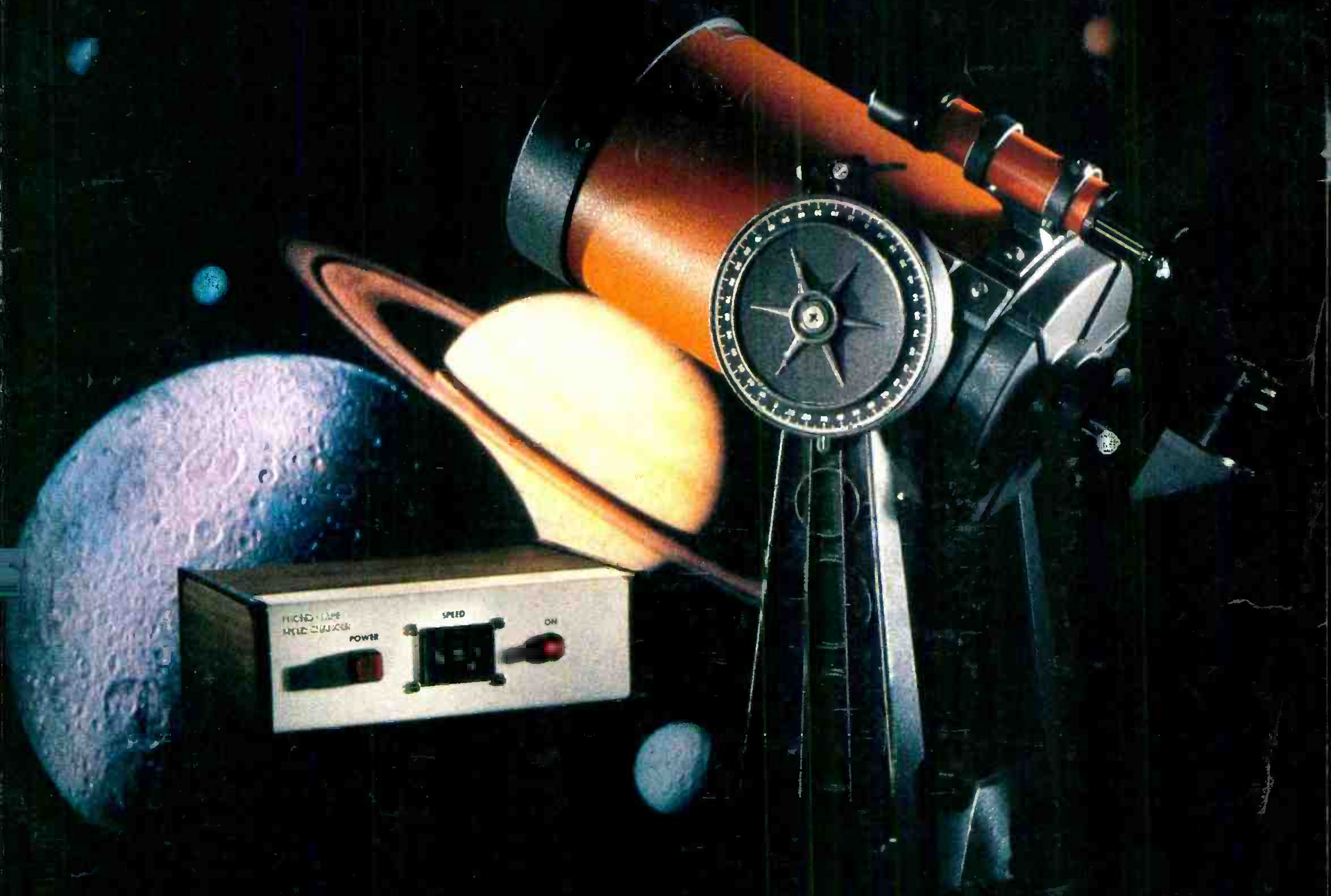
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

APRIL 1981/95¢

An Oscilloscope Buyer's Guide
Expanding Microcomputer Memories
Build a Rumble-Cancelling Circuit

Speed Control for Synchronous Motors



Tested in this Issue:
APF Imagination Machine
Tektronix T922 Dual-Trace Scope

0 04 14024 14278

www.americanradiohistory.com

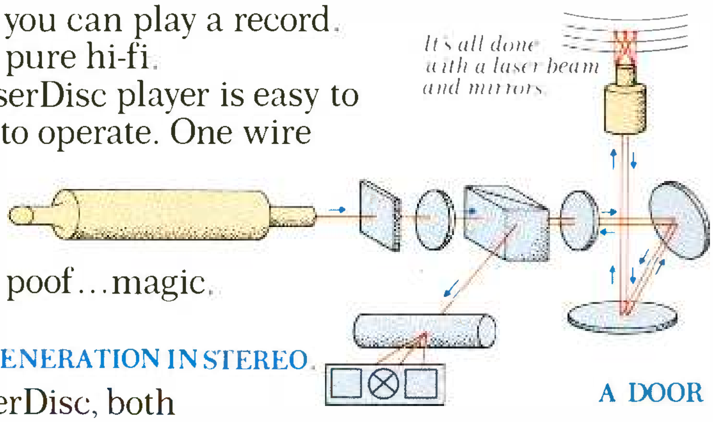
In hi-fi, up until now, sound was the whole picture.

Since the very beginning, hi-fi has appealed to one sense: your hearing. The rest was up to your imagination.

Now Pioneer brings you closer to the reality of performance than you've ever experienced at home: LaserDisc.™

Now you can hear and *see* a concert or a movie as easily as you can play a record. With sound that's pure hi-fi.

The Pioneer LaserDisc player is easy to hook up and easy to operate. One wire to your TV; two to your hi-fi. Then just place a disc on the player, and poof...magic.


It's all done with a laser beam and mirrors.

THE SOUND: A NEW GENERATION IN STEREO.

With Pioneer LaserDisc, both channels are completely discrete from each other. It's stereo in its truest sense. And since the disc is read by a light beam rather than a video head or needle, with normal use, it doesn't wear out from play. In addition, unlike conventional records, you can handle the LaserDisc as much as you wish. Even minor surface scratches won't effect the superb audio and video fidelity. You can enjoy the disc forever.


Concerts like Paul Simon.


New movies and classics like Dracula.


Sports like NFL Football.

THE PICTURE: BETTER THAN HOME VIDEO TAPE.

The Pioneer LaserDisc player offers a picture with actually 40% better resolution than the picture delivered by a home video tape player. A picture of the highest broadcast quality. For the first time on your television set, video fidelity is matched by audio fidelity.

TRULY PERSONAL HOME ENTERTAINMENT.

Try to imagine what it would be like to sit down in front of your television and see whatever program you wished whenever you wished to see it. With a sense of performance, a feeling of "being there" never before experienced at home: Movies, concerts, sports.

Pioneer Artists and MCA/Discovision discs like Paul Simon, Liza Minelli, Loretta Lynn, Jaws, Animal House, The Blues Brothers, the NFL.

A DOOR TO EDUCATION.

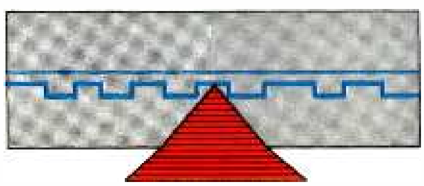
With standard-play discs, you can create your own instant sports replays at home, you can go in fast motion, slow motion, one frame at a time, even stop motion indefinitely. But LaserDisc offers something far more revolutionary. Everyone of the up to 108,000 frames on the disc is coded. And a built in micro-computer lets you access any individual frame at will. This means you can go to your favorite scene in a movie or song in a concert in seconds.

But that's merely the beginning. On one disc you can stroll through the National Gallery and study art masterpieces one masterpiece at a time.

And since play can't wear out the disc, they can be studied forever.

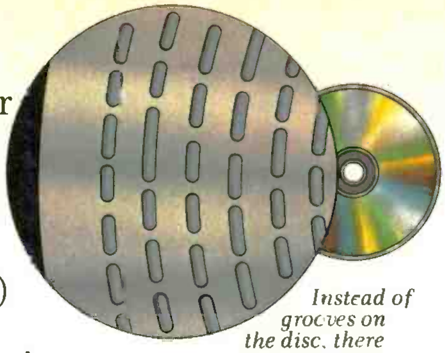
THE FUTURE IS IN REACH.

One of the most surprising parts of this new technology is that it's affordable.


A beam of light instead of a needle.

www.americanradiohistory.com

The Pioneer LaserDisc player has a suggested retail price of $749.*(Optional remote control just $50* more.) As surprising, a full length movie on LaserDisc can even cost less than taking your family out to the movies. And about half or a third of the price of that same movie on video tape.



Instead of grooves on the disc, there are microscopic pits.

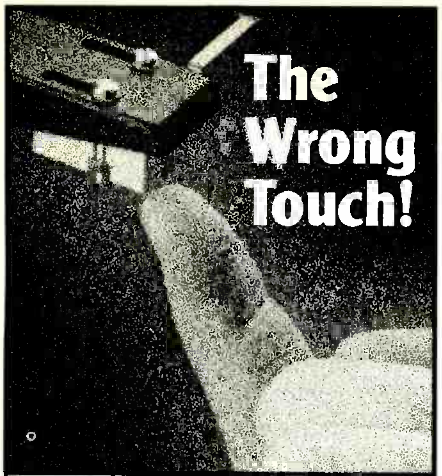
YOU WON'T BELIEVE IT UNTIL YOU SEE IT.

Irrespective of how much we say here, the true magic of LaserDisc can only be appreciated in person. So we've arranged for a personal demonstration in your area. Just call us at **800-621-5199,**** and we'll give you the names of the stores nearest you. Go by all means. You won't believe your eyes. Or your ears.

*Suggested retail price. Actual price set by dealer. **(In Illinois 800-972-5855).

Simulated TV picture from The Blues Brothers.

www.americanradiohistory



The Right Touch Is a Discwasher SC-2 Stylus Care System.

The SC-2 is a three-function system which safely removes microscopic stylus contaminations that cause record abrasion.

SC-2 Fluid enhances and speeds cleaning and yet protects diamond adhesives, cartridge mounting polymers and fine-metal cantilevers against the corrosive effects of many other "cleaners".

The Discwasher SC-2 System. Stylus care with which your cartridge and records can live.

discwasher®
PRODUCTS TO CARE FOR YOUR MUSIC

Discwasher, Inc.
1407 N. Providence Rd.
Columbia, MO 65201

CIRCLE NO. 11 ON FREE INFORMATION CARD

APRIL 1981 VOLUME 19. NUMBER 4

Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

COVER: Composite Photo by Fred Burrell; Saturn Photo Courtesy NASA.
Celestron C-5 Telescope Courtesy Roger W. Tuthill, Inc.

COPYRIGHT © 1981 BY ZIFF-DAVIS PUBLISHING COMPANY. All rights reserved. Popular Electronics (ISSN 0032-4485) April 1981, Volume 19, Number 4. Published monthly by Ziff-Davis Publishing Co., at One Park Ave., New York, NY 10016. Philip B. Korsant, President; Selwyn Taubman, Treasurer; Bertram A. Abrams, Secretary. One year subscription rate for U.S. and Possessions, $14.00; Canada, $17.00; all other countries, $19.00 (cash orders only, payable in U.S. currency). Controlled circulation Postage Paid at Salem, IL 62881. Authorized as second class mail by the Post Office Dept., Ottawa, Canada, and for payment of postage in cash. POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature. Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, and Tape Recording & Buying Guide. **Forms 3579 and all Subscription Correspondence:** POPULAR ELECTRONICS, Circulation Dept. P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address, enclosing, if possible, an address label from a recent issue. **Permissions.** Material in this publication may not be reproduced in any form without permission. Requests for permission should be directed to John Babcock, Rights and Permissions, Ziff-Davis Publishing Co., One Park Ave., New York, NY 10016.

www.americanradiohistory.com

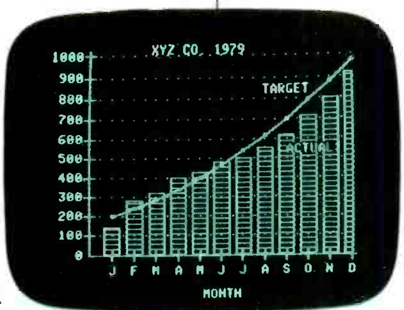
Three good reasons why professionals pick Apples.

1 In research

Apple personal computer systems help you collect, store and analyze data as fast as you can load a disk and execute a program. Because more than 100 companies offer software for Apple, you have the largest program library for manipulating your data in the personal computing world. Need special programs? Use any of Apple's development languages — BASIC, FORTRAN, Pascal.

2 In engineering

Apple personal computer systems let you define models, make trade-offs and refine prototypes. Want to study cause and effect of several variables? Apple computes new results instantly and displays them in colorful, easy-to-read graphs, charts or plots on a video monitor.



3 In production management

Apple personal computer systems make it easy to gather data, analyze productivity, measure yields and facilitate all phases of production control. Want to speed up repetitive tasks? Rely on Apple's word processing capabilities to write, edit and print your reports.

Apples grow with you.

Whichever system you pick, Apple never locks you into a single configuration. You can use up to four or eight I/O accessory expansion slots to add an IEEE bus, Apple's Silentype™ printer, a modem or a graphics tablet. Add memory up to 64K bytes or 128K bytes. Add up to four or six 5¼" disk drives without adding any overhead.

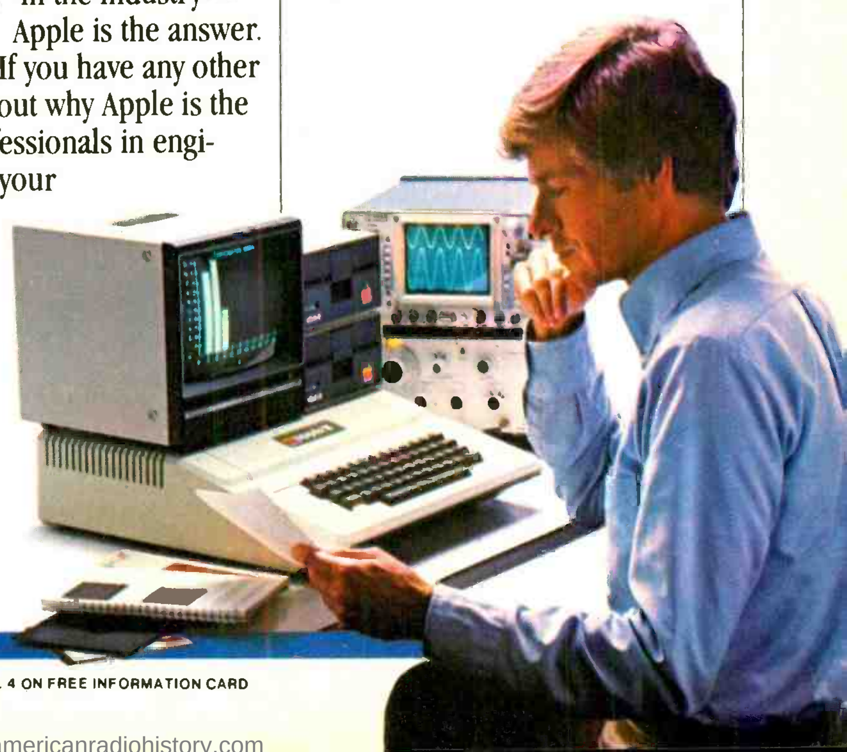
For support, service and the best extended warranty in the industry — Apple is the answer.

If you have any other questions about why Apple is the pick for professionals in engineering, see your nearest Apple computer dealer or call **800-538-9696**. In California, **800-662-9238**. Or write: Apple Computer, 10260 Bandley Drive, Cupertino, CA 95014.

	Apple II	Apple III
Maximum Memory Size	64K bytes	128K bytes
Screen Display	40 column (80 column with peripheral card) 24 Lines Upper Case	80 column 24 Lines Upper Case/Lower Case
Screen Resolution (B&W)	280 x 192	560 x 192
Screen Resolution (Color)	140 x 192 (6 colors)	280 x 192 (16 colors)
Keyboard	Fixed	Programmable
Numeric Key Pad	Accessory	Built-in
Input/Output	8 expansion slots	4 expansion slots plus built-in: disk interface RS-232 interface Silentype™ printer interface clock/calendar
Disk Drives	Add-on one to six drives	One drive built-in, plus interface to support three more drives
Languages	BASIC Fortran 77 Pascal Assembly Pilot	Enhanced BASIC Fortran 77 Pascal Assembly
Typical Configuration Pricing	CPU, 48K RAM, single disk drive, B&W Monitor (9"), Silentype™ printer, and BASIC. **$2875.00***	CPU, 96K RAM, Integrated disk drive, B&W Monitor (12"), Silentype™ printer, SOS, Enhanced BASIC. **$4865.00***

*Suggested retail price.

apple computer inc.



CIRCLE NO. 4 ON FREE INFORMATION CARD

www.americanradiohistory.com

EDITORIAL

Babel Revisited

Sometimes the trip to Las Vegas for the Winter Consumer Electronics Show seems like a step into a glittering, magic world in which all manner of strange and wondrous things happen, almost as in a dream. At the end, one finds oneself suddenly awake (though slightly dazed), wondering what it all meant.

This year, the rush of radically new technology seems to have slowed somewhat, and the overall emphasis fell, by and large, on new marketing concepts and, in some cases, stunning new cosmetics. Underlying all of this, however, there appear to be some new and continuing trends, one of which is highly disturbing.

The electronic marketplace, as it condenses into shape for the 1980s will encompass: three video cassette systems, three video disc systems, three digital audio disc systems (related in various ways to the video disc systems), at least four tape companding formats and three types of encoded phonograph discs. And that does not even begin to look at the confusion in the computer market, where a consumer who buys and interconnects equipment supposedly designed for compatibility (S-100, anyone?) will be lucky indeed if it works properly. And then consider the proliferation of noncompatible BASICs, and the other programming languages that spring up like so many dandelions. Such a state of affairs certainly does not promote confidence among consumers, who must not only match their needs to what is available, but also take a gamble on which of several competing systems will finally win.

A look at recent history shows that, when technology has been settled early in its development, the industry has prospered, with manufacturers competing not to see whose system would do best, but who could produce the *established* system at the lowest cost and with the most desirable features. A case in point is the compact cassette, for which Philips, the licensor, went to great pains to ensure compatibility of hardware and software, regardless of manufacture. The market strength of the compact cassette has let it withstand challenges from competing formats with ease.

FM stereo is another example. Imagine the chaos that would result if different stations encoded their signals in different ways, forcing the consumer to buy matching decoders that would not work for all. Rather than proving a handicap to industry or consumers, standardization in this case has proved a boon to all. And in no way was competition and free enterprise thwarted.

For a dismal example of the contrary situation, quadraphonics comes to mind. Here there was no standardization, and to enjoy all the competing formats, a music lover needed no less than three separate decoders. That new and improved decoders were being offered, seemingly on a monthly basis didn't help matters, either. Not surprisingly, many consumers waited for the smoke to clear before buying. Of course, the smoke had been coming from the funeral pyre of quadraphonics itself all along.

Clearly, there is a lesson here. For product categories to disappear because they cannot be introduced to market in an orderly fashion is a disservice to consumer and industry alike. There must be a better way.

Hal Rodgers

JOE MESICS
Publisher
ARTHUR P. SALSBERG
Editorial Director

HAROLD A. RODGERS
Executive Editor
LESLIE SOLOMON
Senior Technical Editor
JOHN R. RIGGS
Managing Editor
EDWARD I. BUXBAUM
Art Director

ALEXANDER W. BURAWA
Features Editor
JOHN J. McVEIGH
Technical Editor
ANDRE DUZANT
Technical Illustrator
CARMEN ROBLES
Production Editor
JEFF NEWMAN
Editorial Assistant

Contributing Editors
Carl Warren, Stan Prentiss
Glenn Hauser, Julian Hirsch, Forrest Mims

MARIE MAESTRI
Executive Assistant
OLIVIA WILSON
Promotion Coordinator
PEARL HARRINGTON
Assistant to the Publishing Director
SIDNEY HOLTZ
Publishing Director

Popular Electronics®

Editorial and Executive Offices
One Park Avenue
New York, New York 10016
212 725-3500

Publisher
Joe Mesics
212 725-3568

New York Office
Advertising Manager:
Richard Govatski (725-7460)

Eastern Advertising Manager
Bonnie B. Kaiser (725-3580)
Richard B. Eicher (725-3578)

Midwestern Office
Suite 1400, 180 N. Michigan Ave.,
Chicago, IL 60601 (312 346-2600)
Sales: Ted Welch

Western Representative
Norman S. Schindler & Associates, Inc.
7050 Owensmouth Ave., #209
Canoga Park, CA 91303 (213 999-1414)
Sales: Norm Schindler, Jon Marshall

Representation in Japan
James Yagi
Oji Palace Aoyama
6-25, Minami Aoyama, 6 Chome, Minato-Ku
Tokyo, Japan (407-1930/6821, 582-2851)

Ziff-Davis Publishing Company

Philip B. Korsant	President
Richard Friese	Senior Vice President
Phillip T. Heffernan	Senior Vice President
Sidney Holtz	Senior Vice President
Edward D. Muhlfeld	Senior Vice President
Philip Sine	Senior Vice President
Albert S. Traina	Senior Vice President
Robert Bavier	Vice President
Paul Chook (Research)	Vice President
Baird Davis (Production)	Vice President
Edgar G. Hopper (Marketing)	Vice President
George Morrissey	Vice President
Selwyn Taubman	Treasurer
Bertram A. Abrams	Secretary
W. Bradford Briggs	Vice Chairman

Ziff Corporation

William Ziff	Chairman
I. Martin Pompadur	President
Hershel B. Sarbin	Executive Vice President
Furman Hebb	Vice President
Bruce Maggin	Vice President
Lawrence Sporn	Vice President

Editorial correspondence: POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models submitted.

The publisher has no knowledge of any proprietary rights which will be violated by the making or using of any items disclosed in this issue.

Member Audit Bureau of Circulations

www.americanradiohistory.com

NOW CLEANING YOUR OWN DISKETTE HEADS COULD SAVE YOU A $40 SERVICE CALL. AND A LOT MORE.

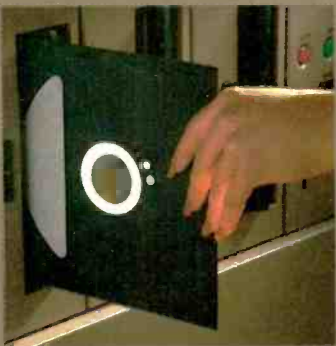
The recording heads on your diskette drives may be dirty—and that can cause you a lot of grief. There's the serviceman you have to call when the machine doesn't perform. (You know how much service calls cost these days!) There's machine down-time. Idle data entry clerks. All the other delays a cranky machine can cause.

And that service call might not even be necessary.

3M solves the problem in seconds—and leaves your heads "Computer Room Clean".

The Scotch® head-cleaning diskette kit lets you clean the read-write heads on your 8" or 5¼" diskette drives. In just 30 seconds, without any disassembly, mess or bother, the heads can be completely cleansed of dirt, dust, magnetic oxides—all the things that can get into your machines every day. And foul them up.

Just saturate the special white cleaning pad in its jacket with the cleaning solution. Then insert the jacket into the diskette drive and turn it on. Your machine does the rest. The



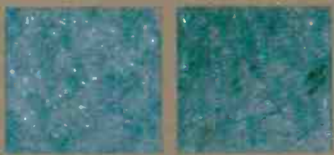
heads are microscopically cleaned without wear, without abrasion.

This 3M head-cleaning diskette kit has been evaluated and approved by major diskette drive manufacturers. It's the best possible way to clean your heads without service calls or machine teardowns.

At only $1 per cleaning—it's the best insurance you can get

This fast-cleaning new Scotch kit comes with everything you need (including special fluid, applicator tip, cleaning diskettes) to handle up to 30 cleanings. That's only about a dollar a cleaning.

With the Scotch head-cleaning diskette kit, you could save yourself a lot more than just a service call. So try this remarkable kit today. For the name of



A Scotch cleaning diskette shown before use, and after 15 cleanings of recording heads.

the dealer nearest you, call toll free: 800-328-1300. (In Minnesota, call collect: 612-736-9625.) Ask for the Data Recording Products Division.

(Not yet available for Burroughs Mini-Disk II, Vydec or 96 TPI Drive.)

3M

CIRCLE NO. 53 ON FREE INFORMATION CARD

www.americanradiohistory.com

LETTERS

Clearing Up Heat Transfer

In the interesting article, "Check Your Heat Loss with a Degree-Day Meter" (September 1980), there are two misleading statements. First, the author says "The temperature of an object is a function of the heat energy it contains. . ." Actually, an object can no more contain heat that it can contain work; heat is a form of energy in transit. We usually use the term "internal energy" rather than "heat energy."

Second, he says, "Unless artificial means (e.g., refrigeration) are used, heat always flows from a warmer reservoir to a cooler one. . ." The implication seems to be that, when we use refrigeration, heat flows from cold to warm. The refrigerator will not transfer heat unless it is plugged in. The quantity of heat transferred from hot to cold at the original heat engine to produce electricity to run the refrigerator was far greater than the amount of heat the refrigerator transfers from cold to hot; hence the net flow in the system is from hot to cold.

In the context of the article, these are rather nit-picking points, but hopefully readers interested in degree-days may also be interested in the thermodynamic aspects of energy (e.g., why it may be unwise to use an energy form with a lot of available work, like electricity, for resistance heating of homes).—*John Lord, Editor-in-Chief, Energy '80.*

Super Music Maker

There are some ambiguities in "Build a Super Music Maker" in November 1980 Popular Electronics. I cannot reconcile the Parts List descriptions of *C2* and *C3* with the components shown in the schematic diagram. Also, in high-power versions, transistors *Q5* and *Q6* are to be removed and the speaker connected directly to the +12-volt line. What happens to the wire from *D6* to *Q5*? Is it not supposed to be used?—*Alfred Leger, Leominster, MA*

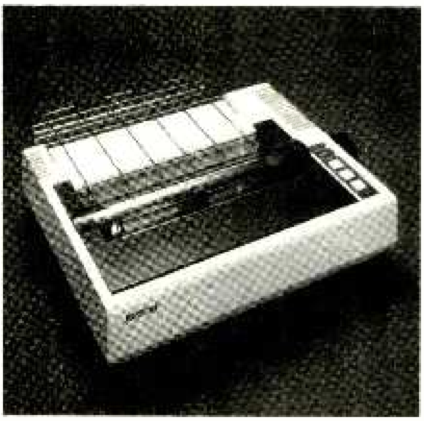
Capacitor C2 *should be a 1000-μF, 10-volt, radial-lead component. It is connected in parallel with zener diode D7. Capacitor C3 should be a 220-μF, 25-volt, radical-lead component. It is connected between the anode of D2 and ground. Note that the connection between the positive side of C1 and the cathode of D1 was inadvertently omitted from the schematic diagram. For high-power operation, simply remove Q5 and Q6 and install the insulated jumper as described in the article. There is no "wire" between the cathode of D6 and the base of Q5. There is a printed-circuit foil, however. It is not necessary to cut this foil when modifying the project to provide for high-power operation.*

OUT OF TUNE

In the "Gating Circuit Quiz" (February 1981, p 78), due to a drafting error, the answer for diagram No. 1 is incorrect. With the diagram as shown, the output would be zero. The answer is correct as given if the rightmost gate in the diagram is an OR instead of a NOR.

POPULAR ELECTRONICS welcomes comments from its readers. However, queries can be individually answered only if they are accompanied by stamped self-addressed envelopes. Please do not telephone.—Ed.

The printer you always wanted but could never afford,



now you can afford. Epson.

The most revolutionary thing about the Epson MX-80 isn't the bidirectional printing or the logical seeking function. It isn't even the disposable print head—although that's pretty revolutionary. The most revolutionary thing about the MX-80 is the price. How, you may ask, could a printer that does as much as the MX-80 cost less than $650?

Frankly, it wasn't easy. But the MX-80 could only have come from the world's largest manufacturer of print mechanisms. Epson.

The world's first disposable print head: when it wears out, just snap it out and throw it away. A new one costs less than $30, and you can install it yourself with one hand.

We spent three long years designing the MX-80 from the ground up to have all the functions people wanted, to be reliable like all Epson Printers, and to be produced on a scale that would allow us to charge less for each one. The MX-80 is our proof that it can be done.

Among its features, the MX-80 prints 96 ASCII, 64 graphic and eight international characters in a tack-sharp 9x9 matrix. It prints bidirectionally at 80 CPS with a logical seeking function to maximize throughput. And it has the world's first *disposable* print head.

If you've ever wanted a printer that could do it all at a price you could afford, you've got to see the Epson MX-80.

Because seeing is believing.

EPSON
EPSON AMERICA, INC.
23844 Hawthorne Boulevard, Torrance, California 90505 • Telephone (213) 378-2220

CIRCLE NO. 16 ON FREE INFORMATION CARD

www.americanradiohistory.com

The first personal computer for under $200.

The Sinclair ZX80.
A complete computer— only $199.95 *plus $5.00 shipping.*

Now, for just $199.95, you can get a complete, powerful, full-function computer, matching or surpassing other personal computers costing several times more.

It's the Sinclair ZX80. The computer that "Personal Computer World" gave 5 stars for 'excellent value.'

The ZX80 cuts away computer jargon and mystique. It takes you straight into BASIC, the most common, easy-to-use computer language.

You simply take it out of the box, connect it to your TV, and turn it on. And if you want, you can use an ordinary cassette recorder to store programs. With the manual in your hand, you'll be running programs in an hour. Within a week, you'll be writing complex programs with confidence.

All for under $200.

Sophisticated design makes the ZX80 easy to learn, easy to use.

We've packed the conventional computer onto fewer, more powerful LSI chips—including the Z80A microprocessor, the faster version of the famous Z80. This makes the ZX80 the world's first truly portable computer (6½" x 8½" x 1½" and a mere 12 oz.). The ZX80 also features a touch sensitive, wipe-clean keyboard and a 32-character by 24-line display.

Yet, with all this power, the ZX80 is easy to use, even for beginners.

Your course in computing.

The ZX80 comes complete with its own 128-page guide to computing. The manual is perfect for both novice and expert. For every chapter of theory, there's a chapter of practice. So you learn by doing—not just by reading. It makes learning easy, exciting and enjoyable.

You'll also receive a catalog packed with items that can make your ZX80 even more useful. Including 27 program cassettes, from games and home budgeting for just $6.95, to Sinclair's unique Computer Learning Lab (a workbook, six cassettes with 100 lessons, and two cassettes for storing programs).

ZX80's advanced design features.

Sinclair's 4K integer BASIC has performance features you'd expect only on much larger and more expensive computers.

- Unique 'one touch' entry. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry to reduce typing and save memory space.
- Automatic error detection. A cursor identifies errors immediately to prevent entering programs with faults.
- Powerful text editing facilities.
- Also programmable in machine code.
- Excellent string handling capability—up to 26 string variables of any length.
- Graphics, with 22 standard symbols.
- Built-in random number generator for games and simulations.

Sinclair's BASIC places no arbitrary restrictions on you—with many other flexible features, such as variable names of any length.

And the computer that can do so much for you now will do even more in the future. Options will include expansion of 1K user memory to 16K, a plug-in 8K floating-point BASIC chip, applications software, and other peripherals.

Order your ZX80 now!

The ZX80 is available only by mail from Sinclair, a leading manufacturer of consumer electronics worldwide.

To order by mail, use the coupon below. But for fastest delivery, order by phone and charge to your Master Charge or VISA. The ZX80 is backed by a 10-day money-back guarantee, and a 90-day limited warranty which can be extended by 12 months under Sinclair's extended service program for $25.00.

Price includes TV and cassette connectors, AC adaptor, and 128-page manual.

All you need to use your ZX80 is a standard TV (color or black and white). The ZX80 comes complete with connectors that easily hook up to the antenna terminals of your TV. Also included is a connector for a portable cassette recorder, if you choose to store programs. (You use an ordinary blank cassette.)

The ZX80 is a family learning aid. Children 10 and above will quickly understand the principles of computing—and have fun learning.

To order call toll free: 800-543-3000.
In Ohio call: 800-582-1364.
Ask for operator #508.
Phones open 24 hours a day, 7 days a week.

sinclair **Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.**

To: **Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.**
Please send me ______ ZX80 personal computer(s) at $199.95 each (US dollars), plus $5 shipping. (Your ZX80 may be tax deductible.)
Send me ______ Computer Learning Lab(s) at $49.95 each.
Register me for ______ extended service program(s) at $25.00 each.
I enclose a check/money order payable to Sinclair Research Ltd. for $______

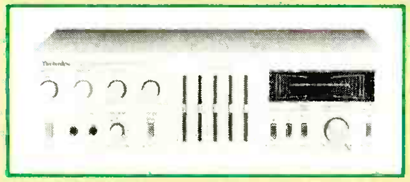
Name ______
Address ______
City ______ State ______ Zip ______
Occupation ______ Age ______
Intended use of ZX80 ______
Have you ever used a computer? ☐ Yes ☐ No Do you own another personal computer? ☐ Yes ☐ No
PE-4-1

www.americanradiohistory.com

NEW PRODUCTS

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Technics Space Dimension Controller



The Model SH-8030 "Space Dimension Controller" from Technics is designed to allow you to tailor your acoustical environment or the character of individual pieces of music to your taste. It has a five-band (60-Hz, 240-Hz, 1-kHz, 4-kHz, 16-kHz) graphic equalizer, controls for mike mixing, bucket-brigade delay (BBD) electronic echo, and disc-jockey console effects fade controls. It is also said to electronically expand the stereo image to a maximum of 240° with only two speakers. A dimension and signal-level display changes according to the dimension selected and can be used as a fast-responding, 5-dB-step signal-level indicator when the dimension controls are not being used. The controller connects to the tape jacks of an amplifier, but it has jacks on its rear apron to restore the tape-monitoring facility to the system.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Micronta Autoranging DMM

The Micronta digital multimeter (Cat. No. 22-196) from Radio Shack offers the convenience of automatic ranging and the low power consumption of a 0.4" liquid-crystal display as well. Designed to measure up to 1 kV dc, 500 volts ac, 200 mA dc, and 2 megohms, the DMM has a rated accuracy of ±1 digit, with a useful bandwidth of 15 kHz for ac volts. All ranges are overload protected. Functions are selected via the only rotary control on the instrument. A slide switch, the only other control, defeats the autoranger and "freezes" scaling. Indicators show when a measurement is out of range and when the battery is low. The DMM requires a 9-volt battery or ac adapter. Size is 6 7/8"H x 3 7/8"W x 1 5/8"D. $99.

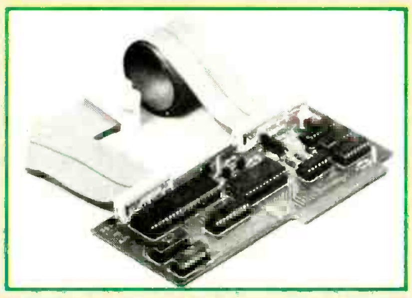
CIRCLE NO. 91 ON FREE INFORMATION CARD

Percom Speech Driver

Percom Data Co. has announced availability of an advanced speech driver and eight "talking" game programs for the company's "Speak-2-Me-2" interface. The driver routines and games are on diskette. The Speak-2-Me-2 printed-circuit card installs in a Texas Instruments "Speak & Spell." By providing the interface between the Speak & Spell and a computer, it allows the user to add speech to business and game programs. The module and software are configured for a TRS-80 Model I or II computer, but they can be adapted for other computers. The driver program provides a routine for outputting words and phrases of the Speak & Spell vocabulary and includes routines that create new words using syllables from Speak & Spell words, plus a routine to modulate the speed at which words are spoken. Included among the games are Hangman, card and dice games, and a version of Simon Says. The speech driver and games diskette are priced at $29.95, Speak-2-Me-2 adapter plus TRS-80 cable at $69.95.

CIRCLE NO. 92 ON FREE INFORMATION CARD

SSM Serial/Parallel Interface For Apple II Computers



SSM Microcomputer Products' AIO enhanced serial and parallel interface is designed for use with the Apple II microcomputer. It provides expanded capability to interface with a broad range of peripherals, including printers, plotters, terminals, modems, and other computers. It can also interface with both serial and parallel devices simultaneously when operated under Pascal. The RS-232 serial port has three handshaking lines (RTS, CTS, DED), and eight standard baud rates from 110 to 9600, including 134.5 baud for IBM Selectrics. Additional baud rates are possible through external input. The two bidirectional 8-bit parallel ports provide four additional interrupt and handshaking lines and programmable interface configurations. $225 assembled and tested, $175 kit. Address: SSM Microcomputer Prod., 2190 Paragon Dr., San Jose, CA 95131.

Buscom Tone Dialer

The Soft Touch 2 tone encoder from Buscom Systems, Inc., lets you inexpensively add convenient tone dialing to a standard telephone equipped for rotary dialing. The Soft Touch 2's pushbutton keyboard has pyramidal-shaped keys that allow easy dialing even with large fingers and long fingernails. Installation is simple: just remove the mouthpiece from the standard handset and replace it with the Soft Touch 2. $39.95. Buscom Systems, Inc., 4700 Patrick Henry Dr., Santa Clara, CA 95050.

RKO Videotape Color Filing System

RKO Tape Corp. has devised a new color-coded filing system for home videocassette

www.americanradiohistory.com

"Here's great news for electronics enthusiasts on small budgets.

Now you can take home a Fluke DMM for $125.*"

Whether you're just starting out in electronics or moving up from an analog VOM to a digital multimeter, you'll be smart to make sure that you're getting your money's worth.

In your search for a basic-performance DMM, be sure to consider the new D 800 from Fluke. Priced at only $125,* this dependable six-function handheld DMM is available now at select electronics supply stores throughout the U.S.

The D 800 offers 0.5% basic dc accuracy (five times better than analog voltmeters), a razor-sharp 3½-digit LCD readout, unsurpassed overload protection, and true, one-hand operation.

This hard-working basic measurement multimeter is designed from the inside out for long life and reliability. All D 800 specifications are traceable to the National Bureau of Standards.

As part of Fluke's new Series D line of low-cost digital multimeters, the D 800 carries a limited one-year parts and labor warranty and comes complete with the battery, and safety-designed test leads.

Ask your supplier about the D 800, then compare it feature-for-feature with any other low-cost DMM. You'll find that for only $125* there's never been more multimeter than the new D 800 from Fluke.

From the world leader in DMM's. Now we've designed one for you.

*Suggested U.S. list price

For technical data circle no. 20 ON FREE INFORMATION CARD

If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

FLUKE®

www.americanradiohistory.com

THE FIRST TRULY WATER RESISTANT ALARM/CHRONO DIGITAL

Casio's Mariner

You Don't Have Time To Worry About Your Watch

It's so convenient you just put it on and forget it! Never worry about the Mariner getting wet, because it's water resistant to 300 ft. Swim, ski and live the active life with this durable timepiece. Even the buttons have been engineered to prevent the loss of water resistancy during virtually any activity you undertake. Includes lithium batteries that won't need changing for approx. 5 years.

Use the Chronograph Without Losing Sight of the Time

The convenient and unique 12 digit LCD display allows you to view the time and your choice of the alarm, chronograph, countdown alarm, or calendar. Imagine a daily alarm, hourly chime, chronograph track accurate to 1/100th second, an 11 hr. countdown alarm, and self adjusting calendar at your command. Plus one touch allows you to change between 12 & 24 hour military/European time. All this backed by the manufacturer's one year warranty.

Buy with Confidence

We've become a leading media merchandiser by offering advanced technology products, prompt delivery, and a 30-day, no-risk, money-back guarantee. If this product isn't everything you expect, return it in new condition in 30 days or less for a complete refund.

Order Today

Charge customers call toll free 24 hours a day. Order product #91 for watch in tough black case and band, only $39.95. Order product #93 for watch in stainless steel case and tough black band, only $59.95.

(800) 854-3831 In California (800) 432-7451

DWS marketing international

350-A Fischer Avenue Dept. T04.
Costa Mesa, California. 92626.
(714) 540-4444

Call our toll-free number for quickest service or send your check money order or credit card info. Please allow time for checks to clear. We accept VISA M C A E D C charge cards. Add $2 50 for insured postage & handling for first product & $1 00 for each additional product. Calif residents add 6% sales tax

©DWS marketing international 1981

libraries, designated the RKO ColorCode. The system is derived from a filing method used by RKO Radio in its broadcast operations. Each RKO ColorChrome videocassette is supplied with nine pressure-sensitive labels, each a different color for nine general categories—movies, sports, news, documentaries, education, drama, music, comedy, and specials. These chromium-dioxide videotapes are a new entry to the market and are available in both Beta and VHS formats.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Boston Acoustics Speaker System

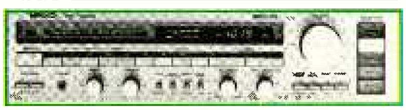
Boston Acoustics' Model A150 is a three-way speaker system with a 10" acoustic-suspension woofer, 4½" midrange driver with ferrofluid, and 1" soft dome tweeter, also with ferrofluid. The 8-ohm speaker system has a rated frequency response of 30 to 25,000 Hz ±3 dB, with crossovers at 550 Hz and 3 kHz. Sensitivity is rated at 90 dB SPL at 1 meter with 1-watt input. Cabinet size is 30½"H x 16½"W x 8"D with a pedestal for floor placement.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Metz Amateur Radio Antennas

Metz Communications Corp. has announced a complete line of amateur-radio vhf and uhf stainless-steel antennas, hardware, and low-loss RG-8/X coaxial cable. Stainless-steel coils are designed for each group of amateur frequencies, from the 10-meter band through 450 MHz. All antennas will mate with any ⅝" x 24 threaded connector with SO-239 configuration. Magnetic, through-vehicle, and other types of mounts are also available. Coils are rated for 250 watts of input power over extended periods. Address: Metz Communications Corp., Corner Rts 11 and 11C, Laconia, NH 03246.

Nikko AM/FM-Stereo Receiver



Nikko Audio's Model NR-1000 65-watt/channel (no more than 0.03% THD, both channels driven 20 to 20,000 Hz) AM/FM-stereo receiver uses quartz synthesized tuning with a digitally generated numeric frequency display and up/down scanning. Up to six AM and six FM stations can be programmed in memory for instant recall. The preamplifier includes a head amp for low-output moving-coil phono cartridges as well as a standard phono input. Two tape monitors allow bi-directional dubbing. Power output can be monitored on paired seven-section LED bar graphs, calibrated from 0.01 to 65 watts. The dc power-amplifier section has sophisticated electronic protection for the output transistors and speakers. Size is 17.3"W x 15"D x 4.7"H. $620.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Sabtronics 1-GHz Counter

Sabtronics Model 8000B frequency counter has a rated 10-Hz to 1-GHz range, with worst-case sensitivity of 30 mV. It offers nine-digit resolution; separate 1-megohm/100-pF and 50-ohm nominal inputs for 10 Hz to 100 MHz and 100 MHz to 1 GHz, respectively; 0.1-, 1-, and 10-second gate times; 10-MHz crystal time base with ±1 ppm temperature stability from 0° to 40° C; and battery operation (four C cells). It can also be powered by an optional Ni-Cd battery pack and/or ac adapter. Maximum resolution is rated at 0.1 Hz on 10-MHz range, 1 Hz on 100-MHz range, and 10 Hz on 1-GHz, all with 10-s gate time. Measurement accuracy is 1 Hz + 1 digit + time-base error. Size is 8"W x 6½"D x 3"H, and weight is 1.3 lb, not including battery. $199. Model 8610B ($129) has the same features but a high-frequency limit of 600 MHz.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Heathkit Circuit-Board Course

With the Heathkit/Zenith Educational Systems Model EI-3134 Printed Circuit Boards Course, electronics hobbyists can learn how to make their own pc boards. The course uses a self-teaching textbook and explores the various aspects of pc design and fabrication in a learn-by-doing approach. To this end, the text is supplemented by course experiments, all materials for which are included. These materials include an etch-resist pen, dry transfers, art tape, etchant, and plastic bags to make direct-pattern pc boards plus a positive pattern, clear acetate, and photographic developer to make boards by the

www.americanradiohistory.com

SCAN THIS REBATE

Save up to $25. The greatest scanner rebate ever offered on America's leading line. Bearcat® Scanners.

Now you can be a part of all the on-the-scene police calls, fire calls, weather warnings, and emergency information broadcasts the second they happen—and receive up to a big $25 factory rebate—on Bearcat Scanners.

Choose from 11 models.

This special rebate offer is good on eleven of the most popular Bearcat Scanner models. No-crystal fully synthesized Bearcat Scanners. Multi-band crystal Bearcat Scanners. Pocket sized hand-held Bearcat Scanners. One to fit any need. Any lifestyle. Any price range.

$25 — $20 — $15 — $10 — $5.

$25 rebates: Bearcat 300, America's most sophisticated scanner. Bearcat 250 with 50 channels and search, store/recall. Bearcat 220 that tunes in AM aircraft and FM public service. Bearcat 210XL, America's best selling scanner. $20 rebate: Bearcat 160 with smooth keyboard. $15 rebate: Bearcat 150, the new low priced no-crystal scanner. $10 rebates: Bearcat III and Bearcat 12, popular crystal scanners. Bearcat Four-Six Thin Scan.™ 4 band 6 channel hand-held scanner. $5 rebates: Bearcat 5, low-priced crystal scanner. Bearcat Thin Scan,™ the shirt pocket scanner.

Rebate expires May 15, 1981.

See your Bearcat Dealer for rebate details.* Then pick your kind of Bearcat Scanner and save up to $25.

*Rebate offer good on consumer purchases made between April 1, 1981 and May 15, 1981. Offer good only in U.S.A. Void where taxed or prohibited by law. Restricted to one rebate per customer regardless of the number of scanners purchased.

BEARCAT® SCANNERS

Electra Electra Company
Division of Masco Corp. of Indiana
300 East County Line Road
Cumberland, Indiana 46229

International Business Office
Suite 102, 1828 Swift
North Kansas City, Missouri 64116

© 1981 Masco Corp. of Indiana

CIRCLE NO. 14 ON FREE INFORMATION CARD

www.americanradiohistory.com

ETCO

CABLE TV CONVERTERS AND OTHER GOOD STUFF!

SMASHING ALL SALES RECORDS – OUR NEW 30 CHANNEL CABLE TV CONVERTER!
Converts mid & super band cable channels for viewing on your TV set! No. 334AE047
39.95 — $34.95 ea. / 5

HOT NEW IMPORT! REMOTE CONTROL 30 CHANNEL CABLE TV CONVERTER!
89.95 — $79.95 ea. / 5, $74.95 ea. / 10
Includes remote TV on/off switch and fine tuning control! No. 334VA275

ETCO MKII WIRELESS – THE ULTIMATE CABLE TV CONVERTER!
Set TV to channel 3, and the hand held remote control does it all! No. 334ZA008
189.00

VIDCOR 2000 CONVERTER ELIMINATES PROBLEMS WHEN TAPING FROM CABLE TV
89.95
Restores your VCR's capability for programming. Restores remote channel control. Enables videotaping of one cable program while watching another. No. 334VA950

UNUSUAL FACTORY SURPLUS MID-BAND – SUPER-BAND CABLE TV TUNER
Converts cable channels to a common IF frequency. Experimenters – build cable converters, decoders, etc. With schematic. No. 334VA342
19.95 — $17.50 ea. / 10
334VA389 Detailed schematic & spec sheet $1.50

FACTORY SURPLUS UHF TUNERS
4.95 — $3.95 ea./10
Brand new production surplus. All solid state. Ideal for experimental work building cable TV converters, etc. No. 334SU099

MINIATURE FM WIRELESS MICROPHONE
Hides in the palm of your hand. Reception on any standard FM radio or receiver. No. 334VA482
29.95 — $27.50 ea. / 5, $24.95 ea. / 10

QUARTER-MILE WIRELESS MICROPHONE & RECEIVER SYSTEM
69.95 — $49.95 ea. / 5
FCC approved crystal controlled wireless mike & receiver. All battery operated. Electret wide range response. VU meter. No. 334VA093

ETCO GENERAL PURPOSE TUBE TESTER
IN KIT FORM. Checks for leakage, shorts, emission. 7, 9 pin, octal, loctal, compactrons, nuvistors. In portable case. No. 334KT146
49.95
Wired: No. 334TE053 – $79.95
Pix tube adapter (334TE344) $19.95

DUMPING! NORELCO ENDLESS LOOP CASSETTES!
4.95 — $4.49 ea./10
Impossible to find at any price!
3 minutes – No. 334VA605
6 minutes – No. 334VA606
ENDLESS!

IN STOCK – THE MURA CORDLESS TELEPHONE SYSTEM!
Answer & originate calls with this wireless pocketphone. 400 ft. range! Rechargeable! Last number recall! Paging feature! Use with rotary, touch systems! No. 334VA724
144.88 — $129.95 ea. / 5

SALE OF QUARTZ BATTERY-OPERATED CLOCK MOVEMENTS!
9.95 — $8.96 ea. / 5
Accuracy of 1 min. / year, up to 4 years operation on 1 alkaline "C" cell. Imported from West Germany. No. 334VA561
334VA565 Matching hands – $2.49/set; $1.95/set / 5

20 AMP REGULATED 12VDC POWER SUPPLY!
13.8 vdc no load, 12.5 vdc full load. Easily handles ham station, marine radio, SSB linears up to 400w P.E.P. Brand new, factory sealed cartons. No. 334VA394
59.88 — $48.95 ea. / 5
334VA395 as above, 10 amps – $49.95, 39.95 ea. / 5

FREE
OUR LATEST 98 PAGE FASCINATING CATALOG – jam packed with unique items, electronic bargains and unusual offers. Write or circle the information card number below.

ETCO
ETCO ELECTRONICS
NORTH COUNTRY SHOPPING CENTER
PLATTSBURGH, N.Y. 12901

Check with order, please. Visa & Mastercard OK. (Sorry, no C.O.D.'s). Add 15% for UPS & Handling (Excess refunded). N.Y. State residents add 7% sales tax. Dealer & Export inquiries invited. Our telephone order desk never closes. Call 1 518 561 8700.

CIRCLE NO. 17 ON FREE INFORMATION CARD

photographic method. At completion of the course, the student will have made two useful projects—an automatic lamp switch and a touch control switch. $64.95.

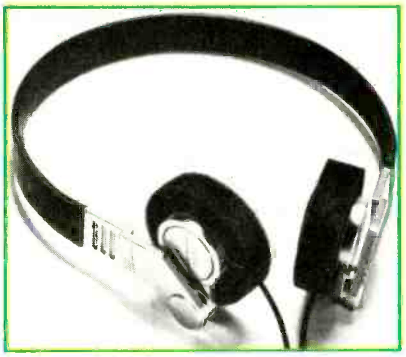
CIRCLE NO. 90 ON FREE INFORMATION CARD

Mitsubishi Projection TV Receiver

Mitsubishi's Model VS520U one-piece 50" projection TV system features dual amplifiers and speakers for stereo sound, screen brightness rated at more than 200 foot lamberts, and 105-channel capability. Supplied as part of the system is a full-function remote controller. The three-tube in-line system has a washable screen and four-element f 1.2 glass lenses. The unit also has a comb filter in the video-amplifier section and additional jacks for external speakers. It is available in two versions: Model VS-520U for $4,200, and Model VS-520UD, with doors that close over the screen for $4,500.

CIRCLE NO. 97 ON FREE INFORMATION CARD

A-T Ultralight Stereophones



Audio-Technica's Model ATH-0.5 ("Point 5") ultralight stereo headphones are designed especially for low-powered radios and tape players often used by joggers, skiers, bikers, and beach-goers. According to the company, the phones employ drivers with very light samarium-cobalt magnets and thin polyester film diaphragms to produce unusually lightweight drivers with improved transient response and lower distortion. Acoustical foam earcushions, a padded stainless-steel headband, and a lightweight Y cord that connects to both earcups are said to ensure proper fit. Rated frequency range is 25 to 20,000 Hz, and impedance is 4 to 16 ohms. Weight without cord is 1.9 ounces. $79.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Dual Auto-Reverse Cassette Deck

Dual's Model 828 automatic-reverse deck features an exclusive lock-and-load system that provides open access to cassettes. The deck is designed to accommodate all tape formulations, including metal, via switches that simultaneously set bias and equalization. The transport features solenoid-activated controls, a four-point tape-guidance system, and two dc servo motors with integral frequency generator. Photoelectric sensors across the light well halt tape motion whenever the light beam is interrupted. A handy one-button RECORD system eliminates the need to press RECORD, PLAY, and PAUSE. Peak-indicating LED "meters", bidirectional memory wind, Dolby noise reduction, and a multiplex filter round out the deck's features.

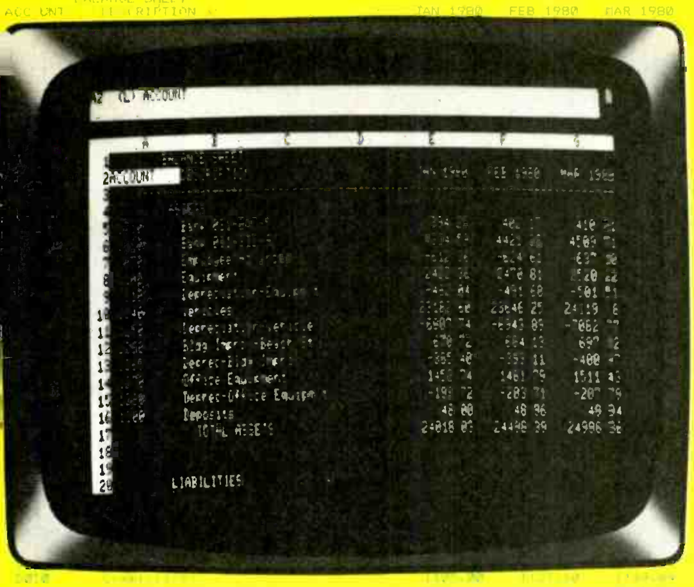
CIRCLE NO. 99 ON FREE INFORMATION CARD

Sharp Memowriter Calculator

The Model EL-7001 "Memowriter" calculator from Sharp incorporates the functions of a miniature typewriter that prints alphanumerics on a built-in printer. The pocket-size Memowriter has a 10-digit liquid-crystal display that can be used independently of its 16-character/line impact printer. As many as 48 characters can be retained in memory. Each of the typewriter's 40-word memories can hold seven letters and 10 numerals or 15 letters. The printer automatically switches to a new memory when one becomes full. Basic functions like plus constant, chain calculations, reciprocals, powers, percentages, and roundoffs, are featured in the calculator portion of the Memowriter. Also included are a four-key memory and fixed/floating decimal-point selection, soft carrying case, and paper roll. $129.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD

www.americanradiohistory.com



Radio Shack's New VisiCalc™ Program Is the Most Important Planning Tool a Manager Can Use!

A Revolutionary Decision-Making Aid Designed For Use With TRS-80™ Models I, II and III

Designed for the Decision Maker, VisiCalc is so effective that if no other computer program existed VisiCalc alone would justify your owning a TRS-80. It's an all-purpose planning and modeling program that dramatically changes the way you make calculations.

The "Electronic Worksheet." VisiCalc adapts itself easily to numerical problems, big or small. Your computer screen becomes a window through which you view a section of an electronic worksheet. This sheet can be divided into as many as 63 columns and 256 rows (depending on amount of available memory). In each "entry position" you can insert a description, number or formula for computation. VisiCalc then automatically performs all calculations, displaying the results.

