C timing action of R3 and C1. With an input signal at pin 8 of less than 200 mV, R3 and C1 cause LED1 to flash.

In Fig. 5 only three outputs are used, but this scheme is very useful for many monitoring and alarm applications. Input voltages greater than 200 mV (representing a low alarm state or alarm release) cause LED1 to turn on; LED2 turns on at input voltages greater than 600 mV (representing correct operation); and LED3 turns on at 1 volt or more (representing a high alarm state or alarm release).

The circuit shown in Fig. 6 can change a sinewave input signal to a stepped triangular output signal through using appropriate values in the pulse-shape resistor network, R2–R6.

Figure 7 shows how the risetime and falltime of an input signal can be used to determine sequential delays at the outputs. This also helps explain the operation of the circuit in Fig. 6.

Some suggested SN75489P applications might include low-resolution metering (in a car, for example, with red, amber and green LED's indicating low, normal and high pressure or temperature); or expanded monitoring a car's battery voltage, as shown in Fig. 8. Instead of LED readouts, LED's contained in opto-isolators could be used to switch on various loads to respond to temperature changes.

Although the SN75489P is relatively new, many TI semiconductor distributors and dealers should have it in stock soon. You should expect the price to be between 60¢ and $1.00 per unit. **R-E**

All About Audio Oscillators

Part 2—The audio oscillator most-often-used today is a sophisticated instrument that is a far cry from the simple AF signal source. This is a continuation of the story on the latest types.

CHARLES M. GILMORE*

THIS STORY OPENED IN THE APRIL ISSUE. We began with a discussion of the basic oscillator and basic circuits and followed through into accessories, such as attenuators, into this continuing discussion of pertinent specifications and features.

Frequency stability

The frequency stability specification indicates the ability to maintain an original frequency under various electrical and environmental conditions. Frequency stability and frequency accuracy should not be confused. To measure frequency stability, setting accuracy is ignored, and the actual operating frequency is measured directly with an external frequency meter. Variations from this measured frequency caused by environmental or electrical variations are measurements of the frequency stability.

On extremely low-cost units, frequency stability may not be specified. On the more expensive audio oscillators, this specification is divided among a number of environmental and electrical variations.

The most common variation is that of time, and two time intervals are used: The first is short-term stability, which is the drift expected (after warmup) over a ten-minute period or other short time span. The second is long-term stability, which is the stability expected over a 12- to 24-hour period. An alternate method is for an intermediate period, such as an hour.

In addition to time, the expected variations for line-voltage changes, variations at the oscillator output (usually no load to full load) and temperature can be given. All specifications are given as a percent change for the indicated environmental or electrical variation, nominally a few tenths of a percent or less for any variation. Frequency stability, like frequency accuracy, is a major consideration only when the measurement depends upon the generated frequency remaining a constant. All stability specifications are usually given after a warmup period of an least one hour.

* Manager, Design Engineering, Heath Co., Benton Harbor, MI.

Output voltage

The output voltage specification indicates the maximum voltage available from the audio oscillator. This voltage is generally indicated for two situations: One indicates the oscillator output voltage with no load (open circuit). The other indicates maximum output voltage when the output load is equal to the source impedance of the generator. This voltage is one-half the open circuit voltage. Maximum outputs of 5 to 10 volts RMS are usual.

Amplitude flatness

The consistency of the audio oscillator output amplitude with frequency changes is called amplitude flatness. This specification may be given either as a percentage or as a variation in decibels. There may be a division in amplitude flatness specifications with frequency, with the better flatness specification confined to the center frequencies. Considerable degeneration of the specification can be expected at the frequency extremes. Amplitude flatness is also termed the frequency response, and can be given graphically. Low-cost audio oscillators typically specify ±1-dB flatness, which is equivalent to a ±10% variation. The better audio oscillators specify ±0.05 dB or ±0.5%. Audio oscillators with metered outputs sometimes delete this specification because it is assumed the user can readjust the output level for any frequency change.

Amplitude stability

Amplitude stability is much like frequency stability. It indicates the oscillator's ability to maintain a constant output amplitude under varying environmental and electrical conditions. Amplitude stability specifications, like those for frequency stability, are frequently given for variations in time, line voltage and temperature. Changes of a few tenths of a percent or less can be expected for any particular effect.

Output impedance

Output impedance indicates the value of resistance that appears to be in series with the audio oscillator if the oscillator is presumed to be of zero impedance. The most common output impedance specification is 600 ohms; however, 50 ohms is used on some oscillators.

Output balance

Output balance is the impedance ratio to earth ground between the output terminals. There are three variations available with audio oscillators. The first is the full-floating or ungrounded oscillator. The impedance from either output terminal to earth ground is high and relatively equal. On these oscillators there is a specification indicating the maximum DC potential that can be applied between either terminal and earth ground. Common ranges for this voltage are ±300 to ±500. Note that impedance balance between output terminals may degenerate for higher oscillator frequencies as the capacitive effect of wiring within the oscillator becomes appreciable.

A second variation on output balance also yields a floating output that can be raised to a high DC voltage level with respect to earth. This indicates a high and equal value of resistance from either terminal to earth ground. However, one of the terminals, normally called the low or common side, has a large capacitor (between 0.04 and 0.1 μF) connected to earth ground. For all but the lowest of audio frequencies and direct current, this terminal is effectively connected to earth ground. It cannot be connected into a circuit where the floating voltage has an AC component.

The third variation connects one side of the output directly to earth ground at all times. No floating is possible. In either of the first two configurations, a strap or a switch can be provided to connect the common terminal to earth ground, if desired.

Distortion

One of the more important and expensive specifications on the high-quality audio oscillator is the percentage of THD in the sinewave output. The theoretical definition of THD is the ratio—expressed as a percentage—of the square root of the square of the amplitudes of all harmonics to the amplitude of the fundamental signal. It is not practical to measure this, and usually is measured with an instrument that determines the ratio of the harmonics to the sum of the harmonics plus the fundamental. The error between this measurement and the theoretical THD specification is less than one-half of one percent. Total harmonic distortion values in the area of 0.2% to 0.1% are common for low- and medium-cost generators. On the extremely good generators, THD specifications can be in the area of 0.05% to 0.005%.

Usually, the THD specification is supplied with frequency-limiting data, often in the form of a graph. The curve of Fig. 9 is typical. Some oscillators offer a special low-distortion mode. In such cases, the graphs of THD-versus-frequency may have two response curves, according to the mode of use.

Depending on the measurement meth-

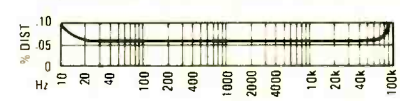


FIG. 9—HARMONIC DISTORTION CURVE for Heathkit IG-18 indicates little distortion in the audible range, with sharp upcurves at the high- and low-frequency extremes.

od used when the manufacturer defines the audio oscillator THD, other signals can be included within that specification. Hum and noise both can contribute to the amplitude of all signals not at the fundamental frequency. Hum and noise can also be specified separately, and are indicated as a percentage of the maximum output, most typically in the area of 0.01%. No attempt is made to separate line-frequency hum from broadband noise.

Output attenuator

An output attenuator can come in three forms: a small variable control, a stepped attenuator, or a combination of the two. Specifications include the step amplitude, expressed as a ratio or a change in decibels, as well as the accuracy of each step. In a similar form, range is given for the variable control. The most common attenuator has 10-dB steps, which give a 1–3–10 voltage sequence. The associated variable control commonly has a 10-dB range to provide continuous settings. Simple vernier controls have 20-dB to 40-dB (10:1 to 100:1 voltage) ranges.

Squarewave output

Many audio oscillators include—in addition to the sinewave output—a squarewave output. This output usually is somewhat less unusual in attenuation and impedance.

Squarewave-output specifications are very similar to those of the sinewave output. The output voltage indicates the maximum voltage obtainable; the output impedance indicates the source resistance in series with the generator; and the output balance indicates the type of output connection.

Attenuator specifications are the same as those for the sinewave output; however, with a more limited range and accuracy. The output amplitude symmetry specification indicates the relationship between the positive and negative portions of the squarewave. Symmetry is usually within a few millivolts. An output time-symmetry specification indicates the relative widths of the positive and negative squarewave pulses. Theoretically, these widths should be equal but shaping circuits often limit the time symmetry to the $\pm 5\%$ area. Risetime indicates the time required for the output squarewave to rise from 10% to 90% of the desired amplitude. The risetime on squarewaves supplied by audio oscillators is generally in the range of 50 to 100 nanoseconds.

Output connectors

The generally accepted output connector is a pair of ¾-inch 5-way binding posts. An alternate to the dual 5-way binding post is a triple 5-way binding post configuration to permit strapping either of the two binding posts to the third one (connected to earth). Binding posts are usually confined to 600-ohm generators.

Fifty-ohm generators tend to use the BNC connector because it offers certain advantages. First, it is fully shielded and, when ultra-low-distortion sinewaves are desired, it is mandatory to have shielded connections between the audio oscillator and the input to the equipment under test to avoid an increase in the hum and noise level. Second, when a generator is used in the squarewave mode, the 50-ohm BNC connector limits the number of reflections on the transmission line caused by impedance mismatches.

Frequency adjustment

The method of frequency adjustment varies considerably from generator to generator. As noted, there are two major types: First, switch-selected decades that are continuously tunable throughout the decade; second, switched incremental tuning that may or may not have a variable control to permit frequency selections between the incremental frequency positions. Each system, of course, has its advantages.

The continuously variable control within one decade is probably used most to manually sweep through the decade to observe the response of a particular device under test. It is the oldest and most common frequency control method. To some extent, the need for the continuously tuned dial is now rendered unnecessary by sweep generators, such as the swept-function variety, which are designed to perform this service.

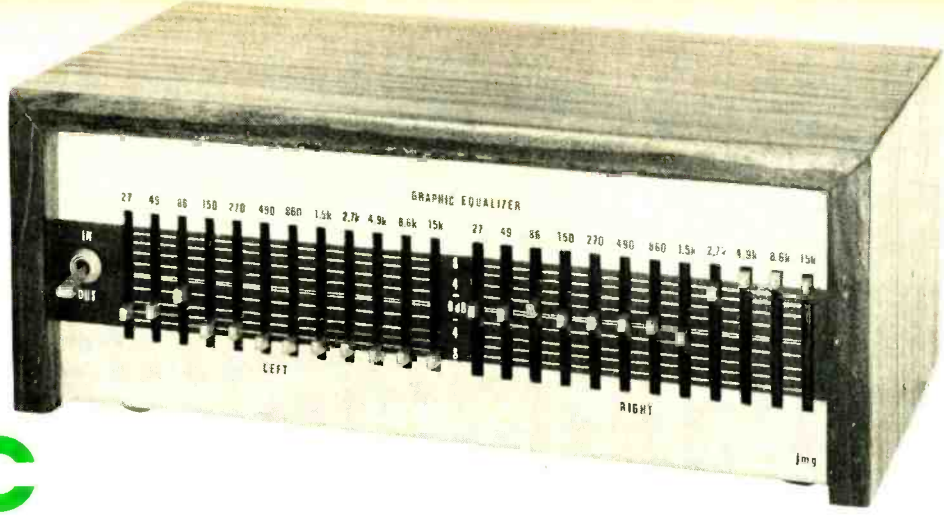
Switched-frequency selection permits rapid changes and eliminates any required dial interpolation. Such a system is excellent for production-line or service situations in which the only requirement is to test at specific frequencies as rapidly as possible. As it is occasionally necessary to set an audio oscillator to an exact frequency, instruments with incremental frequency selection often have a continuously adjustable vernier control. This method permits the frequency to be set between any two switch-selected steps. Exact frequency calibration is given with this control in a calibrated position.

The other frequency control feature that should be analyzed is that of extended frequency range. Although the human ear ceases to perform in the 20-kHz area, virtually all audio oscillators extend at least to 100 kHz. With today's solid-state technology, many audio amplifiers have some response to nearly 1 MHz. If design work on audio amplifiers is contemplated, it is often necessary to observe the frequency response characteristics of the amplifier to 1 MHz. In such a case, a generator with extended frequency response is desirable.

Most audio amplifiers today are specified with a low-frequency cutoff in the 5-Hz to 10-Hz range. But if design work is contemplated, the audio oscillator should probably extend to at least 1 Hz and lower. Other applications, such as general laboratory work, usually dictate the widest frequency range possible, since other instruments and electronic systems may not have the limited frequency response of audio components.

In a future continuation of this series, we will go immediately into frequency synchronization and what is required when the audio oscillator is to be locked to an external frequency source. We think that you'll find it interesting. Watch for it. **R-E**

BUILD



Graphic Equalizer For Your Stereo System

Part 2—A versatile and useful addition to your hi-fi system. This concludes theoretical and construction details begun last month.

JOE GORIN

LAST MONTH WE INTRODUCED THE GRAPHic equalizer, both as a handy tool for the audio expert and discriminating high-fidelity buff. Now we are going to complete the technical discussion and get into construction and installation.

The strength of this design lies in the fact that the components that determine the filter response are independent of the control potentiometers. Thus, the twelve bandpass filters can all be built with only three different capacitor values and eight different resistor values, while using only one potentiometer value. Other designs use from twelve to twenty-four different capacitor values, making parts hard to find.

The signal fed into the equalizer is attenuated by voltage divider R1 and R2 (Fig.1) and then AC-coupled into IC1-c. The attenuation keeps the unit's dynamic range very large so that it can be used in a tape-monitor circuit. Amplifiers IC1-a and IC1-b bring the average gain up to 0 dB. The output of IC1-b is AC-coupled; R33 keeps the op-amp from having to drive a capacitive cable and provides the 600-ohm output impedance. Resistor R34 absorbs any leakage through C27 so that the DC output is zero and switching the unit in and out for comparison will not cause any clicks.

Resistors R71, R72 and R73 and capacitors C28 and C29 filter the bias voltage, V_B, for the op-amps. (In a normal dual supply circuit, V_B would be called ground.) The two-section filter removes almost all the noise on the bias. Op-amp IC2-c reduces the ripple in positive supply to IC1. Since IC1 is a low-noise amplifier with low-noise power and bias supplies, the unit has an excellent S/N ratio despite the attenuation of the signal at the front end.

Rectifier diodes D201-D204 and capacitor C201 are a standard fullwave bridge circuit. The transformer is a wall-plug type. Since the unit draws less than 2 watts, it can be left on all the time or plugged into the switched outlet of a receiver or preamp.

Switch S1 can be wired as shown in the schematic or as shown in the inset in Fig. 1. In the tape-monitor application, the switch replaces the TAPE-MONITOR switch on the amplifier, which can be used to switch the equalizer in and out. In the inset drawing where the equalizer is connected between a preamp and power amplifier, S1 is wired to switch the unit in and out for comparison purposes—a tape-monitor function is unnecessary. In this application, R1 can be shorted, R2 can be removed, and R32 can be changed to 16K. This reduces the maximum input signal but increases the S/N ratio to 100 dB below 2V, so that it will be inaudible with even high-gain amplifiers and very efficient speakers.

The equalizer can also be used as the tone controls in a high-quality preamp. In this case, leave R32 at 39K, and eliminate R1 and R2. Wire the output of the volume control directly to C1, add a phono preamp (the supply voltage is perfect for this application), a selector switch and anything else you want, and you have the equivalent of a very expensive preamp. To provide an equalizer in/out switch for this application, wire a 4PST switch in series with the leads connecting pins 13 and 14 on the two boards.

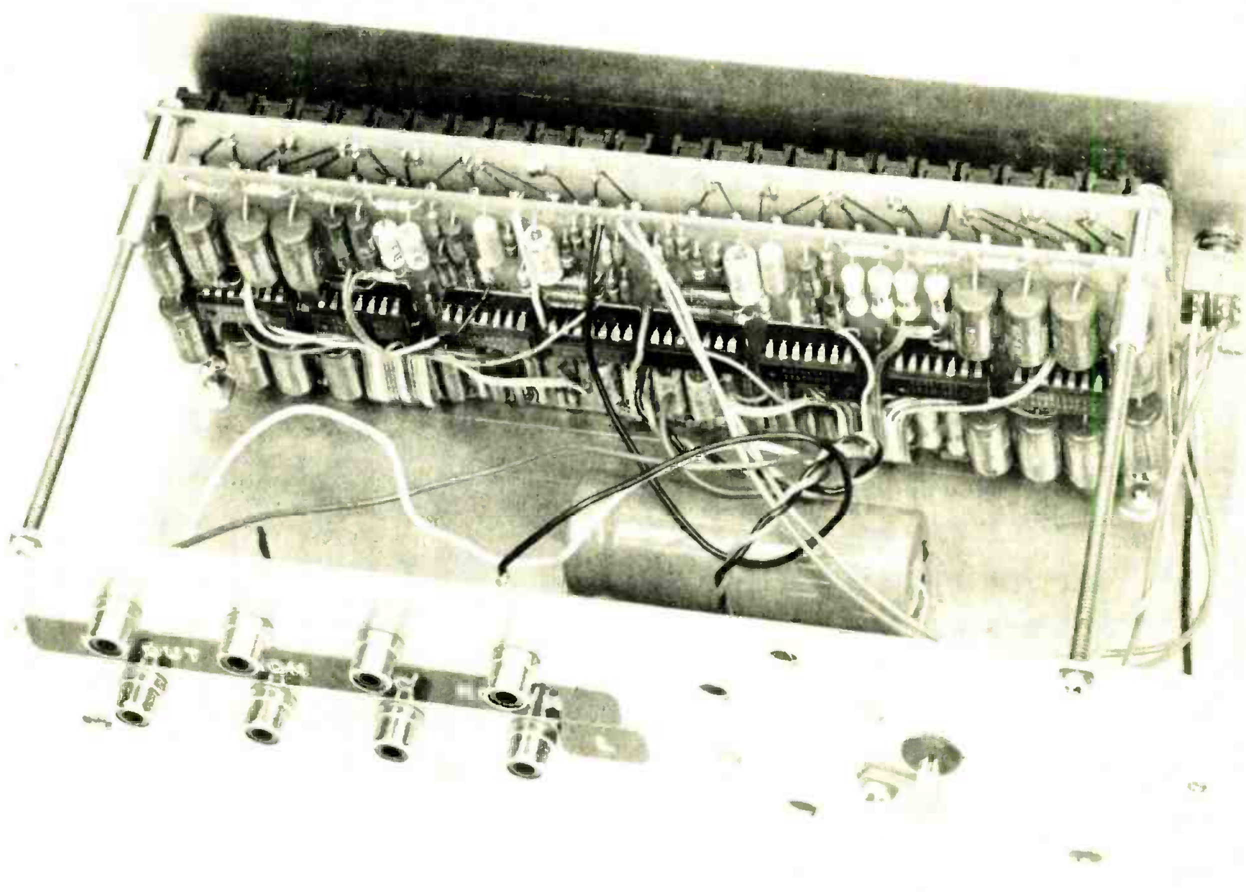
Construction

The compactness of the unit is partially due to the use of two PC boards; the amplifier board and the control board that contains the slide potentiometers and associated resistors. Figures 5 and 6 are the foil patterns of the amplifier and control boards, respectively. Figure 7 shows placement of parts on the amplifier board. The twenty-four slide pots and forty-eight resistors positioned on the control board as shown in Fig. 8.

Install the resistors first, then the capacitors. Be sure to observe the polarity of the electrolytic devices.

Lay the two boards flat 1 inch from each other with their bottom edges facing. Connect the points numbered 1 to 14 from each channel to corresponding points on the other board. Flat ribbon cable will make for neater wiring, or just color-coding the wires will reduce the probability of errors.

Estimate the required wire lengths for the input, output, ground, and power



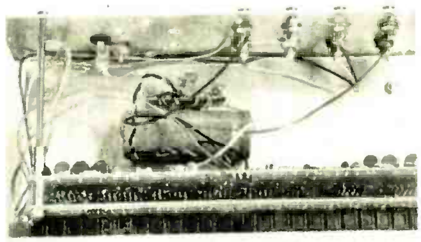
INTERIOR VIEW OF THE EQUALIZER showing the positioning of the two printed-circuit boards. The right and left halves of the two boards are practically mirror-images of each other.

supply wires, and solder one end of each to the amplifier board. Bolt the boards together back-to-back with 1/2-inch spacers and install them in a suitable chassis. In the prototype shown, the mounting holes in the bottom of the chassis are slightly oversized to help line up the slide pots with the slots in the front panel, and the tops of the boards are supported from the rear panel with long screws that allow adjustment of the depth behind the front panel. Construction details can be seen in the interior photograph shown in Fig. 9.

Install the switch and phono sockets in the chassis. Assemble the power supply on a terminal strip and solder connections C and D from the amplifier board and the wires from the power transformer; then install the strip in the chassis.

Wire the switch and phono sockets according to the mode of operation you plan to use (see Fig. 1 and the inset drawing) and wire the ground lead (E) to the chassis lug on one of the phono sockets.

Check your work; be particularly careful about the diode, capacitor and wiring to the amplifier board of the power supply. A mistake here could wipe out *all* of the IC's. Check that the inputs and outputs are wired to the correct sockets, switch terminals and channels. Recheck the IC and electrolytic polarities.



LOOKING DOWN ON THE EQUALIZER from overhead.

Installation

For a tape-monitor installation, connect the TAPE RECORD terminals of your receiver/amp to the EQUALIZER IN terminals and the EQUALIZER OUT to the TAPE MONITOR inputs. Wire the tape recorder to the equalizer as though it were the receiver. The TAPE MONITOR switch on the amplifier will then switch the equalizer in and out of circuit; the switch on the equalizer will control the tape monitoring. The tape recorder cannot be used without the equalizer in this setup, but the only reason to switch it out is for comparison when first setting it up.

In a preamp/power amplifier connection (which is superior if possible), wire the preamp output to the EQUALIZER IN and EQUALIZER OUT to the power amplifier inputs.

The equalizer power transformer can be plugged into the switched sockets on the receiver if it is mechanically compatible. If not, the transformer can be plugged in through an extension cord or plugged directly into the wall.

Operation

To use the equalizer as a super tone control, adjust the bands and trust your ears! You may want to experiment to see what all sorts of strange response curves can sound like. To equalize your system, purchase a stereo test record and adjust your system for a flat response. The *Altec Acousta-Voicette* test record is particularly good for this purpose. Your local audio shop may own a sound-level meter you can rent or borrow to equalize perfectly. After you have equalized for a flat response, reduce the gain slowly above 2 khz to compensate for boosts. **R-E**

ERRATA

In the parts list under resistors, change tolerance from 10% to 5% and change R135 to R136. Under miscellaneous, following J1—J4, change phone to phono and delete the reference to knobs. Delete the 3/32-inch reference to board thickness.

Preparation at Home

Wide Choice of Programs

Please note, however, that CREI's new program is only one of 16 state-of-the-art programs in advanced electronic technology offered by CREI. So even if you choose not to specialize in microprocessor technology, CREI has an advanced electronics program to meet your needs.

With CREI, you may choose from any of the following areas of specialization in advanced electronics:

- **Microprocessor Technology**
- **Computer Engineering**
- **Communications Engineering**
- **Digital Communications**
- **Electronic Systems**
- **Automatic Controls**
- **Industrial Electronics**
- **Television Engineering**
- **Microwave Engineering**
- **Cable Television**
- **Radar and Sonar**
- **Nuclear Instrumentation**
- **Satellite Communications**
- **Aeronautical and Navigational**
- **Solid State Theory**
- **Nuclear Engineering**

Unique Lab Program

An exclusive option available with CREI programs in electronic engineering technology is CREI's unique Electronic Design Laboratory program. It gives you actual experience in designing practical electronic circuits. It also helps you to understand the theories of advanced electronics and gives you extensive experience in such areas as tests and measurements, breadboarding, prototype construction, circuit operation and behavior, characteristics of electronics components and how to apply integrated circuits. Only CREI offers this unique Lab Program.

Practical Engineering

CREI programs give you a practical engineering knowledge of electronics. That is, each part of your training is planned for your "use on the job." By using your training, you reinforce the learning process. And by demonstrating your increased knowledge to your employer, you may qualify for faster career advancement.

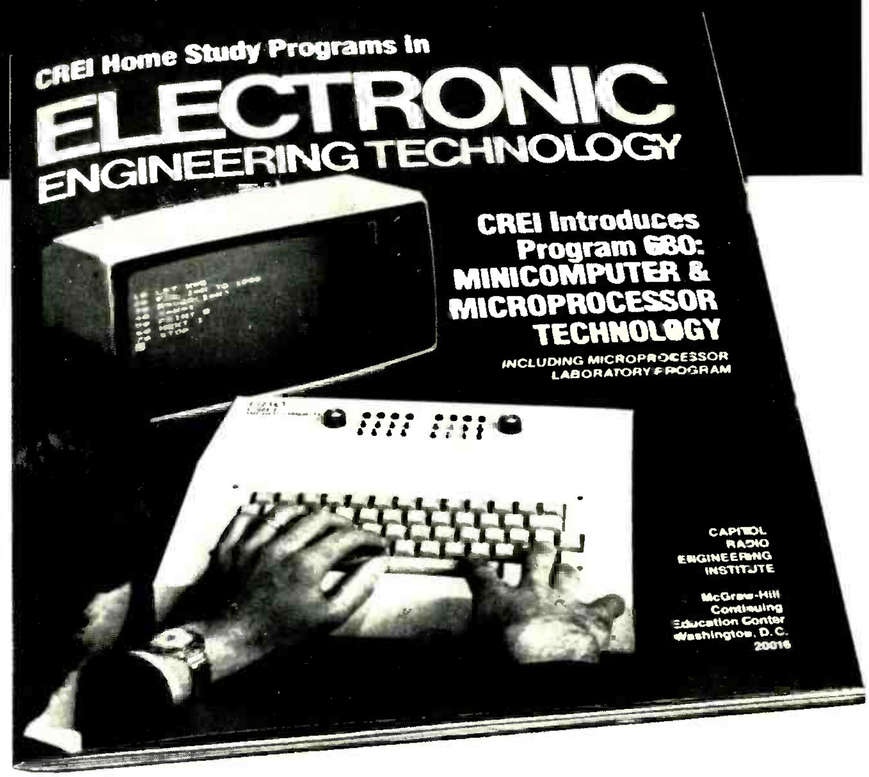
Free Book

There isn't room here to give you all of the facts about career opportunities in advanced electronics and how CREI prepares you for them. So we invite you to send for our free catalog. This fully illustrated, 56 page book describes in detail the programs, equipment and services of CREI.

Qualifications

You may be eligible to take a CREI college-level program in electronics if you are a high school graduate (or the true equivalent) and have previous training or experience in electronics. Program arrangements are available depending upon whether you have extensive or minimum experience in electronics.

Send for this FREE Book describing your opportunities and CREI college-level programs in electronics



Mail card or write describing qualifications to

CREI CAPITOL RADIO ENGINEERING INSTITUTE

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue Northwest
Washington, D.C. 20016

Accredited Member National Home Study Council

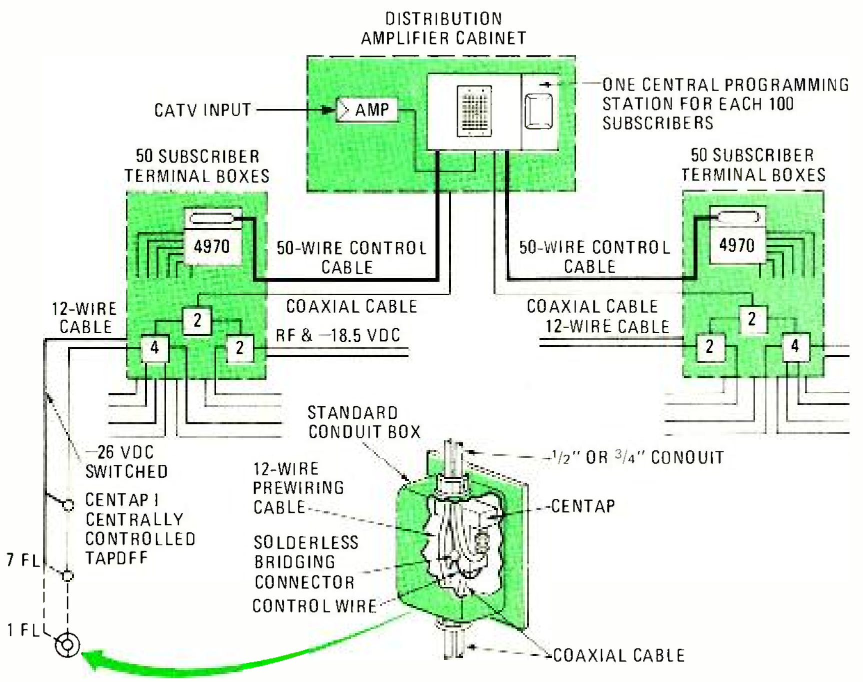
GI Bill

CREI programs are approved for training of veterans and servicemen under the G.I. Bill.

New Directions In MATV Switching Systems

Installing, connecting and disconnecting individual subscribers to TV signal distribution systems is revolutionized by new switching matrix.

RAYMOND ST. LOUIS*



SYSTEM WIRING FOR *CENTAP* CONTROLLED TAP-OFFS, with an internal view of the tapoff itself.

A NEW CENTRALIZED SWITCHING SYSTEM to interconnect MATV, CCTV and CATV subscribers has been especially designed for use in high-rise apartment houses, hotels, condominiums, hospitals, schools and office buildings. This switching system is called *Centap*. It is manufactured by Blonder-Tongue Laboratories, Inc., 1 Jake Brown Road, Old Bridge, NJ 08857.

What the system does

This MATV subscriber tap-off system can turn individual TV outlets on or off from a central location and can handle blocks of up to 100 TV system tap-offs. For example, when individual subscribers in a multiple dwelling have paid for TV service, their particular antenna outlets can be activated. On the other hand, TV service to individual antenna outlets can be turned off when desired from one central location without having to enter the apartment, hotel room, condominium unit, etc. The central-control unit is the *model 8201 Centrol*, while the individual subscriber tap-offs are called the *model 8200 Centaps*.

The system is compatible with all MATV and CATV installations. It can be added to existing systems that have been installed using conduit. The *Centap* system is wired similar to a conventional MATV tap-off scheme except that one additional 24-gauge prewire conductor is connected to each tap-off.

Special features

Some of the special features of the *Centap* system are:

- Simple wiring.
- Much lower labor costs (as little as one-seventh that of home-run systems).
- All connections are made at a single location.
- The system is permanently wired and there is no need to make individual hookups or disconnection.
- It lends itself to high-rise buildings that use vertical risers.
- The central-control unit can be situated anywhere.
- The system offers complete supervisory control over individual tap-offs.
- Self-testing of the system is provided.
- There is instant accountability of which tap-offs are in use, and tap-off condition lists are provided.
- Extensive technical knowledge is not required to connect or disconnect subscribers.
- The system is tamper-proof.

How it works

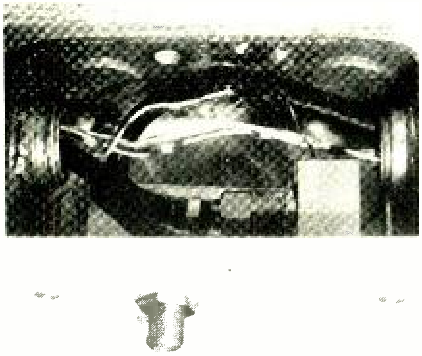
The new system operates as follows: The individual subscriber taps are biased electrically in the off condition by a negative DC voltage (−18.5) that is impressed on the coaxial cable along with the RF signals (see diagram). The prewire control cable carries the −26-volt DC turn-on potential when a connection pin is inserted in the appropriate hole on the central-control unit's front panel.

The tap-offs use three special PIN diodes to handle the actual switching. The circuitry provides over 60 dB of isolation in the turn-off mode and three fixed amounts of attenuation (15 dB, 20 dB, or 25 dB) in the turn-on mode. The 60-dB isolation is more than adequate to insure that no visible TV picture occurs at turn-off, even in a system that delivers a strong local TV signal.

Built-in facilities in the central-control unit panel allows a service technician to monitor the condition of each subscriber's tap-off. In this way it is possible to detect opens, shorts, or other unauthorized misuse of the outlet. No switches or electrical connections are required to turn

*Product Manager, Blonder-Tongue Laboratories, Inc.

the TV service on or off. All that is necessary to instantly determine the status of any tap-off is to insert or remove a pin in the appropriate hole on the front-panel matrix board of the central-control unit.



INTERIOR OF BLONDER-TONGUE *CENTAP* BOX.

Cost comparison

Assume you wish to install a CATV or MATV system in a 12-floor apartment house with eight apartments per floor. Let's compare the cost of material and labor for a home-run system and for the *Centap* system.

Comparing material and labor costs for the two systems using ½-in. conduit shows that the materials cost about $50 more with the *Centap* system. If ¾-inch conduit is used, then the materials for the home-run system cost about $425 more than for the *Centap* system. However, the *Centap* system uses one-seventh as much coaxial cable and one-seventh the amount of conduit. When you add the cost of labor for installing seven times as much cable and conduit required for the home-run system, the home-run system is far more costly than the *Centap* system in either case.

Another advantage of the *Centap* system is that tap-offs can be wired in the normal vertical-riser fashion used in high-rise buildings. Although the home-run method is economical for low-density (4- to 24-outlet) systems, it is not compatible with construction methods used for telephone and electrical wiring and plumbing, heating and ventilating services used in high-rise construction.

Installation

The RF portion of the *Centap* system is wired in the normal tap-off riser fashion. A maximum of 12 tap-offs per riser is recommended. Each distribution riser requires one RF coaxial cable (Nos. RG-59 or RG-6) and one telephone prewiring cable obtainable from the manufacturer. Each tap-off on a riser requires one conductor of the prewire cable.

To install the system, pull the prewiring cable through the TV system conduit along with the coaxial cable. At each tap-off conduit box leave a loop of coaxial cable, but allow the prewire cable to pass straight through the box. (The prewire cable need not be cut to connect it.)

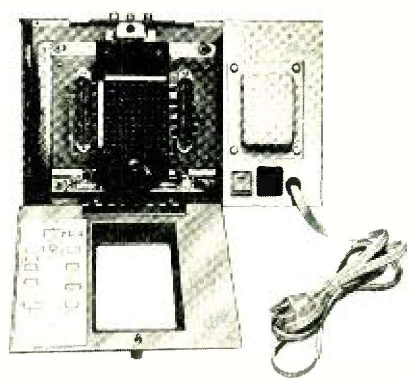
After the cables have been pulled, install the *Centap*. The control wire of the *Centap* must be connected to one wire of the prewiring cable. Connect the control wire of the first tap-off on the riser to wire No. 1 of the prewire cable.

Next, prepare the coaxial cables and attach the standard F-connectors. Connect the cable to the tap-off and secure the cover plate, using the F-connector nut. Next, fasten the *Centap* tap-off to the conduit box with the tamper-proof screws supplied. The last tap-off on the riser should be terminated with a resistor.

A terminal block and RF splitters are then mounted in an electrical box measuring at least 12 × 12 × 6 inches. The quick-connect clips of the terminal block eliminate the necessity to strip the conductor insulation when making terminations. A special tool is available that simultaneously cuts away the wire insulation and makes a good electrical connection with the conductor. The tool also simultaneously seats the conductor and trims off the excess wire.

Now connect wire No. 1 of the first tap-off riser to the upper-left terminal of the terminal block. Wire No. 1 will connect later to the proper terminal on the central-control unit. Connect all wires in order, starting at the top left and working down to the bottom left, and then to the top of the next column of terminals. After connecting one complete riser, write down the wire destinations on a chart affixed to the terminal-block cover. This step is most important since it will save much time in later identifying the proper subscriber-wire locations.

Next, connect the terminal block to the central-control unit. For this connection, a special running cable is used that contains 50 wires with prewired plugs attached and is available in 5-ft., 25-ft., 50-ft., 100-ft., and 200-ft. lengths. The running cable has a plug on one end and a connector on the other end so that different cable lengths can be connected together for longer distances. The end of the running cable that must be connected to the terminal block is identified by a small "2D" in the lower portion of the plug's plastic housing. The cable end that connects to the central-programming station carries a "1D" identification in the matching location.



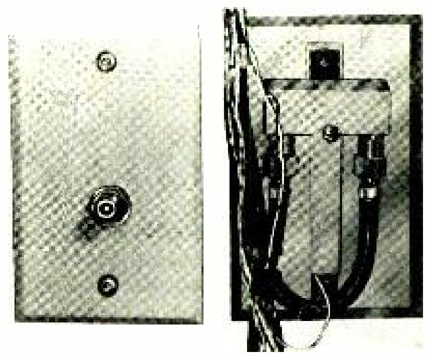
BLONDER-TONGUE CENTRAL-CONTROL UNIT with front panel opened.

Running cables can be pulled through conduits measuring 1½ inches and more. If a conduit measuring at least 1½ inches has not been provided, running cables can be pulled through conduits as small at 1¼ inches by removing the plug cover and carefully wrapping the wiring in several layers of electrical tape. Installing a running cable in a smaller conduit, say, one that measures ¾ inch, requires removing and reinstalling one plug.

Finally, connect the running cable to the proper central-control terminal to conform with the "2D" designation at the terminal block. Then, connect the coaxial cables, which feed the splitter at the terminal block, to the power-adding splitter in the control unit. Connect the output of the system distribution amplifier to the input of this splitter.

Testing the system

Insert the central-control-unit test cord in a matrix hole position that is connected



FRONT AND REAR VIEWS OF A *CENTAP* BOX.

to a *Centap* tap-off. As the plug is inserted, the red LED glows brightly. This indicates that the station's power supply is delivering voltage to the matrix. When the plug is fully inserted, the red LED grows dimmer. This indicates that a tap-off is properly connected to that matrix position, and that the DC power supply added at the central-control unit's RF splitter/DC adder is passing through the coaxial cable and splitter, through the system.

After installing the system, record the subscriber location on the large adhesive-backed label supplied with the *Centap* equipment. Affix this label permanently to the door of the central unit's high-security housing. Write down the apartment numbers (in numerical order) to correspond to the station's terminal positions on the bottom half of the label. Just make a copy of the completed first half of the label and cut it up so that each location can be sorted by apartment number. Then, record this information on the bottom half of the label. This will save time on service calls. R-E

hobby corner

Most active experimenters and constructors develop a cache of useful short-cuts. Here are some you can use.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

EVERY FEW MONTHS IT SEEMS NECESSARY to stop and gather up a bunch of short but useful tips and ideas. So, here is another collection of ideas for your workbench.

Keeping records

Do you make a record of the circuits you design? And how about drawing schematics for the equipment you build? Even when you construct something from a circuit, do you file away a copy of the schematic? Do you note on the schematic any and all changes made both in the original construction and in later modifications?

If you do not do any or all of these things, you are asking for trouble. My file system leaves a lot to be desired but *somewhere* in there I keep all schematics and pertinent notes on every piece of equipment I own, every past item constructed, and every circuit ever designed (I hope!). A lot of time and work was involved in assembling those files, but in the long run it has been worth it.

At first, my file system was a hit-and-miss affair. I only became serious when problems began to arise. The straw that broke the camel's back was a homebrew ham transmitter that started acting up. Lengthy searches produced no notes on the many modifications I had made or even the original schematic of the unit. Before repairs could be made, I had to trace out and draw the entire circuit—a tremendous waste of time. I swore, *never again!*

It is very difficult to trace out and draw the circuit of a piece of complex equipment. I have done it since then but not on my own equipment. Students and friends who have asked for help occasionally have received along with it a strong lecture on properly documenting their work.

Documentation is even more important with modern breadboarding systems. It is especially easy to become curious about a circuit, put it on a breadboard, modify it in a dozen ways, and then throw the parts back in the cabinet. If you do it that way and omit the record-making step, you can be sure that somewhere, sometime you're going to need that circuit again. So, you have to start all over from the beginning.

If you don't keep records, start now. Your documentation doesn't have to be complete in every detail, but just enough so you won't have to repeat your work later. Rough sketches and abbreviated notes are sufficient. Keep a road map of where you have been just in case you have to go back.

Tool holders

I have never known a hobbyist who had not accumulated a sock full of tools. And I've never known one who wasn't continually adding new tools as they struck his fancy, or as he found one to perform a new task or an old task better. Also hobbyists store their tools in a variety of ways.

Some store tools in a jumbled mess on the workbench. Some use a tool box and have to search for everything. Others apparently do use socks! And still others have their tools arrayed on a wall board with nails for holders or on a pegboard.

I prefer a pegboard because it has movable holders. The tools are easier to find, remove and replace, and they can be rearranged readily whenever a new tool must be inserted among its fellows.

If you use a pegboard for tools (or other items), you can make your own holders, and thereby also save a lot of money! The number of holder shapes that can be bought is limited. The number of shapes you can create is limited only by your imagination. The tools and materials needed are quite elementary.

I make my holders and brackets of aluminum clothesline wire (about 10 gauge). Other types of wire can be used, of course, but the aluminum wire is easily obtained, inexpensive, easily bent and very satisfactory. If you can locate some lighter-gauge aluminum, you can use it for hanging miniature tools.

The only essential tool for making the holders is a pair of sturdy yet narrow pliers. Long-nose pliers will not do the job as they are not strong enough to repeatedly bend the heavy wire. I have found the best pliers for the job to be small (about 5 inches) battery pliers—they are also called utility and pump pliers.

The two most critical bends in any holder are at the top where the wire must be inserted and attached to the pegboard—you must use the narrow pliers here. These bends are close together and each one is angled at 90 degrees. They must be made as perfect as possible so that the holder will hang from the board properly. Other larger pliers can be used for the other holder bends.

By the way, you can use these same holders on plain boards instead of pegboards. Just omit making the "pegboard bends" at the end and create a small loop to accommodate a screw or nail.

While you can do the entire job with pliers, I would not recommend it; especially if you plan to make more than a half-dozen holders. I use a small and inexpensive wire-bending jig (Radio Shack No. 64-1960). Using this tool, I can make a simple hook in a few seconds and a pliers holder in a minute or less. A bonus is that the aluminum wire is not gouged and rough when the jig is used.

The jig consists of a metal base (about 1 inch by 5 inches) and four short metal rods. The base has slots of several sizes for holding the wire being bent and five holes for the rods. Two (or more) rods are placed in the holes to hold the wire when you make unusual bends—circles, spirals, zig-zags, arcs and the like. The jig can be clamped in a vise, or screwed or bolted to the top of your workbench through the holes provided.

By planning your wire bending carefully, you can make hooks, holders and brackets similar to the commercial types. Without welding you can even duplicate the welded types by judicious wire routing. You can make custom hooks, holders, etc., to fit an infinite number of different size tools, for example, screwdrivers from jeweler's size to 15-inch monsters, or pliers measuring from 3½ inches to 12 inches. You can design and make holders for needle oilers, epoxy tubes, rolls of hook-up wire, spray cans, wiring pencils, etc.

The first step in the procedure is to make the pegboard hanger end using pliers. Then, form the business end on the bending jig. If the holder is a dual-hanger type, the second hanger is fashioned last.

When the holder is complete and you are ready to cut the aluminum wire—*don't.* Most wire cutters leave a sharp edge on the wire. You will find it more satisfactory to notch the wire two or three times with the wire cutters. The wire will then break easily and be less sharp.

Thread files

What do you do when you damage the

threads on a potentiometer? I've found dozens of ways to mess up the threads on bolts, shafts, pots, switches, lamp housings and all kinds of devices. Cross-threading, sawing off excess lengths, slipping pliers, using a wrong-size nut, etc., can really cause problems, especially when working with something that cannot be replaced easily.

You, too, have probably tried using a triangular file but the angle was wrong and it wouldn't reach down into the thread. Usually you can make a repair with a die of the proper size and thread. However, I have never been fortunate enough to have complete sets of all the English and metric, coarse, fine, extra fine, etc., threads that one runs into. And now I don't need them!

The *Fitz-All* screw thread files (M & B Special Purpose Hand Files, Box 306, Oak Ridge, NJ 07438) are available in two sizes. Each one can be used with any V-thread screw. The difference is in the maximum size (diameter) they fit. Since the *V. P. Mini File* ($2.50) can be used with threads that are over 5/8-inch in diameter, it will probably meet your needs. Just run the file along the mangled thread and it will clean it up nicely.

Grinding PC boards

Now and then we all would like to be able to turn out a simple "quick and

continued on page 119

state of solid state

A single IC from National Semiconductor adds true RMS measurements of voltage to a multimeter.

KARL SAVON, SEMICONDUCTOR EDITOR

THE MEASUREMENT OF TRUE RMS VOLTage and current, the technique against which other AC methods are weighed, has only recently been used in compact, low-cost instruments.

The importance of an RMS measurement is that it stems from the fundamental concepts of energy and power. The root-mean-square voltage, when squared and divided by the value of the resistance across which it is impressed, results in the power being dissipated in the resistor. This happens whether the waveforms are pure sinewaves, squarewaves or any other form.

RMS measurements are fundamental to measuring noise, harmonic analysis, intermodulation distortion, SCR waveform and mechanical vibration.

The final step to a numerical readout of the measured value is invariably an analog or digital DC meter. Therefore, the key component of an RMS measurement system is an RMS-to-DC converter.

Most conventional multimeters respond to the *average* value of the rectified AC input known as the mean absolute value. These instruments usually have an RMS scale, calibrated with a scale factor that is 1.11 times the DC scale. The average value of a fullwave rectified sinewave is $2/\pi$ times its peak value, and the RMS value is $\sqrt{2}/2$ of the peak. The scale factor is the ratio of these two constants, or

$$\frac{\sqrt{2}/2}{2/\pi} = 1.11072.$$

For many common measurements with known waveforms, such simple corrections are adequate. However, when a waveform becomes complicated or unpredictable, better methods must be used. The RMS value of a DC voltage is equal to its DC value; so, in this case, multiplying by 1.11 for RMS causes a reading that is 11% high. The RMS value of a squarewave is equal to its peak voltage; therefore, the same error applies. Noise measurement errors, on the other hand, tend to be negative.

For RMS reading meters, the ratio of the peak to the RMS value of the input waveform is important. It is quite possible for signal peaks to overload the input circuitry even though the reading may be less than full scale. The term given to this ratio is *crest factor*.

Bandwidth is another important parameter, since pulsed waveforms can be decomposed into a Fourier series of discrete-frequency sinewaves that are harmonics of the basic signal repetition rate. If the harmonic spectrum is wider than the instrument bandwidth, part of the input energy is lost and the meter reads low.

For many years, RMS-to-DC conversion was performed thermally; the thermal methods are still used in modernized form.

Figure 1 shows a type of dual-thermocouple system. In the simplified diagram, the input signal is buffered by active follower A1, and the voltage is transferred across the resistive element of thermocouple T1. Amplifier A2 has a second thermocouple in its feedback loop that balances its inverting and noninverting inputs until they are equal. This condition is reached when the outputs of both thermocouples are identical, so that their resistive elements dissipate the same power. The power in R1 is $V^2_{rms}/R1$ and in R2, it is $E^2_o/R2$. Setting the two equal to each other and solving for E_o gives

$$E_o = \frac{\sqrt{V^2_{rms}\, R^2}}{R1}$$

If R1 is equal to R2, this reduces to simply $E_o = V_{rms}$.

Matching errors between two thermocouples is a problem because of their natural sensitivity to temperature. Figure 2 shows an example of a single thermocouple design; it demonstrates that a thermocouple is an expensive complicated method that has led to its luxury classification.

Other techniques calculate the RMS value by performing the actual computation dictated by the mathematical expression for RMS $\sqrt{\overline{V^2}}$, where the bar stands for mean or average. Perform the computation as follows: Square the voltage instant by instant; take the mean by integrating the squared voltage over a period of time T and dividing by T; then, take the square root.

The RMS value is constant, which is convenient for repetitive (stationary) waveforms. Step 2 can be replaced with a simpler DC-averaging process—an R-C low-pass filter.

Figure 3 shows the circuit used in explicit or direct computation methods. The problem with this type of circuit is that the squarer circuit takes an input signal with a dynamic range of, say, 100 to 1 at the input, and ends up with a

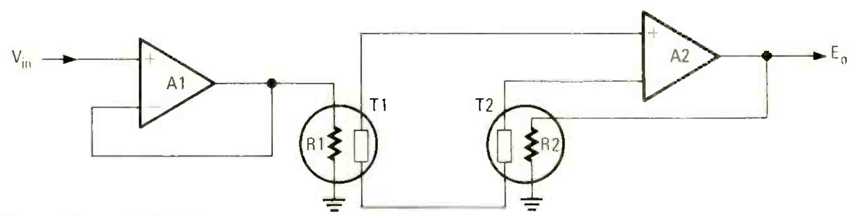


FIG. 1—DUAL THERMOCOUPLE RMS-TO-DC converter.

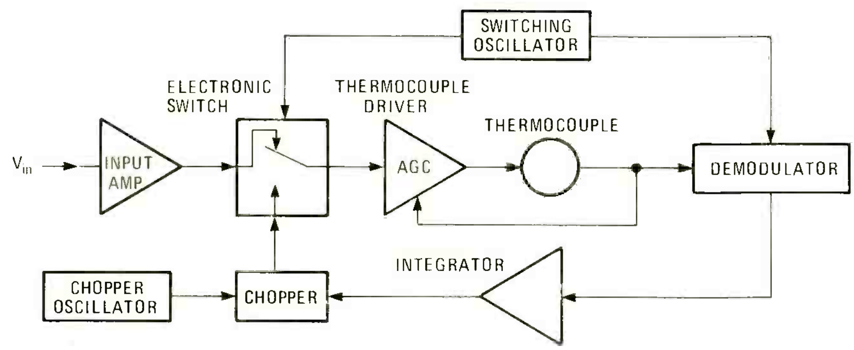


FIG. 2—SINGLE THERMOCOUPLE RMS-TO-DC converter.