Here's Where the Magic Begins. Suppose you're considering a new employee. Simply add the cost into a VisiCalc spread sheet containing current and projected profit and loss figures. VisiCalc will instantly recalculate every related figure to show the effect of your new acquisition. Instant "What if . . ." exercises—as simple as this, or very complex—give every manager a fast, effective new way to predict the potential results of his decision.

Amazing Versatility. VisiCalc can be used for everything from corporate fiscal planning to family budgeting. Sales projections, engineering analysis and thousands of other time-consuming chores can be done in minutes. And more thoroughly than ever before! VisiCalc can print specified portions of your "worksheet" (with an optional printer) and also store it all on disk for later use.

And It's Affordable. VisiCalc software is available in three versions: for 32K disk Model I, 32K disk Model III (each $99.95) and 64K Model II ($299). You can get started for only $2495 with a 2-disk Model III (plus software). Add a printer later for as little as $799. Available through Radio Shack's 6000 outlets or 120 Computer Centers. Supported by 130 service centers nationwide.

Radio Shack®

The biggest name in little computers™

A DIVISION OF TANDY CORPORATION

Retail prices may vary at individual stores and dealers. Special order may be required initially.

™VisiCalc is a trademark of Personal Software, Inc.

Send for More Information on VisiCalc or TRS-80 Computers

Radio Shack, Dept. 81-A-115
1300 One Tandy Center
Fort Worth, Texas 76102

NAME ______________________

STREET ______________________

CITY ____________ STATE ____________

ZIP ____________ PHONE ____________

www.americanradiohistory.com

ENTERTAINMENT ELECTRONICS

By Ivan Berger

A Little Traveling Music

YOU KNOW a product's hot when everyone jumps on the bandwagon. Sony's Walkman is a good example. It's only been on the market for a year or so, yet at least 20 other companies (Caprice, Cybernet, Craig, Emerson, GE, Guardian, Gustronic, Infinity, KLH, Liberty, Mona, Panasonic, JC Penney, Randix Audiologic, Sanyo, Soundtripper, Technidyne, Toshiba, Unisef, and Yorx) are bringing out similar small, headphone-only portable stereo cassette players. Six companies (Sony, Mura, Technidyne, Caprice, Unisef and Alaron) are bringing out FM-stereo radios in similar form. Sony, Aiwa, and Technidyne have introduced ultra-compact, portable stereo recorder/players. And Panasonic will be introducing a radio/recorder combo.

All these mini-portables share the same basic concept: that a stereo system can be small if it doesn't use speakers. Headphones give stereo in a small space, and can be driven adequately by milliwatts of power. The breakthrough was Sony's development of ultra-miniature, ultra-light headphones with good sound and high efficiency.

Headphones isolate you from ambient sound, so Sony's Walkman has a "Hot Line" button that switches on a built-in microphone and cuts the music level, so the headphone wearers can hear what's being said to them. Most other pocket portables have this feature, too. Sanyo's M5550 turns the mike on but leaves the music at full volume, so you can sing along with it. The main exceptions are GE's Stereo Escape (which cuts the volume, but has no mike) and the Aiwa and Sony recorders, whose mikes are strictly for recording.

Sony's TPS-L2 Stereo Cassette Player

I recently had a chance to compare the Walkman with six other stereo players (the GE Stereo Escape, Panasonic RS-J3, Randix Audiologic Soundaround, Sanyo M5550 Sportster, Technidyne HPS-100 Hip-Pocket Stereo, and Toshiba KT-S2), as well as the Aiwa and Sony recorders, and Sony's "Mystereo" radio. They follow the Walkman's basic concept, most adding details of their own.

Some are truly pocket-sized, and weigh less than a pound (including batteries but not the headphones). The Randix, Panasonic, GE and Panasonic players and Sony's TCS-300 recorder were noticeably heavier, though, at 1¼ to 1½ pounds. They (and the Toshiba) were also a bit big for most pockets.

Headphone connections in these machines use a miniature 3.5-mm, three-conductor jack and plug. Usually, there are two headphone jacks, so you can share the fun. The Toshiba, the Panasonic and the two recorders only have one headphone jack, but the Panasonic also has two RCA phono-type output jacks to feed sound into your hi-fi system . . . albeit at microphone, rather than line, level.

Cue and review, which let you monitor the tape chatter in fast-winding modes, are included in most units. Sanyo's M5550 also has AMSS, which senses the spaces between musical selections; when it hits one during fast-wind, it stops. The Sanyo also has a pitch control, to vary tape speed up to ±6%, if precise pitch is important to you. The Panasonic, Sanyo and Randix have only one volume control and no balance adjustment. The others have two, save for the Aiwa which has separate volume and balance controls.

All the units I've seen have some kind of tone control—usually a two-position switch, but continuous controls are used on the Randix and the Sony recorder. Since almost none of these units has Dolby (a real pity) and since response from CrO_2 and ferric tapes differ so much, you'll need those switches when you change tapes. Some of these switches are marked "equalization" instead of "tone." Toshiba has one switch of each kind, with the "EQ" switch working only on tape.

What does the other tone switch work on? FM radio. The Toshiba comes with a clever FM tuner—stereo, of course—in a cassette shell. It only works in Toshiba's KT-S2 player, which provides the necessary contacts and switching, feeds power from its own batteries, and has a slot in its tape-compartment door for the tuning thumbwheel. The tuner also has a mono/stereo switch and stereo indicator LED, too. KLH and Infinity will have similar (not identical) models, with Dolby noise reduction on Infinity's version.

Both the Toshiba cassette and Sony's pocket radio use their headphone cords as FM antennas (Sony's Mystereo radio has AM, also—Toshiba reportedly offers a separate AM cassette in Japan, but not here). Both are pretty sensitive, too: I picked up some New York stations on a Connecticut hilltop about 90 miles away.

Not all the differences between these portables show up in spec sheets, though: they neither sound nor feel alike. The main sonic differences were in wow and flutter, and in frequency (especially treble) response. And control feel and layout varied considerably.

Using a Nakamichi T-100 Audio Analyzer, I measured wow and flutter on these units. It was lowest on the two recorders (0.25% for the Aiwa, 0.15% for the Sony), where low wow and flutter matters most. The others were mostly around 0.3%, which is about as much as I feel comfortable with. The Sanyo and Technidyne had 0.35% wow and flutter, which begins to bother me, and the Randix had 0.4%.

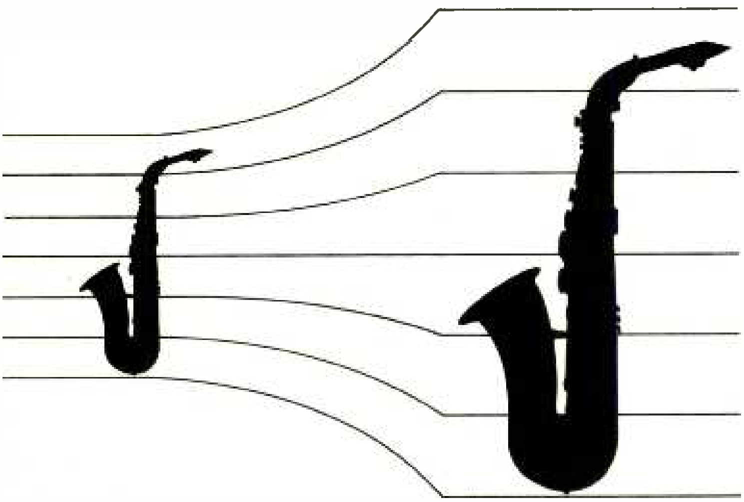
Frequency response seemed to depend less on the decks themselves than on the headphones you plug into them. The Sony MDR-3L2 sounded best to me, with the Aiwa phones just a hair behind them. All the phones sounded pretty good and were reasonably comfortable. The GE and the bright-sounding Sanyo phones, whose drivers swivel slightly, were especially comfortable. Most of the rest had angled headbands (which made them uncomfortable if you put them on backward), but they could be bent somewhat for custom fit. Technidyne's phones also folded in the middle, for more compact carrying. And the Randix phones were noticeably more efficient than those from Sony.

Miniature headphones are becoming available for home use too. Sony foresaw that, when they packed a quarter-inch jack adapter with their MDR-3L2 phones, and Mura, Pickering and Audio-Technica have since brought out lightweight phones with quarter-inch plugs. Pickering supplies an adapter for the pocket system's 3.5-mm jacks, and Audio-Technica makes a 3.5-mm plug standard on their Point-1 phones, in contrast to the quarter-inch-plug Point-3 and Point-5 models. Koss has a folding model with 3.5-mm stereo plugs plus adapters for 3.5-mm mono and ¼" stereo jacks.

(Continued on page 20)

www.americanradiohistory.com

How to get 50% more sound without turning up the volume.



A dbx Dynamic Range Expander restores the music dynamics that were lost in the recording process – giving you up to 50% more sound. The technology is based on a technique originally developed by dbx for professional recording studios.

There's a whole range of sound in a live performance that you never hear from your stereo system. And it's not a question of turning up the volume.

The problem is in the records you play.

When recording engineers master a record, they electronically eliminate up to half the music. They literally compress the sound to make it "fit" on the vinyl record.

Fortunately, there's one solution to the problem: dbx Dynamic Range Expanders.

A dbx Dynamic Range Expander in your system restores most of the lost music. And it reduces annoying record surface noise by as much as 20 dB. So instead of a compressed 50 or 60 dB of dynamic range, you get a full 75 to 90 dB. The loud passages begin to thunder. The softs are truly subtle. All your music comes to life.

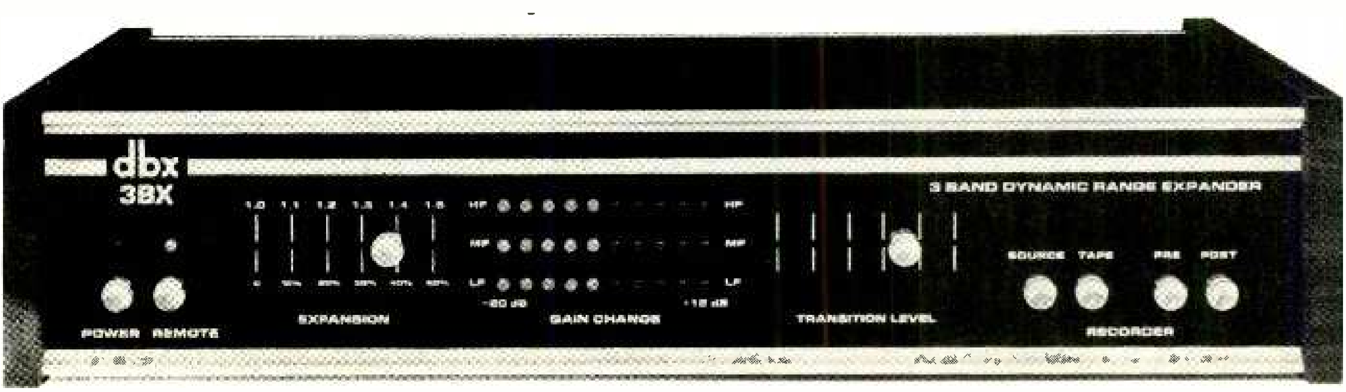
And you can use a dbx Dynamic Range Expander not only with your records, but also with tapes and FM broadcasts.

Visit your authorized dbx retailer for a demonstration of the 1BX, 2BX and 3BX Dynamic Range Expanders. Then select the model that's best for your system.

Because there's a lot more to music than has been reaching your ears.

dbx, Inc., 71 Chapel St., Newton, MA 02195 U.S.A. Tel. (617) 964-3210. Telex 92-2522. Distributed throughout Canada by BSR (CANADA) Ltd., Rexdale, Ontario.

dbx®
Making good sound better



CIRCLE NO. 9 ON FREE INFORMATION CARD

www.americanradiohistory.com

If you have put off learning more electronics for any of these reasons, act now!

- ☐ I don't have the time.
- ☐ High school was hard for me and electronics sounds like it may be hard to learn.
- ☐ I can't afford any more education.
- ☐ I have a family now.
- ☐ I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

Read the opposite page and see how you can get started today!

www.americanradiohistory.com

Be honest with yourself. Are the reasons really excuses? You already know enough about electronics to be interested in reading this magazine. So why not learn more? If you need encouragement, read on and see how excuses can be turned into results.

You don't have the time. Be realistic. All you have in life is a period of time. Use it. Try to know more tomorrow than you do today. That's the proven way to success. CIE studies require just about 12 hours of your time a week, two hours a day. You probably do have the time.

Electronics sounds like it may be hard to learn. You already know something about electronics or you wouldn't be reading this. Now, build on that. CIE Auto-Programmed® Lessons help you learn. Topics are presented in simple, logical sequence. All text is clear and concise for quick, easy understanding. You learn step by step, at your own pace. No classes to attend. Nobody pressures you. You **can** learn.

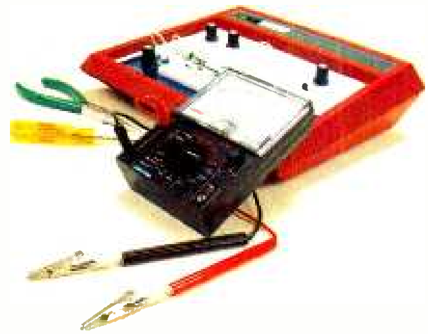
You can't afford any more education. Actually, you can't afford NOT to gain the skills that can put you ahead of the others. You know what inflation is doing to you now. Education—learning a skill—is an inflation-fighter that can be yours. If you are not able to pay full tuition now, CIE will lend you funds on a monthly payment plan.

You have a family now. All the more reason why you have the responsibility to advance yourself. For the sake of your family. Do you want them to have what you had or have **more** than you had? The choice is yours. Electronics is a rewarding career choice. CIE can help you to get started on that career.

You're there. We're here. How does CIE help you learn? First, we **want** you to succeed. You may study at home, but you are not alone. When you have a question about a lesson, a postage stamp gets you your answer fast. You may find this even better than having a classroom teacher. CIE understands people need to learn at their own pace. When CIE receives your completed lesson before noon any day of the week, it will be graded and mailed back the same day with appropriate instructional help. Your satisfaction with your progress comes by return mail. That's how CIE helps you learn.

NOW, IF YOU AGREE CIE TRAINING CAN WORK FOR YOU, HOW ELSE CAN CIE HELP YOU?

Cleveland Institute of Electronics is the largest independent home study school in the world that specializes exclusively in electronics. Although "big" does not always mean "best," it is evidence that CIE is a strong, successful institution with the people and resources to help you succeed.



Step-by-step learning includes "hands-on" training.
The kind of professional you want to be needs more than theory. That's why some of our courses include the Personal Training Laboratory, which helps you put lesson theory into actual practice. Other courses train you to use tools of the trade such as a 5MHz triggered-sweep, solid-state oscilloscope you build yourself—and use to practice troubleshooting. Or a Digital Learning Laboratory to let you apply the digital theory that's essential today for anyone who wants to keep pace with electronics in the eighties.

Your FCC License can impress employers.
For some electronics jobs, you must have your FCC License. For others, employers usually consider it a mark in your favor. Either way, your License is government-certified proof of your knowledge and skills. More than half of CIE's courses prepare you to pass this exam. Surveys show that some 80% of CIE graduates who take the exam are successful.

Find out more! Today. Now.
There's a card with this ad. Fill it in and return. If some other ambitious person has already removed it, use the coupon.

You'll get a copy of CIE's free school catalog, along with a complete package of personal home study information.

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

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

This could be the best decision you've made all year.

Associate Degree

Now, CIE offers an Associate in Applied Science Degree in Electronics Engineering Technology. In fact, all or most of every CIE Career Course is directly creditable towards the Associate Degree.

"If you're going to learn electronics, you might as well learn it right."
John Cunningham
Senior Technical Director

CIE Cleveland Institute of Electronics, Inc. — PE-36

1776 East 17th Street, Cleveland, Ohio 44114

☐ **YES...** I want to learn from the specialists in electronics—CIE. Send me my FREE CIE school catalog...including details about the Associate Degree program...plus my FREE package of home study information.

Print Name ____________________

Address ____________________ Apt. ______

City ____________________

State ____________________ Zip ______

Age ______ Phone (area code) ____________________

Check box for G.I. Bill bulletin on Educational Benefits: ☐ Veteran ☐ Active Duty

MAIL TODAY!

www.americanradiohistory.com

(Continued from page 14)

Recorders and Radios. Of the two miniature stereo recorders, the Aiwa TP-S30 was most like the Walkman-style players in its size and weight. It has a built-in, monophonic mike; if nothing else is plugged in, it will feed both channels. Plug a mono mike into the left-channel mike input alone, and it, too, will feed both channels—but if you plug that mike into the right input instead, it will feed only the right channel, while the built-in one will feed the left. External stereo mikes (such as Aiwa's nice little $36 electret one) plug into both inputs. A flick of a switch, and the jacks become line-level, Aux inputs—only be careful to set it properly, since it doubles as the tape equalization selector during playback.

The Sony TCS-300 was considerably bigger, but had a few more things built in: a loudspeaker, for monophonic playback; a monophonic earphone jack (in addition to the stereo headphone one); and a built-in stereo microphone. Jacks are provided for external mikes, too, and there's a Pre-End alarm LED, to warn you shortly before the tape runs out.

Both made recordings of about equal quality—I can't tell which I'm listening to. Both did their best on standard-bias, 120-microsecond ferric tapes, but could also record quite well on chrome or chrome-equivalent ones though with a bit more hiss in the latter case. To me the Aiwa's more convenient size outweighed the Sony's extra features. But it could have benefitted from the use of a clip to hold the stereo mike (as it is, recording in stereo requires either two hands or one hand plus a pocket), and a tiny speaker for emergency playback.

Sony's Mystereo radio was the most compact and the best sounding portable—it seemed to have wider frequency response and (on strong signals) less noise than any of the tape systems, and of course it was immune to wow and flutter. The $220 radio system also includes a 2-speaker box into which the radio slides for stereo listening without phones. The box also has its own power source (four C cells) and a jack for a power supply, plus a jack for playback from a Walkman or similar player. The box can sit on a table or hang from a shoulder strap. The speakers, though, don't sound as good as the headphones, and the stereo effect is only perceptible when you're close to the speakers.

Compact as all these pocket systems are, there's more compact equipment right around the corner. Several similar systems using microcassette tapes were shown in Japan last Fall. Fisher showed one in January, and Aiwa has one that also records from its built-in AM/FM tuner. I wouldn't expect to see many in the stores for several months, however. And microplayers won't do you much good unless you have a microcassette stereo deck to make tapes with. Prototypes of such decks have been shown, though, by Olympus and Fisher; and Fisher has announced that its will be available soon. ◇

AUDIOPHILE RECORDINGS

By Harold A. Rodgers
Executive Editor

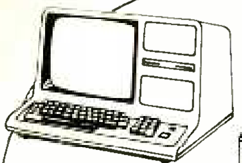
ALTHOUGH the mainstay of the audiophile recording market has, of course, been the vinyl phonograph disc—and this is not expected to change markedly in the near future—high-end prerecorded cassette tapes are beginning to appear. Mobile Fidelity Sound Labs, for one, is introducing such a line (recorded in real time on BASF chromium dioxide) for just under $18 per cassette. These Original Master Recording High-Fidelity Cassettes, like MFSL's discs, are prepared from leased master tapes.

Prerecorded cassettes are also available from dbx—encoded, of course, and claiming a dynamic range in excess of 80 dB. Offered at a retail price of $20, these are also recorded on chromium dioxide. Source material, which includes some digital master tapes, is drawn from recording companies now participating in the dbx encoded disc effort. The same decoder, incidentally, works for discs and tapes. Duplication (in real time) is provided by In Sync Laboratories.

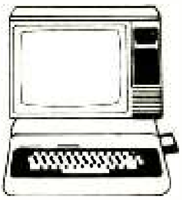
But the most exotic prerecorded cassettes to date will come from AudioSource and are recorded on JVC metal particle tape. Prices will vary between about $15 and $30, depending on the individual release.

Enter the UHQR. Soon to be available from Mobile Fidelity is the Ultra High Quality Record. Manufactured, according to MFSL's Gary Giorgi, from the same metal parts as the company's regular releases, this disc starts out with a 200-g slug (185 g after deflashing) of vinyl and a five-minute pressing cycle. This means a maximum of 12 discs per hour per press. UHQRs will be individually numbered and sold to collectors at $40 each.

On the basis of what can be heard from a test pressing, these discs are about as quiet as MFSL's regular production—which is very quiet. Their special quality lies in an excellent sense of depth and articulation. This, says Giorgi, results from the fact that at 3 mils the grooves on these discs are twice as deep as those on standard audiophile discs. The superior control of stylus motion thus afforded reduces minor mistracking—rarely audible as such, but deleterious to sound quality in any case—to very low levels. ◇



TRS-80
MODEL III
48K, $1039



TRS-80
COLOR
COMPUTER
16K RAM
$399

APPLE II +
48K, $1199

APPLE II Disk w/Controller	$579 00
APPLE II Disk	$439.00
LOBO Disk Drive	$379.00
PASCAL Language System	$469.00
MICROSOFT Z-80 SoftCard	$279.00
MICROSOFT RAMCard	$169.00
KURTA Graphics Tablet	$659.00
VERSAWRITER	$239.00
ALF AM II Music Synthesizer	$189 00
MOUNTAIN COMPUTER Music System	$519.00
MOUNTAIN COMPUTER Super Talker	$289 00
MOUNTAIN COMPUTER Exp. Chassis	$609.00
EPSON Parallel Card	$100.00
CCS Calendar/Clock	$125.00
CCS Asynchrous RS-232-C Card	$159.00
CCS Arithmetic Processor	$399.00
LYNX Communications Interface	$239 00
APPLE II Oust Cover	$7.95
Carrying Case, APPLE w/2-drives	$119.00
Carrying Case, above w/9" monitor	$129.00

ATARI 800
48K, $1089

ATARI 400
8K, $439

TYPPRINTER 221	$2595.00
VISTA Daisy Wheel Printer	$1795.00
NEC 5510 or 5530 rinter	$2595.00
EATON LRC 7000+ Printer	$279.00
CENTRONICS 737 Printer	$769.00
OKIDATA Microline 80 Printer	$499.00
OKIDATA Microline 82 Printer	$669.00
OKIDATA Microline 83 Printer	$999.00
OKIDATA SL-300 Printer	$3795.00
EPSON MX-70 Printer	$449.00
EPSON MX-80 Printer	$519.00

TERMS: Prices and specifications are subject to change. HARDSIDE accepts VISA & MASTERCARD. Certified checks and Money Orders: Personal checks accepted (takes 3 weeks to clear) HARDSIDE pays all shipping charges (within 48 states) on all PREPAID orders OVER $100.00. On all orders under $100 a $2.50 handling charge must be added. COD orders accepted (orders over $250 require 25% deposit) there is a $5.00 handling charge. UPS Blue Lavel, Air Freight available at extra cost. TRS-80, APPLE, and ATARI are trademarks of Tandy, Apple Computer, and Warner Communications, respectively.

TSE-HARDSIDE
6 South St., Milford, NH 03055 (603) 673-5144
TOLL FREE OUT-OF-STATE 1-800-258-1790

CIRCLE NO. 23 ON FREE INFORMATION CARD

WHY SPEND $200 MORE ON A BETTER TAPE DECK WHEN ALL YOU NEED IS $2 MORE FOR A BETTER TAPE.

No matter how much you spend on a tape deck, the sound that comes out of it can only be as good as the tape you put in it. So before you invest a few hundred dollars upgrading your tape deck, invest a few extra dollars in a new Maxell XLI-S or XLII-S cassette.

They're the newest and most advanced generation of oxide formulation tapes. By engineering smaller and more uniformly shaped oxide particles, we were able to pack more of these particles onto a given area of tape.

Now this might not sound exactly earth-shattering, but it can help your tape deck live up to its specifications by improving output, signal-to-noise ratio and frequency response.

Our new XL-S cassettes also have an improved binder system, which helps keep the oxide particles exactly where they're supposed to be. On the tape's surface, not on your recording heads. As a result, you'll hear a lot more music and a lot less distortion.

There's more to our XL-S tape than just great tape. We've also redesigned our cassette shells. Our new Quin-Lok™ Clamp/Hub Assembly holds the leader firmly in place and eliminates tape deformation. Which means you'll not only hear great music, but you'll also be able to enjoy it a lot longer.

So if you'd like to get better sound out of your tape system, you don't have to put more money into it. Just put in our new tape.

maxell

IT'S WORTH IT.

Maxell Corporation of America, 60 Oxford Drive Moonachie, N.J. 07074

CIRCLE NO. 34 ON FREE INFORMATION CARD

www.americanradiohistory.com

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Yamaha T-7 FM/AM Tuner

Motor-driven tuner has preset memories for 5 FM and 5 AM stations

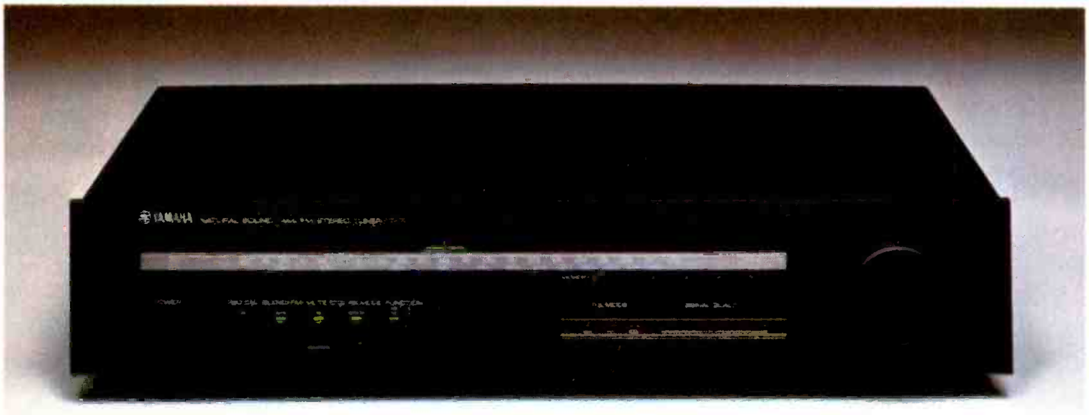
SEVERAL years ago, the Yamaha CT-7000, one of the early "super" FM tuners, set new performance standards for its time. The T-2, a later, less expensive model, earned an enviable reputation among audiophiles. Much of the technology of the CT-7000 and T-2 has now been brought into a more affordable price range in the new Yamaha T-7 FM/AM tuner.

Features of the T-7 include preset memories for 5 FM and 5 AM stations, automatic motor-driven tuning, and excellent distortion and S/N ratings. Finished entirely in black, the unit measures 17⅛" W x 13⅛" D x 3¾" H, and weighs 11½ pounds. Suggested retail price is $400.

General Description. FM tuners have not kept pace with the vanishingly low distortion and noise of amplifiers. Technological limitations are part of the cause as is the fact that FM broadcast standards and practical difficulties (such as multipath effects) would render much of the effect of such performance moot.

However, Yamaha's philosophy is to make its products as competent as possible, within the constraints set by the market. In the case of the T-7 tuner, balance between tuning convenience and noise level has been sought, without undue sacrifice elsewhere. This necessitates adjustment of operating parameters, manually and automatically, to optimize performance under different receiving conditions.

Yamaha rejected digitally synthesized tuning in this case principally because the circuitry required tends to raise the background noise level of the tuner. Also, to make the large number of varactor-tuned circuits needed for the desired image rejection would be difficult and costly. Therefore, a conventional capacitor-tuned front end was chosen. To offer the convenience of preset tuning channels, Yamaha used a motor-driven tuning capacitor, combined with a digital memory. The motor turns the capacitor until it is very close to the stored setting, after which an analog servo system (operating from a discriminator output voltage) fine tunes to the exact station frequency. The afc (which Yamaha calls OTS, for "Optimum Tuning System") remains in effect constantly. A full scan over the FM band requires about 12 seconds. While the tuner is scanning, a touch on the tuning knob instantly disengages the motor



www.americanradiohistory.com

Video Review® knows a bright idea when it sees one.

Simulated TV picture. Simulated wood cabinet.

Video Review magazine tests a lot of sophisticated video products.

They get to see virtually every make and type of color TV receiver.

Which makes their selection of Magnavox as their standard TV receiver pretty impressive.

"We thought the Magnavox picture quality and resolution were superb."

"Ever since *Video Review* began testing products," says the magazine, "we've been looking for a top quality, 19-inch TV set that might serve as a standard of reference for all of the other products we test...video cameras, video cassette recorders, video cassettes.

"We thought the Magnavox picture quality and resolution were superb, and that off-the-air sensitivity was also extremely good.

"Major VHF channels were received with uniformly accurate color fidelity. This receiver produced superior color pictures even when using its own indoor VHF and UHF antennas."

"The special tuning features and remote control capabilities of the Magnavox receiver are awesome."

"The tuning system is purely electronic and totally digital," they continue. "There is a fine tune switch and a memory lock button. If any channel is received mistuned, the user simply fine tunes up or down in frequency by holding the button, and when perfect tuning has been achieved, the button is released and the memory lock button is depressed once.

"Nearby is Magnavox's Videomatic feature. Depressing this button activates the electronic eye for automatic brightness adjustment, color adjustment circuits and automatic fine tune."

"...unusually good for any receiver."

Overall, *Video Review* rated the Magnavox 9.5 or better (out of a possible 10.0) on Video Quality, Reception Sensitivity, Color Fidelity, and Video Resolution and Fidelity. As they put it, "...unusually good for any receiver."

We can only add that once you see a Magnavox color TV at your Magnavox dealer, we think you'll agree.

For Magnavox color TV specifications, write Magnavox Consumer Electronics Company, Dept. 700, P.O. Box 6950, Knoxville, Tennessee 37914.

© 1980 MAGNAVOX CONSUMER ELECTRONICS CO

MAGNAVOX

The brightest ideas in the world are here to play.

CIRCLE NO. 35 ON FREE INFORMATION CARD

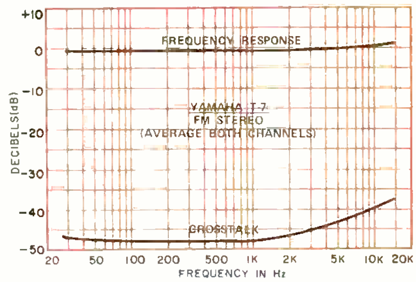
www.americanradiohistory.com

drive and restores manual tuning simultaneously disabling the OTS. OTS returns automatically a couple of seconds after the knob is released.

Although the tuning of the T-7 is analog, its station memory is digital. The angular position of the tuning capacitor is converted into a 10-bit digital word that is stored in one of 10 memories in an LSI chip. The A/D conversion appears to be based on a frequency-to-voltage conversion. The memory should retain tuning locations with a resolution of about 20 kHz on FM, or 1 kHz on AM. These errors lie well within the corrective range of the OTS system.

Yellow bars on each side of the dial pointer travel with it, lighting to show when a signal is nearby and which way the tuning should be shifted to reach the channel center. At the correct point, both bars light to equal brightness, becoming visibly brighter to show that the OTS is operating, after the tuning knob is released.

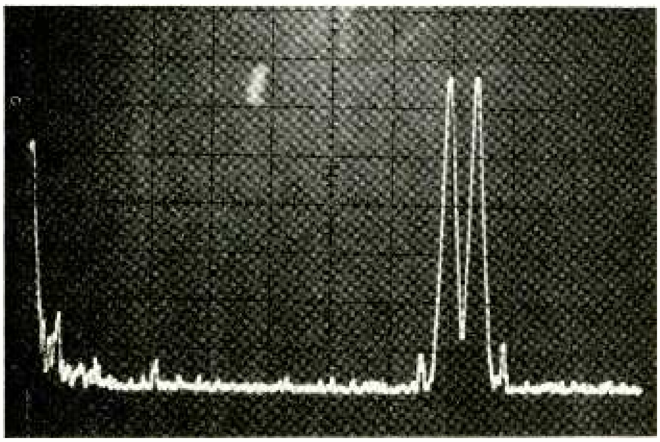
Below the dial, a row of line segments successively light up to show relative signal strength. A red STEREO light and two green lights marked DX and LOCAL show the status of the automatic bandwidth and channel separation switching. The



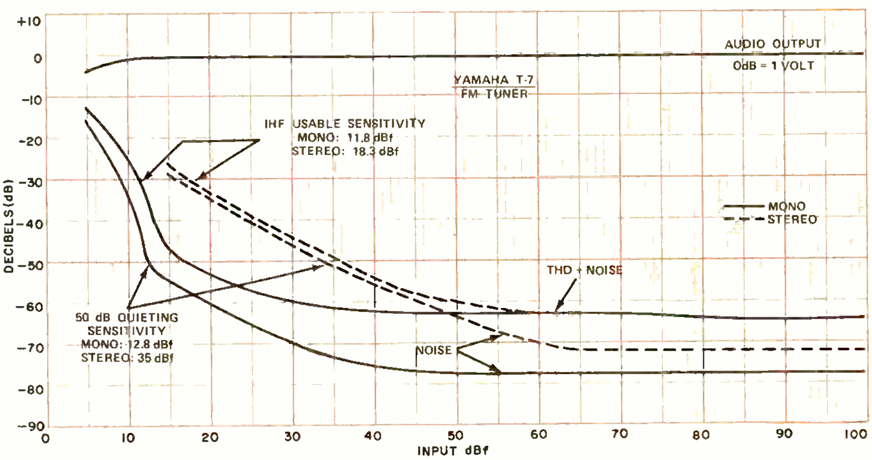
Frequency response and crosstalk.

i-f section includes a special narrow-band stage for high selectivity. When signal power exceeds 39 dBf, the extra selectivity is bypassed, improving distortion and channel separation. An AUTO/DX switch can be used to place the tuner in its LOCAL mode regardless of signal strength.

Five small pushbuttons control the tuner's operating modes. Each is a momentary contact type that changes its assigned function (and an indicator light) on alternative operations. Switches include one for AUTO/DX/LOCAL and one, a combined FM MUTE/OTS, that disables muting and OTS, simultaneously converting the signal strength readout to a multipath display. In this mode, the signal-strength indicators are dimly lit. Multipath distortion (which creates strong amplitude modulation of the received signal) causes the low-level segments to flash to full brightness. The next switch is BLEND, with AUTO and OFF settings; it automatically reduces noise on weak stereo signals by blending the high frequencies between the two channels. Switching it off gives maximum separation at all times. A FUNCTION switch selects AM or FM reception, and a REC CAL button replaces the audio program by a tone, nominally 400 Hz, whose level is equal to 50% FM modulation, as an aid to setting levels for recording off the air. The POWER switch is a larger rectangular button that also operates in a nonlatching, momentary-contact fashion.



Spectrum analyzer photo of IM distortion with 14- and 15-kHz input tones. Zero dB equals 100% modulation at 1 kHz.



Tuner noise and sensitivity curves.

The rear apron of the Yamaha T-7 contains two sets of audio outputs, one at a fixed level and another adjustable via a knurled wheel under the front edge of the panel. Binding posts are provided for a 300-ohm FM antenna, and there is a coaxial jack for a 75-ohm antenna. The AM antenna is a hinged, removable, rectangular shielded loop that can be located anywhere within a couple of feet of the tuner.

Circuitry of the Yamaha T-7 includes a multiplex pilot carrier canceller that does not cause any loss of high-frequency response in FM stereo reception, and a highly linear wide-band ratio detector said to give lower distortion than any other type. In addition, the multiplex demodulator uses high-speed CMOS integrated circuit switches.

Laboratory Measurements. The IHF Usable Sensitivity of the T-7 in mono was 11.8 dBf. In stereo it was 18.3 dBf. The stereo switching threshold was 11.8 dBf. Sensitivity for 50-dB quieting, a measurement more reflective of real performance, was 12.8 dBf in mono and 35 dBf in stereo.

At 65-dBf input the tuner noise level was −76.5 dB in mono and −71 dB in stereo; the respective distortion readings were 0.078% and 0.073%. These measurements were made with the tuner in its LOCAL mode.

IHF-IM distortion was measured by modulating the signal generator with equal-amplitude tones at 14 and 15 kHz, whose combined peak level was equal to that of a sine-wave modulation of 100% (75-kHz deviation). The tuner output was displayed on a spectrum analyzer. Third-order IM products at 13 and 16 kHz were 57 dB (0.014%) below the primary tone levels, and the second-order difference tone component was −73 dB (0.022%) referred to 100% modulation.

Capture ratio was between 1.65 and 1.7 dB, depending on signal strength, and AM rejection was 69 to 70 dB. Front-end selectivity was exceptionally high, placing its image rejection beyond our measurement ability (>106 dB).

www.americanradiohistory.com

In LOCAL mode, alternate channel and adjacent channel selectivity were 46 and 9 dB, respectively. The former is adequate for most receiving conditions (it was perfectly usable in the New York metropolitan area) and the latter is actually better than average. In the DX mode, the respective ratings were 84 and 17 dB. Transition between DX and LOCAL modes (for both the selectivity and blend functions) took place at about 38 dBf.

The muting threshold was approximately the same as the stereo threshold, and 19-kHz pilot carrier leakage into the audio outputs was low at −68 dB. Hum was at −74 dB. When the REC CAL button was pressed, the tone delivered corresponded to 52% modulation.

Frequency response in stereo was ruler-flat from 30 Hz to several kHz, rising gradually to +1.2 dB at 15 kHz. Channel separation was very uniform—about 48 dB from 30 to 1,000 Hz, reducing to a minimum of 36.5 dB at 15 kHz.

The only measurements made on the AM section of the T-7 were of frequency response, in both LOCAL and DX modes. In LOCAL, frequency response was −6 dB at 55 and 3,500 Hz. In DX mode, the high-frequency response was −6 dB at 2,200 Hz, confirming increased selectivity for weak signal reception.

User Comment. In appearance, the T-7 is deceptively simple, considering its complex circuitry. Fortunately, its operation is simple (not at all deceptively) and free of annoying quirks.

FM muting is perfect, with the tuner totally silent until a station is tuned in exactly. Muting is effective on AM too, but only when the preset station selection is used. For anyone accustomed to the essentially instantaneous frequency transitions of digitally synthesized tuners, the relatively leisurely movement of the T-7's dial pointer when a preset button is pressed may seem amusingly anachronistic. However, unless one makes a habit of switching between stations at the opposite ends of the dial, the operation is not likely to take more than 3 or 4 seconds. This compares very favorably to the speed of manual tuning, and is considerably easier as well as more likely to be accurate. With the indication provided (the red STEREO light comes on only when the tuning is exactly correct), the user of the T-7 will enjoy low distortion in practice as well as in theory.

Many of the performance qualities and features of the Yamaha T-7 were formerly available only in very expensive "super tuners." Now the owner of a moderately priced stereo system, can have, paying only $400 for the T-7, FM performance and convenience that rival anything available. In design philosophy, the unit represents a happy marriage of the best of the analog and digital worlds. In operation and use, it is simply a pleasure. —*Julian D. Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

$28

ONE OF THE

Finest Pen Watches in the World at the Lowest Price!

SOLD BY OTHERS FOR $69.95

The Original ARTRON Pen/Watch

The pen/watch is not a revolutionary new product. It has been on the market now for years. Unfortunately, from our experience, almost all were novelty-looking in appearance and cheaply constructed. Comparable pen/watches sell for $60 and more.

UNTIL NOW!

We engage in world trade. Being in the import/export business, we are aware of a countries outstanding products. The Artron Pen is sold worldwide and THE EGBERT CO. is the largest distributor of them in the U.S. Since we buy thousands at a time direct from the manufacturer, we can offer the Artron Pen/Watch at $28 . . . a truly wholesale price.

A UNIQUE COMBINATION

The Artron is an accurate, easy-to-read timepiece, combined with a quality writing instrument. The 100% stainless steel construction and classic styling of the Artron Pen/Watch offers you the quality of the undisputed leaders, such as Cross and Schaeffer, with the addition of an accurate LCD watch (accurate to ± 15 sec. a month). The finest quartz digital watches have comparable accuracies usually somewhere between ± 15 to ± 5 sec. a month.

THE WATCH

The LCD display constantly shows you the hour and minutes without any awkward button pushing. When you need the month and day, you just depress the top of the pen once or twice for seconds. An additional push returns it to the time. The watch is powered by a tiny silver oxide Eveready 392 battery that lasts about two years and is easily replaced.

THE ULTIMATE PRACTICAL GIFT

The Egbert Co.
11055 Sunset Blvd.
Los Angeles, CA 90049

Your Artron Pen/Watch comes with full instructions, a one year manufacturer's guarantee against defects and its battery in place. Included with every Pen/Watch is the beautiful presentation case shown. When you receive your Artron Pen/Watch, use it constantly for three full weeks. If, after you've thoroughly tested it, you don't agree that your

CONTINUOUS	1st PRESS	2nd PRESS
2:35	9:13	:07
TIME READOUT	MONTH DAY	SECONDS

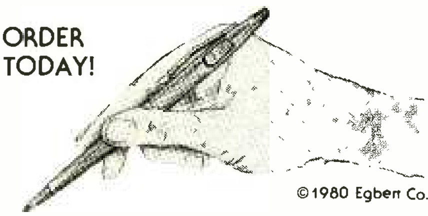
Artron Pen/Watch represents a major breakthrough in price, quality and value, send it back.

We'll refund your entire investment, including the delivery charge. You can't lose . . . we guarantee it.

Time is of the essence.

We can only guarantee the continuation of this introductory price for a short time.

ORDER TODAY!



©1980 Egbert Co.

The Egbert Company, Dept. PE-2
11055 Sunset Blvd. ● Los Angeles, CA 90049

RUSH the following Pen/Watches to me by first class insured mail:

☐ Stainless Steel Model . . . . . . $28 (2 for $52)
☐ Gold Plated model . . . . $38 (2 for $70)
A Generous 5 Micron
☐ Deluxe Stainless Steel & Gold Plated models. . . . . Both for $62
plus $1.50 postage & handling per order.
Calif. add 6% sales tax.

Enclosed find check or money order for $________.
Charge to my ☐ Visa ☐ Master Charge

Card # __________ Exp. Date ________

Name: __________

Address: __________

City/State/Zip: __________

For credit card orders only, call TOLL FREE, 24 hours, 7 days: 800-824-7880.
Ask for operator 107.
In Calif.: 800-852-7777 ● In Alaska/Hawaii: 800-824-7919

CIRCLE NO. 13 ON FREE INFORMATION CARD

www.americanradiohistory.com

Popular Electronics Tests

Sharp 19E91 19" Color TV Receiver

SHARP's Model 19E91 is a handsome 19-inch table-model color-TV receiver housed in a walnut-grained plastic cabinet. It is equipped with a calculator-like keyboard for random channel selection, LED channel display, automatic color and balance control, and a CATV/MATV jack. Included also is an infrared remote-tuning system, also with a keypad, that operates a sophisticated 24-function microprocessor. Among the 19E91's other features are a 4-inch round speaker and a sensor that varies picture brightness according to ambient light level. Dimensions are 24³⁄₁₆"W × 19⅛"D × 17⅞"H, and weight is 51.8 lb. Suggested retail price is $739.95.

Technical Description. Beginning with the ac input in Fig. 1, the 19E91 has the usual line filter coils, followed by a conventional "hot-chassis" full-wave bridge rectifier that delivers two 80-volt (approximately) outputs to the remote-on power controller on the remote-control board and initial dc bias to the anode of thyristor *SCR701*. A return from the emitter of the power controller then turns on *SCR701*, which now becomes a half-wave rectifier that delivers 120 volts to the entire system.

When the horizontal-output transformer (HOT) "fires," *D705* and *D601* conduct and a sawtooth driving voltage reaches power regulator *I701*. In addition, the sawtooth voltage establishes +190 volts dc through *D705* for collector biasing of the red, blue, and green luminance/chroma matrix outputs into the picture tube. The 190- and 120-volt sources are filtered by series "doubler" capacitors *C706* and *C707*. Power regulator *I701* now operates with the 18-volt source, taking its reference through a potentiometer connected between the 120-volt output and ground. The power regulator controls the gate conduction of

www.americanradiohistory.com

SCR701, thus determining its on time and, hence, its current output.

Also in the primary of the *T602* horizontal output transformer are a few turns that furnish both heater voltage for the cathode ray tube and ac that is rectified and filtered to provide the threshold potential for 22-volt zener diode *ZD651*. When *ZD651* breaks over and conducts, a positive dc potential is sent to the X-ray protector in the sync processor. This voltage turns on the X-ray gate at an initial net potential of about 3 volts and kills the CRT's heater and high voltages—and the raster.

The sync processor, a 16-pin chip, extracts composite video from the luminance/chroma processor, and has an internal automatic frequency detector (afc) that regulates the horizontal oscillator frequency, provides an RC-controlled sync gate and, after the vertical oscillator, shapes a sawtooth wave for the vertical amplifier output. It also, via a flip-flop, shuts off the horizontal driver and output when there is too much high voltage, and it contains a voltage regulator.

When there is no incoming signal, a dc-operated horizontal-hold control keeps the RC-timed oscillator in approximate flywheel sync. Sharp's horizontal output stage (Fig. 1) is a conventional current-driven power transistor with shunt diode damper, in parallel with small 3- and 1.6-kV capacitors to ground. The vertical output stage consists of stacked npn transistors that deliver a sawtooth voltage through a 470-μF capacitor to the deflection coils. A side pincushion transformer corrects for any concave nonlinearities, while a variable linearity coil does the rest for horizontal sweep.

Following video detection, luminance information is routed directly (dc) to the chroma/luminance IC while chroma is inverted and LC bandpass filtered before it enters. This LSI chip processes virtually all luminance and chroma functions (except matrix outputs) for the entire receiver.

After inversion and bandpass filtering composite video is routed to the first chroma amplifier. A dc potentiometer sets gain for the contrast amplifier, which routes video information through the usual luminance delay line (D.L.) and on to the sync pedestal clamper. The degree of clamper conduction is monitored by a transistorized automatic brightness limiter (abl) and its varying reference voltage from the HOT. With black reference restored, luminance intelligence is then direct-coupled to the base of a video driver transistor and on to the emitters of the RGB matrix output amplifiers.

After amplification by the first chroma amplifier, chroma and color burst go to the burst amplifier and second chroma amplifier via the color killer, which cuts off the latter when there is no incoming chroma. A gating signal from the sync separator IC alternately turns on and off the chroma and burst amplifiers so that automatic phase control (apc) is applied to the 3.58-MHz voltage-controlled (color sync) oscillator during horizontal blanking. It also automatically controls the gain of the first chroma amplifier through the agc detector. During the line-scan period, amplified chroma goes to the RGB−Y (red, blue, and green minus luminance) demodulators, whose reference phase-control voltage is applied through the lower matrix. Demodulated outputs issue through the upper matrix to the bases of the RGB matrix output transistors.

I-f amplification and automatic gain control (agc) are provided by a single IC that also delivers automatic fine tuning (aft) and detected video. In addition, it amplifies the video signal and cancels any momentary incoming noise that would upset chroma, luminance, audio, and sync.

Uhf and vhf tuners supply sound and picture information to this IC through the i-f preamp and a surface acoustical wave (SAW) filter. The latter has sharp bandpass skirts and excellent adjacent-channel rejection. The only tunable element in the i-f circuit is an LC tank circuit for the synchronous video detector.

I-f and r-f agc voltages are developed by peak detection without flyback sync gating; tuner sensitivity is statically set by manual r-f agc control. Aft error voltage is detected and differentially amplified, then filtered and translated into dc control voltages for the tuner oscillators. High-level noise passing through is detected by the noise canceller, which cuts off video and sync for its duration. To prevent detection "tweets" and develop additional linearity, mid-band 44-MHz information is detected synchronously. Composite video, including sound, is developed for further chroma and luminance processing. The usual 4.5-MHz intercarrier sound develops from heterodyne action between the 45.75- and 41.25-MHz video and sound carriers. The sound carrier is first limited and amplified, and then FM detected and ac coupled to a pair of push-pull class B output amplifiers.

Tuners and their controls in this remote IR set contain complex microprocessor and logic circuitry. We can, however, give you some idea of what this part of the receiver can do.

To properly interact with the "microcomputer," each channel-select key on the front-panel and infrared remote-controller keyboards is assigned a unique 5-bit binary code. The system can be programmed to accept up to 20 channel designations, 12 vhf and eight

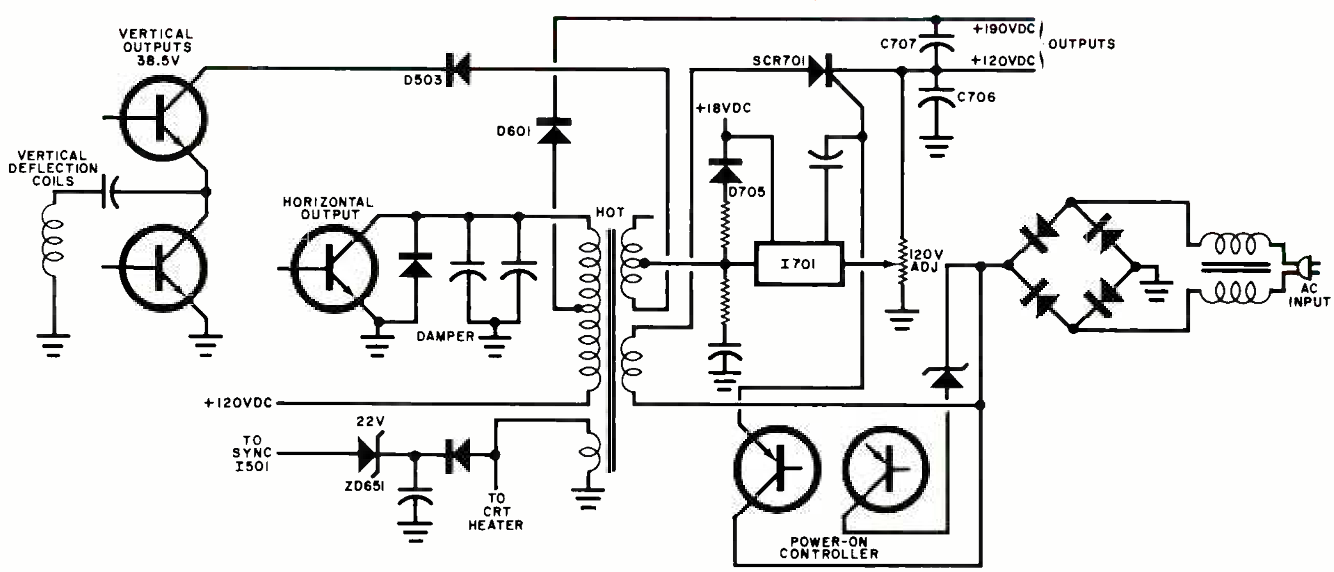


Fig. 1. Simplified schematic of the 19E91's complex power supply.

www.americanradiohistory.com

uhf. Since volume up, volume down, mute, and power are also microprocessor controlled, they too have their own unique binary-code assignments.

When a channel select key is pressed on the front panel or remote controller, its code is transmitted to the processor, which instantly accesses the desired channel and shows its actual number on a large LED display. There are no channel scan buttons. Volume up and down buttons, on the other hand, operate in a scan mode.

When the receiver is initially energized, the power-on command to the microprocessor resets tuning and sound so that the channel assigned to button 2 automatically comes on the screen and its vhf number appears in the LED display. Subsequent channel designations result in a 4-bit data transfer to the decoder and driver, programmable divider, nonvolatile memory, and decoder drivers. Appropriate frequency and display division and comparisons are made in the phase detector. The output of the local oscillator in the phase-locked loop (PLL) is divided and then directed to a buffer that acts as the clock generator for the microprocessor. At the same time a transistor selects bandswitching for low or high vhf or uhf for the prescalers and the U/V tuners.

If there is a phase difference between the local PLL oscillator crystal and command channel frequency, an error voltage from the phase detector goes to the D/A converter, whose dc reference produces an analog correction voltage. When applied to the tuners, this voltage holds them precisely on frequency. Feedback from the prescaler to the PLL programmable divider closes the loop for positive feedback control.

Uhf stations up to a total of eight may be fine-tuned into memory from the receiver's front panel and then command-

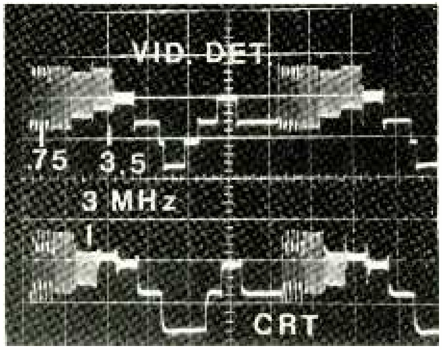


Fig. 2. Multiburst test pattern at video detector (top) and CRT cathodes (bottom).

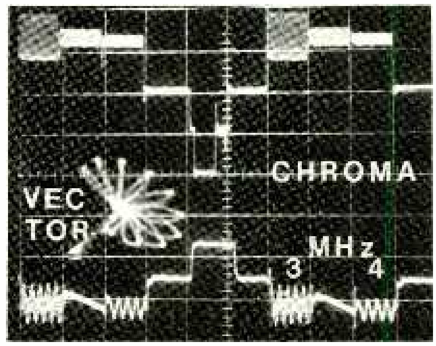


Fig. 3. Swept chroma and vector patterns from the video detector and CRT cathodes.

executed via either the keyboard or remote control. Discrete transistors take care of the muting, volume, and on/off controls.

This Sharp receiver possesses an unpluggable chassis that is nicely laid out for servicing. The EIA312 code identifies the CRT as a Sylvania product, and the microprocessor is socket-mounted for easy removal and substitution.

Test Results. The worst voltage regulation we measured was an excellent 98 percent. Signal/noise measurement read 39.5 dB, a very good figure, and the vhf tuner field-strength reading before onset of snow was an excellent −17 dBmV (−65.8 dBm). Agc also had a wide dynamic range, from −17 to +35 dBmV (−65.8 to −13.8 dBm), a respectable swing before sync clipping at 52 dB. No CB interference was noted during our test on any channel at a distance of 60 feet between outside antennas, and pincushion/barreling effects were nonexistent.

Multiburst pattern revealed at least 3.5 MHz of bandpass at the video detector and 3 MHz at the CRT (Fig. 2). However, the 4.08-MHz swept-chroma pattern at both the video detector and CRT was slightly down, and there was some fuzzy high-frequency accumulation in the 3.08-MHz portion of the signal. The vector pattern between the two waveforms (Fig. 3) was slightly asymmetrical and flared between blue at 180° and green at 300°. There are also some overshoot spikes of voltage in both chroma displays.

SHARP MODEL 19E91 RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity at 75Ω (min. signal for snow-free picture):	vhf (Ch. 3): −17 dBmV (−65.8 dBm) uhf (Ch. 40): −8 dBmV (−56.8 dBm)
Voltage regulation (line varied from 105 to 130 V):	Low voltage: 183-V supply—100% 12-V supply—99% High voltage: 24.5-kV supply—98%
Luminance bandpass at CRT:	3 MHz
Luminance bandpass at video detector:	3.5 MHz
S/N at CRT:	39.5 dB
Convergence:	99.9%
Horizontal overscan:	10%
Agc linear swing (−17 dBmV to +35 dBmV):	52 dB
Audio bandpass (3 dB down):	110 Hz to 3.5 kHz
Power requirement (signal applied):	75 W (incl. remote)

Note: Instruments used in these measurements are from Tektronix, Sadelco, Data Precision, B&K-Precision, and Sencore. They include: Telequipment D66, D67A oscilloscopes; FS-3D-VU f/s meter; Models 245, 1350, 1750 multimeters; types 1248, 1250, CG169 and VA48 (modified) color bar and signal generators; and a variable PR57 power supply.

Comments. In many respects, the Sharp 19E91 is a high-performance receiver with a number of outstanding measurements that place it a good cut above much of its competition. Tuner control, particularly, is excellent. Thanks to the chassis's superlative voltage regulation, we noted hardly any picture shrinkage or blooming when we varied the ac input between 95 and 135 volts. While the picture was not quite as crisp as it could have been on the sample we evaluated, it was no worse than we've experienced with other 19" models in the same price range. Picture brightness and color quality were about average. Finally, Sharp's "energy-saving" Sigma 400 chassis, rated at 95 watts maximum, should go easy on your electric bills.—*Stan Prentiss*

CIRCLE NO. 102 ON FREE INFORMATION CARD

www.americanradiohistory.com

Save on Scanners! NEW Rebates!

Communications Electronics™ the world's largest distributor of radio scanners, celebrates Father's Day early with big savings on *Bearcat* scanners. Electra Company, the manufacturers of *Bearcat* scanners is offering consumer rebates on their great line of scanners, when purchased between April 1 and May 15, 1981.

With a scanner, you can monitor the exciting two-way radio conversations of police and fire departments, intelligence agencies, mobile telephones, energy/oil exploration crews, and more. Some scanners can even monitor aircraft transmissions! You can actually hear the news *before* it's news. If you do not own a scanner yourself, now's the time to buy your scanner from **Communications Electronics**. Choose the scanner that's right for you, then call our *toll-free* number to place your order with your Visa or Master Charge.

We give you excellent service because **CE** distributes more scanners worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of scanner orders every week. We also export scanners to over 300 countries and military installations. Almost all items are **in stock** for **quick shipment**, so if you're a person who prefers fact to fantasy and who needs to know what's *really* happening around you, order your scanner today from **CE**!

NEW! Bearcat®† 350

The Ultimate Synthesized Scanner!

Allow 120-240 days for delivery after receipt of order due to the high demand for this product.

List price $599.95/**CE price $419.00**

4-Band, 50 Channel • Alpha-Numeric • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 30-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 350 introduces an incredible breakthrough in synthesized scanning: Alpha-Numeric Display. Push a button—and the Vacuum Fluorescent Display switches from "numeric" to word descriptions of what's being monitored. 50 channels in 5 banks. Plus, Auto & Manual Search, Search Direction, Limit & Count. Direct Channel Access. Selective Scan Delay. Dual Scan Speeds. Automatic Lockout. Automatic Squelch. Non-Volatile Memory. Reserve your *Bearcat* 350 today!

Bearcat® 300

List price $549.95/**CE price $349.00/$25.00 rebate**

Your final cost is a low $324.00

4-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

NEW! Bearcat® 350

FREE Bearcat® Rebate Offer

Get a coupon good for a $25 rebate when you purchase a *Bearcat* 300, 250, 220 or 210XL; $20 rebate on model 160; $10 rebate on model Four-Six Thin Scan and $5 rebate on the *Bearcat* 5. To get your rebate, mail this coupon with your original dated sales receipt and the *Bearcat* model number from the carton to Electra. You'll receive your rebate in four to six weeks. Offer valid only on purchases made betwen April 1, 1981 and May 15, 1981. All requests must be postmarked by May 30, 1981. Limit of one rebate per household. Coupon must accompany all rebate requests and may not be reproduced. Offer good only in the U.S.A. Void where taxed or prohibited by law. Resellers, companies, clubs and organizations–both profit and non-profit–are not eligible for rebates. Employees of Electra Company, their advertising agencies, distributors and retailers of *Bearcat* Scanners are also not eligible for rebates. Please be sure to send in the correct amount for your scanner. Pay the listed **CE** price in this ad. *Do not* deduct the rebate amount since your rebate will be sent directly to you from Electra. Orders received with insufficient payments will not be processed and will be returned.

Bearcat® 250

List price $429.95/**CE price $279.00/$25.00 rebate**

Your final cost is a low $254.00

50 Channels • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time, at your convenience.

Bearcat® 220

List price $449.95/**CE price $289.00/$25.00 rebate**

Your final cost is a low $264.00

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting AM aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Not only does this new scanner feature normal search operation, where frequency limits are set and the scanner searches between your programmed parameters, it also searches marine or aircraft frequencies by pressing a single button.

Bearcat® 210XL

List price $349.95/**CE price $229.00/$25.00 rebate**

Your final cost is a low $204.00

18 Channels • 3 Bands • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

NEW! Bearcat® 160

List price $299.95/**CE price $189.00/$20.00 rebate**

Your final cost is a low $169.00

16 Channels • 3 Bands • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

Would you believe...the *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner.

This scanner presents a new dimension in scanning form and function. Look at the smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Of course the *Bearcat* 160 incorporates other advanced *Bearcat* features such as Priority, Direct Channel Access, Dual Scan Speeds, Automatic Channel Lockout, Scan Delay and Auxiliary. All this performance in sleek, contemporary styling. And at a price so low, it astounds even us!

Bearcat® 5

List price $134.95/**CE price $94.00/$5.00 rebate**

Your final cost is a low $89.00

8 Crystal Channels • 3 Bands • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches.

Bearcat® Four-Six ThinScan™

List price $189.95/**CE price $124.00/$10.00 rebate**

Your final cost is a low $114.00

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This three band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1." Includes rubber ducky antenna. Order crystals for each channel. Made in Japan.

TEST ANY SCANNER

Test any scanner purchased from **Communications Electronics**™ for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

Low cost 6-channel, 3-band scanner!

The *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna. Order crystal certificates for each channel. Made in Japan.

Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel. Made in Japan.

FANON SCANNER ACCESSORIES

SCMA-6 Mobile Adapter/Battery Charger.......... $49.00
CHB-6 AC Adapter/Battery Charger $15.00
CAT-6 Carrying case for Fanon w/Belt Clip $15.00
AUC-3 Auto lighter adapter/Battery Charger....... $15.00

OTHER SCANNERS & ACCESSORIES

Regency®‡ M400 Scanner......................$259.00
Regency® M100 Scanner........................$199.00
Regency® R1040 Scanner......................$169.00
SP50 AC Adapter $9.00
SP51 Battery Charger.................................$9.00
SP58 Carrying Case for *Bearcat* 4-6 ThinScan™ ...$12.00
FB-E Frequency Directory for Eastern U.S.A. $12.00
FB-W Frequency Directory for Western U.S.A. $12.00
FFD Federal Frequency Directory for U.S.A. $12.00
MK350 Mobile mounting kit for *Bearcat* 350 ...... $12.00
B-4 1.2 V AAA Ni-Cad's for ThinScan™ and Fanon ... $9.00
A-135cc Crystal certificate.............................$3.00
Add $3.00 shipping for all *accessories* ordered at the same time.

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your scanner, it is essential that you use an external antenna. We have six base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna. Order **#A63** is a ¾ inch hole mount. Order **#A64** is a ⅜ inch snap-in mount, and **#A70** is an all band base station antenna. All antennas are $35.00 and $3.00 for UPS shipping in the continental United States.

BUY WITH CONFIDENCE

To ***get the fastest delivery from CE*** of any scanner, send or phone your order directly to our Scanner Distribution Center.™ Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability. All sales on accessories are final. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. Most products that we sell have a manufacturer's warranty. Free copies of warranties on these products are available prior to purchase by writing to CE. International orders are invited with a $20.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

Mail orders to: **Communications Electronics,**™ Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $7.00 per scanner or phone product for U.P.S. *ground* shipping and handling, or $14.00 for faster U.P.S. *air* shipping to some locations. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. Dial 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited**. All order lines at **Communications Electronics**™ are staffed 24 hours.

Scanner Distribution Center™ and CE logos are trademarks of Communications Electronics.™

† *Bearcat* is a federally registered trademark of Electra Company, a Division of Masco Corporation of Indiana.

‡ *Regency* is a federally registered trademark of Regency Electronics Inc.

Copyright ©1981 Communications Electronics™

COMMUNICATIONS ELECTRONICS™

854 Phoenix □ Box 1002 □ Ann Arbor, Michigan 48106 U.S.A.

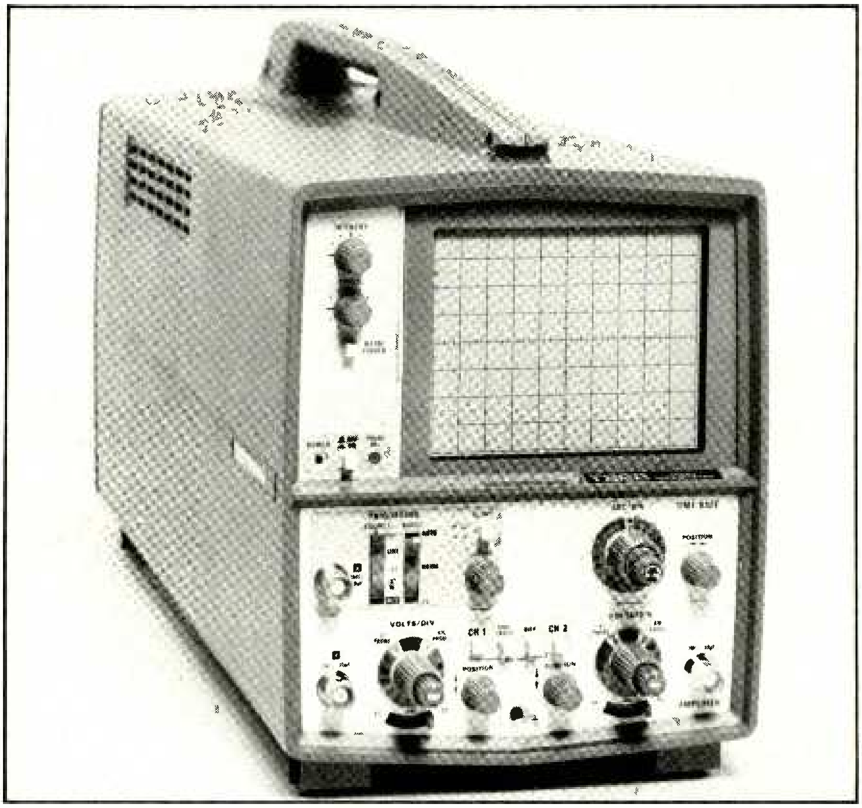
Call TOLL-FREE (800) 521-4414 or outside U.S.A. (313) 994-4444

We're first with the best.℠

CIRCLE NO. 1 ON FREE INFORMATION CARD

www.americanradiohistory.com

Popular Electronics Tests
The Tektronix T922 Dual Trace Oscilloscope



THE Tektronix T922 Dual Trace Oscilloscope is a dc-to-15-MHz instrument designed for general-purpose waveform viewing. Its companion, the T922R is a more elaborate 19" rack-mounted version, and the T921 is a single-trace version. This new line of instruments, carrying the Tektronix name, is aimed at engineers and service technicians who demand a lot from a relatively low-priced scope.

Some of the interesting features of the T922 are a rectangular CRT with an 8-x-10-cm display area, a built-in graticule to eliminate parallax viewing error, a 12.4-kV accelerating voltage, a BEAM FINDER that locates either or both traces if the position control has taken the trace off the screen, and a tilt stand and skid-proof feet to enable use on a smooth-topped workbench.

The T922 measures 7"W x 19"D x 10"H and weighs 19 lb. Suggested retail price is $1,090.

General Description. The two vertical channels have their operating controls symmetrically arranged about the center of the front panel. Selection of either channel, or dual trace, is made via pushbuttons.

The VOLT/DIV scale of each vertical step attenuator is optically arranged so that only two ranges are clearly visible at a time—one for use with a ×1 probe, and the other for use with a ×10 probe. The VARiable input gain control, color-coded red and mounted coaxially with the step attenuator, forms a vernier between the 1-2-5 settings of the step attenuator control.

Mounted alongside each range switch is the trace POSITION control. Each vertical input (BNC type) is provided with an AG/GND/DC signal selector switch; and a separate additional ground connector is provided.

The common time base TRIGGERING SOURCE can be selected from INTernal, LINE, EXTernal, EXT/10, or X-Y (vector). The TRIGGERING MODE can be selected from AUTO, NORM, or TV. AUTOmatic

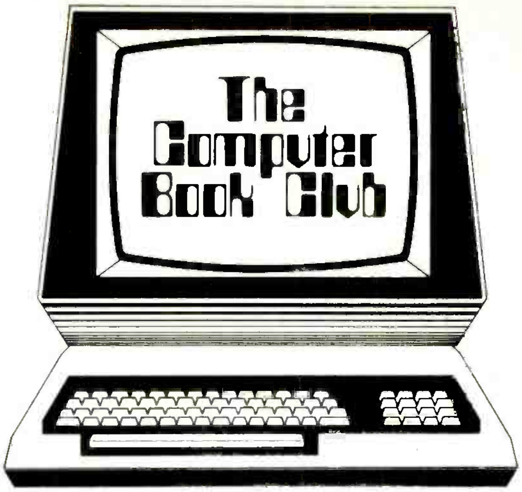
www.americanradiohistory.com

Into computers? Want to get started?

Take 4 books for $1.00

. . . and get one FREE!

(values to $70.75)



What is The Computer Book Club? An exciting new concept that puts hobbyists and businessmen on top of the fast-paced, dynamic world of computers. CBC will bring you info on software, hardware, applications, and theory . . . at savings up to 75% on hundreds of fact-packed volumes.

CBC is not just another book club! You can get in on Members' Bonus Benefits, like discounts on practical software packages, games, cassettes and disks, plus extra-value book dividends, and much, much more!

This introductory membership offer is for a limited time only. Join today!

1205 List $15.95

1050 List $9.95

1095 List $8.95

1062 List $12.95

1191 List $16.95

1187 List $14.95

1141 List $12.95

1055 List $7.95

1160 List $12.95

1241 List $12.95

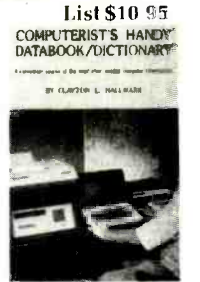
1203 List $14.95

1045 List $10.95

More books to pick from . . .

- **The Complete Handbook of Robotics.** List $12.95. No. 1071
- **57 Practical Programs & Games in BASIC.** List $10.95. No. 1000
- **The GIANT Handbook of Computer Projects.** List $15.95. No. 1169.
- **Illustrated Dictionary of Microcomputer Terminology.** List $13.95. No. 1088
- **How To Design, Build & Program Your Own Working Computer System.** List $14.95. No. 1111
- **Handbook of Remote Control & Automation Techniques.** List $16.95. No. 1077

FREE when you join . . .



List $4.95

7 very good reasons to try The Computer Book Club . . .

- **Reduced Member Prices.** Save up to 75% on books sure to increase your know-how
- **Satisfaction Guaranteed.** All books returnable within 10 days without obligation
- **Club News Bulletins.** All about current selections—mains, alternates, extras—plus bonus offers. Comes 10 times a year with dozens of up-to-the minute titles you can pick from
- **"Automatic Order".** Do nothing, and the Main selection will be shipped automatically! But . . . if you want an Alternate—or no books at all—we'll follow the instructions you give on the reply form provided with every News Bulletin
- **Continuing Benefits.** Get a Dividend Certificate with every book purchased after fulfilling Membership obligation, and qualify for discounts on many other volumes
- **Extra Bonuses.** Take advantage of added-value promotions, plus special discounts on software, games, and more
- **Exceptional Quality.** All books are first-rate publisher's editions, filled with up-to-the minute info

THE COMPUTER BOOK CLUB
Blue Ridge Summit, PA 17214

Please accept my Membership in The Computer Book Club and send the 4 volumes circled below, plus a free copy of *Computerist's Handy Databook/Dictionary*. I understand the cost of the books selected is $1.00 (plus shipping/handling). If not satisfied, I may return the books within ten days without obligation and have my Membership cancelled. I agree to purchase 4 or more books at reduced Club prices during the next 12 months, and may resign any time thereafter.

1000 1045 1050 1055 1062 1071 1077 1088 1095
1111 1141 1160 1169 1187 1191 1203 1205 1241

Name ______________________ Phone ______________

Address ____________________________________

City ____

State ___________________________ Zip __________

(Valid for new members only. Foreign and Canada add 20%. Orders outside U.S. must be prepaid with international money orders in U.S. dollars.) PECC-481

CIRCLE NO. 52 ON FREE INFORMATION CARD

www.americanradiohistory.com

MANUFACTURER'S SPECIFICATIONS

CRT
Display area: 8 × 10 cm (rectangular)
Phosphor: P31
Accelerating potential: 12.4 kV
Built-in graticule
Vertical amplifier
Deflection factor: 2 mV/div to 10 V/div, 12 steps, 1-2-5 sequence
Accuracy: +20°C to 30°C within 3%
0°C to 45°C within 4%
Variable range: continuous between settings. Extends deflection factor to at least 25 V/div.
Frequency response: dc to at least 15 MHz.
Risetime: 23 ns or less
Chopped mode: approximately 250 kHz
Input impedance: approximately 1 MΩ/30 pF
Max. input voltage: 250 V (dc + peak ac)
500 V (p-p ac) at 1 kHz
Sweep Rate
Range: 0.5 s/div to 0.2 μs/div, 20 steps in 1-2-5 sequence.
Magnifier: ×1 to ×10
Accuracy (0° to +45°C): Unmagnified within 4%, magnified within 6%
X-Y operation
Deflection factor: ×10 magnifier approximately 100 mV/div, ×1 approximately 1 V/div.
X-axis bandwidth: dc to at least 1 MHz.
Input impedance: 1 MΩ/30 pF
Phase difference between axes: 5° or less from dc to 50 kHz.
Triggering
Sensitivity: 0.5 div internal or 100 mV external from 2 Hz to 1 MHz, increasing to 1.5 div int. or 150 mV ext. to 15 MHz.
TV sync: composite sync 1 div internal or 100 mV external (approximately 2.3 div or 230 mV composite video).
External trigger: max. 250 V (dc+peak ac) or 500 V (p-p ac) 1 kHz or less.
Input impedance: 1 MΩ/30 pF.
Level range: +0.5 to −0.5 V external, +5 to −5 V external/10.
Power: 120/240 V, 50/60 Hz, 50 watts.
Environmental
Storage temp: −55 to +75°C,
Operating temp: 0 to +45°C,
Altitude: 50,000 feet.
Physical
Weight: approximately 15 lb.
Width: 7.09 in.
Height (to top of handle): 10 in.
Depth: 18.7 in.
Accessories: 2 probes, clear filter, manual.
Optional Accessories: plain and rainproof covers, stand, 1× probe, switchable 1×-10× probe, 100× probe, 1000× probe, ac current probe, 10× dc to 35 MHz probe.

trigger syncs the sweep in accordance with the preset switches, NORMal means manual adjustment of the triggering, while TV selects an internal TV-like sync clipper as the source of sync pulses. This latter position is useful for TV servicing. Trigger SLOPE can be either positive or negative, with the triggering point determined by the LEVEL control.

Like the vertical attenuator, the time base SEC/DIV switch is also arranged so that only the range in use can be easily read. Coaxial with this switch is a red-colored knob that allows sweep time magnifications from ×1 to ×10 between each step-switch setting. This latter control is used in place of the usual fixed sweep magnifier.

Mounted on the rear of the chassis, the Z-axis connector can be used to modulate the intensity of the traces with a positive-going signal causing a decrease in trace intensity. Discretely molded into the front panel are a series of slots for an optional camera or protective front panel cover. Each of the two P6006 Probes that come with the T922 are of the ×10 type, having an input resistance of 10 megohms, and a voltage rating of 600 volts dc, or 600 volts ac peak-to-peak and dc combined.

Accompanying each probe is a 12" and 5" ground lead having an alligator clip, a plastic probe holder, BNC tip, banana plug, probe tip hook, spring tip, and a pincher tip. The last five items screw onto the probe.

Probe compensation is accomplished by connecting the probe tip to the scope front-panel PROBE ADJ connector, loosening the probe locking sleeve, then twisting the probe body until a clean square wave is displayed. After compensation, the locking sleeve is tightened.

The manual accompanying the T922 is impressive and contains everything you need to know for initial start-up, adjustments, service, etc. It is profusely illustrated and contains complete schematics, board interconnections, and a detailed parts list.

Comments. The manufacturer's own specifications for the T922 are shown in the Table. The instrument was checked by the Lockheed Instrumentation Measurements Lab., against standards traceable to the Nation Bureau of Standards. The lab issued a certificate testifying that the T922 meets or exceeds its claimed specifications in all respects.

We found the T922 very easy to use, with all controls clearly identified. At first, the small knobs felt a little uncomfortable, but we soon got used to them. Triggering quality was excellent, even on very short duration waveforms. Even after several hours of use, the scope ran cool.

The only flaw we found was a trace "ghost"—a faint defocussed image that accompanies each trace and produces a faint background haze. Tektronix informed us that this "ghosting" is due to the use of 12.4 kV on their post acceleration CRT, as compared to the 2 to 3 kV usually used in scopes. This very high voltage gives the T922 its excellent writing speed but also knocks secondary electrons out of the CRT faceplate mesh element thus causing the haze. From where we sit, the haze is a very small tradeoff for the writing speed. Never does it seriously obscure the traces.

During our dozens of hours of T922 use, we found the beam finder very advantageous when the screen "went blank" due to excessive manipulation of the trace position controls. That single pushbutton has saved many hours of pot twisting in search of a missing trace. We also like the trace brightness when examining some rather fast waveforms, and have found the T922 excellent for examining some of the fast waveforms on a disc-controller board. With our old scope, we had to darken the room just to get a glimpse of what was happening, but the T922 lets us work in normal room light. Even at the high brightness, the focus remains excellent. We also found the T922 capable of rock-steady sync at low-amplitude high frequencies.

The clearly identified controls have positive detents to permit easy setting. We also found that keeping the front-panel clean is a snap—all you need is a small sponge and warm water.

The relatively light weight of the T922 has allowed us to take the instrument into the field. It has withstood being bounced around in a van with no damage.

We find the T922 a well-balanced combination of accuracy, ruggedness, versatility, and human engineering. It is a bit more expensive than some of the "low-cost" dual tracers available, but the difference, in our opinion represents money well spent. Without a doubt, the instrument delivers value for its cost.

—Leslie Solomon.

CIRCLE NO. 104 ON FREE INFORMATION CARD

www.americanradiohistory.com

COMPUTER BITS

By Carl Warren

NCC Is Just Around The Corner

THOSE of you who live in the Chicago area will want to get ready to visit the National Computer Conference (NCC), to take place May 4–7 at McCormick Place. If you're unfamiliar with the show, it's the one where just about all computer companies in the industry get together to show their wares.

This year, the format of the show has been changed. Personal computers will no longer be separated; they will be part of the main exhibits.

Expect very heavy crowds and limited parking facilities. Those of you who may be coming from out of town will find that hotel space is at a premium, too, and you may have to stay quite a distance away if early hotel room reservations were not made.

Advance reports indicate that some of the real excitement at the show will be generated by the introduction of a number of personal computers from Japanese manufacturers. Expect to see units that are priced well under $500, and possibly a new offering from Apple.

Should your interest be in innovative disk systems, you can expect to find very-high-density floppies. For example, Iomega (Ogden, UT) is planning to show a 10M-byte floppy system. The unit employs a unique cartridge-type design and a flying head. No pricing yet for the end user, but expect something in the $3,000 range.

While there, you will want to make a stop at Vector Graphic's booth, where you will see the Models 3005 and 2600 desk-top computer systems. Both are unitized systems each consisting of a CRT, a keyboard, a four-slot S-100 bus backplane that houses a Z-80 microprocessor-based single-board computer, 64K RAM board, Flashwriter video board, and a dual-mode disk controller board. The basic differences in the systems are as follows. The 3005 comes with a Seagate Technology ST-506 Microwinchester and a Tandom quad density 5.25-in. floppy. The Model 2600, on the other hand, comes with two floppy drives.

A nice feature of the 2600 is that it can be easily upgraded to the 3005 by simply buying the Microwinchester. The controller will support it and three floppies. Its software is already optimized to support it. The Model 3005 is priced at $7,950; the 2600 at $4,995.

Vector Graphics has some really exciting software. Specifically, its Memorite III word processing package, with a 33,000-word spelling dictionary, is very useful. In concert with this type application software, they are offering "Execugraph," which is a Visicalc-like (from Personal Software) tabulating system.

When I asked Robert Harp, the company's chief executive officer, if they were going to be offering any of the software separately, he gave a qualified no. Harp asserts that they would lose too much control and wouldn't be able to offer the same level of support for the software as they do when it's with their systems.

Follow this visit by heading to Hewlett-Packard to view the new HP-83 system. Interestingly, the HP-83 is not really a new system; its actually a downgrade of the popular HP-85. The 83 offers all the features of the 85, including graphics, but is minus the built-in printer and tape cartridge drive.

HP officials said that they took this move since there was so much interest in the machine among computer hobbyists. However, a lower price was desirable and interest in the small printer and special tape cartridge system wasn't high. The HP-83 is priced at $2,250.

Think PM. One of the many things users of computer systems seem to forget is preventive maintenance (PM). This is basically just taking care of your system to avoid costly breakdowns.

In reality, PM is cleaning the CRT screen, dusting off the keyboard, and cleaning out paper dust from the printer.

Although this sounds simple enough, it is often forgotten. To assist you in keeping your system up to snuff, Inmac, a computer supply house, is offering specialized maintenance kits for around $35 to $50, depending on contents.

Typically, what you can expect to find in the helpful kits are: a screwdriver and nutdriver set, CRT cleaning solution, font cleaning paper, and canned air for blowing out dust in hard-to-reach places. Some of the kits will contain small vacuums, and other specialized PM items.

To introduce these items, Inmac will be providing a free little kit at NCC just to get you started. Don't write for one—they won't send it! You must stop by their booth.

Make a MODEM Choice. One category of products that seems to hold high interest, among peripherals is the MODEM. Microperipheral Corp. in Redmond, WA. recently added some exciting products to their line in this field. This includes the TRS-80 Connection; the RS-232C Connection, for any system with an RS-232C port, the Atari Connection; and even support for some European systems. The Connection Modems start at $199.95 with an additional $79.95 for the autodial/autoanswer option. The MODEMs come complete with software, and you really only have to plug them in and compute.

(Continued overleaf)

Vector Graphic's 3005 word and data processing system has 5-MB $5\frac{1}{4}$-inch Winchester disk and one 630-KB floppy disk for expanded capability.

www.americanradiohistory.com

FREE
HEATHKIT®
CATALOG

400 electronic kits: Stereo components, color TV's, computers, test instruments, electronics educational programs, amateur radio gear — things you've always wanted, now at low kit prices.

Discover the fun of kit building: It's a great way to relax in your spare time, resulting in beautiful things you'll be proud to have in your home. And it's easy. The famous Heathkit illustrated manuals make it easy for anyone to build reliable craftsman-like kits.

Send today! It costs nothing to discover the complete line of Heath electronic kits. Don't miss it. Clip and mail the coupon now.

Heathkit

If coupon is missing, write:
Health Company, Dept. 010-762
Benton Harbor, MI 49022

Heathkit — Health Company, Dept. 010-762, Benton Harbor, MI 49022

Send my free Heathkit Catalog now.
I am not currently receiving your catalog.

Name ____________
Address ____________
City ____________ State ______
CL-730 Zip ______

CIRCLE NO. 25 ON FREE INFORMATION CARD

Clean Your Dirty Head. To old Navy types, the lead-in to this paragraph may carry an interesting connotation, but for 3M it means keeping the heads on your floppy drives clean to avoid hard errors that may possibly ruin a valuable data diskette.

What 3M is offering is the Scotch brand 7400 and 7440 head-cleaning diskette kits. The 7400 is for 8-in. drives and the 7440 for 5.25-in. The $30 kits consist of two head-cleaning diskettes and one 4-oz bottle of cleaning solution with a dispenser cap. All you do is put the solution on the exposed cleaning surface, insert the diskette in the drive and access it. About 30 seconds later you have a clean, smooth head. Alan Henaman, 3M's marketing communication manager, says if you use the cleaning system at least once a week, you can probably avoid some unforeseen problems. I have to agree. Since I started using the cleaning diskettes, some error problems I was having literally disappeared.

Extend Your S-100 Bus. A few weeks ago, I was experiencing some interfacing problems with my S-100 bus system. I knew that I really needed to look at what types of signals were showing up on the serial card, but I couldn't reach the pins to hang a scope on them. Therefore, I called my old friend Bob Mullen of Mullen Computer Products. I explained my problem to Bob and he asked if I was a proud owner of an extender card. To which I replied yes, though only for the Heath H-8 bus. The next morning I had a TB-4 A/T extender board with logic probe. He sent the $79 assembled and tested version rather than the $59 kit since I wanted to solve my problem as quickly as possible. Within about 10 minutes of opening the package and inserting the board in the bus with the suspect board in it, I had isolated the problem. And I did it with the attached logic probe.

Shortly after solving this problem I got the urge to add a parallel port to the system. As luck would have it, I didn't have a handy piece of Vector Electronics S-100 bus wirewrap board. I was about to abandon my urge to build when I noticed that Bob had gone to all the trouble of providing a kluge area on the board just for such purposes, making the board a sort of universal tool.

I'm Dreaming of Some Software. The question that seems to show up the most in letters I receive from PE readers is "What software should I buy?" The question is really a difficult one to answer. It greatly depends on what you want or think you want to achieve, of course. However, basically I think you're safer to stick with well-known established companies. Since they have already gone to all the trouble to figure out what really is needed and works. There are lesser-known companies whose products may be super, of course, but risks are naturally higher in trying to choose the best ones.

Here are some software packages that I have used and consider good stuff. From Microsoft: BASIC interpreter, $350; BASIC Compiler, $395; COBOL-80, $750; FORTRAN-80, $500; MuMath, $250; MuLISP, $200 (the latter two packages offer engineers some marvelous possibilities, which I'll reserve for a later column); and EDit-80, $120.

All of the foregoing packages come under the heading of system software, and are used for developing other software. Microsoft has put a lot of effort in their design.

Give Jim a Call. Recently, I was talking to Jim Blake, Heath's software honcho. Jim was saying that things are going well for the "Softstuff" department of Heath. They have a number of packages, from CP/M to CBASIC, and some pretty good applications including a full-screen editor for the H-89 and H-19.

But Jim wasn't totally happy since he doesn't have all the software he would like. He wants things like a spooler, a tabulation program, business applications, and utility programs. Jim says he's interested in talking to competent programmers who can call him at (616) 982-3813.

While I was talking to Jim, I mentioned that I had just finished writing a book using Organic Software's Textwriter III ($125), which gave me the ability to automatically create a table of contents and an index. I thought Jim might want Mike Poshn, its creator, to make it available to Heath users—which is possible if you have CP/M.

I told Jim that Mike had developed two other packages; Datebook for $295, and Milestone for $395. These are applications that allow a user to set up an appointment calendar and develop Pert or goal charts.

Up Your Apple II to 64K. Dottie Hall, Microsoft Consumer Products' product manager, called recently to tell me that the 16K RAMCard for the Apple II was ready. This $195 add-on is designed to work in tandem with the Microsoft Softcard and

Hewlett-Packard's HP-83 personal computer.

www.americanradiohistory.com

Start learning and computing for only $129.95 with a Netronics 8085-based computer kit. Then expand it in low-cost steps to a business/development system with 64k or more RAM, 8" floppy disk drives, hard disks and multi-terminal I/O.

THE NEW EXPLORER/85 SYSTEM

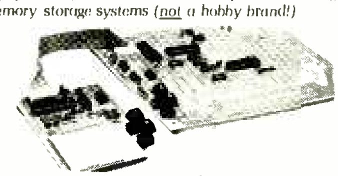
Special! *Full 8" floppy, 64k system for less than the price of a mini! Only* **$1499.95!**

(Also available wired & tested, $1799.95)

Imagine — for only $129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers onboard S-100 bus expansion. Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only $129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.

Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)

Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. $129.95



Level "A" With Hex Keypad/Display.

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O . . . all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader . . . cassette tape recorder input and output . . . cassette tape control output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems . . . RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at FØØØ, leaving ØØØØ free for user RAM/ROM. Features include tape load with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point, a debugging/training feature . . . go to execution address . . . move blocks of memory from one location to another . . . fill blocks of memory with a constant . . . display blocks of memory . . . automatic baud rate selection to 9600 baud . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high-speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling . . . tape dump with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point . . . go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

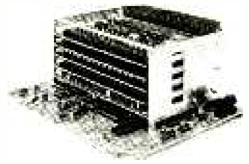
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks . . . address decoding for onboard 8k EPROM expansion selectable in 8k blocks . . . address and data bus drivers for onboard expansion . . . wait state generator (jumper selectable), to allow the use of slower memories . . . two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from ØØØØ to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP. professional drive.
- LSI controller.
- Write protect.
- Single or double density
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track).

DISK CONTROLLER/ I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
- Onboard crystal controlled.
- Onboard I/O baud rate generators to 9600 baud.
- Double-sided PC board (glass epoxy.)

DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

ORDER A COORDINATED EXPLORER/85 APPLICATIONS PAK!

Beginner's Pak (Save $26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply (regular price $199.95), now at SPECIAL PRICE: **$169.95** plus post. & insur.

Experimenter's Pak II (Save $53.40!) — Buy Level "A" (Hex Keypad/Display Version) with Hex Keypad/Display, Intel 8085 User Manual, Level "A" Hex Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price $279.35), all at SPECIAL PRICE: **$219.95** plus post. & insur.

Special Microsoft BASIC Pak (Save $103.00!) — Includes Level "A" (Terminal Version), Level "B", Level "D" (4k RAM), Level "E", 8k Microsoft in ROM, Intel 8085 User Manual, Level "A" Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price $439.70), now yours at SPECIAL PRICE: **$329.95** plus post. & insur.

ADD A TERMINAL WITH CABINET, GET A FREE RF MODULATOR: Save over $114 at this SPECIAL PRICE: **$499.95** plus post. & insur.

Special 8" Disk Edition Explorer/85 (Save over $104!) — Includes disk-version Level "A", Level "B", two S-100 connectors and brackets, disk controller, 64k RAM, AP-1 5-amp power supply, Explorer/85 deluxe steel cabinet, cabinet fan, 8" SD/DD disk drive from famous CONTROL DATA CORP. (not a hobby brand!), drive cabinet with power supply, and drive cable set-up for two drives. This package includes everything but terminal and printers (see coupon for them). Regular price $1630.30, all yours in kit at SPECIAL PRICE: **$1499.95** plus post. & insur. Wired and tested, only **$1799.95.**

Special! Complete Business Software Pak (Save $625.00!) — Includes CP/M 2.0, Microsoft BASIC, General Ledger, Accounts Receivable, Accounts Payable, Payroll Package: (regular price $1325), yours now at SPECIAL PRICE: **$699.95.**

Please send the items checked below:

- ☐ **Explorer/85 Level "A" kit** (Terminal Version) . . . **$129.95** plus $3 post. & insur.
- ☐ **Explorer/85 Level "A" kit** (Hex Keypad/Display Version) . . . **$129.95** plus $3 post. & insur.
- ☐ **8k Microsoft BASIC** on cassette tape, **$64.95** postpaid.
- ☐ **8k Microsoft BASIC in ROM kit** (requires Levels "B", "D" and "E") . . . **$99.95** plus $2 post. & insur.
- ☐ **Level "B" (S-100) kit** . . . **$49.95** plus $2 post. & insur.
- ☐ **Level "C" (S-100 6-card expander) kit** . . . **$39.95** plus $2 post. & insur.
- ☐ **Level "D" (4k RAM) kit** . . . **$69.95** plus $2 post. & insur.
- ☐ **Level "E" (EPROM/ROM) kit** . . . **$5.95** plus 50¢ p&h
- ☐ **Deluxe Steel Cabinet** for Explorer/85 . . . **$49.95** plus $3 post & insur.
  - ☐ Fan For Cabinet . . . **$15.00** plus $1.50 post. & insur.
- ☐ **ASCII Keyboard/Computer Terminal kit:** features a full 128 character set, u&l case; full cursor control; 75 ohm video output; convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator) . . . **$149.95** plus $3.00 post. & insur
  - ☐ **DeLuxe Steel Cabinet** for ASCII keyboard/terminal . . . **$19.95** plus $2.50 post & insur.
- ☐ **New! Terminal/Monitor:** (See photo) Same features as above, except 12" monitor with keyboard and terminal is in deluxe single cabinet; kit . . . **$399.95** plus $7 post & insur
- ☐ **Hazeltine terminals:** Our prices too low to quote — **CALL US**
- ☐ **Lear-Sigler terminals/printers:** Our prices too low to quote **CALL US**
- ☐ **Hex Keypad/Display kit** . . . **$69.95** plus $2 post & insur
- ☐ **AP-1 Power Supply Kit** ±8V @ 5 amps) in deluxe steel cabinet . . . **$39.95** plus $2 post. & insur.
- ☐ **Gold Plated S-100 Bus Connectors** . . . **$4.85** each, postpaid.
- ☐ **RF Modulator kit** (allows you to use your TV set as a monitor) . . . $8.95 **postpaid.**
- ☐ **16k RAM kit** (S-100 board expands to 64k) . . . **$199.95** plus $2 post. & insur.
- ☐ **32k RAM kit** . . . **$299.95** plus $2 post. & insur.
- ☐ **48k RAM kit** . . . **$399.95** plus $2 post. & insur.
- ☐ **64k RAM kit** . . . **$499.95** plus $2 post. & insur
- ☐ **16k RAM Expansion kit** (to expand any of the above in 16k blocks up to 64k) . . . **$99.95** plus $2 post. & insur. each
- ☐ **Intel 8085 cpu Users' Manual** . . . **$7.50** postpaid
- ☐ **12" Video Monitor** (10MHz bandwidth) . . . **$139.95** plus $5 post. & insur.
- ☐ **Beginner's Pak** (see above) **$169.95** plus $4 post & insur
- ☐ **Experimenter's Pak** (see above) . . . **$219.95** plus $6 post & insur.
- ☐ **Special Microsoft BASIC Pak Without Terminal** (see above) **$329.95** plus $7 post & insur.
- ☐ Same as above, plus **ASCII Keyboard Terminal With Cabinet, Get Free RF Modulator** (see above) **$499.95** plus $10 post & insur
- ☐ **Special 8" Disk Edition Explorer/85** (see above) **$1499.95** plus $26 post & insur.
  - ☐ **Wired & Tested** **$1799.95** plus $26 post & insur
- ☐ **Extra 8" CDC Floppy Drives** **$499.95** plus $12 post & insur
  - ☐ **Cabinet & Power Supply For Drive** **$69.95** plus $3 post & insur
- ☐ **Drive Cable Set-up For Two Drives** . . . **$25** plus $1.50 post & insur.
- ☐ **Disk Controller Board With I/O Ports** . . . **$199.95** plus $2 post & insur.
- ☐ **Special: Complete Business Software Pak** (see above) . . . **$699.96** postpaid.
  - SOLD SEPARATELY
  - ☐ **CP/M 1.4** . . . **$100** postpaid.
  - ☐ **CP/M 2.0** . . . **$150** postpaid.
  - ☐ **Microsoft BASIC** . . . **$325** postpaid.
- ☐ **Intel 8085 cpu User Manual** . . . $7.50 **postpaid.**
- ☐ **Level "A" Monitor Source Listing** . . . **$25** postpaid.

Continental U.S.A. Credit Card Buyers Outside Connecticut

CALL TOLL FREE: 800-243-7428

To Order From Connecticut Or For Technical Assistance, call (203) 354-9375

Total Enclosed (Conn res add sales tax) $ ______
Paid By:
☐ Personal Check ☐ Cashier's Check/Money Order
☐ VISA ☐ Master Charge (Bank No. _ _ _ _)
Acct. No. ______________ Exp. Date ______
Signature ______________
Print Name ______________
Address ______________
City ______________
State ______________ Zip ______________

NETRONICS Research & Development Ltd.
333 Litchfield Road, New Milford, CT 06776

greatly expands utility of the Apple II for running FORTRAN, COBOL, and BASIC-80. If you have this card and a 48K system you can boast a full 64K to your friends. Even if you're not quite ready for the card, give Dottie a call and ask for a catalog of some of the exciting products they have hidden away.

Come on, Charlie. If you are a Heath owner and want to keep in touch with other Heath owners, or are interested in finding out what Heath and others are making available, you should subscribe to BUSS—The independent Newsletter of Heath Company Computers. This informative monthly newsletter is full of ideas, gripes and helpful hints. Its editor, Charles Floto, says that interest is mounting in the Heath sysems; and, as a consequence, he is finding more to write about.

Charlie isn't pulling any punches either. When he thinks the Benton Harbor company hasn't done right, he calls it to their and your attention.

BUSS is $18 for 12 issues and worth the money. If you talk to anyone who is a member of a Heath users group, you'll more than likely find they keep a notebook of BUSS as a ready reference.

Answers to Questions. Since I get an unbelievable amount of a mail each month, I can't always answer each letter directly. So here are some short answers with questions implied.

No, Atari BASIC is not a Microsoft version. The reason that BASIC from the same software house, for the same processor, but for different systems, can look so different, is that the company making the system tells the software house what extensions they want and how they want them to work. Yes, you can do bit manipulation in BASIC, but you have to know what bit to toggle, and how logic AND, OR, and XOR operate. ◇

MORE INFORMATION

For additional information about products or services mentioned in this column, contact the companies directly.

BUSS
326 Pennsylvania Ave., S.E.
Washington, DC 20003
202-544-0484

Hewlett-Packard
1501 Page Mill Rd.
Palo Alto, CA 94304
415-857-1501

Inmac
Box 4780
Santa Clara, CA 95051
408-727-1970

Lifeboat Assoc.
1651 Third Ave.
New York, NY 10028
212-860-0300

3M
Data Recording Prod. Div.
223-5N 3M Center
St. Paul, MN 55101
612-733-1995

Microsoft
400 108th Ave., N.E. Ste. 200
Bellevue, WA 98004
206-454-1315

The Microperipheral Corp.
2643 151st Pl., N.E.
Redmond, WA 98052
206-881-7544

Mullen Computer Prod. Inc.
Box 6214
Hayward, CA 94545
415-783-2866

Organic Software
1492 Windsor Way
Livermore, CA 94550
415-455-4035

Personal Software
1330 Bardeaux
Sunnyvale, CA 94086
408-745-7841

Vector Graphic Inc.
31364 Via Colinas
Westlake Village, CA 91361
213-991-2302

apple II
16K computer
$1103
APPLE II 48K $1253
DOS 3.3 with upgrade kit $54
Disk II With Controller $535
. . . without $446
Nearly Everything for Apple
EXCITING DISCOUNTS

APPLE COMPUTER INTERFACE CARDS

Asynchronous Serial Interface #7710A	$145
Applesoft II Firmware Card	149
CCS Arithmetic Processor Card #7811B	329
CCS Parallel Interface Card #7720A	155
Centronics Printer Interface Card	179
Apple Clock/Calendar Card by Mountain Hardware	229
Communications Card & DB25 Cable	179
Integer Basic Firmware Card	149
Parallel Printer Interface Card	139
Prototyping Hobby Card	22
Romplus Card with keyboard filter	169
Romplus Card without keyboard filter	159
SSM AIO Serial/Parallel I/O Assembled & Tested	169
Serial Interface Card	139
Symtec Light Pen Card	214

APPLE II ACCESSORIES

Apple Joystick	47
ABT Numeric Input Keyboard	99
ALF Music Synthesizer	245
Brightpen Lightpen from Softape	32
Clear Cover for Apple Computer	25
CCS Programmable Timer Module	159
Dan Paymer Lower Case Kit (Model I)	59
Dan Paymer Lower Case Kit (Model II)	59
Hayes Micromdem	335
Extender Board	27
Graphics Input Tablet	649
Introl X-10 Remote Control System	239
Introl X-10 Controller Only	164
M&R Sup-R-Term 80 Column Board	325
Microsoft Z-80 Soft Card	299
Novation Cat Modem	159
Romwriter	149
Speechlink 2000/64 Word Vocabulary	215
SuperTalker Speech Synthesizer	239
Sup-R-Mod RF TV Modulator	25
SVA 8" Disc Controller Card	329
Versa-Writer Digitizer Drawing System	209

apple computer III
IN STOCK. CALL FOR PRICES!

PRINTERS, MONITORS, DISCS

Daisy Wheel Printer!	1795
Anadex DP8000	850
Anadex DP8000AP	850
Centronics without cable	819
Epson TX80-B W/Graphics	799
Epson MX80	645
MPI 88T	650
NEC Spinwriter #5510	2695
Paper Tiger 460G	1394
Silentype with Interface Card	540
Leedex Video 100-12" B&W	129
Sanyo 9" B&W	169
Dyson disks (pkg 10)	50
Memorex (pkg 10)	40
Verbatim (pkg 10)	30

SOFTWARE

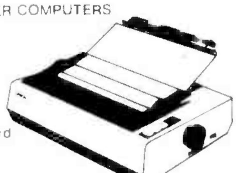
Adventure	27
Apple Bowl	14
Assembler/Dissassembler	69
Applebug Debugger	27
Apple Graph & Plot System	59
Applepost Mailing List System	44
Applesoft Utility Programs by Hayden	27
Applewriter Word Processor	65
Bill Budges Space Game Album	39
Bill Budges Trilogy of Games	29
The Cashier Retail Management System	189
CCA Data Management by Personal Software	84
The Contributed Volumes 1-5 w/manuals	29
Desktop Plan by Personal Software	79
Dow Jones Portfolio Evaluator	44
Forth II by Softape	45
Fortran for use with Language System	159
Pascal Language System	419
Sargon II Chess Game-cassette	27
Sargon II Chess Game-disk	35
Shell Games	27
Space Invader-Cassette	18
Space Invader-disk	25
Sub-Logic FS-1 Flight Simulator Cassette	23
Sub-Logic FS-1 Flight Simulator-disk	29
Sybex Apple 80 8080 Simulator	17
Visicalc by Personal Software	119
Business Package	595

WE SHIP FAST!

ATARI 800
PERSONAL COMPUTER SYSTEM
$747

Atari 400 Computer	$469
Atari 820 Printer	489
Atari 810 Disk Drive	569
Atari 410 Program Recorder	69
Atari 16K RAM Module	149
Atari 8K RAM Module	99
Atari Basic ROM	45
Atari Visicalc	179
Basketball	30
Video Easel	30
Super Breakout	30
Music Composer	45
Computer Chess	30
Star Raiders	39
850 Interface	169
825 Printer	795
Assembler/Editor	45

Epson Printers
APPLE & MOST OTHER COMPUTERS
NEW! MX80
40 80 132 columns
LIST ~~$645~~
TX 80 w Graphics
LIST ~~$799~~
Apple Controller & Card & Cable
LIST ~~$110~~



OUR PRICE CALL
- Most reliable small printers ever sold!
- Uses standard printed paper
- Graphics option transfers screen image directly to paper

1-800-854-2833

TO ORDER: Phone orders invited using Visa Mastercard or bank wire transfers Visa & MC credit card service charge of 2%. Mail orders may send charge card number (include expiration date) cashiers check money order or personal check (allow 10 business days for checks to clear). Please include phone number. Include 3% shipping handling and insurance ($5.00 minimum) in USA. Shipments within Cal.* add 6% sales tax. Foreign orders include 1% handling-shipped freight collect. Foreign orders over $1000 allow 6 weeks extra and include $25 license fee. All equipment is in factory cartons with the manufacturers warranty. Equipment is subject to price change and availability. We ship the same day on most orders. No C.O.D.s or P.O.s accepted. Retail store prices differ from mail order prices.

master charge
VISA

MAIL TO: 1251 BROADWAY EL CAJON CA., 92021
MEMBER BBB (714) 579-0330

AUTHORIZED APPLE SALES & SERVICE
Computer Specialties
DIV OF COMPUTER METRICS INC

CIRCLE NO. 7 ON FREE INFORMATION CARD

COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

Atari RAM. The RAMCRAM can expand an Atari 400 system to 32K bytes and the Atari 800 to 48K bytes. In the 400, RAMCRAM replaces the Atari-supplied 8K module. This allows the 400 to use disks, printers, and other peripherals. Any 32K Atari 800 software will run on a 400 with RAMCRAM. Address: AXLON Inc., 170 N. Wolf Rd., Sunnyvale, CA 94086.

132 by 30 Terminals. The Displaymaster is a Z80-based terminal using a 13″ by 7″ P32 green phosphor CRT. It features 132 or 80 characters per line, 24, 27, or 30, lines, 16 programmable keys, numeric keypad, screen highlighting, addressable cursor, set-up mode, 129 ASCII characters, up to 19.2K-baud rate, Hazeltine/Lear-Siegler/

DEC VT100 emulation, fixed tabs, 16K-byte display memory, auxiliary port, block mode, and line drawing. Options include separate keyboard, second 128-character set, 32K memory, graphics, and light pen. Address: GDS Inc., 1911 22nd Ave. South, Seattle, WA 98144 (Tel: 206-322-9330).

Hardware Catalog. Contains data on 6502 machines, power supplies, various Apple plug-ins, 2716 programmers, Z80 machines, A/D converters, and a number of bare boards. Address: John Bell Engineering, Box 338, Redwood City, CA 94064.

16-Bit Trainer. The TM990/189 University Module 16-bit trainer features a TMS9980A processor (16-bit), an on-board 45-key alphanumeric keyboard and 10-character display, a firmware debug monitor and symbolic assembler, a cassette interface, on-board user-addressable LEDs/speaker/displays, 16-bit programmable I/O controller with interrupts and timer, 4K bytes of ROM with 2K-byte expansion socket, 1K RAM, and optional EIA/20-mA interface. $299. The Memory and I/O Expansion Module expands the University Module by 8K, has sockets for 8K bytes of RAM, and 8K bytes of EPROM. It also includes an EPROM programmer for 2708/2716. $299. The TM990/519 Power Supply provides all necessary voltages for University Module. $65. Address: George Goode & Associates, Inc., 12840 Hillcrest Rd., Suite 113, Dallas, TX 75230 (Tel: 214-980-0730).

TRS-80 Add Ons. The AN-538 Analog Port Interface provides A/D and D/A conversion for the TRS-80. The unit also houses an interface with both latched 8-bit data output and 8 decoded device control lines. $79.95. The AN-

511 Digital Port Interface provides 8 bits of input data, 8 bits of output data, 8 device control lines (decoded port addresses), and the 8-bit data bus at the front panel. $79.95. The AN-551 EPROM Programmer can program either 2716 or 2732 EPROMS from a BASIC program in less than 300 seconds. $89.95. The Digital Speech Processor provides voice interface for the TRS-80. Digitized voice data is saved in RAM or on diskette to create vocabulary files. $89.95. Address: The Design Solution Facility, Box 1225, Fayetteville, AR 72701 (Tel: 501-521-0281).

64K Apple. The RAMcard provides an additional 16K bytes of RAM to an Apple, making a 48K system (present maximum) into a full 64K system. With the Softcard, a full 56K CP/M environment is provided. $195. Address: Microsoft Consumer Products, 400 108th Ave., NE, Suite 200, Bellvue, WA 98004 (Tel: 206-454-1315).

SS-50 Interface. The ACIA Interface Card occupies one slot in the SS-50 system to allow users to design and prototype RS-232, 20-mA, or TTL outputs from two 6850 ACIAs. Separate baud rate control for each 6850 is provided. The card supplies +5 volts to chips and

ILP AUDIO MODULES
A new concept in audio design
Compact high performance modules
Ideal for * Home music systems
* Subwoofers and bi-amplification
* Musical instrument amplification
* Professional sound reinforcement
MODULAR SYSTEMS APPROACH ALLOWS YOU TO BUY ONLY WHAT YOU NEED!
* Stereo or Mono, you decide wattage
* Basic power or with preamplification
* Start simple, expand when you need to * Design your own custom cases
FULL FIVE YEAR WARRANTY
Power Amplifiers
• Built-in heatsinks
• Protected circuitry
• No external parts required
• 5 simple connections

HY50 30 watts RMS $28.95
High performance amp with rugged aluminum heatsinks. Measure only 4″ × 2″ × 1″ thick! Mounts with 2 screws. Gives 30 watts RMS at 0.02% distortion. Response 10 — 45 KHz. 4 to 16 ohms. ± 25 V/2A.
HY30. 15 watts RMS. Size/specs as HY50. 20 V/2A. 25.95
HY200 120 watts RMS $79.95
High performance amplifier with large heatsink area for cool operation. Fully protected circuitry. Distortion only 0.01% at 120 watts RMS (1 KHz). Response 10 Hz — 45 KHz. S/N ratio 100 db. Only five connections. Amazingly compact — only 4½″ × 4″ × 2″ D. Mounts with 2 screws. Requires ± 45 V/3A.

HY120. 60 W RMS. Specs/size as HY200. 35 V/2A. 59.95
HY400 240 Watts (4 ohm). Double the power, double heatsink area! Same specs as HY120/200. May be used into 8 ohms at reduced output. 4″ × 4½″ × 4″. ± 45 V/4A $99.95
HY400 bridging circuit for 480 watts available 1981.
PreAmplifiers

HY66 Stereo $48.95
HY6 Mono $25.95
Inputs for RIAA phono, tape with monitor, tuner, auxiliary and microphone; full tone control circuitry. Incredible performance: Response DC to 100 KHz, distortion 0.05%, S/N 90 db. Output to 4.5 V RMS. Supplied with edge connectors. Compact. Reliable. Internal voltage regulation — use from 15 to 50 V safely! May be used in multiples for PA, instrument mixers etc. Order optional pcb's to extend edge connectors: B6 (for HY6) $3.75 and B66 (for HY66) $4.75
Power Supplies
Circuit boards with all components plus TOROIDAL transformers (except PSU30 and 36). Toroidals are half the size and weight of conventional transformers; and are quieter and more efficient. Note: HY6 and HY66 can also be powered from any supply.
PSU50 for 1 or 2 HY50 .... $33.60
PSU60 for 1 HY120 .... $51.00
PSU70 for 1 or 2 HY120 .... $64.00
PSU90 for 1 HY200 .... $65.50
PSU180 for 1 HY400 or 2 HY200 .... $89.50
PSU36 for 1 or 2 HY30 .... $33.60
PSU30 for 12 HY6 or 6 HY66 .... $22.95
Telephone Order (716) 849-0735
DEALER AND OEM ENQUIRIES INVITED
GLADSTONE Electronics
901 Fuhrmann Blvd., Buffalo N.Y. 14203
Name ______
Address ______
City ______ Zip ______
Please send ______
Amt. enclosed ______
Check ( ) M/O ( ) Visa ( ) M/C ( )
Number ______ Exp. ______
In Canada: Gladstone Electronics, 1736 Avenue Rd., Toronto (416) 787-1448
CIRCLE NO. 21 ON FREE INFORMATION CARD

www.americanradiohistory.com

user area, and the IRQ line is jumper programmable for one or both 6850 IRQ outputs. $8.50 for bare pc board and instructions. Address: Quality Research Co., Box 7207, Spokane, WA 99207.

Software

List Management The Ultimail Version 5 List Management System for the TRS-80 Model I with 48K requires two mini-disks or one 8" floppy. It uses random disk files and stores 650 records on a mini or 1000 on the 8" diskette. Program routines include: data entry, database-record display, edit, delete, directory in alphabetic order, labels with zip code, and any number of labels printed per address. Each record consists of a zip code, alpha key entry for directory printouts, and 3 to 4 lines per address with the first up to 31 characters, second and third lines 29 characters, and fourth line 28 characters. Errors can be immediately corrected. $124.95. Address: Computer Generated Data, 5541 Parliament Drive, Suite 208, Virginia Beach, VA 23462 (Tel: 804-497-1165).