10,000-to-1 dynamic range at its output. Multiplier errors can reduce the useful

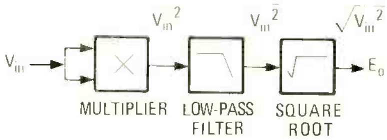


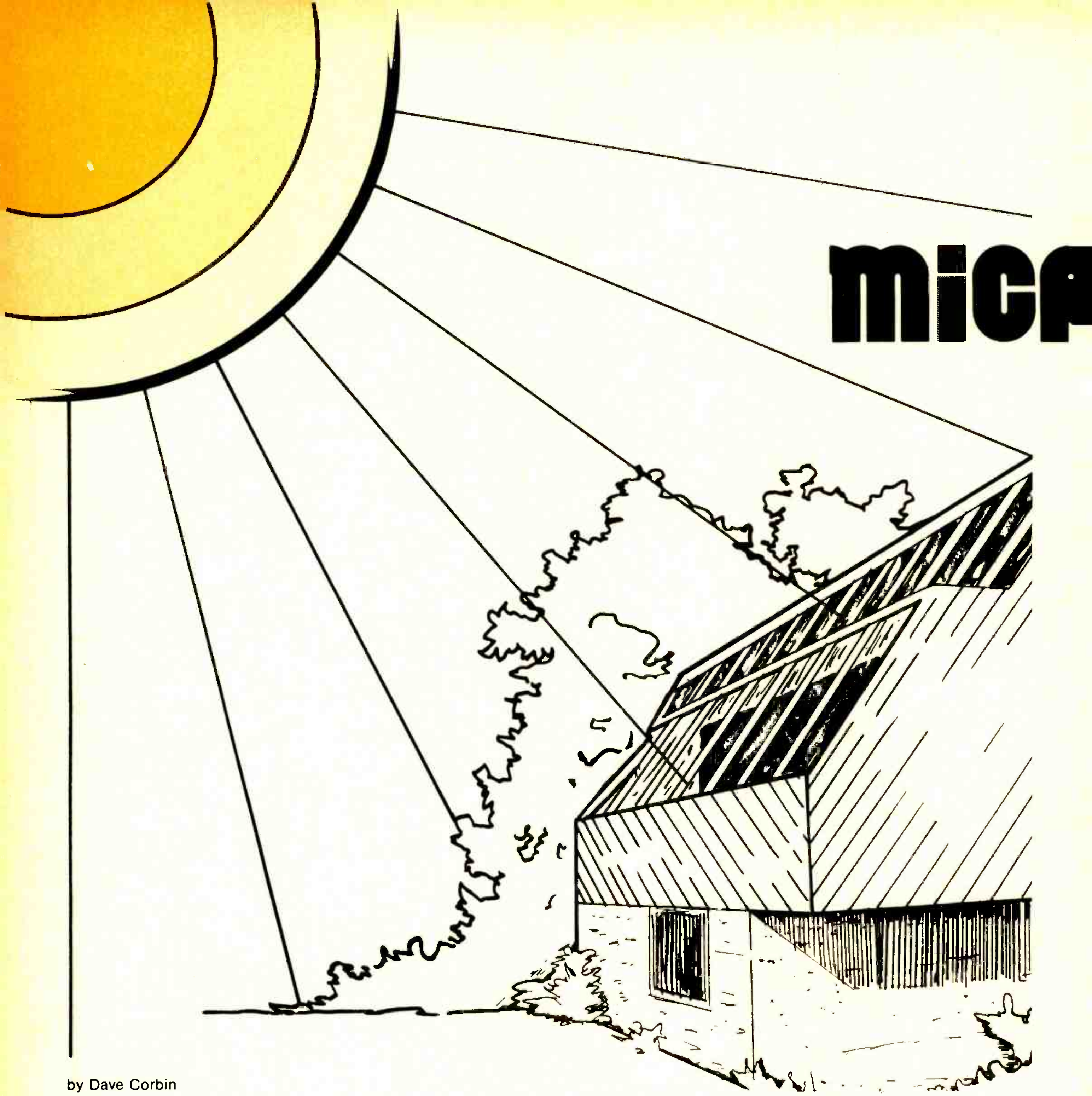
FIG. 3—EXPLICIT METHOD of RMS-to-DC conversion.

dynamic range to 10 to 1.

Implicit methods use feedback to solve problems of cost, resolution and dynamic range. The implicit method is used by National Semiconductor in their single-IC LH0091 True RMS-to-DC Converter and is shown in Fig. 4 on page 106.

In calculating the square of a waveform, it is immaterial whether the signal is positive or negative. The square of a negative number is still positive. It is easier and more accurate to work with voltages and currents that vary in only one direction. The input circuit of the LM0091 is an absolute-value circuit, or an active fullwave rectifier. The job can't be done with just a couple of diodes since it is important to be as precise as possible. The two vertical lines enclosing V_{in} in the first block is the mathematical way of indicating absolute value.

continued on page 106



by Dave Corbin

Energy is being consumed today in greater quantities than ever; at the same time, yesterday's seemingly unlimited resources are now seen to be quite finite. As a result, energy conservation has assumed a new importance, and the search for alternative energy sources has begun in earnest. One of the more promising possibilities is harnessing the sun as a direct source of heat.

The solar heating systems now being installed in homes, apartment complexes, and businesses contain heat collecting and storing devices from which resources are drawn during non- and low-sunlight periods. Although there are many types of such systems, the most common circulate water or some other liquid through solar heating panels, or collectors, during the day and store the heated fluid in tanks. When required, this fluid is pumped through radiators or radiant coils to provide area heating. To maintain comfort and make the best use of the available energy, the user must continuously monitor the temperature of every area to be heated, as well as the temperatures of the collectors and the storage tanks. Valves must then be opened or closed and pumps turned on or off to maintain the desired relationship among the system components. A computerized energy mangement system, or solar controller, can perform all of the monitor and control functions with optimum efficiency.

A microprocessor-based solar controller designed by Fairchild for Rho Sigma, Inc., a major manufacturer of solar controls, is specifically intended to accept the low voltages produced by thermistor temperature sensors, process and display the data, and provide outputs for relay and switch opening and closing. The solar controller contains a single-

PROCESSOR-BASED SOLAR CONTROLLER

board F8™ microprocessor, two input and two output cards, an A/D converter control card, a display control card, two 4K EPROM program storage cards, and a 1K RAM and memory address card *(Figure 1)*.

Also included in the unit are an A/D converter, a 5-digit LED display, and a 16-key keyboard. The display automatically sequences through all input channels, displaying the number and temperature of each channel for one second before cycling to the next. The keyboard can be used to halt this sequencing and either make the display continuously monitor only one channel or convert it to a clock-only display that shows time of day.

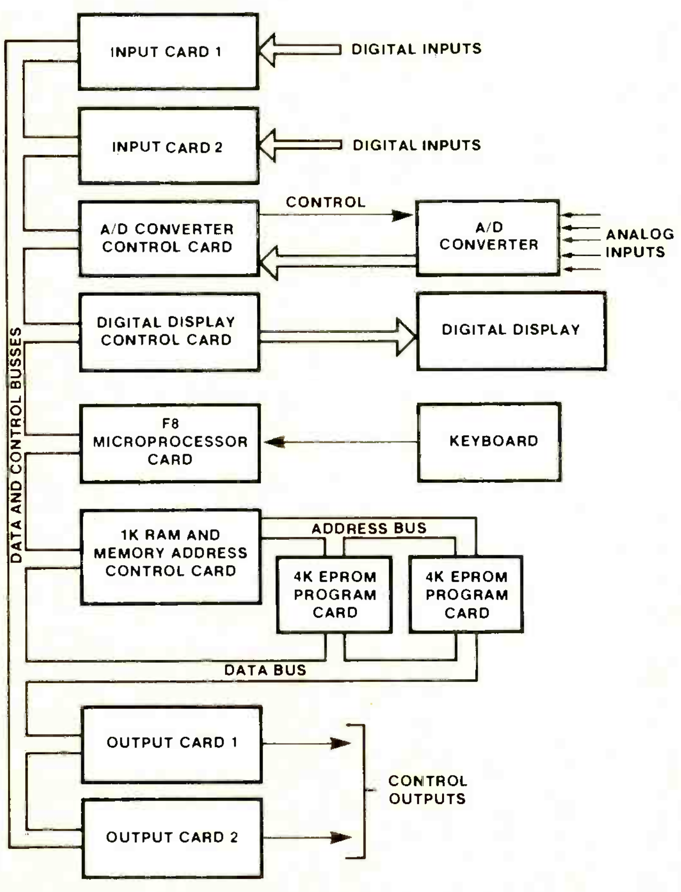


Fig. 1 Solar Controller Functional Block Diagram

CONTROLLER OPERATION

The microprocessor is programmed to solve a set of logic/arithmetic equations. These equations are contained in the EPROM program storage, with the associated constants being held in the 1K RAM. The keyboard can be used to change a number of the equation constants, permitting system changes to be made without hardware modification.

In normal operation, the A/D converter receives analog temperature information from as many as 16 thermistors and presents the converted data to the microprocessor. Digital data, such as that produced by switch closures and teletype signals, can be presented directly to the microprocessor through the 16 digital inputs of the input cards. These data are used to solve the system functional equations and produce two types of microprocessor outputs.

In the channel-monitor modes, temperature information is output to the display in degrees Fahrenheit or Celsius, depending upon resident program. In the time-display mode, a timekeeping routine program assumes control of the display circuitry and the temperature information is not provided.

The other microprocessor output consists of control signals that are suitable for opening and closing relays and activating solid state switches. These signals perform such functions as turning on pumps and opening valves to let water run into the storage tank or circulate through radiators.

Since program storage is in ROM, power failure does not cause catastrophic loss of memory. When power is restored, a resetting sequence begins, with the controller ensuring that all valves and controls are turned off so that stored energy is not lost. The controller then cycles through all of the inputs, decides what the system operating conditions should be, and generates the necessary output signals. This analysis takes approximately five seconds. To indicate to the user that power has been off, the display flashes until manually reset.

Originally designed for use in solar heating applications, the intelligent microprocessor-based controller is applicable to any system in which the ability to deal with multiple sensor inputs and generate control outputs is required. R-E

Reprinted from "Progress"

service clinic

Attacking the fault with a systematic troubleshooting approach.

JACK DARR, SERVICE EDITOR

I'M NOW GOING TO GIVE AWAY ONE OF MY professional secrets! Actually, it's not all that secret. It requires only one piece of non-bench equipment that'll help you make diagnoses of tough dogs in the least possible time. Next time you think you're stuck, "try it—you'll like it!"

The equipment: one clip-board with paper; one pencil or pen; and last of all, one head (yours) that knows how electronic circuits work.

Now, the method: Sit down and *look* at the subject. What symptoms do you see? Write them down at the top of the page, and be sure to get them all down. Next, what do you *think* is the cause? Write this down. This is your first assumption. ("Assumption"—a guess based on observed reactions.) Now, prove it. Take test readings, voltages, signals, etc., and write down *each* test and its result.

Read your results and see what you have. In other words, you've assumed that a certain part or parts in a particular circuit is the cause of a problem. You'll know if you've been thorough in making the tests. Is resistor Rx in tolerance, open or what? Are all DC voltages in the ballpark? Are signals getting through the circuit? These tests will indicate whether the cause *is* in this circuit or not. If it is not, don't consider this is "wrong." On the contrary, you've just eliminated *one* possible cause. Find another cause and check that out too. By writing down the reasons and the results of each test, you can always tell where you are and where you should proceed. You just eliminate one possibility after another until you find the one causing the problem.

There's only one limitation—never make a test without a valid reason. This just wastes time and confuses you. By logging the reason for each test and its results, you'll see the whole problem much more clearly.

For example, if you suspect AGC (*A*utomatic *G*ain *C*ontrol) trouble in a tube set, check each DC voltage on the tube and log them. Now, if one DC voltage is off, it'll stick out like a sore thumb. Compare the voltage values you obtain with those shown on the schematic. With transistors, you do the same thing.

The first thing is to *eliminate* as many possible causes in the least time. You can therefore eliminate stages that are working and pin the problem down to only one or two stages. For instance, you have a set with no picture, and the set has eight stages. Feed a test signal into the input and follow it with your scope to see where it stops. Let's say you read a signal at the output of the second IF transistor, but not at the output of the third IF transistor. Check all DC voltages on the transistor. If you get collector voltage and the emitter voltage is zero but should read +2.65, there you are.

There are now three possible causes. First, an open transistor, which can be checked with an ohmmeter. Second, a transistor could be cut off by too much reverse bias on the base. Use a DC voltmeter for this check. Third, you could have an open emitter resistor or a bad solder joint; use your ohmmeter again. Writing all this down as you perform the tests makes it a lot easier to keep track of everything and to arrive at the final conclusion. ("Conclusion"—the *end* of a process.)

Look for shortcuts. The eight-stage set can be divided into sections very quickly. Read the video signal at the output of the video detector. If the reading is normal, the trouble is not in the tuner, the IF, the AGC, the video detector, or the DC power supply. The trouble lies in the circuits after this point. Of course, if you do not see the normal signal at the video-detector output, you can eliminate the circuits after this stage, because you know that the problem lies in the IF, the tuner, the AGC, etc. A tuner-subber can quickly check the IF and confirm or eliminate that as a source of the problem.

Multiple symptoms

Let's suppose that you see multiple symptoms: loss of both syncs, pale video, hum-bars in the picture, and so forth. It is very likely that these symptoms have a *common cause*. You might find, say, two different problems, but it's rare to find more at the same time. The best place to look for the cause is in the DC power supply. A defective filter capacitor can allow multiple feedback loops and all kinds of trouble to develop at once. The quickest check is to scope the DC power lines for any kind of signals. In many solid-state sets, the DC power supplies are tightly regulated. These supplies are critical and should be checked first thing. Most of the DC power lines have at least one shutdown circuit and some of these circuits can overreact! I know of one set with a +118-volt DC line that shuts down instantly when the DC voltage reaches +125 volts!

At this point, someone usually asks: "Yes, but what if it's an intermittent?" The answer is *do not* just sit there and wait for it to quit. The typical intermittent may play for a couple of weeks. In the September 1977 Service Clinic called "Attacking The Intermittent" I wrote that intermittents can be classified very quickly. There are two major causes: *heat*, which causes a shift in part value, or *physical*, meaning bad solder joints, hairline cracks in PC board conductors, intermittent plug-socket contacts, etc. There are also so-called "combinations": for example, a hairline crack in a PC board may not open until the chassis warms up and expands. Some physicals can be found by bending or tapping the board, parts, or wiring. To attack a "thermal," apply heat from a heat-gun, or cold from a spray can. Move the wiring, tap the board, as you apply heat or spray.

There is one final cause for an intermittent: *voltage*. In certain sets if the line voltage goes high or low, it will cut out. (Don't forget the shutdown circuits.) The answer: vary the line voltage with a variable-voltage transformer. (Note—in sets with voltage-regulating power transformers having saturated cores, this technique cannot be used; these transformers hold the DC voltages too tightly.) Sets that cut out on high line voltage are often really thermals; some stage is taking too much current and overheating some component. By taking detailed notes on each test and its results you can get a better idea of what's happening.

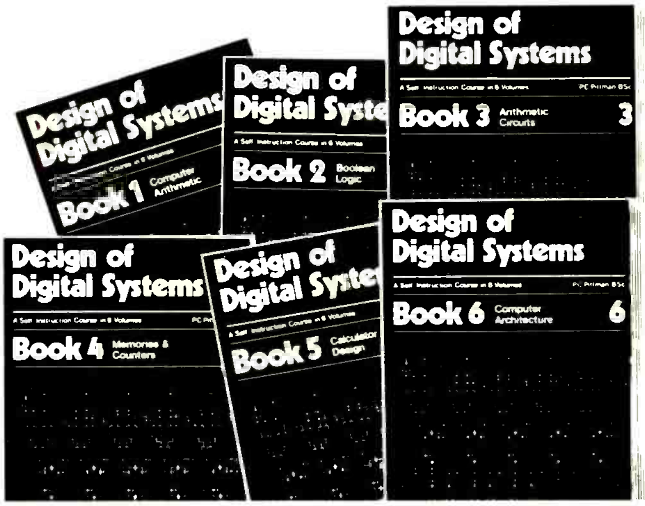
IC troubleshooting

This definitely also applies to IC's. Here's an illustration: A stereo tape-recorder went dead at irregular intervals on both channels. After writing out the list of reactions, we monitored the signals out of the heads and the output signal. When the line voltage did cut out, it could be brought back by cooling the boards. So, we monitored the signal out of the preamplifier, which was a dual IC op-amp with separate outputs. We warmed up the IC, monitoring one output on the scope and the other with a digital DC voltmeter. Sure enough, when the IC became warm, the DC voltage on the output terminal began to drop. (The

continued on page 98

Understanding Digital Electronics

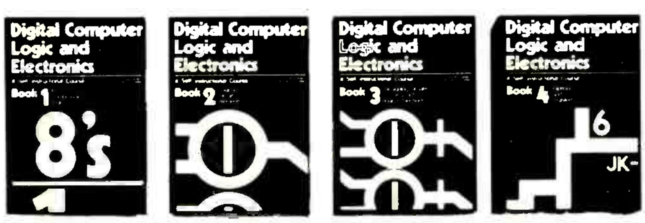
New teach-yourself courses



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2" x 8-1/4" are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1/2" x 8-1/4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your automobile speed and gas consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.

The six volumes of Design of Digital Systems cost only: **\$19.88**

And the four volumes of Digital Computer Logic and Electronics cost only: **\$14.88**

But if you buy both courses, the total cost is only: **\$29.90**

a saving of over: **\$5.00**

SEVEN-DAY MONEY-BACK GUARANTEE: If you are not satisfied with your Cambridge course, return it within 7 days for a full refund.

To order your books, complete the order form below and send it together with your check or money order to GFN Industries, Inc., 6 Commercial Street, Hicksville, N.Y. 11801.

To: GFN INDUSTRIES, INC.
6 COMMERCIAL STREET, HICKSVILLE, NY 11801

Please send me:
___ Sets of Design of Digital Systems \$19.88 ______
___ Sets of Digital Computer Logic & Electronics \$14.88 ______
___ Sets of both courses \$29.90 ______
Sales tax (N.Y. residents) ______
Shipping and handling \$2.50 per set ______
Enclosed is check/mo (payable to GFN Industries, Inc.)

Total \$______

Name ______
Address ______
City/State/Zip ______

Prices include overseas surface mail postage. RE6B

SERVICE CLINIC
continued from page 80

log showed this drop was normal at first, at −6.4 volts.) When it went down to about −0.4 volts, the signal disappeared. When the IC was cooled, the signal suddenly popped in again. The DC supply voltage to the IC was also being monitored, as was the input signal. There was no change in either voltage supply. So it was possible to isolate the problem between these two points: the IC. When any of the DC voltages that come from inside the IC change, this is an almost sure sign that the IC is defective. You should check all external parts, of course.

The important thing to remember in this method is your *attitude* toward the equipment you are checking. You should not view it as a mysterious box full of things. It is only a piece of electronic apparatus that has a bad part somewhere inside that you *can* find! Be completely impartial as to what you hope to find. A completely open mind is the most valuable asset you can have. Write everything down; it'll help keep track of what you're doing and it'll also give you a few good laughs when you get through! **R-E**

service questions

CHASSIS ALWAYS HOT

While working on a Magnavox T982, I found that the chassis was hot to ground. I reversed the AC line plug but it was still hot. Something in there is shorted, but I can't find it.—G.O., Wickes, AR

This is normal in this model and in the T981! Both types use a full-wave bridge rectifier tied directly to the line. No matter which way the plug is inserted, you'll read about 70-volt AC to an earth ground. Magnavox explains it in their *Service News*, January, 1974 (see circuit diagram). An isolation transformer should always be used when *servicing*; it's safe if all insulators are in place.

ROLLING ON CHANNEL 7 ONLY

We get Channel 13, locally, and Channels 7, 10 and 15 from about 60 miles away. All the channels are good, but Channel 7 rolls. I can't figure it out.—H.W., Lynchburg, VA

We once had a similar case on our CATV. One channel rolled on all sets. We finally checked sync amplitude on all stations and found that the bad one showed something like a 10% sync level, 90% video! The normal levels are 75% video, 25% sync. Calls to the station produced no instant response, but we finally learned that their console monitor was badly out of calibration! If this is fixed there should be no more trouble. You might try calling or writing the station.

(Feedback: "Thank you for the letter. It was very effective. Channel 7 stopped rolling the day the letter arrived and hasn't rolled since. If it starts again, I will wave your letter in front of the screen and stop it!")

DIMMER PROBLEMS

Lamp dimmers make two kinds of noise—RFI and a "singing," which can be heard if the lamp is near enough. I've found the best cure for the singing effect is to change the bulb. Try screwing it in tighter or loosening it.

Some commercial dimmers apparently do not contain RFI filters. I've found that a 0.05 of 0.1-μf capacitor, 600 volts across the line cord, will take the hash out of these. Oddly enough, this capacitor must be connected across the line at a point about 18 inches from the dimmer. I have no idea why this happens, but it does. Do you?

(No, frankly I don't. Possibly this acts as a resonant circuit. Thanks to Carl F. Hartman, Newport Beach, CA, for the hints and experiments.)

continued on page 100

SERVICE QUESTIONS
continued from page 98

FUSE BLOWS FAST

I've checked almost everything, but I can't find out why the fuse blows in this Magnavox T982-12. It pops inside of 30 seconds.—B.H., Decatur, GA

As a last resort, try replacing the "four-legged capacitor" in the collector circuit of the horizontal output transistor.

(Feedback: "Got it! Thanks.")

CONSTANT FUSE BLOWOUTS

I've just repaired a Magnavox T940. It quit, and the owner replaced a 20-amp fuse with a bigger one! Blew all the rectifier diodes and burned up the PC board. I fixed this; now it plays OK for 5–10 minutes, and then the 20-amp fuse goes out again. Any suggestions?—W.I., Salt Lake City, UT

Well, it took me quite a time to find that 20-amp fuse and then to find out where it went. It kept getting lost. This fuse is in the *heater* circuit for all tubes except the picture tube and 6BK4 high-voltage regulator.

You have one of two problems: An intermittent wiring short, where a lead goes around a sharp corner of a metal

continued on page 102

SERVICE QUESTIONS

continued from page 100

object, or a possible heater-to-cathode short in a tube that does *not* have a cathode resistor. (If it does, the resistor burns up and tells us where the problem is.) Even small tubes can do this; it would be a "hot short." The tube has to get pretty hot to expand enough to make it happen. Since this apparently blew up the rectifiers, check the damper or horizontal output.

HALF VERTICAL SCAN

If you see about half the normal vertical scan, with heavy retrace lines at the top of the screen, in the Magnavox T995 chassis, check the vertical output *choke*. It may be shorted. The normal resistance is 9–10 ohms; some have been found with only about 3 ohms.

(Magnavox Service News Letter.)

TWO CORRECTION NOTICES

In the March issue of **Radio-Electronics** (page 82), I said (referring to an Aims amplifier) that "6550 tubes are rated at 20 watts, etc., etc."

John Dalnes, service manager of Ace Music, North Miami, FL, wrote me that in his RCA tube manual *No. RC-30* these tubes are rated at 100 watts each. He's right! I found them in my own copy of *RC-29*, too . . . I just didn't look far enough down the page. I'm glad you told me, John. Thanks.

The second mistake is one that is not due to stupidity, but to just plain ignorance. In the same issue on page 81, I told the technician complaining of a speed loss at high volume levels in a Panasonic SG-635 to check the DC power supply.

George Weiss (Patis-Bell TV, Chicago, IL) informs me that this is a common problem in this unit. It is due to high-resistance contacts in the on-off switch in series with the motor. This information should be helpful, and I thank George for letting me in on it. It's now duly filed for future reference.

HIGH DC VOLTAGES

I can't get a handle on this one—a Sylvania model EO-8 that has no sound or raster; and the breaker trips. The B+ voltages are all too high. Take a look in the crystal ball and tell me a good way to get hold of this.—F. L., San Diego, CA.

You've got a dandy "typical symptom" that appears in almost all solid-state TV sets. If your DC voltages are *too high*, the chances are there's a problem in the voltage regulator. In most you'll find one or more *shutdown* circuits that trip instantly if the high voltage or the B+ volt-

continued on page 104

NEW for Professional Technicians

Forest Belt's

TRAINING WORKSHOPS 1978

- THREE-DAY
- INTENSIVE
- UP-TO-DATE
- PERSONAL
- UNIQUE

- Includes lodging
- Breakfasts, lunches, and coffee breaks during WORKSHOPS
- Grand AWARDS BANQUET
- FREE Extra SEMINAR

ADVANCED
VIDEO SERVICING

Featuring VCRs, Digital Controls, VIR . . . and much more

Intensive Forest Belt teaching techniques and exclusive, proven training aids bring you right up-to-date in the troubleshooting and repair of today's video equipment for home or industry.

Special emphasis on solid-state and integrated circuits. See new IF and color alignment methods you probably never thought of. Learn about Vertical Interval Reference (VIR) automatic color control in newly introduced TV receivers. Understand digital and solid-state tuning systems. Participate in live equipment demonstrations. Sit in on the industry's first look at practical, **Easi-Way™** repair of video cassette recorders.

DON'T BE LEFT BEHIND in your own industry! Be the one technician in your region who not only keeps up but stays AHEAD of new technology and servicing methods. ENROLL NOW to be sure you do not miss this vital and unique Advanced Video Servicing WORKSHOP.

FREE Price and Profit SEMINAR Tuesday evening.

ADVANCED
COMMUNICATIONS SERVICING

Featuring FM Two-Way, PLL, Single Sideband . . . and much more

Here, too, intensive Forest Belt teaching methods and exclusive, tested learning aids assure you up-to-the-minute training troubleshooting and maintaining communications systems.

Special emphasis on solid-state and integrated circuits. Observe professional alignment and tuneup methods. Deal profitably with Business and Land Mobile Radio—and the growing General Mobile Radio on UHF wavelengths. Learn of new developments in Marine and Aircraft Radio. Study the latest phase-locked loops, including their digital programming. Take part in live equipment demonstrations. See **Easi-Way™** techniques applied to communications.

GROW AS A REAL EXPERT in your specialty. Grab this exceptional opportunity to polish up your diagnosis and repair skills. Become familiar with new technology and money-saving instruments. ENROLL NOW in Advanced Communications . . . a giant step beyond our popular CB Servicing WORKSHOPS.

FREE Math and Formulas SEMINAR Tuesday evening.

September
11-13 (Communications)
or 18-20 (Video)

Hospitality Inn East
Interstate 70 at Post Road
Indianapolis, INDIANA

Centrally placed for convenient travel from anywhere in the mainland U.S. Also timed earlier in the year, in case you should not be away from your shop during the pre-Christmas season. You can attend in time to prepare you for the year-end service rush and the new sets being sold.

Comfortable, pleasant accommodations: two people to a room (two beds). Indoor pool. Shopping downtown by freeway. Bring your spouse if you wish, at the nominal No-WORKSHOP fee (she joins the WORKSHOP group for breakfasts and lunches). If you prefer to room with a specific other WORKSHOP attendee, tell us.

Enrollments close August 4, 1978, or when capacity is reached.

Per Workshop $495

November
6-10 (Communications)
or 13-17 (Video)

South Seas Plantation
Captiva Island, FLORIDA
(near Sanibel and Ft. Myers)

For technicians who could use a bit of get-away time as part of this unique training package. Two days of consulting or on-your-own follow each WORKSHOP. Make your own airline reservations, well in advance; but we take care of placing you in our luxury cottage lodging.

Exceptional resort accommodations: four people (two bedrooms, four beds, two baths) or six people (three bedrooms, six beds, three baths) in fancy beach cottages. Bring your spouse, if you wish, at the nominal No-WORKSHOP fee (she joins the WORKSHOP group for breakfasts and lunches). If you prefer to share a room with a specific other WORKSHOP attendee, tell us. Cottages have kitchen facilities. An unusual winter-season bargain.

Enrollments close Sept. 15, 1978, or when capacity is reached.

Per Workshop $595

------ **FIRST COME, FIRST SERVED** ---------- **ENROLLMENT DEADLINES ABOVE** ------

Yes, enroll me promptly for TRAINING WORKSHOP at right.

☐ Advanced Communications Servicing
☐ Advanced Video Servicing

I enclose check or money order for $________ U.S. dollars.

☐ $495 per WORKSHOP in Indianapolis
☐ $595 per WORKSHOP in Florida

☐ $175 for spouse
☐ $250 for spouse (includes lodging, same meals as for WORKSHOP enrollee)

☐ $475 for CB Service WORKSHOP (same as 1977, and includes lodging) at Indianapolis August 21-23, 1978.

Name ____________ Age ____
Company ____________
Address ____________ Phone ____
City ________ State ______ Zip ____

NOTE: You need 2 years electronics training or experience to gain proper benefit from these Advanced TRAINING WORKSHOPS. NOT FOR BEGINNERS.

Mail to: Forest Belt's TRAINING WORKSHOPS, Box 68120, Indianapolis IN 46268

SERVICE QUESTIONS
continued from page 102

ages exceed certain limits.

Plug the set into a variable-voltage line transformer. Now, monitor the B+ source, and bring the line voltage slowly up to the point where B+ is correct. If the set now starts to work normally, then this is where your problem lies. Check out that entire voltage-regulator circuit, including all Zeners, transistors, diodes, etc. Something is not doing its job.

NEW TUBES, SAME SYMPTOM!

Here's a zinger for you. Zenith model 12A12C52 had a dark, about 1½-inch-wide vertical band on the left-hand side of the screen. Said to myself, this is a problem in the damper stage, and put in a new normally reliable 6CJ3 tube. It went away for five minutes, then came back! I tried another new tube of the same brand. Same thing happened. I tried a third time—no change! Then I found an old but good 6CJ3 tube of a different make on my bench. I put this new tube in and the set has operated properly ever since! Can you think of an obscure reason why this happened?—S. M., Bloomfield, CT.

Nope. The same thing happened to me. Apparently you managed to get hold of three new tubes of a reliable brand that had some kind of screwball fault! We have run across similar problems in several different tube types, from horizontal outputs to triode-pentodes. This is the first time I've ever heard of this problem in the 6CJ3's, but I'll remember it! Thanks.

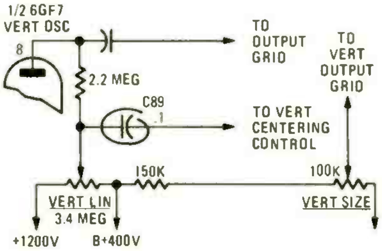
COLOR, PICTURE VERY DIM

I asked about a Zenith model 14A10C19 with dim color and picture. You steered me right: The plate voltage on the video output was fluctuating and dropping to 50 to 60 volts instead of maintaining the normal +308 volts. The answer turned out to be an intermittently open resistor, R208 (R77, Sams 1108-3). The original resistor was 7 watts; I replaced it with a 10-watt resistor and a new tube. The set has been working perfectly for quite a while! Thanks.—J. K., Pine Bush, NY.

Don't mention it. Even a blind pig gets an acorn now and then. Here's a coincidence: I ran into the same problem in another make of set about three weeks ago! I used the same cure; one of the two feed paths to the video-output plate was opening.

CONTROL AND BOOST-DIODE BURNING UP

This Magnavox *model U920* chassis was burning up vertical-linearity controls and boost-rectifier diodes as fast as I could put them in! Following your suggestions, I rechecked the wiring. I discovered that there should be a B+ supply

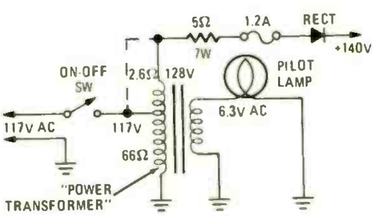


400-volt connection to the end of the vertical-linearity control. The boost goes to the other end, the +1200 volt B++. The cause of this problem was a shorted 0.1-μF capacitor, Sams C89 (C160 in Magnavox 7288) that goes from here to the vertical centering control. Thanks again!—Rex Gray, Garland, TX.

REPLACEMENT POWER TRANSFORMER

I need a replacement power transformer for an old Emerson TV, Sams 858-1. I tried to get one from the company, but they don't have them any more. Nobody lists a replacement. Otherwise, the set worked fine before the transformer went out.—A. W., Parkersburg, WV.

I did a doubletake when I looked at the schematic! Actually, this isn't much of a "power transformer" at all. It does noth-



ing but light the *pilot light!* The primary is tapped; the tap is marked "tapped at 117 volts" (see diagram). However, there doesn't seem to be any useful step-up; the DC output is about normal at +140 volts.

I'd replace it with a stock 6.3-volt filament transformer and connect the AC input to the DC power supply right to the line. This should work. Apparently they're doing this to keep the escutcheon from shock hazard, since this is a hot-chassis set.

SWEEP GENERATOR TIP

Here's a helpful hint I discovered when I was working on my Eico model 369 Sweep Generator. I couldn't get a marker response at 45 or 50 MHz; the harmonics were too low. I couldn't find any actual circuit faults. Finally, I tacked a small 3-to 5-pF capacitor across capacitor C18, and it works fine!—S. G., Hayward, CA.

Thank you. This hint might come in handy for others. **R-E**

STATE OF SOLID STATE
continued from page 93

Next, to square the waveform you can use either the straightforward multiplier technique or the explicit method. However, there are distinct advantages to using a logarithmic method for squaring because of its ability to handle wide dynamic range inputs.

As you remember from high-school math, if you take the logarithm of two numbers, add them together and take the antilog, you end up with the product of the original numbers. The block in Fig. 4 marked "2 ln" represents the adding of the two logarithms; ln stands for natural logarithm, which uses base epsilon or 2.718, compared with log, which uses base 10. Semiconductor junctions by natural law follow a ln-relationship. Squaring the input means multiplying the same number by itself, so that the log of the input is added to itself, which accounts for the 2 in front of the ln function.

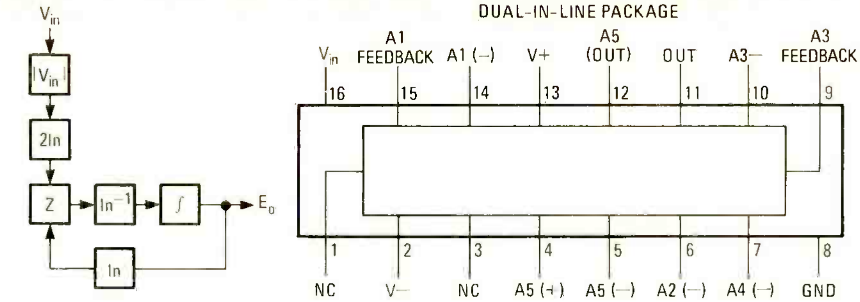


FIG. 4—NATIONAL LH0091 single IC RMS-to-DC converter.

The signal then proceeds through the summation block to the antilog circuit where the square is extracted. Antilogs are calculated by raising the number base to a power equal to the signal.

The next block with the integral sign is the averaging circuit that takes the mean of the squared signal.

The feedback block marked "ln" is the implicit method used to perform the final square-root function. Just as adding logarithms is equivalent to multiplication,

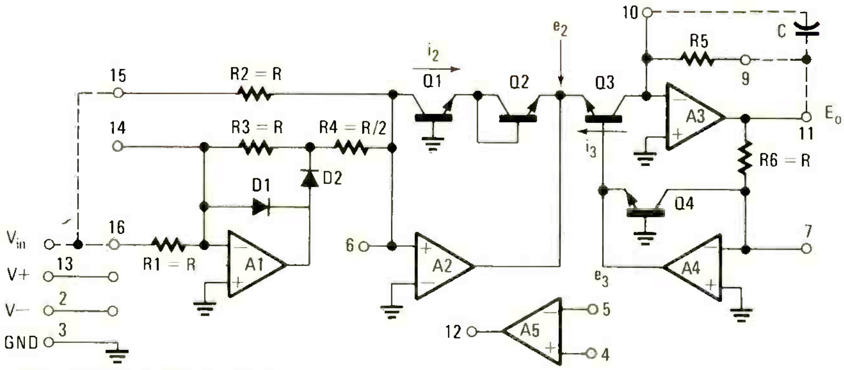


FIG. 5—SIMPLIFIED SCHEMATIC of National's LH0091.

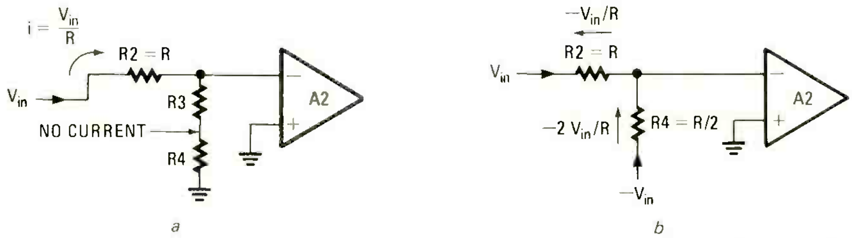


FIG. 6—ABSOLUTE VALUE input circuit of LH0091. Equivalent circuit for positive inputs is shown in *a* and equivalent circuit for negative inputs is shown in *b*.

subtracting them is the same as division. By producing an output that is proportional to the average of V^2_{in}/E_o, E_o will be the square root of the average value of V^2_{in}.

In Fig. 5, A1 with its associated diodes and resistors is the absolute value circuit. The noninverting input of A1 is tied to ground, and, because of the negative feedback around the amplifier, the inverting input is also negative. Any voltage on the input terminal is then impressed across R1 so that the input current through pin 16 is V_{in}/R. When the input terminal goes above ground, current flows into pin 16 to turn on D1. The voltage drop across the forward-biased junction of D1 subtracts from the ground potential on the noninverting input of A1, biasing the output of the amplifier at about 0.7 volt below ground. This negative potential reverse-biases D2, keeping it off.

Figure 6-a shows the equivalent circuit for positive inputs. The input of A2 is also a virtual ground, so there is no voltage across R3 and R4 and no current through them. Input current arrives at the noninverting input of A2 only through R2, and the current is V_{in}/R. Amplifier A1 has acted as a sensitive detector of where the input signal goes positive, and then it acts as a switch to reduce the circuit to one resistor!

Negative-input swings cause the current in R1 to flow from right to left; D1 is biased off and D2 turns on. Because R1 is equal to R3 and their junction is at zero volts, the cathode D2 voltage is positive and has the same magnitude as the input voltage. Figure 6-b shows the two current paths—the first is identical to that for positive inputs through R2; the second is through R4. Summing the currents in the two resistors yields $i_2 = V_{in}/R - V_{in}/(R/2) = -V_{in}/R$. Taking the negative of the negative input makes this current positive. This is exactly the same as the positive input, so the sign of the input is ignored by the circuit!

Next (see Fig. 5), A2 with Q1 and Q2 is the 2 ln-circuit that does the first part of the squaring function. Again, the amplifier has the noninverting input connected to ground. The output voltage is equal to the voltage on the base of Q1, which is zero, plus the negative drops across the base-to-emitter junctions of the two transistors. The logarithmic characteristic of the transistor junctions are used to perform the very useful logarithmic operation on the absolute input current, which is proportional to the absolute value of the input voltage.

The next operation is a summation or, more precisely, a subtraction to take care of the ln-feedback, and then an exponential or inverse logarithm function. Both functions are done in a single process by Q3. Back in A2, an input current was fed into the collector circuit of a transistor, and its junction voltage was used as the output. The opposite is done to take the inverse log by applying the input voltage across a transistor junction and using the collector current as the output. By putting the feedback voltage on the transistor base and the output of the 2 ln-circuit on the emitter, the base-to-emitter voltage on Q3 becomes the difference, $e_3 - e_2$. Solving the equations yields:

$$E_o = \sqrt{\overline{V^2_{in}}}.$$

Amplifier A5 remains unused in the IC and can be used to allow the system to work with high crest factors. Figure 7 shows the recommended circuit for crest factors greater than 2. An external resis-

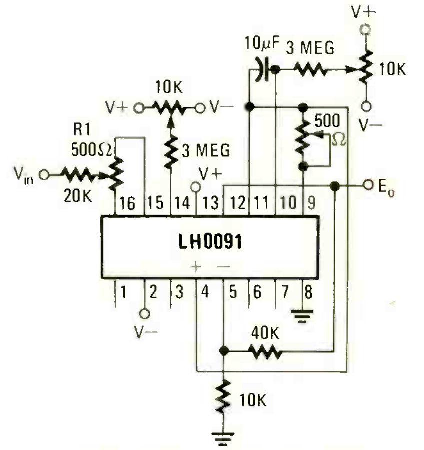


FIG. 7—HIGH CREST-FACTOR CIRCUIT is used with crest factors greater than 2.

tor drops the input current by a factor of 5 in order that input peaks do not overload the circuit. Amplifier A5 is set up with 40K and 10K resistors to get back the gain.

Matched transistors

Some precision DC amplifier applications are adversely affected by the input offsets of conventional operational amplifiers. Balance potentiometers null out the initial offset but temperature and aging drifts must be considered. In power-supply and thermometer circuits, these errors may be significant.

Precision Monolithics Inc.'s MAT-01 Ultra Matched Monolithic Dual Transistor series has outstanding specifications for offset voltage, offset, current and offset temperature coefficients. Improvements compared to other monolithic devices is on the order of 10 times. Both devices must be placed on the same monolithic IC, geometrically interwoven so that they share virtually identical thermal environments.

The V_{be} match for the MAT-01 is 40-μV typical, 110-μV maximum, which compares favorably with numbers that would normally be on the order of 5 mV. The temperature coefficients of this offset are 0.5 μV/°C maximum.

Two fully packed pages of specifications make it fairly obvious that PMI is proud of these circuits. Included are not only the usual offset voltage-versus-temperature plots, but also offset drift-versus-time. These curves remain essentially flat out to the 13-month limit of the abscissa.

The PMI data sheet points out that during circuit turn-on, reverse-bias voltages can be applied to the transistor base-to-emitter junctions. If these voltages exceed 5, degradation in h_{fe} (current gain) and h_{fe} matching may occur. Although essential when using devices such as the MAT-01 series where matching is what it's all about, it's important to remember that all circuits should be checked for excessive reverse bias during turn-on and modified if necessary. Protection may take the form of the diodes that are used across transistor junctions and are poled opposite to the junction.

Prices for the commercial versions of the MAT-01 range from $2.75 to $3.50 each in 100 quantities. Precision Monolithics Incorporated, 1500 Space Park Drive, Santa Clara, CA 95050.

Signetics-Motorola agreement

As the result of an agreement between the two companies, Signetics will manufacture Motorola's MC1399 color-processing IC and Motorola will make Signetics' TCA440 five-stage AM radio IC.

The MC1399 IC has unmatched linearity for DC chromatic control and uses a phase-locked-loop subcarrier regenerator that is more accurate than injection lock systems.

The TCA440 IC has a 100-dB dynamic range and can be used in both AM and CB applications.

8080 assembler

RO-CHE System's Assem 1.0 8080-assembler works with their multi-cassette controller. It can assemble source-code programs that are larger than the computer memory.

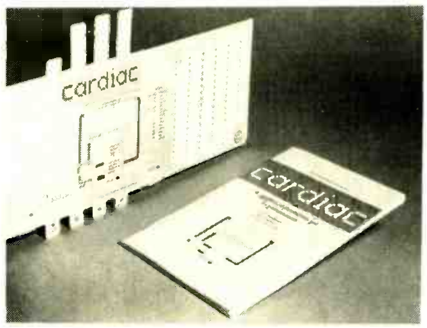
The first of two passes reads the source code from the tape and builds a symbol table. The tape is read again in the second pass, and the object program (machine language) is created and stored in memory. The assembled program can then either be run or stored on cassette tape.

The Assem 1.0 can be purchased from RO-CHE Systems, 7101 Mammoth Avenue, Van Nuys, CA 91405, for $10. Also provided are a line editor, the assembler on cassette tape and instructions. **R-E**

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

COMPUTER LEARNING SYSTEM, *Cardiac,* is a simple manually operated computer training device plus 53-page manual for a complete "hands-on" teaching aid. *Cardiac* operates by manipu-



lating cardboard slides to display register contents through windows. A series of 10 different programs range from the simple to more complex formats. Loops, indexing, bootstrapping, double-precision techniques and subroutines are all demonstrated. Price: $4.95, plus $1.50 shipping and handling.—**Comspace Corp.,** 350 Great Neck Rd., Farmingdale, NY 11735.

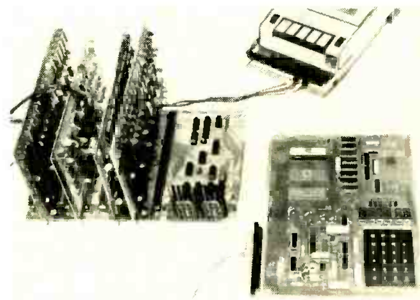
CIRCLE 106 ON FREE INFORMATION CARD

SOLDER/SOLDERING ACCESSORIES, a complete line of products designed for many professional and home uses. Included are Multicore

solders in a variety of alloys and/or fluxes; solid-wire solders; creams, pastes and wicks; an emergency solder; and special formulation for soldering stainless steel and silver jewelry.—**Multicore Solders,** Westbury, NY 11590.

CIRCLE 107 ON FREE INFORMATION CARD

INTERFACE/MOTHERBOARD, *Kimsi,* comes in kit form or assembled. Attaches to any KIM-1 computer to provide, on a single board, both interface and motherboard with eight 100-pin slots. *Kimsi* allows S-100 compatible boards to be plug-compatible with KIM. Instructions are executed at top speed, with no extra instructions or software needed. The board includes complete address decoding and power regulation for KIM, as well as facilities for DMA and multiprocessing on the S-100 bus.



Kit comes with double-sided circuit board with soldermask and owner's manual; all parts, IC sockets and 100-pin connector are included. Prices: kit, $125; assembled, $165.—**Forethought Products,** Box 386, Coburg, OR 97401.

CIRCLE 108 ON FREE INFORMATION CARD

CABLE TIES AND CLAMPS, *EZ Fasteners,* come in reusable display package (*Re-Use-A-Pac*). Removable card enables refilling heavy-gauge plas-

tic bubble when necessary. Point-of-purchase rack available. Clamps and ties are also available in bulk.—**South Shore Trading Corp.,** 422 S. Franklin St., Hempstead, NY 11550.

CIRCLE 109 ON FREE INFORMATION CARD

PROJECTION TV SYSTEM, *Projectapix II,* uses superfast f/1.85 optic lens for sharper image and brilliant color. Featuring solid-state electronics, system contains a video tape recorder and a built-in digital clock/timer with LED readout that can be used to control and record one program as you watch another; unit can also record radio music or perform as a tape recorder; even home movies can be created (with the use of a video camera). A stop-action pushbutton is provided for either instant replay or erase. A four-foot screen is also available. Optional accessories

include remote controls; video games; mikes and mike mixers; cameras; a special control accessory that projects smaller image in corner of the screen, for dual-program monitoring; plus a video disc. The *Projectapix II* sells for $2790; the four-foot screen, $1495.—**Projectapix, Ltd.,** Suite 1L, 300 West 53rd St., New York, NY 10019.

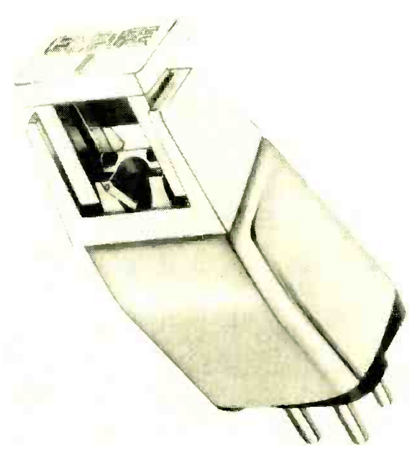
CIRCLE 110 ON FREE INFORMATION CARD

40-CHANNEL CB TRANSCEIVER, *Sidebander IV*, is an SSB/AM unit that uses digitally synthesized circuitry, with an RF output of 4 watts and 12 watts SSB PEP. Controls include squelch,

volume, clarifier, RF gain, and switchable noise blanker and limiter. Also included are PA provision and mike. Suggested list price: $379.95.—**SBE, Inc.,** Dept. P, 220 Airport Blvd., Watsonville, CA 95076.

CIRCLE 111 ON FREE INFORMATION CARD

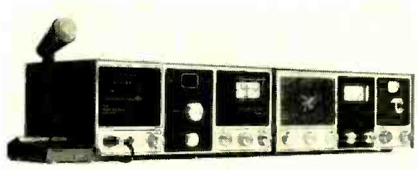
PHONO CARTRIDGE, *model 2000T*, is designed for stereo and matrix 4-channel (SQ, QS, RM) playback. Specifications include: frequency re-



sponse of 20 Hz–20 kHz ± 1½ dB; tracking force range of ¾–1¼ grams; lateral and vertical compliance of 30 × 10^{-6} cm/dyne; tracking ability of 38 cm/sec at 1 kHz at 1 gram; channel balance within 1 dB at 1 kHz; a rated input load of 47,000 ohms/channel; an output of 3 mV/channel at 3.54 cm/sec. Price: $90.—**Empire Scientific Corp.,** 1055 Stewart Ave, Garden City, NY 11530.

CIRCLE 112 ON FREE INFORMATION CARD

CB BASE STATION, *Golden Eagle Mark IV SSB/AM*, uses *Transcan* system to sweep all transmit frequencies. Circuitry is phase-locked loop with



full 4-watt power and 100% modulation. Transmitter RF output, up to 12 watts PEP (SSB); carrier suppression is better than −70 dB. Receiver sensitivity is 0.32 μV for a 10 dB signal-to-noise ratio.