Apple PASCAL. The PASCAL Utility Express Package contains four procedural units that simplify I/O formatting: access and/or change in the disk directory from a PASCAL program: perform integer, string, and real conversions: and support files of variable-length records. It also contains five sample programs of PASCAL demos with BASIC equivalents, a routine to view disk files in ASCII or hex, a text formatter for simple word processing, and a program to maintain a variable-length data file for the international traveler. $45 on diskette. Address: Software Express, Box 50453, Palo Alto, CA 94303 (Tel: 415-856-9244).

Typing Tutor. Type-It is a typing tutor, a drill master, and a speed tester. It assumes the user knows nothing about typing, and is self paced. Runs on TRS-80 Model I, Level 2 or disk BASIC. Supplied on cassette or disk. $14.95. Address: Bluebird's Inc., 2267 23rd St., Wyandotte, MI 48192 (Tel: 313-285-4455).

New VisiCalc. The VisiCalc program, previously only available for the Apple, is now available for the Atari 800 and Commodore systems. The Commodore version automatically senses whether it is running in a PET with a 40-character screen, or the CBM 8032 with an 80-character screen. The VisiCalc creates a 64-column wide, 254-row high matrix on screen. It speeds repetitious calculations like inventory planning, sales forecasts, financial analyses, and modelling of physical phenomena. Address: Personal Software Inc., 1330 Bordeaux Drive, Sunnyvale, CA 94086 (Tel: 408-745-7841).

Payroll Package. The Payroll System calculates complete payroll transactions including Federal tax returns for 300 employees. It permits up to four user-definable pay rates for each employee, and handles tips, bonuses, expense reimbursements, advances, sick pay, and vacation pay. It will calculate for any combination of pay schedules: weekly, bi-weekly, monthly or semi-monthly. Three additional categories may be created for each employee. It will operate stand alone, or with the SSG General Ledger. Requires CP/M with 54K RAM, two disk drives, 132 column printer, 24 × 80 terminal, and 2.04 version of CBASIC. Address: Structured Systems Group, 5204 Claremont Ave., Oakland, CA 94618 (Tel: 415-547-1567).

PL/65 for AIM-65. The high-level system implementation language PL/65 is now available for the Rockwell AIM-65 computer. Control statements such as conditional execution (IF-THEN-ELSE) and conditional looping (FOR-TO-BY), coupled with simplified block capability, support structured program design techniques. It generates R6500 assembly language source code and allows assembly language instructions to

www.americanradiohistory.com

ALBIA ELECTRONICS

NEW...

LOW COST CAPACITANCE METER MODULE!!

NOT A KIT

Completely assembled and tested . . . for only

$49.95 Includes Warranty

INSTANT ORDER INFORMATION BELOW!

Connect this high-quality Albia Capacitance Meter Module Model DM-8 to your digital multimeter and turn it into a Digital Capacitance Meter — the low cost way!

— Push to read range (button) from 1 pf to 20,000 uF.
— Zero calibration control
— In one easy to use, self-contained package
— Battery powered (with "push to read" battery saver)

IN STOCK! IMMEDIATE DELIVERY!

LOW COST HIGH FREQUENCY COUNTER

The Albia Model DM-7, 8 Digit High Frequency Counter is easy to use, switch selectable time base input by a single BNC, nothing to build — nothing more to buy!

— 5 Hz to 550 MHz
— 8 big easy-to-read .43" high intensity LED display
— Crystal (±3 ppm @ 25°C) controlled 0.1 or 1.0 sec. gate times
— Convenient benchtop size (7"x10"x3") durable attractive case

NOT A KIT

NEVER BEFORE AT THIS LOW PRICE .... **$119.95** Includes Warranty

COMPLETELY ASSEMBLED • PRE-CALIBRATED • PRE-TESTED

NEW ALBIA DESIGN-MATE CIRCUIT DESIGNER

NOT A KIT

Albia Quality Hardware — your ideas — not a kit — pre-wired pre-tested — don't let this price fool you, this is a high quality, high IC capacity, portable self-contained circuit designer — includes;

— Control switches and buffered LED logic indicators.
— Plug in your IC s into solderless breadboards, tie in power and ground, connect your logic switches and LED indicators — FAST, EASY TO USE!
— All interconnections between LED s, switches, and circuits via 22-26 solid wire.
— Self-powered, in one compact, good looking and durable carrying case.
— Ideal for home experiments, the laboratory and students.
— Battery (4 1½ Volt C cells*) or AC powered provides economical bench use or convenient portable use.

Available in two models.

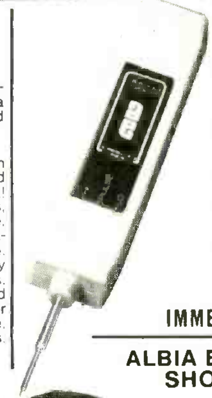
Albia Model DM-5A containing 4 LEDs and 4 logic switches **$49.95** Includes Warranty

Albia Model DM-5 contains 8 LEDs and 8 logic switches **$64.95** Includes Warranty

*Batteries not included.

INSTANT ORDER INFORMATION BELOW!

ALBIA'S ECONOMY DIGITAL DM-9 MULTI-LOGIC COMPATIBLE 5-15VDC PROBE



The features are many on this quality Albia test instrument; will detect low repeat rate pulses (up to 1.5 MHz); detects low, high or pulsed logic levels with a minimum detectable pulse width of 300 nsec. Easy-to-interpret 3 LED readout. Built-in over-voltage and reverse polarity protection.

$26.95 Includes Warranty

IMMEDIATE DELIVERY . . . NOT A KIT

ALBIA EXTERNAL REGULATED, SHORT PROOF ADAPTER

Model DM-5B, supplies up to 300 MilliAmps at 5V, saves batteries . . . ONLY **$19.95** Includes Warranty

REGULATED TRIPLE POWER SUPPLY
BARGAIN PRICED ALBIA MODEL DM-6

A fully assembled and tested power supply that provides a solid, fully wired triple power supply including fixed 5V @ 1 Amp, 5V to 15V @ 0.5 Amp, and −5V to −15V @ 0.5 Amp — all supplies regulated, short proof. Each supply has short indicator LED. Complete and ready for use in a durable (8"x6"x3½") metal case.

$79.95 Includes Warranty

FREE!! NEW 1981 SPRING CATALOG

Exciting new products! Send today!!

ALBIA SATISFACTION WARRANTY: If for any reason, whatsoever, you are not completely satisfied with your purchase, return it within 30 days of purchase date for a full refund — it's as simple as that!

POSTAGE & HANDLING	
ORDERS	ADD
UP TO $10.00	$1.75
$10.01 - $25.00	2.25
$25.01 - $50.00	2.75
$50.01 - $100.00	3.25
ORDERS OVER $100.00 WITHIN UNITED STATES	N/C

FOR FAST AND DEPENDABLE DELIVERY SERVICE

CALL TOLL FREE: 1-800-243-6953 9 A.M. to 5 P.M. E.S.T.

WE ACCEPT MASTER CHARGE, VISA AND AMEX CREDIT CARDS

Connecticut Residents add 7½% Sales Tax • Prices shown in U.S. currency only. Foreign orders add 15%.

ALBIA ELECTRONICS INC

24 Albia St. • New Haven, CT 06512

FREE ALBIA "TEMPLATE" WITH EVERY ORDER RECEIVED by April 25, 1981

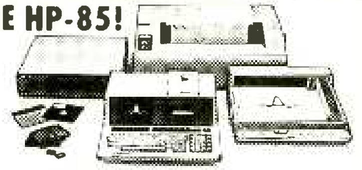
www.americanradiohistory.com

computique computique computique

TEXAS INSTRUMENTS INCORPORATED
electronic calculators

TI 30SP	17 95
TI 35SP	24 95
Bus Anal I	21 95
BA I Exec NEW	44.95
Bus Card	39 95
Invest Anal NEW	49.95
TI 55	34 95
TI 57	54 95
TI 5100	39 95
TI 5015	64 95
TI 5040	89 95
TI 5135 NEW	79 95
TI 5142 NEW	124.95
TI 808 41 NEW	62.95
TI 58C	104.95
TI 59	209.95
PC 100C	169.95
TI 58/59 Libraries	35.00
Speak & Spell	59.95
Speak & Read NEW	CALL
Speak & Math NEW	CALL
Lang Tutor NEW	169.95
Home Comp 99 4	
Console Only	499.95

THE HP-85!



Complete Enhancements, Peripherals and Accessories

Your HEWLETT PACKARD *Headquarters*

HP 33C NEW	89.95
HP 34C NEW	124.95
HP 38C NEW	124.95
HP 32E	54.95
HP 37E	59.95
HP 41C NEW	CALL
HP 85 NEW	CALL
HP 41CV NEW	CALL
HP 83 NEW	CALL

(714) 549-7373 INFORMATION LINE
(800) 432-7066 TOLL FREE (Within CA)
(800) 854-0523 TOLL FREE (Outside CA)

apf	IMAGINATION MACHINE	495 00
apple computer	II PLUS (16K)	999.95
apple ///	APPLE III NEW	CALL
SHARP	6200 NEW EXECUTIVE	99.95
	5813 NEW SCI PROGRAMMABLE	34.95
	5100 NEW LCD ALPHANUMERIC	89.95
	5102 NEW FIN PROG	79.95
	7000 NEW MEMO WRITER	124.95
CASIO	ML 90	49.95
	FX 68	27.95
Fidelity	CHESS CHALLENGER "7"	99.95
	SENSORY CHESS CHALLENGER "8" NEW	129.95
ATARI	800 (16K) STARTER SYSTEM	899.95
CODE-A-PHONE	1000	109.95
	1750 NEW	269.95
BSR X-10	TIMER NEW	59.95
	CONTROLLER COMMAND	33.95

ALSO: CANON, TOSHIBA, NSC, SEIKO, MATTEL, PEARLCORDER, ITT, GTE, AND MANY OTHERS ALL AT GREAT PRICES!!

WE WILL MEET OR BEAT ANY COMPETITOR'S ADVERTISED PRICE ON MOST ITEMS IF HE HAS THE MDSE ON HAND VISA, MASTERCARD, MONEY ORDER, PERS CK (14 WRKG DAYS TO CLR), COD ACCEPTED MIN $4 95 SHIPPING U S A AIR ON REQST, CAL RES ADD 6% SALES TX. ALL MDSE SUBJ TO AVAIL., PRICES SUBJ TO CHANGE. POPEL Apr 81

MAIL & PHONE ORDERS ONLY

Send orders to: **computique** WRITE OR CALL FOR FREE CATALOG

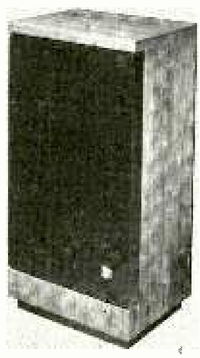
3211 SO. HARBOR BLVD SANTA ANA, CA 92704	WEST LOS ANGELES (213) 820-0423	MID-WILSHIRE (213) 385-7777	PASADENA (213) 795-3007
NEWPORT (714) 549-7373	TARZANA (213) 705-7507	LAWNDALE (213) 370-5795	BREA (714) 990-6600

PROFESSIONAL DISCOUNTS

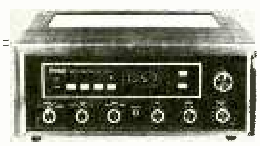
CIRCLE NO. 8 ON FREE INFORMATION CARD

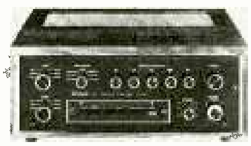
FREE McIntosh

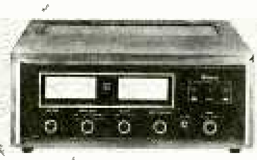
STEREO CATALOG and FM DIRECTORY



Get all the newest and latest information on the new McIntosh catalog. In addition you will receive an FM station directory that covers all of North America.







SEND TODAY!

McIntosh Laboratory, Inc. PE
East Side Station P.O. Box 96
Binghamton, N.Y. 13904

NAME ______
ADDRESS ______
CITY ______ STATE ____ ZIP ______

If you are in a hurry for your catalog please send the coupon to McIntosh. For non rush service send the **Reader Service Card** to the magazine.

CIRCLE NO. 41 ON FREE INFORMATION CARD

be incorporated in line. It is contained in two 4K-byte ROMs which plug in the AIM 65 master module. $125. Address: Microsystems Marketing, Electronic Services Div., Rockwell International, Box 3669, Anaheim, CA 92803 (Tel: 714-632-3729).

Medical Software. The Medical Secretary, written for the Apple computer, is a complete administrative package that includes elements for appointment scheduling, patient registration, private patient billing, insurance claim preparation, and medical record preparation. The system requires one or two Apple II's (or Apple II Plus) with either two or three disk drives each and a 130-column printer. Comes on four diskettes. $500. Address: Monument Computer Service, Village Data Center, Box 603, Joshua Tree, CA 92284 (Tel: 800-854-0561 Ext. 802; in CA, 800-432-7157).

TRS-80 Time Keeping. Timetrak is a utility for adding time intervals to a TRS-80. The start and stop boundaries in hours and minutes are entered via the keyboard. In operation, the program processes all start/stop time pairs and displays to five decimal places. An interval can be from one minute to 48 hours and up to 150 intervals can be entered. Applications include time charging, rental, equipment operating times, lab experiments, etc. Cassette is $25, diskette is $35. Address: Omni Systems Co., Box 29347, Minneapolis, MN 55430.

OS Business Package. The EIS GEN-200 is an accounting package designed for all Ohio Scientific disk-based systems. It contains journals, general ledger, statements, aging reports, and customer/vendor files. It can be integrated with an upcoming payroll and inventory system. Address: Electronic Information Systems, Box 5893, Athens, GA 30604 (Tel: 404-353-2858).

TI Music Packages. Two music programs for the Texas Instruments TI-99/4 Home Computer are now available. The first is Music Melody for one or two players that includes 50 melodies in which players race to identify the melody played. Points are awarded according to the amount of time required to identify the score. The Music Skills Trainer features: "Pitch Trainer" to help the user recognize particular notes; "Interval Recognition" to test the ability to recognize intervals between two notes; "Chord Recognition" for identifying a key and major/minor chords; and "Phase Recall" to improve aural memory by asking the student to repeat a sequence of notes played by the computer. $24.95 for tape cassette, $29.95 for diskette. Address: Texas Instruments Inc., Consumer Relations, Box 53, Lubbock, TX 79408 (Tel: 800-858-4565, in Texas 800-858-4279). ◇

www.americanradiohistory.com

THE AFFORDABLE HOME COMPUTER

IS NOW ON SALE.

When PMC-80 was first introduced to the United States, the response was overwhelming! The Computer World was ASTONISHED at the QUALITY, as well as the PRICE. In fact, the PMC-80 has almost all the features of America's best selling computer, the TRS-80, but with a price tag of $200.00 less! (SIMUTEK'S price is $275.00 less!)

Microsoft's Level II Basic and 16K Memory.

Another reason for all the commotion is that the PMC-80 uses the same, easy to learn, LEVEL II BASIC language that the TRS-80 uses! What does this mean? It means that the PMC-80 can run all the 1000's of programs that have been written for the TRS-80 Level II, 16K computer! Some of the programs available include: Flight simulation, World Champion Chess program, Scores of educational and business programs. Word processing programs and hundreds of other games and simulations.

The PMC-80 is expandable!

Your PMC-80 is ready to grow with your needs. Using a special cable, available from Simutek for $35.00, it may be connected to Radio Shack's Expansion interface, to give you up to 48,000 characters of memory, up to 4 disk drives, addition of a telephone communication system, Voice Synthesizer, various printers, a real time clock, as well as plotters and other neat interfaces! As your skills with the PMC-80 improve, you're sure to want some of the ADD-ON's described above. (And these are just a few!)

Save Money! Use your own television!

The PMC-80 has a built in RF MODULATOR so you can use your black and white or color TV for a VIDEO MONITOR! A simple hook-up to your television's antenna connector, makes channel 3 your computer's video channel.

Special Introductory Offer: 25 Free Programs

SIMUTEK, a leading innovator in Home Computer Software, is making a SPECTACULAR INTRODUCTORY OFFER to people that ORDER the PMC-80 NOW With each purchase, we will give 25 FREE HOME COMPUTER PROGRAMS! Some of these include: Home Amortization tables program, Loan payment programs, Depreciation rate program, Interest table program, Annuity and Investment calculation programs as well as these great animated games: GRAPHIC-TREK 2000: Command the Enterprise!, INVASION WORG . Stop the invading marauders from space before they take over earth! You command Earth's forces of androids, space fighters, laser guns etc., against the enemy's robots, saucers, proton destroyers, etc!, STAR WARS: Fly your space fighter into the Death Star to destroy it! But watch out, Darth Vader doesn't like you!, SPACE TARGET: A fantastic animated arcade game of skill and daring!, SAUCERS: Can you win win the coveted Medal of Honor?

Comparison Chart

Features	PMC-80	TRS-80
Microsoft's Fantastic Level II Basic	Yes	Yes
Full 128 x 48 Graphics	Yes	Yes
16,000 characters memory	Yes	Yes
Tape recorder for storing or retrieving programs	Yes	Yes
Use your own TV (Save $$)	Yes	No
Expandable to 48,000 characters of in computer memory	Yes	Yes
Use TRS-80 expansion interface	Yes	Yes
Expandable to 4 floppy disk drives (over 100,000 characters of storage on each one!)	Yes	Yes
Telephone Communications available connect to large computers/electronic mail etc	Yes	Yes
1000's of ready made programs availble for "educational" and "scientific" applications?	Yes	Yes
Printers available	Yes	Yes
High Speed Z80 CPU	Yes	Yes
Interface available for controlling lights and appliances in home	Yes	Yes
Retail Price	**$645.00**	**$849.00**

Here's what you get:

The PMC-80 microcomputer with 16,000 characters of "In Computer Memory", Microsoft's Level II Basic (in 12K ROM), a cassette player for storing or retrieving programs or data (cassette player is built into the computer!), an RF Modulator for connecting the PMC-80 to your television set, 25 FREE programs so you start using your computer immediately, complete instruction manual, learning manual and owners manual so you can begin writing your own programs right away!

Also available is a special Leedex Video Monitor Regular price $170.00. Special price to PMC-80 customers $139.95 The resolution of the Leedex Monitor is 10 times better than a regular television.

There is a 10 day money-back guarantee on all SIMUTEK PRODUCTS.

This price is good for a limited time only

Order Now Save $50.00

Credit card holders may use our TOLL FREE NUMBER. Or send check for $595.00 plus $10.00 delivery. (Arizona residents add $35.70 sales tax). Please mention this magazine. (No tax on out of state orders).

Call Toll Free
800-528-1149
In Arizona call 602-323-9391 Collect

SIMUTEK COMPUTER PRODUCTS™
4877 E. Speedway Blvd.
Tucson, AZ 85712

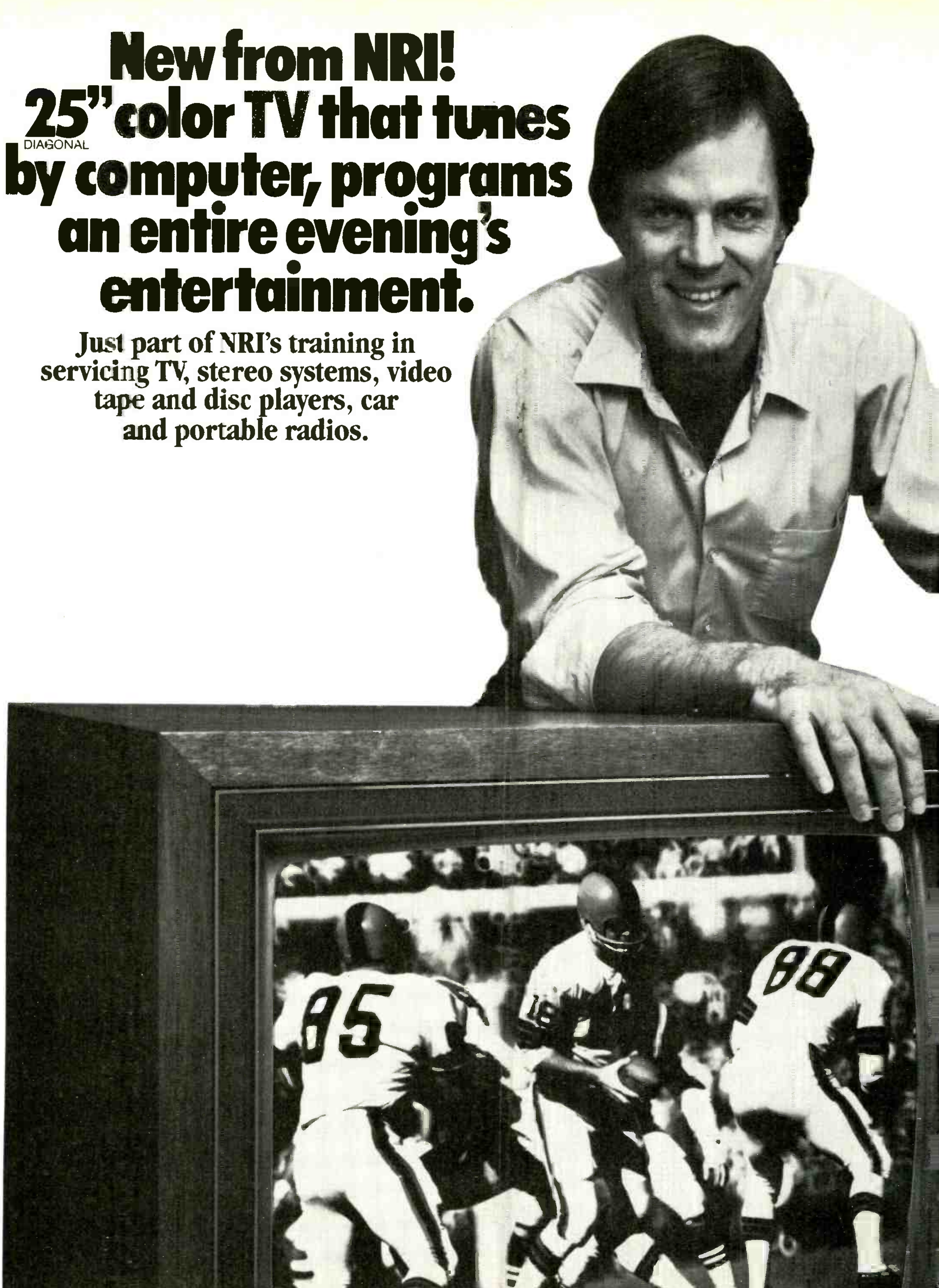
TRS-80 is a registered trademark of Radio Shack a Tandy Corp

CIRCLE NO. 50 ON FREE INFORMATION CARD

www.americanradiohistory.com

New from NRI! 25" DIAGONAL color TV that tunes by computer, programs an entire evening's entertainment.

Just part of NRI's training in servicing TV, stereo systems, video tape and disc players, car and portable radios.

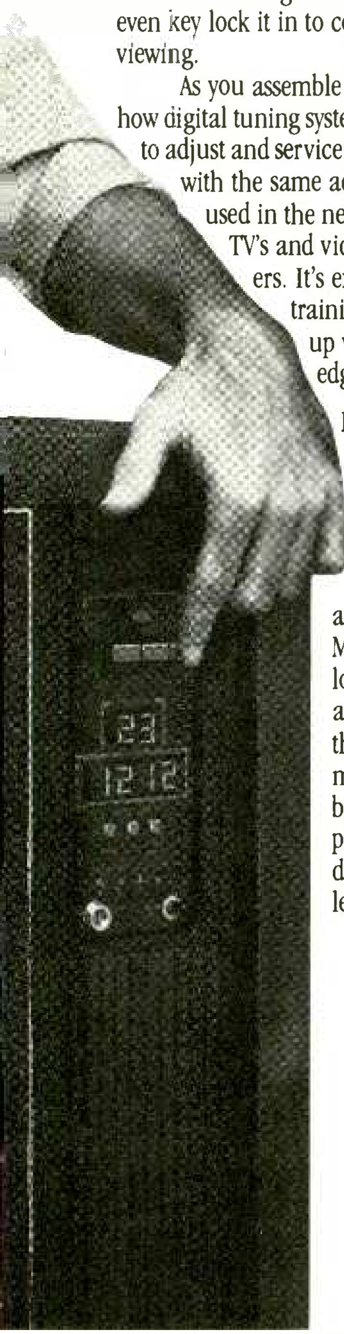


www.americanradiohistory.com

Only NRI home training prepares you so thoroughly for the next great leap forward in TV and audio...digital systems. Already, top-of-the-line TV's feature digital tuning, computer programming is appearing, and new digital audio recording equipment is about to go on the market.

NRI is the only home study school to give you the actual "hands-on" training you need to handle servicing problems on tomorrow's electronic equipment. Because only NRI includes this designed-for-learning, 25" diagonal color TV with electronic tuning, built-in digital clock, and computer programmer as part of your training. With this advanced feature, you can pre-program an entire evening's entertainment... even key lock it in to control children's viewing.

As you assemble it, you learn how digital tuning systems work, how to adjust and service them. You work with the same advanced features used in the new programmable TV's and video tape recorders. It's exclusive NRI training that keeps you up with the leading edge of technology.



Exclusive Designed-for-learning Concept

The color TV you build as part of NRI's Master Course looks, operates, and performs like the very finest commercial sets. But behind that pretty picture is a unique designed-for-learning chassis...

the only such unit in the world. Rather than retrofit lessons to a hobby kit or an already-built commercial set, NRI instructor/engineers have designed this television so each step of construction is a learning experience.

As you build it, you perform meaningful experiments. You see what makes each circuit work, what it does, how it interacts with other circuits. You even introduce defects, troubleshoot and correct them as you would in actual practice. And you end up with a magnificent, big-picture TV with advanced features. One you can sell or use in your home.

Also Build Stereo, Test Instruments

That's just a start. You demonstrate basic principles and circuits on the unique NRI Discovery Lab,® then apply them as you assemble a fine AM/FM stereo receiver, complete with speakers. You also get practical experience as you build your own test instruments, including a 5" triggered sweep oscilloscope, CMOS digital frequency counter, color bar generator, and transistorized volt-ohm meter. Use them for learning, use them for earning as a full- or part-time TV, audio, and video systems technician.

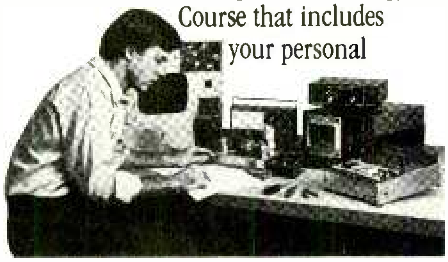
Complete, Effective Training Includes Video Systems

Using NRI's exclusive methods, you learn far more than TV servicing. You'll be prepared to work with stereo systems, car radios, record and tape players, transistor radios, short-wave receivers, PA systems, musical instrument amplifiers, electronic TV games, even video tape recorders and tape or disc video players. Your training covers just about every kind of electronic entertainment equipment available now or in the near future.

And because NRI has unmatched experience gained in over 60 years and a million students worth of training, your course is designed for ease of learning and practical utility. You need no previous experience of any kind. Starting with the basics, exclusive "bite-size" lessons cover subjects thoroughly, clearly, and concisely. "Hands-on" experiments reinforce theory for better comprehension and retention. And your personal NRI instructor is always available for consultation, ready with explanations, answers, and advice.

Send for Free Detailed Catalog... No Salesman Will Call

Get all the facts on this exciting course and its potential for you by mailing the postage-paid card today. Our free 100-page catalog includes color photos of all kits and equipment, complete lesson plans, convenient time payment plans, and information on other electronics courses. You'll also find out about NRI's new Computer Technology Course that includes your personal



microcomputer. Or Complete Communications with 2-meter transceiver that gets you ready for opportunities in broadcasting, 2-way radio, microwave, and other growing fields. If card has been removed, write to:

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

www.americanradiohistory.com

Do more than ever before– spend less than you planned

Heath makes the All-In-One Computer more versatile

Many satisfied customers know Heath takes the risk out of buying a balanced computer system. With the Heathkit All-In-One Computer, you get 16K Random Access Memory (expandable to 48K), keyboard, video terminal and floppy disk system – together in one self-contained, compact unit – for up to hundreds of dollars less than comparable systems.

Heath now makes the All-In-One Computer more versatile than ever! The new Heathkit H77 Floppy Disk System gives the All-In-One even more data storage and recall capacity. Combined, the All-In-One and H77 Floppy Disk give you up to 300K bytes of on-line data storage – enough to hold entire files. You can mount operating system and program disks at the same time, to make computing even faster.

You can run programs written in MICROSOFT™ BASIC™ and Assembly Languages, and all current software written for the popular Heathkit H8 Computer.

Heath User's Group (HUG) will share with you a library of over 500 programs to make your computer serve you in ways you never imagined.

There's no better way to learn about computer systems – and save money – than by building one yourself.

Concise, easy-to-follow Heathkit assembly manuals show you the way, from start to finish. And a nationwide network of service centers protects your computer investment.

Join the Heathkit computer family today – and pocket the savings!

For complete details on Heathkit computer systems, as well as nearly 400 other electronic kits for your home, work or pleasure, send today for your free, value-packed Heathkit catalog. Or pick up your copy at the nearest Heathkit Electronic Center.

Heathkit®

SEND FOR FREE CATALOG

Write to: HEATH COMPANY, DEPARTMENT 010-764, BENTON HARBOR, MI 49022

VISIT YOUR HEATHKIT STORE

In the U.S. and Canada, visit your nearby Heathkit Electronic Center where Heathkit products are also displayed, sold and serviced. See the white pages of your phone book. In the U.S., Heathkit Electronic Centers are units of Veritechnology Electronics Corporation.

CP-184

CIRCLE NO. 24 ON FREE INFORMATION CARD

www.americanradiohistory.com

PE Tests APF's "Imagination Machine"

IN THE "Imagination Machine" APF has a color-and-sound home computer with a strong video-games flavor. Built around an MC-6800 CPU, the basic system consists of two major parts: a stand-alone video-games-playing unit (MP1000) with handheld controllers that connects to a standard color or B&W TV receiver and uses ROM cartridges, and an interconnected base unit (MPA-10) with built-in cassette deck and keyboard that provides the "computer" portion of the system. Also supplied is a 12-kilobyte BASIC Interpreter cartridge that allows you to get the system up and running. In combination, the MP1000 nestles atop the MPA-10.

APF originally offered the MP1000 and MPA-10 separately for $129.95 and $499, respectively, or $599 when purchased together. Now the company is marketing the two units together as the Model 1 for only $399.

A number of options is available for expanding the Imagination Machine's computing abilities. Building Block 1 (BB1) at $199.95 enables you to add a Model TM-150 telephone modem or a hard-copy printer (not yet available). More memory than is provided by the 14K of ROM and 9K of RAM is available with the 8K memory module (R8K for $99.95). Building Block 2 (BB2) is a $149.95 floppy-disk controller for adding the Model D-100

www.americanradiohistory.com

5¼" floppy disk drive ($399.95).

Software for the Imagination Machine is available in ROM cartridges and on cassette tapes. Like the BASIC interpreter, which comes with MP1000/MPA-10 system, most video games are stored in ROM cartridges; other programs (home finance, educational, etc.) are on tape. Prices for the software range from $19.95 to $29.95, with a "BASIC Tutor" on cassette at $49.95.

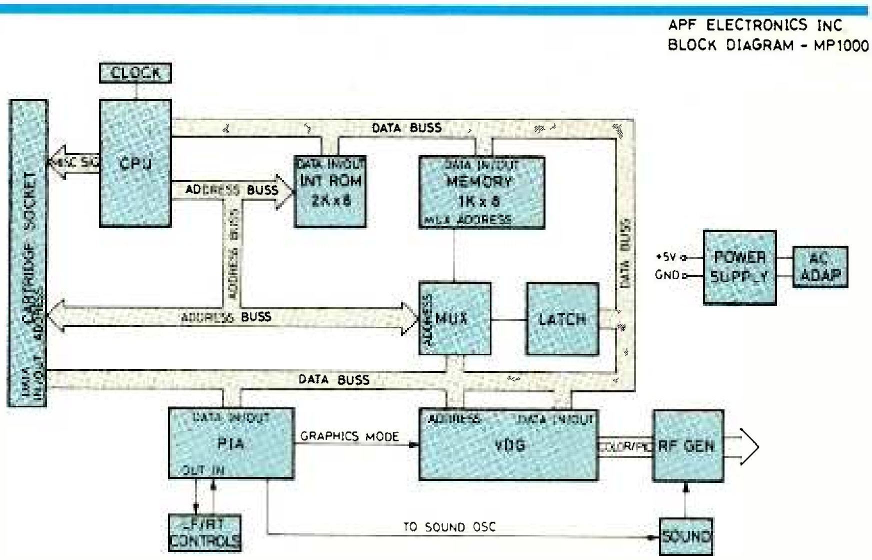


Fig. 1. Block Diagram of the MP1000. It contains 2K of ROM, 1K of screen-display RAM, and the MC 6800 microprocessor.

General Description. The MP1000 (Fig. 1) comes with its own power supply, two joystick/keypad controllers, circuitry to produce eight colors (green, yellow, blue, red, black, cyan, purple, and orange), and a sound generator. It also contains 2K of ROM, 1K of screen-display RAM, a peripheral interface adapter, and the MC6800 microprocessor. The MP1000 memory maps the display screen, which resides at memory locations 512 through 1023. A single ROM-cartridge slot is provided for plugging in any of the various games cartridges.

Connection of the MP1000 to a color-TV receiver is made through a supplied COMPUTER/TV isolation switch. After applying power, the TV selector should be set for channel 3, the switch on the isolation block to COMPUTER, and you're all set to go. Pushing RESET on the MP1000 brings up a Rocket Patrol game, which is built into every system.

The MP1000 can generate both alphanumeric characters and semigraphics, both a function of the internal ROM. A 5 x 7 dot matrix is used in generating the 64 ASCII characters, with one or two colors or in an inverse mode. The semigraphics mode is generated in an 8 x 12 box that is subdivided into four boxes, each four by six dots (Fig. 2). You can specify one of the eight available colors (dark green, yellow, blue, red, white, cyan, purple, or orange) for any given box and luminance on or luminance off to create specific effects.

Although the display is limited to 32 x 16 boxes per TV frame, the MP1000 can create "high-resolution" graphics with either 128 x 192 or 256 x 192 character dots. In this mode, the screen is mapped to 32 x 12 character boxes, each 8 or 4 dots wide by 16 dots high.

The joystick assemblies move the cursor up, down, left, and right on the TV screen. These are switch-type joysticks, rather than potentiometer types, which means that there are no intermediate points between left and right and top and bottom. The keypad is used for entering numbers (0 through 9), clearing the screen, and performing an implicit ENTER.

Using the optional games cartridges in the MP1000 is very simple. With the unit turned off, plug your choice of cartridge into the slot at the back of the player, power up, and press RESET. At this point, the menu of choices appears on-screen. Key in your choice and tell the computer how many players there will be.

Adding the MPA-10 (Fig. 3) to the MP1000, via a J-shaped connector that also provides data and address buffering, brings computing capability. Basically, the MPA-10 permits programs on cassettes to be loaded into the computer and allows you to develop your own software and store it on tape. The MPA-10 also supplies the system's alphanumeric keyboard, a built-in cassette deck that operates under processor control, 8 kilobytes of RAM, and a 50-pin connector to accommodate optional peripherals. Interface with the TV receiver is still through the games-playing unit.

To connect the MPA-10, it is necessary to insert a grounding bar in the ROM cartridge slots. With this in place, the MP1000 sits in a dished-out area atop the MPA-10 and is electrically and mechanically secured by a special J-shaped connector. Then the 12-kilobyte BASIC Language Interpreter cartridge supplied with the MPA-10 plugs into a slot in the base unit.

Powering up both units and pressing ENTER causes the APF logo and "basic" (lower case, done in graphics) to be displayed in a rainbow of colors. To get into the BASIC command mode, the EN (enter) key on either joystick controller must be pressed, at which time, the computer clears the screen and places a block cursor in the upper left.

Programs can now be entered from the cassette deck or by typing them in from the keyboard. For tape operation, you must type in CLOAD or 1 CLOAD (depending on instructions supplied with the tape), followed by RETURN and RUN. A message then instructs you to rewind the tape, push PLAY on the cassette deck, and once again press RETURN. From here on, deck operation is under computer control, via the BASIC interpreter, until a prompt on the screen tells you to press STOP.

The MPA-10's keyboard is made up of 53 keys that generate only upper-case letters, numbers, and shifted characters. Since it's set up in a manner similar to a standard Teletypewriter, such keys as HERE IS, BRK (break), and REPT (repeat) aren't used. Although an ESC (escape) key is provided and shown on the wiring matrix, it appears to be nonfunctional.

The keyboard setup includes 24 commonly used BASIC keyword commands that can be invoked with two simultaneous keystrokes. Above the keyboard are printed commands like CLOAD, PRINT, DIM, etc., that are invoked by holding down the CTRL (control) key and the key that corresponds to the desired command. This informs the computer of the command and spells out the command word on the screen.

Data transfer rate for the cassette system is approximately 1500 baud, which allows an 8-kilobyte tape to load in about 2 minutes. In addition, the tape system permits use of an audio track to create a voice header (via a microphone, not supplied) that can be heard from the deck's built-in speaker. Since tape system operation is under program control, data can be loaded and saved while a program is operating.

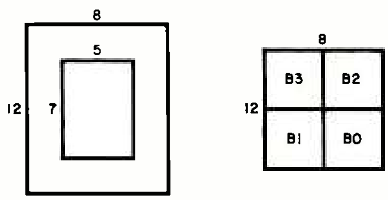


Fig. 2. Etiher alphanumeric characters (left) or semigraphics can be generated.

The BASIC interpreter permits access to the processor by a specific call and can handle BASIC statements in tandem with machine-language programs. To enter a machine-language routine from BASIC, you simply call location at 28672. Then, after entering your routine, typing G8894 tells the monitor to GO back to the entry point of

www.americanradiohistory.com

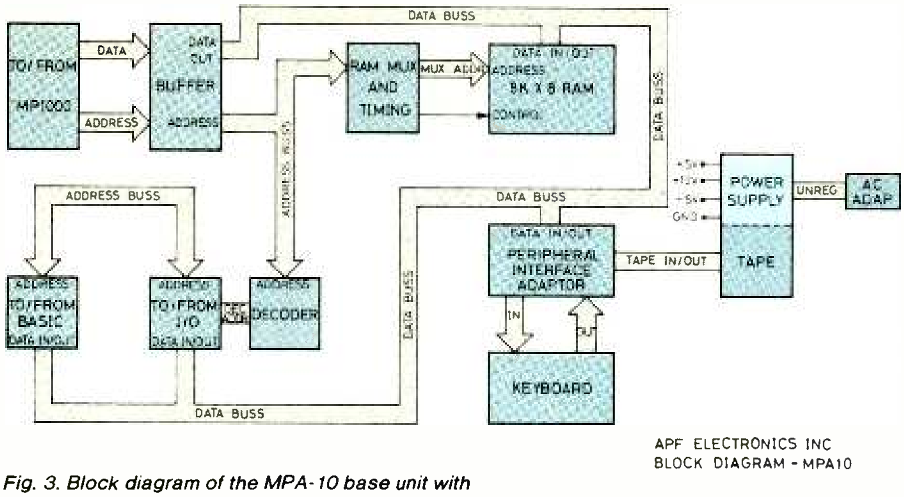


Fig. 3. Block diagram of the MPA-10 base unit with built-in tape deck and keyboard. A plug connects to the MP1000.

BASIC at location 8894. At this point, you can write a BASIC program that calls the machine-language routine. One of the things you can do using machine-language routines is divide the screen into four quadrants and have activity occur in each. Incidentally, more than one machine-language routine can be written and called from BASIC as needed.

The built-in sound generator can add an extra dimension to your programs. Sound can be created using either machine-language routines or the POKE command in BASIC. Should you decide to add the optional floppy-disk system to your Imagination Machine (we didn't have it for this review), APF's Basic interpreter already contains the necessary disk operating system (DOS).

Evaluation. Taken as a whole, the basic MP1000/MPA-10 Imagination Machine performed as described in the well-written and comprehensive literature. (We didn't have the optional building blocks for this report.) Machine- and BASIC-language programs, including those that use graphics and color, were easy to load, run, and save on tape.

During our initial evaluation, however, a few annoying bugs showed up. One was erratic operation of the joystick/keypad controllers. Most of the key-sticking problem cleared up after several hours of exercise, but a multiple-entry problem persisted. When queried about this, APF informed us that our evaluation unit was part of an early production run and was fitted with older controllers. We've been assured that all Imagination Machines manufactured since last November have been fitted with newly designed controllers that have looser-fitting keys and full debouncing.

Another minor annoyance we encountered was in cassette-deck operation. We found that, even when a program tape was fully rewound, we still had to run the rewind sequence before it would load.

Most of the games cartridges we tried were apparently geared to the younger set. Only four games—Hangman, Tic-Tac-Toe, Breakdown, and Pinball—offered more than passing challenge.

Of the taped programs we reviewed, "Music Composer and Piano Player" and "Artist and Easel" were the best in terms of demonstrating what you can do with the computer's hardware and software. On the whole, however, the taped programs fell short of their potential for producing three-dimensional graphics, though they made good use of the computer's two-dimensional graphics, color, and sound-generating capabilities.

APF's BASIC interpreter is fairly good and comes with an easy-to-follow manual that spells out every step of its use in detail, but it does have limitations. For example, the BASIC doesn't provide such attributes as editing functions, renumbering, and automatic line numbering. Trig functions aren't provided, either, but they can be written as subroutines and called by a program as needed. Curiously, no "scratch" or "kill" command can be invoked to erase a BASIC program once it has been entered. If you wish to erase a program, you must either write a new program over it or press RESET on the MP1000 and the EN key on either controller. We suggest the latter, since it's a two-key operation and the BASIC in ROM is available immediately.

Comment. The ready-to-go Imagination Machine offers a fairly inexpensive entry to the world of microcomputing. This is especially true when considering its built-in features such as video color and sound generation, cassette deck, and hand controllers. It has a growing software support base and a nice list of optional accessories that will allow you to expand to a reasonably powerful computer system, though it is clearly not designed for serious business or professional use. As a low-priced home computer, sophisticated video games player and computer trainer, the Imagination Machine is difficult to beat. —*Carl Warren*

CIRCLE NO. 103 ON FREE INFORMATION CARD

NEW!!! THE
ELECTRIC MOUTH *

for S100, Elf II, Apple, TRS-80 Level II*

From $99.95 kit

Now — teach your computer to talk, dramatically increasing the interaction between you and your machine.

That's right: the ELECTRIC MOUTH actually lets your computer talk! Installed and on-line in just minutes, it's ready for spoken-language use in office, business, industrial and commercial applications, in games, special projects, R&D, education, security devices — there's no end to the ELECTRIC MOUTH's usefulness. Look at these features:

- ★ Supplied with 143 words/letters/phonemes/numbers, capable of producing hundreds of words and phrases.
- ★ Expandable on-board up to thousands of words and phrases (just add additional speech ROMs as they become available).
- ★ Four models, which plug directly into S100, Apple, Elf II and TRS-80 Level II computers.
- ★ Get it to talk by using either Basic or machine language (very easy to use, complete instructions with examples included).
- ★ Uses National Semiconductor's "Digitalker" system.
- ★ Includes on-board audio amplifier and speaker, with provisions for external speakers and amplifier.
- ★ Adds a new dimension and excitement to programming; lets you modify existing programs and games to add spoken announcements of results, warnings, etc.
- ★ Installs in just minutes.

Principle of Operation: The ELECTRIC MOUTH stores words in their digital equivalents in ROMs. When words, phrases, and phonemes are desired, they are simply called for by your program and then synthesized into speech. The ELECTRIC MOUTH system requires none of your valuable memory space except for a few addresses if used in memory mapped mode. In most cases, output ports (user selectable) are used.

Spoken Material Included

one	eighteen	at	dollar	inches	number	ss	c	t
two	nineteen	cancel	down	is	of	second	d	u
three	twenty	case	equal	it	off	set	e	v
four	thirty	cent	error	kilo	on	space	f	w
five	forty	400hertz tone	feet	left	out	speed	g	x
six	fifty	80hertz tone	flow	less	over	star	h	y
seven	sixty	20ms silence	fuel	lesser	parenthesis	start	i	z
eight	seventy	40ms silence	gallon	limit	percent	stop	j	
nine	eighty	80ms silence	go	low	please	than	k	
ten	ninety	160ms silence	gram	lower	plus	the	l	
eleven	hundred	320ms silence	great	mark	point	time	m	
twelve	thousand	centi	greater	meter	pound	try	n	
thirteen	million	check	have	mile	pulses	up	o	
fourteen	zero	comma	high	milli	rate	volt	p	
fifteen	again	control	higher	minus	re	weight	q	
sixteen	ampere	danger	hour	minute	ready	a	r	
seventeen	and	degree	in	near	right	b	s	

"Elf II" and "The Electric Mouth" are reg. trademarks of Netronics R&D Ltd. "Apple" is a reg. trademark of Apple Computer Inc. "TRS-80 Level II" is a reg. trademark of Tandy Corp.

Continental U.S.A. Credit Card Buyers Outside Connecticut

CALL TOLL FREE 800-243-7428

To Order From Connecticut Or For Technical Assistance, Etc.,

Call (203) 354-9375

NETRONICS R&D LTD. Dept PE

333 Litchfield Road, New Milford, CT 06776

Please send the items checked below:

- ☐ **S100 "Electric Mouth" kit $99.95**
- ☐ **Elf II "Electric Mouth" kit $99.95**
- ☐ **Apple "Electric Mouth" kit $119.95**
- ☐ **TRS-80 Level II "Electric Mouth" kit $119.95**

Add $20.00 for wired & tested units. All plus $3.00 postage & insurance. Conn res. add sales tax.

Total Enclosed $ ______

☐ **Personal Check** ☐ **Cashier's Check/Money Order**

☐ **Visa** ☐ **Master Charge (Bank No.** ______**)**

Acct. No. ______

Signature ______ **Exp. Date** ______

Print Name ______

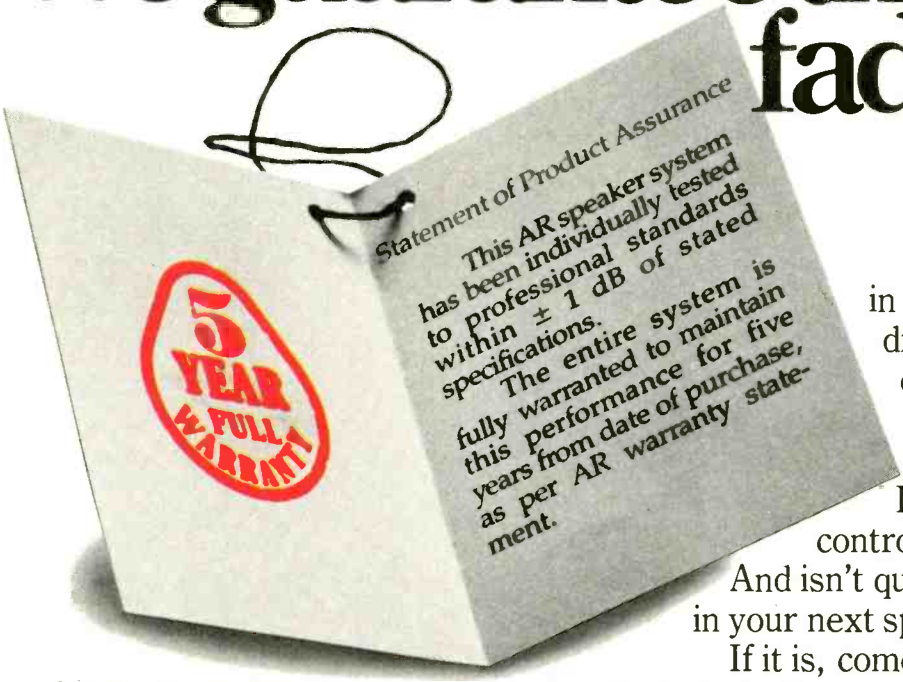
Address ______

City ______

State ______ **Zip** ______

www.americanradiohistory.com

We don't just guarantee AR speakers won't die. We guarantee they won't fade away.



All good speakers are guaranteed against defects in parts and workmanship.

So are AR's.

But AR also gives you a full warranty (not a limited one) with an important extra.

We not only promise that your speakers won't fall apart, we also promise that they'll perform within 1dB of design specs for 5 years from the day you walk them out the door (see our warranty for full details).

That's quite a promise.

But we build quite a speaker.

It's designed for accuracy; the most important quality in a speaker no matter what kind of music you're into.

Building it to stay accurate is the real challenge.

It means designing, building, testing and re-testing every driver in the AR factory. We never buy drivers or cross-overs from outside suppliers as some makers do. We even wind our own air-core chokes.

It's the only way to really control quality.

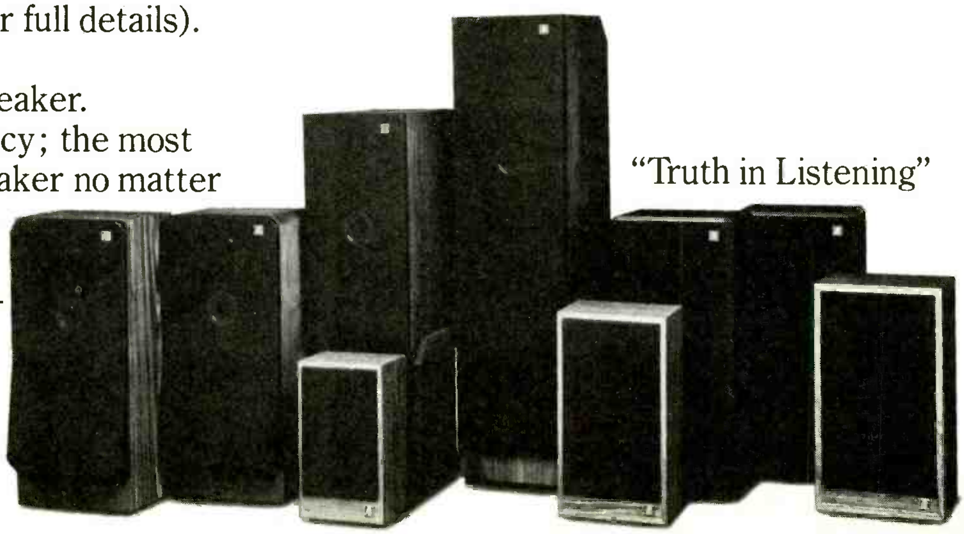
And isn't quality what you're looking for in your next speakers?

If it is, come listen to the best at your AR dealer's.

He has a catalog with pictures and specs of all nine models we build. If he's out of catalogs temporarily, write and we'll send you one.

We don't just promise to. We guarantee it.

TELEDYNE ACOUSTIC RESEARCH
10 AMERICAN DRIVE, NORWOOD, MASSACHUSETTS 02062 USA © 1981
IN CANADA BY A. C. SIMMONDS AND SONS LTD.
AND IN AUSTRALIA BY W. C. WEDDERSPOON PTY. LTD.



www.americanradiohistory.com

Popular Electronics
APRIL 1981

BY BERT MARLIN

OSCILLOSCOPES: 1981

A guide to medium-priced scopes for experimenters

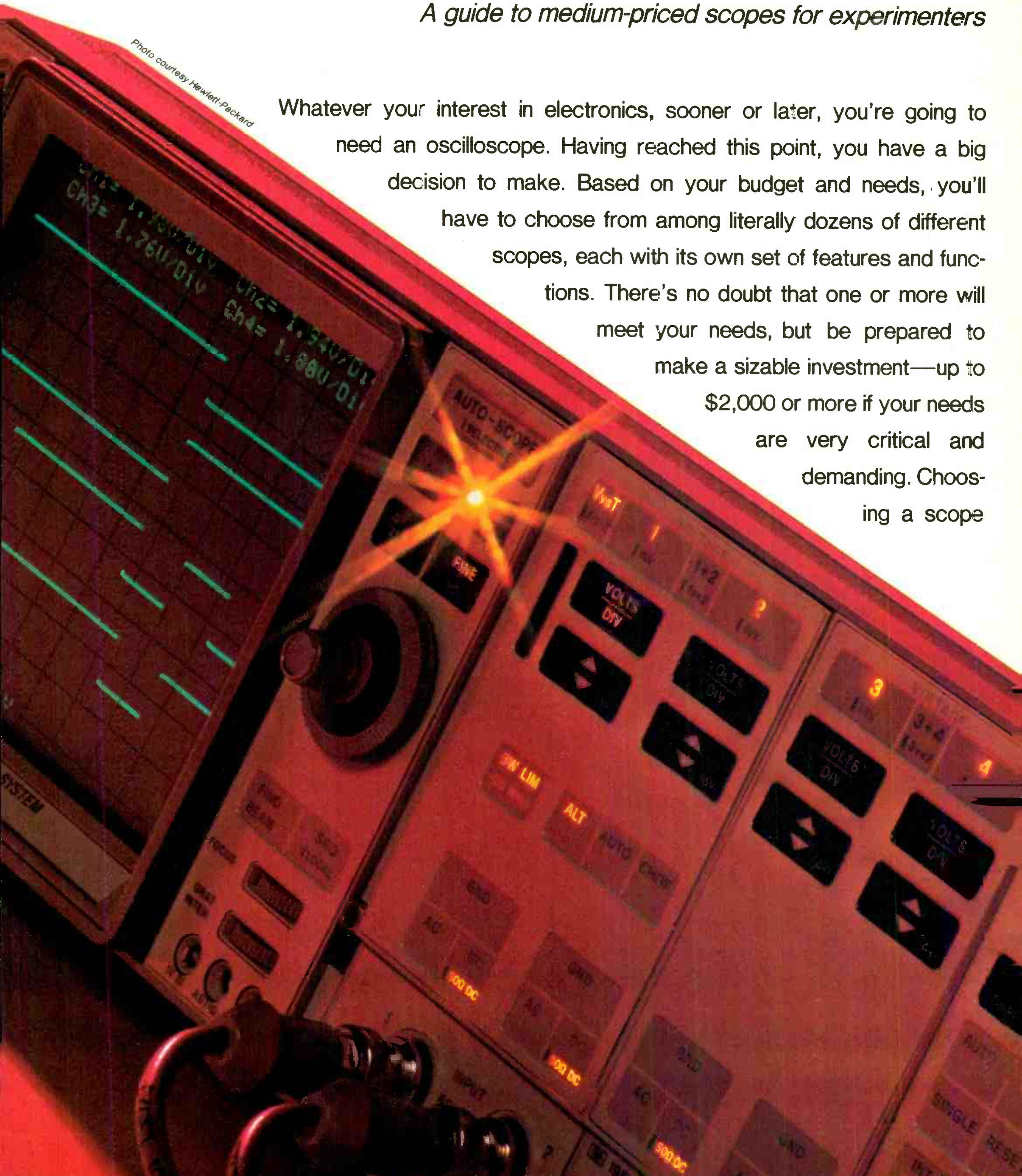
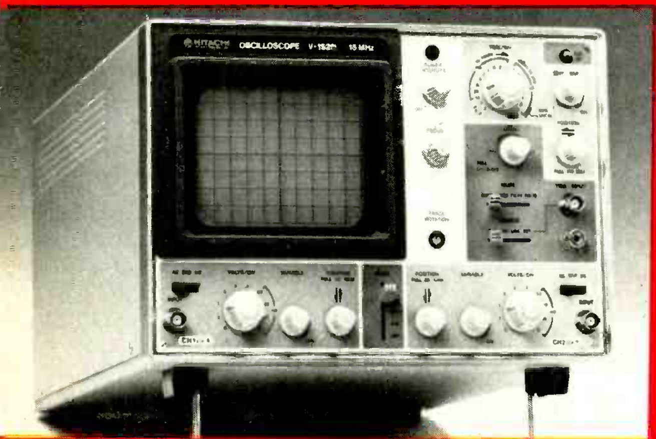


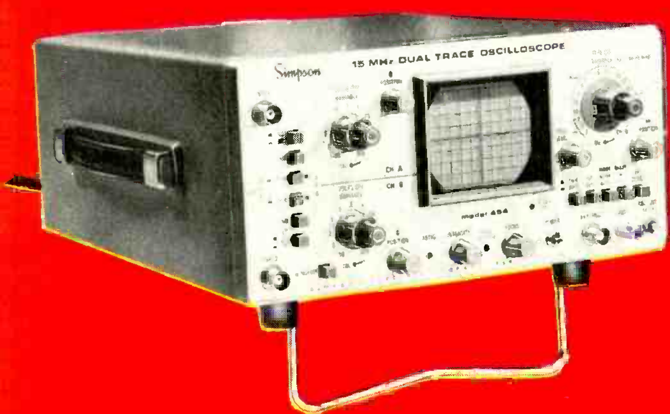
Photo courtesy Hewlett-Packard

Whatever your interest in electronics, sooner or later, you're going to need an oscilloscope. Having reached this point, you have a big decision to make. Based on your budget and needs, you'll have to choose from among literally dozens of different scopes, each with its own set of features and functions. There's no doubt that one or more will meet your needs, but be prepared to make a sizable investment—up to $2,000 or more if your needs are very critical and demanding. Choosing a scope

www.americanradiohistory.com



Hitachi Model V-152



Simpson Model 454

Ballantine Model 1032A

demands considerably more comparison shopping than any other piece of general-purpose test equipment. If you take your time and learn what a scope can and should do, you'll be able to make an intelligent decision.

What Is An Oscilloscope? In general terms, an oscilloscope is an electronic "window" that allows you to see the variations of voltage at any point in a circuit. The scope will display in graphic form on its screen the actual waveform of voltage plotted against time. In addition, it can serve as an accurate ac/dc voltmeter and time-period counter.

To accomplish all its functions, the typical scope is made up of five major interrelated parts: vertical amplifier section, horizontal amplifier section, sweep and synchronization circuits, picture tube (cathode-ray tube or CRT), and power supply.

The vertical amplifier accepts the input signal and amplifies it to produce vertical deflection of the beam in the CRT. To be of value, the vertical amplifier's frequency response or bandwidth, must be wide enough to encompass both the fundamental frequency of the input signal and a minimum of 10 harmonics (whole multiples of the fundamental). Input-signal level to the vertical amplifier is controlled by a frequency-compensated step attenuator/vernier-control setup. Input impedance is usually at least 1 megohm bypassed by a low-picofarad capacitance to present minimum instrument loading of the circuit under test. The sweep and sync section includes the circuitry that makes the electron beam in the CRT move from left to right. Every time the beam traverses the screen, it produces a trace that can be deflected up and down by a signal from the vertical-amplifier section. When it reaches the right side of the screen, the beam is cut off. The horizontal deflection voltage quickly reverts to a value corresponding to the left edge of the screen. This prevents the right-to-left retrace from appearing on-screen.

The horizontal-amplifier section usually serves two purposes. First, it amplifies the sweep signals for application to the CRT's horizontal deflection plates. In addition, it serves as a "second" signal-input amplifier when a scope is used as a vector display to compare phase relationships between two signals. In this mode, sweep is disabled. (Not all scopes are equipped for vector display. Any scope that is will have an "X-Y" legend at one position of its input selector.) The vector mode is useful for color-TV and stereo alignments. For X-Y use, bandwidth of the horizontal amplifier should be comparable to that of the vertical amplifier, and, more important, the phase response of the two amplifiers should match as closely as possible.

The CRT can be either round, usually 5″ in diameter, or rectangular. Rectangular tubes provide a full-screen display, including the corners, while the construction of the round tube cuts off the corners. The usual practice of applying several kilovolts to the final anode of the CRT suffices when the trace does not have to move too rapidly. However, to display a low-repetition-rate waveform with a fast rise time, the trace moves so fast that it may become too faint, even with the BRIGHTNESS fully up. "Post deflection acceleration" delivers a bright trace at almost any beam speed.

The power supply in a scope is of critical importance if you expect to perform precise tests and measurements. Since it supplies power to every part of the scope, the power supply must be tightly regulated to prevent undesired interactions between circuits. In a poorly regulated supply, for example, the amplitude of the displayed waveform might vary slightly if you adjust the intensity (brightness) control.

Features. More than any other factor, features are what "tailor" a given scope to your needs. "Standard" features vary tremendously from manufacturer to manufacturer and even

www.americanradiohistory.com

from model to model of a single manufacturer. Some features that are common to all scopes are: BNC-type input connectors; CRT intensity and astigmatism controls; trace-positioning controls; vertical and horizontal "gain" controls; sweep-speed selectors; etc. Features that might be shared by many, but not all, scopes include: dual-trace display capability; sweep magnification; triggered sweep; on-board calibrating voltage and/or frequency; and vector-display capability.

One of the major features of a scope is the type of sweep it uses. Recurrent sweep, found primarily in economy scopes, is generated by a free-running oscillator whose frequency is adjusted by sweep controls on the scope's front panel. The oscillator can be synchronized to the vertical input signal, ac power line, or an external source. If the sync isn't correct, the displayed waveform will drift across the screen. Triggered-sweep, on the other hand, starts only when an input (trigger) signal is applied to the vertical amplifier. With no signal present, no trace appears. The sweep is very linear and stable, and eliminates waveform shift.

Triggered-sweep ranges generally permit measurements on very slow and very fast waveforms. Sync can be taken from the vertical amplifier, power line, or an external source. Provisions are usually made to allow triggering on the positive- or negative-going side of the input signal, at almost any intermediate point on the waveform, or in conjunction with a built-in TV-like sync clipper (from a TV signal used as the vertical-input source).

Some scopes are equipped with a feature called "sweep magnification," which horizontally expands the sweep by a factor of 5 or 10, depending on design. The magnifier "stretches" the sweep as though it went beyond the edges of the CRT screen. Using the horizontal positioning control, you can move the elongated sweep back and forth past the "window" of the screen to obtain a magnified view of one-fifth or one-tenth of the waveform.

The importance of sweep magnification lies in its ability to let you examine the leading or trailing edge of a pulse at a faster sweep than would otherwise be possible. Keep in mind, however, that sweep magnification decreases the brightness of the trace.

While many modern scopes are still single-trace instruments, a growing number of models have dual-trace capability. The latter appear to display two traces simultaneously, but in actuality, the traces are drawn by a single electron beam, using either of two modes.

In the "alternate" mode, each channel's waveform is displayed for 50% of the time, with the channels alternating with successive sweeps. At very low sweep speeds, the traces would be seen at different times, but at higher speeds, persistence of vision (and the CRT phosphor) makes both traces appear to be on-screen simultaneously.

In the "chop" mode, an internal oscillator gates the two channels on and off at a very high rate, breaking the two traces into series of minute "slices" that appear to make up two continuous waveform traces. One problem with the chop mode is that the input signal frequency may be very close to the chop frequency, which would cause the displayed image to be blurred. Some scopes permit adjustment of the chop frequency to get around this problem. If the chop frequency cannot be adjusted, you can simply switch to the alternate mode. The advantage of dual-trace display is that you can compare two signals for coincidence, measure the time delay between them, or compare the output of a circuit with its input.

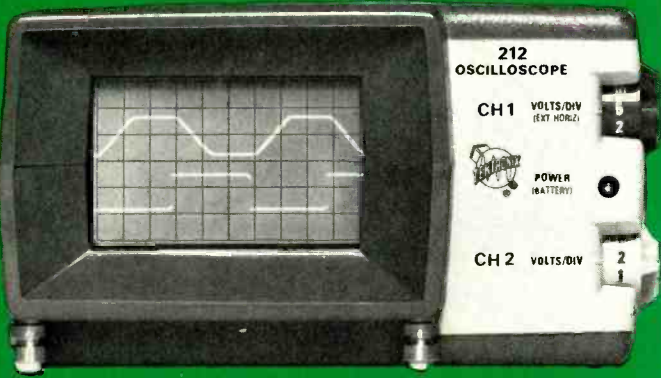
Intensity modulation is another feature that many scopes provide as standard fare. A "Z-axis" input, usually located on the rear of the scope, allows modulation of trace intensity by the signal applied.

A feature that until very recently could be found only on laboratory-grade scopes priced in the $5,000 range and now

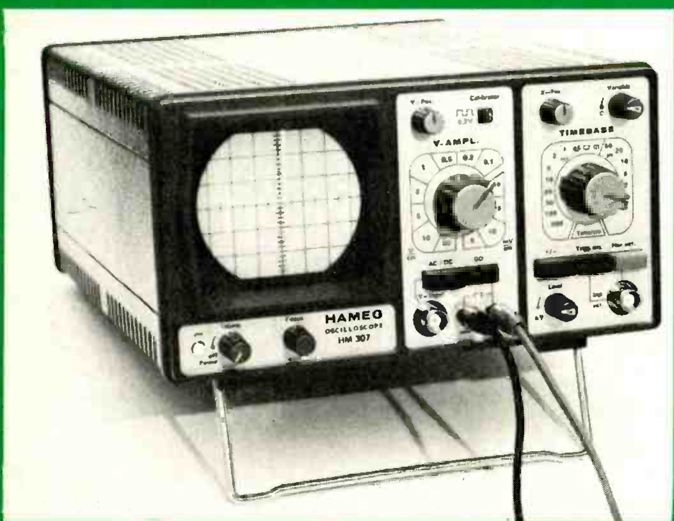
Phillips Model PM3207

B&K Precision Model 1420

Heathkit Model IO-4550



Tektronix Model 212



Hameg Model HM 307

Vu-Data Model 2522

appearing on a few scopes that list for less than $2,000 is delayed, or intensified, sweep. It is a very sophisticated form of sweep magnification, that allows you to examine any portion of the trace at any speed up to the main sweep speed. With delayed sweep, you can take a 1% slice from any point on the trace, and expand it to fill the entire screen, without losing brightness.

Options. A very practical way of extending the usefulness of a basic scope is by supplementing the instrument with options. Wise selection of options, can often make a marginal scope operate beyond its normal capabilities.

Among the most popular options are specialty probes. Voltage-divider probes that have a 10:1 ratio can extend the vertical-input limit by a factor of 10. There are also probes that can convert a 50-kV signal to a level that is safe for a normal scope input. And high-frequency demodulator probes allow you to observe amplitude modulation impressed on a carrier of up to 250 MHz. Most of these probes provide a high degree of isolation between the scope and circuit under test and are designed to minimize loading.

Another very useful accessory for work on digital circuitry, is a multichannel adapter. If you have a single-trace scope and want dual-trace capability, you can buy a two-trace adapter. For computer work, however, you'll almost certainly want an eight-trace adapter. Adapters connect directly to the vertical input of the scope and require separate probes for each "channel." Additionally, trace-positioning controls are provided on the adapters themselves.

A scope represents a sizable investment and should receive tender loving care if you want to enjoy its full lifespan. If you plan to set your scope in a fixed location, seriously consider buying a cover to protect it from dust and other foreign matter. A scope that must be transported from one location to another should have a protective carrying case.

Now beginning to appear on lower priced scopes is "trigger view," which allows observation of the trigger signal, in addition to the vertical input signals. At least one scope that lists for less than $2,000 comes with a combination of delayed sweep and trigger view so you can look at the entire main sweep, delayed sweep, main trigger, and delayed trigger on four traces simultaneously! Trigger view is an internal connection that adds the trigger to the display. Its bandwidth is limited, and gain is fixed and uncalibrated. Consequently, trigger view is useful for providing a reference timing marker, rather than for critical observation of the trigger.

In the past, calling a scope "portable" simply meant that it had a handle. The modern portable scope, however, is a truly portable instrument. It is compact, lightweight, battery powered, and provides a full range of features and functions.

Specifications. You can tell a great deal about how a scope will perform by closely examining the manufacturer's literature, especially the list of technical specifications. Since oscilloscopes are "professional" instruments, their published specifications are, on the whole, comprehensive.

Bandwidth is the most often quoted spec. This frequency-response parameter is almost universally specified as the frequency at which the displayed vertical signal drops to half the amplitude (−3-dB point) it was at some arbitrarily selected low frequency. While most scopes will respond beyond the stated −3-dB point, higher-frequency signals will be displayed at progressively lower amplitude than signals of the same level within the rated bandwidth.

Scopes that use peaking networks to extend their upper-frequency response can attain a bandwidth of 10 or 15 MHz, beyond which, response drops off precipitously. Hence, a fast-rising high-frequency pulse may cause "ringing" in the viewed waveform. Some scopes, particularly those designed

www.americanradiohistory.com

Manufacturer and Model	Cost ($)	Channels	Bandwidth (MHz)	Maximum Input Sensitivity (mV/div)	Minimum Input Sensitivity (V/div)	Fastest Calibrated Sweep Speed (µs/div)	Slowest Calibrated Sweep Speed (s/div)	Sweep Magnifier	Dimensions in.	Remarks
B&K Precision										
1420	825	2	15	10	20	1	0.5	5	3.3 x 7.8 x 10	Battery-powered
1432	855	2	15	2	10	0.5	0.5	5	5.5 x 8.3 x 14.3	Battery-powered
1405	289	1	5	10	—	—	—	—	6 x 7.5 x 12	Recurrent sweep. Max. sweep speed 100 kHz; min. 10 Hz
1466	560	1	10	10	20	1	0.5	5	7.4 x 10.1 x 14.8	
1476	715	2	10	10	20	1	0.5	5	7.4 x 10.1 x 14.8	
1477	840	2	15	10	20	0.5	0.5	5	7.4 x 10.1 x 14.8	
1520	840	2	20	5	20	0.5	0.5	10	7.4 x 10.1 x 13.9	
Ballantine										
1021	765	1	12	5	2	1	0.1	10	3.3 x 8 x 8.7	Battery-powered
1022	895	2	12	5	2	1	0.1	10	3.3 x 10 x 11.8	Battery-powered
1031A	765	1	25	5	20	1	0.5	10	5.3 x 11.5 x 15.5	
1032A	945	2	25	5	20	1	0.5	10	5.3 x 11.5 x 15.5	
Gould										
OS255	795	2	15	2	10	0.5	2	5	5.5 x 12 x 18.3	
Hameg										
HM 307	405	1	10	5	20	0.5	0.2	No	4.5 x 8.4 x 10.4	Has built-in component test circuit
HM312	609	2	20	5	20	0.5	0.2	5	9.3 x 8.4 x 15	
HM412	913	2	20	5	20	0.5	0.2	5	9.3 x 8.4 x 15	Delayed sweep
Heath										
SO-4105	375	1	5	10	20	0.2	0.2	No	8 x 13 x 17	Available in kit as IO-4105 for $200
SO-4205	450	2	5	10	20	0.2	0.2	No	8 x 13 x 17	Available in kit as IO-4205 for $280
IO-4235	950	2	35	2	10	0.05	0.2	5	7.8 x 13.8 x 19.8	Delayed sweep. Available wired as SO-4235 for $1295
SO-4510	840	2	15	1	5	0.1	0.2	No	6.5 x 12.9 x 19.3	Available in kit as IO-4510 for $590
SO-4550	650	2	10	10	20	0.2	0.2	5	6.5 x 12.9 x 19.3	Available in kit as IO-4550 for $400
IO-4555	290	1	10	10	20	0.2	0.2	No	6.9 x 12.9 x 19.3	Kit form only
Hewlett-Packard										
1220A	795	2	15	2	10	0.01	0.5	No	7.1 x 12.3 x 16.3	
1222A	895	2	15	2	10	0.01	0.5	No	7.1 x 12.3 x 16.3	
Hitachi										
V-059B	1200	1	7	50	2	10	20	10	3.4 x 7.8 x 11.5	Battery-powered
V-151	545	1	15	5	5	0.2	0.2	10	7.5 x 10.8 x 15.8	
V-152	695	2	15	5	5	0.2	0.2	10	7.5 x 10.8 x 15.8	
V-301	745	1	30	5	5	0.2	0.2	10	7.5 x 10.8 x 15.8	
V-302	945	2	30	5	5	0.2	0.2	10	7.5 x 10.8 x 15.8	
Kikusui										
5509	475	1	10	10	5	1	0.1	5	8.3 x 9.8 x 16.5	
5513	595	2	10	10	5	1	0.1	5	8.3 x 9.8 x 17.1	
5520	795	2	20	5	5	0.2	0.5	5	8.3 x 9.8 x 17.1	
Leader Instruments										
LBO302	790	2	10	10	5	1	0.2	5	4.8 x 7.8 x 11.8	
LBO308S	975	2	20	2	10	0.5	0.2	5	4.6 x 9.2 x 12.6	
LBO310A	290	1	4	20	—	—	—	—	7.5 x 5 x 12	Recurrent sweep. Max sweep speed 100 kHz; min 10 Hz
LBO507A	625	1	20	10	20	0.5	0.2	5	6.8 x 10.3 x 14.8	
LBO508A	880	2	20	10	20	0.5	0.2	5	6.8 x 10.3 x 14.8	
LBO511	420	1	10	300	—	—	—	—	7.1 x 9.8 x 16.3	Recurrent sweep. Max. sweep speed 100 kHz; min. 10 Hz
LBO513	535	1	10	5	10	0.5	0.2	5	6.8 x 10.3 x 14.8	
LBO514	695	2	10	5	10	0.5	0.2	5	6.8 x 10.3 x 14.8	
Lectrotech										
TO-55	475	1	10	10	20	0.5	0.2	5	9 x 10 x 13	
TO-60	575	2	15	100	20	0.5	0.2	5	9 x 10 x 13	
Non-Linear Systems										
MS-15	350	1	15	10	50	0.1	0.5	5	2.7 x 6.4 x 8	Battery-powered
MS-215	465	2	15	10	50	0.1	0.5	No	2.9 x 6.4 x 8	Battery-powered
MS-230	598	2	30	10	50	0.1	0.5	No	2.9 x 6.4 x 8	Battery-powered
Philips										
PM3207	795	2	15	5	10	0.5	0.2	5	5 x 11.8 x 14.6	
PM3225	675	1	15	2	10	0.6	0.2	5	Not specified	
PM3226	975	2	15	2	10	0.5	0.2	5	Not specified	
Simpson										
452	830	2	15	5	10	0.2	0.5	5	6.5 x 12 x 16	
454	675	2	15	6	10	0.5	0.5	No	4.6 x 9.8 x 13.3	
Soltec										
5101B	495	1	10	10	5	0.1	0.1	5	5.8 x 6.2 x 6.2	
5102B	640	2	10	10	5	0.1	0.1	5	5.8 x 6.2 x 6.2	
Tektronix										
212	1350	2	0.5	10	5	5	0.5	5	3 x 5.3 x 9.5	Battery-powered
213	1750	1	1	20	100	2	0.5	5	3 x 5.2 x 9	Battery-powered
221	1325	1	5	5	100	1	0.2	10	3 x 5.2 x 9	Battery-powered
Viz										
WO-527A	575	1	15	10	20	0.5	0.5	10	7.5 x 13.5 x 17.5	
WO-555	799	2	15	10	20	0.5	0.5	10	7.5 x 13.5 x 17.5	
Vu-Data										
PS915A	1120	1	20	10	20	0.1	10	5	2.5 x 8.5 x 15.4	Battery-powered
PS935	1695	2	35	5	10	0.1	0.5	10	4.2 x 8.5 x 15.4	Battery-powered
PS950	1999	2	50	5	10	0.1	0.5	10	4.2 x 8.5 x 15.4	Battery-powered
2521	1395	2	25	5	10	0.1	0.5	5	5.8 x 12.5 x 11.5	Battery-powered
2522	1795	2	25	5	10	0.1	0.5	5	5.8 x 12.5 x 11.5	Delayed sweep

MANUFACTURERS' ADDRESSES

B&K Precision
6460 West Cortland St.
Chicago, IL 60635

Ballantine Laboratories
P.O. Box 97
Boonton, NJ 07005

Gould Inc.
Instruments Division
3631 Perkins
Cleveland, OH 44114

Hameg
191 Main St.
Port Washington, NY 11050

Heath Company
Benton Harbor, MI 49022

Hewlett-Packard
1501 Page Mill Road
Palo Alto, CA 94304

Hitachi
175 Crossways Parkway West
Woodbury, NY 11797

Kikusui
17121 South Central Ave.
Unit 2-M
Carson, CA 90746

Leader Instruments
151 Dupont St.
Plainview, NY 11803

Lectrotech
5810 North Western Avenue
Chicago, IL 60659

Non-Linear Systems
533 Stevens Ave.
Solana Beach, CA 92075

Philips Test and Measuring Instruments
85 McKee Drive
Mahwah, NJ 07430

Simpson Electric
853 Dundee Ave.
Elgin, IL 60120

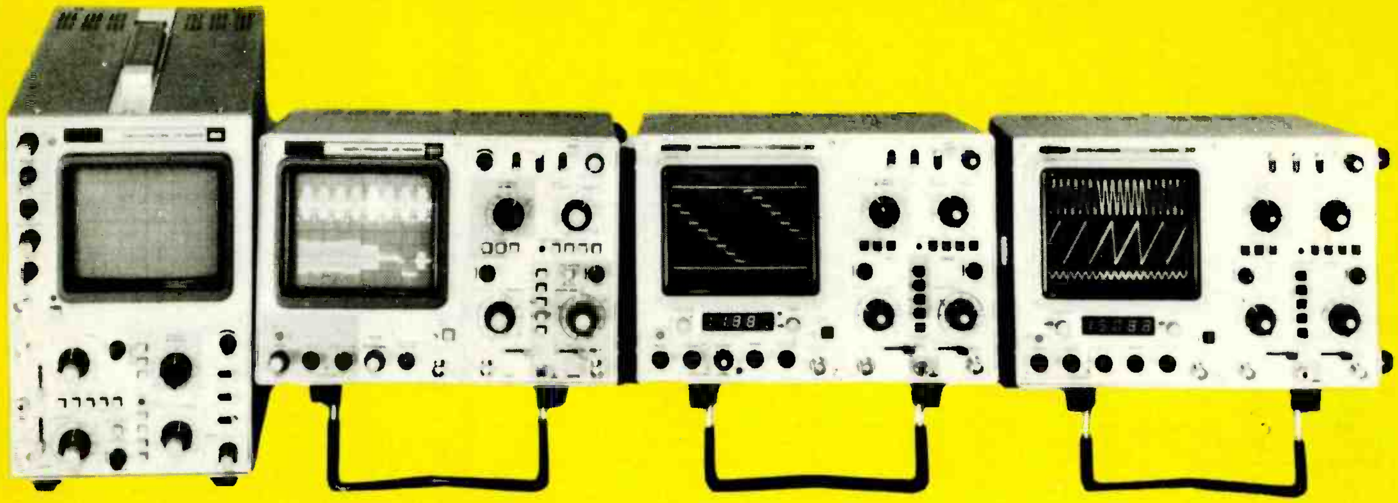
Soltec
11684 Pendleton St.
Sun Valley, CA 91352

Tektronix
P.O. Box 500
Beaverton, OR 97077

Viz Manufacturing
335 East Price St.
Philadelphia, PA 19144

Vu-Data Corporation
7170 Convey Court
San Diego, CA 92111

www.americanradiohistory.com



Soltec Series 500

for pulse waveform viewing, have upper-frequency limits (-3-dB point) of only 5 MHz or so, followed by a gradual rolloff. Such a scope can often display very-high-frequency waveforms with less distortion than one with double the rated bandwidth and a fast upper-end rolloff. But remember to display a reasonable representation of a pulse waveform, a scope must pass at least 10 harmonics of the fundamental scope's vertical amplifier frequency.

Sweep speed is closely related to bandwidth. It is the speed at which the CRT beam scans horizontally across the screen and is specified in terms of time per division, a division being one of the major segments along the horizontal axis of the graticule. (The graticule divides the CRT screen into squares, usually 10 boxes horizontally by eight vertically. Box rulings are usually 1 cm apart but can be anywhere between 0.5 and 0.9 cm apart on scopes with smaller CRTs. A few very expensive laboratory scopes have rulings more than 1 cm apart.)

In general, the fastest sweep speed ranges from 50 nanoseconds per division to 5 microseconds/division. Slowest speed is normally 0.2 or 0.5 second/division. Speed is usually switch-selectable in a 1-2-5 sequence. You'll have to worry about the sweep speed only if you must measure periods of repetitive waveforms.

The time at which the sweep begins can be every bit as important as how fast it is. Internal sweep triggering makes it difficult to see the leading edge of the input signal because the sweep begins slightly after the input waveform. A few scopes come with a delay line connected in series with each input jack to delay the signal for a short period of time so that the sweep can begin before the signal is displayed. This allows you to see the leading edge of the waveform. Another important parameter is how large an input signal is required for stable triggering. Check this specification if you expect to be working with low-level signals.

Sensitivity refers to the level of input voltage that produces one division of *vertical* scan on the CRT. Sensitivity is usually switch selectable in a 1-2-5 sequence. Maximum sensitivity ranges between 2 and 5 mV/div and minimum up to 100 V/div. Those scopes that have a built-in feature that trades off bandwidth for sensitivity are calibrated in terms of sensitivity at full bandwidth for all but the most sensitive range, which is calibrated at the reduced bandwidth.

In many applications, the sensitivity that counts most is the smallest voltage that produces one full division of deflection. Some scopes are equipped with the vertical equivalent of a sweep magnifier, called a vertical multiplier, which allows expansion of the vertical scan by a factor of five. Using the vertical multiplier, however, can reduce bandwidth.

There are some applications for which minimum sensitivity can be just as important. Minimum sensitivity is the maximum input voltage the scope can handle while calibrated and still produce just one division of scan. Since most scopes have graticules eight divisions high, the maximum peak-to-peak voltage a scope can display and remain calibrated is eight times the greatest V/div setting provided. A scope whose minimum input sensitivity is 5 V/div, for example, can accurately display a signal of no more than 40 V peak-to-peak. A scope with a 100 V/div sensitivity, on the other hand, can accurately display a signal 20 times larger.

Choosing a Scope. Concentrate on those scopes that will fill your needs through the projected lifetime of the instrument. Stay within your budget, but buy what you really need. On the other hand, every "extra" you buy—more bandwidth, greater sensitivity, sweep magnifier, vector-display capability, etc.—is going to add to the cost. For example, if you're primarily interested in analyzing audio amplifiers, there's little point in paying for a 50-MHz scope when a much less expensive 5-MHz model will do. Conversely, for digital work, you may find that nothing less than a 10-MHz instrument will do the job.

Depending on what's available in your budget range, you may have to make some tradeoffs. You may find, for example, a scope that has the bandwidth you need but insufficient sensitivity; and those that offer both are priced beyond your means. In a case like this, you might compromise a bit on bandwidth to obtain the required sensitivity. Should you find a scope in your price range that gives everything you need except a second channel, you can buy it and add a two-channel adapter when your funds permit.

When comparison shopping, don't forget to look at the list of options available. As pointed out above, some of these can give a basic scope capabilities normally reserved for a more expensive instrument. Whatever choice you make, if you've done your homework well, a scope will give you a new vantage point on electronic circuits. ◇

www.americanradiohistory.com

POWER SUPPLIES FOR OP AMPS

BY ARTHUR F. BLOCK

For best performance from operational amplifiers, special power-supply needs should be satisfied

OPERATIONAL-amplifier circuits almost always call for power sources that furnish clean, stable dc. Batteries are sources of good dc, but their expense relegates them principally to portable applications where commercial ac power is not readily available. The more economical solution to the problem of powering op amps is to use a *power supply* to convert commercial ac into smooth dc. In this article, we will examine several basic power-supply circuits that are well suited for use with operational amplifiers.

Symmetry is one of the principal characteristics required of most op-amp power supplies. Integrated operational amplifiers usually have two power-supply terminals—V+ and V−. If the voltages applied to these terminals are not symmetrical with respect to the input signal's ground potential (be it earth ground or an "artificial" ground), the output signal will ride on a dc level proportional to the power-supply asymmetry. This is usually undesirable—if a dc voltage is to be amplified, there will be error; if an ac voltage is to be amplified, capacitive coupling might be needed to prevent the upsetting of a subsequent stage's bias levels. Also, the possibility exists that the output signal will be asymmetrically clipped.

There are two basic types of power supplies that can be used with operational amplifiers—*bipolar* and *single-ended*. In a bipolar supply, positive and negative output voltages (usually equal in absolute value) are generated. The required symmetry arises from the fact that both the positive and negative supply rails are removed from ground by equal but opposite voltages. A single-ended supply generates only one voltage referenced to ground—either positive or negative. The ground of the power supply functions as one of the supply rails, and an "artificial ground" or "signal ground" is synthesized with a resistive voltage divider for reference purposes. This provides the required symmetry to the circuit.

Each type of supply has advantages and disadvantages. A bipolar supply furnishes a signal ground that is at true ground potential. This simplifies circuit design and eliminates at many points the need for capacitive coupling. However, a bipolar supply is more complex than a single-ended one and is more expensive to construct. A single-ended supply is simpler but usually makes the circuit to be powered slightly more complex. Let's examine some basic supplies of each type and see how they can be used to power op-amp circuits.

Basic Power Supplies. Appearing in Fig. 1 are simple single-ended (A) and bipolar (B) power supplies. In the single-ended supply, bridge rectifier *D1* through *D4* delivers pulsating dc to filter capacitor *C1*, which provides a smoothed dc output. Resistor *R1* is a bleeder component. A voltage divider comprising *R2* and *R3* synthesizes an artificial signal ground at half of the positive dc output voltage (assuming *R2* = *R3*) or approximately +17 volts. The op amp's positive power-supply terminal is connected to V+ and its negative supply terminal is connected to V−, which is actually true ground. An amplifier powered by this supply can process an ac signal symmetrically if the signal input is at ARTIFICIAL GROUND and the constraints of the power supply are not exceeded. The use of a blocking or coupling capacitor at the output of the amplifier permits the recovery of a pure ac signal with no dc component.

A basic bipolar power supply appears in Fig. 1B. The major differences between it and the single-ended supply just described lie in the transformer used, the need for a second filter capacitor, and the lack of a ground-synthesizing voltage divider. A transformer with a center-tapped secondary is needed. The bridge rectifier comprising *D1* through *D4* simultaneously charges filter capacitor *C1* positively and *C2* negatively. The GROUND at the output of the supply is connected to the transformer's center tap, and the positive and negative output voltages are symmetrical with respect to it. Note that the *differential* voltage between the positive and negative supply rails in each supply is the same even though the actual voltages on each of the rails with respect to true ground are not the same.

As a rule, operational amplifiers consume small amounts of current. This points to a disadvantage of the bipolar supply shown in Fig. 1B. Because only a small amount of output current is required, compact transformers rated at 300 mA or less are particularly attractive. Unfortunately, small transformers with center-tapped secondaries are not as widely available as ones lacking a center tap. The bipolar supply shown schematically in Fig. 2 offers a solution to this problem.

www.americanradiohistory.com

A glance at this supply reveals that it delivers positive and negative output voltages by means of a transformer lacking a center-tapped secondary. Also, note that the voltage rating of the secondary is half of that of the transformer shown in Fig. 1B. This supply can be thought of in one of two ways—either as two half-wave supplies, one positive and one negative with a common ground, or as a full-wave voltage doubler. In any event, it provides positive and negative voltages approximately equal to those produced by the supply shown in Fig. 1B. Also, the GROUND at the output of the supply is true ground, not an artificial one.

In practice, the true grounds of Figs. 1 and 2 are often connected to earth ground for shielding purposes. A fundamental difference between the bipolar supplies of Figs. 1B and 2 is that larger filter capacitors are required in the circuit shown in Fig. 2 for the same amount of ripple rejection. This is because the ripple frequency is lower (60 Hz as opposed to 120 Hz). Therefore, twice the capacitance is required if the capacitive reactance of the ripple shunt path to ground is to be kept at the same value as before.

Electronic Filtering. If the current drain from any of the power supplies that have been described is very low, and if the values of the filter capacitors are sufficiently large, only a small amount of ripple will be present in the dc output. However, in some applications even a low-level ripple component can be troublesome. An excellent safeguard against ripple is the use of electronic filtering such as that provided by a zener diode.

If a zener diode or similar component or electronic filtering network is connected to the output of a simple power supply, ripple can be almost entirely suppressed. The diode will provide not only the equivalent of several thousand or tens of thousand microfarads of filter capacitance in a very small space, but also a high degree of voltage regulation, which is very beneficial.

A basic electronic filter for positive-voltage applications is shown schematically in Fig. 3. When a positive unregulated voltage is initially applied to the input of the filter, capacitor *C1* begins to charge up to the input voltage. Zener diode *D1* clamps the voltage across the capacitor when the zener knee of its characteristic curve is surpassed. The voltage applied to the base of transistor *Q1* is thus kept at a fixed level. This transistor effectively performs two functions. It multiplies the capacitance of *C1* by its dc beta and behaves as an emitter follower, presenting a voltage at its emitter equal to the zener voltage less

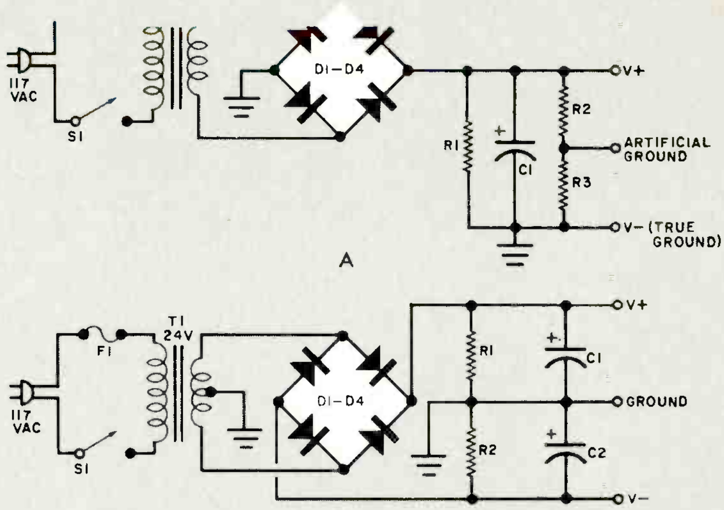


Fig. 1. Single-ended dc power supply for op-amp (A). Bipolar dc power supply that employs a center-tapped transformer (B).

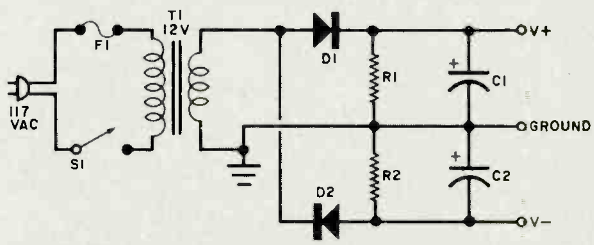


Fig. 2. A bipolar dc supply whose transformer does not have a center tap.

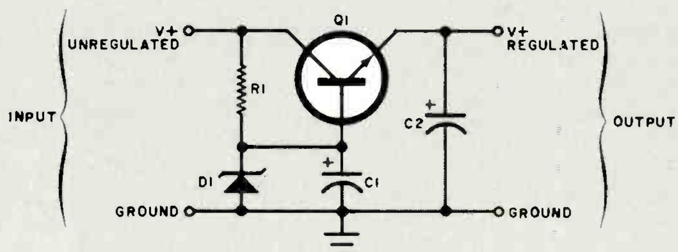


Fig. 3. This electronic filter provides a regulated positive dc output.

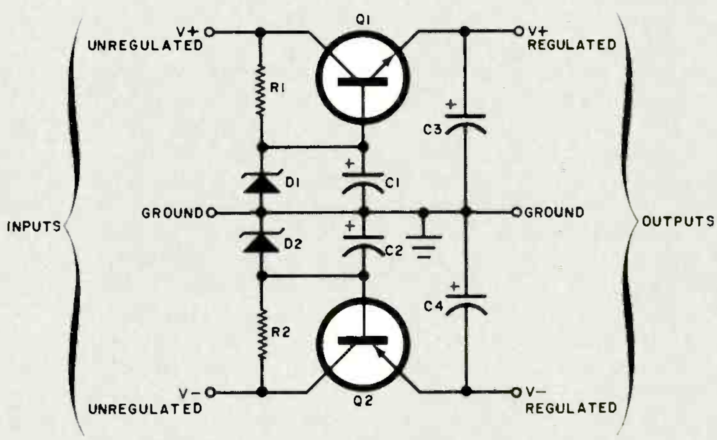


Fig. 4. An electronic filter for use with bipolar dc supplies.

www.americanradiohistory.com

the forward voltage drop across the base-emitter junction. Capacitor *C2* improves the performance of the electronic filter by helping to absorb transients. The time constant *R1C1* results in a slow turn-on characteristic that eliminates potentially troublesome switching transients (clicks) from the supply rails.

The filter shown in Fig. 3 is designed for use with positive-output (negative-ground), single-ended power supplies. It can be adapted for negative-output applications by inverting the polarities of *C1* and *D1* and employing a pnp pass transistor instead of an npn component. The unregulated negative dc voltage would then be applied to the node *R1*-collector of *Q1* and the regulated negative voltage would appear at the emitter of *Q1*. This technique is employed in the bipolar electronic filter shown schematically in Fig. 4. The top portion of this circuit is essentially the same as that shown in Fig. 3, and the bottom is a mirror image of the top—that is, a negative-output electronic filter.

Practical Supplies. A complete bipolar regulated power supply for op-amp audio applications appears schematically in Fig. 5. It is basically an amalgam of Figs. 2 and 4 with a few additional elements included. Hum and ripple components in its bipolar outputs are so low in level that they can be ignored in most applications, even where op amps are operating at high gain. The one precaution that is necessary is careful placement of transformer *T1*. This component should be located as far from high-gain stages as is practicable, and it should be physically oriented to keep induced hum signals as small as possible.

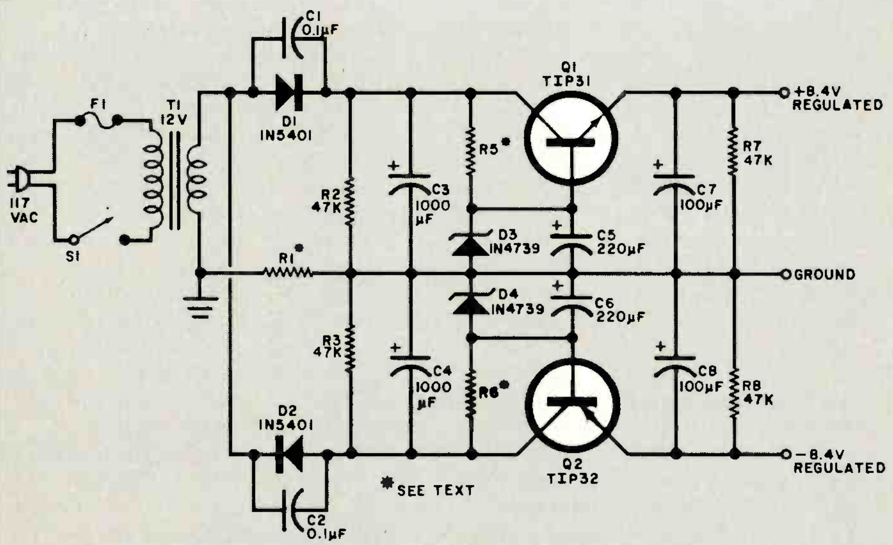


Fig. 5. Complete regulated bipolar supply for op-amp circuits. Transistors Q1 and Q2 might require heat sinking.

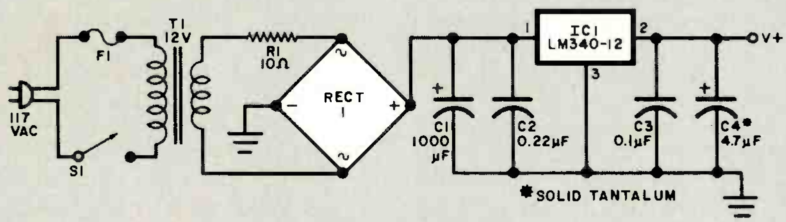


Fig. 6. Regulated single-ended dc supply for powering operational amplifiers.

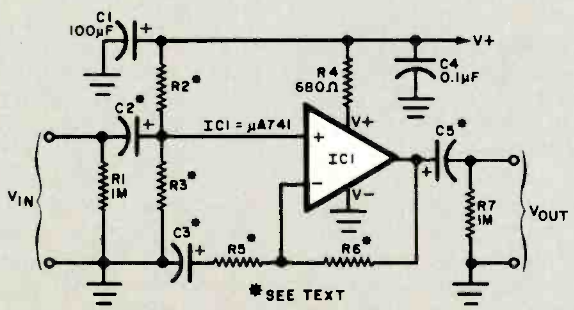


Fig. 7. Typical noninverting op-amp stage designed for use with a single-ended supply.

Rectifiers *D1* and *D2* have forward current ratings of three amperes rms. This high current rating, together with the current-limiting action of *R1*, prevents damage to the diodes by excessive charging current to the capacitors when ac power is first applied to the supply. Actually, the inherent resistance of the 300-mA transformer secondary is great enough to prevent the initial charging current from damaging three-ampere diodes. However, if one-ampere diodes or a transformer with a larger secondary-current rating (and thus less winding resistance) are used, or both, it would be wise to include resistor *R1* in the circuit.

The value of this resistor can be determined by measuring the resistance of the secondary and then solving Ohm's law for the resistance necessary to limit the current through the diodes to the rms rating. The peak voltage delivered by the secondary (1.414 times the rms voltage) should be used in this calculation, and the electrolytic capacitors should be considered dead shorts. Thus, only the inherent secondary resistance and any supplemental resistance provided by *R1* will be available for current limiting. If the resistance value obtained by this calculation is larger than the resistance of the secondary winding, *R1* should be included. Its value is simply the remainder obtained by subtracting the secondary resistance from the total resistance required. This results in a greater degree of protection for the diodes than is really necessary, but ensures trouble-free diode performance.

Note that 0.1-μF disc ceramic capacitors are shown in parallel with each rectifying diode. The function of these components is to suppress the spikes that are generated each time the diode junction breaks into and out of conduction. Fourier analysis of the waveform generated by the diode reveals the presence of significant high-order harmonic components. These harmonics can be troublesome to high-gain op-amp audio stages as well as a source of radio-frequency interference to AM or FM tuners.

Resistors *R5* and *R6* provide current limiting for zener diodes *D3* and *D4*. Values of these components are best determined empirically after performing an initial calculation. First, the rated

www.americanradiohistory.com

zener voltage sould be subtracted from the voltage appearing across *C3* or *C4*. The remainder is the voltage drop across the current-limiting resistor. Then Ohm's law should be solved for that value of resistance that results in a current flow of two milliamperes through the resistance. Using this as a starting value, connect a suitable component to the rest of the circuit and temporarily connect a load resistor between the regulated output and ground. The load resistance should be such that the supply will be required to source two or three times the amount of current drawn by the op-amp circuit to be powered under worst-case (maximum current) conditions.

Apply power to the circuit and measure the voltage across the load resistor. Next, disconnect the load from the output of the supply and measure the open-circuit output voltage. If the difference between the loaded and unloaded output voltage is greater than a few percent at most, decrease the value of the current-limiting resistor to the next smaller commercial value and repeat the procedure. (Alternatively, employ a trimmer potentiometer in place of fixed resistors.) When the supply voltage has sufficient regulation, permanently install a fixed resistor of the *next smallest* commercial value with respect to the resistance value that has been empirically determined. This will provide an extra margin of voltage regulation.

The use of this empirical method, though somewhat crude, is justified by the fact that many experimenters purchase surplus zener diodes and transistors whose parameters might be unknown or considerably different from their rated values. Parameters such as a transistor's dc beta and the sharpness of a diode's zener knee will have a significant influence on the appropriate values of the current-limiting resistors. If this method does not produce the desired result, that is, if adequate voltage regulation cannot be obtained, either the zener diode or transistor (or both) should be replaced with another component of the same type. Deficiencies in either device can cause this problem.

Some readers might question the choice of the bipolar output voltage, ±8.4 volts, as opposed to the more common ±12 or ±15 volts. The author was more interested in extended, reliable op-amp performance than in large output-voltage swings. A lower supply voltage places less strain on an op amp and can also help prevent it from becoming noisy. The lower supply voltage does *not* affect stage gain. However, if a higher differential supply voltage is desired, simply use higher-voltage zener diodes for *D3* and *D4* and follow the same resistance-selection procedure that has already been outlined.

Keep in mind that the output voltage will be approximately 0.7 volt less than the zener voltage of the diode and that decreasing the differential input-to-output voltage (V_{CE} of the pass transistor) can degrade voltage regulation when large amounts of current are drawn from the supply. A ±8.4-volt prototype supply can simultaneously power four op-amp audio stages with fine regulation and lack of hum.

A complete single-ended supply for op-amp applications is shown in Fig. 6. It generates a regulated +12-volt output referenced to ground and employs a 100-PIV modular bridge rectifier and an integrated 12-volt regulator. Resistor *R1* limits the surge current through the bridge during power-up. Capacitors *C2* and *C3* are disc ceramic components that should be placed close to the regulator IC package. Solid tantalum capacitor *C4* improves the transient response of the regulator IC. Alert readers might have noted that no spike-suppressing capacitors are shown connected across the bridge's diodes. The capacitors might not be necessary, but any reader who plans to duplicate this circuit should leave space for them if actual performance indicates a need for them. Four capacitors would then be installed—one across each diode forming the bridge.

The +12-volt output is usually sufficient for most op-amp applications. It permits the output of an operational amplifier to swing almost 12 volts peak-to-peak without clipping. If a greater output swing is desired, a higher-voltage regulator IC and either a diode-capacitor voltage multiplier or a transformer with a smaller step-down ratio can be used.

Figure 7 is the schematic diagram of an op-amp audio amplifier that the author has powered with the single-ended supply just described. Resistors *R2* and *R3* form a voltage divider across the supply rails. The values of these components are identical (typically 100,000 ohms) so that the noninverting input of the op amp, the one to which input signals are applied via coupling capacitor *C2*, is at exactly half the supply voltage. This artificial signal "ground" potential permits the op-amp output to swing symmetrically in response to ac excitation. Components *C1* and *R4* decouple the supply line that feeds the biasing resistors to ensure good performance.

The bias level applied to the noninverting input of the op amp causes the output of the amplifier to remain at this same level during quiescence due to the effectively infinite dc feedback provided by *R6*. No dc amplification can occur, however, because *C3* prevents any dc voltage division by *R5* and *R7*. Resistors *R1* and *R6* provide dc return paths at the input and output of the stage.

The amplifier's voltage gain equals the quantity (1 + R6/R5) because the stage is noninverting. Selection of these resistor values is made to obtain the required voltage gain. The capacitance of *C3* should be large enough that the component's capacitive reactance should be low at the lowest frequency to be amplified. One hundred microfarads or more should be sufficient for most audio applications, especially if the gain-determining resistances are on the order of kilohms or more.

Electrolytic capacitors *C2* and *C5* couple ac signals into and out of the amplifier, respectively. Their values have an influence on the frequency response of the amplifier. As a rule, the capacitance of *C5* must be higher than that of *C2* for a given low cutoff frequency because the output impedance of the amplifier is much lower than the input impedance. Practical audio circuits of similar design commonly employ tens of microfarads or more capacitance for input coupling and hundreds or thousands of microfarads for output coupling. The optimum values for a given application depend on the lowest frequency to be amplified, the load impedance, etc.

Some audio circuits employing electrolytic capacitors and op amps powered by bipolar supplies have appeared previously in the literature. These circuits have one principal disadvantage—there is no dc polarizing voltage impressed across the coupling capacitors. During one half of the ac signal cycle, the capacitors are reverse-polarized and a reverse current flow exists. At best, this can result in varying circuit impedances and shortened capacitor useful lifetimes. At worst, it can cause catastrophic capacitor failure and the application of dc levels from a previous stage to a subsequent one. In the op-amp circuit we have just described, all electrolytic capacitors are properly dc-polarized.

In Conclusion. Operational amplifiers are among the most useful devices available to the electronics experimenter. For best performance, their relatively modest power requirements should be satisfied through the use of stable sources of clean dc. To that end, a number of power-supply design ideas and practical circuits have been presented in this article. The experimenter can use them for guidance in the construction of power supplies that will enable him to derive the best possible results from his op-amp projects. ◇

www.americanradiohistory.com

BY ALLEN H. WOLACH

SIMPLE MEMORY ADDITION FOR TRAINING COMPUTERS

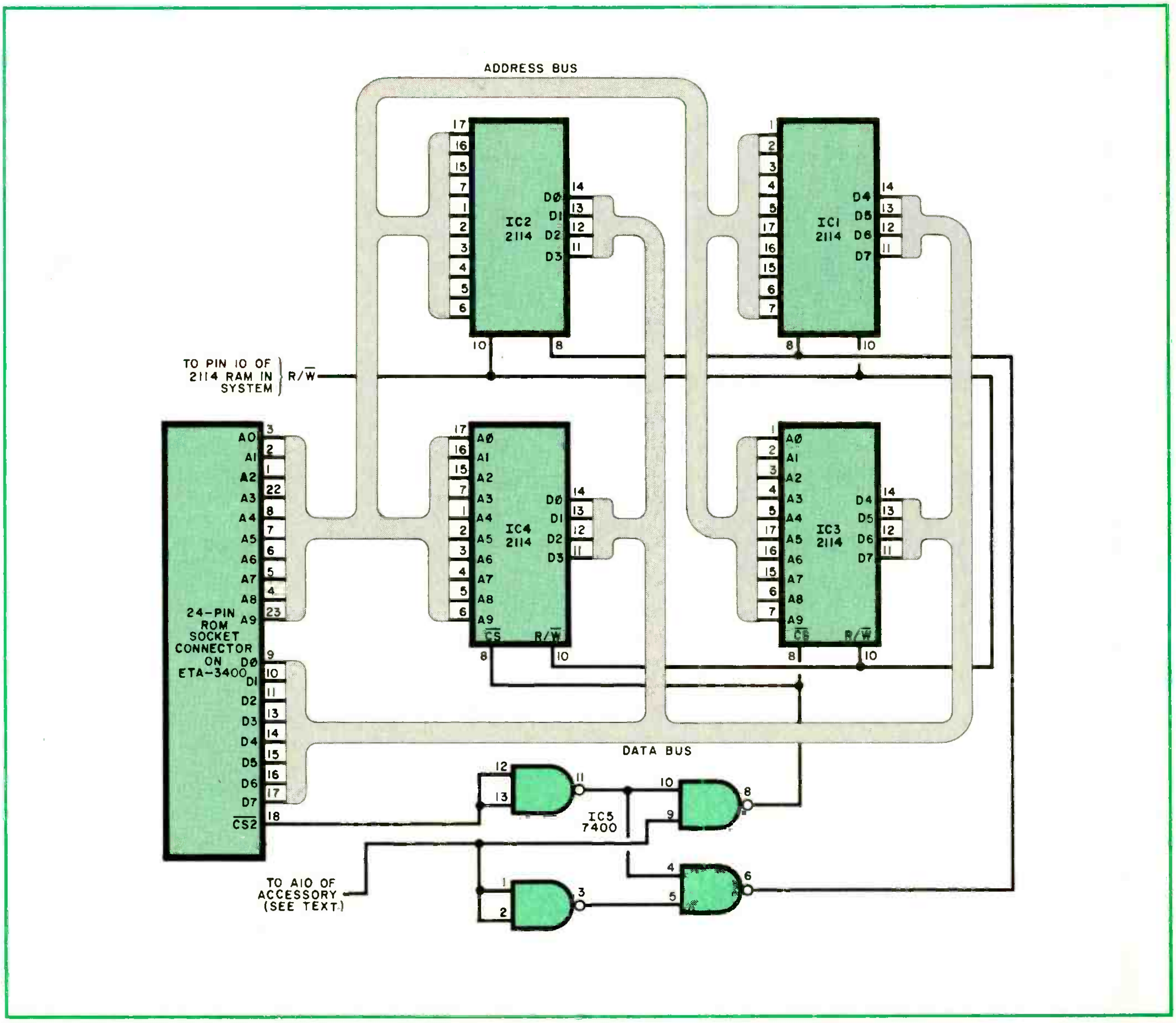
Substitute RAM for ROM

MOST one-board computers, particularly those intended for microprocessor training, contain an operating system and/or a limited high-level language in ROM and some small amount of user RAM. This RAM is usually sufficient to use the system for training purposes; but, after one becomes proficient, the need often arises for more user-memory space. Some systems provide for outboard memory but many do not. Although designed for the Heathkit ET-3400/ETA-3400 Computer Trainer/Trainer Accessory, the memory-expander approach described here can be adapted to other systems.

In this particular system, the Trainer Accessory contains Tiny BASIC in a 2K ROM. If this ROM is replaced with RAM, an additional 2048 bytes of user memory becomes available. If desired, the Tiny BASIC can be recorded on cassette and re-entered at any time using conventional cassette techniques.

Since the ROM is already placed in the system memory map, the address locations for the new RAM are safe. In actuality, the RAM connects to the system via the old ROM socket, thus no extensive wiring is required.

The 2114 static RAMs used in this project are 1K-x-4-bit types that have 1024 addresses with each addressing a



www.americanradiohistory.com

4-bit word. Thus, four 2114 RAMs create a 2048-x-8-bit memory.

In the ETA-3400, Tiny BASIC ROM pins 1 through 8, 22, and 23 are analogous to pins 1 through 7, 15, 16, and 17 of a 2114 RAM. On the ROM, pins 9, 10, 11, and 13 through 17 are the eight data I/O pins, while pins 11 through 14 are the four data I/O pins on the 2114. Pins 21 (CS3) and 20 ($\overline{\text{CS1}}$) on the ROM are chip-select that are placed high (pin 21) and ground (pin 20) in the Heath System. These pins can be ignored since the 2114 RAM uses pin 8 (chip select) that is analogous to pin 18 ($\overline{\text{CS2}}$) on the ROM.

When the ROM is addressed, a circuit within the ETA-3400 decodes address lines A10 through A15 and places a low at $\overline{\text{CS2}}$ (pin 18) when the appropriate high addresses, A10 through A15, occur for any memory locations within the ROM. Since the $\overline{\text{CS2}}$ pin goes low for all 2K locations contained in the ROM, this line must be further decoded so that it goes low separately for the first and last half of the 2K locations. When the decoded input for the first half of the 2K locations goes low, the first half of the replacement 2K RAM is addressed; and, when the decoded input for the second half of the 2K locations goes low, the second half of the replacement RAM is similarly addressed. The complete schematic is shown in Fig. 1.

The modification can be wired on a "solderless socket" having room for four 18-pin 2114s and one 14-pin 7400 TTL chip. Mount the ICs on the board with one unused row of connections between the ICs. Sockets are optional.