Transmitter features include LED readout, RF amplifier for AM operation, automatic level control for SSB, channel reset and lock detector. Receiver has fine tune control, AGC on-off switch, beat-frequency oscillator, noise blanker. *Model 776* high-impedance mike is included with unit; the *Astatic model GD-104* mike is available as an option. Unit measures 6¾ × 15½ × 10 inches. Two-year warranty. Price: $950.—**Browning Laboratories, Inc.,** O'Shea Industrial Park, Laconia, NH 03246.

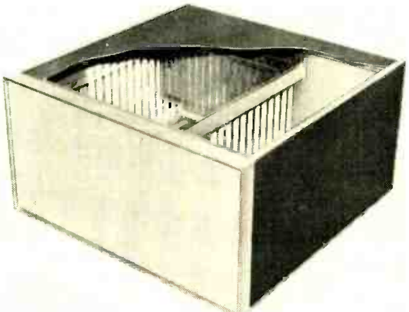
CIRCLE 113 ON FREE INFORMATION CARD

CB HEADSET MIKE, *SpeakEasy*, is voice-activated via miniaturized preamp for hands-free operation. Features separate amplifier with red/green LED readout for transmit/receive modes and built-in mini-microphones. Made of lightweight aluminum, *SpeakEasy* can be powered from any 12-volt supply. Suggested retail price,

$79.95.—**Chase Western Product Sales Division,** 11526 Burbank Blvd., North Hollywood, CA 91601.

CIRCLE 114 ON FREE INFORMATION CARD

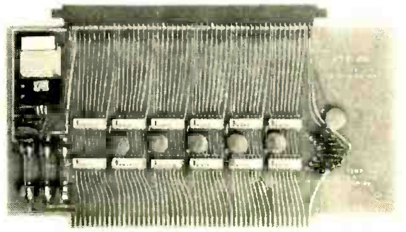
MICROCOMPUTER CARD CASES, *Vector-Pak models VP1, VP2,* accommodate IMSAI, ALTAIR and other 5.31- by 10-in. cards. Fully assembled cases are compatible with IMSAI and ALTAIR systems, *model VP1* having front-to-back orientation, *model VP2,* with side-to-side orientation. Cases have space for 21 cards, and adjustable slots that permit receptacle or motherboard mounting. Plastic card guides are supplied separately. Both cases have sturdy aluminum chassis and measure 17.85 × 9.01 × 17.1 in. and weigh 5 lbs. Optional accessories include prepunched 10-hole rear panel for 25-pin D-type connectors,



Vector *Series 8800* prototyping cards, and sockets, connectors, pins and tools. Prices: *model VP1*, $128.30; *model VP2*, $134.30.—**Vector Electronic Co., Inc.**, 12460 Gladstone Ave., Sylmar, CA 91342.

CIRCLE 115 ON FREE INFORMATION CARD

EXTENDER BOARD, *model VTE-100. The Exterminator*, is an S-100 bus compatible card that occupies one slot on the motherboard. It serves as a terminator for the entire bus, using bridge terminating networks that do away with crosstalk and extraneous noises. The *model VTE-100* can be used with any memory or I/0 card without interference from adjacent boards. Fused power buses protect against accidental damage and provide easy access for current monitoring. Unit comes assembled and tested and costs $49.95, plus $2 shipping and handling ($4 for foreign orders).—**VAMP Inc.**, Box 29315, Los Angeles, CA 90029.



CIRCLE 116 ON FREE INFORMATION CARD

EARLY WARNING SMOKE DETECTOR, *model S29*, is a self-contained ionization home unit designed to detect early stages of a fire, thus making it ideal for home, mobile homes, apartments, vacation houses, etc. No wires are

needed; simply screw the detector into the ceiling. AA batteries are included. Can operate remote equipment such as a bell, siren, light, monitor panel or telephone dialer by using built-in relay with 0.125-amp, 115-volt rated contacts. The *model S29* measures 5½ in. square and is 3 in. high. Price: $79.—**Mountain West Alarm Supply Co.,** Box 10780, Phoenix, AZ 85064.

CIRCLE 117 ON FREE INFORMATION CARD

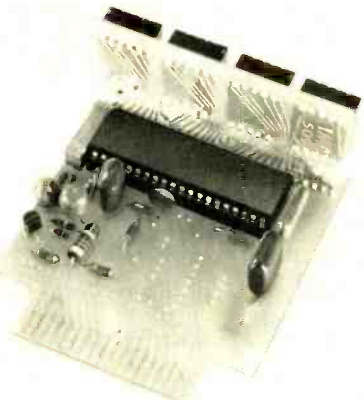
MICROWAVE LEAKAGE DETECTOR, *model 245M,* is a self-powered, hand-held instrument that needs no batteries or outside power source.

Designed for home, industry and commercial applications, instrument checks for 2450-MHz microwave leakage. The meter is calibrated to

0–5 mW/cm^2, with a maximum of 5 mW/cm^2 from oven as a safe limit. Mounted in a high-impact case, the *model 245M* measures 2 × 4 × 0.5-in., and sells for $49.95.—**UCE, Inc.,** 20 N. Main St., Norwalk, CT 06854.

CIRCLE 118 ON FREE INFORMATION CARD

DIGITAL PANEL METER, *Series B500*, succeeds manufacturer's earlier *Series 500* unit. The DPM consists of a single IC, 7 passive components and a 0.5-inch red 3½-digit LED readout. Features auto-zeroing, with a 200 mV–1000-volt input range, and operates from either 5 volts DC or



115–230 volts AC, 47–400 Hz. Single unit price, $59; 100 quantity, $39.—**International Microtronics Corp.,** 4016 E. Tennessee St., Tucson, AZ 85714.

CIRCLE 119 ON FREE INFORMATION CARD

SAMPLE SOLDER KIT, dispenser-packed kit includes five different solders for the following uses: stainless-steel and jewelry; plumbing, sheet

metal and general metal joining; electrical wiring, electronic assemblies and PC boards; and aluminum soldering. Multiple cores provide proper flux to metal ratio, let you work faster and use less solder. Kit comes with *Solder User's Guide*, and costs $8.95 (introductory price, includes shipping/handling). For detailed information on solders in sampler kit and how to order, write the manufacturer.—**Multicore Solders,** Westbury, NY 11590.

STATIC ELIMINATOR GUN is the first in a line of *Audio Groome* products designed to improve stereo record performance. Double-barrel gun

releases a flow of negative and positive ions to remove static from records. No batteries or outside power source are needed.—**Empire Scientific Corp.,** 1055 Stewart Ave., Garden City, NY 11530. R-E

CIRCLE 120 ON FREE INFORMATION CARD

next month

■ Build A Darkroom Timer

Great addition to your darkroom. Has an LED readout and keyboard entry of exposure time. Automatically turns off your safelight when exposing a print.

■ All About Disposable Batteries

Ever wonder what the differences between akaline, carbon zinc and mercury batteries are. Here's an in-depth explanation plus what you should expect in terms of performance from each type.

■ Digital Hi-Fi Recording

Your hi-fi tape recorder will never be the same. Here's a look at where the industry is going and what may happen to your tape recorder in the near future.

Plus:

Hi-Fi Lab Test Reports

Computer Corner

Jack Darr's Service Clinic

Hobby Corner

State-Of-Solid-State

and more

books

SERVICING SONY COLOR TV FOR 1969–1972, by Stan Prentiss. Theodore Audel & Co., Div. of Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 304 pp. 8½ × 11 in. Softcover $49.95.

This service guide contains adjustment and alignment specifications, troubleshooting information, schematics, parts lists, disassembly instructions and operational theory. Chapter 1 gives the reader a basic understanding of the barrier AGC system used in today's TV receivers. Other chapters deal with specific troubleshooting methods for the models covered in this book. Foldout schematics are included in the back of the book.

RADIOMAN'S GUIDE, Fourth Edition, by Robert G. Middleton. Theodore Audel & Co., Div. of Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 470 pp. 5½ × 8¼ in. Hardcover $7.50.

When radio was first developed, it was greeted as the miracle of the age, but no one could have predicted its many present-day uses in such diverse fields as industry, navigation, space exploration, surveillance—the list is endless. This book provides the layman with a sound understanding of the basic principles of radio. It presents its material clearly and simply. Some of the chapter titles are: "Elements of Radio," "Magnetism," "Inductors," "Capacitors," "Basic Electronic Circuits," Radio Transmitters," and "Radio Testing."

THE 8080A BUGBOOK, MICROCOMPUTER INTERFACING AND PROGRAMMING, by Peter R. Rony, David G. Larsen and Jonathan Titus. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 416 pp. 5½ × 8½ in. Softcover $9.95.

This latest in the *Bugbook* series contains the basic interfacing concepts of the Intel 8080 IC along with a discussion of I/O programming so that you can then develop your own interfaces to other devices such as teletypes, panel meters, A/D and D/A converters, etc.

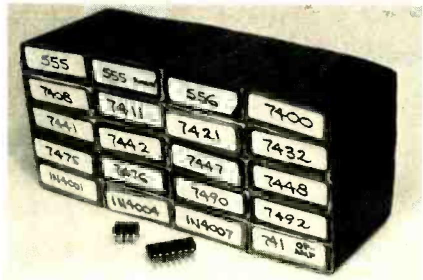
The first three chapters introduce you to the microcomputer, describe a small 8080 device and how to program it. Later chapters deal with device select-pulse generation, clock cycles, the international operation of 8080 IC; subroutines, interrupts, external flags and stacks are discussed in Chapter 7. The appendixes contain references, and instruction set summaries for both the 8080 and 8080A microcomputers.

ELECTRONIC COMMUNICATIONS SYSTEMS, Second Edition, by George Kennedy. Gregg/McGraw-Hill Book Co., 1221 Ave. of the Americas, New York, NY 10020. 774 pp. 6½ × 9¼ in. Hardcover $16.95.

This book is written for postsecondary-level engineering students having a basic familiarity with electronics communications and who have completed algebra, trigonometry and binary arithmetic. This volume includes all the latest developments in the field, and chapter sequence has been reorganized. Two new chapters have been added: Broadband Communications Systems and Television Fundamentals. Each communications system is described in logical progression—what it does and how, where it is applicable and what its future applications could be. An instructor's manual with exercises and solutions is contained in the back. **R-E**

Organize Your Junkbox

FRED BLECHMAN



A SIMPLE INEXPENSIVE WAY TO FIND small parts easily and quickly is to use match boxes. Parts cabinets can be made from pocket-size match boxes available in supermarkets, the brand used here is Ohio Blue Tip Matches (Ohio Match Company, Wadsworth, OH 44281). Each box is approximately 2-long, 1½-wide and ½-inches high. A 10-box package only costs around 20¢!

To make small-parts storage cabinets, glue, self-adhesive plastic and labels are needed. Rubber cement is ideal since it doesn't "set" immediately. The self-adhesive plastic comes in various designs and colors, and is available in most five-and-ten-cent and variety stores for about 70¢ a yard in the 18-inch width. The Avery Label Company (Azusa, CA 91702) makes No. S-620, ⅜ × 1¼-inch self-adhesive labels sold in stationery stores in boxes of 1,000 labels for around $2.

To make a parts cabinet, empty the matches out of the individual boxes and glue them together in a convenient arrangement. Four-boxes-wide by five-boxes-high makes a cabinet about 6 × 3 × 2-inches, with 20 drawers. Before the cement has dried thoroughly, cut a 2½-inch-wide strip of self-adhesive plastic long enough to band the tops and sides of the assembled boxes. (A walnut-grain design makes the finished cabinet look like wood.) Peel off the paper backing and carefully apply the plastic around the boxes so that it holds them together securely. Trim with scissors or a razor blade and the cabinet is finished. **R-E**

For faster service USE ZIP CODE on all mail

HOBBY CORNER

continued from page 91

dirty" PC board, perhaps for a circuit that uses only a couple of transistors and a few other parts. It hardly seems worthwhile to draw with resist and then etch such a small board. You don't have to if you have a hand-held grinder or a flexible shaft tool.

If the pattern is not too small and/or complex, you can *grind* away the copper that you would have etched away. You can isolate pads of copper to receive two, three or more leads. Transistor sockets are not difficult to make, except for DIP sockets for IC's which are very difficult to construct. It can be done but it requires patience and a *very* steady hand.

The unwanted copper can be ground away with any of the small steel cutters that are normally used with a flexible shaft or hand-held tool. I have discovered that the round end cutters are less satisfactory than those with square and pointed ends. Some of the grinding bits used by dentists are excellent for PC board use. Ask your dentist to save his dull ones for you—they have a lot of copper-grinding life left in them.

When cutting away copper, try not to dig too deep into the board. Cutting away too much of the base material will weaken the board mechanically. If the tool slips and you cut across a copper run (and you will do this at first), don't discard the board because you can always jump the cut with wire. Finally, **always wear safety goggles** to protect your eyes—those fast-spinning cutters really throw out very fine slivers of material.

You now have a quick and easy way to construct PC boards that should speed up your prototype and one-of-a-kind construction.

Reader suggestions

From time to time we have invited readers to send in ideas and suggestions for this column. We have especially welcomed circuits that you would like to share with other readers. Numerous ideas and suggestions have been received, and we appreciate every one of them.

We've also received letters about circuits, but most of the letters begin, "I need a circuit that will . . ." Well, sometimes I have such a circuit, but most often I can only suggest how it can be developed.

However, some of you must be *building* circuits, too. Just what kinds of things are you constructing? How about sharing your projects and ideas with others?

All you have to do is sketch a schematic diagram, attach a parts list and a short description of the project, and mail it to **Radio-Electronics.** We will examine each entry carefully and publish the best in future "Hobby Corner" articles. Of course, your name will be listed as the contributor.

Here are a few items that others have asked for:

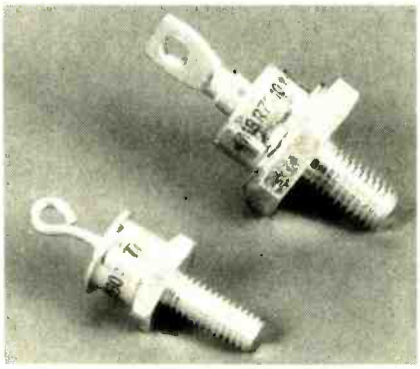
- A reader in New York wants an add-on for his model rocket launcher that would provide a digital readout, automatic countdown and close the launch circuit at time zero.
- Someone in Ohio wants to discourage burglars. He needs a timer that will turn lights on and off in different parts of the house at different times.
- A Florida reader needs a simple circuit to put numbers on a digital readout from a keyboard the way it is done in calculators.
- A model railroad club in New York would like to have a layout running-time counter that would be cumulative from one session to another yet continue to operate under derail conditions.
- A reader in Connecticut wants a rate counter for motor RPM, a wind-speed indicator and similar devices.

Those are only a few ideas. Electronics is present in every field of human endeavor. If you've developed a circuit to perform a task, why not consider sharing it? Send it along to Hobby Corner, **Radio-Electronics**, 200 Park Avenue South, New York, NY 10003. **R-E**

Solid-State Update

Schottky rectifiers

Schottky rectifiers are ideal for power rectification because of their lower forward voltage and the resulting lower power dissipation. The 17-device MBR7520 family from Motorola has a greater transient capacity than other rectifiers on the market. The diodes have a forward-current rating from 25 to 75 amp and



SCHOTTKY RECTIFIERS FROM MOTOROLA

have reverse voltage ratings up to 45 volts. Most devices in the series have dV/dt ratings of 100 volts-per-μs.

At a 100°C case temperature, 70-amp forward current and 45 volts, test units have been subjected to 8.3-ms, 1300-amp pulses once-per-minute, with no failures. The diodes recover from transients above the operating voltage specifications that drive them into temporary avalanche breakdown.

The rectifiers are mounted in DO-4 and DO-5 stud packages. Additional data is available from Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036.

Operational amplifiers

Signetics' SE/NE5534 operational amplifier has a 10-MHz small-signal bandwidth and a 200-kHz power bandwidth. It can drive 600 ohms to 10 volts RMS. The operational amplifier is internally compensated for gains equal to or higher than 3, and can be used in high-quality audio equipment, instrumentation and control circuits and telephone channel amplifiers.

The DC gain is 100,000 volts, the AC gain is 6000 volts at 10 kHz and the supply range is ±3 to ±20 volts. The amplifiers are available in 8-pin mini-DIP and TO-5 packages, cost between $1.50

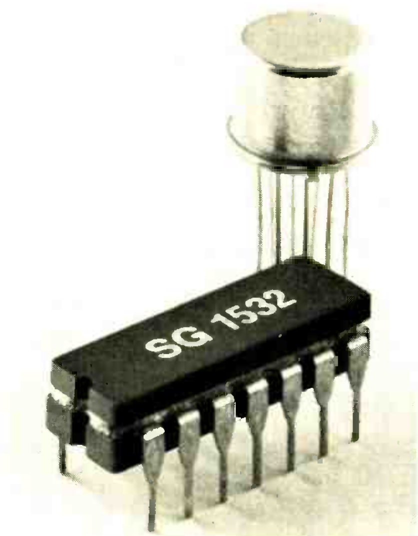
and $2.00 in quantities of 100. Details are available from Signetics, 811 East Avenue, Box 9052, Sunnyvale, CA 94086.

Texas Instruments has expanded their BIFET (*B*ipolar *F*ield-*E*ffect *T*ransistor) operational-amplifier line to 12 circuits. The TL061 and TL071 series combine JFET's (*J*unction *F*ield-*E*ffect *T*ransistor) and bipolar transistors, which results in low input-bias current requirements with higher internal current levels for higher performance levels.

The TL061 has a 3.5-volt-per-μs slew rate and a 0.2-mA current drain that makes it suitable for battery operation. Specifications for the TL071 are a 13-volt-per-μs slew rate and a 2.5-mA maximum current drain. The low noise and distortion levels for the TL071 makes it suitable for use in preamplifiers. Inquiries should be sent to Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308 (Attn: TL061 and TL071), Dallas, TX 75222.

Voltage regulator

Silicon General's SG1532, SG2532 and SG3532 precision general-purpose regulators are substantially improved versions of the industry standard SG723. The SG1532 has a minimum required



SILICON GENERAL'S SG1532 VOLTAGE REGULATOR

input voltage of 4.5 compared with the SG723's 9-volt specification. Lower voltages can be sustained across common 5-volt regulators, reducing the dissipation.

The SG1532 has thermal shutdown and current-limit protection. The IC is protected even if an external pass transistor fails. A sense voltage of only 89 mV is needed to current-limit the SG1532 compared with 650 mV for the SG723. A series-current sense resistor is inserted in the output current path to trigger the current-limit protection circuit. At 650 mV and, for example, 10 amps, the sense resistor dissipates 0.65 × 10 or 6.5 watts—a lot of wasted energy.

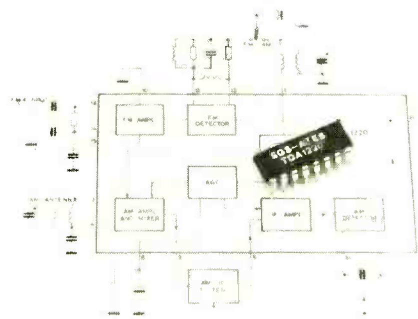
turn page

The older SG723 design uses a Zener diode reference, while the SG1532 has a lower noise band-gap reference.

Line regulation is 0.01%-per-volt maximum, and the output current capacity is a minimum of 100 mA. The price is $1.10 per unit in quantities of 100. Silicon General, Inc., 7382 Bolsa Avenue, Westminster, CA 92683.

Another radio circuit

SGS-ATES Semiconductor Corp. also has AM/FM integrated circuits—the TDA1220 and TDA1230. The TDA1220 has an FM IF amplifier-limiter, an FM detector, and an AM RF amplifier, mixer, oscillator, IF amplifier and detector. The FM limiting sensitivity is 30 μV, the amplitude modulation rejection (AMR) is 50 dB and the S/N ratio is better than 60 dB.



SGS-ATES FM/IF amplifier

The TDA1230 goes further with an AF power amplifier that is driven from the on-chip FM detector or from an external audio source. **R-E**

CROSSTALK IN ORGAN

I wrote about a crosstalk problem in a home-made electronic organ I am building. You said it was out of your line but made some helpful suggestions! One suggestion was to reduce the signal level at the point where the problem started.

I also found a lot of good data in some articles written by John S. Simonton, especially the article in which he wrote that, in some cases, too many grounding points would actually be a drawback. Thanks to you both.—H. B., Lancaster, PA.

You're welcome!

LONG-TERM INTERMITTENT

I wonder if you can give me some clue on this RCA model CTC-16X. It works for quite a while, then goes out of focus. The picture turns red, then it blacks out. The worst part is it's MY set!— L. S., Oak Park, IL.

Oh, you've got one of the *later* models; mine's a *model CTC-15*! Anyway, I remember a *model CTC-10* that showed exactly these symptoms. After watching it in vain for some time, I finally caught the symptom. A quick check in the back of the set showed that the *damper* tube heater was slowly going out! In this case, it was not the damper tube, but a bad contact on one of the heater pins in the socket. You already changed the damper tube, but you should clean up the contacts on that socket. (I still haven't figured out why the picture turned red as it went out, but I saw it.)

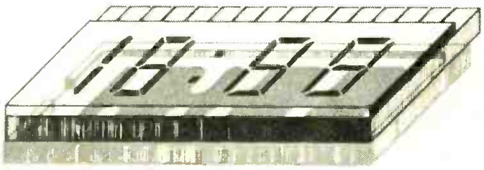
NO VERTICAL HOLD

This Philco model 21KT40 has a unique problem: The height and linearity are good, the vertical sync is very critical, and, the unique part, the vertical hold control has no effect whatsoever! I replaced the plate-load resistor, the multiplier grid resistor, etc., nothing. I changed capacitor C62, nothing. Everything else seems to check OK. I'm just scratching my head!—K. S., Seymour, IN.

What can mess up this circuit is a leakage in the capacitors in the feedback loop, especially capacitor C59. Somehow, the time constant in the input-grid circuit is way off. As a last resort, get out your shotgun and change them all at once.

(Feedback: "You're right. I loaded up the shotgun and the third capacitor was the one—C59, the coupling capacitor from the end of the feedback loop to the input grid. Thanks a million.") **R-E**

What is an LCD?



BY KEITH RIORDAN

LIQUID CRYSTAL DISPLAYS (LCD'S) DIFFER FROM OTHER types of displays in that they scatter, rather than generate, light. Two basic types are available: reflective, which require front illumination, and transmissive, which require rear illumination. Both types use a field-effect cell that is filled with liquid crystal material.

A liquid crystal material is an organic compound – that is, a compound containing carbon, hydrogen, oxygen, and nitrogen – that has the optical properties of solids and the fluidity of liquids. In the liquid crystal state, which is exhibited over a specific temperature range, the compound has a milky, yellow appearance. At the high end of the temperature range, the milky appearance gives way to a clear liquid. At the low end of the range, the compound turns to a crystalline solid.

The molecules of a liquid crystal compound are in the form of long, cigar-shaped rods. Because of the special grouping of the atoms that form these molecules, the rods act as dipoles in the presence of an electrical field. This characteristic enables the molecules to be aligned in the direction of the electrical field and provides the basis for operation of a liquid crystal display.

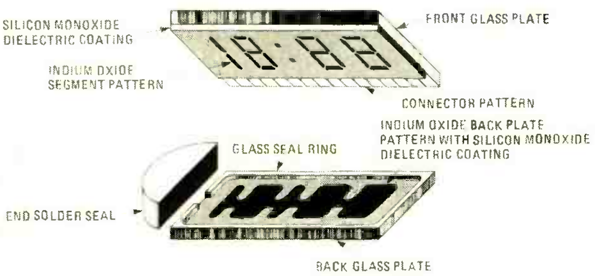


FIG. 1 - FIELD-EFFECT CELL STRUCTURE

FIELD-EFFECT CELL STRUCTURE

A field-effect liquid crystal cell consists of two glass plates, each with a transparent conductive coating, between which the liquid crystal material is sandwiched (*Figure 1*). A thin film of indium oxide – a transparent electrical conductor – is deposited on the top, or front, glass plate. This oxide is patterned to produce a series of 7-segment characters. Each segment has a lead that extends to the long edge of the glass. The bottom, or back, glass plate also has an indium oxide coating, but the pattern is designed as a common electrode that, when the plates are fused, registers to the top glass pattern. The oxide-coated side of both the top and bottom glass plates is entirely covered by an evaporated layer of silicon monoxide dielectric, which produces the desired alignment of the liquid crystal molecules.

After the conductive and dielectric coatings have been applied, the top and bottom plates are fused to within 0.0005 inch by a glass ring that has a 0.05-inch opening on one side. Both plates have a strip of solderable metal – gold over copper over chrome – on the side with the opening. This opening is used to introduce the liquid crystal material into the display envelope, after which the metal strips are soldered to seal the opening.

REFLECTIVE LCD OPERATION

A reflective LCD consists of a vertical polarizer, liquid crystal field-effect cell, horizontal polarizer, and reflector (*Figure 2*). With no voltage applied, the treatment of the

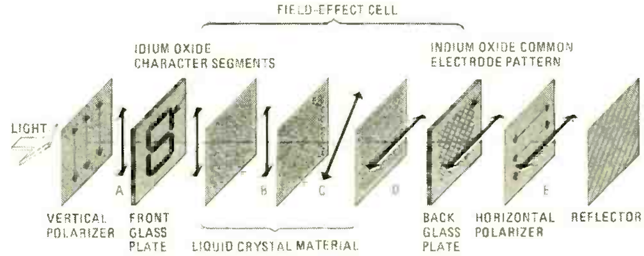


FIG. 2 - UNENERGIZED REFLECTIVE LCD

liquid crystal cell plates produces a uniform alignment of the crystal molecules. If the front and back plates are mounted at right angles to one another – according to the way in which the crystal molecules line up – a 90-degree rotation, or twist, of the alignment occurs. Vertically polarized light entering the front of the cell (A) follows the rotation of the crystal alignment as it passes through the cell (B, C, D). Having been rotated 90 degrees, the polarized light passes through the horizontal polarizer to the reflector (E). The light is then returned through the cell, again rotating 90 degrees, and passes out of the LCD through the vertical polarizer.

When voltage is applied across one or more of the character segments (*Figure 3*), the crystal molecules in the area

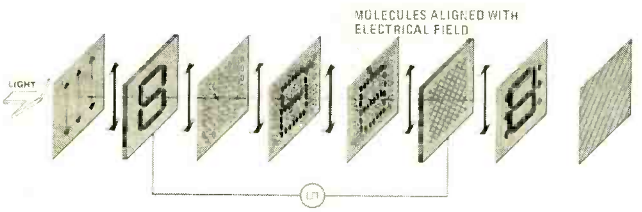


FIG. 3 - ENERGIZED REFLECTIVE LCD

of the segments align themselves with the electrical field. Rotation therefore does not occur in the region of the energized pattern elements. The vertically polarized light conforming to the image produced by these elements cannot pass through the horizontal polarizer but is, rather, absorbed by it. The energized display elements therefore appear as black images against a light background.

TRANSMISSIVE LCD OPERATION

A transmissive LCD consists of a vertical polarizer, field-effect cell, horizontal polarizer, and light source. The light source, which may be of any suitable type, is in the same position as the reflector in a reflective display.

With no voltage applied to the cell, light from the source passes through the horizontal polarizer, is twisted by the cell, and passes out of the LCD through the vertical polarizer at the front of the display. When voltage is applied to the cell, the twist is destroyed in the region of the energized pattern segments. The horizontally polarized light emitted by the source is absorbed by the vertical polarizer, forming the black-on-white image of the energized pattern segments.

A white-on-black effect can be achieved by using two horizontal (or two vertical) polarizers. In this case, light in the area of the energized pattern elements passes through both polarizers while light in the surrounding area is absorbed. **R-E**

Radio-Electronics Tests Lux R-1120 Stereo AM/FM Receiver

1

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

LUX AUDIO OF AMERICA, LTD., THE AMERICAN subsidiary of Lux Corporation of Japan, has labeled their three receivers as tuner-amplifiers in the advertising campaigns introducing the products to the U.S. market. After three years establishing its reputation as a maker of top-quality separate components, the firm now seeks to capture some of the high-volume sales potential of the all-in-one receiver market.

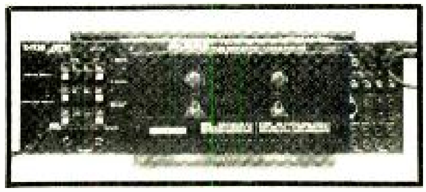
The *Luxman model R-1120* stereophonic AM/FM receiver is shown in Fig. 1. It is clear from this photo that Luxman receivers (all of which bear a family resemblance) are not merely carbon copies of other better-known integrated units. The front panel contains a large bronze-colored dial area opening camouflaging less-used controls and switches while the most-used controls are neatly positioned below them, creating a distinctly uncluttered rich look.

Major controls are arranged along the bottom of the panel. They include an input program selector switch (with two phono settings, AM, FM and AUX); BASS and TREBLE controls, which, when gently pulled forward, offer alternate crossover or turnover frequencies; a large central tuning knob; dual-concentric volume/balance controls; and a SPEAKER selector switch. The headphone jack is located to the right of this last switch.

Secondary controls and switches blend neatly into the dark-colored area above the dial scales. These controls include a Dolby FM switch (active only if you purchase an optional extra Dolby decoder board that plugs into the chassis via an otherwise empty multiple-pin connector), a tape-monitor switch, a tape-selector switch (up to two tape decks can be handled by the *model R-1120*), a tape dubbing switch (one-to-two or two-to-one), a mono/stereo mode switch, a LOUDNESS switch, a SUBSONIC switch, low- and high-cut filter switches, a selector switch that governs the sensitivity of two series of peak indicator power switches and a main POWER on-off switch.

Linear FM and AM dial scales positioned just below these controls illuminate softly when power is applied. Below the dial scales, at the left, are indicator lights for the Dolby switch and for stereo FM reception, plus illuminated signal-strength and center-of-channel tuning meters. The lower right-hand side of the dial area includes two symmetrically placed groups of LED indicators, calibrated at −18, −15, −12, −9, −6 and 0 dB. The 0-dB calibration corresponds either to the rated power output of 120 watts (into 8-ohm loads) or, when the sensitivity button is depressed, to an output of 7.5 watts. This arrangement extends the usefulness of the LED indicators so that power output can be read instantaneously even when you listen at low levels (down to 120 milliwatts-per-channel). An additional LED serves as a power-on indicator and, when power is first applied, flashes intermittently for a few seconds as voltage in the receiver become stabilized. The light remains continuously lit when this process is completed, and only then is sound fed to the speaker systems.

The rear panel of the *model R-1120* is shown in Fig. 2. Three sets of spring-loaded speaker terminals are located to the left,



2

together with switched and unswitched convenience AC receptacles. Two sets of speaker terminals are used for connecting two pairs of conventional dynamic speaker systems, while the third set of terminals is specifically for connecting electrostatic wide-range speakers that often require (or present) different amplifier impedances. Speaker-line fuses for each channel are located below the three sets of speaker terminals.

A metal grill in the center of the rear panel covers and protects the four output transistors that are mounted directly to projecting heat sinks. In the right-hand section of the panel are four antenna input terminals (for connection to external AM, 75-ohm and 300-ohm FM antennas), a chassis ground terminal, two sets of phono input terminals, auxiliary input terminals, two sets of tape input and output terminals and a DIN connector that parallels the pin-jack tape-1 terminals. An antenna attenuator switch is located in this area for use during reception of overly strong incoming FM signals. A large AM ferrite-bar antenna can be rotated away from the metal chassis surface and oriented for best reception.

A wide variety of equipment can be connected to and used with the *model R-1120* receiver (see Fig. 3). Rather surprisingly, there are no jacks for separate operation of the two sections of the receiver (preamplifier-out/main amplifier-in jacks), despite the emphasis Lux places on the tuner/amplifier characteristics of this receiver. There is no FM detector output jack (for possible future use with four-channel FM adapters) nor any jacks for connection to an oscilloscope to observe multipath interference and antenna orientation.

Circuit highlights

The preamplifier section of the *model R-1120* uses a three-stage, direct-coupled circuit using PNP transistors, followed by a two-stage direct-coupled voltage amplifier, a buffer stage using NPN transistors and a two-stage direct-coupled control amplifier section using PNP devices. In the power amplifier section, a difference amplifier using low-noise transistors

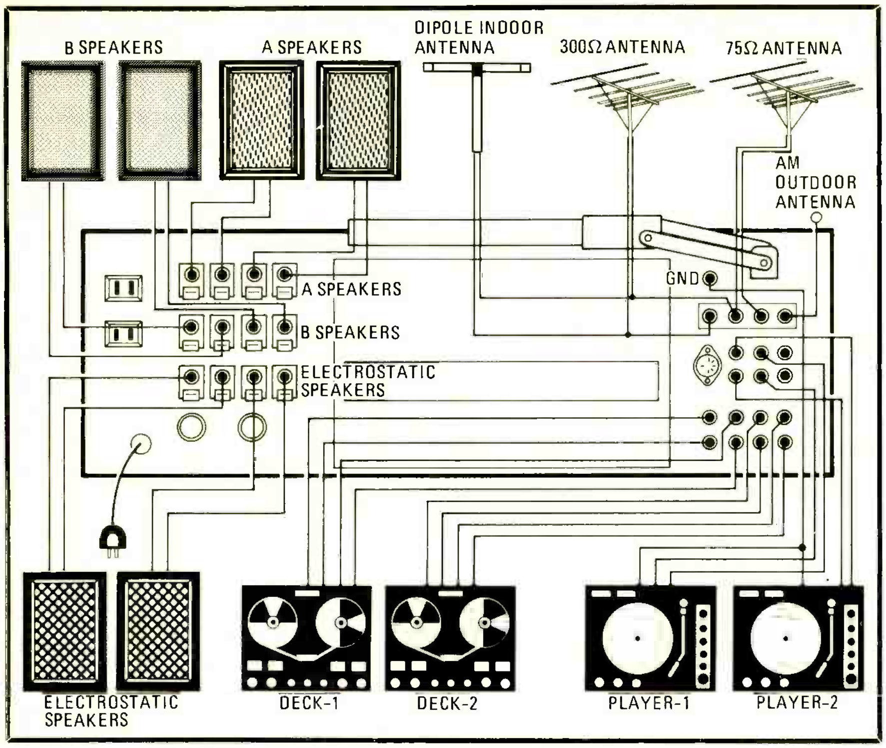
MANUFACTURER'S PUBLISHED SPECIFICATIONS

FM TUNER:
IHF Sensitivity: mono, 1.8 μV (10.3 dBf); stereo, 4.0 μV (17.2 dBf). **50-dB Quieting:** mono, 2.8 μV (14.1 dBf); stereo, 38 μV (36.8 dBf). **S/N Ratio:** mono, 74 dB; stereo, 70 dB. **Selectivity:** 80 dB. **Frequency Response:** 20 Hz to 15 kHz, +0.2, −1.5 dB. **Distortion:** mono, 0.1% at 1 kHz, 0.3% at 6 kHz; stereo, 0.2% at 100 and 1000 Hz, 0.4% at 6 kHz. **Capture Ratio:** 1.3 dB. **Image Rejection:** 80 dB. **IF Rejection:** 85 dB. **AM Suppression:** 55 dB. **Stereo Separation:** 48 dB at 1 kHz, 45 dB at 100 Hz, 42 dB at 10 kHz. **Subcarrier Rejection:** 60 dB. **SCA Rejection:** 60 dB.

AM TUNER:
Sensitivity: 200 μV-per-meter (internal antenna). **Image Rejection:** 75 dB. **IF Rejection:** 80 dB. **S/N Ratio:** 52 dB. **THD:** 0.5% (30% modulation). **Selectivity:** 32 dB.

AMPLIFIER & PREAMPLIFIER:
Power Output: 120 watts-continuous-per-channel into 8-ohm loads, 20 Hz to 20 kHz. **Rated THD:** 0.03%. **Rated IM:** 0.03%. **Frequency Response:** 15 Hz to 60 kHz, ±1.0 dB. **Residual Noise:** 1.3 mV. **Input Sensitivity:** phono, 2.6 mV; high level, 160 mV. **Phono Overload:** 160 mV. **S/N Ratio:** phono, 72 dB (94 dB referenced to 10 mV, A-weighted); high level, 88 dB (95 dB referenced to full output, A-weighted). **Bass Control Range:** ±6 dB or ±11 dB at 100 Hz. **Treble Control Range:** ±8 dB or ±13 dB at 10 kHz. **High- and Low-Filter Cutoff Frequencies:** subsonic, 15 Hz; low, 70 Hz; high, 7 kHz (all at −12 dB per octave).

GENERAL:
Power Consumption: 500 watts maximum, 120 volts, 60 Hz. **Dimensions:** $19\frac{5}{16}$ W × $7\frac{3}{32}$ H × $16\frac{7}{32}$ D. **Weight:** 37.4 lbs. net. **Suggested Retail Price:** $895.



3

TABLE I
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lux Audio of America, Ltd.** Model: **R-1120**

FM PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE		
IHF sensitivity, mono: (μV) (dBf)	1.7 (9.8)	Excellent
Sensitivity, stereo (μV) (dBf)	3.7 (16.6)	Excellent
50-dB quieting signal, mono (μV) (dBf)	2.7 (13.8)	Very good
50-dB quieting signal, stereo (μV) (dBf)	30 (34.8)	Very good
Maximum S/N ratio, mono (dB)	76	Excellent
Maximum S/N ratio, stereo (dB)	71	Excellent
Capture ratio (dB)	1.2	Very good
AM suppression (dB)	57	Good
Image rejection (dB)	80	Very good
IF rejection (dB)	88	Very good
Spurious rejection (dB)	90	Very good
Alternate channel selectivity (dB)	82	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (± dB)	0.5	Excellent
Harmonic distortion, 1 kHz, mono (%)	0.07	Superb
Harmonic distortion, 1 kHz, stereo (%)	0.08	Superb
Harmonic distortion, 100 Hz, mono (%)	0.085	Superb
Harmonic distortion, 100 Hz, stereo (%)	0.10	Excellent
Harmonic distortion, 6 kHz, mono (%)	0.09	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.12	Superb
Distortion at 50-dB quieting, mono (%)	0.7	Very good
Distortion at 50-dB quieting, stereo (%)	0.5	Good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	3.3 (15.6)	Excellent
Separation, 1 kHz (dB)	54	Superb
Separation, 100 Hz (dB)	60	Superb
Separation, 10 kHz (dB)	33	Good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	3.3 (15.6)	Excellent
Dial calibration accuracy (± kHz at MHz)	40 at 98	Excellent
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Superb
Ease of tuning		Very good
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Excellent
Construction and internal layout		Very good
Ease of servicing		Good
Evaluation of extra features, if any		Very good
OVERALL FM PERFORMANCE RATING		Excellent

suppresses any possible DC drift. A constant current-drive system loads the predriver stages. A power limiter circuit protects the output transistors from excessive current, and a time-delay muting circuit safeguards the speakers.

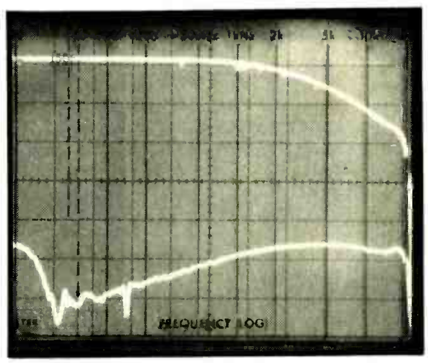
The FM section uses a four-gang tuning capacitor and a dual-gate MOSFET RF stage in its front end. The IF section uses linear phase ceramic filters to achieve sharp skirt selectivity while maintaining adequate bandwidth for low distortion mono and stereo reception. A quadrature detector/limiter circuit in the form of an IC is used to recover the composite signal that is fed to a phase-locked-loop multiplex decoder IC stage, followed by an IC low-pass filter that suppresses subcarrier products. A modified form of AFC circuitry that Lux terms its *closed-lock-loop tuning system* locks received signals but, unlike conventional AFC circuits, is limited to a locking range of only ± 100 kHz to prevent pulling in adjacent strong-signal channels.

The AM tuner uses a three-gang tuning capacitor and amplified AGC circuitry as well as a ceramic filter in its IF section. The front-panel signal-strength meter can be used both in the AM and FM modes.

FM measurements

Table I summarizes FM tuner lab measurements made on the *model R-1120*. While the receiver either equaled or exceeded most of the published specifications, particularly noteworthy were the incredibly low harmonic distortion figures that were obtained in both mono and stereo modes and the unusually high stereo FM separation figures obtained at 100 Hz and 10 kHz.

Figure 4 is a sweep-frequency analysis of FM audio response (including 75-μs deemphasis) of a desired output signal (shown in



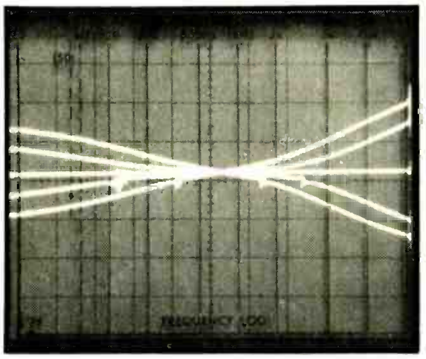
4

the upper trace) and an undesired opposite-channel output signal, which confirms higher separation at low audio frequencies. Note, too, the steep filtering action at 19 kHz that virtually eliminates any high-frequency subcarrier output signals at the output of the tuner or of the complete receiver. The AM suppression ratio was less impressive. Although this figure was better than specified, it seemed rather low for a set of this quality and price. Stereo threshold, sensitivity and overall muting threshold were ideally set by the factory to provide the best possible results in mono and stereo.

Table II summarizes amplifier and preamplifier performance, and a comparison with the manufacturer's published specifications shown elsewhere in this report shows that the amplifier is very conservatively rated.

Both the available phono inputs have identical input sensitivities (2.8 mV) and identically high overload capabilities (200 mV as compared with the 160 mV claimed). While we prefer to measure signal-to-noise ratios based upon rated input sensitivities, it should be noted that if the reported 75-dB figure were referred to a 10-mV input, it would be equivalent to 87 dB—still without the benefit of any weighting curve. RIAA equalization was found to be accurate to within 0.2 dB from 30 Hz to 15 kHz.

Figure 5 is a scope photo showing the range of control of the BASS and TREBLE controls. With the control knobs in their depressed or normal positions, turnover frequencies are 200 Hz and 10 kHz; with the control knobs pulled out, the turnover frequencies shift to 400 Hz (for the BASS control) and 2 kHz (for the TREBLE control) for additional tone-control flexibility. In Fig. 6, it is not possible to observe the action of the steep subsonic filter since it begins to roll off well below the 20-Hz

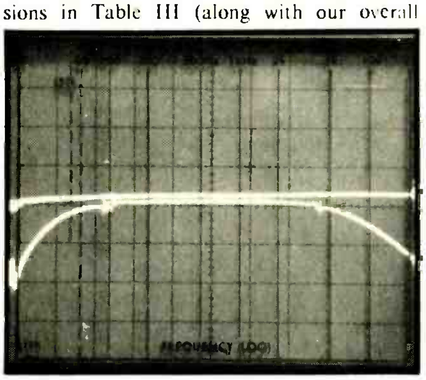


5

lower limit of the spectrum analyzer's log sweep range. The 12 dB-per-octave roll-off of the low-cut and high-cut filters is shown clearly in Fig. 6, however, and the −3-dB cutoff points correspond closely to the 70-Hz and 7-kHz frequencies specified by Lux.

Summary

In order to arrive at the summary conclusions in Table III (along with our overall



6

product evaluations), we listened to a great deal of recorded and broadcast material using the *model R-1120*. More than one pair of speakers was used so that we could characterize the sound produced by the receiver itself rather than judge the sound reproduction solely on the basis of the speakers used. Our experience with conventional dynamic speakers (both low- and high-efficiency types) leads us to believe that serious audiophiles will be willing to pay just a bit more for Lux equipment. As far as power output is concerned, there are only a few—a very few—loudspeakers that would ever demand more power than that provided by the *model R-1120* in any home listening situation. If, as Lux's brochures maintain, their engineers spend as much time listening as they do designing circuits, then the extra effort has paid off in the *model R-1120*. **R-E**

TABLE II
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lux Audio of America, Ltd.** Model: **R-1120**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	137	**Excellent**
RMS power/channel, 8-ohms, 20 Hz (watts)	130	**Superb**
RMS power/channel, 8-ohms, 20 kHz (watts)	130	**Excellent**
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	
Frequency limits for rated output (Hz-kHz)	13-23	**Very good**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.0095	**Superb**
Intermodulation distortion, rated output (%)	0.025	**Good**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.03	**Good**
Intermodulation distortion at 1-watt output (%)	0.02	**Very good**
DAMPING FACTOR, AT 8 OHMS	40	**Very good**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±dB)	0.2	**Excellent**
Maximum input before overload (mV)	200	**Excellent**
Hum/noise referred to full output (dB) (at rated input sensitivity)	75	**Excellent**
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±dB)	8-44, 1.0	**Very good**
Hum/noise referred to full output (dB)	95	**Excellent**
Residual hum/noise (minimum volume) (dB)	97	**Very good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 5	**Excellent**
Action of secondary tone controls		**N/A**
Action of low frequency filter(s)	See Fig. 6	**Excellent**
Action of high frequency filter(s)	See Fig. 6	**Very good**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.8/2.8	
Input sensitivity, auxiliary input(s) (mV)	175	
Input sensitivity, tape input(s) (mV)	175	
Output level, tape output(s) (mV)	175	
Output level, headphone jack(s) (V or mW)	460 mV/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Excellent**
Adequacy of input facilities		**Very good**
Arrangement of controls (panel layout)		**Superb**
Action of controls and switches		**Very good**
Design and construction		**Very good**
Ease of servicing		**Good**
OVERALL AMPLIFIER PERFORMANCE RATING		**Excellent**

TABLE III
OVERALL PRODUCT ANALYSIS

Retail price	**$895**
Price category	**High**
Price/performance ratio	**Good**
Styling and appearance	**Excellent**
Sound quality	**Superb**
Mechanical performance	**Very good**

Comments: The Lux Corporation's emphasis on listening quality (as opposed to just power output and measurable specifications) is as evident in this, their most powerful receiver, as it is in their separate components. The *model R-1120 sounds* good—and its audible superiority is evident even if you connect relatively inexpensive loudspeakers (although its true potential is best realized when accurate-sounding, more costly speakers are used with it). A good deal of human engineering has obviously gone into the layout, and all controls have been positioned for the easiest, most logical operation. The idea of a separately available Dolby decoder board makes good sense, since many areas do not as yet have Dolby FM broadcasts and to have penalized all purchasers of the receiver with the added built-in cost of a Dolby decoder would have been unfair. Lux's description of this receiver (as well as of their lower-powered, lower-priced *models R-1050* and *R-1040*) as a tuner/amplifier is justified in some ways and not in others. The implication is, of course, that the unit offers the same sort of reproduction provided by a separate tuner and amplifier. The *model R-1120* does just that. However, the absence of separate access to its preamplifier output and its main amplifier inputs (a feature found on many less-costly receivers) limits its flexibility to that of an all-in-one integrated receiver. Like other Lux products we have seen, the receiver cannot be judged on power output alone, for if so its price would be on the high side. This component must be seen and heard at a properly equipped audio shop, with a bit of hands-on operation. There is a sense of handcrafted detail about this receiver that offers positive aesthetic advantages but also makes for a slightly crowded internal layout that is not the easiest to service. Still, if superb sound in an all-in-one receiver is what you crave and 120-watts-per-channel plus are what you need to drive your speakers, the *model R-1120* may well be for you.

CIRCLE 48 ON FREE INFORMATION CARD

CIRCLE 82 ON FREE INFORMATION CARD

market center

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). **$1.50 per word (no charge for zip code)** . . . minimum 15 words.

NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) **85¢ per word** . . . no minimum.

ONLY FIRST WORD AND NAME set in bold caps. Additional bold face (not available as all caps) at 10¢ per word. Payment must accompany all ads except those placed by accredited advertising agencies. 5% discount for 6 issues, 10% for 12 issues within one year, if paid in advance. All copy subject to publisher's approval. Advertisements using P.O. Box address will not be accepted until advertiser supplies publisher with permanent address and phone number. Copy to be in our hands on the 26th of the third month preceding the date of the issue (i.e., August issue closes May 26). When normal closing date falls on Saturday, Sunday or a holiday, issue closes on preceding working day.