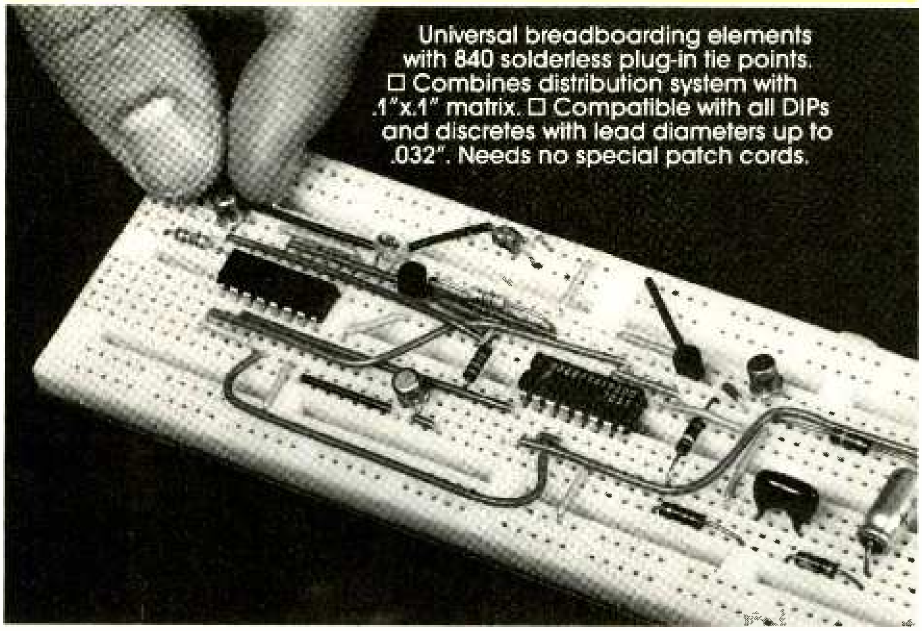
The 24-pin ROM socket connector is formed from a 24-pin DIP header. If such a header is difficult to locate, two 16-pin DIP headers can be suitably cut and cemented together in such a way as to form one 24-pin device.

The upper row of connectors on the solderless socket is connected to pin 24 on the 24-pin header to supply +5 volts to the RAM system. The bottom row of connectors on the solderless socket is connected to pin 12 on the 24-pin header to supply −5 volts (ground). The 2114 RAMs, *IC1* through *IC4*, have their pins 9 connected to the ground line and their pins 18 connected to the +5-volt line. Pin 7 of *IC5* is connected to ground and pin 14 to +5 volts.

The five ICs are wired in accordance with Fig. 1 and connected to the 24-pin header as shown. Use lead lengths long enough to reach the ROM socket in the ETA-3400. The address and data busses shown in Fig. 1 are for the RAM addition and are *not* the system busses. For example, pins 17 of *IC2* and *IC4* are connected to A0 (address line 0) as do pins 1 of *IC1* and *IC3*.

The $\overline{\text{CS2}}$ modification is implemented by *IC5* as shown in Fig. 1. In the Heath system, the line goes low for memory locations 1C00h through 23FFh. Address line 10 in the accessory is high for the first half of these locations (1C00h through 1FFFh) and low for the remaining locations between 2000h and 23FFh. Thus, in the *IC5* stage of Fig. 1, the output from pin 8 is negative for locations 1C00h through 1FFFh while the output from pin 6 is negative for locations 2000h through 23FFh.

Only two connections must be made to the computer accessory. First, pins 1, 2, and 9 of *IC5* are connected (soldered) to A10 on the 40-pin connector of the accessory (pin 18 on the Heath 40-pin connector). Second, the R/$\overline{\text{W}}$ pin for the 2114 is pin 10. Interconnect pin 10 of each 2114 then connect them together via a length of wire to pin 10 of any one of the eight 2114 RAMs in the memory accessory. ◇



Your breadboarding is a super-snap with a solderless A P Super-Strip.

Build a circuit almost as fast as you dream it up. Pull it apart and do another—everything's as good as new.

Our versatile Super-Strip mini-breadboards give you the same top-quality contacts you get in our full-scale ACE All-Circuit Evaluators. Not so "mini," either. You can build circuits with as many as nine 14-pin DIPs.

Instant-mount backing and quick-removal screws make stacking and racking a snap, too.

Where to buy? Phone (toll-free) 800-321-9668 for the name of your local A P distributor. And ask for our complete A P catalog, The Faster and Easier Book.

A P PRODUCTS INCORPORATED
9450 Pineneedle Drive
P.O. Box 603
Mentor, Ohio 44060
(216) 354-2101
TWX: 810-425-2250
In Europe, contact A P PRODUCTS GmbH
Baeumlesweg 21 • D-7031 Weil 1 • W. Germany

CIRCLE NO. 3 ON FREE INFORMATION CARD

www.americanradiohistory.com

TARGET

A new game to play on your Elf computer

BY RON BURCH

THIS short program for the Elf computer plays a game called Target. In this game, 10 "targets" are displayed on the video screen in successive order. The target byte is selected either by keying it in via the hex keypad, or by setting the toggle switches to that byte.

When a target is displayed, the intent is to depress the INPUT switch at that instant. If you were fast enough, the Q LED will glow and 00 will replace the target byte. Play is resumed by depressing the INPUT switch. If you miss the target, the display continues sequencing.

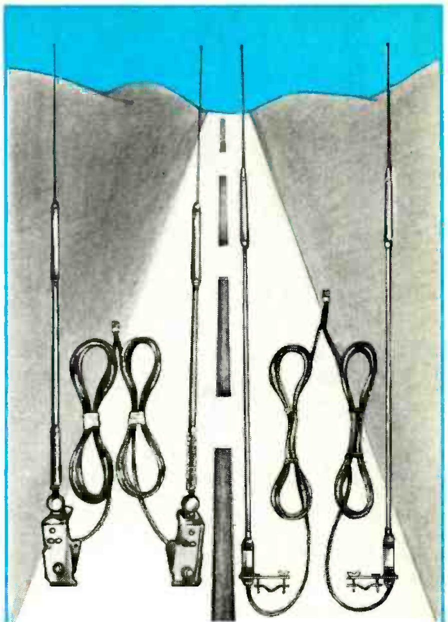
To create the game, enter the program shown in the Table. Addresses 0007 and 0018 limit the number of targets to 10, while addresses 001B and 001E control the speed of the moving targets. If you desire a self-loading 1 to 9 target sequence, replace the first 20 bytes of the program with:

```
F8 A0 A1
F8 00 A2
F8 09 A3
12 82
51 11
23 83
3A 09
C4 C4 C4
```

◇

PROGRAM

Address	Op Code	Address	Op Code
0000	F8 A0 A1		F8 05 B6
	F8 90 A2		26 96
			3A 41
	37 09		37 28
	3F 0B	0047	7B
	E1 6C 64	0048	F8 00 51
	23 83		64 21
	3A 09		37 4D
	F8 A0 A1		3F 4F
	F8 0A A3		7A
	F8 08 B4	0052	30 28
	F8 00 A4		
	64 21		
	24 94		
	3A 22		
0026	30 2F		
0028	11		
	23 83		
	3A 1A		
	30 14		
	E2 6C		
	E1 F5		
	3A 28		
	F8 FF A7		
	27 87		
	32 28		
	3F 38		



HUSTLER — STILL THE LEADER IN DUAL CB ANTENNA SYSTEMS

Since introducing the industry's first dual CB antenna systems, Hustler has continually led the way in the development of these advanced designs.

Today, Hustler offers you the widest selection of quality dual CB systems available. Whether you're behind the wheel of the family car, RV, or a long-haul semi, a Hustler dual antenna system will give you a signal pattern unmatched in uniformity. Total electrical and mechanical reliability. Freedom from fading and blind spots when you change direction, and twice the signal capture area.

Hustler dual antenna systems feature professional-quality components: heavy chrome plated mounts, oversized "Hi-Q" resonators, superflex stainless steel radiators, dual phasing harnesses with balanced power feed, and much more . . .

For a consistently clear channel any way you turn, you can't surpass dual CB antenna systems by the original: Hustler — still the standard of performance.

HUSTLER®

3275 North "B" Avenue
Kissimmee, Florida 32741

An Armatron Company

CIRCLE NO. 27 ON FREE INFORMATION CARD

Licenced by Sinclair Research Ltd.

A Microcomputer for everyone at a Micro Price

The MicroAce - a new generation of miniature computers

A COMPLETE COMPUTER for $149.00 for 1K Kit

Post and Packing FREE

(Add 6% Tax for Shipments inside California)

The unique and valuable components of the MicroAce

The MicroAce is not just another personal computer. Quite apart from its exceptionally low price, the MicroAce has two uniquely advanced components: the powerful BASIC interpreter, and the simple teach yourself BASIC manual.

The unique versatile BASIC interpreter offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the MicroAce eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

'Excellent value' indeed!

For just $149.00 (excluding handling charge) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or color); everything!

Yet the MicroAce really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The MicroAce is programmed in BASIC, and you can use it to do quite literally anything, from playing chess to managing a business.

The MicroAce is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV ... link it to the mains adaptor ... and you're ready to go.

Fewer chips, compact design, volume production-more power per Dollar!

The MicroAce owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the MicroAce 1K byte RAM (expandable to 2K on board) is roughly equivalent to 4K bytes in a conventional computer — typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the MicroAce is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.

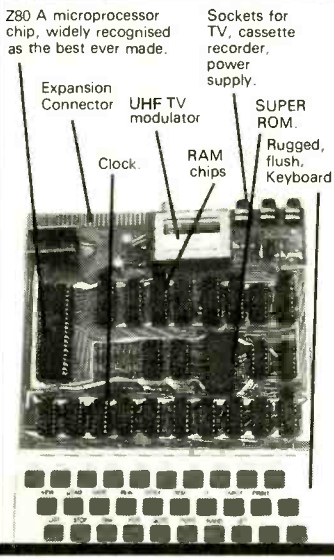
The MicroAce teach-yourself BASIC manual.

If the features of the BASIC interpreter mean little to you-don't worry. They're all explained in the specially-written book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming-from first principles to complex programs. (Available separately-purchase price refunded if you buy a MicroAce later.)

A hardware manual is also included with every kit.

The MicroAce Kit:
$149.00 with IK COMPLETE
$169.00 with 2K

Demand for the MicroAce is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. If you are unsuccessful in constructing your kit, we will repair it for a fee of $20.00, post and packing FREE. Of course, you may return your MicroAce as received within 14 days for a full refund. We want you to be satisfied beyond all doubt — and we have no doubt that you will be.



Your MicroAce kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs-all manufactured by selected world-leading suppliers.
- New rugged keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- Mains adaptor of 600 mA at 9VDC nominal unregulated.
- FREE course in BASIC programming and user manual.

JOIN THE REVOLUTION - DON'T GET LEFT BEHIND - ORDER YOUR MICRO ACE NOW!!

Send Check, Money Order or quote your Credit Card No. to:
MicroAce 1348 East Edinger, Santa Ana, California, Zip Code 92705.
or phone (714) 547 2526 quoting your Credit Card Number.

Quantity	Description	Unit Price	TOTAL
	MicroAce Kit 1K	$149.00	
	MicroAce Kit 2K	$169.00	
	Manual	$10.00	
	1K Upgrade Kit	$29.00	
Shipments inside California add 6% TAX		**TOTAL**	

☐ Amex.
☐ Diners
☐ Check
☐ Money Order
☐ Master Charge
☐ Visa

Card No. ____________

Exp. Date ____________

Name ____________

Address ____________

City ____________ State ____________ Zip ____________

CIRCLE NO. 38 ON FREE INFORMATION CARD

www.americanradiohistory.com

VARY THE SPEED OF SYNCHRONOUS MOTORS WITH THIS PROGRAMMABLE CONTROL

BY GARY McCLELLAN

BECAUSE of their performance, reliability, and relatively low cost, synchronous ac motors are found in many turntables, tape decks, electrical timepieces, and even in the clock drives of amateur telescopes. The rotational speed of such a motor depends largely on the frequency of the ac source that powers it. In most applications, utility-generated ac powers a synchronous motor, making for an operational speed that is accurate and stable but difficult to vary.

Sometimes it is desirable to vary the speed of a synchronous ac motor. This article describes a project, the Programmable Speed Control, that provides this capability. It converts +12-volt dc into line-voltage, square-wave ac whose frequency is crystal-controlled and selectable in 0.1-Hz increments from 10.0 to 100.0 Hz. The project can provide up to 15 watts of output power, and can be modified to provide more. When properly calibrated, it has a rated frequency accuracy six times greater than that of the U.S. ac power grid. The Programmable Speed Control also has a moderate parts count and a relatively low construction cost.

About the Circuit. The heart of the system (Fig 1.) is a phase-locked loop comprising *IC1*, *IC2*, *IC3*, BCD thumbwheel switches *S1* through *S3*, and a quartz crystal. An oscillator in MOS LSI chip *IC1* generates a 3.5795-MHz signal whose frequency is controlled by the quartz crystal *XTAL*. Also included in this chip is a programmable-modulo counter. For this application, the counter is programmed so that a 100-Hz square wave appears at its output. This signal is used as a stable reference input for the phase-comparator section of CMOS phase-locked loop *IC2*.

Applied to the other input of the phase comparator is a square wave derived from the output of the voltage-controlled-oscillator (vco) section of *IC2*. The output of the vco is a square wave whose frequency can vary from 10 to 100 kHz. In the example shown, it is nominally 60 kHz. This signal is applied to programmable-modulo counter *IC3*, which divides its frequency by a factor determined by the settings of thumbwheel switches *S1*, *S2*, and *S3*. These switches generate twelve BCD bits which are applied to the programming inputs of *IC3* and whose decimal equivalent is read off the faces of the switches.

In Fig. 1, the switches are shown set to read 60.0, but the decimal equivalent of the BCD number actually applied to the counter is 600. Accordingly, the vco output frequency is divided by 600, and a 100-Hz square wave appears at the output of *IC3*. The phase comparator accepts the two square-wave inputs. If they are not in phase the comparator sends a dc *error voltage* to the control input of the vco. In response, the vco shifts its frequency of oscillation until the square wave generated by *IC3* is in phase with the quartz-derived reference. (Frequency can be considered the rate of change of phase.) At this point, the output of the vco is phase-locked to the reference.

Switches *S1*, *S2*, and *S3*, together with *IC1*, *IC2*, and *IC3* form a frequency synthesizer that generates an extremely stable square wave. Its frequency will be between 10 and 100 kHz, the exact value determined by the settings of the thumbwheel switches. Counters *IC4* and *IC5* divide the vco output frequency by a factor of 1000. For the example shown, the output of *IC5* is 60.0 Hz. Counter *IC5* functions such that the duty cycle of its square-wave output is 50 percent.

This signal is inverted by buffer *IC6F*, whose output is simultaneously applied to driver *Q1* and to inverting

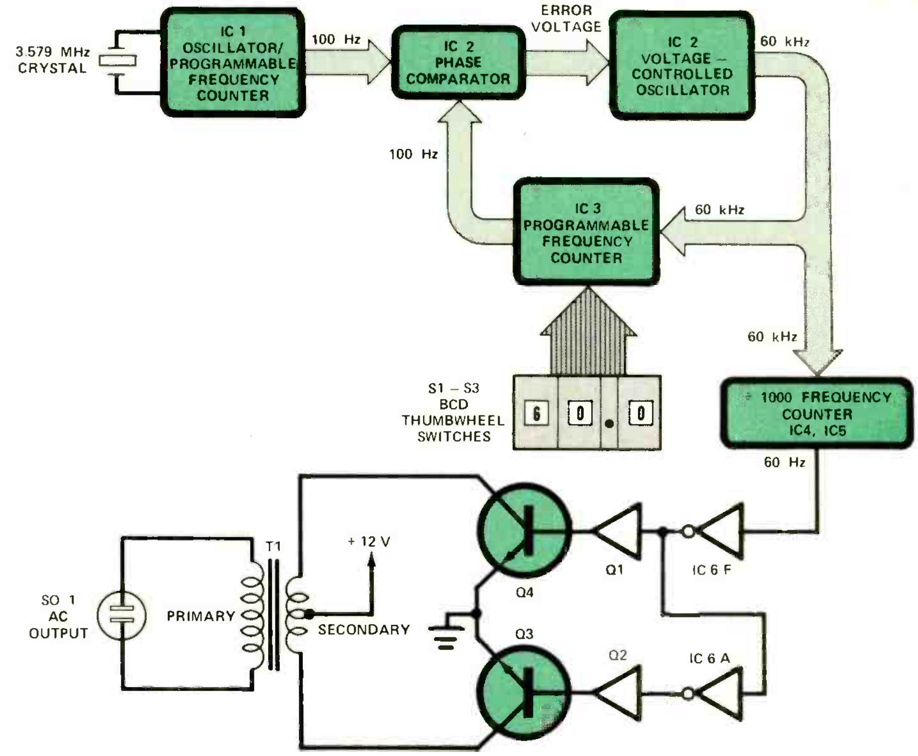
Crystal-controlled, frequency-synthesized dc-to-ac inverter has many useful applications

www.americanradiohistory.com

buffer *IC6A*. The output of the second inverting buffer is applied to driver *Q2*. When *Q1* is conducting, it provides base drive to power transistor *Q4*, but driver *Q2* and, hence, power transistor *Q3* are cut off. Similarly, when the output of *IC6A* causes *Q2* and *Q3* to conduct, *Q1* and *Q4* are cut off. The emitters of the power transistors are grounded, and their collectors are connected to the ends of the secondary winding of transformer *T1*. The center tap of the secondary is connected to +12 volts.

Power transistors *Q3* and *Q4* cause current pulses of opposite polarity to flow through the secondary of *T1*. Actually, the nominal secondary is used as a primary winding in this application, and vice versa. Line-voltage, square-wave ac appears across the primary of *T1* and is routed to power socket *SO1*. There it is available to the synchronous ac motor whose speed is to be controlled.

The schematic diagram of the Programmable Speed Control (Fig. 2.)



PARTS LIST

Components denoted by an * are needed only if the optional line-powered supply is built.

C1—30-pF NPO disc ceramic or silver mica capacitor
C2—15-pF NPO disc ceramic or silver mica capacitor
C3—6-to-20-pF air-dielectric trimmer capacitor (E.F. Johnson 275-0320-005 or equivalent)
C4, C6, C8—0.1-μF disc ceramic capacitor
C5—1-μF, 16-volt tantalum capacitor (do not make substitutions)
C7—47-pF NPO disc ceramic or silver mica capacitor
C9—10-μF, 16-V, radial-lead aluminum electrolytic
C10—220-μF, 16-V, radial-lead aluminum electrolytic
C11—2200-μF, 16-V, axial-lead aluminum electrolytic
C12—0.47-μF, 600-V, Mylar tubular capacitor
C13*, C14*—0.01-μF, 250-V, disc ceramic capacitor
C15*—4700-μF, 25-V, axial-lead aluminum electrolytic
D1, D2*, D3*, D4*, D5*—6-ampere, 50-PIV silicon rectifier (Motorola MR750 or equivalent)
F1—2-ampere, type 3AG fast-blow fuse
F2*—1-ampere, type 3AG fast-blow fuse
IC1—MM5369EST MOS LSI oscillator/17-stage programmable counter (National Semiconductor)
IC2—CD4046BC CMOS phase-locked loop

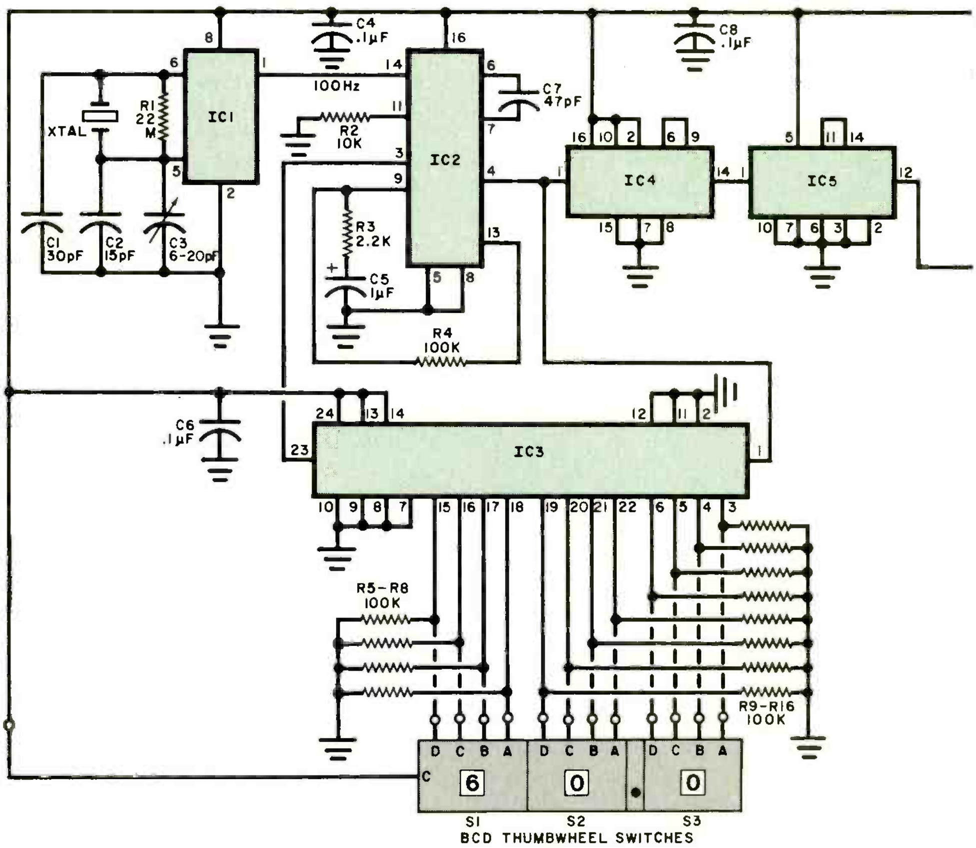


Fig. 2. Schematic diagram of the system. It can provide up to 15 watts of output at SO1, with frequency variable from 10 to 100 Hz.

www.americanradiohistory.com

closely resembles the block diagram. Components *C5*, *R3*, and *R4* comprise a loop filter—a low-pass filter that processes the error-voltage output of the phase-comparator in *IC2*. It ensures that clean dc is applied to the control input of *IC2*'s vco and that the vco's output frequency is stable. A tantalum capacitor is specified for *C5*. Using a standard aluminum-electrolytic capacitor for *C5* can cause circuit instability.

Inverting buffers *IC6A* and *IC6F*, because they are CMOS stages, can source only a few milliamperes of current. Driver transistors *Q1* and *Q2* function as emitter followers and provide base drive for power transistors *Q3* and *Q4*. The amount of base drive, nominally 20 mA, is determined by the values of resistors *R17* and *R18*. It can be adjusted if necessary by changing the values of these components.

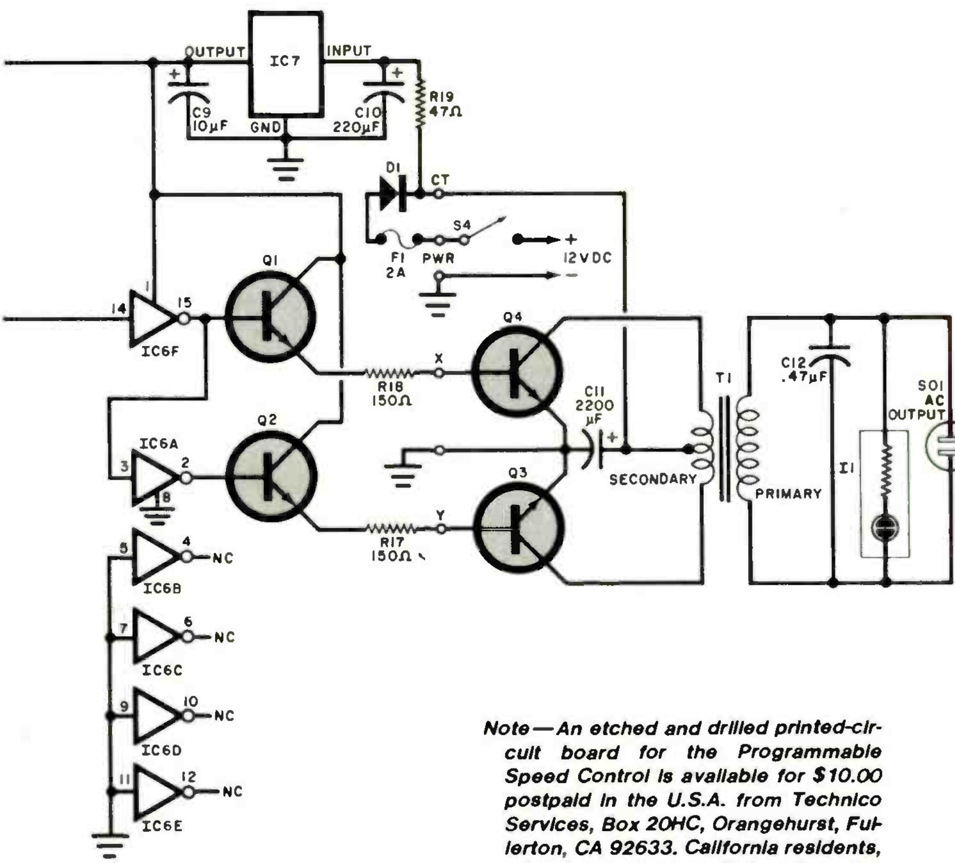
In line-powered applications, synchronous ac motors are driven by a sinusoidal waveform. The output waveform of the Programmable Speed Control, however, is a square wave. Capacitor *C1* is wired in parallel with the transformer's primary winding (functionally the secondary winding) to damp the square wave and to protect the transformer and the synchronous ac motor from transient spikes. Also wired in parallel with the primary winding is neon pilot indicator *I1*. This lamp glows to alert the user that line-voltage ac is present at output power socket *SO1* and that the project is ready for use.

The Programmable Speed Control is designed to be powered by a +12-volt dc source. Diode *D1* protects the polarity-sensitive components in the project from application of reverse-polarity dc. Voltage regulator *IC7* enhances the stability of the frequency synthesizer by isolating it from voltage fluctuations in the dc power source.

Using a dc power source makes the project ideal for applications such as powering the clock drive of an amateur telescope during an outdoor viewing session. However, there are applications for the Programmable Speed Control in which ac line power is readily at hand. Two alternatives suggest themselves. One is to use a 12-volt rechargeable battery connected to a line-powered trickle charger. The other is to use a +12-volt, 3-ampere battery eliminator or the power supply shown in Fig. 3. This unregulated full-wave dc supply is more than adequate to power the circuit. It can be incorporated into the main project enclosure if the Programmable Speed Control will always be used in line-powered applications. Power switch *S4* then becomes superfluous.

Construction. Fashion a printed-circuit board using Fig. 4 as a guide. Referring to the component-placement guide in Fig. 5, install IC sockets or Molex Soldercons at locations *IC1* through *IC6* and add the two bare-wire jumpers between locations *IC2* and *R13*. Next, install the on-board capacitors, observing polarity

(Continued on page 72)



Note—An etched and drilled printed-circuit board for the Programmable Speed Control is available for $10.00 postpaid in the U.S.A. from Technico Services, Box 20HC, Orangehurst, Fullerton, CA 92633. California residents, add state sales tax. Orders from foreign countries must be accompanied by remittance of U.S. currency and a $3.00 postage-and-handling charge.

IC3—CD4059AE CMOS 4-decade programmable counter
IC4—CD4518BC CMOS dual-synchronous BCD up counter
IC5—MM74C90 CMOS 4-bit decade counter
IC6—CD4049C hex inverting buffer
IC7—LM78L05CZ 5-V, 100-mA regulator
I1—Neon pilot indicator with integral series resistor
Q1, Q2—2N3904 npn silicon switching transistor
Q3, Q4—2N3055 npn silicon power transistor
The following are 1/2-watt, 5% tolerance, carbon-composition fixed resistors.
R1—22 MΩ
R2—10 kΩ
R3—2.2 kΩ
R4 through R16—100 kΩ
R17, R18—150 Ω
R19—47 Ω
S1, S2, S3—Ten-position thumbwheel switch with BCD outputs
S4—Spst toggle switch (not needed if optional line-powered supply is built)
S5*—Spst toggle switch
SO1—Ac power socket
T1—20-V, 1.5-A, center-tapped transformer (Signal Transformer Co. No. 241-6-20 or equivalent)
T2*—25-V, 3-A, center-tapped transformer
XTAL—3.579545-MHz quartz crystal
Misc.—Heat sink, mica insulators, silicone thermal compound, IC sockets or Molex Soldercons, printed-circuit board, suitable enclosure, fuseholder*, pc-mount fuse clips, line cord*, strain relief, power cable, heavy-duty alligator clips (used only if optional line-powered supply is not built), ac power plug*, hookup wire, hardware, solder, etc.

www.americanradiohistory.com

EQUIPMENT AND TRAINING NO OTHER SCHOOL CAN MATCH.

NTS HOME TRAINING INVITES YOU TO EXPLORE MICROCOMPUTERS, DIGITAL SYSTEMS AND MORE, WITH STATE-OF-THE-ART EQUIPMENT YOU ASSEMBLE AND KEEP.

Without question, microcomputers are the state of the art in electronics. And NTS is the only home study school that enables you to train for this booming field by working with your own production-model microcomputer.

We'll explain the principles of trouble-shooting and testing your microcomputer and, best of all, we'll show you how to program it to do what you want.

You'll use a digital multimeter, a digital logic probe and other sophisticated testing gear to learn how to localize problems and solve them.

We believe that training on production-model equipment, rather than home-made learning devices, makes home study more exciting and relevant. That's why you'll find such gear in most of NTS's electronics programs.

For instance, to learn Color TV Servicing you'll build and keep the 25-inch (diagonal) NTS/HEATH digital color TV.

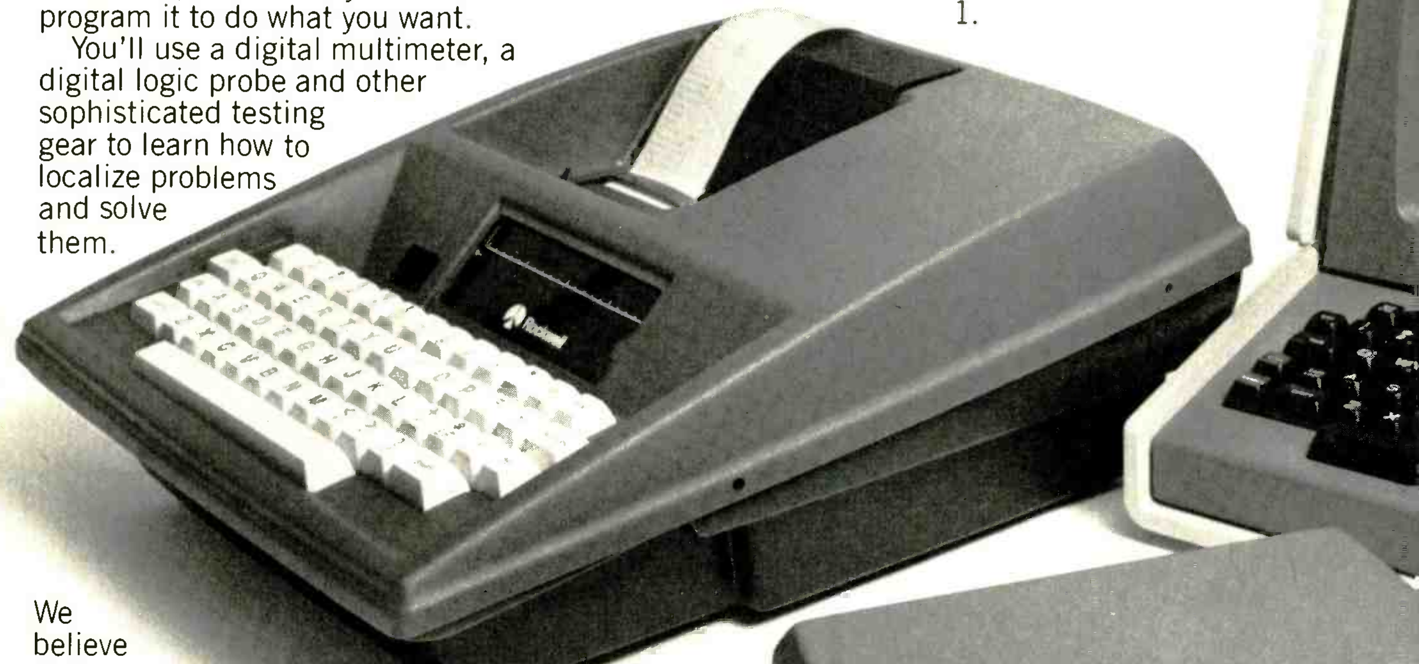
In Communications Electronics you'll be able to assemble and keep your own NTS/HEATH 2-meter FM transceiver, plus test equipment.

But no matter which program you choose, NTS's Project Method of instruction helps you quickly to acquire practical know-how.

Send for the full color catalog in the electronics area of your choice – discover *all* the advantages of home study with NTS!

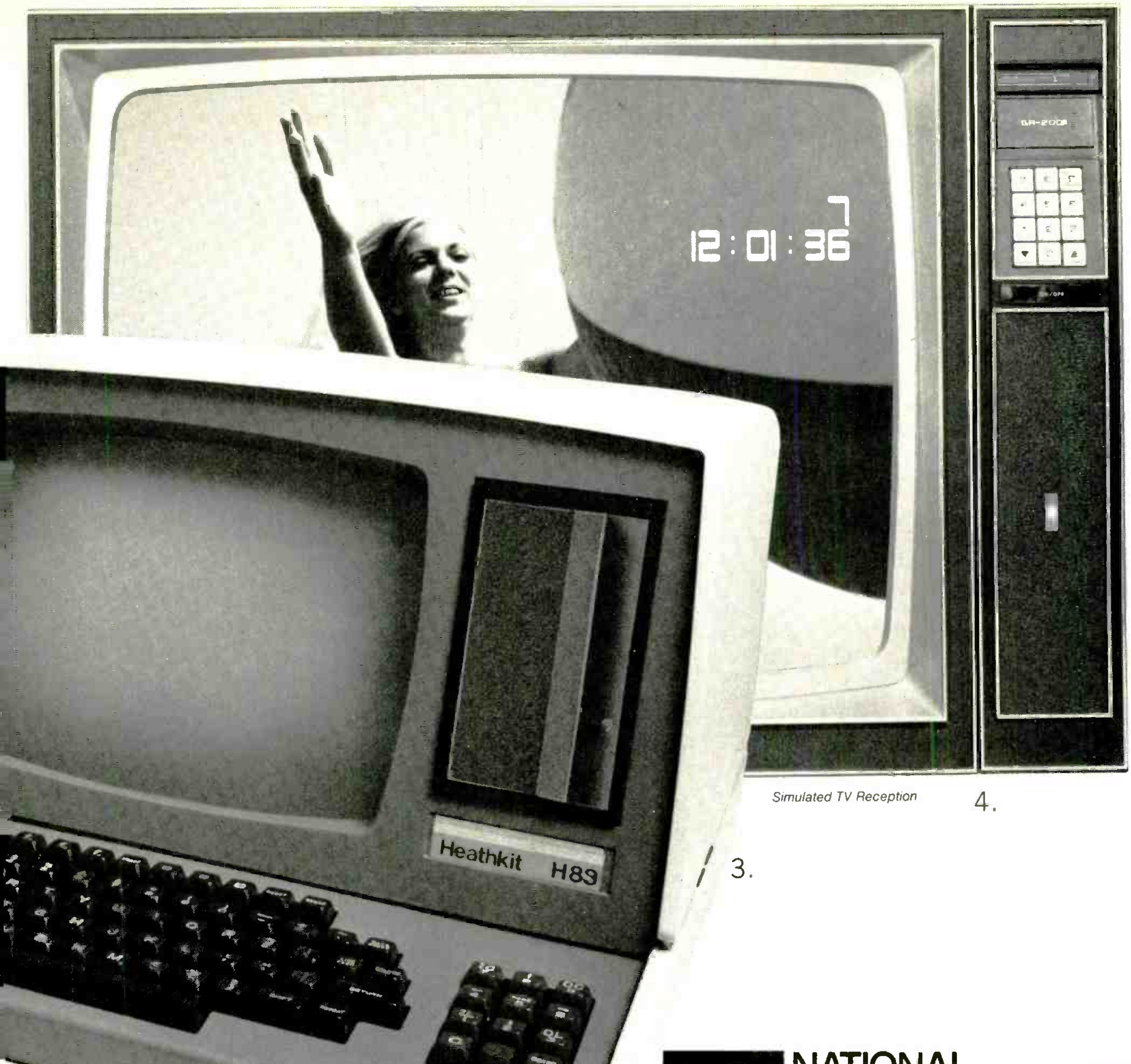
NTS also offers courses in Auto Mechanics, Air Conditioning and Home Appliances. Check card for more information.

1.



2.

www.americanradiohistory.com

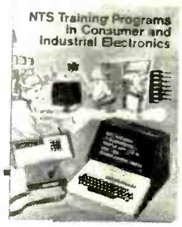


Simulated TV Reception 4.

3.

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 SO. FIGUEROA ST., LOS ANGELES, CA. 90037



1. **The NTS/Rockwell AIM 65 Microcomputer** A single board unit with on-board 20 column alphanumeric printer and 20 character display. A 6502-based unit 4K RAM, expandable. 2. **The NTS/KIM-1 Microcomputer** A single board unit with 6 digit LED display and on-board 24 key hexadecimal calculator-type keyboard. A 6502 based microcomputer with 1K RAM, expandable. 3. **The NTS/HEATH H-89 Microcomputer** features floppy disk storage, "smart" video terminal, two Z80 microprocessors, 16K RAM memory, expandable to 48K. 4. **The NTS/HEATH GR-2001 Digital Color TV (25" diagonal)** features specialized AGC-SYNC muting, filtered color and new solid-state high voltage tripler rectifier.

NATIONAL TECHNICAL SCHOOLS
4000 South Figueroa Street, Dept. 205-041
Los Angeles, California 90037

Please rush FREE color catalog on course checked below

- ☐ **MicroComputers/MicroProcessors**
- ☐ **Communications Electronics**
- ☐ **Digital Electronics**
- ☐ **Industrial Technology**
- ☐ **Auto Mechanics**
- ☐ **Air Conditioning**
- ☐ **Home Appliances**
- ☐ **Color TV Servicing**

Name ______________________ Age ______

Address ______________________

Apt. ________ City ______________________

State ______________________ Zip ________

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

www.americanradiohistory.com

 (Continued from page 67)

where appropriate. Make sure to install trimmer capacitor *C3* with the pin connected to the rotor plate and the adjustment screw soldered to the ground foil at the edge of the pc board. Before installing *C5*, double-check that it is a tantalum capacitor—not an aluminum electrolytic.

Next, mount quartz crystal *XTAL*. It might be necessary to drill another hole in the pc board to accommodate one of the crystal's pins. There are many such crystals on the market, and not all have the same pin spacing. Then install regulator *IC7* and transistors *Q1* and *Q2*, making certain their leads are oriented correctly. Use of transistor sockets at these three locations is optional, but will simplify replacement in the event of device failure. Mount copper fuse clips for *F1* and, when they have cooled, snap in the fuse. Install diode *D1* so that its polarity is correct. Finally, mount the fixed resistors on the board.

The remaining components mount off the board and are connected to it by means of flexible, stranded hookup wire or by the attached leads (*T1*, for example). Thumbwheel switches *S1*, *S2* and *S3* are best connected to the pc board using suitable lengths of multiconductor ribbon cable.

When all leads and wires have been soldered to the appropriate pc foil pads, the board should be installed in the project enclosure using standoffs. If a metallic enclosure is used (and this is recommended), it will probably not be necessary to employ heat sinks for power transistors *Q3* and *Q4*. They can be bolted directly to the enclosure using suitable hardware, mica insulating washers, and silicone thermal compound. After the transistors are fixed in place, the leads running from the pc board can be soldered to the appropriate transistor leads. Remember to keep the case or tab of the power transistors isolated electrically from the project enclosure if it is metallic or from any heat sink that is used.

Secure transformer *T1* and power socket *SO1* firmly in place inside the project enclosure. Install a strain relief on the enclosure where the dc power cable leaves it. Connecting large color-coded alligator clips to the free ends of these leads will ease connection to a 12-volt battery.

Checkout and Operation. First, plug the device to be controlled into *SO1*. An electric clock is a good test load. Always remember to connect the device to be controlled to the project before applying power to the project. Running the project without a load can damage *C12* or *T1*. Next, set the thumbwheel switches to read "60.0" to select an ac output frequency of exactly 60.0 Hz. Then apply power to the Programmable Speed Control. Upon closure of the power switch, the project should come to life and the clock start to run. If this isn't the case, refer to the "Troubleshooting" section. Compare the operation of the clock with another being powered by the ac line to see how accurate the frequency generated by the Programmable Speed Control is. (Note that two accurate clocks are required for this!) Change the setting of the thumbwheel switches and note how you can apparently speed up or slow down the passage of time.

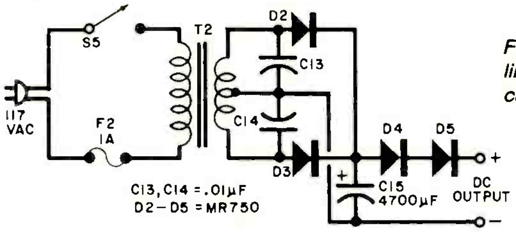


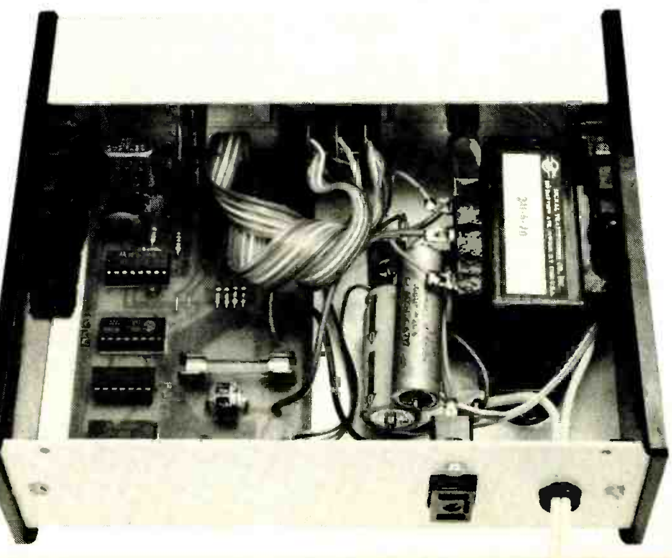
Fig. 3. Schematic diagram of a line-powered supply that can be used with the project.

The Programmable Speed Control can now be used as is or can be calibrated for more accurate output using a frequency counter. Connect the ground of an oscilloscope probe to the case of the project or to circuit ground. Then touch the "hot" side of the probe to pin 7 of *IC1*. Carefully adjust trimmer capacitor *C3* for a reading of 3.579,545 MHz. Then touch the probe to pin 4 of *IC2*, and you should read almost exactly the significant digits of the setting of the thumbwheel switches. For example, if the switches are set for 60.1 Hz, you should read 60.101 kHz. That completes the calibration. It's an optional, but useful step. Uncalibrated, you can expect the project to be accurate to within ±0.01% with the rotor of trimmer *C3* set to midposition. For many applications, that's good enough.

Troubleshooting. Here's a simple procedure you can use to troubleshoot the project. A multimeter and a counter are needed. First, note whether the fuse blows. If it does, disconnect the wire running to board location *CT*. This should stop the fuse from blowing, and reduce the current drain from the dc source to approximately 30 mA.

Measure the voltage on pin 16 of *IC2*. If it is not +5 volts ±5%, suspect *IC7* or the presence of inadvertently created shorts. When the correct reading is obtained, use the counter to measure the frequency at pin 1 of *IC1*. You should read 100 Hz. If you measure 60 Hz and can't obtain the desired ac output frequency, chances are you've used the wrong version of the MM5369! Replace it with the EST-suffix version specified in the parts list. When you've obtained the desired 100-Hz reading, move the counter probe to pin 4 of *IC2* and set thumbwheel switches to read "55.5". The counter should read

Photo of the interior of the author's prototype.



www.americanradiohistory.com

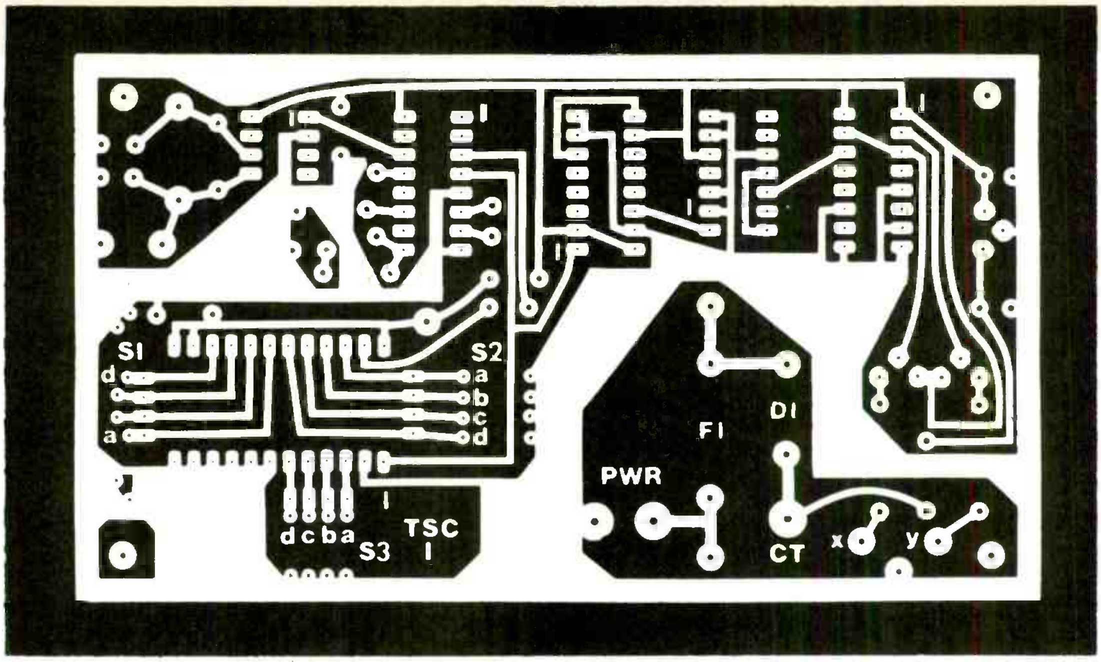


Fig. 4. Etching and drilling guide for a printed-circuit board for the project.

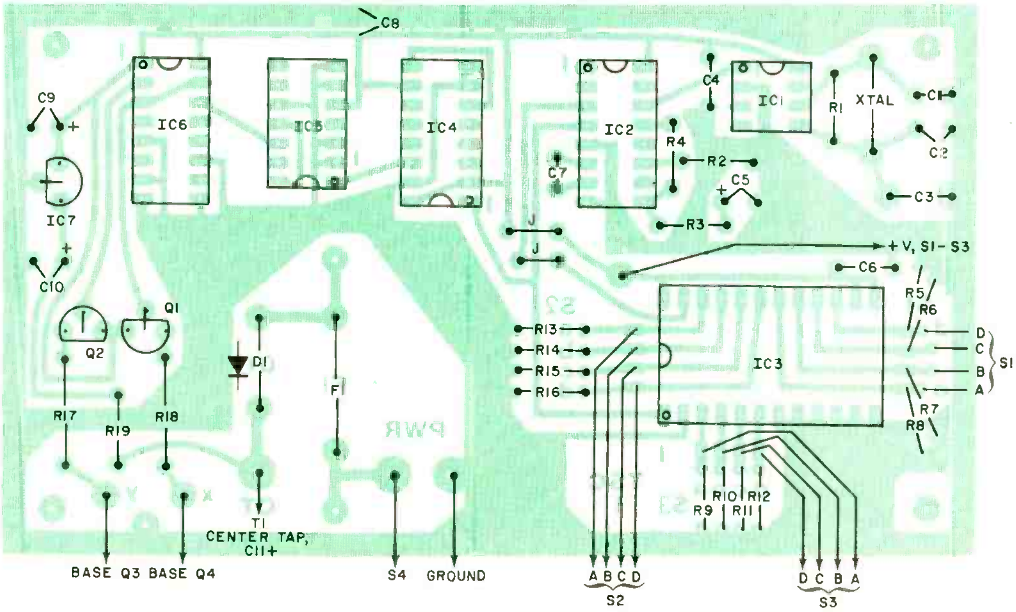


Fig. 5. Use this guide to assemble the components on the printed-circuit board.

55.500 kHz. If not, check *IC2* and its associated components. Then switch to "60.0." You should read 60.000 kHz. Obtaining any other frequency means that the thumbwheel switches may be miswired or that counter *IC3* is defective.

Once the desired 55.5 Hz is obtained, shift the probe to pin 15 of *IC6*—the reading should be 55.5 Hz. If it is not, *IC6*, *IC5*, and *IC4* are suspect. There should also be 55.5 Hz present at pin 2 of *IC6*, so check it out. At this point, the only problems remaining on the board can be a defective or incorrectly installed transistor at *Q1* or *Q2*. If these components are operating correctly, the problem lies in the off-board section of the project—most likely in *Q3*, *Q4*, or *T1*.

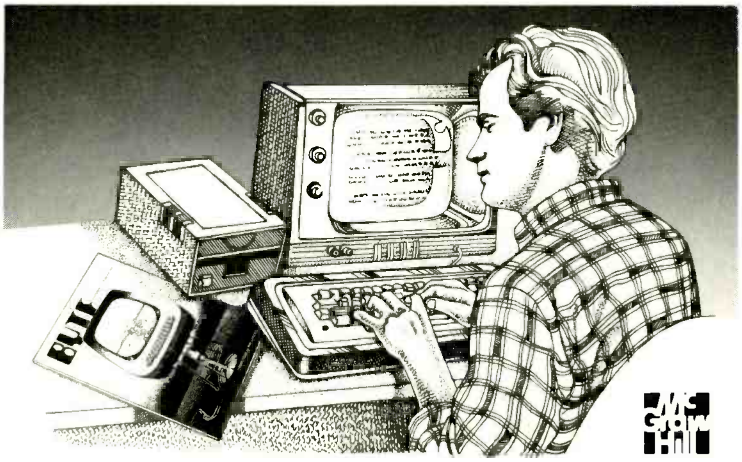
Applications. There are many different applications for this project. Let's detail the few mentioned earlier. Doubtlessly, you'll be able to come up with ones of your own.

A Turntable Speed Controller. The Programmable Speed Control was originally designed for this application, so I have many application hints to offer. First, if your turntable has an incandescent pilot lamp wired in series with the motor like my Empire unit, remove it. The lamp reduces the current flowing through the motor and thus its torque. You'll find that the turntable platter comes up to speed more quickly. Besides changing the turntable speed to correct for off-speed recordings, this project can be used in portable applications.

On the other hand, if you have damaged 78-rpm records that you want to copy on tape, this project can be very helpful. As you might already know, warped 78s will often play at reduced speeds. That's the key to success here. Set your turntable to 45 rpm and the Programmable Speed Control to 50.0 Hz. Then record the music using a tape recorder running at 3¾ ips. When the recording has been completed, play the tape back at 7½ ips, and you'll hear the program

www.americanradiohistory.com

BYTE...for the Serious Microcomputer User.



Do you use a personal computer for business or pleasure? If so, join the over one-quarter million professionals, beginners, engineers, and business people who get the latest microcomputer information in BYTE.

With a circulation of 170,000 and a total readership of 320,000, BYTE is the world's largest computer magazine. Each month's issue brings you the latest about graphics, mass storage, personal data bases, word processing, speech synthesis, new integrated circuits, new software for engineering, business and fun, plus do-it-yourself projects of all kinds.

And if you are in the market for hardware or software, our new expanded product review section gives you the unbiased facts.

So, if you are serious about microcomputing, **get serious about BYTE**.

BYTE®
the small systems journal

Fill in and mail the coupon today. Read your first copy of **BYTE**. If it is everything you expected, honor our invoice. If it isn't, just write "Cancel" on the invoice and mail it back. You won't be billed and the first issue is yours at no charge.

Mail coupon or call us toll-free
800-258-5485

BYTE Subscription Dept. P.O. Box 590 Martinsville, NJ 08836
Please enter my subscription for:
☐ One year $19 (12 issues) ☐ Two years $34 ☐ Three years $49
☐ Check enclosed entitles me to 13 issues for price of 12 (North America only)
☐ Bill Visa ☐ Bill Master Charge ☐ Bill me (North America only)

Card Number ______ Expiration ______
Signature ______ Name (please print) ______
Address ______
City ______ State/Province/Country ______ Code ______

Foreign Rates (To expedite service, please remit in U.S. Funds)
☐ Canada or Mexico ☐ One year $21 (12 issues) ☐ Two years $38 ☐ Three years $55
☐ Europe, one year (air delivered) $43
☐ All other countries, one year (surface delivered) $35. Air delivery available on request

Please allow 6-8 weeks for processing.

7341

©BYTE Publications, Inc. 1981

CIRCLE NO. 5 ON FREE INFORMATION CARD

material being played at normal speed or close to it. Use an equalizer to improve the sound. I've salvaged many "unplayable" 78s this way.

A Tape-Deck Speed Controller. Have you ever played back a tape that was recorded on another machine and noticed a speed difference? This project can compensate for this if the playback deck has a synchronous ac motor that requires no more than 15 watts. You'll probably have to dig inside the deck and isolate the motor from the rest of the power wiring to avoid placing too great a power demand on the project. But the result is that off-pitch tapes can now be played so that they sound right!

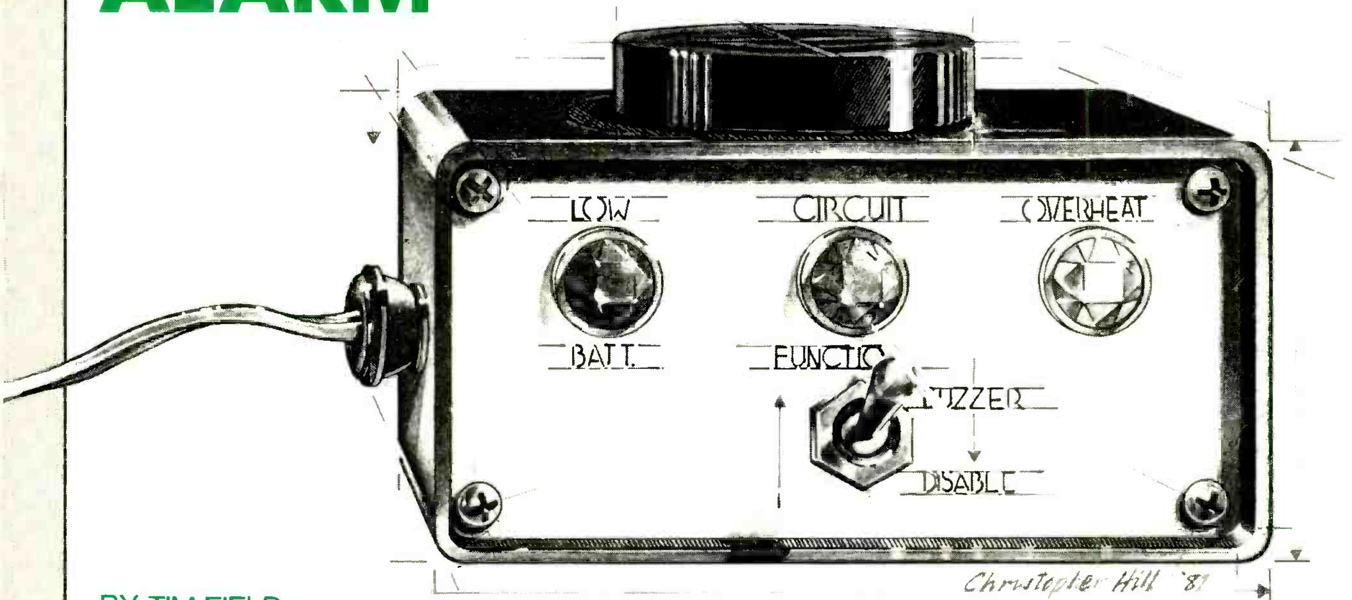
A Telescope Clock-Drive Controller. The telescopes owned by most amateur astronomers use synchronous ac motors to keep astronomical objects in their fields of view. Unfortunately, a number of commercially available inverters aren't stable enough to hold the subject of interest in the viewfinder for any period of time. The Programmable Speed Controller is of great help here, as you might expect. It permits fine adjustment of the operation of the clock drive to suit the nature and apparent motion of the object to be viewed or photographed—be it the sun, the moon, a planet, a star, a cluster, a nebula, galaxy or cluster of galaxies.