PLANS & KITS

CONSTRUCTION plans; over 100. From TV to telephone, from broadcasting to computers. Catalog air mailed $1.00; includes year's subscription to Electronic Newsletter. **DON BRITTON ENTERPRISES,** PO Box G, Waikiki, HI 96815

MINI-laser plans $1.00. Science project catalog 25¢. **MOTEN,** 323 S. Franklin, #804, Chicago, Il 60606

HOBBYIST give your project the professional look. Printed circuit boards from your sketch or artwork. Affordable prices. Also fur kit projects. Rush free details. **DANOCINTHS,** Box 261, Westland, MI 48185

MANUALS for Govt. surplus radios, test sets, scopes. List 50¢ (coin). **BOOKS,** 7218 Roanne Drive, Washington, D.C. 20021

LINEAR Amplifier: Ham only 2—30 MHz, 100 watt, solid-state. **Frequency Counter:** 300 MHz, miniportable/mobile, memory! **VOX—Compressor:** Splatter-free modulation booster. Construction plans $3.00 each. All $7.50! Kits, others, catalog available. **PANAXIS PRODUCTIONS,** Box 5516-F6, Walnut Creek, CA 94596

EDUCATION & INSTRUCTION

GRANTHAM's FCC License Study Guide—377 pages, 1465 questions with answers/discussions—covering third, second, first radiotelephone examinations. $13.45 postpaid. **GSE PUBLICATIONS,** 2000 Stoner, Los Angeles, CA 90025

UNIVERSITY degrees by mail! Bachelors, Masters, Ph.D's . . . Free revealing details. **COUNSELING,** Box 317-RE6 Tustin, CA 92680

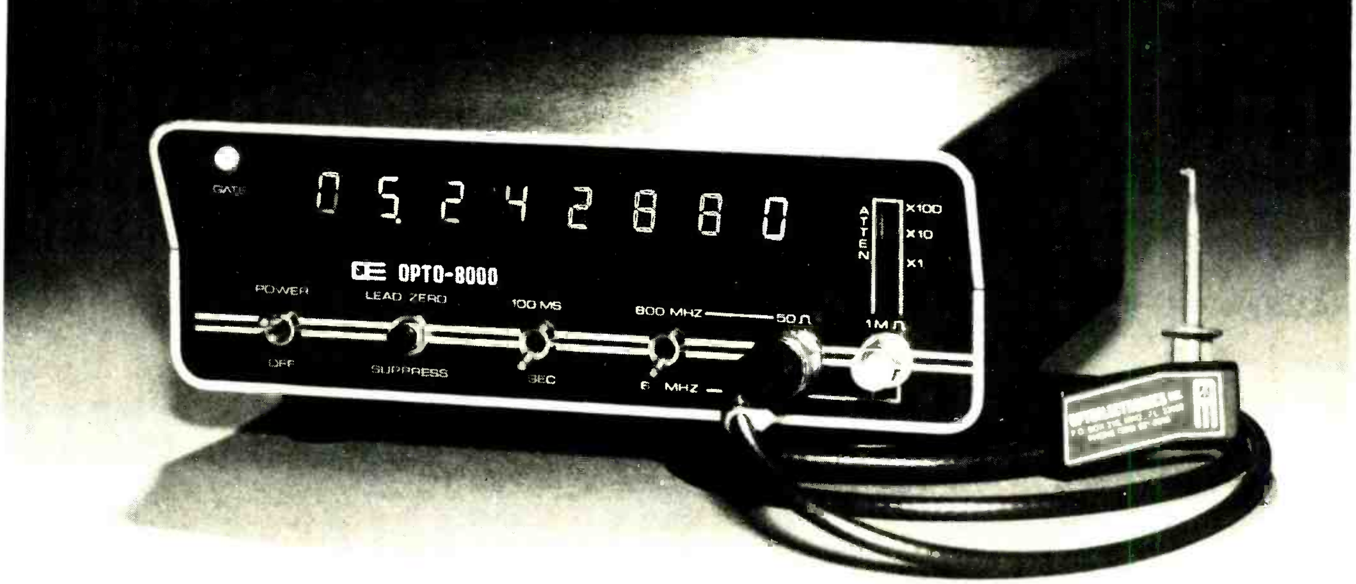
To run your own classified ad, put one word on each of the lines below and send this form along with your check for $1.50 per word (minimum $15.00) to:

Radio-Electronics, 200 Park Avenue South, N.Y., N.Y. 10003

				15.00
16.50	18.00	19.50	21.00	22.50
24.00	25.50	27.00	28.50	30.00
31.50	33.00	34.50	36.00	37.50
39.00	40.50	42.00	43.50	45.00

600 MHZ. FREQUENCY COUNTER
±0.1 PPM TCXO

OPTO-8000.1



This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090" thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.

OPTOELECTRONICS, INC.

5821 NE 14 Avenue
Ft. Lauderdale, FL 33334
Phones: (305) 771-2050 771-2051
Phone orders accepted 6 days, until 7 p.m.

master charge
BANKAMERICARD

SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3"h x 7½"w x 6½"d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090" thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz or internal batteries

OPTO-8000.1 Factory Wired	**$299.95**
OPTO-8000.1K Kit	**$249.95**

ACCESSORIES:

Battery-Pack Option—Internal Ni-Cad Batteries and charging unit	**$19.95**
Probes: P-100—DC Probe, may also be used with scope	**$13.95**
P-101—LO-Pass Probe, very useful at audio frequencies	**$16.95**
P-102—High Impedence Probe, ideal general purpose usage	**$16.95**
VHF RF Pick-Up Antenna-Rubber Duck w/BNC #Duck-4H	**$12.50**
Right Angle BNC adapter #RA-BNC	**$ 2.95**

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.

FC-50 — Opto-8000	**Kit $59.95**
*FC-50 — Opto-8000F	**Factory Update $99.95**
FC-50 — Opto-8000.1 (w/TCXO)	**Kit $109.95**
*FC-50 — Opto-8000.1F	**Factory Update $149.95**

*Units returned for factory update must be completely assembled and operational

TERMS: Orders to U.S. and Canada, add 5% to maximum of $10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: $1.00. Personal checks must clear before merchandise is shipped.

CIRCLE 18 ON FREE INFORMATION CARD

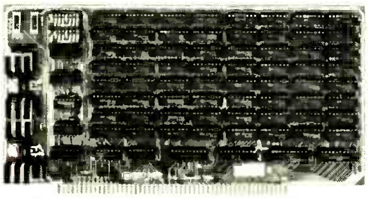
BEST BUYS

OUR BEST SELLER: ECONORAM II™

S-100 compatible 8K×8 in a cost-effective package. All lines buffered, fast, low power, unique configuration as two 4K blocks, handles DMA, and many other features . . . packed on a high quality board and using high quality parts (all sockets included). Totally static design.

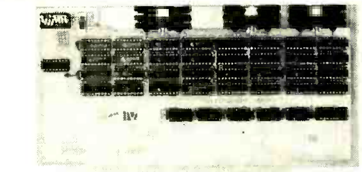
See the 1/78 issue of **Kilobaud** for an in-depth evaluation, or send SASE to "KB Reprint" and we'll send you a copy . . . or better yet, talk to somebody who owns one.

Kit: $135.00; 3 kits: $375.00; Assembled: $155.00



NEW! 16K ECONORAM IV™ KIT

S-100 compatible 16K×8 memory. Static design, current under 2000 mA, manual write protect switches for 4K blocks, can be used with or without phantom line . . . and it actually costs less than dynamic equivalents!



COMING SOON: 24K ECONORAM VII™ KIT

Just around the corner for the S-100 buss . . . we think you'll like it. All the regular features of our static Econorams, plus some extras. It's static, it's 24K, it's an Econoram . . . watch for it!

H8 COMPATIBLE ECONORAM VI™ KIT

12K×8 for the H8, with the same features that have made Econoram the name in S-100 buss memory. Static design, buffering, plus all sockets and bypass caps are already soldered in place so you can get right into the best part of kit building.

Kit form: $235.00

PLUG FROM BILL: There's more to life than computers . . . like music. Craig Anderton, noted author and designer of our Musikit products, has produced a cassette tape of original music that is distributed by our friends at PAIA Electronics (1020 W. Wilshire, Oklahoma City, OK 73116, $6.45 ppd). In addition to hearing our Musikits in action, you get to hear some really good modern music. We like it . . . you probably will too.

TERMS: Please allow up to 5% for shipping; excess refunded. Californians add tax. COD orders accepted with street address for UPS. For VISA®/Mastercharge® orders call our 24 hour order desk at (415) 562-0636. Prices good through cover month of magazine.

FREE FLYER: These are just a few of the items we carry for the computer enthusiast. We also stock a broad line of semiconductors, passive components, and hobbyist items. We will gladly send you a flyer describing our products upon receipt of your name and address.

GODBOUT

BILL GODBOUT ELECTRONICS
BOX 2355, OAKLAND AIRPORT, CA 94614

CIRCLE 47 ON FREE INFORMATION CARD

TELEPHONE bugged? Don't be Watergated! Countermeasures brochure $1.00. **NEGEYE LABORATORIES,** Box 547-RE, Pennsboro, WV 26415

F.C.C. EXAM MANUAL

PASS FCC EXAMS! Memorize, study—Tests-Answers for FCC 1st and 2nd class Radio-telephone licenses. Newly revised multiple choice questions and diagrams cover all areas tested in FCC exams, plus Self-Study Ability Test. $9.95 postpaid. Money-back guarantee.

COMMAND PRODUCTIONS — P.O. BOX 26348 E
RADIO ENGINEERING DIV. — SAN FRANCISCO, CAL 94126

WIN an electronics workshop! Plus instant prizes! R.T.T.'s new accelerated radio & TV course. **RADIO TELEVISION TRAINING,** P.O. Box 279-R68, Syracuse, NY 13206

BUSINESS OPPORTUNITIES

CABLE FM STATION. No experience required, excellent spare-time income, others operate for you. Details free. **BROADCASTING,** Box 5516—F6, Walnut Creek, CA 94596

HIGHLY PROFITABLE **ONE-MAN ELECTRONIC FACTORY**

Investment unnecessary, knowledge not required, sales handled by professionals. Ideal home business. Write today for facts! **Postcard will do. Barta-RE-F, Box 248, Walnut Creek, CA 94597.**

MECHANICALLY inclined individuals desiring ownership of Small Electronics Manufacturing Business—without investment. Write: **BUSINESSES,** 92-R, Brighton 11th, Brooklyn, NY 11235

UNIVERSAL 4Kx8 MEMORY BOARD KIT $69.95

32-2102-1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 44 pin buss, may be used with F-8 & KIM

EXPANDABLE F8 CPU BOARD KIT $99.00

featuring Fairbug PSU 1K of static ram, RS 232 interface, documentation, 64 BYTE register

4K BASIC FOR FAIRBUG F8

on paper tape — $25.00

C/MOS (DIODE CLAMPED)

		4012	16	4023	16	4046	1.45
		4013	29	4024	.66	4047	1.50
						4049	34
4001	16	4015	74	4025	.16	4050	34
4002	16	4016	29	4027	37	4055	1.25
4006	95	4017	78	4028	73	4066	58
4007	16	4018	78	4029	77	4071	24
4009	37	4019	.37	4030	.33	4076	97
						4518	89
4010	37	4020	84	4035	97	74C10	22
4011	16	4022	85	4042	.58	74C193	1.50

2708-8K EPROM (450 ns)	$10.95
2522 STATIC SHIFT REG.	$ 1.95
2513 CHARACTER GEN	$ 6.75
2518 HEX 32 BIT SR	$ 3.50
5203-2K EPROM	$ 4.50
21LO2-1 (450 ns)	$ 1.35
MM5270-4KX1 DYN	$ 3.45
MK 4008P	$ 1.95
2111-1-256 × 4 STATIC	$ 3.45
2112-1-256 × 4 STATIC	$ 2.75
5280/2107B 4K DYNAMIC RAM	$ 4.25
1702A UV PROM	$ 4.95
5204-4K PROM	$10.95
82S23	$ 1.95
AY-5-1013 UART	$ 6.95
8703C TELEDYNE 3 STAGE BINARY 8 BIT A/D CONVERTER	$13.50
8080A	$11.95

AP PROTO BOARDS USED FOR SOLDERLESS BREADBOARDING

264L	128 FIVE-TIE POINT TERMINALS	$12.75
212R	POWER BOARD	$ 2.50
2248L	96 FIVE-TIE POINT TERMINALS	$ 9.75
209R	POWER BOARD	$ 2.25

IC TEST CLIPS
TC-14 — $4.50 TC-16 — $4.75

CTS 206-8 eight position dip switch . . . $1.90
CTS-206-4 four position dip switch . . . $1.45
LIGHT ACTIVATED SCR's TO 18, 200V 1A $ 1.10

SILICON SOLAR CELLS

2¼" diameter .4V at 500 ma $4.00

RS232 CONNECTORS

DB 25P male $2.95
DB 25S female $3.50

LED READOUTS

FND 357 C.C. .4" $ .50	MAN 7 .3" C.A. $ .85
FCS 8024 4 digit C.C. .8" display $5.95	DL 747 C.A. .6" $1.65
FND 503 C.C. .5" $ .85	FND 800 C.C. .8" $1.95
FND 510 C.A. .5" $ .85	FND 807 C.A. .8" $1.95
DL 704 .3" C.C. $ .85	

PRINTED CIRCUIT BOARD

4-1/2"×6-1/2" SINGLE SIDED EPOXY BOARD 1/16" thick, unetched
$.60 ea — 5/$2.60

7 WATT LD-65 LASER DIODE IR $8.95

2N 3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4 $1.00
2N 6028 PROG. UJT	$ .65

MINIATURE MULTI-TURN TRIM POTS
100, 500, 1K, 2K, 5K, 10K, 25K, 50K, 100K, 200K, 500K, 1Meg, 2Meg, $ .75 each 3/$2.00

WSU 30 Hand wire wrap tool used to wrap, unwrap & strip #30 wire $5.30

VERIPAX PC BOARD

This board is a 1/16" single sided paper epoxy board, 4½"×6½" DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16, or LSI DIP IC's with busses for power supply connector $4.00

MV 5691 YELLOW-GREEN BIPOLAR LED	$ .90
FP 100 PHOTO TRANS	$ .50
RED, YELLOW, GREEN or AMBER LARGE LED's .2"	6/$1.00
1L-5 (MCT-2) OPTO-ISOLATOR	$ .75
MOLEX PINS	100/$1.00
	1000/$8.00
10 WATT ZENERS 3.9, 4.7, 5.6, 8.2, 18, 22, 100, 150 or 200V	ea. $ .60
1 WATT ZENERS 4.7, 5.6, 10, 12, 15, 18 or 22V	ea. $ .25
MC6860 MODEM CHIP	$9.95
MCM 6571A 7 × 9 character gen	$10.75

Silicon Power Rectifiers

PRV	1A	3A	12A	50A	125A	240A
100	06	14	30	80	3.70	5.00
200	07	20	35	1.15	4.25	6.50
400	09	25	50	1.40	6.50	9.50
600	11	30	70	1.80	8.50	12.50
800	15	.35	90	2.30	10.50	16.50
1000	20	.45	1.10	2.75	12.50	20.00

SAD 1024 a REDICON 1024 stage analog "Bucket Brigade" shift register. $18.95

IN 4148 (IN914) 15 $1.00

MCA 81 OPTICAL LIMIT SWITCH $1.50

REGULATORS

309K	$ .95	340K-12, 15 or 24V	$ .95
723	$ .50	340T 5, 6, 8, 12, 15, 18 or 24V	$ .95
LM 376	$ .60	78 MG	$1.35
320K 5, 12 or 15V	$1.00	79 MG	$1.35
320T-5, 15 or 24V	$ .95		

TRANSISTOR SPECIALS

2N6233-NPN SWITCHING POWER	$ 1.95
MRF-8004 a CB RF Transistor NPN	$ 1.50
2N3772 NPN Si TO 3	$ 1.00
2N1546 PNP GE TO-3	$ .75
2N4908 PNP Si TO 3	$ 1.00
2N6056 NPN Si TO 3 Darlington	$ 1.70
2N5086 PNP Si TO-92	4 $ 1.00
2N3137 NPN Si RF	$ .85
2N404 PNP GE TO 5	5 $ 1.00
2N3919 NPN Si TO 3 RF	$ 1.50
MPSA 13 NPN Si TO 92	3 $ 1.00
2N3767 NPN Si TO 66	$ .70
2N2222 NPN Si TO 18	5 $ 1.00
2N3055 NPN Si TO 3	$ .50
2N3904 NPN Si TO 92	5 $ 1.00
2N3906 PNP Si TO 92	5 $ 1.00
2N5296 NPN Si TO 220	$ .50
2N6109 PNP Si TO 220	$ .55
2N3638 PNP Si TO 5	5 $ 1.00

TTL IC SERIES

7400	.13	7445	.65	74151	.61
7401	.13	7446	.68	74153	.61
7402	.13	7447	.58	74154	.94
7403	.13	7448	.68	74155	.58
7404	.15	7450	.15	74157	.55
7405	.13	7472	.25	74161	.55
7406	.16	7473	.28	74163	.55
7407	.20	7474	.28	74164	.85
7408	.18	7475	.45	74165	.95
7409	.18	7476	.30	74170	1.68
7410	.13	7480	.31	74173	1.20
7411	.18	7483	.65	74174	.95
7412	.13	7485	.87	74175	.85
7413	.36	7486	.28	74176	.75
7414	.60	7490	.42	74177	.75
7416	.22	7491	.58	74180	.65
7417	.25	7492	.43	74181	1.90
7420	.13	7493	.43	74190	1.00
7425	.25	7494	.67	74191	1.00
7426	.22	7495	.65	74192	.79
7427	.19	7496	.65	74193	.79
7430	.13	74107	.28	74194	.80
7432	.22	74121	.29	74195	.85
7437	.21	74122	.38	74196	.86
7438	.21	74123	.45	74279	.55
7440	.13	74125	.40	74367	.65
7441	.70	74126	.40	75491	.50
7442	.37	74150	.94	75492	.50

DATA CASSETTES $1.25

44 Pin Solder Tail .156" Connector $2.20

MM 5387AA new clock chip which will directly drive LED's 12/24 hrs., 1 supply & alarm $5.95

NO. 24 8 CONDUCTOR SPECTRA FLAT CABLE 10' $1.50 100' $13.50

NO. 30 WIRE WRAP WIRE SINGLE STRAND 100' $1.40

ALCO MINIATURE TOGGLE SWITCHES

MTA 106 SPDT	$ 1.05
MTA 206 DPDT	$ 1.70
MTA 206 P-DPDT CENTER OFF	$ 1.85
MSD 206 P-DPDT CENTER OFF LEVER SWITCH	$ 1.85

Full Wave Bridges

PRV	2A	6A	25A
100			1.30
200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

DIP SOCKETS

8 PIN .22 24 PIN .40
14 PIN .25 28 PIN .50
16 PIN .28 40 PIN .60
18 PIN .30

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	$ 6.80
Si 1020 G 20 WATTS	$13.70
Si 1050 G 50 WATTS	$25.90

TANTULUM CAPACITORS

22UF 35V	5 $1.00	6.8UF 35V	4 $1.00
47UF 35V	5 $1.00	10UF 10V	$ .25
68UF 35V	5 $1.00	22UF 25V	$ .40
1UF 35V	5 $1.00	15UF 35V	3/$1.00
2.2UF 20V	5 $1.00	30UF 6V	5/$1.00
3.3UF 35V	4 $1.00	47UF 20V	$ .35
4.7UF 15V	5/$1.00	68 UF 15V	$ .50

74LS SERIES / LINEAR CIRCUITS

74LS SERIES				LINEAR CIRCUITS	
74LS00	.21	74LS126	.47	LM 101	.75
74LS02	.21	74LS132	.80	LM 301/748	.29
74LS03	.21	74LS136	.39	LM307	.30
74LS04	.28	74LS138	.70	LM 308	.75
74LS05	.28	74LS139	.70	LM 311	.75
74LS08	.21	74LS151	.70	LM 318	1.20
74LS09	.28	74LS153	.70	LM 319	.95
74LS10	.21	74LS155	.70	LM 324	1.05
74LS11	.21	74LS156	.70	LM 339	1.10
74LS13	.44	74LS157	.72	LM 358	1.40
74LS15	.25	74LS160	.88	LM 370	1.15
74LS20	.24	74LS161	.85	LM 377	2.50
74LS21	.26	74LS162	.85	LM 380	.95
74LS22	.26	74LS163	.85	LM 381	1.25
74LS26	.32	74LS168	.88	LM 382	1.25
74LS27	.32	74LS169	.85	LM 537	2.50
74LS30	.26	74LS170	1.68	LM 553	2.50
74LS32	.32	74LS173	1.10	LM 555	.39
74LS37	.32	74LS174	1.00	LM 556	.85
74LS38	.32	74LS175	.80	NE540L	2.25
74LS40	.26	74LS190	.95	560	2.00
74LS42	.65	74LS191	.95	565	.95
74LS47	.79	74LS192	.95	566	1.25
74LS51	.26	74LS193	.95	567	1.30
74LS54	.26	74LS195	.95	703	.90
74LS90	.95	74LS196	.95	709	.25
74LS74	.35	74LS197	.95	710	.35
74LS76	.35	74LS221	1.25	741C or V	.31
74LS85	1.30	74LS257	.70	747	.65
74LS86	.35	74LS258	.70	LM 1310	2.50
74LS90	.55	74LS279	.55	1456	.95
74LS92	.55	74LS365	.55	1458	.50
74LS93	.55	74LS366	.55	CA3046	.75
74LS109	.38	74LS367	.55	3900	.49
74LS112	.38	74LS368	.55	8038CC	3.90
74LS113	.38	74LS390	1.40	791	1.95
74LS114	.38				
74LS125	.47	MC1468D	1.35	LF356H	1.75

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

Terms: FOB Cambridge, Mass. Send Check or Money Order. Include Postage, Minimum Order $5.00, COD'S $20.00

Send 25¢ for our catalog featuring Transistors and Rectifiers
145 Hampshire St., Cambridge, Mass.

SOLID STATE SALES
P.O. BOX 74D
SOMERVILLE, MASS. 02143 TEL. (617) 547-7053

WE SHIP OVER 95% OF OUR ORDERS THE DAY WE RECEIVE THEM

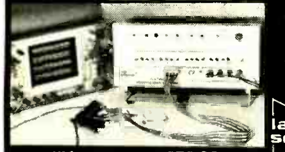
CIRCLE 26 ON FREE INFORMATION CARD

FOR SALE

FREE catalog. IC's, Semi's. **CORONET ELECTRONICS,** 649A Notre Dame W., Montreal, Que., Canada, H3C-1H8. US Inquiries.

RECONDITIONED test equipment. $0.50 for catalog. **WALTER'S TEST EQUIPMENT,** 2697 Nickel, San Pablo, CA 94806

VERSATILE LOGIC ANALYZER



DATA DOMAIN, WAVESHAPE, AND MAP MODE - 16 BITS X 16 WORDS — POS, MID OR NEGATIVE TIME DISPLAY - 10 MHZ - 0-9999 CLK OR EVENT DELAY. MANY MORE FEATURES. WRITE FOR MORE INFORMATION.

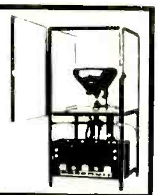
VLA - 1000 $575.00

lab science PO BOX 1972 BOULDER, CO 80306

COMPUTER, peripheral, technical reports; project supplies; kits. Send $1 for **THE CPU HOBBYIST,** Box 738-RE, College Park, MD 20740

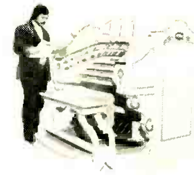
RECORDS-TAPES! Discounts to 73%; all labels; no purchase obligations; newsletter; discount dividend certificates; 100% guarantees. Free details. **DISCOUNT MUSIC CLUB,** 650 Main St., Dept. 3-0678, New Rochelle, NY 10801

PICTURE TUBE MACHINE
We buy and sell NEW and USED CRT rebuilding machinery. COMPLETE TRAINING. Buy with CONFIDENCE from the ORIGINAL MFGR.
For complete details send name, address, zip to:
LAKESIDE INDUSTRIES
3520 W. Fullerton Ave.
Chicago, Ill. 60647
Phone: 312-342-3399



NAME brand test equipment. Up to 50% discount. Free catalog and price list. **SALEN ELECTRONICS,** P.O. Box 82, Skokie, IL 60076

ELECTRONIC parts! Refundable $1 gets you 1978 catalog. Send to: **B.C. ELECTRONICS,** P. O. Box 226, West Lynn, MA 01905



YES, YOU CAN BUILD AN ELECTRONIC ORGAN

That has a PIPE ORGAN SOUND

With DEVTRONIX easy to build assemblies. Own the ultimate in organ design & sound at ½ the cost of commercial organs.

Several models to choose from.

BROCHURE AND DEMO RECORD $1.00

Devtronix ORGANS, INC. Dept. B
5872 Amapola Dr.
San Jose, CA 95129

INTO TV ANTENNA SYSTEMS? YOU'LL BE INTO TASCO!
Below wholesale prices on a full line of antenna installation surplus shipped from stock. Unbelievable prices on connectors, wall plates, splitters, transformers, amplifiers, etc. Write for free catalogue. Order now & compare.
TASCO. PO Box 30143 Houston Tex 77009

RADIO & TV tubes 36¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, Calif. 92105

SERVICEMEN—Cleaners, lubricants, adhesives for all electronic repairs. Write for free catalog. **PROJECTOR-RECORDER BELT CORP.,** Box 176, Whitewater, WI 53190 800-558-9572 ex. WI

Govt. SURPLUS ELECTRONIC EQUIPMENT CATALOG

New ITEMS . . . New BARGAINS!

FREE *UPON REQUEST!* If you haven't received our new Catalog, write for free copy today. Address: Dept. RE

FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

CARBON film resistors—¼W, 5% (1-4M7 ohms) 3.5¢ each. 50/value—$0.85. Postage, handling $1.00. Other components. Free catalog, resistor sample. **COMPONENTS CENTER,** Box 295R, West Islip, NY 11795

BREATHE BETTER AIR WITH AMAZING
NEGATIVE ION GENERATOR
Scientists have long known that negative ions can be beneficial to man's health. These tiny but potent, atmospheric particles abound in nature. Now, through the magic of science, you can duplicate this delightful phenomenon in the privacy and convenience of your own home or office.

Output: 9×10^9 ions/sec
Size: 19" x 14" x 8"
Weight: 18 pounds

DEALERS WANTED

GOLDEN ENTERPRISES
P.O. Box 1282-RE
Glendale, Arizona 85311

(Please send $1.00 for fascinating details)

TUBES, receiving and Industrial, semiconductors, factory boxed, low prices, free price list. **TRANSLETERONIC INC.,** 1365 — 39th Street, Brooklyn, NY 11218 212-633-2800

NO-ETCH
Duplicate or make additions to, modifications of Any Etched Board. Ideal for point-to-point or wire wrap breadboards. Complete set of (3) tools IP6003 $25.00 ppd. A.F. Stahler Co., P.O.Box 354R, Cupertino, CA 95014 · (408) 252-4219.

B&K test equipment. Free catalog. Free shipping. Dinosaur discounts. **SPACETRON-DF,** 948 Prospect, Elmhurst, IL 60126

Why is this the
LARGEST SELLING low cost COUNTER KIT?

This counter is such a great seller because people like you have found that, feature for feature, the CT-50 gives you more for your money. Advanced LSI and CMOS circuitry has; lowered power consumption, increased performance, and reduced cost. Complete push button operation makes using the CT-50 a snap, and automatic decimal point positioning gives you quick, reliable readings. Battery operation is also possible becuase the CT-50 runs equally as well on 12VDC as it does on 110VAC. For ultra-accuracy we offer the CB-1 color burst adapter, it locks the CT-50's internal crystal to the television networks color standard for .001 ppm accuracy! Why sacrifice performance by using another counter when you can get professional quality at the unheard of price of **$89.95**? Order yours today!

SPECIFICATIONS
Sensitivity: less than 10 mv.
Frequency range: 5 Hz to 60 MHz, typically 65 MHz
Gatetime: 1 second, 1/10 second, with automatic decimal point positioning on both direct and presacle
Display: 8 digit red LED .4" height
Accuracy: 2 ppm, internal TCXO standard.
Input: BNC, 1 megohm direct, 50 Ohm with prescale, option
Power: 110 V ac 5 Watts or 12 V dc @ 300-400 ma
Size: Approx. 6" x 4" x 2", high quality aluminum case

CT 50,60 MHz Counter Kit $89.95
CT-50 wt 60 MHz Counter Wired & Tested $159.95
CT-600, 600 MHz prescaler option for CT-50, add.. $29.95

MINI-KITS

FM WIRELESS MIKE KIT
Transmit up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added super-sensitive mike preamp.
FM-1 — $2.95 FM-2 — $4.95

SUPER-SLEUTH AMPLIFIER
A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.
Complete Kit, BN-9. . . . . $4.95

COLOR ORGAN/MUSIC LIGHTS
See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.
Complete Kit, ML-1. . . . . $7.95

TONE DECODER KIT
A complete tone decoder on a single PC Board. Features: 400-5000 Hz adjustable frequency range, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK demod, signaling, and many other uses. Use 7 for 12 button touchtone decoding. Runs on 5 to 12 volts.
Complete Kit, TD-1. . . . . $4.95

LED BLINKY KIT
A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.
Complete Kit, BL-1 . . . . $2.95

POWER SUPPLY KIT
Complete triple regulated power supply provides variable +15 volts at 200 mA and ±5 volts at 1 Amp. 50 mV load regulation good filtering and small size. Kit less transformers. Requires 6-8V at 1 Amp and 18 to 30 VCT.
Complete Kit, PS-3LT $6.95

SIREN KIT
Produces upward and downward wail characteristic of police siren. 5 watts audio output, runs on 3-9 volts, uses 8-45 ohm speaker.
Complete Kit, SM-3 . . . . $2.95

VIDEO MODULATOR KIT
Converts any TV to video Monitor, Super stable tunable over Ch. 4-6. Runs on 5-15V, accepts std video signal. Best unit on the market.
Complete Kit, VD-1. . . . . $6.95

SIX DIGIT 12/24 HOUR CLOCK KIT

Here's a clock you can be proud of. The best looking, most complete kit on the market! Features include: time set push-buttons, jumbo .4" readouts, and extruded aluminum case available in 5 colors. All parts included. Colors: gold, silver, bronze, black, blue (specify)

Clock Kit, DC-5	$22.95	Alarm Clock, 12 Hr., DC-8	24.95
Mobile Clock, DC-7	25.95	Clock with HAM ID timer DC-10	25.95

Assembled and tested clocks available, add $10.00 to Kit price.

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. Specify −10 or −100. Wired, tested,
PS-1 B $59.95
Kit, PS-1 B $44.95

CALENDAR ALARM CLOCK

Has every feature one could ever ask for. Kit includes everything except case, build it into wall, station or even car!

FEATURES:
- 6 Digits, .5" High LED
- 12/24 Hour Format
- Calendar shows mo./day
- Snooze button
- True 24 Hour Alarm
- 7001 chip does all!!
- Battery back up with built-in on chip time base.

Complete Kit, less case
DC-9 . . . . $34.95

TV TYPEWRITER KIT

A compact 5 x 10 inch PC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal for connection to your microprocessor asynchronous interface. Its many features are single 5-volt supply, crystal controlled sync and baud rates (up to 9600 baud), 2 pages of 32 characters by 16 lines, read to and from memory, computer and keyboard operated cursor and page control, power-on initialization, full 64-character ASCII display, block-type, see-thru cursor. Keyboard/computer control backspaces, forward spaces, line feeds, rev. line feeds, home, returns cursor. Also clears page, clears to end of line, selects page 1 or 2, reads from or to memory. The card requires 5 volts at approx. 900 ma and outputs standard 75 ohm composite video.

TH3216 Kit	$149.95
TH3216, Assembled and Tested	239.95
VD 1 Video to RF Modulator Kit	6.95

CAR CLOCK KIT

12/24 Hour 12-Volt AC or DC
- High Accuracy (1 minute/month)
- 6 Jumbo 4" LED readouts
- Easy, no-polarity hookup
- Display blanks with ignition
- Case mounting bracket included
- Super instructions

Complete Kit, DC-11 . . . .$27.95

Auto dimmer for DC-11 . . . . $2.50

741 OP AMP SPECIAL
Prime, Mini-dip 10/$2.00

ICs		LINEAR		REGULATOR		TRANSISTORS	
5314 Clock	$2.95	555	$ .50	78MG	$1.49	MRF-238 30W VHF	$11.95
7001 Clock	6.95	556	.75	309K	.89	NPN 2N3904 type	10/$1.00
5369 Cnos	1.95	566	1.49	309H	.99	PNP 2N3906 type	10/$1.00
7447	.79	567	1.49	340K-12	.99	NPN Power Tab 40W	3/$1.00
7473	.35	1458	.50	7805	.89	PNP Power Tab 40W	3/$1.00
7475	.50	LED DRIVER		7812	.89	FET MPF-102 type	3/$2.00
7490A	.55	75491	.50	7815	.89	UJT 2N2646 type	3/$2.00
74143	3.50	75492	.50	7818	.89	2N3055 NPN Power	.75

SPECIAL

ORDER BY PHONE OR MAIL
Satisfaction guaranteed or money refunded. Add 5% for shipping and insurance. COD add $1.00. Orders under $10.00 add $.75. NY residents add 7% sales tax. Minimum order $6.00

ramsey electronics
BOX 4072B ROCHESTER, NY 14610 (716) 271-6487

CIRCLE 39 ON FREE INFORMATION CARD

CIRCLE 2 ON FREE INFORMATION CARD

ELECTRONIC SYSTEMS

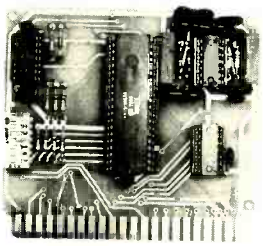
P.O. Box 9641 San Jose, CA 95157 (408) 374-5984

FOR CATALOG INCLUDING PARTS LISTS AND SCHEMATICS, SEND A SELF ADDRESSED ENVELOPE WITH 24¢ POSTAGE.

RS-232/TTY * INTERFACE

NEW

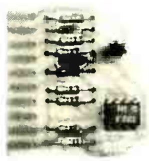
Part no. 600
- Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
- Two separate circuits
- Requires +12 and -12 volts
- Board only $4.50, with parts $7.00



UART & BAUD RATE GENERATOR*

Part no. 101
- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity.
- All connections go to a 44 pin gold plated edge connector
- Board only $12.00; with parts $35.00

RS-232/TTL INTERFACE*



Part no. 232
- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin gold plated edge connector
- Board only $4.50; with parts $7.00

DC POWER SUPPLY*

Part no. 6085
- Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp.
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only $12.50; with parts $42.50 excluding transformers

Part no. 111

TAPE INTERFACE*

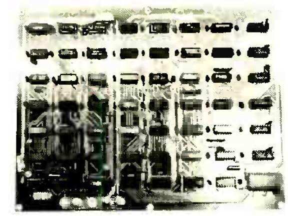
- Play and record Kansas City Standard tapes
- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL-serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- Requires +5 volts, low power drain
- Board $7.60; with parts $27.50
- No coils

Part no. 107

RF MODULATOR*

- Converts video to AM modulated RF, Channels 2 or 3
- Power required is 12 volts AC C.T., or +5 volts DC
- Board $7.60; with parts $13.50

TELEVISION TYPEWRITER



Part no. 106
- Stand alone TVT
- 32 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled curser
- Auto scroll
- Non-destructive curser
- Curser inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
- Requires +5 volts at 1.5 amps, and -12 volts at 30 mA
- All 7400, TTL chips
- Char. gen. 2513
- Upper case only
- Board only $39.00; with parts $145.00

8K STATIC RAM

Part no. 300
- 8K Altair bus memory
- Uses 2102 Static memory chips
- Memory protect
- Gold contacts
- Wait states
- On board regulator
- S-100 bus compatible
- Vector input option
- TRI state buffered
- Board only $22.50; with parts $160.00

TIDMA*

Part no. 112
- Tape Interface Direct Memory Access
- Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate.
- S-100 bus compatible
- Board only $35.00; with parts $110.00

Apple II Serial I/O Interface*

Part No. 2
- Baud rates up to 30,000
- Plugs into Apple Peripheral connector
- Low-current drain
- RS-232 Input and Output

SOFTWARE
- Input and Output routine from monitor or BASIC to teletype or other serial printer.
- Program for using an Apple II for a video or an intelligent terminal. Board only – $15.00; with parts – $42.00; assembled and tested – $62.00.

MODEM*

Part no. 109
- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- No coils, only low cost components
- TTL input and output-serial
- Connect 8 ohm speaker and crystal mic. directly to board
- Uses XR FSK demodulator
- Requires +5 volts
- Board $7.60; with parts $27.50

To Order:

VISA master charge

Mention part number and description. For parts kits add "A" to part number. Shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Dealer inquiries invited. 24 Hour Order Line: (408) 374-5984.* Designed by John Bell.

NEW periodic table of chemical elements. Striking wall chart $3.00. **CIRCLON,** Greenriver George, Enumclaw, WA 98022

VOX

VOICE ACTIVATED CONTROL SWITCH. Self contained, solid state. Has excellent adjustable sensitivity. Recorder activated by voices or other sounds. Uses recorder mike or remote mike. Single AA bat. incl. Great for home, business etc. 2¼ x 1¾ x ¾"

AMAZING ELECTRONIC MICRO MINI MIKE

World's smallest, solid state, self contained with 1.3V Merc. Bat. furn. Picks up most sounds and transmits without wires up to 300 ft. thru FM Radio. Tuneable. Use as mike, ampf., alarm & alert system, baby sitter, hot line, etc. VOX only $24.95*. Mike only $18.95* (*plus $1.00 ea. pstg. & hand.) B/A, M/C, cod. ok. Cal. res. add tax. Free data. Mail Order. Qty. disc. avail. AMC SALES. Dept 19
2¼ x ¾ x ½" 9335 Lubec St., Box 928, Downey, CA 90241

SUMMER special! New, adjustable, three output, regulated power supply, plus 900 parts worth over $400.00 in complete **cartrivision** television electronics assembly. Documentation included. Perfect for **microprocessor** and all electronic applications. $11.50 plus $3.50 S&H. Master Charge, BankAmericard. **MADISON ELECTRONICS,** 369, Madison, AL 35758. **Money back guaranteed.**

BEARCAT 210, $239.00. Regency Touch, $234.00. CB-40, $54.95. Free freight on orders over $200.00. Quotes: tell us what's wanted. **JOHNNY'S,** Box 584, Sturtevant, WI 53177

FREE KIT Catalog

STOP! Take a minute & let us send our latest kit catalog. If you like, send us the name & address of a friend who may also be interested and we'll include to you our booklet "How to build-electronic thermometer"

contains TEST & EXPERIMENTER'S EQUIP.

DAGE SCIENTIFIC INSTRUMENTS BOX 1054R LIVERMORE CA 94550

AMAZING ELECTRONIC PROJECTS and PRODUCTS:
Lasers Super Powered, Burning, Cutting, Rifle, Pistol, Pocket. See in Dark—Shotgun Directional Mike—Unscramblers—Giant Tesla—Stunwand—TV Disrupter—Energy Producing, Surveillance, Detection, Electrifying, Ultrasonic, CB, Auto and Mech. Devices. Hundreds More—All New Plus INFO UNLTD PARTS SERVICE. Catalog $1. **Information Unlimited, Box 626, Lord Jeffery Court, Amherst, N.H. 03031.**

FREE bargain catalog, IC's, LED's, semiconductors, crystals, electron tubes. Send stamp. **ASTRAL,** P.O.B. 707RE, Linden, NJ 07036

A Fabulous First: Motion Detector ICs, converts motion to a voltage which triggers internal alarm circuitry. May be programmed for certain changes in light (motion). Includes on-chip musical sequence generator .... **MDIC $6.95**

Premium OP AMP! BB-3500 from *BURR-BROWN*, features: LOW NOISE, DRIFT, LOW INPUT BIAS, 15 kHz, 20V P-P output (Iv/uS slew rate), and more. Regularly sells for *up to $36.00 each!* **Exclusive................ only 99c ea., 6/$5.00**

Audio Synthesis Literature: "Tech Notes" featuring *circuits, ideas, new products, parts sources, construction aids, calibration methods* & more. Our own *R&D newsletter.* **12 issues/$17.50**

Hybrid Active Filter: identical to the AF-100-ICJ DIP Package. D.C. to kHz, 4 on-board op amps, state-variable filter. Simult. HP, BP, LP & notch outputs **$6.95 ea.**

CFR ASSOCIATES Box F Newton NH 03858

System Power Supplies
PS1: ±15 @ .5A, 5V @ 2.5A, and 0–35V with 24V @ .5A, PS2: ±15V @ .3A, 5V @ 3.3A, and 0–16V with 12V @ 1A
Both have four excellently regulated voltages (resister programmable). From three winding; compare. Great for home computer, bench or hobby work. Just add AC cord and plug 'em in. Assembled; PS1 or PS2 $27.95. Kit (less transformer); PSK1 or PSK2 $19.95.
$2.00 postage & handling; in Calif. add 6% sales tax.
PLUS+ Electronics, 1260 El Camino No.306 Millbrae Ca. 94030

LEARN MICROCOMPUTER PROGRAMMING

At home. At your own pace. Complete course consisting of 10 lessons, problems, solutions, practical examples in 8080, 8085 assembly language. $49.95.
Write or call for FREE BROCHURE.
LOGICAL SERVICES, INC., 1080H East Duane Ave., Sunnyvale, CA 94026
(415) 245-8855

SCOOP!! 4MEGABYTE TAPE RECORDER!
$269.00 QUAD 5 CHANNEL TAPE TRANSPORT, ONE FURNISHED, LOGIC FOR AUTO SELECT, REWIND, TAPE BREAK, EOT, LOW LEVEL & LAST CARTRIDGE. POWER REQ'D 12 VOLTS 5 AMPS DC
STD RACK PANEL 12 1/8"HIGH 19"WIDE 20"DEEP, WT 85LBS BOOK $10 SHIPPED COD-USED-GOOD COND. LIMITED QTY.
J&E ELECTRONICS INC.
P.O BOX 4504, FORT WORTH, TEXAS, 76106; OR PHONE 817-625-2961, BANK AMERICARD, M.C. OR VIZA ACCEPTED TEXAS RES. ADD 5% SALES TAX-NO CHECKS

MAKE PC boards. Step-by step "how-to" manual with build-it-yourself equipment plans, charts and illustrations. For polyez and film-chemical processes. $4.98 plus 50¢ p&h. **CENTURY AMERICAN INSTRUMENTS,** Dept. 616, Box 1014, Placentia, CA 92670

We're Fighting for Your Life

Please give generously
American Heart Association

ACOUSTIC COUPLER BY NOVATION OR LOGIC
This originate only coupler was manufactured for use in T.I. 725 data terminal. It is compatible with Bell 103 and 113 data sets or the equivalent. The coupler operates asynchronously to a maximum speed of 300 baud in the half or full duplex mode. All signal outputs are compatible with TTL. Transmit freq. is 1270hz for mark and 1070hz for space. Receive freq. is 2225hz for mark and 2025hz for space. Unit requires ±12 V and -5 V for operation. Complete with schematic and all pertinent information. Fully reconditioned, calibrated, and guaranteed $47.50
RS232 to TTL to RS232 converter kit. Complete with PC board, components, and schematic $6.50

POWER SUPPLIES NEW
±15VDC @ .5A Powertec $75.00
5VDC @ 10A Powertec $75.00
5VDC @ 15A Elexon $75.00
16VDC @ 5.5A Elexon $75.00
24VDC @ 4A Elexon $65.00
5VDC @ 15A Lambda $299.95
Available in limited quantities

OPTIMA ENCLOSURE NEW
Royal blue with white front bezel 19" rack, 7" panel space, and 16" deep. ACE special price $59.95 while they last. SPECIAL HALF PRICE OFFER!

NE555V– 8 PIN MINI DIP BY INTERSIL SPECIAL OFFER 10/$2.50

THERMAL PRINTHEAD EPN1.2 printhead used in T.I. Silent 720 and 730 series printers. Equivalent to EPN2200 shown in T.I. opto-electronics data book. $75.00 EA

22 PIN EDGE CONNECTOR 22/44 pin dual readout with .156 ctrs. and solder eyelet pins. Cinch p/n 251-22-30-210 $2.75 ea.

EDGE CONNECTOR 43/86 pin dual read-out, .156" spacing with solder eyelet pins. Used, but you will love them at $1.00 each.

ASSORTMENTS

HEAT SHRINK TUBING 25 6" lengths in various sizes & colors. $2.95 PER ASST

TEFLON TUBING $1.95 PER ASST 25 6" lengths in various sizes and colors.

DISC CAPACITORS 100 FOR $2.95 INCLUDES THESE VALUES 75pf, 100pf, 220pf, 470pf, .0047mfd, .01mfd, .001mfd, .047mfd, .1mfd& .2mfd

ELECTROLYTICS 100 FOR $9.95 Miniature alum. axial leads. Includes values from 1mfd/50V to 1500mfd/16V

DIPPED POLYESTER FILM CAPS 100 FOR $4.95

1% PRECISION RESISTORS 200 FOR $4.95 assortment contains a balanced inventory

POWER CORD ASSORTMENT 6 FOR $2.95 2 conductor w/ strain relief. 3 conductor molded vinyl plug and connector. 6.8 ft. UL LISTED

SLIDE SWITCHES STANDARD & MINIATURE 40 FOR $5.00

AC ADAPTERS 4 FOR $9.95 INCLUDES 3.1 VDC @ 100ma, 4.4VDC @ 50ma, 8VDC @ 60ma & 8VAC @ 100ma

TO 3 HEATSINK 680-1.25A BLACK ANODIZED ALUM 1.81" BASE x 1.25" HIGH $1.25 EACH 10 FOR $9.95

THERMALLOY 6111 B-6e TO-66 heat sink. 10/$5.00

THERMALLOY 6030B flat power device heat sink 10/$1.98

ZERO CROSSING DETECTOR SN16268 by T.I. detects when line current is at it's minimum for switching devices at zero current. 14 pin package with specs 10 for $4.95

WHILE THEY LAST SPECIAL! $3.50 EA. 10 FOR $32.50 DBM-25-S FEMALE CONNECTOR NEW! GREEN INSERT, SOLDER-CUP PINS.

NATIONAL MM5013 1K SHIFT REGISTER 8 PIN MINI DIP $.80 EACH 10 FOR $4.95

PC BOARD MATERIAL IS BACK! White polyester fiberglass 1/16" thk. Unetched copper clad 1 or 2-sided.

	10	100
6X12"	$1.25ea	$1.00ea
9X12"	$1.75ea	$1.50ea
12X12"	$2.00ea	$1.75ea

G-10 1/16 thk. epoxy unetched copper clad 1 or 2-sided.

	10	100
9½X10⅝"	$1.75ea	$1.50ea

ETCH POWDER ACE makes it easy with etch powder. Etch'em to your own specifications.
FP-1 .... makes 1 qt. $1.50
FP-2 .... makes 1 gal. $3.50
(with instructions)

TMS4030JL DYNAMIC RAM 4096–BIT LOW POWER (400mW), REMOVED FROM SOCKETS, TESTED AND GUARANTEED. WITH DATA AND 22 PIN SOCKET. $9.95ea. 8/$64.95

CA3033A RCA operational amp for high output-current applications. 14 pin ceramic. $1.50ea. 10/$9.

CA3045 RCA general purpose transistor array for low-power applications. 14 pin ceramic. $.39ea. 10/$3.95

CA3085A RCA positive voltage reg. for regulated voltages from 1.7V to 36V at currents up to 100ma. $.98 10/$7.95

SIGNETICS N8T18A Dual 2-input high voltage to TTL interface gate. 14 pin plastic dip. 10 for $2.50

12VDC REED RELAY Electrol p/n R4422.2 DPST N.O. 440 ohm coil $1.50 10/$12.50

5VDC REED RELAY P&B p/n JRM 10439 DPST N.O. 1000 ohm coil. $1.95 10/$17.50

5VDC REED RELAY P&B p/n JRM 10440 SPST N.O. 400 ohm coil. $4.50 10/$39.95

50 PIN "D" SUBMINIATURE CONNECTOR BY AMPHENOL (with solder-cup pins)
DD-50-P .... PLUG $3.75
DD-50-S .... SOCKET $4.75

WIRE WRAP WIRE
KYNAR WIRE WRAP WIRE, SOLID SILVER PLATED 30AWG, AVAILABLE IN BLUE, RED, YELLOW, BLACK, GREEN, OR WHITE
100' SPOOL $2.50 500' SPOOL $5.95 1000' SPOOL $9.95
26AWG, RED OR BLACK, 500' SPOOL $7.95, 1000' SPOOL $12.50
24AWG, BLUE 500' SPOOL $7.95, 3000' SPOOL $35.95

HOOK UP WIRE Stranded 22 GA available in white, brown, red, orange, black, blue, purple, yellow, green or gray. 200 FT. SPOOL FOR $3.50
SPECIAL! 1000' roll of 24AWG, type "B" PVC, 16 strand, tinned copper. Color: orange $5.95

SHOP ACE FOR THE REAL SURPLUS BARGAINS!

DIPPED TANTALUMS

	10	100		10	100
.47MFD@35V	$.20	$.15	15MFD@20V	$.30	$.25
2.2MFD@16V	$.20	$.15	33MFD@10V	$.30	$.25
3.3MFD@35V	$.20	$.15	47MFD@20V	$.35	$.25
4.7MFD@25V	$.20	$.15	100MFD@10V	$.60	$.50
6.8MFD@16V	$.25	$.20	220MFD@10V	$.75	$.60
10MFD@25V	$.25	$.20	PRICED PER EACH		

SPRAGUE 360 POWERLYTICS LIKE NEW PARTS AT USED PRICES! PULLED FROM NEW EQUIPMENT AND OFFERED TO YOU AT SUBSTANTIAL SAVINGS. AVAILABLE IN 5500MFD @ 40V, 8200MFD @ 25V. YOUR CHOICE $1.00 EA. 10 FOR $7.95

PHOTO FLASH CAP 600 MFD @ 360 VOLT 1" X 3⅝"L $1.98 EACH .... 10 FOR $15.00

EAGLE-PICHER BATTERY CF6V5, 6 VOLT 5A.H. SPILL-PROOF, RECHARGEABLE BATTERY $12.50EA. NEW 1 YEAR WARRANTY.

TEFLON TUBING Extremely high operating temperature range and chemical inertness. Will not crack or become brittle. Remains flexible throughout entire operating temp. range. CLEAR 18 GA. 100' roll $4.95 1000' roll $24.95

SLOTTED OPTICAL SWITCH (TYPE OPB 800) *The OPB800 consists of a gallium arsenide infrared LED coupled with an npn silicon photo transistor in a plastic housing. The gap in the housing provides a means of sensing motion of opaque objects. ⅜" mounting centers. Manufactured by OPTRON INC. $1.98 EA*

BISMUTH ALLOY MELTS IN BOILING WATER. 4 OUNCE INGOT FOR $3.95, 1 POUND INGOT $9.95. FUN TO PLAY WITH!

PITTMAN 12VDC MOTOR Runs on as low as 2 volts rated 12 volts, 250 ma with 2.8 inches of torque at 5000 RPM. 1-1/8" dia. x 2" long with 0.118" shaft. NEW & GUARANTEED 10 for $15.00 $1.95 EA

12VDC SOLENOID 36 ohm, 10 oz. push with 1/8" stroke. Panel mount bushing. 3/4" dia. x 1 3/4" overall. $1.98 ea. 10 for $15.00

SPEEDY BEND BEND ¼W RESISTORS ON ONE SIDE, ½W ON THE FLIP SIDE TO PRECISE MEASUREMENTS. $1.95 EA.

MILLER CHOKE P/N 6310, 1392 TURNS 50 mh 65 ma 10 FOR $2.95

LITTLE VINYL FEET We all know there are many uses for vinyl feet, so stock up with these self-sticking square or round feet. 1/2 x 3/16 high. Sheet of 50 for $1.00 (For customers with vivid imaginations, feet are not shaped as shown.)

CINCH TERMINAL BLOCKS
12-140 .... 10/7.50
4-140Y 10/3.00
12-140Y 10/9.95
19-140Y 10/12.50
13-141Y 10/12.50
15-141Y 10/12.50

SCREW TYPE TERMINAL ideal for stereo or TV. H.H. Smith 872, Cinch 17-2 1-3/8" nut. 9/16" terminal spacing. 20/$1.00 100 $3.95

PERMA-FLEX TAPE ¾" wide X 60' long. All weather. 8000s. .085" thick (Black) $1.00 roll 10/$7.95. UL APPROVED

MOLEX I.C. PINS 100/$.98 1000/$6.95

Breadboard jumper wire kit. Each kit contains 300 wires in various colors and sizes. Lengths range from 1.2" to 9". Each wire is stripped both ends, solid tinned 24GA. PVC. $1.95 kit

WHAT? LINEAR POTS WITH SWITCH 4/$1.00
100K P/N 7750, PUSH ON PUSH OFF ¼"x½" shaft 3/8" BUSHING MOUNT.
SUBMINIATURE 250K P/N 1414, ON-OFF SWITCH, 1/8"x3/8" shaft. ¼" BUSHING MT.
250K P/N 1434 ON-OFF SWITCH. ¼"x½" shaft 3/8" BUSHING MT.
¼" Dimmer Knobs for above, specify black, brown, or ivory ..$.10EA.
1/8" Instrument knob for 250K pot. $.25EA. .... 5/$1.00

PHOTO CELL Type CL7508, CDS material by Clairex. Dark resistance 15 meg-ohm, max. voltage 175V. 1/$1.00 100/$17.50

AMP 10 POSITION DIP SWITCH $3.50 EA. 10/$25.00

ARNOLD CORE 135 MH. PER 1000 TURNS. 1" ID x 1-7/8" OD x 3/4" THK. P/N A-759135-2 $1.50 EA.

RECESSED RUBBER BUMPERS 1"dia.x 1"h. w/ 5/16"hole. 8/$1.00 50 $3.95

NEW! EVEREADY BATTERY STOCK-UP ON THIS SUPER SAVINGS "AA" 10/$2.00 100 $15.00

VARIABLE CAP JOHNSON P/N 167 3, 4–50PF. $2.50 EACH 10 FOR $19.95

BEAT THIS DEAL! **STACKED FOIL CAPS** Metalized polycarbon with stack foil construction. Extremely low self-inductance. 100/$1.50 1000/$12.50

PLASTIC TEST LEAD WIRE 18 GA. TIN COPPER WITH FLEX LIFE JACKET. 65/36 STRANDING. AVAILABLE IN BOTH RED AND BLACK. 25 FOOT FOR $.98

PRECISION POTS 5K OR 10K OHM 10–TURN POTS BY SPECTROL. THIS MODEL 534 IS ±.25% LIN. AND ±5% RES (.750" x .875" DIA. .... $2.50 EA. 10 FOR $19.95

SCHOTTKY DIODE *1N5812 High efficiency rect. 20A 50PIV, low leakage, fast recovery $1.00EA. 10 for $7.95*

G.E. SC51B TRIAC 15A 200V in press fit case. Ideal for color organs. $1.00 10 FOR $7.50

1N914B (switching diode) 100/$4.95 1000/$39.95

1N752 (5.6V zener @ 400mW) 100/$5.95 1000/$49.95

SNAP-IN ROCKER SWITCH "ON–OFF", 10A–120VAC. FITS 1/2" X 1-1/8" CUT-OUT. 10 FOR $2.50

ROCKER SWITCH 2 pole–3 position. 4A 125VAC, .5A–125VDC, 1.5A–250VAC. Specify spring loaded center off or 3-pos lock. 10 FOR $2.50

WRITE FOR FREE CATALOG

ACE ELECTRONIC PARTS 5400 MITCHELLDALE, B8 HOUSTON, TEXAS 77092 (713) 688-8114

TERMS: MINIMUM ORDER $10. Send check or money order. NO COD. Texas residents add 5% sales tax. Canada and Mexico add $2.50. Overseas countries add $5.00 for surface rates. We pay postage up to 10 pounds.

CIRCLE 66 ON FREE INFORMATION CARD

DIGITAL CASSETTE TAPE C-60

FOR DIGITAL
COMPUTER RECORDING
All these tapes made in U.S.A.
Never Recorded—Reg. $6.80 each

OUR PRICE 3 for $5.00

- without B.O.T., E.O.T.
- 60 minutes recording time
- Write enable tap
- ANSI Notch
- ANSI support plane

MICROPROCESSOR CRYSTALS

FREQUENCY	MICROPROCESSOR OR CLOCK IC	Price
1.0 MHz	6800/S6860	$5.95
1.8432 MHz	MC14411 Baud Rate Generator	$9.80
2.0 MHz	F-8/CPU 3850	$5.95
2.097152 MHz	MM5378 MM5379 Auto Clock	$8.50
2.4576 MHz	34702 Bit Rate Generator	$8.50
2.667 MHz	Pace	$8.50
3.00 MHz	MCS 48	$8.50
3.20 MHz	RCA 1803	$8.50
3.2768 MHz	Intersil ICM 7205	$8.50
3.579545 MHz	NSC MM5369 (TV Color Burst)	$1.25
4.0 MHz	Intel 4040/4004/4201	$4.95
4.0 MHz	Pace	$4.95
4.194304 MHz	Intersil ICM 7038A	$4.95
4.91520 MHz	Standard Clock Frequency	$4.95
5.0 MHz	Non-standard MPU Frequency	$4.95
5.0688 MHz	COM 5016 Dual Baud Rate Generator COM 5016T Dual Baud Rate Generator	$4.95
5.185 MHz	Intel 4040/4004/4201	$4.95
5.7143 MHz	National Semiconductor	$4.95
6.00 MHz	MCS 48	$4.95
6.144 MHz	Intel 8085	$4.95
6.40 MHz	RCA 1803	$4.95
6.5536	Intersil Precision Timer Crystal ICM 7045	$4.95
8.0 MHz	Signetics	$4.95
10.0 MHz	Non-standard MPU Frequency	$4.95
14.318 MHz	Processor Tech	$4.95
18.00 MHz	Intel 8080/8008/8224	$4.95
18.432 MHz	Intel 8080/8008/8224	$4.95
20.0 MHz	Non-standard MPU Frequency	$4.95
22.1184 MHz	Intel 8080A	$4.95
27.0 MHz	Intel 8080A Series	$4.95
36.0 MHz	Intel 8080A Series	$4.95
48.0 MHz	T.I. Mod. TIM9904 P.N. SNLS362	$4.95

COMPUTER GRADE CAPACITORS

All capacitors are Brand New
U.S. made in standard size

5600MFD	60V	$2.20 EA.
8500MFD	35V	$2.75 EA.
9000MFD	50V	$3.25 EA.
4200MFD	150V	$2.50 EA.
3000MFD	15V	$1.50 EA.
11000MFD	35V	$3.20 EA.
20000MFD	55V	$3.50 EA.
23000MFD	20V	$3.00 EA.
58000MFD	20V	$3.20 EA.
100,000MFD	6V	$2.50 EA.

VHF MODULATOR

(Size of a Match Box)

This unit converts the video signal to RF signal. Ideal for computer terminal or TV games.

Video input: 1V DC RF
output: 1.5MV
Preset at 61.25 MHz
(channel 3)
Frq. adjustable ± 3 MHz
Power Supply 5~8V DC 10 MA

$4.50 EACH

DIP SWITCHES

(On-Off Contacts)

4 positions	$1.50
5 positions	$1.60
6 positions	$1.70
7 positions	$1.70
8 positions	$1.80
10 positions	$2.00

8K STATIC RAM MEMORY BOARD (BARE) $24.50 PER BOARD
Memory Chips: 21L02 X 64 pcs.
Fully buffered; all support chips are LS type; total of 26 bypass capacitors on the board; four 340T-S voltage regulators give more than enough power to the board.

16K STATIC RAM MEMORY BOARD (BARE) $24.50 PER BOARD
MEM-2 uses 2114 any speed any power
Start address and stop address selected on board so board can be used portionally populated; capable of block address, can be used in SOL$_{TM}$ and systems without front panel.

The MQ-1 QUIET MOTHER BOARD 13 SLOT $29.50 BARE
This Quiet Mother is standard 2-100 BUS with 13 slots; Kluge area; extensive ground plane; passive terminal for all lines; double solder mask; silk screen parts layout.

8080A CPU BOARD $29.50 BARE
With 8 level vector interrupt. CPU chip 8080A; clock chip: 8224; X'tal freq.: 18 MHz; vector interrupt chip: 8214.

RTC-1 REAL TIME CLOCK BOARD for S-100 BUS $24.50 BARE
On Board Oscillator: 1 MHz Crystal
Number of Interrupt: 2, one is decade; it steps from 100μ Sec to 100 Sec. Second is 16 bit counter, it is selectable from 10μ Sec to 655, 360μ Sec in 10μ Sec step.

All above boards include all documents and detailed parts list and instructions.

MINIMUM ORDER $10.00. California residents add 6% sales tax and 10% shipping.
Out of state add 15% of total purchase for shipping charges, out of USA and Overseas add 25% of total purchase.
SEND CHECK OR MONEY ORDER TO:

FORMULA INTERNATIONAL INC.

12603 CRENSHAW BOULEVARD • HAWTHORNE, CALIFORNIA 90250
For more information please call (213) 973-1921, (213) 679-5162
STORE HOURS 10-7 Monday - Saturday

CIRCLE 60 ON FREE INFORMATION CARD

DON'T MISS ANY

Get every single issue of Radio-Electronics delivered right to your door, and before it appears on the newsstand. Use this coupon and subscribe now.

Mail to: Radio-Electronics
SUBSCRIPTION DEPT., P.O. BOX 2520,
BOULDER, COLO. 80322

name **(please print)**

address

city **state** **zip code**

check offer preferred

☐ 1 Year—12 issues **ONLY $9.98**

☐ 2 Years—24 issues **SAVE MORE $19.00**
(You save $5.00 over newsstand)

☐ 3 Years—36 issues **GREATER SAVINGS $27.00**
(You save $9.00 over newsstand prices)

☐ Payment enclosed ☐ Bill Me

☐ Check here if this is a new subscription

☐ Check here if you are extending or renewing your subscription

Extra Shipping: Canada $3.00 per year, all other countries $5.00 per year.

40F8

NEW TV CAMERA with ZOOM LENS

9 TO 30 mm f 1:9 Lens

- USE WITH ANY V.T.R. ATV, SSTV, HOME SECURITY
- USE INDOORS OR OUTDOORS
- ALL SOLID STATE

15 FOOT CABLE AND PISTOL GRIP

NOT A KIT
Fully Guaranteed

$195.00 Complete

DIGITAL AUTO INSTRUMENTS

SEVEN MODELS!

- #1 TACHOMETER
- #2 WATER TEMP.
- #3 FUEL LEVEL
- #4 SPEEDOMETER*
- #5 OIL PRESSURE
- #6 OIL TEMP.
- #7 BATTERY MONITOR

KIT INCLUDES:
- CASE & ALL HARDWARE
- PRESSURE & TEMP SENDERS
- ASSEMBLED MAIN PC BOARD

FEATURES:
- 4" ORANGE LED'S
- 4 1/2" x 4" x 2" ABS CASE

*ADD $10 FOR REQUIRED SPEED SENDER $15 FOR SPEED SENDER ALONE

KIT: $49.95. . . . . . .ASSEMBLED: $59.95

SPECIFY 12 OR 24 HOURS

3½ DIGITAL CLOCK

- 4 DIGIT KIT $49.95
- 4 DIGIT ASSEMBLED $59.95
- 6 DIGIT KIT $69.95
- 6 DIGIT ASSEMBLED $79.95

117 VAC 12 OR 24 HR MODE . . . . KIT COMES COMPLETE!
6 DIGIT VERSION: 27" x 5" x 1½" . . . 4 DIGIT VERSION: 18" x 5" x 1½"

MARK FOSKETS'

SOLID STATE TIME
P.O. BOX 2159
DUBLIN, CALIF. 94566
ORDERS (415) 828-1923

master charge THE INTERBANK CARD

PLEASE ADD $1.50 OR POSTAGE & HANDLING

BANKAMERICARD

CALIFORNIA RESIDENTS - ADD 6% SALES TAX

CIRCLE 29 ON FREE INFORMATION CARD

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20—100,000 Hz. This amplifier has QUASI—Complimentary class B output. Output max is watt (10 watt RMS) at 4 Ω.

ONLY $23.50 each

FM WIRELESS MIC KIT

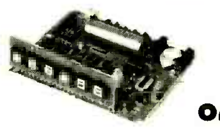
$6.95 EACH KIT

This new model FM wireless MIC kit uses 3 high freq. transistors, works in the FM range (88-108 MHz). It transmits the sound wave fidelity clearly over long distances (up to 2500 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

SOUND ACTIVATED SWITCH

All parts completed on a PC Board
SCR will turn on relay, buzzer or trigger other circuit for 2 ~ 10 sec. (adjustable)
Ideal for use as door alarm, sound controlled toys and many other projects
Supply voltage 4.5V ~ 9V D.C.
$1.75 ea./2 for $3.00

30MHZ FREQUENCY COUNTER KIT



Take advantage of this new state-of-the-art counter featuring the many benefits of custom LSI circuitry. This new technology approach to instrumentation yields enhanced performance, smaller physical size, drastically reduced power consumption (portable battery operation is now practical), dependability, easy assembly and revolutionary lower pricing!

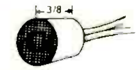
Model 250-30A

Only $59.50

Includes all parts, PC Board and Transformer

- 0.5" red LED 6 digits display
- Resolution: 1 Hz at 1 sec. 10 Hz at 1/10 sec.
- Sensitivity: 10 Mv RMS to 30 Hz
- Internal power supply: 5.2V at 1 amp regulated
- Input connector: BNC type
- Input power required: 117V AC 50/60 Hz
- Diode protected for over voltage input

Sub-Mini Size Condenser Microphone



$2.50 each
FET Transistor Built-in

CALCULATOR with STOPWATCH

6 Functions with % and memory
8 Digits big green display
*Built-in X'tal controlled stop watch count to 1/10 of a second.
Special Price Only
$16.50 Ea.
BATTERIES NOT INCLUDED

MECHANICAL DIGITAL CLOCK

WITH DAY AND DATE OF THE WEEK

This clock is beautifully designed. Case is made from high quality die cast alloy. Movement is the popular flip type with a back up light

Supply Voltage 110V AC. limited quantity **$15.50 ea.**

FLUORESCENT LIGHT DRIVER KIT

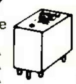
12V DC POWERED
Lights up 8 ~ 15 Watt Fluorescent Light Tubes
Ideal for camper, outdoor Auto or Boat
Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!
ONLY $5.50 PER KIT

1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board
Supply Voltage 6 ~ 9V D.C.
SPECIAL PRICE $1.95 ea.

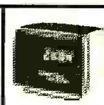
12V DC MINI RELAY

P.C. Board Solder Type



2AMP Contact SPDT $1.30 EA
2AMP Contact DPDT $1.75 EA
5AMP Contact 4PDT $2.20 EA

12V D.C. AUTO DIGITAL CLOCK



Complete Unit
Not a Kit!

0.4" blue color 4 digits display. Turn off readouts when car is not running. X'tal controlled time base for time accuracy. Special designed case for easy mounting on top of your dashboard. Ideal for car, boat and campers.

ONLY $28.50 ea.

HEAVY DUTY CLIP LEADS

10 pairs — 5 colors
Alligator clips on a 22" long lead. Ideal for any testing.
$1.85/pack

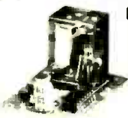
"FISHER" 30 WATT STEREO AMP

(15W X 2)

Kit includes: 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply: ± 16V DC (not included). Power band with (KF = 1% ± 3dB). Voltage gain: 33dB, 20Hz – 20KHz

Super Buy Only $22.50 each kit

ELECTRONIC SWITCH KIT



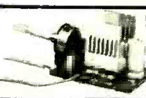
CONDENSER TYPE
Touch on · Touch Off
use 7473 I C
and 12V relay
$5.50 each

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!!
Receives all AM stations
Batteries and ear phone included

Only $8.50

5W AUDIO AMP KIT



2 LM 380 with Volume Control
Power Supply 6 ~ 18V DC
only $5.00 ea.

NEW! 4 EASY-TO-BUILD KIT

LED PROJECTS ON ONE BOARD

- HO-Guage railroad crossing blinker
- Variable LED flasher
- Six-bit binary counter
- Wheel of fortune

Kit includes all electronic components and PC Board
Especially designed for experimenters
Guaranteed — they all work!!
(Battery not included)
$12.50 PER KIT

NI-CD RECHARGEABLE BATTERIES

AA	SIZE	$1.25 EA
C	SIZE	$1.50 EA
D	SIZE	$2.50 EA
5 Sub C pack	SIZE	$4.90 EA

*12V Mini Size
Motorcycle rechargable wet battery 6AMP/Hour
Brand new, but ltd. quantity
$12.50 EA.

TIMER KIT

Time Controlled from 1-100sec.

Ideal to be used as time delay unit for burglar alarm, photo service, and other purposes. Max. loading 110V, 2 AMP. Supply voltage 12-18V D.C.

FT-80 ELECTRONIC IC TIMER

$11.50 each

Sub Mini Size PANEL METER

500 UA
ONLY $1.20 ea

MINI-MINI TOGGLE SWITCH

Half size of submini toggle switch rated 3 amp 125V AC contact

		1 9	10 99
MS 2432P	SPST	0 90	0 80
MS 244	SPDT	1 00	0 90
MS 245	DPDT	1 20	1 10

LARGE QUANTITY AVAIL FOR OEM

ELECTRONIC ALARM SIREN

COMPLETE UNIT
Ideal for use as an Alarm Unit, or hookup to your car back up to make a reverse indicator
Light Output up to 130 dB.
Voltage Supply 6 — 12V
AU — 999
$7.50

LED ALARM CLOCK

COMPLETE UNIT NOT A KIT

- 0.5" RED LED READ OUT
- 24 HRS. ALARM SET
- 10 MINS. SNOOZE SET
- AM/PM ALARM INDICATORS
- SECOND DISPLAY SWITCH
- AUTOMATIC BRIGHTNESS CONTROL
- COMPACT AND HANDSOME PACKING
- 110V AC 60HZ INPUT

$17.50 EACH

PANEL METER (D.C. Type)

Size 60MM X 66MM
White Face Type

$5.50 ea.

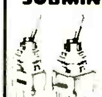
0 50UA	0 30V
0 1MA	0 50V
0 5MA	0 100V
0 100MA	

TRANSFORMERS

ALL 117 VOLT INPUT

30V	4AMP	$7.50 EA.
36V CT	3AMP	$6.50 EA.
48V CT	3AMP	$6.50 EA.
24V CT	3AMP	$6.50 EA.
12 or 24V	2AMP	$3.90 EA.
24V CT	0.8AMP	$1.80 EA.
12V CT	0.8AMP	$1.80 EA.

SUBMINIATURES TOGGLE SWITCHES



SPDT	On Off	$1 30 ea
DPDT	On Off	$1 50 ea
3PDT	On Off	$1 75 ea

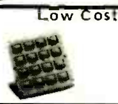
Mini Size Rocker Type Also Available at the Same Price

19 KEY HEXADECIMAL KEY PAD

- 1 — 0
- ABCDEF
- Homekey
- ←→ Key

SPECIAL $10.50 ea.

Low Cost Hexadecimal 16 Key Pad



Designed for Calculator
Can be used for Computer Data Entry Pad or Digital Lock
All key tops blank with super good touch feeling
$0.95 ea

5" MUFFIN FAN

HEAVY DUTY
5 Blade Type
110V 50/60HZ
Case made of Die-Cast metal used but almost brand new
SPECIAL PRICE $9.60 ea.

AC POWER SUPPLY

Wall Type Transformer

12V AC	Output	200MA	$2.75 EA.
16V CT AC	Output	100MA	$2.10 EA.
6V DC	Output	120MA	$1.90 EA.
12V DC	Output	100MA	$1.90 EA.

MINI SIZE REED RELAY

Approx. 1" square
SPST Normal Open
Contact rated 1AMP
Coil 6 ~ 12V DC
All brand new by AMF
3 for $2.00

DIGITAL ELECTRONIC LOCK KIT

$6.50 ea.
CMOS I.C. IN CIRCUIT

for auto ignition, entry door, burglar, alarm, etc
4 Digits Programable to Any Combination

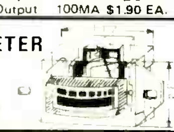
400Ω RELAY AND KEY PAD NOT INCLUDED

BIPOLAR LED

Jumbo Size red/green change color when reverse polarity of voltage. Ideal for go/nogo indicator.
Two for $1.50

150UA METER

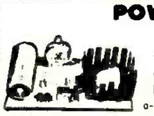
only
$1.50 ea.



PUSH-BUTTON SWITCH

N/Open Contact
Color: Red, White, Blue, Green, Black. 4/$1.00
N/Close also Available 50¢ ea.
LARGE QTY AVAILABLE

POWER SUPPLY KIT



0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.
0-30 POWER SUPPLY $10.50 each
Transformer for Power Supply, 2 AMP 24V x 2 $6.50
30V DC Panel Meter $4.20

I.C. TEST CLIPS

Same as the E Z clips
With 20" Long Leads
In Black and Red Colors
$2.75 per pair

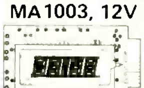
HOUR INDICATOR

This unit is 1 5/8" long operating voltage 4V D.C. will tell you how many hours your circuit or machine has been in service up to 100 hours.
Limited Quantity ONLY $1.75 ea.

SOLID STATE ELECTRONIC BUZZER

Mini Size 1" × 3/4" × 3/4
Supply voltage 1.5V 12V
Ideal for Alarm or Tone Indicator
$1.50 each

MA1003, 12V DC CLOCK MODULE



Built in X'TAL controlled time base. Protected against automotive volt transients. Automatic brightness control with 0.3" green color display. Display turnoff with ignition "OFF".

$19.50

MINIMUM ORDER $10.00. California residents add 6% sales tax and 10% shipping.
Out of state add 15% of total purchase for shipping charges, out of USA and Overseas add 25% of total purchase.
SEND CHECK OR MONEY ORDER TO:

FORMULA INTERNATIONAL INC.

12603 CRENSHAW BOULEVARD • HAWTHORNE CALIFORNIA 90250
For more information please call (213) 973-1921, (213) 679-5162
STORE HOURS 10-7 Monday - Saturday

master charge — your BANKAMERICARD welcome

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.) Permits quick testing of inaccessible lines.

Part No.: 922576-26 No. of contacts: 26 Price $6.90 ea.

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching.

Part No.: IS-26 No. of contacts: 26 Price $13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

SWITCHES

¼" mounting holes

Type	Part	Pole	Action	1-9	10+
TOGGLE (sub-minature)	JMT121	SPDT	on-off-on	$1.95	$1.43
	JMT123	SPDT	on-none-on	1.65	1.21
	JMT221	DPDT	on-off-on	2.55	1.87
	JMT223	DPDT	on-none-on	2.15	1.58
TOGGLE (Printed Circuit)	MPC121	SPDT	on-off-on	$2.05	$1.53
	MPC123	SPDT	on-none-on	1.75	1.31
	MPC221	DPDT	on-off-on	2.65	1.97
	MPC223	DPDT	on-none-on	2.25	1.68
PUSH BUTTON	PB123	SPDT	maintained	1.95	1.47
	PB126	SPDT	momentary	1.95	1.17
PUSH BUTTON Minature	MS102	DPST	momentary open	.35	.30
	MS103	SPST	momentary closed	.35	.30
DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1.65
	206-7	14 pin dip	7 switch	1.95	1.85
	206-8	16 pin dip	8 switch	2.25	2.15

1/16 VECTOR BOARD

	0.1 Hole Spacing Part No.	P-Pattern L	P-Pattern W	Price 1-9	Price 10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

SLIT-N-WRAP

Model P180 Includes 2-100' spools #28 AWG wire wrap wire

Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method.

Model P180 $24.50

REPLACEMENT WRAP BIT for P180 Slit N Wrap No. P180A $12.95 each

Replacement wire-wrap wire for P180 #28 AWG (pkg. of 3) $2.75 each
W28-2-A green W28-2-B red W28-2-C clear W28-2-D blue

INSTRUMENT/ CLOCK CASE

Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16"

$3.49

MICROPROCESSOR COMPONENTS

COP 1802	CPU	$19.95	Z80	CPU	$24.95
P8085	CPU	29.95	2650	MPU	26.50
8080A	CPU	10.95	MC6800	MPU	19.95
8212	8-Bit Input/Output	4.95	MC6810API	128 X 8 Static Ram	5.95
8214	Priority Interrupt Control	7.95	MC6820	Periph. Interface Adapter	7.95
8216	Bi-Directional Bus Driver	4.95	MC6821	Periph. Interface Adapter	11.50
8224	Clock Generator/Driver	5.95	MC6830L8	1024 X 8 Bit ROM	14.95
8228	System Controller/Bus Driver	5.95	MC6850	Asychronous Comm. Adapter	14.95

USER MANUALS

1802M	COP1802 Manual	$7.50
Z80M	Z80 Manual	7.50
2650M	2650 Manual	5.00

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM507H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5013N	1024 Bit Accumulator Dynamic	2.95
MM5016H	500/512 Bit Dynamic	.89
MM5017N	Dual 500/512 Bit Dynamic	2.95
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2519	Hex 40 Bit Static	4.00
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4 X 4 Register	1.95

ROM'S

2513(2140)	Character Generator (upper case)	$9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048 Bit Read Only Memory	1.95

UART'S

AY-5-1013	30K BAUD	$5.95

RAM'S

1101	256 X 1	Static	$1.49
1103	1024 X 1	Dynamic	.99
2101	256 X 4	Static	5.95
2102	1024 X 1	Static	1.75
2107/5280	4096 X 1	Dynamic	4.95
2111	256 X 4	Static	6.95
2114	4K X 1	Static 450ns	9.95
2114L	4K X 1	Static 450ns Low Power	10.95
2114-3	4K X 1	Static 300ns	10.95
2114L-3	4K X 1	Static 300ns Low Power	11.95
7489	16 X 4	Static	1.75
8101	256 X 4	Static	5.95
8111	256 X 4	Static	6.95
8599	16 X 4	Static	3.49
21L02	1024 X 1	Static	1.95
74200	256 X 1	Static	6.95
93421	256 X 1	Static	2.95
MM5262	2K X 1	Dynamic	.49
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	5.95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	29.95
TMS4044-45NL	4K	STATIC	14.95

PROMS

1702A	2048	Famous	$5.95
5203	2048	Famous	14.95
82S23	32 X 8	Open C	5.00
82S115	4096	Bipolar	19.95
82S123	32 X 8	Tristate	5.00
74S287	1024	Static	7.95
2708	8K	EPROM	10.95
2716 T.I.	16K	EPROM	29.95
2716 Intel	16K	EPROM	59.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open C Bipolar	2.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14.95
AY-5-9200	14.95
AY-5-9500	4.95
AY-5-2376	14.95
HD0165	7.95
74C922	9.95

ICM CHIPS

ICM7045	$24.95
ICM7205	19.95
ICM7207	7.50
ICM7208	19.95
ICM7209	6.95

NMOS READ ONLY MEMORIES

MCM6571	$13.50
MCM6574	13.50
MCM6575	13.50

TV GAME CHIP SET AY-3-8500-1 Chip and 2.010 MHz Crystal $7.95

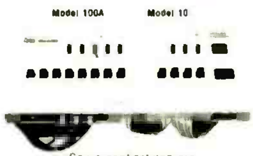
MISCELLANEOUS

11C90	$19.95	MK40240	$17.50
MC3061P	11.95	DS0026CH	3.75
MC1408L7	4.95	TIL308	10.20
MC1408L8	5.75	95H90	11.95
LD110/111	$25.00/set		
MC4016(74416)	7.50		
4N33	3.95		

PARATRONICS

Logic Analyzer Kit Model 100A

$229.00/kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

Some applications are
- Troubleshooting microprocessor address, instruction, and data flow
- Examine contents of ROMS
- Tracing operation of control logic
- Checking counter and shift register operation
- Monitoring I/O sequences
- Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word — Connects direct to Model 100A for integrated unit).

Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage - 0-1000V; AC Voltage 0-1000V; Freq. Response 50-400 HZ; DC/AC Current 0-100mA; Resistance 0-10 meg ohm; Size 6.4 x 4.4 x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:
AC Adapter BC-28 $9.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 7.50

CSC 100 MHz 8-Digit Counter

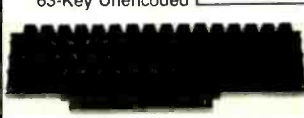
- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces: i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator — use 110 V AC — Model 100 — CA! $9.95

KEYBOARDS

63-Key Unencoded



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most applications. IN STOCK **$29.95/each**

Hexadecimal Encoder

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

The Incredible "Pennywhistle 103"

$129.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) — 1070 space, 1270 mark; High — 025 space, 2225 mark
Receive Sensitivity	46 dbm accoustically coupled
Transmit Level	15 dbm nominal. Adjustable from 6 dbm to -20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

The Original the 3rd Hand

$9.95 each

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE700 CLOCK

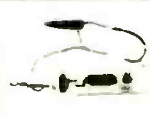
12 or 24 Hour

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

115 VAC *KIT ONLY* **$16.95**

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



$9.95 Per Kit

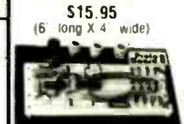
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **JE225 $9.95 Per Kit**

CSC PROTO BOARDS

PROTO BOARD 6
$15.95
(6" long X 4" wide)



PB100 - 4.5" x 6"	$19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1978A Catalog Available–Send 35¢ stamp

NEW NAME

Jameco ELECTRONICS
A division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru June

CIRCLE 57 ON FREE INFORMATION CARD

7400 TTL

SN7400N	.16	SN7472N	.29	SN74160N	.89
SN7401N	.18	SN7473N	.35	SN74161N	.89
SN7402N	.18	SN7474N	.35	SN74162N	1.95
SN7403N	.18	SN7475N	.49	SN74163N	.89
SN7404N	.18	SN7476N	.35	SN74164N	.89
SN7405N	.20	SN7479N	5.00	SN74165N	.89
SN7406N	.29	SN7480N	.50	SN74166N	1.25
SN7407N	.29	SN7482N	.99	SN74167N	1.95
SN7408N	.20	SN7483N	.59	SN74170N	1.59
SN7409N	.20	SN7485N	.79	SN74172N	6.00
SN7410N	.18	SN7486N	.35	SN74173N	1.25
SN7411N	.25	SN7489N	1.75	SN74174N	.89
SN7412N	.25	SN7490N	.45	SN74175N	.79
SN7413N	.40	SN7491N	.59	SN74176N	.79
SN7414N	.70	SN7492N	.43	SN74177N	.79
SN7416N	.25	SN7493N	.43	SN74179N	1.95
SN7417N	.25	SN7494N	.65	SN74180N	.79
SN7420N	.20	SN7495N	.65	SN74181N	1.95
SN7421N	.29	SN7496N	.65	SN74182N	.79
SN7422N	.39	SN7497N	3.00	SN74184N	1.95
SN7423N	.25	SN74100N	.89	SN74185N	1.95
SN7425N	.29	SN74107N	.35	SN74186N	9.95
SN7426N	.29	SN74109N	.59	SN74188N	3.95
SN7427N	.25	SN74116N	1.95	SN74190N	1.25
SN7429N	.39	SN74121N	.35	SN74191N	1.25
SN7430N	.20	SN74122N	.39	SN74192N	.79
SN7432N	.25	SN74123N	.49	SN74193N	.79
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.25	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.79	SN74198N	1.49
SN7442N	.49	SN74142N	2.95	SN74199N	1.49
SN7443N	.75	SN74143N	2.95	SN74200N	5.59
SN7444N	.75	SN74144N	2.95	SN74251N	1.79
SN7445N	.75	SN74145N	.79	SN74279N	.79
SN7446N	.69	SN74147N	1.95	SN74283N	2.25
SN7447N	.59	SN74148N	1.29	SN74284N	3.95
SN7448N	.79	SN74150N	.89	SN74285N	3.95
SN7450N	.20	SN74151N	.59	SN74365N	.69
SN7451N	.20	SN74153N	.59	SN74366N	.69
SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
SN7459A	.25	SN74156N	.79	SN74390N	1.95
SN7460N	.20	SN74157N	.65	SN74393N	1.95
SN7470N	.29				

C/MOS

CD4000	.23			CD4070	.55
CD4001	.23			CD4071	.23
CD4002	.23	CD4028	.89	CD4072	.49
CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	.99
CD4011	.23	CD4041	1.25	CD4098	2.49
CD4012	.25	CD4042	.99	MC14409	14.95
CD4013	.39	CD4043	.89	MC14410	14.95
CD4014	1.39	CD4044	.89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	.75
CD4018	.99	CD4049	.49	MC14507	.99
CD4019	.49	CD4050	.49	MC14562	14.50
CD4020	1.19	CD4051	1.19	MC14583	3.50
CD4021	1.39	CD4053	1.19	CD4508	3.95
CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	3.00
74C02	.55			74C164	3.25
74C04	.75	74C89	6.49	74C173	2.60
74C08	.75	74C90	3.00	74C192	3.49
74C10	.65	74C93	2.00	74C193	2.75
74C14	3.00	74C95	2.00	74C195	2.75
74C20	.65	74C107	1.25	74C922	9.95
74C30	.65	74C151	2.90	74C923	8.95
74C42	2.15	74C154	3.00	74C925	14.95
74C48	4.75	74C157	2.15	74C926	11.95
74C73	1.50	74C160	3.25	80C95	1.50
74C74	1.15	74C161	3.25	80C97	1.50

LINEAR

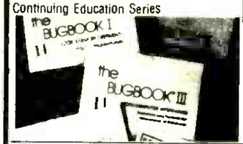
78MG	1.75			LM733N	1.00
LM300H	.80			LM739N	1.19
LM301H	.35			LM741CH	.35
LM301CN	.35			LM741CN	.35
LM302H	.75	LM340T-8	1.25	LM741-14N	.39
LM304H	1.00	LM340T-12	1.25	LM747H	.79
LM305H	.60	LM340T-15	1.25	LM747N	.79
LM307CN/H	.35	LM340T-18	1.25	LM748H	.39
LM308H	1.00	LM340T-24	1.25	LM748N	.39
LM308CN	1.00	LM350N	1.00	LM1303N	.90
LM309H	1.10	LM351CN	.65	LM1304N	1.19
LM309K	1.25	LM370N	1.15	LM1305N	1.40
LM310CN	1.15	LM373N	3.25	LM1307N	.85
LM311H	.90	LM377N	4.00	LM1310N	2.95
LM311N	.90	LM380N	1.25	LM1351N	1.65
LM317K	6.50	LM380CN	.99	LM1414N	1.75
LM318CN	1.50	LM381N	1.79	LM1458CN/H	.59
LM319N	1.30	LM382N	1.79	MC1488	1.95
LM320K-5	1.35	NE501N	8.00	MC1489	1.95
LM320K-5.2	1.35	NE510A	6.00	LM1496N	.95
LM320K-12	1.35	NE529A	4.95	LM1556V	1.75
LM320K-15	1.35	NE531H	3.00	MC1741SCP	3.00
LM320K-18	1.35	NE536T	6.00	LM2901N	2.95
LM320K-24	1.35	NE540L	6.00	LM3053	1.50
LM320T-5	1.25	NE550N	1.30	LM3065N	.69
LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
LM320T-8	1.25	NE556	.99	LM3905N	.89
LM320T-12	1.25	NE560B	5.00	LM3909	1.25
LM320T-15	1.25	NE561B	5.00	MC5558V	1.00
LM320T-18	1.25	NE562B	5.00	LM7525N	.90
LM320T-24	1.25	NE565H	1.75	LM7534N	.75
LM323K-5	5.95	NE565N	1.25	8038B	4.95
LM324N	1.80	NE566CN	1.75	LM75450	.49
LM339N	.99	NE567H	1.25	75451CN	.39
LM340K-5	1.35	NE567V	.99	75452CN	.39
LM340K-6	1.35	NE570	10.50	75453CN	.39
LM340K-8	1.35	LM703CN/H	.45	75454CN	.39
LM340K-12	1.35	LM709H	.29	75491CN	.79
LM340K-15	1.35	LM709N	.29	75492CN	.89
LM340K-18	1.35	LM710N	.79	75494CN	.89
LM340K-24	1.35	LM711N	.39	RC4151	5.95
LM340T-5	1.25	LM723H	.55	RC4194	5.95
LM340T-6	1.25	LM723N	.55	RC4195	4.49

74LS00 TTL

74LS00	.23			74LS155	.69
74LS02	.23			74LS157	.69
74LS03	.23	74LS74	.35	74LS160	.89
74LS04	.29	74LS75	.49	74LS161	.89
74LS05	.29	74LS76	.35	74LS162	.89
74LS08	.23	74LS83	.75	74LS163	.89
74LS10	.23	74LS85	.99	74LS164	.99
74LS13	.49	74LS86	.35	74LS175	.79
74LS14	.99	74LS90	.49	74LS181	2.49
74LS20	.23	74LS92	.59	74LS190	.89
74LS26	.29	74LS93	.59	74LS191	.89
74LS27	.29	74LS95	.79	74LS192	.89
74LS28	.29	74LS96	.89	74LS193	.89
74LS30	.23	74LS107	.35	74LS194	.89
74LS32	.29	74LS109	.35	74LS195	.89
74LS40	.29	74LS112	.35	74LS253	.79
74LS42	.69	74LS123	.99	74LS257	.69
74LS47	.69	74LS132	.79	74LS260	.55
74LS51	.23	74LS136	.39	74LS279	.59
74LS55	.23	74LS138	.69	74LS367	.59
74LS73	.35	74LS139	.69	74LS368	.59
		74LS151	.69	74LS670	1.95

BUGBOOK®

Continuing Education Series



BUGBOOKS I and II — $17.00 per set
by Peter R. Rony, David G. Larsen, WB4HYJ

Sold as a set these two books outline over 90 experiments designed to teach the reader all he will need to know about TTL logic chips to use them in conjunction with microprocessor systems. You'll learn about the basic concepts of digital electronics including gates, flip-flops, latches, buses, decoders, multiplexers, demultiplexers, LED displays, RAM's, ROM's, and much, much more.

BUGBOOK IIa — $5.00
by Peter R. Rony, David G. Larsen, WB4HYJ

This volume will introduce you to the fabulous UART chip — that all important interface between data terminals, etc., and your microcomputer. It also covers current loops, and the RS 232C interface standard. Particularly recommended for any RTTY enthusiast.

BUGBOOK III — $15.00
by Peter R. Rony, David G. Larsen, WB4HYJ, Jonathan A. Titus

Here is the book that puts it all together. Besides having much valuable text there are a series of experiments in which the reader completely explores the 8080 chip pin by pin and introduces you to the Mark 80 microcomputer, a unique easily interfaced system. It is recommended that you have the background in the BUGBOOKS I & II before proceeding with BUGBOOK III.

BUGBOOK V and VI — $19.00 per set
by David G. Larsen, Peter R. Rony, Jonathan A. Titus

Experiments in digital electronics, 8080A microcomputer programming and 8080A microcomputer interfacing. An integrated approach to self instructed basic digital electronics, breadboarding and 8080A interfacing/programming. Bugbook VI integrates the digital concepts of Bugbook V into a treatment of 8080A microcomputer programming and interfacing. Detail & laboratory experiments included with each book.

CMOS-M — DESIGNERS PRIMER AND HANDBOOK New expanded version — $8.50

Starts at basic structure of CMOS devices through integration into MSI.

THE 555 TIMER APPLICATIONS SOURCEBOOK WITH EXPERIMENTS — $6.95
by Howard M. Berlin W3HB

This book shows you what the 555 timer is and how to use it. Included are over 100 various design techniques, equations and graphs to create "ready to go" timers, generators, power supplies, measurement and control circuits, party games, circuits for the home and automobile, photography, music and Amateur Radio.

INSTRUCTOR'S MANUAL — $3.00

Necessary for instruction of Bugbook I and II. Answers questions regarding experiments, suggestions for further reading, philosophy of authors approach to digital electronics. A must for self-teaching individuals.

OP AMP MANUAL by Howard M. Berlin W3HB — $9.00

An experiment guide to application of operational amplifiers. Over 25 experiments on all phases of Op Amps.

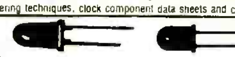
DBUG — $5.00

8080 interpretive debugger. A program for entering, debugging and storing assembly language programs.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks

Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips — $3.95

DISCRETE LEDS



.125" dia			.190" dia		
XC209	Red	5/$1	XC111	Red	5/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia			.185" dia			.200" dia		
XC22	Red	5/$1	XC526	Red	5/$1	XC556	Red	5/$1
XC22	Green	4/$1	XC526	Red	100/$8	XC556	Red	100/$8
XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1
XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Orange	4/$1
						XC556	Clear	7/$1

.085" dia: MV50 - Red 6/$1

INFRA RED LED 1/4 x 1/4 x 1/16 Flat 5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6730	Common Anode-red ±1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	MAN 6780	Common Cathode-red	.560	.99
MAN 74	Common Cathode-red	.300	1.25	DL701	Common Anode-red ±1	.300	.99
MAN 81	Common Anode-yellow	.300	.99	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3630	Common Anode-orange ±1	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.400	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4730	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode (FND500)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6630	Common Anode-orange	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6650	Common Cathode-orange ±1	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6660	Common Anode-orange	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	.49
CA3081	2.00	CA3600	3.50

CALCULATOR CHIPS AND DRIVER

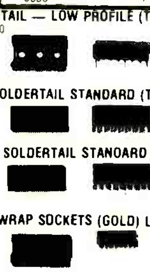
FCM3817	$5.00
MM5725	2.95
MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
7001	5.95

9374 - 7-segment LED driver common anode LEDs $ .99

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS



	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$.37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

14 pin ST	$.27	.25	.24	28 pin ST	$.99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin WW	$.40	.38	.35	22 pin WW	.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5% = 50 PCS.
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5% 50 PCS.
		470 OHM	560 OHM	680 OHM	820 OHM	1K	
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5% 50 PCS.
		3.3K	3.9K	4.7K	5.6K	6.8K	
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	1/4 WATT 5% 50 PCS.
		22K	27K	33K	39K	47K	
ASST. 5	5 ea.	56K	68K	82K	100K	120K	1/4 WATT 5% 50 PCS.
		150K	180K	220K	270K	330K	
ASST. 6	5 ea.	390K	470K	560K	680K	820K	1/4 WATT 5% 50 PCS.
		1M	1.2M	1.5M	1.8M	2.2M	
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5% = 50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1978A Catalog Available – Send 35¢ stamp

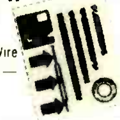
NEW NAME

Jameco ELECTRONICS
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru June

WIRE-WRAP KIT — WK-2-W



WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire

$12.95

WIRE WRAP TOOL WSU-30
WRAP • STRIP • UNWRAP - $6.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.95 ea.**
- Cuts wire to desired length
- Strips 1" of insulation Specify — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

EXAR

XR-L555 $1.50 Micro-Power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuits.

XR2242CP $1.50 Precision timing circuit for generating timing pulses in **minutes, hours** and days or up to 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter.

XR2206KA-$14.95 XR2206KB-$19.95

XR205	$8.40	XR1489	1.39	XR2556	$3.20
XR210	4.40	XR1800	3.20	XR2567	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.47

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CIRCLE 58 ON FREE INFORMATION CARD

TRANSFORMER HINT

Steve P. Dow, Gibsons, BC, Canada, writes:

"Low-end stereos which need unavailable OEM transformers can be replaced with standard brands, as you said in the Service Clinic, January 1978 issue. Many of the originals fail because a thermal fuse was used in the primary circuit. The UL and CSA safety tests on these receivers are based upon this intrinsic energy-limiting device. However, many of the standard low-voltage transformers in replacement lines do not have this protective device. So, when these are used, a fuse should be added, if the original part isn't used.

"This thermal fusing seems to be the result of tightened transformer standards since 1973. Manufacturers had to guarantee that when a transformer burned out it could not short any primary terminal to the core. Since this burnout test was made with the primary energized and the secondary shorted, the simple solution was to use thermal links. Burnout then terminated with the open primary circuit, and the insulation did not overheat."

(Thank you very much, Steve. To be honest, I didn't know that! However, I had wondered about the rash of cases with open primary winding. You may remember that the older power transformers rarely, if ever, opened the primary; they just overheated and burnt up.

Thermal fusing is a very good idea, and I should have added that. Also, if the replacement transformer *is* well derated, as suggested, there won't be as much risk of overloading it, as the original obviously was.)

THIN BLUE LINE

I'm having a time with this J.C. Penney model 2874. All I get is a thin blue horizontal line on the screen! I've checked several things and come up dry.—M. B., Pearl, MS.

There are several possible causes for this. One, make *sure* that the service switch is good. The ohmmeter must show zero resistance between the vertical-output base and the bottom end of the 39-ohm resistor to the vertical driver's collector circuit. Also, read the *emitter* voltage of the vertical-output transistor. If this reads normal (+5.21 volts), then the output stage *is* working, and there should be an open circuit in the secondary of the vertical-output transformer or vertical-deflection yoke. Check all yoke plug contacts.

If all these seem to be OK, check the 220-μF electrolytic capacitor in the yoke circuit. This is the yoke-return capacitor, and if it's open there will be no sweep.

For the blue line, check the red and green screen-control settings.