In this application, the modest current demand (approximately 1.2 amperes) will allow many hours of operation from a motorcycle battery. If you are stargazing in cold weather, keep the project warm before use to minimize drift during the early portion of the viewing session.

If you need more output power from this project, there are things that you can do. A slight increase can be had by decreasing the values of *R17* and *R18*. Right now they provide approximately 25 mA of base drive to power transistors *Q3* and *Q4*. However, don't exceed a dc current drain of 1.5 amperes from the power source or you'll overload *T1*. A heavier-duty transformer can replace the device specified as *T1*—it is a 20-volt, center-tapped transformer rated to handle 1.5 amperes of secondary current. You might use a 12.6-volt, center-tapped, 10-ampere unit and four power transistors (two each connected in parallel using current-balancing resistors) for increased output. It is possible to get up to 100 watts this way. Be sure to use heavy wire for the power cable and transistor wiring if this approach is taken. ◇

www.americanradiohistory.com

FREEZER OVER-TEMPERATURE ALARM



BY TIM FIELD

Warns you if the temperature in your freezer gets above a preset safe level

ONE OF the hazards facing the owner of a well-stocked freezer is the possibility of a "melt-down" of the food. Power failure, a power cord accidentally unplugged, or a mechanical failure could spell catastrophe. This is especially true for freezer units kept in the garage or cellar, where they must operate for extended periods of time without being checked.

Presented here is a simple, inexpensive circuit that will detect when the temperature inside a freezer rises to a predetermined "threshold" point above which the food is in danger. Once this condition is detected, the circuit sounds an alarm. Construction requires less than $15 worth of readily available parts.

Circuit Operation. The Electronic Freezer Protection Unit is shown schematically in Fig. 1. Three-terminal current source *IC4* provides a current that is directly proportional to its absolute temperature. (See Table I for temperature conversion equations.) Flowing through resistors *R7* and *R8*, this current develops a voltage across *R8* that varies linearly with temperature. With V_{cc} greater than 3.3 volts, and *R7* 230 ohms, the voltage across *R8* would be 10 mV/°K. Thus, at the freezing point of water (32°F, 273°K) the output from the sensor will be 2.73 volts.

Note that *IC4* and *R7* can be remote from the remainder of the circuit since the series resistance of the interconnecting leads does not affect the accuracy of the sensor output voltage. Thus, *R7* can be directly soldered to *IC4*. Voltage from the junction of *R7* and *R8* is applied to the inverting input of comparator *IC2A*. The noninverting input of the comparator is held at 2.49 volts by diode *D3*.

TABLE I
TEMPERATURE CONVERSION EQUATIONS

To convert from:	Fahrenheit	Celsius	Kelvin
To: Fahrenheit	—	(C x 9/5) + 32	(K−273) x 9/5 + 32
Celsius	(F − 32) x 5/9	—	K − 273
Kelvin	(F − 32) x 5/9 + 273	C + 273	—

Examples: Boiling point of water = 212°F = 100°C = 373°K
Freezing point of water = 32°F = 0°C = 273°K

www.americanradiohistory.com

freezer alarm (cont'd)

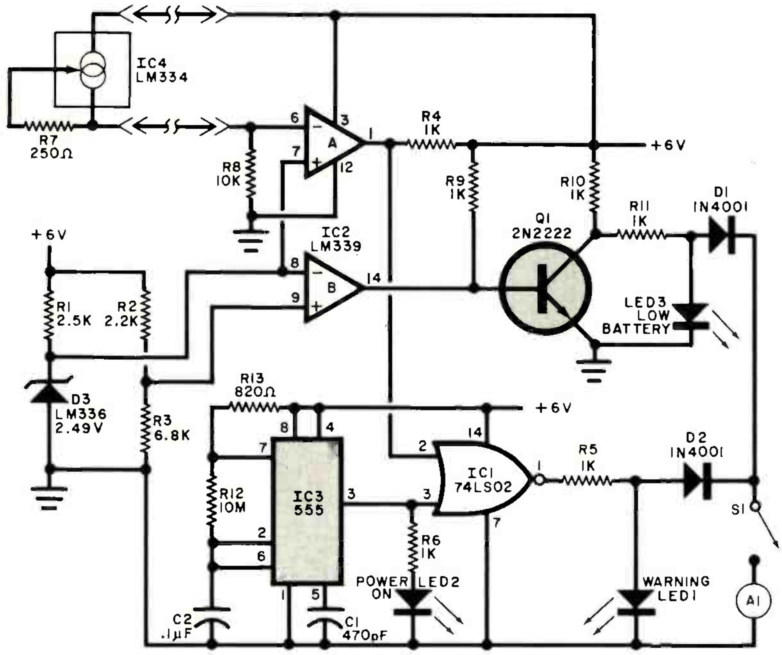


Fig. 1. The three-terminal current source, IC4, provides a current directly proportional to temperature. Both visual and audible alarms are used.

PARTS LIST

A1—Alarm (Radio Shack 273-060 or similar)
C1—470-pF capacitor
C2—0.1-μF capacitor
D1, D2—1N4001 diode
D3—LM336, 2.5-V reference diode (Jameco or similar)
IC1—74LS02 quad 2-input NOR gate
IC2—LM339 quad comparator (Radio Shack 276-1712 or similar)
IC3—555 timer (Radio Shack 276-1723 or similar)
IC4—LM334 adjustable current source (Radio Shack 276-1734 or similar)
LED1—Yellow light-emitting diode
LED2—Green light-emitting diode
LED3—Red light-emitting diode
Q1—2N2222 transistor
R1—2.5-kΩ resistor
R2—2.2-kΩ resistor
R3—6.8-kΩ resistor
R4, R5, R6, R9, R10, R11—1-kΩ resistor
R7—250-Ω resistor
R8—10-kΩ resistor
R12—10-MΩ resistor
R13—820-Ω resistor
S1—Spst switch
Misc.—Four 1.5-V alkaline cells, battery holder, suitable enclosure, two-conductor cable, 2-pin connectors (2), mounting hardware, solder, etc.

In the prototype, it was desired that the alarm sound at about 30°F, so the value of *R7* was adjusted to set the voltage across *R8* at 2.49 volts at 30°F. The exact value of *R7* was found to be 253 ohms, but the closest standard value was used. Comparator *IC2A* gives a low output when the sensor temperature exceeds the predetermined freezer temperature, and a high when the freezer temperature is safe.

Battery voltage is fed to the noninverting input of comparator *IC2B* via *R2* and *R3*, while the inverting input is coupled to the 2.49-volt reference diode. As long as the battery voltage is high, the output of *IC2B* is high. Transistor *Q1* is kept in saturation by *R9*. Thus, the voltage at its collector will be too low to turn on Low Battery warning *LED3*. When the battery voltage drops, comparator *IC2B* outputs a low, which turns *Q1* off, raising its collector voltage high enough to turn on *LED3*, forward bias diode *D1*, and, if switch *S1* is closed, operate the alarm (*A1*).

Timer *IC3* is connected as an oscillator that is always running. *LED2*, via its associated current limiter *R6*, flashes at the oscillator rate to indicate that the system is powered. The output of *IC3* (pin 3) is connected to one input of 2-input NOR gate *IC1*. The other input to this gate is from *IC1A*, the comparator in the temperature sensor circuit. When both inputs to NOR gate *IC1* are simultaneously low, the output is high. Thus, when the freezer temperature is at the critical level and the output of *IC2A* goes low, the output of *IC1* alternates at a frequency determined by *IC3*. When *IC1* output is high, warning indicator *LED1* flashes, and when switch *S1* is closed, alarm *A1* is operated via isolation diode *D2*. Since the output of *IC1* alternates, both the LED and alarm are turned on and off to attract attention. Switch *S1* is used to silence the alarm when required, but the warning light will still function.

Construction. Since component placement is not critical, any form of interconnection can be used to build the circuit—or a small pc board can be designed and fabricated. Resistor *R7* is mounted directly to *IC4*, and the two connections to this sensor are made via a 2-pin connector. This assembly is placed within the freezer, and a length of two-conductor cable connects the sensor with the remainder of the circuit.

The main circuit can be mounted in a 1.5" x 2.5" x 5" plastic enclosure, and the four 1.5-volt series-connected dry cells in a battery holder. If desired, a 6.5-volt line-operated power supply can be used as shown in Fig. 2. Normally, the output voltage of the power supply is higher than the battery voltage, reverse-biasing the diode and keeping the battery out of circuit. If the power line fails, the battery forward-biases the diode and feeds the circuit until line power is restored. The warning circuit will operate for about three months on conventional alkaline cells alone.

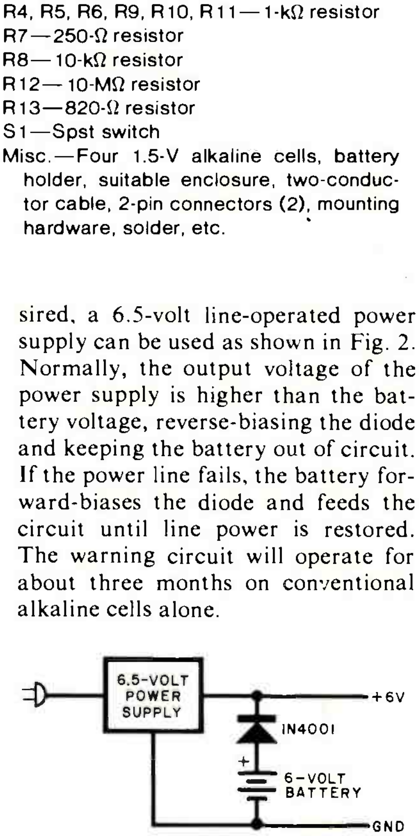


Fig. 2. This power supply can be used in addition to batteries if desired.

Use. Position the main section of the alarm where you are certain to see and/or hear it should it trip. Place the sensor inside the freezer and connect it to the main section with a length of 2-conductor cable. (Resistor *R7* is large enough to make the actual length of any reasonable wire run noncritical.) If your alarm is line-powered, plug it in. Then stop worrying about your frozen food. ◊

www.americanradiohistory.com

CANCEL RUMBLE WITH THIS BASS-SUMMING AMPLIFIER

Versatile project can also be used as an electronic crossover for a subwoofer power amp.

BY JOHN H. DAVIS

THE presence of deep bass in the output of an audio system adds a satisfying "floor" to reproduced program material. However, designing a system to reproduce low frequencies well heightens the probability that rumble will make itself disconcertingly apparent. Presented here is the Bass Summing Amplifier, a project that can attenuate rumble without adversely affecting the low-frequency content or the high-frequency separation of a phonograph disc. It can also be used as an electronic crossover that sums the extreme bass to feed a subwoofer power amplifier. The Amplifier is easily and inexpensively constructed and requires no critical components or adjustments.

Rumble is low-frequency noise that is generated by phonograph recording and playback equipment. High-pass filtering can attenuate subsonic noise to a large extent, but it can't suppress audible rumble without also removing some desired bass content.

Most of the rumble entering a phono cartridge does so as vertical modulation that results in out-of-phase electrical signals at the phono cartridge's outputs. If these low-frequency out-of-phase signals are combined, they will cancel each other. Since recordings contain little or no out-of-phase, low-frequency information, low-frequency summation does not appreciably degrade the program material. What little bass separation exists and is recorded is not audibly significant to human beings. Psychoacoustic studies indicate that bass localization is mostly a function of attack transients and overtones.

To verify that bass summing will attenuate rumble, play a silent groove on a vinyl disc and increase the volume until the rumble can readily be heard. Then switch your amplifier or preamplifier to its monaural mode. If your left and right channels are balanced and in proper phase, you will hear a drop in the rumble level.

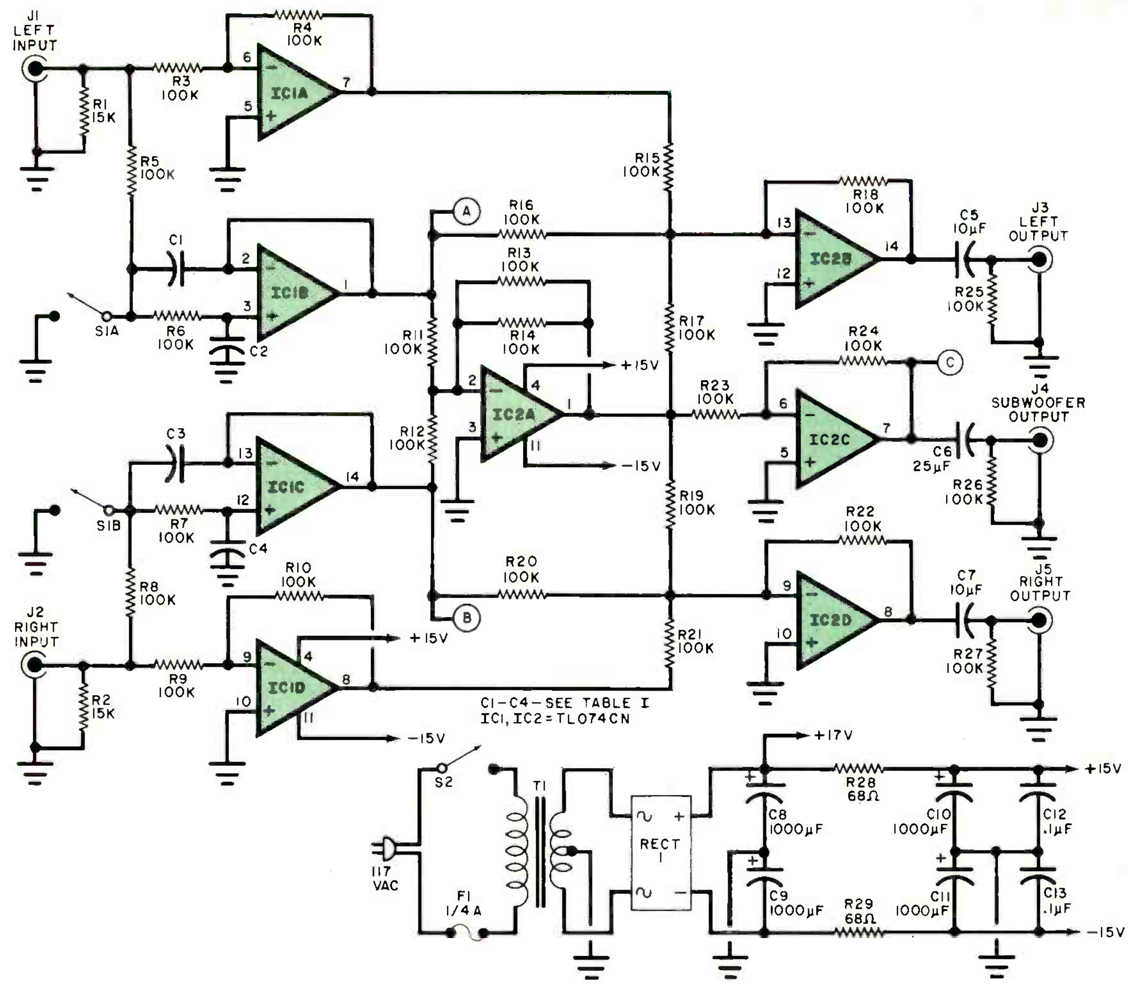
About the Circuit. A schematic of the Bass Summing Amplifier appears in Fig. 1. Line-level stereo inputs are applied to jacks *J1* and *J2*. Unity-gain inverters *IC1A* and *IC1D* shift the phase of the input signals by 180°. However, the unity-gain, low-pass filters comprising *IC1B*, *IC1C* and their associated passive devices do not appreciably alter the phase of those components of the input signals below their cutoff frequencies. If the outputs of *IC1A* and *IC1B* and those of *IC1C* and *IC1D* are combined, the low frequencies will cancel, leaving inverted midrange-and-treble stereo signals.

If the bass outputs of *IC1B* and *IC1C* are combined, a composite, summed bass signal results. This summed bass contains all of the in-phase information but no difference information. If this composite bass is recombined with the middle-and-high-frequency stereo signals, the resulting stereo outputs are almost indistinguishable from the original—except for the lack of rumble components. Because the operation of *IC1A* and *IC1D* involves phase inversion, *IC2B* and *IC2D* perform an additional compensating inversion.

The performance of the project in the rumble-suppressing mode is summarized by the graphs of Fig. 2. The heavy curve shows the extent to which low-frequency difference information is cancelled when the low-pass filters have cutoff frequencies of 220 Hz. The lighter-weight curve shows the extent to which channel separation is maintained as a function of frequency. Two dashed curves show the measured separation available from modestly priced and premium phono cartridges. These latter curves demonstrate that, above bass frequencies, the project does not adversely affect realizable separation.

A monaural signal that can be used to drive a subwoofer power amplifier is available at the output of *IC2C*. This filtered and summed bass signal is in phase with respect to the bass components of the stereo input signals. However, in this application, resistors *R17* and *R19* must be deleted so that the summed bass is not also present in the stereo outputs. Accordingly, the stereo system handles only the upper bass, midrange, and high frequencies. Figure 3 shows the low-pass-filter response that characterizes the output presented at *J4* for a cutoff frequency of 110 Hz. The stereo out-

www.americanradiohistory.com



PARTS LIST

Components denoted by an asterisk can be deleted if the optional, dynamic separation indicator is not to be built.

C1,C2,C3,C4—Metallized polyester, metallized Mylar, monolithic ceramic or polystyrene capacitor, 10% or closer tolerance (see Table I for capacitance)

C5,C7—10-μF, 50-V, axial-lead, nonpolarized electrolytic

C6—25-μF, 50-V, axial-lead, nonpolarized electrolytic

C8,C9,C20*—1000-μF, 25-V, radial-lead electrolytic

C10,C11—1000-μF, 25-V, radial-lead electrolytic

C12,C13—0.1-μF, 50-V disc ceramic capacitor

C14*,C15*—0.033-μF, 100-V Mylar capacitor

C16*,C17*—0.33-μF, 35-V tantalum capacitor

C18*,C19*—0.68-μF, 35-V tantalum capacitor

C21*—0.15-μF, 100-V Mylar capacitor

C22*—0.001-μF, 100-V Mylar capacitor

D1*,D2*,D3*—1N300 silicon switching diode

D4*—1N4001 rectifier

F1—¼-ampere fast-blow fuse

IC1,IC2,IC3*—TL074CN quad BiFET operational amplifier

IC4*—LM324N quad operational amplifier

J1 through J5—RCA phono jack

LED1*—Red light-emitting diode

LED2*,LED3*—Green light-emitting diode

The following, unless otherwise specified, are ¼-watt, 5% tolerance, carbon-film fixed resistors.

R1,R2—15 kΩ

R3 through R27, R30* through R35*, R41*, R42*—100 kΩ (see text for recommended preselection procedure)

R28,R29—68 Ω, ½-watt

R36*,R37*,R44*—22 Ω, ½-watt

R38*—330 kΩ

R39*—120 kΩ

R40*—82 kΩ

R43*—27 kΩ

R45*,R46*,R47*—680 Ω

RECT1—1-A, 100-PIV modular bridge rectifier

S1—Dpdt switch

S2—Spst switch

T1—24-V, 300-mA, center-tapped step-down transformer

Misc.—Printed-circuit board, standoffs, suitable enclosure, fuseholder, line cord, shielded cable, hookup wire, suitable hardware, strain relief, solder, etc.

Note—The following is available from M. H. Marks Enterprises, 315 Thornberry Court, Pittsburgh, PA 15237: complete kit of parts (less enclosure and hardware), No. BSA-3, for $44.95 plus $3.00 shipping and handling within U.S.A. Also available separately: etched, drilled and silkscreened printed-circuit board, No. BSA-PC, for $12.95 postpaid within U.S.A. Allow six to eight weeks for delivery. Pennsylvania residents, add 6% state sales tax.

puts presented at *J3* and *J5* have complementary (high-pass) responses.

For those who want reassurance that difference information cancelled along with the rumble is audibly insignificant, an unusual, dynamic separation indicator is presented as an option. It responds primarily to the frequencies affected by the bass-summing process, and is shown schematically in Fig. 4. The design of this indicator is based on the fact that separation is reflected as an increase in the level of difference information relative to the level of in-phase information. Differential amplifier *IC3A* processes the filtered right- and left-channel bass signals to obtain differ-

www.americanradiohistory.com

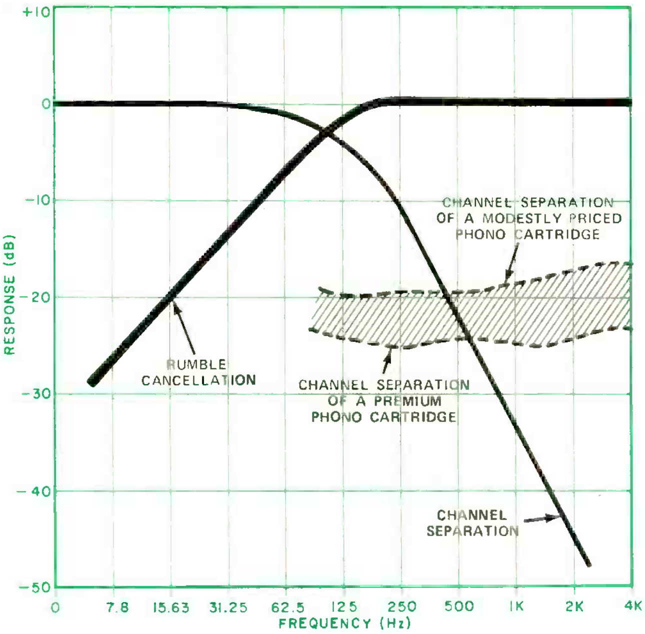


Fig. 2. Performance curves for low-pass-filter cutoff frequency of 220 Hz. Heavy curve shows the extent to which difference information is suppressed as a function of frequency.

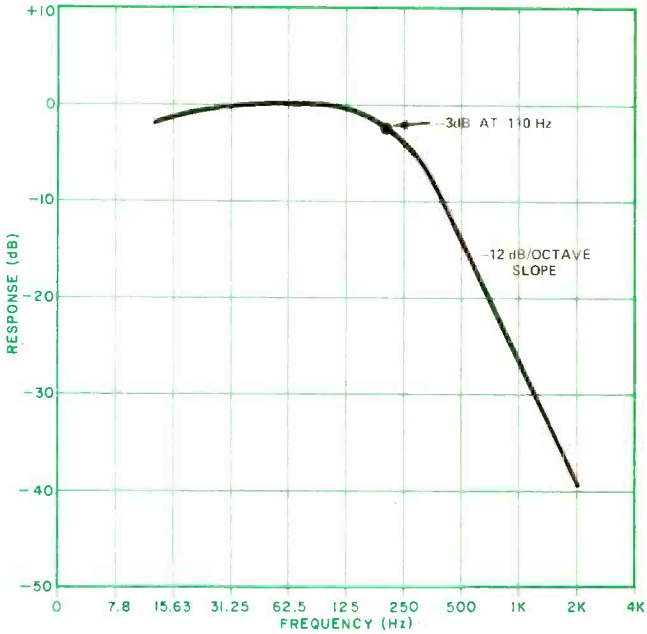


Fig. 3. Low-pass-filter response that characterizes the subwoofer-output channel. Stereo-output channels have a complementary, high-pass characteristic.

ence information. The output of *IC3A* is rectified by *IC3B* and *D1*, and charges *C18*.

Summed bass is available at the output of *IC2C* (point C in Fig. 1). It is brought up to an equivalent level by amplifier *IC3C*. The frequency response of this stage is shaped by capacitors *C21* and *C22* to attenuate the unwanted higher frequencies. The amplified, summed bass output of *IC3C* is rectified by *IC3D* and *D2*, and charges *C19*.

Comparators *IC4A*, *IC4B*, and *IC4C* compare the two resulting dc levels and light *LED3*, *LED2*, and *LED1* at progressively higher levels of separation. The network comprising *D3*, *D4*, *R43* and *R44* maintains a small bias voltage across *C19*. This prevents random triggering of the comparators by noise at low signal levels. Such triggering would otherwise be troublesome because signal comparison is based on ratios, not fixed voltage levels.

Options and Modifications. Before undertaking construction, you should determine exactly what function(s) you want this project to perform. If you want only to suppress rumble, you will probably want a filter cutoff frequency of 220 Hz (330 Hz if the rumble is severe). Table I shows which values of capacitors and resistors to use for these frequencies. Also listed are component values for a cutoff frequency of 110 Hz, which is a better choice if a subwoofer is used.

In a Bass Summing Amplifier to be used for rumble reduction only, there are a few components which *can* be eliminated (*C6*, *J4*, and *R26*). To drive a subwoofer power amplifier in addition, however, two resistors (*R17* and *R19*) *must* be deleted. Whether the project is used for both purposes or only for rumble suppression, you have the option of including the separation indicator. If you choose not to include it, some parts can be deleted. They are denoted by an asterisk in the Parts List.

Construction. There are no high-gain or other stages in which circuit layout is critical. However, the use of a printed-circuit board is recommended because of the rather high parts count. The full-size etching and drilling guide for a suitable pc board appears in Fig. 5. Its corresponding component placement guide appears in Fig. 6. The use of IC sockets or Molex Soldercons is recommended.

There are a few points to consider concerning component selection. To minimize distortion, the capacitors in the low-pass filters (*C1* through *C4*) should be metallized plastic-film or other high-quality components. For the same reason, *C5*, *C6*, and *C7* should be nonpolarized electrolytics. Purists will also want to connect 0.1-μF metallized plastic-film capacitors in parallel with *C5*, *C6*, and *C7*.

Carbon-film, 5%-tolerance resistors are acceptable for use in this project, but a simple preselection procedure requiring only an ohmmeter is recommended. The ohmmeter need not be particularly accurate, but should allow you to resolve slight differences in resistance around a center value of 100 kilohms. Exact values are not as important as close matches.

First, measure the values of some 100-kilohm resistors and set aside four that match very closely for *R15*

TABLE I
VALUES OF FILTER COMPONENTS FOR SELECTED CUTOFF (−3-dB) FREQUENCIES

Frequency	Recommended Application	R5, R6, R7, R8	C1, C3	C2, C4
110 Hz	Rumble suppression and subwoofer crossover	100 kΩ	0.02 μF	0.01 μF
220 Hz	Rumble suppression	100 kΩ	0.01 μF	0.005 μF
330 Hz	Suppression of severe rumble	68 kΩ	0.01 μF	0.005 μF

www.americanradiohistory.com

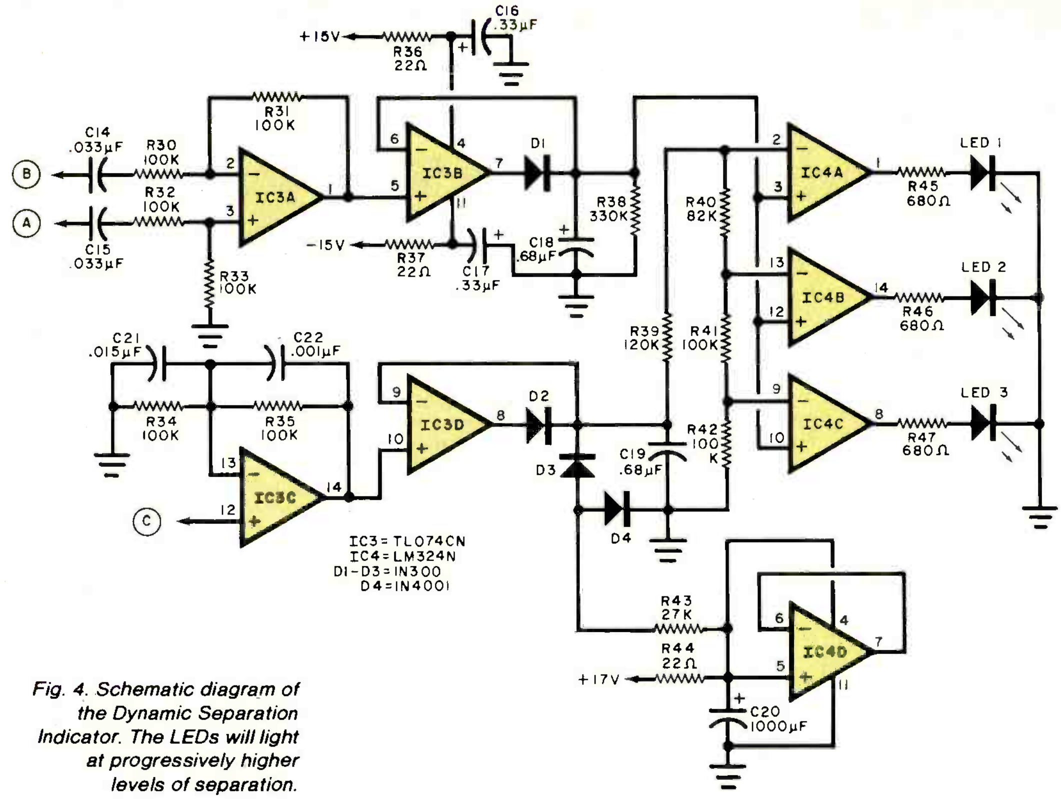


Fig. 4. Schematic diagram of the Dynamic Separation Indicator. The LEDs will light at progressively higher levels of separation.

through *R18*. Select another matching group of four as *R19* through *R22*. Select a third group of four as *R11* through *R14*. Finally, select two closely matched pairs, one pair for *R3* and *R4*, the other for *R9* and *R10*.

The project will perform reasonably well even if this process is not followed, but the more closely matched in value the members of a given group, and the closer the tolerances of *C1* through *C4*, the smoother the frequency response.

When mounting the components on the printed-circuit board, take note of device orientation and the presence of the two short jumpers at pins 5 and 10 of *IC1*. Also note that *R1* and *R2* are soldered across each of the input jacks—they are not mounted on the board. Similarly, *R25*, *R26*, and *R27* are soldered across the appropriate output jacks. The project should be housed in a metal enclosure with shielded cable connecting the pc board to the input and output jacks and switch *S1*.

Testing. Doublecheck the circuit assembly. Then apply power and verify that the positive and negative supply voltages are equal and less than 18 volts. A one-volt, 30-Hz signal applied to *J1*, the LEFT INPUT jack, should result in the appearance of half-volt signals at both *J3* and *J5*, the LEFT and RIGHT OUTPUT jacks. If the project has been built for subwoofer use, the half-volt signal should appear at *J4*, the SUBWOOFER OUTPUT jack, *only*. If a 30-Hz, one-volt signal is applied to *J1* and *J2* simultaneously, the outputs at *J3* and *J5* or the output at *J4* should increase to one volt.

If you have built the dynamic separation indicator, you can test its operation by applying a 30-Hz signal. When the input signal is applied to either *J1* or *J2* (but not both), all three LED's should glow. Ideally, they should all extinguish when both channels are driven by the same input signal. Check to see if this happens.

Next, change the frequency of the test signal to 3000 Hz but keep its amplitude at one volt. Apply this signal to *J1*. A one-volt signal should now appear only at *J3*. Then apply the signal to *J2* and verify that an output appears only at *J5*. At this frequency, none of the LEDs should glow, even if only one channel is driven. If *LED3* does glow, decrease the level of the input signal to see if it extinguishes. (These statements assume, of course, that *S1* is open.)

If you don't have access to test equipment, you can patch the project into your system at a line-level point in the signal chain. The Bass Summing Amplifier should be connected *after* any signal-processing components such as an equalizer, a dynamic-range expander, etc. Then find a quiet groove on a vinyl disc and play it. Listen for rumble, and open and close switch *S1*. A difference in the rumble level should be noticeable. During such a test, *LED3* might flicker, but the other two LEDs should flash only very rarely.

Use. For the Bass Summing Amplifier to function properly, your audio system needs to be well balanced at the point at which signals are routed to the inputs of the Bass Summing Amplifier. Use the monaurally recorded bands of a test record, or listen to a quiet groove of a standard disc

AUTHOR'S SPECIFICATIONS

Input Impedance: 10 KΩ
Recommended Load Impedance: 10 kΩ or greater
Input-signal Level: 0.3 to 3.0 volts rms; 1.0 volt recommended
Total Distortion: Less than 0.05%
S/N: Better than 70 dB (unweighted)
Frequency Response: 50 Hz to 16 kHz ± 1/4 dB at stereo outputs with *R17* and *R19* in project; filter resistors preselected according to procedure described in text; both channels driven, *S1* open.

www.americanradiohistory.com

DOWN-TO-EARTH PRICES ON OUT-OF-THIS-WORLD PERSONAL COMPUTERS AND COMPONENTS.

Look at this!

Ohio Scientific Superboard II

$299

- It's the first complete computer system on a board.
- Superboard II uses the ultra powerful 6502 Microprocessor
- 8K Microsoft BASIC-in-ROM
- 4K static RAM on board, expandable to 8K
- Full 53-key keyboard, with upper and lower case. Plus user expandability.
- Video interface and audio cassette interface.

The Ohio Scientific Superboard II at $299 — in today's economy — has got to be the best buy by far. It will entertain you with spectacular graphics made possible by its ultra high resolution graphics and super fast BASIC. It will help you in school or industry, as an ultra powerful scientific calculator. Advanced scientific functions and a built-in "immediate" mode allow you to solve complex problems without programming.

The Superboard II can be expanded economically, for business uses, or to remotely control your home appliances and security. Even communicate with other computers.

Read what's been written about Superboard II:

"We heartily recommend Superboard II for the beginner who wants to get into microcomputers with a minimum cost. A real computer with full expandability."
—POPULAR ELECTRONICS, MARCH 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."
—BYTE, MAY 1979

Look at these easy hardware prices:

610 Board For use with Superboard II and Challenger 1P. 8K static RAM. Expandable to 24K or 32K system total. Accepts up to two mini-floppy disk drives. Requires +5V @4.5 amps.	**$ 298**
Mini-Floppy Disk Drive Includes Ohio Scientific's PICO DOS software and connector cable. Compatible with 610 expander board. Requires +12V @1.5 amps and +5V @ 0.7 amps. (Power supply & cabinet not included.)	**299**
630 Board Contact us for important details.	**229**
AC-3P 12" combination black and white TV/video monitor.	**159**
4KP 4K RAM chip set.	**79**
PS-005 5V 4.5 amp power supply for Superboard II.	**35**
PS-003 12V power supply for mini-floppies.	**29**
RF Modulator Battery powered UHF Unit.	**35**
CS-900B Metal case for single floppy disk drive and power supply. (While stock lasts.)	**49**
AC-12P Wireless remote control system. Includes control console, two lamp modules and two appliance modules, for use with 630 board.	**175**
AC-17P Home security system. Includes console, fire detector, window protection devices and door unit for use with 630 board.	**249**
C1P Sams C1P Service manual	**8**
C4P Sams C4P Service manual	**16**
C3 Sams Challenger III manual	**40**

Ohio Scientific and independent suppliers offer hundreds of programs for the Superboard II, in cassette and mini-floppy form.

Freight Policies All orders of $100 or more are shipped freight prepaid. Orders of less than $100 please add $4.00 to cover shipping costs. Ohio residents add 5.5% Sales Tax.

VISA master charge

Hours: Call Monday thru Friday. 8:00 AM to 5:00 PM E.D.T.
TOLL FREE: 1-800-321-5805

Guaranteed Shipment Cleveland Consumer Computers & Components guarantees shipment of computer systems within 48 hours upon receipt of your order. **Our failure to ship within 48 hours entitles you to $35 of software, FREE.**

To Order: Or to get our free catalog **CALL 1-800-321-5805 TOLL FREE.** Charge your order to your **VISA** or **MASTER CHARGE** account. Ohio residents call: (216) 464-8047. Or write, including your check or money order, to the address listed below.

CLEVELAND CONSUMER COMPUTERS & COMPONENTS
P.O. Box 46627
Cleveland, Ohio 44146

Order Form: **CLEVELAND CONSUMER COMPUTERS & COMPONENTS** **P.O. Box 46627 Cleveland, Ohio 44146**

- ☐ Superboard II $299.
- ☐ 610 Board $298.
- ☐ Mini-Floppy Disk Drive $299.
- ☐ RF Modulator $35.
- ☐ AC-3P 12" B/W Monitor $159.
- ☐ C1P Sams Manual $8.

(Attach separate sheet for other items.)

NAME ______

ADDRESS: ______

CITY: ______ STATE: ______ ZIP: ______

PHONE: ______

Payment by: VISA ______ MASTER CHARGE ______ MONEY ORDER ______

Credit Card Account # ______

Expires ______ Interbank #(Master Charge) ______

TOTAL CHARGED OR ENCLOSED $______ (Ohio Residents add 6.5% Sales Tax)

Orders of less than $100, please add $4.00 to cover shipping costs. Orders will be accepted from U.S. and Canada only. All prices quoted are U.S., date of publication, standard UPS shipping FOB the factory. P

www.americanradiohistory.com

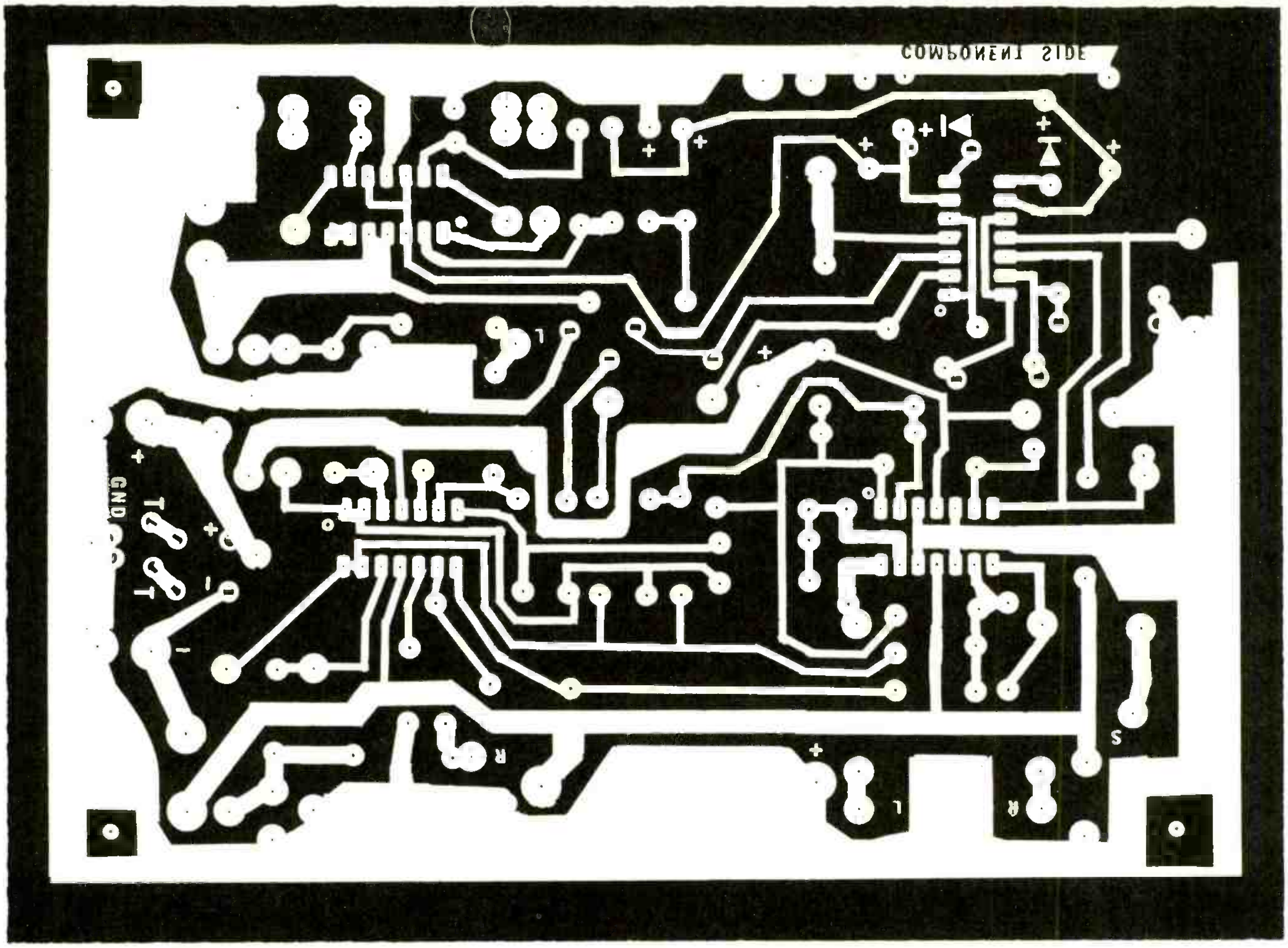


Fig. 5. Full-size etching and drilling guide (above) for the Bass Summing Amplifier and Dynamic Separation Indicator.

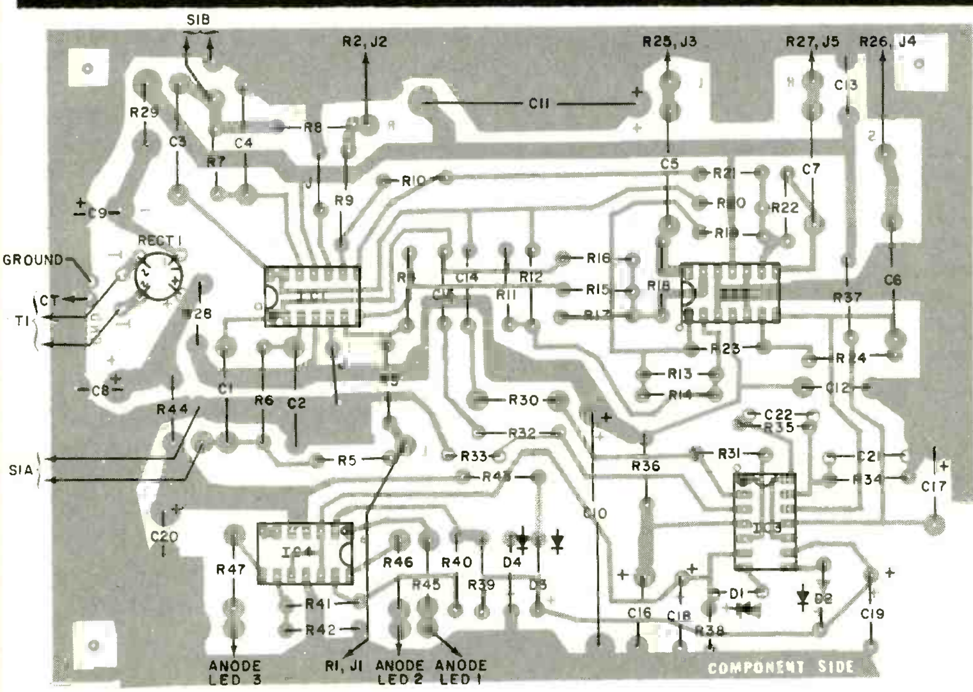


Fig. 6. Component placement guide to be used with the printed-circuit board.

while adjusting interchannel balance. Maximum cancellation occurs when the channels are exactly balanced. Even high-quality phono cartridges have some imbalance, and as much as 2 dB will degrade the rumble-cancelling capability of the project.

The net result of your efforts will be quieter and more satisfying bass. As a bonus, the bass summing amplifier can be used to reduce rumble on tapes that have been dubbed from noisy turntables or from FM broadcasts generated using outdated studio equipment. ◊

www.americanradiohistory.com

EXPERIMENTER'S CORNER

By Forrest M. Mims

Electronic Aids for the Handicapped

ONE of the most rewarding activities that an electronics experimenter can pursue is the design and construction of electronic aids for the handicapped. The Telephone Pioneers of America know this as well as anyone. For many years, members of this organization have designed and built electronic aids for handicapped people, such as softballs that emit a beeping sound for blind children.

Many companies and a few foundations manufacture various electronic aids for the handicapped. Some of these, such as the reading machines for the blind made by Telesensory Systems, Inc., are amazingly sophisticated. They are also expensive.

Prosthesis (pros-thē'-sis) is the technical term for an electronic or mechanical substitute or supplement for a missing or defective part of the body. Many people in need of prostheses are not aware that they exist. For example, I recently observed an elderly blind man attempting to cross a busy street. While helping him across, I informed him that his cane was far too short—he could place it less than a foot in front of his extended foot. He was delighted to learn that *long* canes are readily available.

Many people have a hearing deficiency that can be readily alleviated with the help of a hearing aid. But eyeglasses, which constitute a vision prosthesis, are more readily accepted than hearing aids.

This month, we'll look at several kinds of prostheses that you can make. First, let's consider a valuable service you can probably render to hearing-aid users.

Repairing Hearing Aids. Much of my early education in solid-state electronics was gained by repairing defective hearing aids obtained from dealers for a few dollars or less. I quickly learned that most would work properly when the power switch, earphone jack (if present), battery contacts, or volume control was cleaned with a tiny spurt of solvent spray. Sometimes a frayed earphone cord was the culprit, but this only occurred in "body aids." Most aids of contemporary design are worn in or behind the ear and include an integral transducer acoustically coupled to the ear by means of a plastic tube.

Originally, I converted the repaired aids into miniature transistor radios. This was readily accomplished by removing the microphone and installing in its place a tuned circuit made from a miniature ferrite-core coil and a disc capacitor. I used a germanium diode to demodulate the signal.

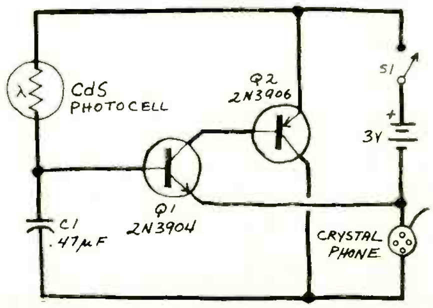


Fig. 1. Simple transistorized light probe for the blind.

During college days, I derived material benefit from repairing damaged and defective hearing aids for a local dealer for $5.00 each. Considering the replacement cost of such devices (often hundreds of dollars or more), the fee was a bargain.

You can easily put together a repair kit to help you solve most common hearing-aid problems. You'll need facial tissue, cotton swabs and alcohol to clean accumulated debris from the exposed portions of the aid. An ink eraser or other abrasive surface (e.g. very fine finishing paper) is handy for cleaning battery contacts. A small can of TV-tuner contact cleaner with a thin spray tube or nozzle is needed to clean switch contacts, phone jacks and volume controls.

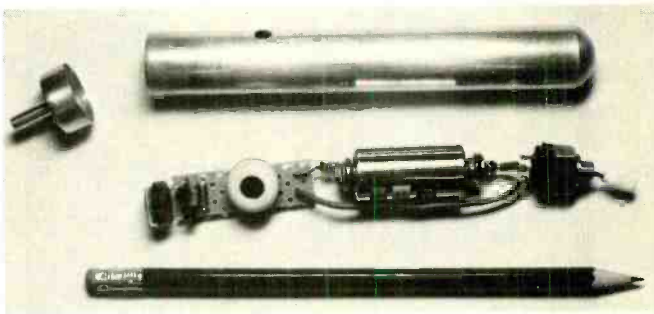


Fig. 2. Construction of a light probe in a cigar tube.

Sometimes, switch contacts fail to engage completely. A pair of high-quality, midget needle-nose pliers or a pair of pointed tweezers can help you remedy this problem. A small hand lens and a portable desk lamp will make it easier to find problems and see what you're doing. You'll also need a multimeter to check batteries and to test the continuity of switch contacts and earphone wires.

Your kit will be complete with the addition of a set of jewelers screwdrivers and a miniature, low-wattage soldering iron. You can put everything in a small fishing-tackle or tool box. The kit can also be used for much of your experimental work.

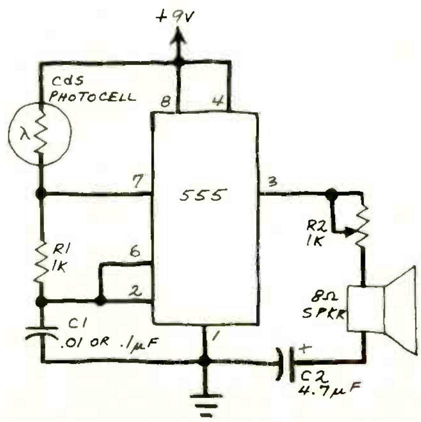


Fig. 3. A 555 light probe with high-volume output.

www.americanradiohistory.com

POLY PAKS

Free!

Look at this fantastic offer from Poly Paks!!

Free Premium offer with every $20 purchase. Your order today will give you FREE tools for tomorrow! Here's how Poly Paks Free Premium offer works:
One free premium with your $20 order.
Two free premiums with your $40 order.
Three free premiums with your $60 order.

AUDIO 8 WATT ENHANCEMENT AMPLIFIER
$14.95 2 for $28.00
• Includes 24VDC Power Supply
• 8 watts Peak Power, 6 W RMS
• ON/OFF-VOLUME, Bass & Treble Controls
• Adds Expanded Tonal Flexibility
Cat. No. 6832 QTY.

12.5 VOLT 600 mA NICKEL CAD BATTERY PAK $12.49 2/$24 QTY
• 10 "AA" Size Cells Connected in Series
• Comes in 2-7/8" x 1-1/8" x 2" Insulated Plastic Case. (Picture Shown Less Top Half of Case)
• Easily Accessible Top Mounted Solder Tab Leads
Cat. No. 6676

GIANT SOLAR DISCS

Cat. No.	Size	Rating VDC	Price
3788	3½	1 amp .5	$ 8.95
5075	4"	1 amp .5	$10.95

"BLOCK" FANS
• 115 VAC • 15 WATTS
• ONLY 4-11/16" SQ.
• 1-1/2" DEEP!
• 75 CFM OR BETTER
Cat. No. 3108
$11.88 2/$23 QTY

4 DIGIT 0.5" LED DIGITAL ALARM CLOCK WITH BUILT-IN "CHIP"
• Uses Famous MM5385 Clock Chip
• Includes Alarm and Snooze Feature
• Clock Radio Timer Output, 1 Hour Sleep Timer, and Brightness Control
• 12 VAC, 60 Hz
$14.95 2/$29
Cat. No. 6827 QTY.

PIEZO ELECTRIC TWEETER HORN SOLID STATE 3-½"
ONLY $8.88 2/$17
• No Voice Coil!
• No Crossover Network!
• Frequency Range: 4000 - 40,000 Hz.
• High Impedance, 8 Ohms // 100K Hz.
• Handles 55 Watts Peak, 35 Watts RMS
Cat. No. 5656 QTY.

"SPACE SHOT" AUDIO GAME BOARD
Provides Authentic "Outer Space" Sound Effects
• Sound Effects Include: Rocket Blast, Phaser Fire, Space Man Breathing, "Clear the Launch Pad" Alarm Gong, Even 21st Century Music
• Requires 8 Ohm Speaker and 9V Transistor Radio Type Battery.
• Size 4-1/2" x 1-3/4" x 1"
$4.49 2/$8
Cat. No. 6707 QTY.

24 VCT 2A POWER TRANSFORMER $4.49 2/$8
Features top-mounted primary & secondary, dual-winding coil, and integrated nylon mounting brackets w/mt. holes on 2-1/4" x 1-3/4" ctrs. Size: 2-5/16" x 3-5/8" x 1-7/8".
Cat. No. 6809 QTY.

40 CHANNEL CB BOARD
From Hy-Gain! Boards have: Heatsinked 9 Watt Amp Chip, RF & MOD. Transistor, and PLL selector IC. May be used for 10 meter conversion. (See continuing series "CB to 10" in 73 magazine). Size: 8" x 2" (h)
Cat. No. 5554
Only $12.88 2/$25 QTY.

CUTTING PLIERS
7-PC. NUTDRIVER SET
FREE!!
LONG NOSE PLIERS

POLY PAKS®
P.O. BOX 942, PE4
S. LYNNFIELD, MA. 01940

Total Amount of Order $ ____
Include Additional $3 for Postage & Handling.
NAME ____
ADDRESS ____
CITY ____
STATE ____ ZIP ____
Enclosed is ☐ CHECK, ☐ MONEY ORDER
Charge my ☐ MASTERCARD ☐ VISA
ACCT. # ____ EXP. DATE ____
☐ Send me your FREE catalog
Order By Phone 1-617-245-3828

ORDERING INSTRUCTIONS • Indicate Quantity in Box Near Item Desired • Complete Coupon Section • Cut Out Ad and Send to Poly Paks, Inc.

CIRCLE NO. 47 ON FREE INFORMATION CARD

experimenter's corner

You must gain experience troubleshooting and repairing discarded hearing aids before attempting to repair a person's only audio link with the outside world. Hearing aids are very fragile and usually very expensive, so you must exercise considerable care when attempting to repair them. Other than minor cleaning, leave the repair of units under warranty to the dealer or the manufacturer.

Spare parts can be expensive and difficult to find. You can sometimes salvage parts from discarded aids. New components can be ordered from hearing-aid manufacturers or distributors. A local hearing-aid dealer might provide you with addresses or let you look through his parts catalogs. Be aware, however, that many dealers do not repair aids and therefore will not have such information.

You can donate salvaged aids you have repaired to a hospital, nursing home, or a nonprofit society for the deaf. This can provide you with a tax deduction (charitable gift) which will help finance future projects. After you've become proficient at repairing discarded aids, you can try repairing aids in everyday use. Call a local nursing home or hospital to find out about aids which need service.

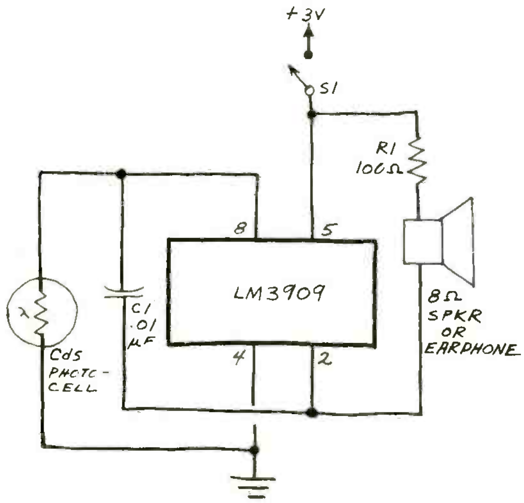


Fig. 4. A light probe circuit using an LM3909.