INTERNATIONAL ELECTRONICS UNLIMITED

IC LED SALE

LED DISPLAYS

MAN 1	.27" Red CA LHD	.99
MAN 2	.30" Red 5x7 LHD	3.95
MAN 5	.27" Green CA LHD	.99
MAN 7	.27" Yellow CA LHD	.49
MAN 54	.30" Green CC RHD	1.19
MAN 66	.60" Red CA LHD	1.19
MAN 72	.30" Red CA LHD	.59
MAN 82	.30" Red CA LHD	.99
MAN 3610	.30" Orange CA RHD	.69
MAN 3640	.30" Orange CC RHD	.69
MAN 4610	.40" Orange CC RHD	.59
MAN 6660	.56" Orange CA RHD	.59
DL 10A	.27" Red CA LHD	.99
DL 702	.30" Red CC LHD	.79
DL 707	.30" Red CA RHD	.79
DL 747	.60" Red CA LHD	1.19
FND 359	.375" Red CC RHD	.59
FND 500	.50" Red CC RHD	.69
FND 507/510	.50" Red CA RHD	.69
NSN 74R	.30" Red CC RHD	.69
MAN 6610	2 Dig .56" Orng CA RHD	.69
MAN 6630	1-1/2 Dig .56" Orng CA RHD	.59
MAN 6640	2 Dig .56" Orng CC RHD	.69
MAN 6650	1-1/2 Dig .56" Orng CC RHD	.59
MAN 6710	2 Dig .56" Red CA RHD	.69
MAN 6730	1-1/2 Dig .56" Red CA RHD	.59
MAN 6740	2 Dig .56" Red CA RHD	.69
MAN 6750	1-1/2 Dig .56" Red CC RHD	.59
DL 33B	3 Dig .17" Red CC	.29
DL 33B	2 Dig .17" Red CC	.49
NSN 33	3 Dig .17" Red CC	.39
HP 5082	4 Dig .11" Mag. RHD	.39
HP 5082	5 Dig .11" Mag. RHD	.49
SP425-09	9 Dig Gas Discharge	.69
Calc Disp	9 MAN 3s on board Red	.79
TI 434	9 Dig Red	.49

Jumbo Red LEDs	12/$1.00	140/$10.00
Jumbo Green LEDs	8/$1.00	100/$10.00
Jumbo Yellow LEDs	8/$1.00	100/$10.00
Jumbo Clear LEDs	12/$1.00	140/$10.00

2708	8K EROM	$8.95
2513(caps)	Char. Gen.	2.95
2513(L.C.)	Char. Gen.	2.95
MM1101	256 bit RAM	.65
MM1103	1K RAM	.75
1702A	EROM	4.75
MM5261	1K RAM	.55
MM5262	1K RAM	.95
F93410	256 bit RAM	.95
MM5314	Clock Chip	2.95
MM5316	Clock Chip	.95
MM5370	Clock Chip	3.95
MM5375AA	Clock Chip	2.95
CT7001	Clock Chip	4.95
2510	Dual 50 bit Shift Reg.	.95
2511	Dual 100 bit Shift Reg.	.95
2518	Hex 32 bit Shift Reg.	1.25
2522	Dual 132 bit Shift Reg.	.95
MM5016	500/512 bit Shift Reg.	.95
SL-5-4025	Quad 25 bit Shift Reg.	.59
CT5002	Calc. Chip	.35
CT5005	Calc. Chip	.75
MM5725	Calc. Chip	
MM5736	Calc. Chip	.65
MM5738	Calc. Chip	.95
MM5739	Calc. Chip	.95

EXAR

320	1.19	4136	.69
2206	3.90	4202	.69
2207	1.49	4212	.69
2567	1.49	4739	.69

SIGNAL DIODES 400mw 100/$1.00

MV10B TO-18 clear 15/$1.00

IASIS MICROCOMPUTER APPLICATIONS HANDBOOK $5.95

301m	Prec. Op Amp	$.19
302H	Volt Follower	.39
308H	Prec Op Amp	.49
311N	Hi Perf V Comp.	.59
340T6v	Pos. V Reg.	.59
540H	Power Amp	1.59
565N	Genl Pump PLL	.99
723N	Volt Reg	.45
733H	Diff Video Amp	.49
739N	Dual Audio Preamp	.69
1414N	Dual Diff Comp.	.99

PC BOARDS · for use with ELEKTOR MAGAZINE PROJECTS

ELEKTOR #27/28 Jul-Aug 77		3.00
LED peak indicator	9525	2.70
knotted handkerchief	9830	.45
phaser	77001	2.50
distortion meter	77005	4.10
guitar preamp	77020	2.45
time switch	77021	3.50
0-10V supply	77059	2.10
11 - qualiser	77071	1.50
automatic Ni Cad charger	77075	1.45
TV games	77084	4.50
4w car radio ampl	77101	1.40
3-1/2 digit DVM	77109	4.70
ELEKTOR #26 June 77		1.50
precision time base	9448	3.40
power supply for time base	9448-1	1.30
music synthesiser keyboard interface (E25)	9721-1	5.75
levitator	9763	5.20
loudspeaker cross-over filters (E25)	9768	4.30
model car track (E24,25) servo ampl	9803	.80
ELEKTOR #25 May 77		1.50
music cleaner	9785	3.90
model car track (E24) multiplex encoder	9796-1	6.85
infrared transmitter	9796-2	3.55
ultrasonic alarm (E19) single transducer/recvr	9815-1	2.80
transmitter	9815-2	.85
ELEKTOR #24 April 77		1.50
digisplay (E13)	9376	6.90
LED volume unit meter rectifier section	9419-1	5.15
display section	9419-2	9.95
FM tuner (E23) i.f. converter	9447-2	3.60
stereo decoder	9447-3	2.55
auto slide changer	9743	1.45
morse decoder	9759	16.25
signal injector	9765	1.10

5 BACK ISSUES OF ELEKTOR MAGAZINE containing a variety of electronic projects, with schematics, PC layouts, parts list. PC boards are available. Regular $1.50/copy
$4.00/5 issues
25 26 29 30 31

ELECTRONIC BUZZER

Miniature, Solid State
6V 15ma (4-9V oper.) $1.29 ea.
12V 15ma (8-20V oper.) $1.29 ea.

ELECTRONIC DOOR CHIME KIT

WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

INTERNATIONAL FLAVOR – PLAYS NATIONAL ANTHEMS OF U.S., BRITAIN, FRANCE AND WEST GERMANY PLUS OTHER FOLK TUNES, CLASSICAL AND TRADITIONAL MELODIES

- SUPPLIED WITH ALL PARTS INCLUDING PC BOARD, SPEAKER, CASE AND COMPLETE INSTRUCTION MANUAL WITH FULL CIRCUIT DETAILS
- USES 2 9V TRANSISTOR BATTERIES (NOT SUPPLIED)
- LOW POWER CONSUMPTION
- INTERNAL SELECTION OF TUNE, VOLUME, TEMPO AND TIMING FUNCTIONS
- PROGRAMMED MATHEMATICALLY TO PLAY IN PERFECT PITCH PERMANENTLY
- ATTRACTIVE CASE CONVENIENT WALL MOUNT

$39.50 SHIPPING $1.00

TANTALUM CAPACITOR KIT
solid dipped, 12 values, 5 each

.1uf/35V	2.2/35	10/25	33/10
.33/35	4.7/16	15/20	47/25
1/35	6.8/16	22/16	56/6

capacitors only......$14.95
supplied in styrene utility box..................$19.95

CAPACITOR KIT - ceramic disc
50V, 24 values, 10 capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95
Packeged in 15 drawer, 60 compartment cabinet....$19.95 plus $2.00 shipping

CERAMIC DISC CAPACITORS - 50V

1pf	22pf	56pf	120pf	270pf	820pf	.022uf
5pf	27pf	68pf	150pf	390pf	.001uf	.030uf
7pf	33pf	82pf	180pf	470pf	.0047uf	.050uf
10pf	47pf	100pf	220pf	600pf	.01uf	

0-10 per value..$.10ea 10-up per value $.05ea
10-up per value $.05ea

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	150/15	1.25
4.7/16	.25	15/20	.35		

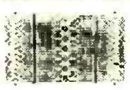
DIODES

Silicon SW diode assorted 400 mw	$.05ea
1N4148 (1N914) Silicon diode 400 mw	.10
1N3064 Silicon SW diode 400 mw	.10
1N4006 Silicon rect. diode 600V 400mw	.10
Zener diode 400 mw - 2.4V, 3.6V, 5.1V, 6.5V, 6.8V, 10V, 12V, 14.5, 15V, 120V	.15
Germanium diode 400 mw	.08

TRANSISTORS

2N1132	PNP Gen Purp. Ampl TO-5	$ .69
2N2218A	NPN Low Power Trans TO-5	.69
2N2222A	NPN Low Power Trans TO-18	.29
2N2223	NPN Low Power Trans. TO-5	.69
2N2369	NPN Low Power Trans TO-5	.29
2N2904	PNP Low Power Trans TO-5	.49
2N2905A	PNP Low Power Trans TO-5	.76
2N3227	NPN Low Power Trans TO-18	.69
2N3904	NPN Low Power Trans TO-92	.17
2N3906	PNP Low Power Trans TO-92	.17
SCA 13572	NPN Pwr Trans - 200V TO-5	1.75

UNIVERSAL BREADBOARD



Silver placed copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16"x5-1/16"
$1.00

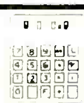
I C BREADBOARD

Silver plated copper circuits holds 5 - 16 pin DIP IC's and interconnection holes. $1.00

PLASTIC CASES

VERO - dark and light gray nominal 0.0.

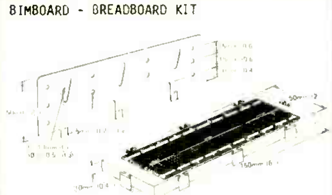
2514F	2"x4"x1"	$4.34
2516G	2"x4"x1.6"	4.90
2518H	2.6"x 4.7"x1.6"	5.48
2520J	3.2"x6"x2"	6.24
2522K	4.3"x7.4"x2.4"	8.28
2755G	2.6"x4.7"x2.6"	6.74
27600	4.3"x7.4"x2.4" (w/ handle/stand)	10.78
2525F	2.8"x5.4"x2.4" (ventilated)	5.40
HAMMOND - blue		
1591C	2.6"x4.8"x1.6"	2.65



KEYBOARD
20 Keys - 2 slide switches
3" x 3-3/4" $1.00/3

BEZELS - with red filters
140-2 cut-out 1.125" x 2.375" max .062" panel thickness $1.75
140-4 cut-out 1.160" x 4.375" max .125" panel thickness $2.75

BIMBOARD - BREADBOARD KIT



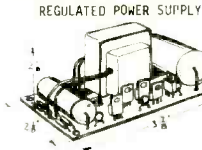
Solderless breadboard section has 94 breadboard strips of 5 sockets each. 2 bus strips of 40 sockets each. Component bracket for switches lamps etc., accepts leads .01" to .035" diameter. $11.95 ea.

LINEAR ASSORTMENT
1 each of following - all functional 301M, 302H, 307M, 311N, 340T-5, 340T-6, 340T-15, 380-8, 385K, 723N, 739N, 741M, 748M, 75453M
$4.75

TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, ± 100 PPM/°C ± 20%
500 ohm, 2K, 10K, 25K, 50K, 100K, 500K, 1M. $.75 ea.
.69/10-

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K $1.75 ea

REGULATED POWER SUPPLY



Plus & minus 5V, 12V and 15V. Uses 3 LM340T and 3 LM320T regulators, 115V/29V CT transformer plus PC board capacitors & diodes. All parts, schematic, instructions
PS-29.........$12.95 + $1.00 Shppng.

CLOCK KIT - Mark I
6 digit clock kit with one PC board. Accommodates MM5314 clock chip and 6 FND 359 displays contains all components except transformer. Includes 3 switches. Board has terminals for remote displays. $10.95

with 12V/300 ma transformer
$13.95

PRECISION RESISTOR PACKAGE
Metal Film ± 1% 1/4 watt
Starter Kit - 2ea. 60 values
120 Resistors 10.5 ohm- 464K
$14.95
Supplied in 15 Drawer 60 Comp. Cabinet - $26.50 + $2.00 Sh.

Rohm QUALITY RELIABILITY

METAL FILM RESISTORS
± 1%, 1/4w, ± 50 PPM/°C
Standard Decade Values 10.5 - 464K

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.20	$.15	
100-999	.20	.10	$9.00/100
1000-			8.00/100

Carbon Film Resistors ± 5% 1/4w, 1/2w

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.05	
100-999	.10	.04	$3.00/100
1000-			2.50/100

RESISTOR PACKAGE
Carbon Film ± 5% 1/4 w or 1/2 w
15 ea. of 12 values:
100, 220, 470, 1K, 1.5K, 3.3K 4.7K 6.8K, 10K, 33K, 100K, 1M.
$5.45

Carbon Film ± 5% 1/4w or 1/2w
Usage Evaluated Assortment
5 to 20 ea of 44 values.
$12.95
Supplied in 15 Drawer 60 Comp. Cabinet. $22.95 + $2.00 Sh.

IC SOCKETS

Low Profile Solder Tail				Wire Wrap	
8 pin	$.16	24 pin	$.36	8 pin	.45
14 pin	.19	28 pin	.44	14 pin	.49
16 pin	.21	40 pin	.61	16 pin	.55
18 pin	.28				

TTL

7400	11	7451	.20	74155	75
7401	18	7453	20	74156	75
7402	14	7454	20	74157	.85
7403	14	7460	20	74158	1.39
7404	16	7464	35	74160	1 23
7405	19	7465	35	74161	95
7406	29	7470	.38	74162	1.39
7407	.28	7472	.35	74163	95
7408	22	7473	35	74164	95
7409	17	7474	31	74165	95
7410	16	7475	49	74166	1 19
7411	25	7476	34	74170	1 90
7413	43	7483	68	74173	1 49
7414	65	7485	88	74174	1 19
7415	25	7486	38	74175	95
7416	35	7489	2.25	74176	84
7417	35	7490	43	74177	84
7420	16	7491	75	74180	.95
7423	37	7492	48	74181	2 30
7425	35	7493	48	74182	85
7426	22	7494	75	74185	2 20
7427	35	7495	75	74190	1.25
7430	20	7496	75	74191	1 15
7432	23	74100	1 15	74192	89
7437	25	74107	37	74193	85
7438	25	74121	37	74194	1 15
7439	50	74122	38	74195	74
7440	15	74123	45	74196	98
7441	85	74125	54	74197	95
7442	59	74126	58	74198	1 69
7443	65	74132	75	74199	1.69
7444	73	74141	85	745200	3.95
7445	.65	74145	.90	74279	79
7446	81	74150	.98		
7447	59	74151	68		
7448	79	74153	60		
7450	17	74154	1 20		

LINEAR CIRCUITS

LM300H	$ 71	LM372N	2 93	LM733H	79
LM301CN	29	LM376CN	59	LM739N	99
LM302H	65	LM380N	1 29	LM741CN(8)	32
LM304H	80	LM380-8CN	95	LM741CN(14)	32
LM307CN	26	LM381N	1 75	LM741CH	35
LM307H	30	LM382N	1 75	LM747H	79
LM308H	89	LM385K	45	LM747N	71
LM309H	1 05	NE531V	2 90	LM748CN	35
LM309K	99	NE540L	2 90	LM1310N	2 80
LM310CN	1 07	NE546A	1 09	LM1414N	1 59
LM311CN	89	NE550A	75	LM1456CN	1 29
LM311H	89	LM555CN	39	LM1458CN	59
LM311N	89	NE556A	85	LM1496N	89
LM319N	1 13	LM560N	2 95	LM1800N	2 48
LM320K		LM561N	2 95	ULN2208	89
5 5 2 12 15	1 29	LM565N	1 19	ULN2209	89
LM320T		LM565H	1 39	CA3046	1 19
5 12 15	1 19	LM566H	1 39	CA3081	1 49
LM322N	1 59	LM566CN	1 19	LM3900N	49
LM324N		LM567CN	1 29	LM7524	79
(LM2902N)	1 52	LM567H	1 49	LM7525	79
LM339N	1 58	LM703H	59	8038B	4 59
LM340K		LM703CN	39	75451CN	35
5 6 8 12		LM709N	25	75452CN	35
15 18 24	1 29	LM709H	29	75453CN	35
LM340T		LM710N	59	75454CN	35
5 6 8 12		LM711N	39	75491N	71
15 18 24		LM723H	55	75492N	85
(78 — — Equiv)	1 19	LM723N	52		

COMPLETE SATISFACTION GUARANTEED. SHIPMENT TO US AND CANADA PREPAID UNLESS INDICATED OTHERWISE. OTHER COUNTRIES ADD 10% - EXCESS REFUNDED. ORDERS SHIPPED IN 3 WORKING DAYS FROM RECEIPT. MINIMUM ORDER $10.00 CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM COD OR CHARGE ORDER $15.00

INTERNATIONAL ELECTRONICS UNLIMITED
VILLAGE SQUARE, P.O. BOX 449, CARMEL VALLEY, CA 93924 USA
TELEPHONE 408 659-3171

CIRCLE 7 ON FREE INFORMATION CARD

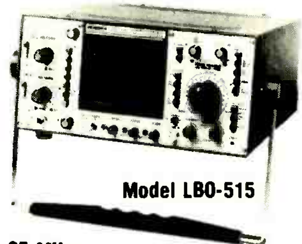
LEADER Instruments Corp. OSCILLOSCOPES

Model LBO-507

20 MHz, TRIGGERED
- Single trace: automatic trigger for highly stable, bright display.
- 17.5nSec rise time. ■ 10mV/cm to 20V/cm Vertical Sensitivity; 11 steps. ■ Displays signals to 27 MHz with ease.

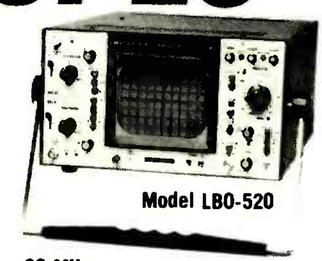
Model LBO-508

20 MHz, DUAL TRACE
- Add, subtract modes on CH-1 & CH-2 facilitate easy checkout for simultaneous pulses, signal levels, distortion & noise cancelling. ■ Front panel X-Y operation for phase shift measuring, sweep alignment, vector scope service. ■ 17.5nSec rise time.



Model LBO-515

25 MHz, DELAYED SWEEP, DUAL TRACE
- Built in variable delay circuitry — 1μSec to 5 Sec. ■ 5mV/Div. Vertical Sensitivity. ■ Rectangular, 8 x 10Div CRT with internal graticule.
- Selectable synchronization, automatic, normal, single trace and reset modes. ■ 14nSec rise time.



Model LBO-520

30 MHz, FIXED DELAY, DUAL TRACE
- Dual trace, 30 MHz bandwidth.
- 5mV/cm Vertical Sensitivity. ■ Fixed delay facilitates hi-speed readings of the leading edge of a pulse or pulse train. ■ Add, subtract, alternate selection, chopped, and front panel X-Y modes

Before you buy, check our prices...

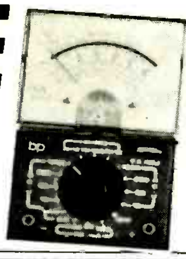
Call TOLL FREE (800) 645-9518

N.Y. State call (516) 752-0050

master charge · your BankAmericard welcome

FREE

20 KΩ/V VOM Multimeter
$29.95 VALUE
With any order from this ad. Ad must accompany order.



FORDHAM

RADIO SUPPLY CO., INC.
855R Conklin St.
Farmingdale, N.Y. 11735

Mastercharge, BankAmericard, VISA and C.O.D.'s accepted

YOUR ONE STOP DISCOUNT CENTER

Send for new 1978 catalog of over 3,000 items ... 164 pages of test equipment, CB, tools, tubes, components and electronic supplies.

ADD $3.00 TO COVER SHIPPING, HANDLING & INSURANCE. N.Y. Res. add approp. sales tax.

CIRCLE 64 ON FREE INFORMATION CARD

---

more than 20,000 different components

RECTIFIERS

	10 For	100 For
1N4001	.60	5.00
1N4002	.70	6.00
1N4003	.80	7.00
1N4004	.90	8.00
1N4005	1.00	9.00
1N4006	1.10	10.00
1N4007	1.20	11.00

VOLT. REG

LM340K-5	1.70
LM340K-6	1.70
LM340K-8	1.70
LM340K-12	1.70
LM340K-15	1.70
LM340K-18	1.70
LM340K-24	1.70
LM340T-5	1.50
LM340T-6	1.50
LM340T-8	1.50
LM340T-12	1.50
LM340T-15	1.50
LM340T-18	1.50
LM340T-24	1.50

5400 SERIES

5400	1.00
5404	1.25
5410	1.00
5426	1.25
5473	1.50
5475	1.50
5486	1.90
5493	2.00
54100	1.80
54LS04	1.00

7400 TTL

7400	.18	7442	1.08	74107	.49
7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

OEM SPECIALS

1N34	.25	2N2905A	.30	2N3903	.16
1N60	.25	2N2906	.25	2N3904	.16
		2N2906A	.30	2N3905	.16
1N270	.25	2N2907	.25	2N3906	.16
1N914	.10	2N2907A	.30	2N3954A	3.75
2N173	1.75	2N2913	.75	2N3955	2.45
2N404	.75	2N2914	1.20	2N3957	1.25
2N443	2.50	2N3019	1.00	2N3958	1.20
2N508A	.45	2N3053	.30	2N4037	.60
2N718	.25	2N3054	.70	2N4093	.85
2N930	.25	2N3055	.75	2N4124	.16
2N956	.30	2N3227	1.00	2N4126	.16
2N1302	1.25	2N3247	3.40	2N4141	.20
2N1305	.75	2N3250	.50	2N4142	.20
2N1540	.90	2N3393	.20	2N4143	.20
2N1544	.80	2N3394	.17	2N4220A	.45
2N1560	2.80	2N3414	.17	2N4234	.95
2N1605	1.75	2N3415	.18	2N4400	.16
2N1613	.50	2N3416	.19	2N4401	.16
2N1711	.50	2N3417	.20	2N4402	.16
2N2102	.70	2N3442	1.85	2N4403	.20
2N2160	.70	2N3553	1.50	2N4409	.16
2N2218	.25	2N3563	.20	2N4410	.16
2N2218A	.30	2N3565	.20	2N4441	1.00
2N2219	.25	2N3638	.20	2N4442	1.15
2N2219A	.30	2N3642	.20	2N4443	1.35
2N2221	.25	2N3643	.20	2N4852	.55
2N2221A	.30	2N3645	.20	2N5061	.30
2N2222	.25	2N3646	.14	2N5064	.50
2N2222A	.30	2N3731	3.75	2N5130	.20
2N2270	.40	2N3740	1.00	2N5138	.15
2N2369	.25	2N3771	1.75	2N5296	.50
2N2484	.32	2N3772	1.90	2N5306	.20
2N2712	.18	2N3773	3.00	2N5400	.40
2N2904	.25	2N3819	.40	2N5401	.50
2N2904A	.30	2N3823	.70	2N5457	.35
2N2905	.25	2N3866	1.25	2N5458	.30

N.J. residents add 5% sales tax.
All orders add $1.00 Postage $1.50 Canada
minimum order $5.00

PARTIAL LISTING — WRITE FOR FREE CATALOG

JAPANESE TRANSISTORS

2SA484	2.44	2SC482	1.40	2SC1226A	.85	2SD170	1.50
2SA495	.60	2SC495	.85	2SC1237	4.00	2SD180	2.50
2SA497	1.44	2SC517	3.60	2SC1239	3.50	2SD188	2.70
2SA634	1.00	2SC634A	.60	2SC1306	3.50	2SD234	.85
2SA636	1.25	2SC710	.49	2SC1307	4.75	2SD235	.85
2SA673	.70	2SC711	.49	2SC1377	4.80	2SD313	1.05
2SA678	.65	2SC735	.49	2SC1383	.50	2SD314	1.50
2SA682	1.49	2SC756A	2.40	2SC1448	1.00	2SD315	1.20
2SA683	.60	2SC778	3.50	2SC1449	.85	2SD358	1.10
2SA699	1.30	2SC781	2.50	2SC1678	2.00	2SD360	1.05
2SA699A	1.45	2SC789	1.00	2SC1728	1.85	2SD427	2.55
2SA733	.49	2SC798	3.95	2SC1760	1.60	2SD525	1.50
2SA777	.99	2SC799	3.25	2SC1816	3.50	2SK19	1.25
2SB54	.49	2SC1000	.49	2SC1908	.49	2SK30A	.75
2SB56	.95	2SC1013	.95	2SC1909	3.75	2SK33	.90
2SB186	.49	2SC1014	.95	2SC1957	1.00	2SK55	1.00
2SB187	.55	2SC1017	1.20	2SC1973	.90		
2SB324	.60	2SC1018	1.00	2SC1975	3.50	3SK22Y	2.20
2SB370	.65	2SC1061	1.25	2SC2028	.80	3SK40	2.00
2SB405	.60	2SC1079	3.95	2SC2029	3.40	3SK45	2.20
2SB415	.65	2SC1096	.80	2SC2091	2.50	3SK49	2.20
2SB461	1.60	2SC1098	1.00	2SC2092	3.25		
2SB463	1.40	2SC1115	3.00				
2SB507	1.40	2SC1170B	4.95	2SD72	.80	4004	3.00
2SC371	.49	2SC1172	5.25	2SD77	1.50	4005	3.00
2SC372	.49	2SC1173	.75	2SD88	4.80	40081	1.50
2SC481	1.50	2SC1209	.75	2SD118	3.00	40082	3.00

JAPANESE CIRCUITS

AN136	2.90	LA4400FS	3.40	TA7055P	3.00	UPC20C	3.75
AN214	3.35	LA4400FR	3.40	TA7060P	1.40	UPC41C	2.80
AN239	6.50	LD3120	2.40	TA7061P	1.50	UPC563H2	8.00
AN241	2.40	M5115PR	7.80	TA7063P	1.50	UPC566H	1.25
AN315	3.50	PLL01A	13.50	TA7075P	3.75	UPC575C	2.60
BA511	3.00	PLL02A	8.50	TA7089P	2.90	UPC595C	2.95
BA521	3.40	PLL02A-G	8.50	TA7120P	1.50	UPC1001H2	3.50
HA1202	2.20	SG613	6.75	TA7150P	3.75	UPC1008C	5.75
HA1306	4.90	STK011	7.50	TA7153P	6.90	UPC1020H	3.25
HA1308	4.50	STK015	6.50	TA7203P	4.25	UPC1025H	3.50
HA1322	4.20	STK032	14.20	TA7204P	3.70	UPC1166H	4.50
LA1201	4.25	STK050	24.50	TA7205P	3.60	UPD277C	4.50
LA4031P	3.20	STK056	11.35	UH1C003	6.50	UPD857C	15.50
LA4032P	4.20	STK415	8.50	UH1C004	6.50	UPD858C	9.50
LA4051P	3.20	TA7045M	3.25	UPC16C	2.50	UPD861C	18.50

CHECK OUR NEW LOWER PRICES

nte

NEW-TONE ELECTRONICS

PO Box 1738A Bloomfield, N.J. 07003
Phone (201) 748-6171, 6172, 6173

CIRCLE 51 ON FREE INFORMATION CARD

hobbi house

Send for Free Hobbi House Catalog
969 BALL AVE., UNION, N.J. 07083
Retail Store Open Mon.–Sat., 9 to 6

Your Store for Prime Components — Money Back Guarantee on all Orders!
Toll-Free Wats Line — 800-631-7485 • Open Saturdays
In New Jersey Call (201) 964-5206

lowest prices

TERMS AND CONDITIONS

Add $1.50 postage and handling for all orders within U.S.. COD orders -- add $2.00 for postage and handling.

$7. Min. order. Phone orders accepted. $15 Min B.A./Visa, Master Charge orders. N.J. Residents add 5% Sales Tax

Outside Continental U.S. send U.S.funds only, and include sufficient postage for first class mail.

OPTO SPECIALS

Cat. #	Order by Cat. # & Type #	
01	7 seg. Display .33" 707 MAN 1 C.A. or C.C.	.59 ea. or 10/$5.00
03	Diffused Jumbo Red Leds 0.2"	7/$1.00, 100/$11.00
04	DL741 Jumbo Displays C.A.	$1.35
05	25PK LEDS ASSTD Sizes & Colors	$2.50
06	Jumbo Red Leds	10/$1.00, 100/$9.00
07	9 digit display by National	$1.00

MA1003
MOBILE CLOCK MODULE (National)
$18.95 complete

Attaches directly to 9-12V Battery. Automatic Nighttime Dimming. Fluorescent Display gives Color Choice (Red, Blue, Green or Yellow) when used w/corresponding Color Filter. Includes — Module, Switches, & Filter

ALUMINUM CASE WITH FILTER. $5.75
(switches included with clock kit). In Silver, Black and Gold. Filter colors — red, blue, green, or yellow.

LM555 TIMERS 3/.99

SWITCHES

Cat. #	Order by Cat. # & Type #	
M9	**Sound Actuated Switch**	.85
M10	**Dry Reed Switch,** 5 AMP, 115 VAC	25/$1.98
M13	**250 K Slide Volume Control** By Mallory	4/$1.00
M51	**DPDT Momentary Slide Switch**	10/$1.00
M52	**DPDT Slide Switch** Low Profile	10/$1.00
M53	**DPDT Slide Switch** Long Button	10/$1.00
M56	**DP4T Slide Switch**	10/$1.00

ADAPTORS

Cat. #	Order by Cat. # & Type #	
M16	**AC DC** 120 V input 6 UDC 130 MA output	$1.00
M65	**AC Input** 120 VAC, 3.7w/output 9 UDC, 100 MA	$1.50

SPECIALS

Cat. #	Order by Cat. # & Type #	
M12	**6" Pioneer Pincusion speakers,** 3.2 OHMS. 7½ watts	**$3.95 a pair**
M17	**8 FT. Stereo Extension Cord.** RCA plugs at both ends.	2/$1.99
M33	**16 Pin Strip sockets,** By AMP	10/$1.00
M41	**6 FT. Line Cords**	6/$1.00
M49	**6 DC Battery Holder**	3/$1.00
M29	**SPDT 12 Volt Relay** 5 AMP contact, Plug in style	$1.00
M35	**Variable Trimmer Cap** 3-18 PF, 50 volt	5/$1.00
M48	**2.5 MEG Trimmer Pot**	5/$1.00
M69	**50K Trim Pot,** Pc mount thum wheel	10/$1.00

Zener Diodes

Cat. #	Order by Cat. # & Type #	
D1	5.1V 1 watt	10/$1.00
D4	22V 1 watt	10/$1.00
D5	3.9V 400MW	10/$1.00
D7	6.8V 400MW	10/$1.00
D8	8.2V 400MW	10/$1.00
D10	30V 400MW	10/$1.00
D11	10V 1 Watt	10/$1.00

Rectifiers

Cat. #	Order by Cat. # & Type #	
D2	IN1084	4/$1.00
D3	IN4384	10/$1.00
D6	IN645	10/$1.00
D13	35AMP 50V DO-5 Case	2/$1.00
D14	25AMP 200V Bridge Rect.	$1.75
D23	IN4148 Switching Diode	50/$1.00
D16	IN4001	10/.55
D17	IN4002	10/.65
D18	IN4003	10/.75
D19	IN4004	10/.85
D20	IN4005	10/.95
D21	IN4006	10/$1.00
D22	IN4007	10/$1.00

DISC Caps

Cat. #	Order by Cat. # & Type #	
C1	680 MMF 500V ± 10%	20/$1.00
C2	200 MMF 500V ± 10% P.C.	20/$1.00
C3	390 MMF 400V ± 10%	20/$1.00
C4	220 $\mu\mu$F 500V ± 10% P.C.	20/$1.00
C5	820 PF 1000V ± 10% P.C.	20/$1.00
C6	27 PF 500V ± 10%	20/$1.00
C7	470 μF 2kV ± 20%	20/$1.00
C8	470 PF 2kV ± 20%	20/$1.00
C34	.03 μF 100V ± 20% P.C.	20/$1.00
C41	16 $\mu\mu$F 500V ± 5% P.C.	20/$1.00
C42	.001 PF 100V ± 10% P.C.	20/$1.00
C45	.1 MF 50V ± 10%	20/$1.00
C47	15 PF 100V ± 10% P.C.	20/$1.00
C49	22μF 750V ± 10% P.C.	20/$1.00
C52	22 PF 500V ± 10%	20/$1.00
C54	100 PF 100V ± 10%	20/$1.00
C57	16 PF 500V ± 5% P.C.	20/$1.00
C59	22 PF 150V ± 10% P.C.	20/$1.00
C61	22 PF 200V ± 10%	20/$1.00
C62	33 PF 100V ± 5%	20/$1.00

IC SOCKETS.

Cat. #	Order by Cat. # & Type #	
M1	Grain of Wheat Display Lamps	10/$1.00
M2	8 PIN	5/$1.00
M3	14 PIN	5/$1.00
M4	16 PIN	5/$1.00
M5	18 PIN	5/$1.00
M6	24 PIN	2/$1.00
M7	28 PIN	2/$1.00
M8	40 PIN	2/$1.00

Transformers

Cat. #	Order by Cat. # & Type #	
M22	**Mini Audio** 1" square	10/$1.99
M32	**70 Volt** Line Transformer, 10 watts	$2.90
M40	**6.3 Volts** 1.2 amp	$1.49

Transistors

CAT #	Order by Catalog # & Type #	
T1	2N918 ITT	5/$1.00
T2	2N2904 ITT	5/$1.00
T3	2N2219 ITT	5/$1.00
T4	2N4949 House #	2/$1.00
T5	MPS5172 MOTO	10/$1.00
T6	2N3638 S.S.	10/$1.00
T7	2N2102 House #	5/$1.00
T8	3N140 Fet N Channel	2/$1.00
T9	2N2907 ITT	5/$1.00
T10	2N914 ITT	5/$1.00
T11	2N2369A ITT	10/$1.00
T12	2N2368 ITT	10/$1.00
T13	2N706 MOTO	10/$1.00
T15	D41E1 Ge P.C.	10/$1.00
T16	2N3416 Sprague	5/$1.00
T17	MPS2369 ITT	10/$1.00
T18	MPS3704 ITT	10/$1.00
T19	2N708 MOTO	5/$1.00
T20	2N3055 S. S.	2/$1.00

Electrolytics — all Axial Leads

CAT. #	Order by Cat. # & Type #	
C15	.15μF 400 V	5/$1.00
C16	1μF 50 V	5/$1.00
C17	10μF 50 V	5/$1.00
C18	1.0μF 200 V	5/$1.00
C19	25μF 25 V	5/$1.00
C20	5/F 25 V	5/$1.00
C21	500μF 15 V	5/$1.00
C22	1500μF 3V	5/$1.00
C24	1000μF 6V	5/$1.00
C25	2000μF 2.5V	5/$1.00
C40	500μF 50V	4/$1.00
C46	4.7μF 50V	4/$1.00
C53	4.7 μF 35 V	4/$1.00
C56	220μF 16 V	4/$1.00
C63	1000MFD 35V	4/$1.00

Tantalum, Axial Leads

Cat.#	Order by Cat. # & Type#	
C13	.047μF 200 V	10/$1.00
C44	1MF 35V	10/$1.00
C48	15μF 35V	10/$1.00

Voltage Regulators

Cat. #	Order by Cat. # & Type #	
1C1	7805 Pos.	$1.00
1C2	7815 Pos.	$1.00
1C3	7806 Pos.	$1.00
1C4	7905 Neg.	$1.25
1C5	7812 Pos.	$1.00
1C6	7824 Pos.	$1.00
1C7	7915 Neg.	$1.25

Mylar Caps

Cat.	Order by Cat. # & Type #	
C9	1.0 100V ± 5%	10/$1.00
C11	.018MF 400V ± 10%	10/$1.00
C12	.47μF 100V ± 10%	10/$1.00

SPECIAL

WESTINGHOUSE TUBES — BOXED AND BRANDED

1V2	1.50	6CG3/W3/Q3	2.50	6HB7	2.40	6LQ6/6JE6C	4.85
2AV2	2.00	6CJ3/6CH3	2.50	6HM5/6HA5	2.30	6Z10/6J10	4.30
3A3C	3.10	6DW4B	2.50	6HZ6	2.00	8FQ7/8C67	2.00
3AT2B	3.00	6EA8	2.50	6JC6A	2.65	12AT7/ECC81	2.00
3CU3A	3.75	6EJ7/EF184	2.20	6JS6C	4.50	12AU7/ECC82	2.00
3DB3/3CY3	3.30	6EW6	2.20	6JL8A	2.60	12AX7/ECC83	2.00
3HM5/3HA5	2.50	6FQ7/6CG7	1.85	6KD6	4.90	12BY7A/V/Q	2.20
5GH8A	2.75	6GF7A	3.20	6KE8	3.60	12HG7/6N7A	3.30
6AQ5A	2.00	6GH8A	2.00	6KT8	3.25	17JZ8	2.50
6AU6A	2.00	6GJ7/ECF801	2.25	6KZ8	2.40	23Z9	3.00
6BK4C/EL4A	4.50	6GM6	2.50	6L6GC	3.60	33GY7A	3.75
8BL8/ECF80	1.75	6GU7	2.50	6LE6	4.75	36MC6	5.00
						38HE7	3.85

ADVANCED COMPUTER PRODUCTS

THE FIRST TO OFFER PRIME PRODUCTS TO THE HOBBYIST AT FAIR PRICES NOW LOWERS PRICES EVEN FURTHER!

1. Proven Quality Factory tested products only, no re-tests or fallouts. Guaranteed money back. We stand behind our products.

2. Same Day Shipment All prepaid orders with cashiers check, money order or charge card will be shipped same day as received.

S100 PRODUCTS

LOGOS I 8K STATIC RAM
- ★ Low Power
- ★ Selectable Memory Protect
- ★ Totally Buffered
- ★ Phantom
- ★ Battery Back-up
- ★ Address on 1K boundary
- ★ Requires no front panel
- ★ No wait states

ASSEMBLED & TESTED
250ns. 199.95
450ns. 179.95

KIT
250ns. 149.95
450ns. 125.95

Bare PC Board w/Data **$21.95**
Now over 1 year successful field experience "Special Offer" Buy (4) 8K 450ns. Kits $117.00 ea.

IMS 16K STATIC RAM
- ★ Memory mapping
- ★ Phantom
- ★ Address 16K Bound
- ★ Use with or w/o front panel
- ★ Power 2.1 amps typ.
- ★ Uses 2114

ASSEMBLED & TESTED ONLY
450ns. $439.95 250ns. $495.95

S-100 32K STATIC RAM
- ★ Address 32K Boundary
- ★ Power 450ns. 2.8 amps typ.
- ★ No wait states on 2MHz
- ★ Fully Buffered
- ★ Phantom can be added
- ★ 2114/TMS4045 or 9135

ASSEMBLED & TESTED	KIT
250ns. $849.00	250ns. $790.00
450ns. $799.00	450ns. $740.00

Bare PC Board w/Data $59.95
SPECIAL OFFER.
Kit without Memory only $99.95. Add 2114 Memory for $160.00 per 8K

MICROBYTE 32K STATIC RAM
- ★ Phantom ★ TMS4044
- ★ Addressable 4K Blks ★ Independed reg.

ASSEMBLED & TESTED ONLY
450ns. $775.00
250ns. $875.00
(Special offer 16K version (expandable) 450ns. $435.00)

DC HAYES DATA COMMUNICATIONS ADAPTER
- ★ Telephone/TWX ★ S-100 compatible
- ★ Bell 103 freq. ★ Originate & answer mode

Assembled & Tested $279.95
Bare PC Board w/data $ 49.95

Z-80/Z-80A CPU BOARD
- ★ On board 2708
- ★ Power on jump
- ★ 2708 included (450ns.)
- ★ completely socketed

Assembled and tested $185.00
Kit $129.95
Bare PC Board $ 34.95
★ For 4MHz Speed Add $15.00

TDL COMPATIBLE Z-80 CPU
- ★ Compatible to TDL software & hardware
- ★ Can be upgraded for 4MHz operation

Assembled and tested $199.95
Kit $139.95
Bare PC Board $ 34.95

BYTE USER 8K EPROM BOARD
- ★ Power on Jump ★ Reset Jump

Assembled & Tested 94.95
Kit 64.95
Bare Pc Board 21.95
Special Offer: Buy 4 kits only $59.95 each

8080A CPU BOARD
S100 compatible with 8 level Vector Interrupt fully socketed.
Assembled & Tested $149.95
Kit $ 99.95
Bare PC Board w/data $ 34.95

TARBELL FLOPPY INTERFACE
- ★ S100 Compatible ★ Uses CPM
- ★ Jumper Selectable ★ Persci, Shugart, etc

Assembled and tested $269.95
Kit $179.95
Bare PC Board $ 39.95
NOTE: For CPM Add $70.00
Documentation Add $20.00

WMC REAL TIME CLOCK
- ★ S100 Compatible
- ★ Two interrupts
- ★ Software programmable
- ★ 1MHz Crystal Oscillator

Assembled and tested $179.95
Kit $124.95
Bare PC Board w/data $ 29.95

MICRODESIGN MR-16 2716 EPROM BOARD
- ★ Individual Prom Address
- ★ Uses Low cost 16K TI EPROMS
- ★ Optional 1K RAM ★ Phantom control

Assembled and Tested 174.95
Kit 99.50

DATABOOKS & MANUALS

NSC TTL Data	$ 3.95	AMI MOS/LSI Data	3.95	Mot. Vol.4 Meci Data	3.95
NSC Linear Data	4.95	GI MOS/LSI Data	4.95	Mot. Vol. 5 CMOS Data	2.95
NSC Linear APP/note I	3.95	Osborne Intro to Micro Vol. 0	7.50	Mot. Vol. 6 Linear Data	3.95
NSC Linear APP/note II	3.95	Osborne Intro to Micro Vol. I	7.50	Mot. Vol. 9 Schottky TTL	2.95
NSC CMOS Data	2.95	Osborne Intro to Micro Vol. II	7.50	Mot. MPU Applications	25.00
NSC Audio Data	3.95	Osborne 8080 Programming	7.50	Mot. MPU Prog. Ref. Manual	3.95
NSC Volt. Reg. Data	2.95	Osborne 6800 Programming	7.50	Mot. Power Data	2.95
NSC Memory Data	3.95	Osborne Z80 Programming	7.50	Mot. Rectifier Data	2.95
NSC MOS/LSI Data	3.95	TI Powr Semi's Data	7.50	Mot. Switching Tran	2.95
NSC Power Transistors	2.95	TI TTL Data	6.95	Mot Zeners	2.95
Intel Databook	3.95	TI Transistors & Diodes	8.50	Basic Software SRI Vol I or II	24.95
Intel MCS85 Manual	7.50	TI Memory Data	3.95	Basic Software SRI Vol III	39.95
Intel MCS80 Manual	7.95	TI Optoelectronics	3.95	Basic Software SRI Vol IV or V	9.95
Intel MCS40 Manual	4.95	TI Lineal Data	3.95	Basic Software SRI Vol VI	49.95
AMD 8080 Handbook	5.95	TI Bipolar Memory	3.95	Basic Software SRI Vol VII	39.95
AMD Linear Data	4.95	TI interface Data	4.95	1978 IC Master	47.50
AMD Schottky Data	4.95	Motorola Semi Data 1, 2, 3	9.95		

6800 DESIGNER BOARDS MODULES PROTO BOARDS

★ Motorola Compatible Modules*

MEK 6800 D2 Kit	$235.00
9600 6800 MPU Module	495.00
9601 16 slot Mother Bd.	175.00
9602 16 slot Card Cage	75.00
9603 8 slot Mother Bd.	99.00
9604 System Power Supply	250.00
9610 Prototype Board	36.00
9615 4KEprom Module	250.00
9620 16 port parallel I/O	375.00
9626 8K Static RAM	295.00
9626K 8K Static RAM Kit	225.00
9630 Extender Card	60.00
9640 Multiple Tuner Prog.	395.00
9650 8 port Duplex Asyn. I/O	395.00
Mot 43/86 Connectors w/w or s/t	5.95
AMI EVK 99* 6800 sub Kit	145.00
AMI EVK 100 Kit	269.95
AMI EVK 200 Kit	449.95
AMI EVK 300 Assembled	649.00
EVK Kluge Board	95.00
EVK 16K Byte Ram Board	75.00
EVK 6 Slot Motherboard	35.00
EVK Extender Board	45.00
EVK Solid Frame Chassis	129.00
EVK Connectors	6.50
AMI 6800 Proto Rom	30.00
AMI 6800 Micro Assembler Rom	30.00
6800 Tiny Basic Paper Tape	20.00
6800 Tiny Basic Eprom	125.00

ZILOG COMPATIBLE BOARDS

Z-80 CPU	395.00
ZDC Disc Controller	395.00
MEM 16/65K Memory	595.00

SUPPORT DEVICES

3881 (Z80 PIO)	11.25
3881-4 (4MHz)	14.95
3882 (Z-80 CTC)	11.25
3882-4 (4MHz)	14.95
8205/74S138 Decoder	2.95
8212 8 bit I/O	3.25
8214 Priority Int	7.95
8216 Bus Driver	3.25
8224 Clock Gen	3.95
8224-4 (4MHz)	12.95
8226 Bus Driver	3.95
8T26 Bus Driver	2.39
8228 Sys Control	6.95
8238 Sys Cont	7.95
8251 Prog I/O	11.50
8253 Int Timer	27.95
8255 Prog I/O	11.50
8257 Prog DMA	27.95
8259 Prog Int	27.95
8279 Prog Keyboard	19.95
6810-1 128 x 8 RAM	4.75
6820 PIA	7.95
6828 Priority Int	11.95
6834-1 512 x 8 Eprom	12.95
6850 ACIA	7.95
6852 Serial Adapter	9.95
6860 Modem	14.50
6862 Modulator	17.50
6871A 1.0MHz OSC	25.95
2350 USRT	9.95
6880 Bus Driver	2.39
1821 SCD 1K RAM	25.00
1822 SCD 256 x 4 RAM	16.95
1824 CD 32 x 8 RAM	9.95
1852 CD 8 bit I/O	10.95
1856 CD I/O	8.95
1857 CD I/O	8.95
6520 PIA	8.95
6522 Mult	9.95
6530-002	15.50
6530-003	15.50
6530-004	15.50
6530-005	15.50
3851 F8 Prog Store	14.95
3853 F8 Memory I/O	14.95

PROMS

2708	12.95
2708-6	5.95
1702A	4.95
1702A-6	3.75
2716-5V	44.95
2716-5V, 12V	24.95
5203AQ	6.95
5204AQ	9.95
6834-1	12.95
IM 5610	2.95
82S123	2.95
82S126	4.50
82S129	2.95

RAMS DYN.

4115 16K x 1	27.95
4115 8K x 1	14.95
4050 4K x 1	4.45
4060 4K x 1	4.45
4096 4K x 1	4.25
2104 4K x 1	4.95
2107B-4 4K x 1	4.25
5261	
5262	1.95
5270	4.95
5280	4.95
1103	1.95
4008L	2.95
TMS4070 16K x 1	19.95

FLOPPY DISK I/O

1771 I/O 8" only	22.95
1771-01 8" & Minifloppy	35.95
uPd372 Nec Floppy	49.95
1781 Dual Floppy	89.95

CHARACTER GENERATORS

RO32513-001 (5V) Upper	9.50
RO32513-002 (5V) Lower	10.95
RO32513-ADM3 (5V) Lower	14.95
MCM6571	10.75
MCM6571A	10.75
MCM6574	14.50
MCM6575	14.50

KEYBOARD ENCODERS

AY5-2376	13.75
AY5-3600	13.75

UARTS/USRTS

TR1602B (5V, 12V)	3.95
AY51013 (5V, 12V)	5.50
AY51014A/1612 (5-14V)	7.95
AY51015A/1863 (5V)	7.95
TMS 6011 (5V, 12V)	5.50
IM6402	9.95
IM6403	9.95
2350 USRT	9.95
1671B Astros	24.95

BAUD RATE GENERATORS

MC14411	11.25
4702	14.95
WD1941	9.95

TV CHIPS

MM5320 TV Synch	7.95
MM5369 Prescaler	3.95
LM1889 Modulator	3.95
CW300 Saw Function	1.50
MM57100 Color TV Game	6.95
MM57104 Clock	3.75
AY38500-1 TV Game	5.95
AY38600 Color TV Game	24.95
AY38615-1 Color Converter	8.95
AY38700-1 Tank Chip	29.95
RF Modulator with Audio	8.95

A/D CONVERTERS

8700	8 bit Binary	13.50
8701	10 bit Binary	22.00
8702	12 bit Binary	36.95
8705	12 bit TS	42.95
9400	Volt to Freq. Conv	7.25
8750	3-1/2 Digit BCD	13.95
8038	Multifunction	3.95
1408L6	6 bit	5.95
1408L8	8 bit	3.95

MPU & COMPUTER KITS

MEK 6800 D2 Kit	235.00
KIM I 6502	245.00
Intercept Jr 6100	281.00
Technico 9900 Kit	299.00
RCA VIP Cosmac	275.00
AMI EVK 99	145.00

MICROPROCESSORS

Z-80	$21.95
Z-80A	29.95
F-8 (3850)	19.95
2650	24.95
CD1802	19.95
8080A	12.95
8085	29.95
8008-1	14.95
2901	21.95
2901A	29.95
TMS 9900JL	89.95
CP1600	39.95
6502	19.95
IM6100	29.95
6800	19.95
6802P	32.95

SOCKETS

8 Pin ww	.32	14 Pin S/T	.20
14 Pin ww	.37	16 Pin S/T	.22
16 Pin ww	.38	18 Pin S/T	.31
18 Pin ww	.60	22 Pin S/T	.35
20 Pin ww	.90	24 Pin S/T	.41
22 Pin ww	.93	28 Pin S/T	.49
8 Pin S/T	.17	40 Pin S/T	.63

CONNECTORS

6 Pin Single S/E	1.49
15/30 Dual S/E	1.95
18/36 Dual S/E	2.35
22/44 Dual S/E	2.95
43/36 Dual S/T	6.50
43/86 Dual W/W	6.50
50/100 IMSAI W/W	4.75
50/100 IMSAI S/T	4.75
50/100 Altair W/W	5.95
50/100 Altair S/T	5.95

25 Pin-D Subminiature

DB25P	3.25
DB25S	3.75
Hood	1.25

IMSAI Card Guides 4/1.00

RS232 CONNECTOR SET W/Hood $6.50

NEW CTS DIPSWITCHES

CTS206-4	$1.75	CTS206-8	$1.95
CTS206-5	$1.75	CTS209-9	$1.95
CTS206-6	$1.75	CTS209-10	$1.95
CTS207-7	$1.75		

We also stock full of 7400, 74LS, 74L Linear and CMOS Send for pricing or use our competitors STD catalog pricing.

NAKED PC BOARD SALE S-100

Z-80 CPU (ITHACA)	34.95
Z-80 CPU (TDL comp.)	34.95
8080A CPU	34.95
8K Static Logos	21.95
8K Eprom Byteuser	21.95
32 Static S-100	59.95
Tarbell Floppy I/O	39.95
Tarbell Cassette	29.95
Vector 8800 Proto	19.95
ACP Proto Bd	27.95
ACP Extender w/conn	15.95
Realtime Clock	34.95
WMC 13 Slot Mother Bd	33.00
S-100 8 Slot Mother Bd	34.95
Vector 8803 11 Slot M. Bd	29.95
SSM Video I/O	25.95
SSM I02 Parallel I/O	25.95

UV "Eprom" Eraser

Model UVs-11E $59.50
Holds 4 Eprom's at a time Backed by 45 years UV experience
Model S-52T $219.95
Professional Industrial Model

KIMSAI

Expand your KIM-1 to S-100
Kit $125.00 Assembled $165.00

SPECIAL DIGITAL CASSETTES
3/$4.25
High quality cassettes manufactured for digital application

TV INTERFACES

Pixie-Verter	8.50
TV-1 Video Interface	8.95
Pickles & Trout TV Mod. Kit	20.00

NOTICE

We are looking for software support packages to offer in our new catalogue. Please write or call if you want to participate.

All Shipments FCM or UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Mastercharge/Bank americard/COD accepted w/25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Same day shipment. Add 25 cents for Data.

Retail pricing may vary from Mail Order Pricing

STATIC RAM HEADQUARTERS

	1-24	25-99	100
21L02 450ns	1.30	1.25	1.15
21L02 250ns	1.59	1.55	1.45
2102	1.25	1.15	1.10
91L02APC	1.75	1.65	1.50
21L11-1	4.10	3.95	3.75
2111-1	3.75	3.65	3.55
21L12-1	4.25	4.10	3.95
2112-1	2.95	2.85	2.65
21L01-1	3.95	3.75	3.65
2101-1	2.90	2.70	2.55
2114-3 300ns.	12.95	10.95	9.95
2114-4 450ns	11.25	10.25	9.50
TMS4044	11.25	10.25	9.50
TMS4045	11.25	10.25	9.50
EMM4200A	12.50	11.95	9.95
EMM4402	9.95	9.95	8.25
5101C-E	10.95	10.50	9.90
upd410 (4200)	10.95	10.25	9.25
AMD9140/41	10.95	10.25	9.25
AMD9130/31	12.95	11.95	10.25
FSC 480/46416K CCD Only $18.95 Each			
1101	1.95	1.75	1.25

WAVEFORM GENERATORS

8038 Function Gen	3.95
MC4024 VCO	2.45
LM566 VCO	1.75
XR2206 Function Generator	5.25

CHARGE COUPLED DEVICES

16K CCD -First time offered Fairchild 460 CCD 16K Memory (now you can experiment with CCD technology at a reasonable price 17 page Application note supplied with each order. Quantity Limited)

$18.95 each (reg. 43.00)

CRYSTALS

Microprocessor Timebases TV Game

Frequency	Application	Price
1.0MHz	6800/S6860	$5.85
1.8432	MC14411	4.95
2.0MHz	G.B/TV Games	5.85
2.01MHz	TV Games	2.95
2.097152MHz	MM5378/79 Auto	5.85
2.4576MHz	34702 Bit Rate Gen	5.85
3.579545MHz	MM5369 (TV Color)	1.50
4.0MHz	4004/4040	4.95
4.194304MHz	8038	5.95
4.91520MHz	Std. CLK Freq	5.95
5.0MHz	Several MPU's	4.95
5.0688	COM5016	4.95
5.7143MHz	PACE	5.95
6.0MHz	Misc	4.95
6.144	intel 80885	4.95
6.5536	ICM7045	4.95
10.0MHz	Several MPU's	4.95
13.0MHz	Misc	4.95
14.31818	Misc	4.95
18.0MHz	8080/8008/8224	4.95
18.432MHz	8080/8008/8224	5.95
20.0MHz	Several MPU's	4.95
22.1184MHz	8080A	5.95
27.0MHz	8080A	5.95
36.0MHz	8080A	5.95
48.0MHz	TIM9904	5.95
100KC	Misc	12.95

DISPLAYS/OPTO

DL 704/707/CC/CA 300	1.25
FND359 CC 357	.95
FND 500/507/CC/CA 500	1.35
FND 503/510 CC/CA 500	.95
FND 800/807 CC/CA 800	2.50
Bowmar 9 digit bubble	.99
FSC 8024 4 digit CC 800	4.95
HP7340 HEX Display	15.95
TIL 305 5 x 7 Array	4.50
TIL 306 7 seg w/logic	8.95
TIL 308 7 seg w/logic	8.95
TIL 309 7 seg w/logic	7.95
TIL 311 HEX Display	9.25
MA 1003 12 auto clock	17.95
MA 1002 4 digit clock module	9.95
MA 1010 4 digit clock module	9.95
NSN 373/374 dual CC/CA 300	2.20
NSN 583/584 ddual CC/CA 500	2.60
NSN 783/784 dual CC/CA 700	3.00
4N25 Opto Isolater	3/1.99
MCT 2 Opto Isolater	.89
4N33 Darlington ISOL	1.75
Red Led's 185 Dia	5/1.00
Green/Yellow	4/1.00

MONTHLY SPECIALS

14 Pin S/T sockets 1000 pcs	.10
16 Pin S/T sockets 1000 pcs	.11
22 Pin S/T sockets 1000 pcs.	.12
FSC460/464 16K CCD's	18.95
AMD 9140CDC Static Ram	10.95
4116/416 16K Dynamic Ram's	8 for/200.00
1488 or 1489 RS232 Driver	1.25
8T97 Buffer	1.25
8130 or 8131	2.45
8833 or 8835	1.99
74367 or 74368	6/5.00
75451/52/53	10/2.50
8T26 Bus Driver	2.39
78L05 Regulator	2/1.00
4N25 Optoisolator	3/1.99
MCT2 Optoisolator	.89
2510A Shift Register	2.95
2519A Shift Register	2.95
MM5056 Shift Register	2.95
LM760N-14 Comparitor	1.10
DS0025CN Clock Driver	1.49
DS0026CN Clock Driver	2.50
8T20 Bidirect oneshot	3.49

NEW
1978 CATALOGUE
AVAILABLE FEB.
SEND .25 POSTAGE

DISCOUNT COMPUTER CORNER

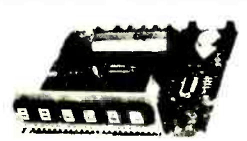
	Cash	Credit Card
Sorоc IQ 120	895.00	925.00
Imsai w/22 slots	629.00	647.00
Speechlab	269.00	278.00
Cromemco Z-2	536.00	551.00
Horizon 1	1439.00	1479.00
North Star	599.00	617.00
TEI MCS122	450.00	462.00
Apple w/16K	1198.00	1234.00
Decwriter II	1475.00	1525.00
Computalker	365.00	380.00
Persci 277	1230.00	1266.00
Shugart 800-2	575.00	590.00
Low cost S100 Bus	149.95	155.95

P. O. BOX 17329 Irvine, California 92713 New Phone (714) 558-8813
TWX: 910-595-1565

Retail Store Open Mon. – Sat.
Located at 1310 "B" E. Edinger,
Santa Ana, CA 92705

30 MHz LOW COST FREQUENCY COUNTER KIT

Features:
- Frequency Range—100Hz to 30MHz min., resolution 100 Hz
- All TTL Circuitry—No tears in the eyes when replacing ICs
- FET Input Stage—Offers high input impedance
- High Sensitivity—15mV typical
- Xytal Time Base—0.001% 10MHz for better accuracy
- On Board Regulator—No external power supply needed
- All ICs Socketed—Easy to service
- Easy to Operate—No switches to flip
- Tin Plated & Screened Board—For easy assembly



COMPARE and SAVE!

$54.95

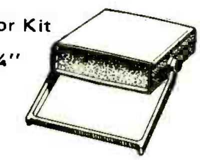
KIT # T-250-30A

KIT INCLUDES: Detailed Instructions (22 pages). All parts including transformer

Now Low Cost !

Instrument Case for Kit

H. 2 7/16" W. 8½" D. 9¼"
and in 6 varying heights also compatible as other instrument housing



Mod. # CH200 PRICE: $17.50

PUT YOUR HAM GEAR OR CB IN YOUR HOUSE WITH THIS SPECIALLY DESIGNED POWER SUPPLY KIT!

KIT INCLUDES: Transformer, PC Board, Large heat sink, Large filtering capacitor and all parts with detailed instruction.

Features:
- Output Voltage = 13.5V
- Output Current = 3.5A Min.
- Load Regulation = 0.01%
- Line Regulation = 0.02%
- Internal Current Limiting
- Over-voltage Protected

ONLY **$16.95** KIT # T-700

WOW! LOOK AT THIS!

5V 10A Power Supply Kit for your TTL Circuits!

Kit Includes: Extra Large Heat Sink, Power Tr., IC Regulator, P.C. Board, with OVP Circuitry. KIT # T-500 $11.95

With Optional Rectifiers and Filtering Capacitor $14.95 (X'former not available)

HERE'S A MUST FOR THE EXPERIMENTER!

2-20V @ 1.3A Continuously Variable Power Supply Kit. Kit Includes: P.C. Board, Transformer, Power Transistor, Heat Sink, IC Regulator & all the parts with detailed instruction. KIT # T-450 $12.95

0.8" 4 Digit Jumbo Display Alarm Clock Kit

Features:
- A. Fairchild 0.8" FSC8000 Display Array
- B. Fairchild Super-Chip – F-3817PC
- C. P.C. Board, Transformer, Speaker and all parts included (less case)
- D. Detailed Instructions

THIS IS A BIG ONE! **$19.50**

6-DIGIT AUTO CLOCK KIT WITH ALARM

Features:
- A. Fairchild 0.5" FND 500 Series Display
- B. Display Board may be remote
- C. X'tal time base
- D. P.C. Boards, speaker, IC's and all parts.
- E. Detailed Instructions

$19.95 KIT # T-1302

Z80 KIT

IMSAI/ALTAIR S-100 COMPATIBLE

On board 2708 EPROM addressable to any 4K boundary above 32K. Power-on-Jump to any 4K boundary above 32K, or the on-board 2708. A wait state may be added to any :

1) M1 cycle 2) Memory request cycle
3) On-board ROM cycle (for use at 4 MHz)
4) Input cycle 5) Out-put cycle

On-board run-stop flip-flop and optional generation of MEMORY WRITE allow front panel-less operation. Selectable 10 addressing mode: 1) 8080 Mode where peripheral address byte is duplicated on high and low order address bytes. 2) Z-80 mode where the peripheral byte appears on the low order address, and the contents of the accumulator appears on the high order byte, allowing simultaneous I/O. DMA Grant tri-states all signals from the processor board. 8224 clock generator provides 8080 look-alike ϕ1 and ϕ2 for the S-100 bus. Status signals SINP, SOUT, SMEMR, & SWO are latched per S-100 bus specs.

$135.00 EA. (2MHZ)
$149.95 EA. (4MHZ)

BARE BOARD **$35.00**

ASSEMBLED & TESTED: ADD $50 to each KIT PRICE

KITS INCLUDE ALL PARTS AND 2708 UNPROGRAMMED

T–8K/ Static Ram Memory Kits

Memory Chips
2102 low power chips. Boards operate with the fastest 2102 on the market (250ns).

Buffering Support Chips
Input and output data lines fully buffered. All possible support chips are low power schottky. Support chips at bottom of board for strong drive signals to bus.

Bypass
26 bypass capacitors on the board.

Voltage Regulation
Four 340T-5 five volt regulators give power even if all chips on board are regular power devices.

Protect
Protect/Unprotect is selected on board so board can be used in systems without a front panel.

Address Select Delay
Can be set in 8K increments. Delays can be selected on board that any speed 2102 memory chip can be used.

	450ns	350ns	250ns
T–8K Kit	$129.95	$139.95	$169.95
Assembled & Tested	$150.00	$159.95	$189.95

Bareboard (without parts): $25.00

CRYSTALS ±0.002%

LOWEST PRICE EVER! HIGHEST ACCURACY!

Frequency MHz	Price	Frequency MHz	Price	Frequency MHz	Price
1.0000	@4.90	4.0000	@3.65	10.000	@2.85
1.8432		4.1943		14.318	
2.000	@4.50	4.9152		14.391	
2.0100		5.000		18.000	
2.097152		6.0688		18.4320	
2.4576		5.1850		20.0000	
2.667		5.7143		22.1184	
3.000		6.000		27.0000	
3.200		6.144		32.0000	
3.2768		6.400		36.0000	
3.5795		6.5536		48.0000	
		8.0000			

TRINICO INTERNATIONAL
(Formerly Trico)
2795 W. Lincoln Ave., Suite L
Anaheim, CA 92801
Tel: (714) 821-0234

Terms: Money Back Guarantee
Calif. residence add 6% sales tax.
Please add $1.00 for postage inside Calif., $2.00 for out of state, overseas add 10% of order.
Minimum order $5.00, C.O.D. $20.00 ($1.00 handling)
STORE HOURS: MON.-SAT., 10-7
BANKAMERICARD MASTERCHARGE

7400 Series

SN7400N	16	SN7472N	.39	SN74160N	1.25
SN7401N	18	SN7473N	39	SN74161N	.99
SN7402N	20	SN7474N	35	SN74162N	1.95
SN7403N	20	SN7475N	.50	SN74163N	.99
SN7404N	20	SN7476N	35	SN74164N	.99
SN7405N	20	SN7479N	5.00	SN74165N	.99
SN7406N	35	SN7480N	50	SN74166N	1.25
SN7407N	35	SN7482N	99	SN74167N	3.25
SN7408N	20	SN7483N	70	SN74170N	2.10
SN7409N	25	SN7485N	.89	SN74172N	6.00
SN7410N	20	SN7486N	39	SN74173N	1.50
SN7411N	30	SN7488N	3.50	SN74174N	1.25
SN7412N	35	SN7489N	2.49	SN74175N	.99
SN7413N	69	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	.75	SN74177N	79
SN7416N	35	SN7492N	49	SN74179N	2.49
SN7417N	35	SN7493N	49	SN74180N	.99
SN7420N	20	SN7494N	79	SN74181N	2.49
SN7421N	.39	SN7495N	79	SN74182N	.95
SN7422N	49	SN7496N	79	SN74184N	1.95
SN7423N	37	SN7497N	3.00	SN74185N	1.95
SN7425N	29	SN74100N	1.25	SN741[illegible]	15.00
SN7426N	29	SN74107N	.39	SN74187N	6.00
SN7427N	37	SN74109N	.95	SN74188N	3.95
SN7429N	42	SN74116N	1.95	SN74190N	1.79
SN7430N	25	SN74121N	.39	SN74191N	1.25
SN7432N	25	SN74122N	.39	SN74192N	.89
SN7437N	35	SN74123N	50	SN74193N	.89
SN7438N	35	SN74125N	60	SN74194N	1.25
SN7439N	25	SN74126N	60	SN74195N	.75
SN7440N	21	SN74132N	1.25	SN74196N	1.00
SN7441N	89	SN74136N	95	SN74197N	1.00
SN7442N	69	SN74141N	1.15	SN74198N	1.75
SN7443N	75	SN74142N	2.95	SN74199N	1.75
SN7444N	75	SN74143N	3.25	SN74200N	5.59
SN7445N	75	SN74144N	3.00	SN74251N	1.79
SN7446N	89	SN74145N	1.15	SN74279N	.90
SN7447N	69	SN74147N	2.35	SN74283N	2.25
SN7448N	89	SN74148N	2.00	SN74284N	6.00
SN7450N	25	SN74150N	1.25	SN74285N	6.00
SN7451N	25	SN74151N	79	SN74365N	75
SN7453N	25	SN74153N	89	SN74366N	.75
SN7454N	25	SN74154N	1.25	SN74367N	.75
SN7459A	25	SN74155N	89	SN74368N	75
SN7460N	25	SN74156N	.89	SN74390N	2.25
SN7470N	45	SN74157N	.89	SN74393N	2.25

CMOS

CD4000	23			CD4069	45
CD4001	23			CD4070	.55
CD4002	23	CD4027	69	CD4071	23
CD4006	1.19	CD4028	89	CD4072	49
CD4007	25	CD4029	1.19	CD4076	1.39
CD4009	49	CD4030	49	CD4081	.23
CD4010	49	CD4035	99	CD4082	23
CD4011	23	CD4040	1.19	CD4098	2.49
CD4012	25	CD4041	1.25	MC14409	14.95
CD4013	39	CD4042	99	MC14410	14.95
CD4014	1.39	CD4044	89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	49	CD4047	2.50	MC14506	75
CD4017	1.19	CD4048	1.35	MC14507	99
CD4018	99	CD4049	49	CD4508	3.95
CD4019	49	CD4050	49	CD4510	1.39
CD4020	1.19	CD4051	1.19	CD4511	1.29
CD4021	1.39	CD4053	1.19	CD4515	2.95
CD4022	1.19	CD4056	1.49	CD4518	1.29
CD4023	23	CD4059	9.95	CD4520	1.29
CD4024	79	CD4060	1.49	MC14562	14.50
CD4025	23	CD4066	.79	CD4566	2.25
CD4026	2.25	CD4068	39	MC14583	3.50

74C00 Series

74C00	.39	74C74	1.15	74C160	3.25
74C02	.55	74C89	4.00	74C161	3.25
74C04	75	74C90	3.00	74C163	3.00
74C10	.65	74C93	2.00	74C164	3.25
74C14	3.00	74C95	2.00	74C173	2.60
74C20	65	74C107	1.25	74C193	2.75
74C30	65	74C151	2.90	74C195	2.75
74C42	2.15	74C154	3.00	80C95	1.50
74C73	1.50	74C157	2.15	80C97	1.50

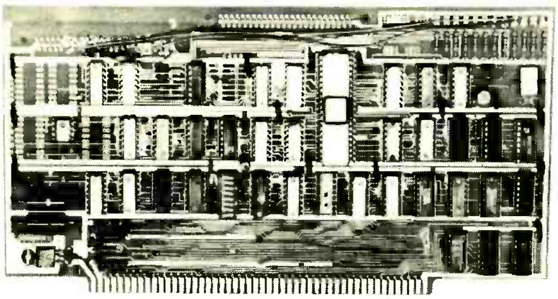
LINEAR

LM300H	.80	LM340T-8	1.25	LM741CH	.35
LM301H	35	LM340T-12	1.25	LM741CN	.35
LM301CN	35	LM340T-15	1.25	LM741-14N	39
LM302H	75	LM340T-18	1.25	LM747H	.79
LM304H	1.00	LM340T-24	1.25	LM747N	79
LM305H	60	LM350N	1.00	LM748H	39
LM307CN	35	LM351CN	65	LM748N	.39
LM308H	1.00	78MG	1.75	LM1303N	.90
LM308CN	1.00	LM370N	1.15	LM1304N	1.19
LM309H	1.10	LM373N	3.25	LM1305N	1.40
LM309K	1.25	LM377N	4.00	LM1307N	.85
LM310CN	1.15	LM380N	1.25	LM1310N	2.95
LM311H	90	LM380CN	.99	LM1351N	1.65
LM311N	90	LM381N	1.79	LM1414N	1.75
LM317K	7.50	LM382N	1.79	LM1458CN	.59
LM318CN	1.50	NE501K	8.00	LM1496N	95
LM319N	1.30	NE510A	6.00	LM1556V	1.75
LM320K-5	1.35	NE529A	4.95	LM2111N	1.95
LM320K-5.2	1.35	NE531H	3.00	LM2901N	2.95
LM320K-12	1.35	NE536T	6.00	LM3053	1.50
LM320K-15	1.35	NE540L	6.00	LM3065N	69
LM320T-5	1.25	NE550N	1.30	LM3900N(3401)	.49
LM320T-5.2	1.25	NE555V	.39	LM3905N	.89
LM320T-8	1.25	NE560B	5.00	LM3909	1.25
LM320T-12	1.25	NE561B	5.00	LM5556N	1.85
LM320T-15	1.25	NE562B	5.00	MC5558V	1.00
LM320T-18	1.25	NE565H	1.75	LM7525N	.90
LM320T-24	1.25	NE565N	1.25	LM7534N	75
LM323K-5	5.95	NE566CN	1.75	8038B	4.95
LM324N	1.80	NE567H	1.95	LM75450	49
LM339N	99	NE567V	1.49	75451CN	.39
LM340K-5	1.35	LM703CN	45	75452CN	.39
LM340K-6	1.35	LM709H	29	75453CN	39
LM340K-8	1.35	LM709N	29	75454CN	39
LM340K-12	1.35	LM710N	79	75491CN	79
LM340K-15	1.35	LM711N	39	75492CN	89
LM340K-18	1.35	LM723H	55	75494CN	89
LM340K-24	1.35	LM723N	55	RC4194	
LM340T-5	1.25	LM733N	1.00	RC4195	
LM340T-6	1.25	LM739N	1.19		

74LS00

74LS00	29			74LS155	1.25
74LS02	29			74LS157	1.50
74LS03	29			74LS160	1.95
74LS04	35			74LS161	1.95
74LS05	35	74LS76	.49	74LS162	1.95
74LS08	29	74LS83	1.75	74LS163	1.95
74LS10	29	74LS85	2.49	74LS164	1.95
74LS13	69	74LS86	.49	74LS175	1.95
74LS14	1.75	74LS90	89	74LS181	3.69
74LS20	29	74LS92	89	74LS190	2.49
74LS26	39	74LS93	.89	74LS191	2.49
74LS27	39	74LS95	1.50	74LS192	2.49
74LS28	39	74LS96	1.89	74LS193	2.49
74LS30	29	74LS107	59	74LS194	1.89
74LS32	39	74LS109	59	74LS195	1.89
74LS40	39	74LS112	59	74LS253	1.75
74LS42	1.25	74LS123	1.25	74LS257	1.75
74LS47	1.25	74LS132	1.25	74LS260	.55
74LS51	29	74LS136	59	74LS279	.79
74LS55	29	74LS138	1.25	74LS367	.99
74LS73	49	74LS139	1.25	74LS368	99
74LS74	49	74LS151	1.25	74LS670	3.95

Tarbell
Floppy Disc Interface
Designed for Hobbyists and Systems Developers



- Plugs directly into your IMSAI or ALTAIR* and handles up to 4 standard single drives in daisy-chain.
- Operates at standard 250K bits per second on normal disc format capacity of 243K bytes.
- Works with modified CP/M Operating System and BASIC-E Compiler.
- Hardware includes 4 extra IC slots, built-in phantom boot-strap and on-board crystal clock. Uses WD 1771 LSI Chip.
- 6-month warranty and extensive documentation.
- **PRICE:** Kit $190 .... Assembled $265

* ALTAIR is a trademark/tradename of MITS, INC.

Tarbell Electronics
20620 South Leapwood Avenue, Suite P
Carson, California 90746
(213) 538-4251

CIRCLE 34 ON FREE INFORMATION CARD

SOCKET SALE

WIRE WRAP SOCKETS

14 Pin Wire Wrap	.30	.27/400
16 Pin Wire Wrap	.32	.29/350

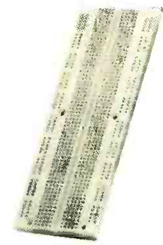
EDGE CARD CONNECTORS

44 Pin ST Edge Card Connector	1.75	1.50/10
100 Pin ST Edge Card Connector	3.50	3.00/10
100 Pin WW Edge Card Connector	3.50	3.00/10

All Sockets & Connectors Include Gold.

SOLDERLESS BREADBOARDS
2.2" x 6.5"

SK 10 $16.50



INCLUDING:
Over 100 pieces of precut wire in assorted lengths — free!
Choose 1 color: Red, Black, Blue, Yellow, Green, White, Orange Or Assortment.

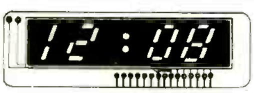
PAGE DIGITAL ELECTRONICS
135 E. Chestnut Street 4A
Monrovia, California 91016
Phone (213) 357-5005

ORDERING INFORMATION
- Orders under $25 and COD's, add $2
- All others, shipped Ppd in U.S. via UPS
- For Blue Label (Air) or 1st Class, add $1
- We accept Visa & Master Charge
- Most orders shipped same day

Dealer Inquiries Invited

CIRCLE 20 ON FREE INFORMATION CARD

JUMBO LED READOUT ARRAY



By Bowmar. .5 in. character common cathode. Designed for use with multiplexed clock chips 4 digits in 1 pack!

$1.95 LIMITED STOCK

NATIONAL SEMICONDUCTOR
SIX DIGIT ALARM CLOCK CHIP

National's second generation clock chip
24 Pin Dip Super easy to use

$1.95 each

COMPARE AT TWO OR THREE TIMES OUR PRICE!

FEATURES:
12 HOUR DISPLAY • 24 HOUR ALARM
4 OR 6 DIGITS • ALARM TONE OUTPUT
SNODZE ALARM • EASY LED INTERFACE
POWER FAIL IND • BRIGHTNESS CONTROL
AM/PM INDICATION • SINGLE POWER SUPPLY
FAST AND SLOW SET • LOW POWER

WE SUPPLY FULL DATA. SPECS

MM5375AA

HUGE SPECIAL PURCHASE!

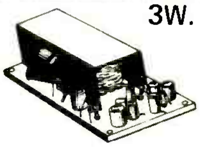
SPECIAL OFFER!

With purchase of Clock Chip at left.
T.I. COMMON ANODE LED READOUTS
#TIL-312 .33 INCH
HIGH EFFICIENCY!
A PERFECT MATE.

59¢ ea.

BUILD YOUR OWN CLOCK!
WE SUPPLY DATA!

3W. AUDIO AMP



$3.95
$2\frac{1}{4}$x3"

Assembled & tested. Not a kit. Has tapped output for either 4, 8 or 16 OHMS. With schematic.

MOTOROLA 7805R
Voltage Regulator

Same as standard 7805 except 750 MA output. TO—220. 5VDC output.
44c each 10/$3.95

MOTOROLA 4K RAM's — 99¢ EACH (WITH DATA)

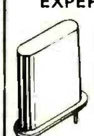
A major U.S. computer mfg. removed these parts from PC boards, then retested them to full specs. Best Memory Buy in the U.S.A.! 4096 x 1 Bits. One of the easiest Dynamic RAM's to use. A complete memory board design using these chips is detailed in the MOTOROLA M6800 APPLICATIONS MANUAL starting on page 4-70. The 6605 is the popular 22 Pin Dip.

8 FOR $6.95
(4096 WORDS OF RAM!)

SURPLUS BUY OF THE DECADE!

MCM6605
470 NS
GUARANTEED!

EXPERIMENTER'S CRYSTAL



262 144KHZ. This frequency is 2 to the 18th power. Easily divided down to any power of 2, and even to 1HZ. New by CTS-Knight. A $5 value!

$1.25 each

LED IC Counter Kit

You Get: 1—7490; 1—7475; 1—7447; 1—Led Readout. All this for **$1.99**
(Led Readout is famous SLA-1. .33 in. By Opcoa.)

FAIRCHILD JUMBO READOUTS
.5 Inch Char. High Efficiency!
FND-503-Common Cathode
FND-510-Common Anode
YOUR CHOICE 69¢
10 FOR $5.75

DISC CAPACITORS
.1 MFD 16V. P.C. leads. Most popular value! By Sprague.

20 for $1.00

Full Wave Bridge
4 Amp 200 PIV
69¢ea. 10/5.75

MALLORY
POWER SUPPLY CAPACITOR
1500 MFD 16 WVDC
3/$1.10 10/$2.95
FACTORY FRESH! SMALL SIZE

2N3904-House No.
TO—92. NPN.
VCEO-45.
HFE 100 to 300
10 for $1.00

Jumbo Red Leds
New by G.E. Like MV5024. Number SSL-22.
6/$1. 25/$3.75

Motorola PNP Power!
2N4905 TO-3 case. 90W. VCEO-60. HFE-100 max. at 2.5A. Good mate for the 2N3055. PRIME!
75¢ ea. 4/$2.50

GE POWER TRIAC
SC 146D. House #.
10 AMPS 400 PIV
TO-220 CASE 75¢ea.
4 FOR 2.50

LS SERIES TTL

74LS00—33c	74LS74—49c
74LS02—35c	74LS90—69c
74LS04—35c	74LS138-89c
74LS08—35c	74LS154-1.49
74LS10—33c	74LS175-1.10
74LS20—33c	74LS367-75c
74LS73—49c	74LS368-85c

Motorola Quad Op-Amp MC3401.
Pin for Pin Sub for popular LM3900.
3/$1.00

Digital Research Corporation
(OF TEXAS)
P. O. BOX 401247 B GARLAND, TEXAS 75040 • (214) 271-2461

TERMS: Orders under $15. add 75c. No COD's. We accept VISA, MasterCharge and American Express Cards. Money Back Guarantee on all items! Texas Residents add 5% Sales Tax. WE PAY POSTAGE!

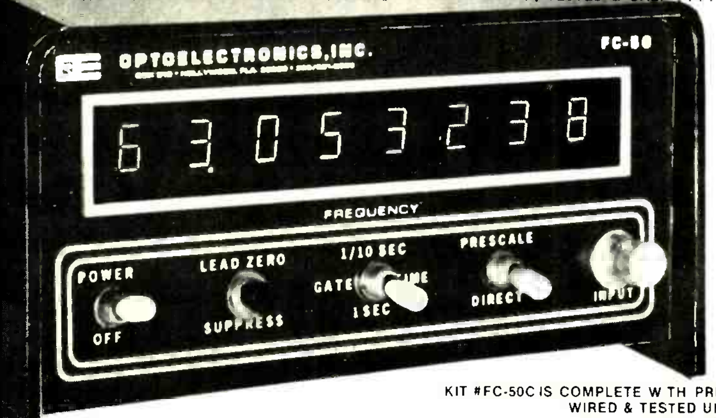
CIRCLE 90 ON FREE INFORMATION CARD

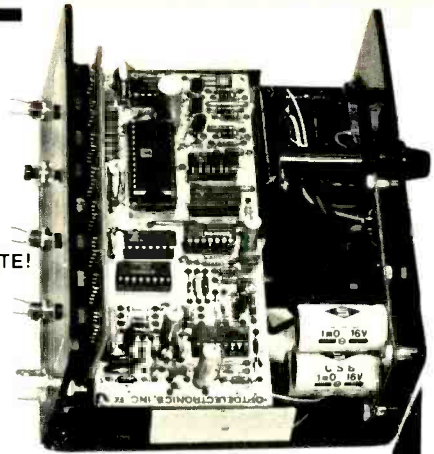
NEW LSI TECHNOLOGY

FREQUENCY COUNTER

TAKE ADVANTAGE OF THIS NEW STATE-OF-THE-ART COUNTER FEATURING THE MANY BENEFITS OF CUSTOM LSI CIRCUITRY. THIS NEW TECHNOLOGY APPROACH TO INSTRUMENTATION YIELDS ENHANCED PERFORMANCE, SMALLER PHYSICAL SIZE, DRASTICALLY REDUCED POWER CONSUMPTION [PORTABLE BATTERY OPERATION IS NOW PRACTICAL], DEPENDABILITY, EASY ASSEMBLY AND REVOLUTIONARY LOWER PRICING!

KIT #FC-50C	60 MHZ	COUNTER WITH CABINET & P.S.	$119.95 COMPLETE!
KIT #PSL-650	650 MHZ	PRESCALER (NOT SHOWN)	29.95
MODEL #FC-50WT	60 MHZ	COUNTER WIRED, TESTED & CAL.	165.95
MODEL #FC-50/600 WT	600 MHZ	COUNTER WIRED, TESTED & CAL.	199.95





SIZE:
3" High
6" Wide
5½" Deep

FEATURES AND SPECIFICATIONS:

DISPLAY: 8 RED LED DIGITS .4" CHARACTER HEIGHT
GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL].
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [± .0001%]; AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.001% XTAL]
IC PACKAGE COUNT: 8 [ALL SOCKETED]
INTERNAL POWER SUPPLY: 5 V DC REGULATED.
INPUT POWER REQUIRED: 8-12 VDC OR 115 VAC AT 50/60 HZ.
POWER CONSUMPTION: 4 WATTS

KIT #FC-50C IS COMPLETE WITH PREDRILLED CHASSIS ALL HARDWARE AND STEP-BY-STEP INSTRUCTIONS. WIRED & TESTED UNITS ARE CALIBRATED AND GUARANTEED.

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H, 6¼"W, 5½"D

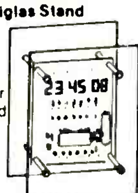
CABINET II
2½"H, 5"W, 4"D

Black, White or Clear Cover
$6.50 ea.

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled

Kit #850-4 CP

Size: 6"H, 4½"W, 3"D

$23.50 ea. 2/$45. Assembled $29.95

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board. Power Req: 5-15V (2.5 MA TYP.) Easy 3 wire hookup. Accuracy: ± 2PPM

#TB-1 (Adjustable)
Complete Kit $4.95
Wir & Cal $9.95

SPECIAL PRICING!

PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.75 ea.	100-199	$1.45 ea.
25-99	1.60 ea.	200-999	1.39 ea.

1000 AND OVER $1.29 ea.

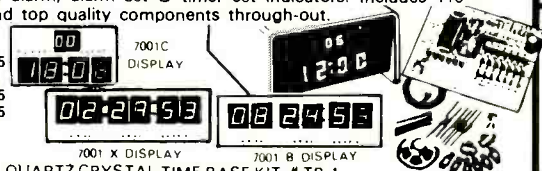
6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM. SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT-7001B WITH 6 - .5" DIGITS	$39.95
KIT-7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS	$42.95
KIT-7001X WITH 6 - .6" DIGITS	$45.95



KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, PC Boards, Transformer, Line Cord, Switches and all Parts. Ideal Fit in Cabinet II

Kit #5314-5 $19.95 2/$38.

JUMBO DIGIT CONVERSION KIT $9.95 ea.

Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & Hook up info.
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

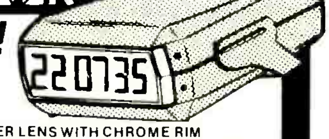
Specify for 7001 B, C or X - $7.95

MOBILE LED CLOCK

12/24 HR .4" DIGITS!

MODEL #2001

12 VOLT AC or DC POWERED



- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY [Use When Key Off in Car, Etc.]
- TOP QUALITY PC BOARDS & COMPONENTS - INSTRUCTIONS.
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT $27.95 EA. 3 OR MORE $25.95 ea. 115 VAC Power Pack #AC-1 $2.50 EA.

ASSEMBLED UNITS WIRED & TESTED ORDER #2001 WT (LESS 9V. BATTERY) Wired for 12-Hr. Op. if not otherwise specified. $37.95 EA 3 OR MORE $35.95 ea.

AUTO BURGLAR ALARM KIT

AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

KIT #ALR-1 $9.95
#ALR-1WT WIRED & TESTED $19.95

VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
- 2N3055 PASS TRANSISTOR
- CURRENT LIMITING AT 1 Amp

KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANS-FORMER) KIT #PS-01 $8.95

TRANSFORMER 24V CT will provide 300MA at 12V and 1 Amp at 5V. $3.50

OPTOELECTRONICS, INC.

5821 N.E. 14th AVENUE,
FORT LAUDERDALE, FLA. 33334
PHONE (305) 771-2050 / 771-2051

ORDER BY PHONE OR MAIL
COD ORDERS WELCOME

ORDERS TO USA & CANADA ADD 5% FOR SHIPPING, HANDLING & INSURANCE. ALL OTHERS ADD 10%. ADDITIONAL $1.00 CHARGE FOR ORDERS UNDER $15.00 - COD FEE $1.00. FLA. RES. ADD 4% STATE TAX.

master charge
BANKAMERICARD welcome here

CIRCLE 17 ON FREE INFORMATION CARD

SC-5 With Rechargeable Batteries & Charger Unit **$89**

FM-7 With Rechargeable Batteries & Charger Unit **$195**

NLS

Features Include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands) • The FM-7 utilizes an LED readout, providing 7-digit resolution • The FM-7 can be calibrated to an accuracy of 0.00001% • The SC-5 is accurate to one part per million • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included • Dimensions of each are 1.9" H x 2.7" W x 3.9" D • The units may be obtained separately or as a "Frequency Duo" • Parts & Labor guaranteed 1 year.

Tilt stand option . . . . . $ 3.50
Leather case $16.00

MS-15 MINISCOPE $289

With Rechargeable Batteries & Charger Unit

- 15 megahertz bandwidth.
- External and internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings. ± 3%.
- Battery or line operation.
- Automatic & line sync modes.
- Power consumption < 15 watts.
- Vertical Gain — .01 to 50 V/div - 12 settings ± 3%.
- Viewing area 1.1" x 1.35".
- Case size 2.7"H x 6.4"W x 7.5"D, 3 pounds.
- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe $24.50
- Leather carrying case $30.00

NLS

● MS-215 Dual Trace Version of MS-15 $395.00

PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

NLS

NEW VOLKSMETERS!

With LCD Display— Excellent Readability in Direct Sunlight!

NEW

1% LM-300 Full three digits $99.50*

0.5% LM-350 3½ digits $125.00*

FEATURES

- Measures DC volts, AC volts, ohms and current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full scale ohms adjust
- Large LCD display for easy reading without interpolation
- Size 1.9" H x 2.7" W x 4.0" D
- Parts and labor guaranteed for one year

SPECIFICATIONS

MODE	RANGE	ACCURACY LM-300	ACCURACY LM-350	RESOLUTION	INPUT RESISTANCE	TEST CURRENT
VOLTS DC*	1 / 10 / 100 / 1000	±1% Reading†	±0.5% Reading†	1 mV / 10 mV / 100 mV / 1 V	10 MΩ	
VOLTS AC*	1 / 10 / 100 / 1000	±1% Reading† 50–400 Hz	±0.7% Reading† 50–400 Hz	1 mV / 10 mV / 100 mV / 1 V	10 MΩ, 20 pF	
KILOHMS**	1 / 10 / 100 / 1000 / 10000	±1% Reading†	±0.5% Reading†	1 Ω / 10 Ω / 100 Ω / 1 kΩ / 10 kΩ		1 mA / 100 μA / 10 μA / 1 μA / 100 nA
CURRENT	1 mA / 10 mA / 100 mA / 1 A	±2% Reading†	±2% Reading†	1 μA / 10 μA / 100 μA / 1 mA	1 kΩ / 100 Ω / 10 Ω / 1 Ω	

* 1000 vdc or peak ac maximum any range. †±2 digits
**Test Voltage (Ohms) 1 vdc Full Scale - LM-300, 2 vdc Full Scale - LM-350
‡ LM-350 has 100% over-range - full scale readings are 1.999, 19.99, etc.

SPECIAL!!

Batteries & Charger $1.00 with the purchase of Meter and the mention of this magazine

Tilt Stand Option, add . . . $3.50
Leather Case . . . $16.00
3AA NiCad-Batts. & Charger . . . $12.00

Standard AA-size batteries provide up to 20 hours of operation
Rechargeable NiCad batteries and charger unit available as optional equipment
Batteries not included

LEDU MG 10A List $72.00

Perfectly balanced, fluorescent lighting with precision magnifier lens. For prof'l, techn'l & hobbist. Has die cast protective shade, inst. start 3 diopter lens. 42" reach

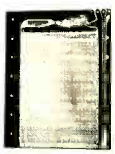
$44.95

with T-9 fluorescent lamp (required) $49.95
colors Gray or Black Chocolate Brown
2 choices please

$44.95 SPECIAL

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

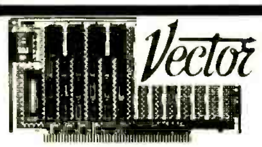
Vector



- Kit includes 12 tantalum capacitors for +5, +12 —12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active, pull up, or floating terminations
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL STD-275 with 10°C rise
- Fits in vector pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

Price: $29.50

Vector Plugboards



8800V

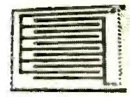
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16

1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1

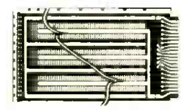
Same as 8800V except plain, less power buses & heat sink

1-4	5-9	10-24
$14.95	$13.46	$11.96



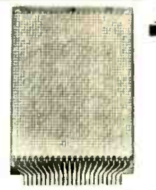
3682 9.6" x 4.5" $10.97
3682-2 6.5" x 4.5" $9.81

Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**

Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156



3662 6.5" x 4.5" **$7.65**
3662-2 9.6" x 4.5" **$11.45**

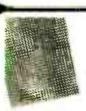
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

R644 P.C. recepticle 22/44 cont .156 ctrs. pierced solder eyelets tails gold . . . $2.95
R644-3 P.C. recepticle 22/44 cont .156 ctrs. Wire Wrap tails gold . . . $4.49

S-100 Bus P.C. Edge Connectors

R681 DIP solder tails on .140 spaced rows for ALTAIR mother boards. Fits .042" dia. holes, gold . . . $7.35
R681-1 .025" sq. 3 wrap lengths posts (.62 long) on .250 spaced rows, gold . . . $5.00
R681-2 .025" sq. 1 wrap length posts (.22 long) on .250 spaced rows for wrapping or DIP solder for IMSAI mother boards, gold . . . $5.85
R681-3 pierced solder eyelet tails, gold . . . $7.35

1/16 Vector BOARD



.042 dia holes on 0.1 spacing for IC's

Phenolic

PART NO.	SIZE	PRICE
64P44-062XXP	4.5 x 6.5"	$ 1.49
169P44-062XXP	4.5 x 17"	$ 3.51

Epoxy Glass

PART NO.	SIZE	PRICE
64P44-062	4.5 x 6.5"	$ 1.70
84P44-062	4.5 x 8.5"	$ 2.10
169P44-062	4.5 x 17"	$ 4.30
169P84-062	8.5 x 17"	$ 6.39

SLIT-N-WRAP

Wraps insulated wire on .025" square posts
FOUR TIMES FASTER than regular manual wrap post tools

P180 with two 100' spools of 28 ga. wire **$24.50**

P160-4T includes charger, wire **$75.00**

"Daisy chain" runs
Reliable and easy to use
Manual or power operation

Vector

NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOL-FED WIRE*

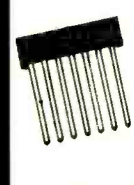
*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner, the bared copper is indented by the sharp edge (7 turns = 28 contacts). Insulation is slit where wrapped but not between terminal posts when fed straight out of the tool.

SLIT-N-WRAP WIRE $2.75 Package
NO. 28 GAGE INSULATED WIRE, 100' SPOOLS
W28-2-A Pkg. 3 Green W28-2-C Pkg. 3 Clear
W28-2-B Pkg. 3 Red W28-2-D Pkg. 3 Blue

2708 8K 450 ns EPROM

FACTORY PRIME
$10.00 EA.
25 + *Call For Price*

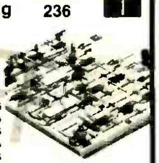
14 & 16 PIN 3 LEVEL WIRE WRAP SOCKETS



14-T3 100 for $30.00
16-T3 100 for $30.00
50 of ea. for $32.00

ACE • All-Circuit Evaluator — for fast, solderless, plug-in circuit building and testing

Model 236



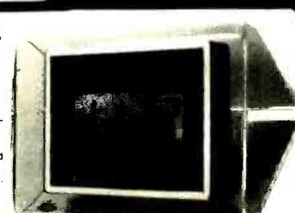
Just plug in any components with leads to .032" dia. Interconnect with solid wire up to 20 ga. Assembled models tool

ACE Model No	Tie Points	DIP Capacity	No. Buses	No. Posts	Board Size (inches)	Price Each
200-K (kit)	728	8 (16's)	2	2	4-9/16 x 5-9/16	$18.95
208 (assem.)	872	8 (16's)	8	2	4-9/16 x 5-9/16	28.95
201-K (kit)	1032	12 (14's)	2	2	16 x 7	24.95
212 (assem.)	1224	12 (14's)	8	2	4-9/16 x 7	34.95
218 (assem.)	1760	18 (14's)	10	2	6-1/2 x 7-1/8	46.95
227 (assem.)	2712	27 (14's)	28	4	8 x 9-1/4	59.95
236 (assem.)	3648	36 (14's)	36	4	10-1/4 x 9-1/4	79.95

... 4 rubber feet

SALE

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR



- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO. Included.
- 2 MODELS AVAILABLE
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is backlighted.
- LCD-101 or LCD-102 your choice . . . **$34.95**
- Clear desk stand for . . . **$2.00**

3 LEVEL GOLD WIRE WRAP SOCKETS

	1-24	25-49	50-99
8 pin	.47	.42	.37
10 pin	.45	.41	.37
14 pin	.39	.38	.37
16 pin	.43	.42	.40
18 pin	.75	.68	.62
20 pin	.84	.77	.71
22 pin	1.00	.97	.95
24 pin	1.00	.94	.75
28 pin	1.09	.98	.84
36 pin	1.59	1.45	1.30
40 pin	1.49	1.39	1.29

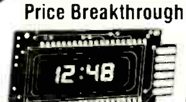
MICRO-KLIP
for .042 dia. holes
(all boards on this page)
T42-1 pkg. 100 . . . $ 1.50
T42-1 pkg. 1000 . . . $11.00
P-149 hand installing tool . . . $ 2.03

.8" LED ALARM CLOCK

12 hr. LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive PIN to PIN interface with S1998A I.C. Just add switches, AC Supply, Alarm Display and I.C. only.

$7.95 or 2/$15.00

Price Breakthrough! $17.95



MA1003 CAR CLOCK

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

SPECIAL

14CS2 100 for $14.00
16CS2 100 for $16.00
14 pin CS2 10 for $2.00
16 pin CS2 8 for $2.00

These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

Vector

WRAP POST
for .042 dia. holes
(all boards on this page)
T-44 pkg. 100 . . . $ 2.28
T-44 pkg. 1000 . . . $14.00
A-13 hand installing tool . . . $ 2.80

PRIORITY ONE ELECTRONICS ©

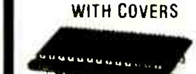
VISA master charge

10031 S. Woodley Ave. Sepulveda CA. 91343

Terms: VISA, MC, BAC, check, Money Order, C.O.D., U.S. Funds Only. CA residents add 6% sales tax. Minimum order $10.00. Orders less than $75.00 include 10% shipping and handling, excess refunded. Just in case please include your phone no. **"Sorry, no over the counter sales"** Good thru July 15, 1978

Send for our latest brochure. **phone orders welcome (213) 893-8202** OEM and Institutional inquiries invited.

24 PIN DIP PLUGS WITH COVERS



3 / $1.00
40 / $10.00

WAREHOUSE ETCO CLEARANCE

GREAT BUYS

EVERY ONE A BARGAIN!

K242SU	110 VAC solenoid water valve (6 oz.) .....$3.95, 10/$34.95
K054EK	Eico Blacklite strobe (5 lb.) $39.95
K197KT	Educational electric motor kit (5 Oz.)....$1.99, 10/$15.95
K233HP	12V-2 A. (4A. surge) CB/car stereo power supply (1 lb.).....$9.95
K150TR	1200' 5" reel Philips recording tape (6 oz.)$2.95, 10/$19.95
K338PT	1 lb. asst. 2 sided glass epoxy PC boards $2.95
K339PT	1 lb. asst. 1 sided glass epoxy PC boards $2.95
K112MP	New electret shotgun microphone (2 lb.) $59.95
K088DS	Hamlin 3½ digit liquid crystal watch display ....$4.95 (2 Oz.)
K263OP	5 assorted optical lenses $1.98
K308SU	Surprise relay board (4 oz.) ....$2.95, 10/$24.95
K604TR	Popular 8 track stereo head (4 oz.) ....$2.89, 10/$24.95
K180AE	10 section 50" whip antenna (5 oz.).........99c
5Y4G	tubes (3 oz.) $1.29
6AQ6	tubes (3 oz.) 99c, 10/$8.95, 100/$79.95.

FREE!

WITH EACH ORDER OF $10.00 OR MORE — 2 of these 12 vdc DPST PC BOARD RELAYS! Request 2 No. K066RL.

UNUSUAL 4 - CHANNEL VLF FM RECEIVER!

NEW

9.95

BRAND NEW FACTORY SURPLUS!

Brand new. Originally used in wireless classroom systems. Picks up transmitted frequencies from a closed-loop antenna (40 x 40 ft.) surrounding an area up to 1600 square feet. 4 channels: 185, 230, 285, 350 KHz. Operates on 1.4 V mercury cell (Mallory RM-12) not included. 4 pushbutton channel selector switches, 2 headphone jacks, volume control. Automatic "on" when head phone is plugged in. Bears Sylvania No. STU - 41031. Fascinating application possibilities. 1½ lb. K310SU.

CLOSE-OUT SALE!

SPECTACULAR PURCHASE !

HAWKEYE RADAR WARNING SYSTEM

SAVE!

MONEY BACK GUARANTEE— You have to be pleased or return it within 10 days for refund.

PRICE CUT

NOW ONLY— 29.95

3/$79.95

WORTH THREE TIMES OUR AMAZINGLY LOW PRICE!

ETCO scoops the industry - buys up closeout inventory of fine, sophisticated X-band radar detectors - and brings them to you at the lowest price ever! Sealed factory display cartons (excellent dealer item). Audio/visual warning. Sensitivity control. Dual brackets. Picks up radar signals at twice the distance that radar operator is able to "sight" you! Easily worth 3 times our low price. Order today while inventory lasts. (1 lb.) K013HM.

BUILD YOUR OWN DUMMY TV CAMERAS!

BANKRUPTCY PURCHASE!

2.95

10/$24.95

We bought up thousands of these dummy TV camera lenses. Originally manufactured for "Foto-Vu" security equipment. Professional appearance. Black plastic with clear lucite lens. 2½" diameter x 3" long. 6 oz. K292SU.

MAIL YOUR ORDER TODAY

FIVE POUND SURPRISE BOX!

5 pounds of pure pleasure! Parts, gadgets, assemblies, hardware - easily worth 5 to 10 times our low price. A box of goodies specially prepared by ETCO to endear us to our customers forever. Each kit is different - order several. A super money saver for servicemen P.S. Don't tell your wife where you got it - she'll shoot us! 5 lb. K097PT.

SPECIAL PURCHASE

HOME CONVERTER FOR CAR STEREO!

400 in stock !

SALE

24.95

AUTOMATIC RADIO®

3/$79.95

A sensational ETCO purchase! Designed to accept and power AR Automatic Radio Car stereo models SPC-5002 & SPE-5004, but can be adapted to just about and car stereo or car radio! (could power CB sets and scanners, too!) 2 speakers included. Exactly as pictured, less car stereo unit. AR No. HCS-5103. Walnut woodgrain finish. Built in 110 VAC power supply. Pilot light. On-off switch. Stereo heedphone jack. Original factory sealed cartons. An excellent dealer item. (9 lb.). K725HP

POTTER & BRUMFIELD 4PDT 24 VDC RELAYS!

VALUE

2500 in stock!

1.99

3/$5.49
10/$14.95
50/$59.95

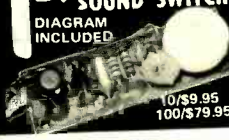
4 amp contact rating. Sensational value. Add diode rectifier for AC use. A thousand applications. 1¼" x 1" x ¾". 2 oz. K010RL.

THE MAGIC SOUND SWITCH

1.29

DIAGRAM INCLUDED

Originally used in the manufacture of an electronic turtle! Sensitive crystal mike picks up sound which is amplified to trigger an SCR. Operates on 3-6 VDC. A great experimental item. Clap hands to operate motors, lights, alarms. A factory surplus assembly. 2 oz. K210SU.



10/$9.95
100/$79.95

RCA 40374 POWER TRANSISTOR WITH HEATSINK!

10/$10.88

BRAND NEW

1.39

TO-66 case. Complete with heat sink as pictured. NPN silicon, AF high voltage 6W power transistor very similar to SK3021. 1 oz. K169DS

RCA 40536 TRIAC WITH HEATSINK!

1.29

10/$9.95

SAVE!

TO-5 case, in heat sink as in photo. Similar to SK3506. Off-state voltage - 400. Forward current: 2.5 A RMS (surge 25 A.) Brand new Factory surplus. 2 oz. K168DS.

SURPLUS WANTED

TELEPHONE YOUR ORDERS — Phone in your charge-card orders at low station-to-station rates!
CALL: 1 - 518 - 561 - 8700.

SURPLUS WANTED - Contact our buying office at 1-514-695-0400 or send list and samples to Plattsburgh address below.

CANADIANS — Ordering from this ad is simple. Please remit in U.S. funds (or add 10% to overall total and remit in Canadian funds) - (Chargex and Mastercharge welcome). We do the paperwork and ship to you direct from the U.S.A. at low American prices. You pay duty and tax to Canadian Customs (Canadian schools are exempt). We have stores in Canada, too! Write for Canadian catalogs. We invite you to visit our Plattsburgh store - just 50 minutes from Montreal on U.S. 87!

ETCO ELECTRONICS T.M.

Rush Your Order Today .....
Shipped to you direct from our new mailorder headquarters and warehouse store!

ETCO ELECTRONICS CORP. U.S.A.
North Country Shopping Center,
Route No. 9, Plattsburgh, N.Y. 12901.

MERCHANDISE SUBJECT TO PRIOR SALE. Full remittance with each order, please. Money Order, Certified check, BANKAMERICARD, VISA, MASTERCHARGE or CHARGEX. Add 20% for UPS (or postage) and handling (we refund excess). Please try to bring your order total to $10 or more. Worldwide export orders solicited. Open account to Government agencies, schools, institutions and triple "A" rated industrial & commercial accounts. Special quotes for quantities. N.Y. state residents: add 7% sales tax.

CIRCLE 46 ON FREE INFORMATION CARD

S-100 32K STATIC MEMORY BOARD

features:
1. FULLY STATIC - usable with all DMA devices.
2. BUFFERED - with noise suppressed control inputs.
3. MODULAR - populated in 1k increments.
4. RELIABLE - single source +5V regulator
5. PROM COMPATIBLE - monitors available on request.

AVAILABLE EITHER IN COMPLETE KITS OR ALREADY ASSEMBLED UNITS WHICH HAVE BEEN FULLY TESTED AND BURNED IN.

BARE BOARD $38.00

	KIT	ASSEMBLED
8K	$270.00	$296.00
16K	$440.00	$465.00
24K	$580.00	$612.00
32K	$695.00	$740.00

PRICES QUOTED ARE FOR 300ns MEMORIES
KITS AND ASSEMBLED UNITS INCLUDE DOCUMENTATION

DEC® LSI-11 16K MEMORY BOARD

- Q-BUS—FULLY STATIC
- BUFFERED AND NOISE SUPPRESSED
- MODULAR
- PROM COMPATIBLE
- ADDRESSABLE TO 128K WORDS
- MAPPABLE IN 4K INCREMENTS

ASSEMBLED, TESTED & BURNED IN $1249.00 COMPLETE KIT $1159.00

LARGEST & FASTEST STATIC MEMORY AVAILABLE

S-100 EXPANDABLE MOTHER BOARD

- 8-SLOT EXPANDABLE BACKPLANE—in line male and female connectors enable backplanes to be plugged together, or the female may be used in place of an extender board.

QUIET—ground plane decouples all signal lines.
RELIABLE—SAE 8100 phenolic body, gold contact connectors.

COMPLETE KIT $66.00 ASSEMBLED $89.00

UNIVERSAL "U DESIGN" WIRE WRAP BOARDS

ALL BOARDS ARE G-10 GLASS EPOXY, HAVE Vcc AND GROUND PLANES. PLATED THROUGH HOLES, & GOLD PLATED EDGE CONNECTORS

No. 1 "BEST ON THE MARKET" MICRO CPU CARD WITH S-100 BUS, 3 ON BOARD REGULATORS. FITS ALL STANDARD I.C. SOCKET CONFIGURATIONS. 1700+ HOLES. SIZE 5"x10" $23.95

No. 2 UNIVERSAL BOARD FITS 86 PIN SOCKET WITH 0.10" CONTACT SPACING. MADE BY LEADING COMPUTER MANUFACTURER AS "IN HOUSE" BOARD. 1600+ HOLES. SIZE 4-7/8"x7-5/8" $7.95

S-100 EXTENDER BOARD

with connector

A MUST for trouble-shooting your Computer boards $17.95

BUILD YOUR OWN
LOGIC PROBE

24 TO 92, SMALL SIGNAL DARLINGTONS AND 24 LEDS—ALL FUNCTIONAL only $4.95

MAXI SWITCH KEYBOARDS

UNENCODED-MOUNTED ON G-10 GLASS EPOXY BOARDS-A BLACK METAL FRAME KEEPS KEY SWITCHES SECURELY IN PLACE.

No. 1
- 53 key main keyboard
- 10 auxiliary & cursor control keys
- 11 key numeric pad
- Bank of 5 auxiliary power and control, rocker arm switches-one of them lights up.

$39.95

WIRE WRAP SOCKET CONNECTOR FOR NO. 1 KEYBOARD $2.95

No. 2
- 53 key keyboard
- 1 auxiliary power/control DPDT rocker arm switch

$29.95

BEIGE METAL FRAME MOUNT FOR NO. 2 KEYBOARD $9.95

SOCKET CONNECTOR FOR NO. 2 KEYBOARD $2.95

OUR NEW ASCII KEYBOARD

HAS ON BOARD UV PROM, A MAIN KEYBOARD SECTION OF 58 KEYS, A HEX PAD OF 15 KEYS AND 16 MORE PERIPHERAL KEYS. 89 KEYS TOTAL & ASCII ENCODED for only $99.95

EDGE VIEW METER

CHARGE DISCHARGE SCALE READS -20,0,-40
MOVEMENT +60,-120mA
0.135 OHMS $2.49

POWER SUPPLY PARTS

DIODES

IN4001	50V at 1A	6c
IN4003	200V at 1A	8c
IN4007	1000V at 1A	12c
IN250	60V at 20A	95c
IN3909	50V at 30A	$1.25

BRIDGES

FAST RECOVERY AVALANCHE BRIDGE
IN4436/T 200V at 10A $4.25
FULL WAVE "MINI BRIDGE" WITH TAB TERMINALS
PR-10F 100V at 12A $3.75

5% ZENERS

IN4733A	5.1V	1w	39c
IN4739A	9.1V	1w	39c
IN4744A	15V	1w	39c

VOLTAGE REGULATORS

		PLASTIC	METAL
uA723-VARIABLE 2V to 3.7V		38c	69c
78L05 5V at 100mA	TO-92		3/98c
340T-6 6V at 1 AMP	TO-220		2/98c

PASS TRANSISTORS

MJE3055	10A	PLASTIC	89c
2N3055	10A	TO-3	95c
2N5301	30A	TO-3	$1.95

PROTECT YOURSELF, INSTALL AN ELECTRONIC CROWBAR CIRCUIT IN YOUR POWER SUPPLY.
CROWBAR SCR C220D 400v at 10A $1.75

BUILD YOUR OWN PAPER TAPE READER

1/10" CENTER STACKABLE
PHOTO TRANSISTERS
10/$9.60

TTL COMPATIBLE
REED RELAY
400 OHMS
$1.49 7/$9.75

4K STATIC RAMS

2114	650ns	600mw	$6.25
TMS-4045-4	450ns	300mw	$10.95
HM-472114	300ns	200mw	$11.95

MINIATURE
16 BUTTON PADS
4x4 MATRIX ENCODED $1.95

for that professional touch CARBIDE DRILL BITS *for* P.C. BOARD WORK
ASSORTMENT OF SIZES FROM NO. 55 TO NO. 70
5MIX/$7.49 10MIX/$12.49 100MIX/$99.00

I.C. SOCKETS

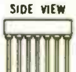
LOW PROFILE-SOLDERTAIL

	GOLD INLAID	TIN
8 PIN	10/$1.59	10/$1.35
14 PIN	10/$1.89	10/$1.49
16 PIN	10/$1.99	10/$1.59
22 PIN	5/$1.69	5/$1.49
24 PIN	5/$1.89	5/$1.59
28 PIN	5/$1.99	5/$1.69
40 PIN	4/$1.99	4/$1.69

GOLD **WIRE WRAP SOCKET STRIPS**

MAKE UNIVERSAL END AND SIDE STACKABLE WIRE WRAP BOARDS

7 PIN STRIP

TOP VIEW
SIDE VIEW


12 PIN 3 LEVEL 48c
14 PIN 2 LEVEL 48c
3 LEVEL 56c

OPTO DEVICES

PHOTO TRANSISTORS SIMILAR TO FPT 100 4/98c

PHOTO DARLINGTONS MOTOROLA 4/98c

ULTRA HIGH SPEED **PHOTO DETECTOR** 0.5ns RISE TIME $3.75

EXTREMELY SENSITIVE LIGHT ACTIVATED **SCR** triggerable by flashlight at several hundred yards $2.95

INFRA RED DETECTOR
ULTRA LOW LEVEL
PIV 7V
I on 1ma $4.95

SOLAR CELLS
2x2cm 130ma
$1.59 ea. 10/$9.90

HEWLETT-PACKARD JUMBO-RED HIGH EFFICIENCY
LED
ON BOARD STATUS INDICATOR 6/$1.00

HIGH INTENSITY RED
LED LAMP
EXTREME WIDE ANGLE VIEWING
3/98c 10/$2.45

GOLD **EDGE CARD CONNECTORS**

No. 1 SAC185/2-2 SINGLE ROW, 18 PIN CONNECTOR WITH 0.156" CONTACT SPACING 99c

No. 2 SAC22S/2-2 SINGLE ROW, 22 PIN CONNECTOR WITH 0.156" CONTACT SPACING 99c

No. 3 2VH31/ICB6 31 SOLDER LUG CONNECTOR WITH 0.125" CONTACT SPACING 99c

WIRE WRAP POST
2 LEVEL
10/98c
100/$7.40
1000/$64.00
3 LEVEL
10/$1.25
100/$8.60
1000/$72.00

HI-REL GOLD
WIRE WRAP SOCKET PIN
10/$1.70
100/$9.00
1000/$79.00
LIST PRICE 29c

OP AMPS

SINGLE	
709	10c
741	12c
DUAL	
MC1458	39c
QUAD	
LM3900	49c

DIODES

IN91	15c
IN270	12c
IN914	15c
IN3600	15c
IN4148	10c

TRANSISTORS

2N2222	12c
2N3904	12c
2N3906	12c
2N3053	49c

D/A CONVERTER
SIGNETICS NE5008
$9.95

SUB MINIATURE
CRYSTAL FILTER
455 KHZ WITH DATA
$2.95

LEDS
YELLOW, GREEN, OR AMBER
(SPECIFY COLOR)
3/88c

3-1/2 DIGIT L.C.D.'s

LIQUID CRYSTAL DISPLAY

No. 1 0.4" CHARACTER-WITH CONNECTOR $6.95

No. 2 THIS MINIATURE L.C.D. IS IDEAL FOR POCKET-SIZED INSTRUMENTS $3.95

HIGH VOLTAGE DIODES

	1500V at 1 AMP	10/$1.99
EG250	2500V at 350mA	95c
HV60EL	6KV at 25mA	1.95
SUBMINIATURE	20KV at 100mA	$2.95

NO BACK ORDERS
YOUR PARTS OR *IMMEDIATE* REFUND

WE PAY POSTAGE & HANDLING
ON U.S. ORDERS ONLY* — CALIF. RES. ADD 6% SALES TAX

MONEY BACK GUARANTEE (MOS AND LED DEVICES EXCLUDED) $20 MINIMUM

FOR UNDER 8 HOUR PROCESSING SEND MONEY ORDER, CERTIFIED OR CASHIERS CHECK.
SORRY! WE CANNOT ACCEPT PURCHASE ORDERS, COD'S, PHONE ORDERS OR CREDIT CARDS.

F. Reichert Sales
1110 E. GARVEY AVE.
W. COVINA, CA 91790

FOREIGN ORDERS

-CANADA, PUERTO RICO, U.S. POSSESSIONS ADD U.S. $3.50. ALL OTHER ADD U.S. $7.00.
-IMMEDIATE SHIPPING ON CHASE MANHATTAN, FIRST CITIZENS, CASHIERS CHECKS & CANADIAN POSTAL MONEY ORDERS.

DROP INTO ONE OF OUR LOCATIONS

LOS ANGELES
(213) 967-4611
LMN ELECTRONICS
1042 E. GARVEY AV., W. COVINA, CA (VINCENT & SAN BERDO FWY.)
TUE. to SAT. 10-8—CLOSED SUN. & MON

PORTLAND
(503) 646-4044
WIZARD OF PARTS
8225 SW CIRRUS DR. BEAVERTON, ORE. (KOLL BUS. CNTR/WASHINGTON SQUARE)

DENVER
(303) 573-5214
ELECTRONIC LOLLIPOP
5643 N. BROADWAY, DENVER, CO (I-25 & 58th AVE.)

ALL ITEMS SUBJECT TO PRIOR SALE

PRICES SUBJECT TO CHANGE

CIRCLE 84 ON FREE INFORMATION CARD

THIS SPECIAL ONE CENT SALE IS FOR MAGAZINE ADS ONLY

ONE CENT IC SALE

IN GOD WE TRUST LIBERTY 1978

POLY PAKS' PENNY REVOLUTION

THESE ONE-CENTERS ARE THE CENT-CIBLE WAY TO SHOP AND SAVE!
BUY ONE AT SALE PRICE,
GET 2ND FOR ONLY 1¢ MORE

TTL'S & OP AMPS!

Order By Cat. No.6R1981 & Type No.

Type	Each	2 for	Type	Each	2 for	Type	Each	2 for
☐ SN7400	$.19	$.20	☐ SN7465	.19	.20	☐ SN74145	1.25	1.26
☐ SN7401	.19	.20	☐ SN7470	.25	.26	☐ SN74148	1.75	1.76
☐ SN7403	.19	.20	☐ SN7471	.25	.26	☐ SN74150	.99	1.00
☐ SN7404	.25	.26	☐ SN7472	.25	.26	☐ SN74151	.99	1.00
☐ SN7405	.19	.20	☐ SN7473	.55	.56	☐ SN74153	.99	1.00
☐ SN7406	.19	.20	☐ SN7474	.29	.30	☐ SN74154	1.75	1.76
☐ SN7408	.21	.22	☐ SN7475	.79	.80	☐ SN74155	.79	.80
☐ SN7410	.19	.20	☐ SN7476	.59	.60	☐ SN74156	.69	.70
☐ SN7413	.39	.40	☐ SN7478	.59	.60	☐ SN74157	.99	1.00
☐ SN7414	.65	.66	☐ SN7480	.29	.30	☐ SN74158	.99	1.00
☐ SN7416	.29	.30	☐ SN7482	.39	.40	☐ SN74160	1.25	1.26
☐ SN7420	.19	.20	☐ SN7483	.99	1.00	☐ SN74161	1.25	1.26
☐ SN7423	.29	.30	☐ SN7485	1.49	1.50	☐ SN74163	1.19	1.20
☐ SN7426	.25	.26	☐ SN7486	.39	.40	☐ SN74164	.99	1.00
☐ SN7427	.25	.26	☐ SN7488	1.95	1.96	☐ SN74165	1.25	1.26
☐ SN7430	.29	.30	☐ SN7490	.69	.70	☐ SN74166	1.25	1.26
☐ SN7432	.25	.26	☐ SN7491	.79	.80	☐ SN74173	1.25	1.26
☐ SN7437	.25	.26	☐ SN7492	.45	.46	☐ SN74174	1.49	1.50
☐ SN7438	.29	.30	☐ SN7493	.49	.50	☐ SN74175	.99	1.00
☐ SN7440	.19	.20	☐ SN7494	.69	.70	☐ SN74177	.79	.80
☐ SN7442	.69	.70	☐ SN7495	.69	.70	☐ SN74179	1.49	1.50
☐ SN7443	.69	.70	☐ SN7496	.69	.70	☐ SN74180	.49	.50
☐ SN7444	.65	.66	☐ SN7498	.69	.70	☐ SN74182	.69	.70
☐ SN7445	.99	1.00	☐ SN74100	1.49	1.50	☐ SN74190	1.49	1.50
☐ SN7446	1.35	1.36	☐ SN74107	.39	.40	☐ SN74191	1.75	1.76
☐ SN7447	1.25	1.26	☐ SN74112	.25	.26	☐ SN74192	.85	.86
☐ SN7448	1.35	1.36	☐ SN74113	.19	.20	☐ SN74193	.85	.86
☐ SN7450	.19	.20	☐ SN74114	.25	.26	☐ SN74194	1.25	1.26
☐ SN7451	.19	.20	☐ SN74121	.49	.50	☐ SN74195	.49	.50
☐ SN7453	.19	.20	☐ SN74123	.69	.70	☐ SN74197	.75	.76
☐ SN7454	.19	.20	☐ SN74125	.59	.60	☐ SN74199	1.75	1.76
☐ SN7455	.19	.20	☐ SN74126	.39	.40	☐ SN74200	5.50	5.51
☐ SN7460	.19	.20	☐ SN74132	1.25	1.26	☐ SN74251	1.75	1.76
☐ SN7462	.19	.20	☐ SN74140	.99	1.00	☐ SN74284	4.50	4.51
☐ SN7464	.19	.20	☐ SN74141	1.49	1.50	☐ SN74285	4.25	4.26

POP-AMPS AT "CENT-CIBLE" PRICES

Case code: T=TO-220 Power Tab; V=Mini dip; K=TO-3; H=TO-5; N=DIP.

Type	Each	2 for	Type	Each	2 for	Type	Each	2 for
☐ LM300H	$.49	$.50	☐ LM370N-H	1.29	1.30	☐ LM741V-H	.29	.30
☐ LM301H-V	.45	.46	☐ LM374H	1.79	1.80	☐ LM1304	.79	.80
☐ LM308V-H	.79	.80	☐ LM376V	.29	.30	☐ LM1310	.99	1.00
☐ LM309K	1.29	1.30	☐ LM377N	2.25	2.26	☐ LM1312	1.99	2.00
☐ LM311H-V	.79	.80	☐ LM381N	1.69	1.70	☐ LM1414V	.79	.80
☐ LM318V	1.29	1.30	☐ LM531H	1.49	1.50	☐ LM1458V	.69	.70
☐ LM320H-5, 12, 15	1.29	1.30	☐ LM532H-N	.29	.30	☐ LM1800N	.99	1.00
☐ LM320K-15	1.29	1.30	☐ LM555V	.75	.76	☐ LM3028H	.65	.66
☐ LM320T-6, 5	1.29	1.30	☐ LM558V	.79	.80	☐ LM3900N	.49	.50
☐ LM322N	1.19	1.20	☐ LM561N	1.00	1.01	☐ LM3909V	1.75	1.76
☐ LM324N	1.75	1.76	☐ LM565N	.99	1.00	☐ LM4195	1.95	1.96
☐ LM339N	1.09	1.10	☐ LM703H	.49	.50	☐ LM4250	1.19	1.20
☐ LM340K-5, 6, 8, 12,15, 18,	1.29	1.30	☐ LM704H	.29	.30	☐ LM75451	.39	.40
☐ LM340T-5, 6, 8, 12, 15, 18, 24	1.29	1.30	☐ LM709N-H	.25	.26	☐ LM75453	.39	.40
☐ LM350N	.59	.60	☐ LM710N	.39	.40	☐ LM75491	.79	.80
			☐ LM733N	.79	.80	☐ LM75492	.79	.80
			☐ LM739N	.89	.90	☐ LM75494	.59	.60

YOU GET 120-DAY MONEY BACK GUARANTEE

HI-POWER STUD RECTIFIERS

Cat. No. 6R3567 - 150 amp

V.		1¢	Sale
☐ 50	$ 2.95	2 for	$ 2.96
☐ 100	3.95	2 for	3.96
☐ 200	4.95	2 for	4.96
☐ 400	7.50	2 for	7.51
☐ 600	9.00	2 for	9.01
☐ 800	10.50	2 for	10.51
☐ 1000	12.50	2 for	12.51

Cat. No. 6R87U68S - 250 amp

V.	Each	1¢	SALE
☐ 50	$ 4.95	2 for	$ 4.96
☐ 100	6.50	2 for	6.51
☐ 200	7.50	2 for	7.51
☐ 400	8.50	2 for	8.51
☐ 600	10.50	2 for	10.51
☐ 800	13.00	2 for	13.01
☐ 1000	14.50	2 for	14.51

Order by Cat. No. & Voltage

10 AMP - POWER TABS! SCRS! TRIACS! QUADRACS!

Order by Cat. No. and voltage!
#6R1448 - TRIACS #6R1730 - SCR
#6R1590 - QUADRACS

PRV	Sale	2 for
☐ 50	$ .55	$ .56
☐ 100	.69	.70
☐ 200	.88	.89
☐ 400	1.19	1.20
☐ 600	1.59	1.60

25 AMP BRIDGE RECTIFIERS

Order by Cat. No. 6R2273 & voltage

V	Each	1¢	SALE
☐ 50	$1.95	2 for	$1.96
☐ 100	1.49	2 for	1.50
☐ 200	1.69	2 for	1.70
☐ 400	1.99	2 for	2.00
☐ 600	2.25	2 for	2.26
☐ 800	2.50	2 for	2.51

25 AMP POWER STUD SCRS, TRIACS

Cat. No. 6R-14A147 (SCRs)
Cat. No. 6R-60B86A (Triacs)

V.	Each	1¢	SALE
☐ 50	$ .95	2 for	$ .96
☐ 100	1.25	2 for	1.26
☐ 200	1.95	2 for	1.96
☐ 400	2.50	2 for	2.51
☐ 600	2.95	2 for	2.96

1N4000 Epoxy Rectifiers

• Miniature! • 1.5 Amp! Order by Cat. No. and Type No.

Cat. No.	Type No.	PIV	Price	1¢ MORE!
☐ 6R2377	1N4001	50	10 for $.65	20 for .66
☐ 6R2378	1N4002	100	10 for .75	20 for .76
☐ 6R2379	1N4003	200	10 for .85	20 for .86
☐ 6R2380	1N4004	400	10 for .99	20 for 1.00
☐ 6R2381	1N4005	600	10 for 1.29	20 for 1.30
☐ 6R2382	1N4006	800	10 for 1.39	20 for 1.40
☐ 6R2383	1N4007	1000	10 for 1.49	20 for 1.50

1¢ SALE

1.5 AMP BULLET RECTIFIERS!

Order by Cat. No. 6R60B84 and voltage

☐ 50V	10 for $.59	20 for $.60
☐ 100V	10 for .69	20 for .70
☐ 200V	10 for .79	20 for .80
☐ 400V	10 for .89	20 for .90
☐ 600V	10 for 1.09	20 for 1.10
☐ 800V	10 for 1.19	20 for 1.20

MICRO MINI TOGGLE SWITCHES!

3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

Cat. No	Type	Sale	2 for
☐ 6R3936	SPDT	$1.29	$1.30
☐ 6R5085	SPDT*	1.39	1.40
☐ 6R4037	DPDT	1.45	1.46
☐ 6R5087	4PDT*	1.95	1.96

* Center OFF

BUY 1 AT OUR SALE PRICE
GET 2 FOR 1¢ MORE

LYTIC KLINIC Electrolytic capacitors

Order by Cat. No. 6R3269 and value

UF	V	Style	Sale	1¢ SALE
☐ 10	15	P.C.	10 for $1.00	20 for $1.01
☐ 50	15	P.C.	8 for 1.00	16 for 1.01
☐ 15	25	P.C.	8 for 1.00	16 for 1.01
☐ 50	25	P.C.	6 for 1.00	12 for 1.01
☐ 20	15	Axial	10 for 1.00	20 for 1.01
☐ 20	15	P.C.	10 for 1.00	20 for 1.01

6 AMP CARTWHEEL RECTIFIERS

Cat, 6R3584 *AXIAL LEADS

V.	Each	1¢	SALE
☐ 50	$ .36	2 for	$ .37
☐ 100	.45	2 for	.46
☐ 200	.61	2 for	.62
☐ 400	.79	2 for	.80
☐ 600	.90	2 for	.91
☐ 800	1.19	2 for	1.20
☐ 1000	1.39	2 for	1.40

LEDS!

YOUR CHOICE 5 for $1.00
1¢ SALE 10 for $1.01

Order by Cat. No.
☐ #6R2135 JUMBO RED LEDS
☐ #6R2137 MICRO RED LEDS
☐ #6R2790 JUMBO RED CLEAR LEDS
☐ #6R2792 JUMBO TAPERED AMBER
☐ #6R2140 MICRO GREEN LEDS

ZENERS!

Order by Cat. No. 6R5210 & voltage & wattage!

1 Watt	Sale	1¢ SALE
☐ 7.5V	5 for $1.	10 for $1.01
☐ 8.2V	5 for 1.	10 for 1.01
☐ 9.1V	5 for 1.	10 for 1.01
☐ 11.V	5 for 1.	10 for 1.01
☐ 12.V	5 for 1.	10 for 1.01
☐ 15.V	5 for 1.	10 for 1.01

5 WATTS	Sale	1¢ SALE
☐ 3.3V	3 for $1.	6 for $1.01
☐ 6. V	3 for 1.	6 for 1.01
☐ 6.2V	3 for 1.	6 for 1.01
☐ 8.2V	3 for 1.	6 for 1.01
☐ 9.1V	3 for 1.	6 for 1.01
☐ 12. V	3 for 1.	6 for 1.01
☐ 15. V	3 for 1.	6 for 1.01
☐ 18. V	3 for 1.	6 for 1.01
☐ 24. V	3 for 1.	6 for 1.01
☐ 30. V	3 for 1.	6 for 1.01

THIS NEW LIST OF "ONE-CENTERS" HELPS FIGHT INFLATION!

Quan. Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 1—WOODGRAIN CABINET, 3½ x 10 x ¼" deep, spkrs, alarms. (#6R5201)	$1.49	2 for $1.50
☐ 2—LCD THERMAL INDICATORS, 88-108°F, 7x1", flexible (#6R5195)	1.00	4 for 1.01
☐ 1—JOYSTICK, four 100K pots, with knob (#6R3808A)	4.95	2 for 4.96
☐ 1—EECO THUMBWHEEL SWITCH, BCD, 0-7 (#6R2870A)	1.49	2 for 1.50
☐ 1—8-TRACK TAPE TRANSPORT, with preamp (#6R3010)	9.95	2 for 9.96
☐ 1—PLESSEY TV SIDEBAND FILTER, for chan. 3 or 4 (#6R3975)	1.95	2 for 1.96
☐ 5—TRANSITORS, 2N3904 equal, NPN, switching (#6R5209)	1.00	10 for 1.01
☐ 1—METER, 50uA, 1½" square, 0-20db (#6R3705)	1.19	2 for 1.20
☐ 1—SPST RELAY, norm. open 12-24 VDC, 1250 ohms, dip style (#6R5175)	1.00	2 for 1.01
☐ 1—VEEDER ROOT COUNTER, 000-999, resettable, panel mt. (#6R5081)	1.49	2 for 1.50
☐ 2—DUAL GATE MOSFET, sim. to 3N200, 3N187, for RF & Mixer (#6R5101)	1.00	4 for 1.01
☐ 1—8-TRACK TAPE HEAD, with plug' n' cord (#6R3468)	2.50	2 for 2.51
☐ 10 CALCULATOR KEYBOAROS, 20 keys and more (6R3524)	$2.00	20 for $2.01
☐ 15 SLIDE VOLUME CONTROLS, asstd values (6R3057)	2.00	30 for 2.01
☐ 10 CRYSTALS, may include CB, Ham & more (6R3250)	2.00	20 for 2.01
☐ 150 MOLEX IC SOCKETS, on a strip, cut to length (6R3144)	2.00	300 for 2.01
☐ 100 TERMINAL STRIPS, from 2 lugs up (6R3136)	2.00	200 for 2.01
☐ 30 NE-2NEON LAMPS, all 100% good (6R2613)	2.00	60 for 2.01
☐ 40-ft. SHIELDED CABLE, 1 cond, mikes, phonos, (#6R3577)	2.00	80 ft. for 2.01
☐ 50 TRANSISTOR ELECTROS, asstd values, styles (6R2747)	2.00	100 for 2.01
☐ 3 SOUND TRIGGERS, sound triggers scr w/amp (6R3625)	2.00	6 for 2.01
☐ 15 6V TEST INDICATORS, leads, grain-o-wheat (6R3526)	2.00	30 for 2.01
☐ 100 CAPACITOR SPECIAL, discs, mylar, lytics, more (6R2738)	2.00	200 for 2.10
☐ 30 MINI TRIMPOTS, to 1 meg, 1 turn, ¼W (6R3345)	2.00	60 for 2.01
☐ 10 VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (6R3330)	2.00	20 for 2.01
☐ 30 PANEL SWITCHES, slides, rotaries, mod, etc (6R3268)	2.00	60 for 2.01
☐ 200 RESISTOR SPECIAL, ¼ to 1W, carbon, metal (6R3054)	2.00	400 for 2.01
☐ 200 HALF WATTERS, resistors, carbon, metal (6R3046)	2.00	400 for 2.01
☐ 100 NATIONAL IC BONANZA, linears, 7400s ROMS (6R2860)	2.00	200 for 2.01
☐ 40 HOBBY LEDS, asstd types, mostly useable (6R2859)	2.00	80 for 2.01
☐ 15 LM340T VOLTAGE REGULATAORS, 5 to 24V, TO-220 (6R2635)	2.00	30 for 2.01
☐ 100 TWO WATTERS, resistors, carbon-metal marked (6R2735)	2.00	200 for 2.01
☐ 100 POLYSTYRENE CAPS, asstd values, voltage, hi-Q (6R2729)	2.00	200 for 2.01
☐ 50 THERMISTORS, resistors that change with temp (6R4089)	2.00	100 for 2.01
☐ 20 BRIDGES, untested, 2, 4, 6, 10, amp, full wave (6R4022)	2.00	40 for 2.01
☐ 25 LAMP'N'SOCKET SETS, micro, 1.5V, T2 (6R3957)	2.00	50 for 2.01
☐ 15 MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (6R3619)	2.00	30 for 2.01
☐ 150 QUARTER WATTERS, resistors, metal film, marked (6R3413)	2.00	300 for 2.01
☐ 100 PLASTIC TRANSISTORS, untested, RO-92 (6R2604)	2.00	200 for 2.01
☐ 200 PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (6R2608)	2.00	400 for 2.01
☐ 200 PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (6R2428)	2.00	400 for 2.01
☐ 60 DIPPED MYLARS, shiny finish, asst values (6R2597)	2.00	120 for 2.01
☐ 30 VOLUME CONTROLS, audio, linear, asstd values (6R2421)	2.00	60 for 2.01
☐ 5 7.5 VOLT ZENER DIODES, 1 watt (6R5187)	1.00	10 for 1.01
☐ 5 9.1 VOLT ZENER DIODES, 1 watt (6R5188)	1.00	10 for 1.01
☐ 30-ft. WIRE WRAP WIRE, 30 gage, for ICs, terminals (#6R3803)	1.00	60-ft for 1.01
☐ 5 — TANTALUM ELECTRO CAPACITORS, 2.2uF, 25V (#6R5189)	1.00	10 for 1.01
☐ 1 ALARM CLOCK CHIP, MM5316, 4-digits (6R1759)	2.95	2 for 2.96
☐ 5 PANCAKE PHOTOCELLS, 600 to 15K ohms (6R2939)	1.00	10 for 1.01
☐ 1 100KHZ MARKER CRYSTALS, approx for marker gen. (6R3896)	1.95	2 for 1.96
☐ 1 MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (6R3987)	3.50	2 for 3.51
☐ 1 48-PIN EOGE CONNECTOR, .156" spacing (6R3963)	1.95	2 for 1.96
☐ 1 JOYSTICK, two 10K pots, for computers, TV games (6R5037)	2.95	2 for 2.96
☐ 1 CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (6R3898)	4.95	2 for 4.96

7-SEGMENT READOUTS

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY. (#6R3960)	3 for $1.19	6 for $1.20
☐ 1 – GE FLUORESCENT "NIXIES", blue, 0.6" char, 9-pin tube (#6R3684)	1 for 1.00	2 for 1.01
☐ 2 — SPERRY FLAT NIXIES, orange, .3" dual digit (#6R5014)	2 for 1.19	4 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#6R5015)	2 for 1.19	4 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red. com cath. (#6R3338)	6 for 1.00	12 for 1.01
☐ 2 — MAN-4 READOUTS, bubble, red, com. anode, .19" (#6R1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#6R2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathod, red (#6R5190)	1 for 1.95	2 for 1.96
☐ FND-503, .5" red, com cathode, 7-seg. (#6R2949)	1.50	2 for 1.51

SPEAKERS!

	Each	2 for
☐ 6" TWIN CONE SPEAKER, hi-fi, for car'n'home (#6R5059)	$4.50	$4.51
☐ 2¼ × 5" OVAL SPEAKER, 8 ohms (#6R2553)	1.49	1.50
☐ 2 × 6" OVAL SPEAKER, 8 ohms (#6R3454)	1.49	1.50

MICROPHONES!

	Each	2 for
☐ CONDENSOR MIKES, sensitive, 500 ohms, 1½V (#6R3178)	$4.95	$4.96
☐ COMMUNICATIONS MIKE, 500 ohms, CB-HAM (#6R4074)	4.50	4.51
☐ NOISE CANCELLING MIKE, Ham-CB, 500 ohms (#6R3902)	6.95	6.96

RELAYS!

	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#6R4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#6R4094)	1.49	1.50
☐ SPDT 12V SENSITIVE, 2000 ohm coil (#6R3044A)	1.95	1.96
☐ 1 — SPST 24V REED RELAY, norm open, dip style, 1250 ohms (#6R5175)	1.49	1.50

AMPLIFIERS!

	Each	2 for
☐ 8 WATTS ON A BOARD, with built-in preamp (#6R5040)	$5.95	$5.96
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#6R5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#6R1522)	1.50	1.51

TRANSFORMERS!

	Each	2 for
☐ 12V TRANSFORMER, 300ma, pc leads, 110pri. (#6R3412)	$1.49	$1.51
☐ 12V TRANSFORMER, 1A, 110/220pri, open frame (#6R4040)	2.95	2.96
☐ 24VCT TRANSFORMER, 300ma, open frame, 110pri. (#6R3323)	1.95	1.96
☐ 2.9V NI-CAD CHARGER PAK, plug-in, 125ma, 125 VAC pri (#6R4098)	1.95	1.96

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#6R3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#6R3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#6R3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#6R2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#6R1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#6R1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#6R3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#6R3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#6R3887)	2 for 1.19	4 for 1.20
☐ 8-PIN TO-5 (#6R1307)	4 for 1.19	8 for 1.20

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 6R2447 & voltage

PRV	Sale	2 for
☐ 50	$1.29	$1.30
☐ 100	1.49	1.50
☐ 200	1.69	1.70
☐ 400	1.99	2.00
☐ 600	2.25	2.26
☐ 800	2.50	2.51

SPECTROL "SKINNY-TRIMS"

3/8" square, screwdriver shaft, 2% tol. 1/4 watt, Cermet PC leads. Order by Cat. No. and value. **2 for $1**

Ohms
☐ 10**
☐ 50**
☐ 100** ☐ 5K*
☐ 200** ☐ 10K*
☐ 500* ☐ 20K**
☐ 1K* ☐ 50K**
☐ 2K** ☐ 100K**

☐ No. 6R3863 25 turn upright, type 64
☐ No. 6R3866 single turn, flat, type 63

*Available in all types
**Available in Cat. No. 3863 only.

RIBBON CABLE!

Order by Cat. No. 6R3939 and Conductors

Cond.	Sale	1¢ Sale
☐ 20	7-ft. $1.98	14-ft. $1.99
☐ 26	4-ft. 1.98	8-ft. 1.99
☐ 34	3-ft. 1.98	6-ft. 1.99
☐ 40	3-ft. 1.98	6-ft. 1.99

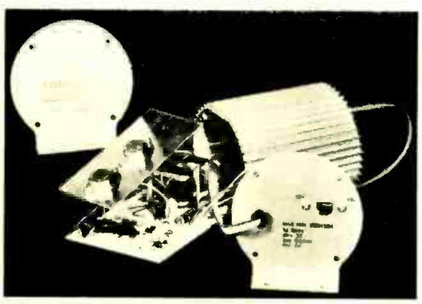
WRITE FOR POLY PAKS CATALOG FEATURING BEST BARGAINS IN ELECTRONICS — FREE!

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.

MINIMUM ORDER — $6.00

C.O.D.'s MAY BE PHONED

POLY PAKS
P.O. BOX 942 -R6
LYNNFIELD, MA.
ZIP 01940



ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

MOVING?

Don't miss a single copy of **Radio-Electronics.** Give us:

Six weeks' notice

Your old address and zip code

Your new address and zip code

ATTACH LABEL HERE

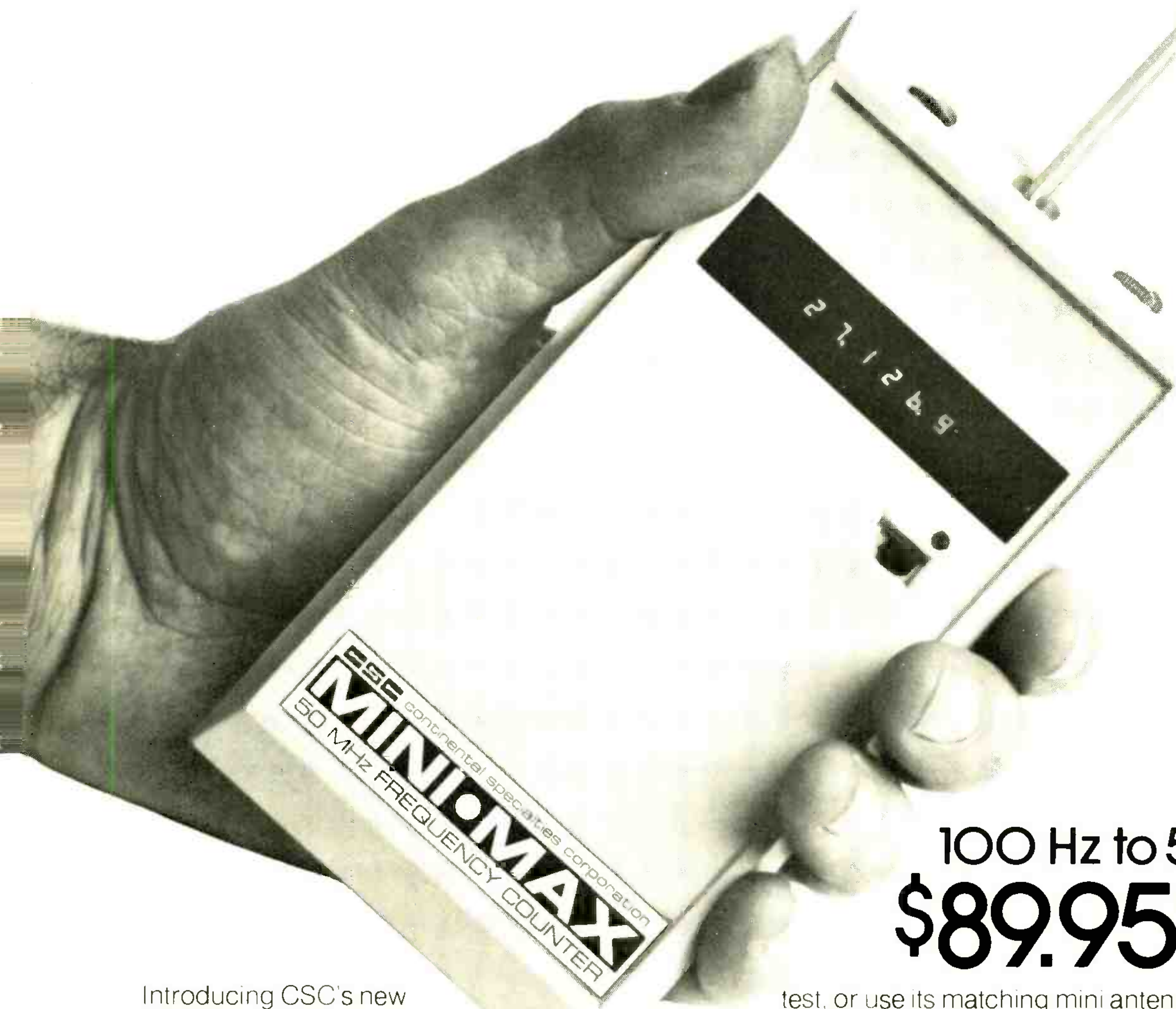
name (please print)

address

city state zip code

Mail to: Radio-Electronics
SUBSCRIPTION DEPT., P.O. BOX 2520, BOULDER, COLO. 80322

FREQ OUT. FOR LESS.



100 Hz to 50 MHz.

$89.95*

Introducing CSC's new Mini-Max. It brings down the cost of counting up the frequency for CB-ers, hams, computer enthusiasts, audiophiles... just about any engineer, technician or hobbyist will find it indispensable. It's "mini"-sized, too – a pocketable 3 x 6 x 1½ inches.

But when it comes to performance, Mini-Max means maximum value. Measuring signals as low as 30 mV from 100 Hz to a *guaranteed* 50 MHz, with ± 3 ppm timebase accuracy and better than 0.2 ppm/°C stability from 0 to 50°C. *Completely automatically.* Advanced LSI circuitry with a crystal controlled timebase provides precise frequency readings on a bright, six-digit LED display, with automatic KHz/MHz indications. Mini-Max is versatile, too. You can connect it directly to the circuit under test, or use its matching mini antenna for easy RF checking. Either way, the input is protected against overload to 50V (100V below 1 KHz).

Mini-Max is as inexpensive to use as it is to own. An ordinary 9 volt alkaline battery gives up to 8 hours of intermittent operation, and you have the flexibility of a battery eliminator for AC operation. For increased versatility, there's a complete line of accessories, including standard clip-lead cable and mini antenna – eliminator and carrying case are optional.

CSC's new, all-American made Mini-Max is everything you need for highly-accurate checking of frequencies up to 50 MHz. At a price that will Freq you out. *Order today.* Call 203-624-3103, 9 a.m. – 5 p.m. Eastern Standard Time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside U.S.A.

CONTINENTAL SPECIALTIES CORPORATION

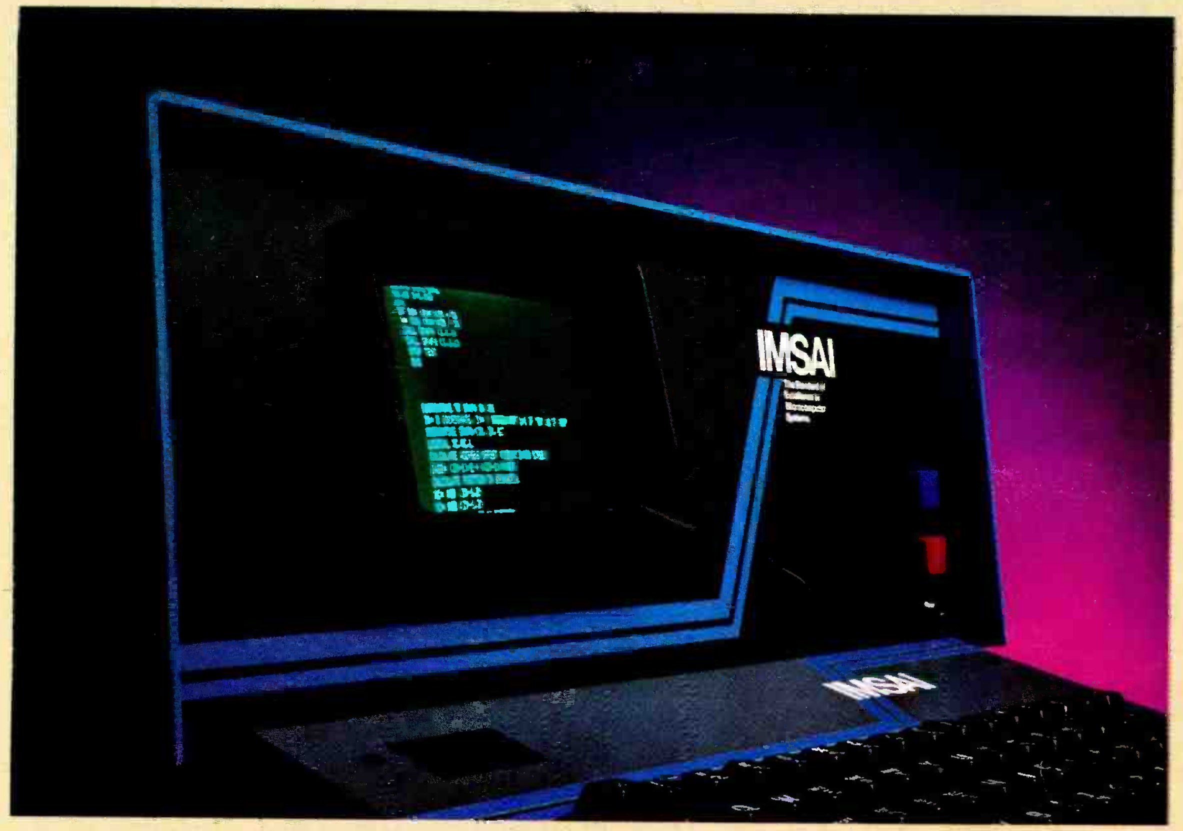
CSC

*Manufacturer's suggested retail price

70 Fulton Terrace, Box 1942, New Haven, CT 06509, 203-624-3103 TWX 710-465-1227
WEST COAST: 351 California St., San Francisco, CA 94104, 415-421-8872 TWX 910-372-7992
GREAT BRITAIN: CSC UK LTD., Spur Road, North Feltham Trading Estate, Feltham, Middlesex, England, 01-890-0782 Int'l Telex: 851-8
CANADA: Len Finkler Ltd., Ontario

CIRCLE 11 ON FREE INFORMATION CARD

Price/Performance no one else has put together.



IMSAI Introduces the PCS-80/30 Integrated Video Computer

- ☐ 3 mHz microcomputer
- ☐ 3K ROM monitor
- ☐ 2K RAM
- ☐ 8 expansion slots
- ☐ 14 mHz integrated intelligent CRT (24 x 80)
- ☐ Intelligent Keyboard
- ☐ Parallel interface
- ☐ 2 serial interfaces
- ☐ Graphic and edit CRT functions
- ☐ 28 amp power supply
- ☐ All for **$1499*** assembled and tested.

Software:

ASSEMBLER, DOS, TTY and ACR BASIC, Commercial/Scientific BASIC, FORTRAN IV and more.

Men ry Options:

d 64K RAM memory boards.

FORMATION CARD

Peripherals:

Printers, floppies—mix and match; standard, mini and high performance double density floppy disks on the same system (an industry first), ½" magnetic tape drive, CRT and TV monitors.

Send today for your copy of the 250-page IMSAI PCS-80/30 User Manual. Price $5.00. The cost of the manual may be applied towards your purchase of a PCS-80/30 Integrated Video Computer. Use the coupon provided.

Gentlemen:
Send me the IMSAI PCS-80/30 User Manual, price $5.00. I understand that the $5.00 may be applied towards the purchase of a PCS-80/30 Video computer System.

Check/Money Order enclosed. Amt. $ ____________
Charge my ☐ BAC ☐ M/C

____________ Exp. Date: ____________

Sig. ____________

Name ____________

Address ____________

City ____________

State/Zip ____________

IMSAI 14860 Wicks Blvd. San Leandro, CA 94577

IMSAI®

The Standard of Excellence in Microcomputer Systems

IMSAI Manufacturing Corporation
14860 Wicks Blvd. San Leandro, CA 94577
(415) 483-2093 TWX 910-366 7287

*U.S. domestic price only. PCS-80/30 kit available. Other PCS-80 kits start at $699. Prices and specifications subject to change without notice.