Do-It-Yourself Prostheses. It's relatively easy for experimenters to design and assemble prosthetic devices for blind and deaf people. You might also be able to build various kinds of remote-control devices that will enable immobile or paralyzed people to turn on a light, radio, television and other device from a fixed location. Let's examine some possibilities.

Aids for the Blind. Probably the simplest gadget you can build for a blind friend or relative is a light probe that produces a sound when a photodetector is illuminated. Light probes date from 1912 when British scientist Fournier d'Albe built a device he called the "Exploring Octophone." It employed a selenium cell in a Wheatstone bridge and generated a musical tone as light intensity was varied.

You can build an updated version of d'Albe's light probe (Fig. 1). This circuit, which I described in a previous article ("Build a Light Probe," POPULAR ELECTRONICS, March 1973, pp. 42-43), can be easily installed in an aluminum or plastic cigar tube (Fig. 2).

The circuit is a two-transistor regenerative amplifier. Its frequency of oscillation depends on the amount of light striking the sensitive surface of the cadmium-sulfide photocell.

Audio output is supplied by a crystal earphone that serves as a miniature speaker. The volume is sufficiently high so that the user can hear the tone, but it is not so loud as to distract nearby persons.

The probe can be made much smaller than the unit shown in Fig. 2. Several years ago, I built a probe, complete with mercury button cell and hearing-aid receiver, into a small plastic tube measuring about 3/8" x 1". This was made possible by the tiny but surprisingly effective hearing-aid receiver unit I used in its construction. I intended to attach the probe to a key chain but, because of its small size, I promptly misplaced it.

There are many ways to make circuits which produce a tone whose frequency is dependent upon light. Figure 3, for example, is an IC version designed around the readily available, inexpensive 555 timer. This circuit is very sensitive and can be adjusted to provide various frequency ranges and threshold levels, but it consumes more current than the circuit shown in Fig. 1.

An important advantage of the circuit in Fig. 3 is that it can provide more drive current to a small speaker or other transducer than the transistor circuit. This may prove a significant advantage to blind people with a hearing problem, a not uncommon combination among older individuals.

Still another light probe circuit is shown in Fig. 4. This circuit uses the amazingly versatile LM3909 LED flasher chip as a light-controlled audio oscillator.

Light probes have many practical applications. Blind telephone operators have used them to find illuminated indicator lights on a switchboard. Such probes can also be used to determine if room lights are on or off, whether or not appliances with pilot lights are on, and to find color changes on clothing and wall surfaces.

Another simple but very useful aid for blind people is a liquid-level indicator. A blind person usually determines when a cup or glass has been filled by keeping a finger tip inside the rim of the container while pouring the liquid. This procedure can be uncomfortable if the beverage is hot and can be unseemly if sighted guests are being served.

The "Project of the Month" in this issue describes a very simple two-tone liquid-level indicator which is essentially identical to the light probe in Fig. 4. Indeed, you may wish to build an LM3909 oscillator with a phone-jack input port. You can then connect either the liquid-level probes described in

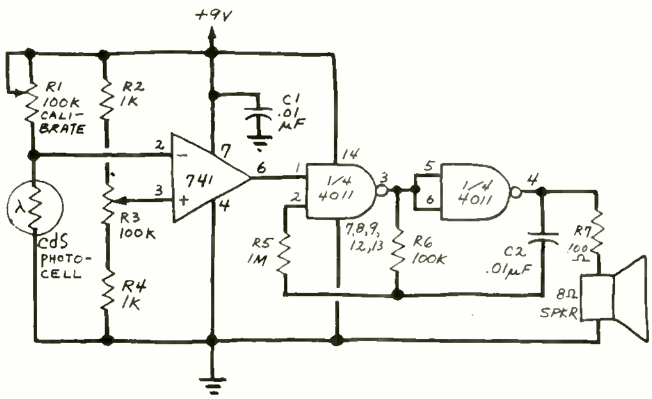


Fig. 5. Color detection circuit for urinalysis.

the "Project of the Month" or the photocell as in Fig. 4.

Partial or even total loss of vision can be an unfortunate side effect of advanced diabetes. A modification of the light-probe concept can be used to help blind diabetics perform their own tests of the sugar level in their urine.

Urinary sugar content is ordinarily determined by dipping a strip of test paper into a specimen. Color changes in the paper denote the sugar level. You can detect the color of a test strip by making a light-tight chamber fitted with a cadmium-sulfide photocell and a small lamp. When a test strip is placed in the chamber, the resistance of the photocell will be determined by the color of the strip.

I built a urine-monitoring device similar to this in 1966, and at least one such device is commercially available today. If you want to assemble one for a blind diabetic, spend the time to calibrate it carefully. Make sure the unit can be reliably operated by a blind person. Erroneous readings from the unit could prove extremely hazardous to a person who uses it.

To experiment along these lines, Fig. 5 is the schematic of an elementary circuit with which you can get started. The operational amplifier, operated without a feedback resistor so that it functions as a comparator, has its switching threshold determined by the setting of *R3*. The photocell is one section of a voltage divider. When the divider output reaches the switching threshold set by *R3*, the comparator actuates the tone generator made from two of the gates in a 4011.

In using this circuit, the photocell is pointed at an illuminated test strip (you can obtain test paper at a pharmacy). The output of the divider is a voltage representative of the reflectance of the strip. Potentiometer *R3* is then adjusted until the tone is heard. Raised markings at predetermined points form a scale for the control knob, which should have a stubby pointer, that a blind person could "read" easily.

Aids for the Deaf. We've already discussed the repair of hearing aids. In a pinch, you can actually *make* a usable hearing aid from a miniature audio-amplifier circuit or a low-cost portable, commercial amplifier and a microphone and earphone. This assembly will be much bulkier than an ordinary hearing aid, and it will pick up rustling clothing noises unless the microphone is mounted in an unobstructed location. It will also be much more subject to acoustic feedback and oscillation, which can be frightening. Such an aid will not necessarily be as good for the amplification of audio frequencies as are the specialized designs of most hearing aids. Nevertheless, it can prove very helpful in an emergency or when a person's hearing aid is being repaired.

The totally deaf cannot be helped by conventional hearing aids. Ways to signal such people include a light panel, CRT display, or printer.

A simple yes-no signalling system can be made with a tactile stimulator. Such devices can be made from piezoelectric substances which, when electrically stimulated, vibrate or poke against the surface of the skin. A more homely but simpler approach that rarely fails to get a person's attention is an eccentric weight attached to the shaft of a small dc motor. When the motor spins, the vibrations generated by the offset weight is easily felt,

thandar

PFM 200 Pocket Frequency Counter
Display 8 digit LED
Frequency 20Hz – 200MHz
Sensitivity 10mV
2 Ranges
4 Gate times
Battery or AC adaptor

$99.95
including mains adaptor

Please send me
_____ PFM 200 @ $99.95 each $
Shipping and handling per order $5.00 *
N.J. residents add appropriate sales tax $
* Continental USA only TOTAL $
☐ Check ☐ Money Order ☐ Master Charge ☐ Visa
(Allow 2-3 weeks clearance time for personal checks)
Credit Card No. __________ Exp. Date __________
Name __________
Street __________
City ______ State ______ Zip ______
SEND TO: Thandar Electronics Inc. P.O. Box 8247, Haledon, New Jersey, 07538.
Tel. 800-526-5311 (Toll Free). (201) 790-3141
PE

www.americanradiohistory.com

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

Amber and Lodestones and Other Topics

THE primary purpose of this column is to cover *new* developments in solid-state electronics. From time to time, however, I would like to describe the historical discoveries which led to the development of the wonderful variety of electronic components and circuits available to us today. Paying tribute to those who made modern electronics possible—and reflecting upon the simple, often crude, methods, instruments, and components they used—helps one to appreciate how far we have come. This month, let's examine the uncovering of phenomena that led to the eventual discovery of electricity.

Magical Minerals. The beginning of this long process can be traced to two naturally occurring substances that exhibit very unusual properties. The substances are *amber* and *magnetite*. Their ability to attract bits of straw and particles of iron, respectively, has been observed since the beginning of recorded history.

In my desk drawer is a small chunk of magnetite from Utah which I purchased at a gem-and-mineral show for 50¢. The mineral, which is commonly called *lodestone* or *loadstone*, is an iron ore that has a generally metallic appearance.

That my piece of magnetite is magnetic is obvious from the whiskers of iron filings projecting from it. A small finishing nail that clings to the lodestone has itself become magnetized, and some iron filings cling to it when it is pulled from the lodestone.

Also in my desk are several pieces of transparent, golden-yellow amber. Amber is fossilized tree sap, and my specimens contain several small entrapped fungus gnats which are easily seen with the help of a small lens. If the amber is rubbed briskly with a piece of flannel, it will attract small bits of leaves and straw.

The attractive properties of lodestone and amber baffled early philosophers and scientists. Aristotle reports that Thales of Miletus (640-548 B.C.) attributed the attractive properties of lodestone to ". . . a soul since it moves iron." Thales proposed a similar explanation for the behavior of amber.

Plutarch (46-120 A.D.) had a different explanation for amber's attractive properties. Rubbing it supposedly opened pores that allowed entrapped vapors to escape. Air, rushing in to fill the pores, pulled along with it nearby particles of dust and bits of straw. Amber is somewhat porous, and does have a distinct pine odor when the friction of rubbing produces heat, but the true explanation for its attractive powers is, of course, static electricity. Similarly, the attractive ability of lodestone lies in its inherent permanent magnetism.

Both lodestone and amber played fundamental roles in early electrical discoveries. The attractive properties of amber led to the investigation of static electricity and the eventual development of friction-operated electrostatic generators. The development of the first electromechanical machines can be traced to the eventual true understanding and exploitation of the properties of lodestone.

Lodestone and amber have also left us an important linguistic legacy. Because it was discovered in Greece's region of Magnesia, lodestones were called *Magnetis lithos* (stone of Magnesia), from which our word *magnet* was derived.

Amber's contribution is just as important. The Greek word for amber is *elektron*. In 1600, William Bilber published a book on magnetism in which he coined the term *electricia* to describe all substances which possess attractive properties like those of amber. In 1646, Sir Thomas Browne used for the first time the word *electricity*.

Microcomputer Update. An important trend in single-chip microcomputers is the incorporation of on-chip analog-to-digital (A/D) conversion. This permits the processing of analog data by a digital microcomputer without the need for an external A/D converter.

One of the latest microcomputers to incorporate on-chip A/D conversion is Motorola's MC6805R2. The architecture of this 8-bit, n-channel MOS chip makes it compatible with the 6800-microprocessor instruction set. It includes a clock, processor, 2048 bytes of user-programmable ROM, 64 bytes of RAM and a four-channel, eight-bit A/D converter.

Figure 1 is the block diagram of its A/D converter. The circuit uses a successive-approximation technique and requires 30 machine cycles per conversion. One of four analog signals can be routed to the converter circuit's comparator through a 4-channel analog multiplexer. The three lowest order bits in the A/D Control Register (CS0, CS1 and CS2) determine which input is selected according to the following coding format:

Input Selected	Control-Register Status		
	CS2	CS1	CS0
AN0	0	0	0
AN1	0	0	1
AN2	0	1	0
AN3	0	1	1

Other bit patterns in the Control Register control various other operations.

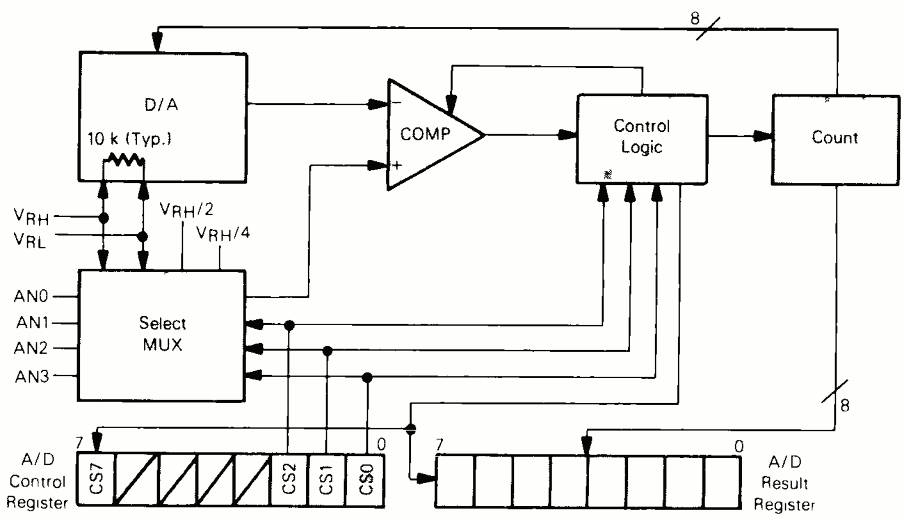


Fig. 1. Motorola's MC6805R 28-bit microcomputer with on-chip A/D converter.

www.americanradiohistory.com

POPULAR ELECTRONICS

WIN A COMPUTER $WEEPSTAKE$

Save up to 41% on *Popular Electronics*, too!

The Popular Electronics Sweepstakes is open to all our readers. No purchase is required — and you'll receive a fantastic home computer kit worth $1695 if you're the lucky winner!

You're sure to win with *Popular Electronics!*

Whether or not you win our Sweepstakes, your electronics projects are certain to be winners when you subscribe to *Popular Electronics.* It's the Number One magazine in its field — filled with news about computers, audio equipment, communications and home projects.

Why not enjoy a year or more of *Popular Electronics* at our low introductory prices? You'll save up to 41% if you subscribe at the same time you enter our Sweepstakes!

How the Sweepstakes works:

Just mail the attached card or the coupon below after filling in your name and address. Be sure to indicate whether you're also subscribing to *Popular Electronics* at the special rates shown — you can save as much as 41%.

Then, if you win, you'll get the Heathkit H-89 All-In-One Computer kit! Put it together and you've got a powerful, compact home system that's user-programmable and expandable. The H-89 has a professional-size video terminal, 80 character keyboard, built-in floppy-disk system, and features twin Z-80 microprocessors plus 16K bytes of RAM memory with capacity for up to 64K RAM. In all, $1695 worth of professional quality equipment!

OFFICIAL RULES
NO PURCHASE REQUIRED

1. On an official entry form or a 3" x 5" piece of paper, hand-print your name, address and zip code. Enter as often as you wish, but mail each entry separately to Popular Electronics Sweepstakes, P.O. Box 2785, Boulder, Colorado 80322. Entries must be received no later than May 31, 1981, and the drawing will be held by June 26, 1981.
2. Winner will be selected in a random drawing from among all entries received under the supervision of the publishers of Popular Electronics, whose decision is final. Only one prize will be awarded in this Sweepstakes. Winner will be notified by mail and may be required to execute affidavit of elegibility and release. Odds of winning will depend on the number of entries received. Ziff-Davis will arrange delivery of prizes. Taxes are the responsibility of the prize winner. Any manufacturer's claims and warranties will apply, but Ziff-Davis makes no claims or warranties with regard to any prize. Prize is not transferable. No substitution or exchange for prize.
3. Sweepstakes open to all U.S. residents except employees of Ziff-Davis Publishing Co., its affiliates, advertising and promotion agencies. Void wherever prohibited by law.
4. For the winner's name, send a stamped, self-addressed envelope to Popular Electronics Sweepstakes, Circulation Department, Ziff-Davis Publishing Co., One Park Avenue, New York, N.Y. 10016.

OFFICIAL ENTRY FORM

MAIL TO: **Popular Electronics Sweepstakes**
P.O. Box 2785, Boulder, Colorado 80322

☐ **YES!** Enter my name in the Popular Electronics Sweepstakes and start my subscription to *Popular Electronics* for the term checked:

☐ One year only $9.97 — 29% off! ☐ Two years only $17.97 — 36% off! ☐ Three years only $24.97 — 41% off!

Savings based on full one-year subscription price of $14.

CHECK ONE: ☐ Payment enclosed. ☐ Bill me.

☐ **NO** I don't wish to subscribe now, but tell me if I've won the Popular Electronics Sweepstakes.

Mr.
Mrs.
Ms. ____________________
(please print full name) 8H096

Address ____________________ Apt. ______

City ____________ State ______ Zip ______

Offer valid only in the U.S. Please allow 30 to 60 days for delivery of first issue if you subscribe.

www.americanradiohistory.com

J&R "RATED NO. 1 FOR SERVICE & RELIABILITY"

THIS MONTH'S SUPER SPECIALS!

Audio & Video

VIDEO
SONY SL-5400 Betamax $799
JVC HR 6700 Video Rec $799
ZENITH VR-9000 Beta Vid Rec $699
RCA VET-250 Video Rec $775
RCA VEP-150 Port Vid Rec $729
SONY KV-1914 19" Color TV $439
PANASONIC CT 9010 19" Col TV $359
PANASONIC CT 288 12" Col TV $279

AUDIO
TECHNICS RS-M45 Cass Deck $225
B I C T-2 Cassette Deck $159
DUAL 606 55 [illegible] W/Cart $219
TECHNICS SA-202 Receiver $165
PIONEER SX-3700 Receiver $259
TECHNICS SL D2 Turntable $109
AKAI UCU-2 Micro Int Amp $159
TECHNICS ST Z1 Tuner $115

CAR STEREO

PIONEER
CASSETTE IN-DASH W/RADIO
KP 1500 84 90
KP-2500 99 00
KP-4500 114 90
KP-5500 124 90
KP-8500 141 90
KE 2100 174 90
KE 3000 209 90
KEX-20 214 90
KP-3500 (foreign cars) 129 90
KP-4502 (foreign cars) 144 90
KP 8000 154 90
KPX9000 (req amp) 154 90
KPX9500 (req amp) 176 90

CASSETTE UNDER DASH
KP-373 84 90
KP-575 94 90
KP-500 129 90
KP-66G (req amp) 78 50
KP-77G (req amp) 104 90
KP-88G (req amp) 99 90
KPX600 118 90
KP707G 144 90

POWER AMPS/EQUALIZERS
BP-320 49 90
AD-30 89 90
AD-50 141 90
GM 40 49 90
GM-120 106 90
CD-5 89 90

CAR SPEAKERS
TS-M2 32 90 PAIR
TS-13 32 90 PAIR
TS107 37 90 PAIR
TS167 44 90 PAIR
TS168 82 90 PAIR
TS695 82 90 PAIR
TS-X6 69 90 PAIR
TX X9 129 90 PAIR

WE ALSO CARRY THE FULL LINE OF CAR STEREOS BY PANASONIC, GRUNDIG, MITSUBISHI, CONCORD, SONY, AUDIOVOX AND CRAIG

JENSEN
CASSETTE IN-DASH W/RADIO
R 402 receiver 174 90
R 406 receiver 199 90
R-410 receiver 219 90
R-420 receiver 259 90
SPEAKERS
J 1001 6x9 separates 94 90
J 1065 6x9 triax 62 50
J-1033 6x9 triax II 79 50
J-1201 6x9 coax II thin 59 90
J-1101 4x10 triax 62 50
J-1130 4x10 triax II 79 90
J-1174 5¼ triax 62 50
J-1124 5¼ triax II 79 95
J 1188 6½ coax thin 42 95
J 1069 6x9 coax 40 50
J 1037 6x9 coax II 59 50
J 1041 5¼ coax II 49 50

SANYO
IN-DASH CASSETTE
FT 1496 179 95
FT 1498 219 90
FT 1495 119 95
FT 2400 224 90
FT C2 54 90
FT C4 64 90
FT-C6 71 90
FT-C8 99 90
FT C10 109 90
FT-C16 147 90

BLAUPUNKT
CR 2001 238 90
CR 3001 432 90
CR 4000 259 90
CR 5001 331 90
BEA 100 107 90
BEA 200 174 90
BEA 50 74 95

CLARION
PE 959 programmable 569 90
PE-9568 319 90
PE 7588 172 90
PE 554A 94 90
100EQB3 77 90
300EQB2 137 90

BLANK CASSETTES

AUDIO
AMPEX GRAND MASTER I OR II C90 2 99
BASF PRO II OR III C90 2 99
FUJI FX I OR II C90 2 99
SCOTCH HIGHLANDER C 90 3-PK 4 99
MEMOREX HI BIAS C90 2 99
SCOTCH MASTER II OR III C90 3 25
SONY FECR C90 3 25
SONY LNX C90 1 64
TDK HD 01 DEMAGNETIZER 16 95
TDK D C60 1 19
TDK D C90 1 68
TDK ADC60 1 68
TDK ADC90 2 45
TDK SAC60 2 15
TDK SAC90 2 99
TDK MA C90 (METAL) 6 29
TDK MA C90 (METAL) 7 99
MAXELL UD, UDXLI, UDXLII TOO LOW TO ADVERTISE
CALL OR WRITE FOR PRICES
SANSUI AUD 5B Int Amp 274 00
TECHNICS SA 303 Receiver 199 00

VIDEO
WE CARRY VIDEO TAPES BY AMPEX, BASF, FUJI, JVC, MAXELL, PANASONIC, MEMOREX, TDK, SCOTCH, SONY, RCA, AND QUASAR
ALL BETA L 500 10 95
ALL BETA L 750 13 95
ALL VSH T-120 (EXCEPT HG) 14 95
MATTEL INTELLIVISION 219 90
ATARI VIDEO GAME CX 2600 148 95
SPACE INVADERS CARTRIDGE 23 00
PANA PV 1400 Video Rec 889 00
ZENITH VR 9750 1020 00

WE STOCK B&W AND COLOR TV'S, VHS AND BETA VIDEO RECORDERS, AND HOME MOVIES FROM ALL MAJOR HOLLYWOOD STUDIOS. SEND FOR CATALOGUE

MINIMUM ORDER 12 TAPES
100% GUARANTEED

ACCESSORIES

CAR ACCESSORIES
FUZZBUSTER ELITE 134 95
FOX XK RADAR DETECTOR 99 50
FOX XKRW (remote) 109 50
SUPERFOX 224 90
PAGE ALERT 4000 114 95
BELL 810 (Superhet) 154 95
HAR FA 80 [illegible] 33 95

MISCELLANEOUS
BIC FM-6 BEAM BOX 24 90
BIC FM-8 BEAM BOX 34 90
BIC FM 10 BEAM BOX 64 90
CASIO C 80 Cal Watch 44 90
CASIO ML-81 CALCULATOR 31 95
CHESS CHALLENGER X7 87 90
BACKGAMMON CHALLENGER 85 90
BSR X10 (Kit) 68 95
BSR X10211 (Timer) 59 95
BIC B 1 19 95
BONE FONE RADIO 63 95
SONY TPSL2 PORT STEREO 179 95

HEADPHONES
KOSS PRO 4 AAA 46 50
KOSS TECH VFR 46 50
KOSS HVX LC 46 99
SENNHEISER HD-420 52 50
SENNHEISER HD 430 72 50
AUDIO TECHNICA ATH-7 94 90
PIONEER SE-205 22 95
SONY MDR 3 34 50
SONY MDR 7 54 95

CARTRIDGES
SHURE M91ED 19 95
SHURE M95ED 29 95
SHURE V15IV 96 99
PICKERING XSV 3000 53 95

WE ALSO STOCK AUDIO TECHINICA, EMPIRE, STANTON, ADC, AT LOWEST PRICES.

RECORDS

ALL ROCK, JAZZ & CLASSICAL
All 7 98 List 4.99 — All 8 98 List 5.99 — All 9 98 List 6.99
Cass & 8-Track Same Price as LP: Minimum Order: 5 Records or Tapes
PRICES MAY VARY ON IMPORTED RECORDS
We Stock all Major Labels

HOW TO ORDER BY MAIL. For prompt shipment send money order, certified check, cashier's check, Master Charge or Visa (include card number, expiration date and signature). Shipping insurance charge is 5% of total or $3 95 minimum ($5 additional for orders outside of Continental U S) N Y S residents add tax. No C O D. All merchandise 100% guaranteed brand new and factory fresh. 3 weeks delay on personal checks

ORDER TOLL FREE (800) 221-8180
Customer Service Hot Line (212) 233 0857
For more information call: 732-8600

J&R MUSIC WORLD
23 PARK ROW, NEW YORK, N.Y. 10038 DEPT. PE
SEND FOR OUR 200 PAGE FREE CATALOG

CIRCLE NO. 34 ON FREE INFORMATION CARD

When a conversion cycle has been completed, the digitized result is placed in the A/D Result Register. Unless different instructions are placed in the A/D Control Register, a new result is loaded into the Result Register after 30 machine cycles. Changing the status of the Control Register to select a different analog input automatically clears the conversion-complete flag (CS7 in the Control Register), and a new conversion cycle is initiated. When the microcomputer is reset, the Control Register is automatically cleared to 0000 0000. This selects the first analog input (AN0).

The capability of sampling each of four separate analog inputs makes possible some fascinating applications. For example, the MC6805R2 can automatically and sequentially monitor up to four parameters of an automobile engine. It can then either calculate or derive from a ROM the optimum fuel-air ration for existing conditions and send appropriate control signals to an automated carburetor or fuel-injection system.

The advance information about the MC6805R2 that I received from Motorola did not include pricing data. For more information and a 26-page data booklet, write to Motorola Semiconductor Products, 3501 Ed Bluestein Blvd., Austin, TX 78721.

More on Magnetic Bubbles. Continuing last month's discussion, the general consensus is that bubble devices will eventually replace tape and flexible and rigid magnetic disks in many applications, but that prices will remain high until high-volume production starts.

A new bubble-memory module from Texas Instruments will give you a good idea how expensive these high-capacity memories with no moving parts currently happen to be. The module, designated the TM990/210L, can be supplied with two, four or six 92K-bit TIB0203 bubble memories for the storage of 23K, 46K or 69K bytes, respectively. This new module has a greater operating temperature range (0°C to 70°C) than its predecessor, the TM990/210. It includes all necessary support circuitry and is bus-compatible with TI's TM990 series of microcomputer modules. Cost in single-unit quantities for the 23K-byte module is $1,160! The 46K-byte and 69K-byte modules cost $1,715 and $2,060, respectively, in single-unit quantities.

TI also sells the TM990/431 TIBUG software package, an interactive monitor for loading, debugging and executing programs for the TM990 microcomputer, which uses the TM990/210 bubble memory. The TIBUG software is available in the form of two TMS2716 EPROMS for $200.

If you want to know more about the TM990/210 bubble-memory module and the TIBUG software package (and if you can afford them!), write to Texas Instruments at Box 225012, M/S 308, Dallas, TX 75265.

Bubble memories are also available from Intel, Rockwell International and National Semiconductor. Intel's latest entry is the iSBC 254, a board that holds up to four one-megabit 7110 bubble-memory chips and their required control chips. The fully loaded 512,000-byte version is currently available for $6,300. According to Intel, the price will fall to $4,200 in several months. For more information, write to Intel Memory Systems, 1302 N. Mathilda, Sunnyvale, CA 94086.

Rockwell International sells a full line of bubble-memory boards having storage capacities of 32K, 64K, 128K and 256K bytes. A unique feature of these boards is that control and support functions are provided by a single-chip microcomputer. Watch for more products and peripherals using microcomputers in support roles. This technique is called *distributed processing*. Later this year, Rockwell will introduce a 256K-byte version of this board. For more information, write to Rockwell International's Electronic Devices Division, 3310 Miraloma Avenue, Anaheim, CA 92803.

National Semiconductor, like TI and Intel, is a major manufacturer of conventional memory chips. It will soon announce the availability of its BLC9081 board that contains eight one-megabit NBM2011 bubble memories and gives a full megabyte of storage capacity. For more information, write to National Semiconductor, 2900 Semiconductor Drive, Santa Clara, CA 95051. ◇

TI's magnetic-bubble data terminal being used by a sports reporter.

www.americanradiohistory.com

AMATEUR RADIO

By Karl Thurber

The Morse Code: Alive and Kicking

CONTINUOUS wave (CW) or Morse code is the mode of transmission that gave radio communications its start. It's true that more sophisticated communications modes—RTTY, SSB, FM and TV—have come of age and supplanted CW to a large extent. However, CW communications still has a special place in ham radio, and it's far from a dying art. Because CW is an excellent training ground for those who want to get involved in radio communications, the FCC requires prospective Novice amateurs to demonstrate Morse-code proficiency at a speed of five words per minute (wpm) to qualify for a license. Furthermore, the Commission grants only CW operating privileges to Novice-class licensees to ensure that they get a healthy dose of CW communications before they upgrade.

Many amateurs with licenses that grant phone privileges do not abandon CW completely because they know it's hands-down the best communications medium when radio propagation is poor or interference (QRM) is heavy. There is nothing like CW for "cutting through the ether" and as a backup for RTTY and SSB circuits, especially under emergency conditions. Many hams thoroughly enjoy CW as an art unto itself. They wouldn't trade in their keys for a mike *for anything*!

It might be well to point out here that International Morse code, the proper name for the code amateurs use today, is sometimes called Continental code because it was first used on European wire telegraphy circuits, well before wireless communications was invented. International Morse code is often confused with American Morse code, which is significantly different and is largely obsolete.

CW Today. What causes this devotion to CW? To some extent, it's nostalgia, plain and simple. It's *fun* to communicate with another ham using techniques similar to those used by land-line telegraphers more than 100 years ago. More importantly, CW is enjoying newfound popularity because of recent technological developments and products embodying them that have made sending and receiving it pleasurable, relaxing and rewarding as never before.

Some of these new products include electronic, programmable-memory keyers and smooth-acting, dual-lever paddle assemblies; mechanically sophisticated semiautomatic keys ("bugs"); highly selective, solid-state audio filters; automatic, microprocessor-based CW-generating and -decoding equipment; and even specially designed, narrow-bandwidth speakers intended specifically for CW reception.

Accordingly, a contemporary CW station's transmitting gear will consist of a precision "iambic" (squeeze) paddle that allows even the neophyte to send code rapidly and accurately with maximum comfort and minimum fatigue. The paddle controls a programmable, solid-state keyer, one that not only generates machine-perfect CW but also has the capability to accept, store and then transmit on command any of several messages. The really sophisticated CW shack sports one of the new microprocessor-controlled Morse-generating keyboards or home-computer interface units that enables the user to send code *automatically* merely by typing out the message on a feather-touch keyboard.

The state-of-the-art CW station's receiver or transceiver is equipped with a sharp i-f crystal or mechanical filter. The station is also likely to have an external audio filter that allows the operator to tune out all stations except the desired one within its very narrow

Microlog Corp.'s transceive video terminal includes split-screen receive and transmit buffer display, RTTY modulator and demodulator, 10 programmable message memories, automatic station ID and other features.

Put Professional Knowledge and a

COLLEGE DEGREE

in your Electronics Career through

HOME STUDY

***Earn Your* DEGREE**

No commuting to class. Study at your own pace, while continuing your present job. Learn from easy-to-understand lessons, with help from your home-study instructors whenever you need it.

In the Grantham electronics program, you first earn your A.S.E.T. degree, and then your B.S.E.T. These degrees are *accredited* by the Accrediting Commission of the National Home Study Council.

Our *free* bulletin gives full details of the home-study program, the degrees awarded, and the requirements for each degree. Write for *Bulletin ET-81.*

Grantham College of Engineering
2500 So. LaCienega Blvd.
Los Angeles, California 90034

ESP

DON'T BLAME THE SOFTWARE!

Power Line Spikes and Hash often cause memory loss or erratic operation. Often floppies, printer & processor interact!

OUR unique ISOLATORS eliminate equipment inteaction AND curb damaging Power Line Spikes, Surges and Hash.

3 filtered 3-prong sockets and integral Spike Suppression. 125 VAC, 15 Amp, 1875 W Total - 1 KW per socket.

ISO-1 ISOLATOR. 3 Filtered Sockets; 1000 Amp 8/20 usec Spike Suppressor $56.95

ISO-4 ISOLATOR. 6 Filtered Sockets; 1000 Amp 8/20 usec Spike Suppressor $96.95

ISO-3 SUPER-ISOLATOR. 3 DUAL filtered Sockets; 2000 Amp 8/20 usec Spike Suppressor $85.95

ISO-7 SUPER-ISOLATOR. 5 DUAL filtered Sockets; 2000 Amp 8/20 usec Spike Suppressor $139.95

Master-Charge, Visa, American Express
Phone:1-617-655-1532

Electronic Specialists, Inc.

171 South Main Street, Natick, Mass. 01760
Dept. PE (617) 655-1532

CIRCLE NO. 15 ON FREE INFORMATION CARD

www.americanradiohistory.com

WANT AUTO-RANGING?

AWS EZ 6100

AND...

- An unprecedented five-year warranty
- Pricing as low as $105
- 3 1/2 digit display
- Autoranging on Volts and Ohms
- Continuity buzzer (Model EZ 6100)
- Range hold (Model EZ 6100)
- Autopolarity
- Automatic indication, unit and signs
- Feather touch button to select AC/DC - Lo Ω/Ω function
- Low battery warning sign
- Safety fused

EZ 6100	
DCV 0-1000	5-Autoranges
ACV 0-600	4-Autoranges
DCMA 0-200	2-Ranges
ACMA 0-200	2-Ranges
Ω 0-2000KΩ	5-Autoranges
Low Power Ω	0-2000KΩ
4-Autoranges Plus Continuity Buzzer	
EZ 6200	
DCV 0-1000	5-Autoranges
ACV 0-600	4-Autoranges
DCMA 0-200	1-Range
ACMA 0-200	1-Range
Ω 0-2000KΩ	5-Autoranges
Low Power Ω	0-2000KΩ
4-Autoranges	

- Order AWS EZ 6200 . . . $105
- Order AWS EZ 6100 with continuity buzzer and range hold $142
- Order AWS C-30 Ever-Ready carrying case $20

☐ For ordering information call toll-free: **800-645-5398** (N.Y., Hawaii, Alaska call collect 516-231-7050).

A.W. SPERRY INSTRUMENTS INC.
The Measurable Advantage.
245 Marcus Blvd., Hauppauge, N.Y. 11787

CIRCLE NO. 51 ON FREE INFORMATION CARD

passband. It is also equipped with a comfortable pair of high-quality headphones for use when listening through the speaker would not allow those weak DX signals to be heard. A specially designed, acoustically resonant CW speaker is also likely to be standard equipment. The station might also have a CW "processor" that regenerates the received code signal and keys an internal audio oscillator. This allows code reception almost completely free of interference, static or fading.

The receiving station will likely contain a digital Morse decoding unit that enables CW and RTTY as well to be decoded and displayed on a terminal for truly effortless copy. More modestly appointed stations (and some SWL listening posts) have relatively inexpensive code readers that print out received Morse on moving LED displays that are reminiscent of outdoor news and advertising displays.

Using CW. If you're new to ham radio, you'll need to increase your operating speed to 13 wpm to upgrade to the General class license. To do this, you will have to study and practice CW operating techniques. One of the best sources of information on how to work effectively using CW is the American Radio League's publications *Operating an Amateur Radio Station* and *Ham Radio Operating Guide*. Ameco, *73* magazine, and others also publish useful CW operating aids and guides.

You'll also have to get on-the-air experience, taking care to acquire only *good* operating habits. Regular listening to the daily code practice sessions broadcast by ARRL headquarters station W1AW is also a good way to help build code proficiency. This is especially true because the code sent is letter-perfect and is therefore excellent for code practice. The League's *QST* magazine lists the operating schedule of W1AW.

Joining an on-the-air net—either a "for-fun" group or a serious, message-handling net—is a fast way to increase code speed. These nets (many of them operate at slow speeds) can be found by scanning the 80- and 40-meter CW bands, including the Novice segments, in the early evening hours.

If you're fortunate enough to own an automatic CW-decoding microprocessor or CW reader, you can use it to back yourself up on your manual copying, and might even be able to get it to send you random-character code practice! However, it's usually best to steer clear of such devices, as well as fancy paddles, "bugs", and keyers until you have mastered ordinary, straight-key operation at speeds up to 10 wpm.

It's likely that CW will continue to prosper as a valuable means of radio communications, one that can be most enjoyable and that gets going when the going gets rough. So get the rust off your fist and the lead off your wrist, and limber up for some good, old-fashioned code work with a new twist. Who says CW isn't fun? ◊

SAVE!

MONEY • TIME • FREIGHT

- QUALITY STEREO EQUIPMENT AT LOWEST PRICES.
- YOUR REQUEST FOR QUOTATION RETURNED SAME DAY.
- FACTORY SEALED CARTONS—GUARANTEED AND INSURED.
- SAVE ON NAME BRANDS LIKE:

PIONEER, SANSUI, KENWOOD, DYNACO, SHURE, SONY, MARANTZ, KOSS

AND MORE THAN 50 OTHERS
BUY THE MODERN WAY
BY MAIL—FROM

illinois audio

BANK CARDS ACCEPTED
12 East Delaware
Chicago, Illinois 60611
312-664-0020
800-621-8042

CIRCLE NO. 28 ON FREE INFORMATION CARD

4PDT RELAY
POTTER BRUMFIELD
• 14 pin style
• 3 amp contacts
• 24 volt d.c. or 120 volt a.c. coil
• Used but fully tested
$1.50 each
specify coil voltage
LARGE QUANTITIES AVAILABLE
SOCKETS FOR RELAY 50¢ each

FLASHER LED
Litronix FRL-4403
diffused red led with built in flashing unit T 1 ¾ package
pulse rate 3hz 5v 20 ma
2 for $1.70

COMPUTER GRADE CAP.
1,700mfd NEW 150 VDC $2.00 2 1/2" DIA X 4 3/4"
6,400mfd 60 VDC $2.50 1 3/8" DIA X 4 1/4"
11,500mfd 18 VDC $1.50 1 3/8" DIA X 3 1/4" HIGH
22,000mfd 15 VDC $2.50 2" DIA X 2 1/2" HIGH
CLAMPS TO FIT CAPACITORS 50¢ ea.

SUBMINI DPDT DIP RELAY
AROMAT #HB2-DC6V
• 6 VDC coil • Fits dip socket
• Norm. op. power 580 mW
• Contacts rated 1 amp @120V
$1.50 each 10 for $13.50

7-17vdc S.S. BUZZER
STAR #CMB-12
• Fits dip socket
• CMOS compatible
• Max. current 14mA
• Sound output 70dB @ 20 cm
$1.25 each

FLAT LEVER HANDLE MINI TOGGLE
SPDT
RATED 6 AMPS @ 125 V
1/4 - 40 BUSHING
$1.00 each
10 for $8.50
100 for $75.00

TRANSFORMERS
120 volt primaries

3 VOLTS @ 200 mA	$1.25
6 VOLTS @ 150 mA	$1.25
12.6 VOLTS C.T. @ 150 mA	$1.50
16.5 VOLTS @ 3 AMPS	$6.50
24 VOLTS C.T. @ 280 mA	$1.65

1N5762 DIAC
SWITCH VOLT. 36v
min. 34 V • max. 38 V
4 for $1.00

22/44 EDGE CONNECTOR
TIN SOLDERTAIL .156" x .200"
$1.35 each 10 for $12.50

DPDT 12VDC ENCLOSED RELAY
10 AMP CONTACTS KUP SERIES
AVAILABLE WITH NO FLANGE. CAN BE SOCKETED.
$3.00 EACH
10 FOR $27.50
SOCKETS $1.00

50K SLIDE POT
Knobs for Slide Pots 20¢ each
75¢ each audio taper
• 3-1/2 inch long • 2-3/4 inch slide

ALL ELECTRONICS CORP.
905 S. Vermont Ave.
Los Angeles, CA 90006
(213) 380-8000
Store & Warehouse Hours
9 AM - 5 PM
Monday thru Friday
Saturday
10 AM - 3 PM

SEND FOR OUR FREE CATALOG

TERMS
• Quantities Limited
• Min. Order $10.00
• Add $2.00 Shipping USA
• Calif. Res. Add 6
• Prompt Shipping

CIRCLE NO. 2 ON FREE INFORMATION CARD

www.americanradiohistory.com

English Broadcasts Audible in No. America

by Glenn Hauser

TIME EST/CDT	TIME UTC/GMT	STATION	QUAL.[2]	FREQUENCIES, kHz[1]
4:00-4:15 a.m.	0900-0915	BBC	A	15070, 11955, 11750, 9640, 9510, 6195
4:00-4:15 a.m.	0900-0915	R. Japan[4]	B	9505
4:00-4:30 a.m.	0900-0930	UN Radio	B	15250, 9565, 9350-SSB (Sat.)
4:00-5:00 a.m.	0900-1000	R. Andorra	C	15026 (varies) (Sun.)
4:00-5:30 a.m.	0900-1030	R. Australia	B	15115
4:00-6:00 a.m.	0900-1100	AFRTS	A	11805, 9700, 9530, 9590, 6030
4:15-6:00 a.m.	0915-1100	BBC	C	17790, 17695, 15070, (21660 Sat. & Sun.)
4:30-5:15 a.m.	0930-1015	V. of the Malayan Revolution	C	15790, 11830
4:30-5:30 a.m.	0930-1030	V. of Germany	C	17780, 11850
4:45-7:15 a.m.	0945-1215	R. New Zealand	C	6105
5:00-5:15 a.m.	1000-1015	UN Radio	A	15250, 11090-LSB† 9565, (Sat.)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12033, 10010
5:00-6:00 a.m.	1000-1100	R. Korea	C	11725, 9570, 9870, 15575
5:00-fade out	1000	R. Australia	B	6045, 5995
5:00-8:00 a.m.	1000-1300	R. Moscow (via Cuba)	B	9600, 600 (5045 -1100)
5:00-11:02 a.m.	1000-1602	ABC, Perth	B	9610, 6140
5:20-5:30 a.m.	1020-1030	V. of Guatemala	B	6180, 640 (time varies widely)
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:30-7:00 a.m.	1030-1200	V. of Asia, Taiwan	D	5980 (Sun. 1030-1040) (time varies)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9655
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:30 a.m.	1100-1130	V. of Vietnam	C	12035, 10010
6:00-6:30 a.m	1100-1130	R. Mogadishu	D	9585
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790, 21535
6:00-7:00 a.m.	1100-1200	V. of Nigeria	C	15119, 17800
6:00-7:00 a.m.	1100-1200	AFRTS	A	6030
6:00-7:30 a.m.	1100-1230	TWR-Bonaire	A	11815 or 15255
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	9977
6:00-8:00 a.m	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A B	25650, 21710, 21660, 21550, 11775, 11750, 9740, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	C	11835, 9770
6:00-10:00 a.m.	1100-1500	VOA	B	11715, 9565
6:00-11:00 a.m.	1100-1600	AFRTS	A	15430, 15330, 11805, 9700
6:15-6:30 a.m.	1115-1130	Vatican R.	C	21485, 17840 (not Sun.)
6:28-9:00 a.m.	1128-1400	CBC Northern Service	B C	9625, 6065 (not all Eng.) (one hour earlier from Apr. 26)
6:30-6:55 a.m.	1130-1155	R. Nacional, Angola	D	11955, 9535 (Mon.-Fri.)
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:15 a.m.	1200-1215	V. of Kampuchean People	C	11938, 9694 (vary)
7:00-7:20 a.m.	1200-1220	Vatican R.	B	21485 17840 (not Sun.)
7:00-7:30 a.m.	1200-1230	Kol Israel	C	25640, 17612.5, 21675
7:00-7:30 a.m.	1200-1230	R. Finland	B	15400, (one hour later in March)
7:00-7:30 a.m.	1200-1230	R. Norway	C	21730, 25730, (Sun.)
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	11785, 9540, 15460
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17875, 17765, 15410
7:00-7:55 a.m.	1200-1255	R. Peking	B	15520 or 11945
7:00-8:00 a.m.	1200-1300	V. of Turkey	D	15185, 9560
7:00-8:00 a.m.	1200-1300	HCJB, Ecuador	A	26020, 15115, 11740
7:00-10:00 a.m.	1200-1500	R. Moscow World Service	B	17810, 15150, 7370
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	C	11825, 6383 or 4850 or 7235† (not Sun.)
7:30-7:55 a.m.	1230-1255	Austrian R.	B	21655
7:30-7:55 a.m.	1230-1255	R. Tirana	D	11965 or 11960, 9515
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21690
7:30-8:00 a.m.	1230-1300	BBC (English by radio)	C	21695
7:30-8:00 a.m.	1230-1300	R. Bangladesh	C	21770 or 21670, 15285
7:30-8:30 a.m.	1230-1330	TWR, Bonaire	A	15255 (Sat.; Sun.-1415)
7:30-8:30 a.m.	1230-1330	R. Korea	C	11830, 7550
7:30-8:30 a.m.	1230-1330	R. Finland	B	15400 (Sun.) (one hour later in March)
7:30-8:30 a.m.	1230-1330	R. Maldives	D	4754
7:30-10:51 a.m.	1230-1551	WYFR, Family Radio	A	21615, 17845 (Sun. only)
7:35-7:45 a.m.	1235-1245	V. of Greece	C	21455, 17830, 11730 (Mon.-Fri.)
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:20 a.m.	1300-1320	R. Canada International	A	17860, 15540, 11955, 9575 (Mon.-Fri.) (one hour earlier from Apr. 27)
8:00-8:30 a.m.	1300-1330	R. Bucharest	C	17850, 15250, 11940
8:00-8:45 a.m.	1300-1345	R. Berlin International	C	21540, 21465, 17700
8:00-9:00 a.m.	1300-1400	R. Australia	C	11705, 9770, 6080
8:00-9:30 a.m.	1300-1430	HCJB, Ecuador	A	26020, 17890, 15115, 11740
8:00-10:57 a.m.	1300-1557	R. RSA	B	25790, 21535, 15220
8:00-12:00 a.m.	1300-1700	WYFR, Family Radio	A	11830 (Sun. 1230-)
8:15-8:45 a.m.	1315-1345	Swiss R. International	B	21570, 21520
8:30-9:00 a.m.	1330-1400	R. Finland	B	21475, 15400 (one hour later in March)
8:30-9:00 a.m.	1330-1400	NYAB, Bhutan	D	4692 (Wed. & Fri. irreg.)
8:30-9:20 a.m.	1330-1420	R. Nederland	C	17605
8:30-9:30 a.m.	1330-1430	V. of Turkey	C	15125
8:30-9:30 a.m.	1330-1430	V. of Vietnam	C	10010
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B C	25650, 21710, 21660, 21550, 21470, 15400 (from 1430), 15070
8:30 a.m.-fade	1330	R. Australia	B	6060

NORMARK®
Introduces
Factory Accessories For The Do-It-Yourselfer:

Power Windows

Power Door Locks

Automatic Headlight Control

Lights-On Alarm

Wiper Delay Control

Power Trunk/ Hatchback Release

Low Washer Fluid Alarm

Low Coolant Level Alarm

Low Fuel Alarm

Electronic Dipstick™

Normark has just what your car, truck or van needs. Write for a complete catalog and name of your local dealer.

NORMARK
Manufacturing Corporation
2000 Hurd Drive
Irving, Texas 75062
(214) 659-1800

CIRCLE NO. 42 ON FREE INFORMATION CARD

www.americanradiohistory.com

Talking Clocks
Video Recorders
Thinking Thermostats
Hit Movie Cassettes
Sleep Machines

FREE Catalogue

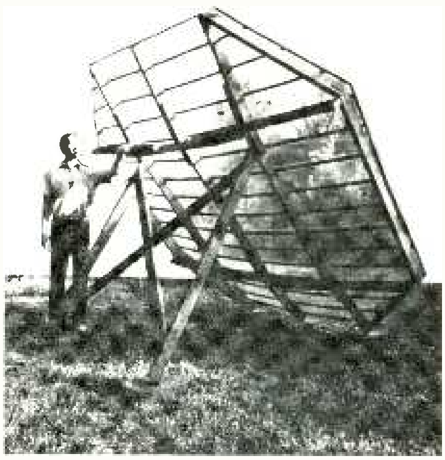
☐ Please send me my FREE copy of THE HIGH TECHNOLOGY CATALOGUE℠. And reward my quick response by including my FREE $5 Gift Certificate!

Name ____________
Address ____________
City ____________
State ________ Zip ________
I now own: ☐ Home Video Recorder
☐ Personal Computer

inovision™
AN EDS CORPORATION
Mail to Inovision, P O Box 400040
Dept PE481, Dallas, TX 75240

CIRCLE NO. 29 ON FREE INFORMATION CARD

Enjoy Satellite TV Now



Better than Cable TV— Over 200 TV and radio services. Why waste money? Learn the whole story and build a video system the family can enjoy. No commercials, **FREE** movies, sports and Vegas shows—world wide, crystal clear reception connects to any TV set. Big (8 x 11 in.) book loaded with details, photos, plans kits—

TELLS EVERYTHING. Satisfaction Guaranteed.

GLOBAL TV ELECTRONICS
P.O. Box 219-K, Maitland, Florida 32751
Send $7.95 Today! Add $2.00 for 1st class (airmail)
or call our 24 hour C.O.D. Rush order line (305) 862-5068
Name ____________
Full Address ____________

8:30 a.m.-5:00 p.m.	1330-2200	R. Moscow World Service (via Cuba)	B	11840 or 11860
8:35-9:05 a.m.	1335-1405	BRT, Belgium	B	21525 (Mon.-Fri.)
8:57-11:55 a.m.	1357-1655	V. of Philippines	D	9578 (Sun.-1555) (not all English)
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	15175, 21730 (Sun. only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	11785, 9540, 15460
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	15200, 11715
9:00-12:00 a.m.	1400-1700	CBC Southern Service	A	17820, 11955 (Sun.) (one hour earlier from Apr. 26)
9:00-12:30 a.m.	1400-1730	R. Australia	C	17795, 9770
9:00 a.m.-6:00 p.m.	1400-2300	CBC Northern Service	B-C	11720, 9625 (not all English) (from 1300 as of Apr. 26)
9:30-10:00 a.m.	1430-1500	KTWR, Guam	B	9510†
9:30-10:25 a.m.	1430-1525	R. Nederland	B	21480, 11735
9:30-11:00 a.m.	1430-1600	HCJB, Ecuador	A	26020, 17890, 15115
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985, 5040
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (when in session)
9:35-10:20 a.m.	1435-1520	R. Nepal	D	3425 or 7105 or 9589
9:50-10:35 a.m.	1450-1535	V. of the Malayan Revolution	C	15790, 11830
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-10:30 a.m.	1500-1530	V. of Asia, Taiwan	C	5980
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9560
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 15260 (Sat, Sun)
10:00-11:00 a.m.	1500-1600	R. Moscow	B	15150
10:00-12:30 a.m.	1500-1730	BSHKJ, Jordan	D	9560
10:30-11:00 a.m.	1530-1600	R. Afghanistan	D	4775 or 6230
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15300, 15240
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	15012, 10040
10:35-10:45 a.m.	1535-1545	V. of Greece	C	21555, 17830, 11730 (Mon.-Fri.)
10:45-11:00 a.m.	1545-1600	R. Canada International	A	(17820 Mon.-Sat.), 21695, 15325
11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	Vatican R.	C	17730
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21755, 21605, 21486, 17910, 17660†
11:00-11:30 a.m.	1600-1630	R. Norway	B	21730, 17795, 15175 (Sun. only)
11:00-11:30 a.m.	1600-1630	R. Portugal	C	21530 (not Sun.)
11:00-12:00 a.m.	1600-1700	R. Korea	B	11830, 9720
11:00 a.m.-12:09 p.m.	1600-1709	BBC	B	21710, 17830, 15260
11:00 a.m.-1:00 p.m.	1600-1800	AFRTS	A	15430, 15330, 11805
11:00 a.m.-4:00 p.m.	1600-2100	R. Moscow World Service	B	11860 †
11:00 a.m.-6:00 p.m.	1600-2300	VOA	A	26040, 21660, 21485, 17870, (15250 from 1900) 15445, (15410 to 2200)
11:05-11:55 a.m.	1605-1655	R. France International	B	21620, 21580, 21515, 17860 (one hour later in March)
11:10-11:55 a.m.	1610-1655	BRT, Belgium	C	21525† (one hour later in March)
11:30 a.m.-1:00 p.m.	1630-1800	R. Nacional Angola	D	11955, 9535, 7245 (Sun. from 1600)
-11:30 a.m.	1630	R. Singapore	C	11940, 9530, 5052, 5010 (fade in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	17820 (Mon.-Sat.), 15325, 21695
11:45-12:45 p.m.	1645-1745	R. Pakistan	C	15485 or 9460 and 9425, 11675†
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:30 p.m.	1700-1730	HCJB, Ecuador	B	26020, 21480, 17790†
12:00-1:00 p.m.	1700-1800	WYFR, Family Radio	A	21615, 17845, 17735, 15440, 11830
12:00-3:00 p.m.	1700-2000	4VEH, Haiti	C	11835, 9770 (Sun.)
12:00-5:00 p.m.	1700-2200	VOA	B	17785, 15205, 11760, 9760, (15140 from 1830)
12:09-12:45 p.m.	1709-1745	BBC	B	17830, 15260
12:15-1:05 p.m.	1715-1805	V. of Germany	C	21600
12:45-3:00 p.m.	1745-2000	BBC	C	17705, 15400, 15070, 12095 (11820 from 1800)
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	A	17820, 15260 (Sat. & Sun. - 1900)
1:00-1:30 p.m.	1800-1830	R. Norway	C	17840, 17715 (Sun. only)
1:00-2:00 p.m.	1800-1900	V. of Vietnam	C	10040
1:00-2:00 p.m.	1800-1900	WYFR, Family Radio	A	21615, 17735
1:00-2:00 p.m.	1800-1900	V. of Nigeria	C	15119, 15185, 17800
1:00-3:00 p.m.	1800-2000	R. Australia	C	21630, 17795
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	11650
1:00-5:00 p.m.	1800-2200	B.S.K. Saudi Arabia	C	11854
1:00-5:00 p.m.	1800-2200	AFRTS	A	15430, 15330, 15345
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	21570, 17830, 17850
1:15-2:15 p.m.	1815-1915	R. Bangladesh	D	15100, 11765 (both vary)†
1:30-1:35 p.m.	1830-1835	UN Radio	A	19505-SSB, 15410, 11960, 17740, 15305 (Mon.-Fri.)
1:30-1:57 p.m.	1830-1857	Austrian Radio	C	15560 (Sun. from 1805)
1:30-2:00 p.m.	1830-1900	V. of Revolution, Guinea	C	15313 (varies) 9650 (Mon. Wed. and Fri.) (irregular)
1:30-2:30 p.m.	1830-1930	V. of Iran	D	9022
1:45-2:15 p.m.	1845-1915	Sri Lanka Br. Corp.	C	17850, 15120, 15115, 11870
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc. Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	B	15270
2:00-2:30 p.m.	1900-1930	R. Canada International	A A	21695, 17875, 15325 (Sat. & Sun. -2000) 17820, 15260 (Mon.-Fri.)
2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	15079 (varies) or 17742†
2:00-3:00 p.m.	1900-2000	HCJB, Ecuador	C	26020, 21480, 17790†, 15295†
2:00-3:00 p.m.	1900-2000	WYFR, Family Radio	A	21615, 15130, 11830
2:00-4:00 p.m.	1900-2100	R. Nacional, Brazil	C	17810, 15125
2:35-5:00 p.m.	1935-2200	TIFC, Costa Rica	C	9645 (Sun.)
2:45-4:15 p.m.	1945-2115	R. Free Grenada	C	15104 (time varies and irregular)
3:00-3:15 p.m.	2000-2015	R. Japan	B	15270
3:00-3:30 p.m.	2000-2030	R. Norway	C	11895, 11860 (Sun.)
3:00-3:30 p.m.	2000-2030	R. Canada International	A	21695, 17875, 17820, 15325 (Mon.-Fri.)
3:00-3:30 p.m.	2000-2030	Kol Israel	C	17685, 15105, 9815, 9425, 9009

www.americanradiohistory.com

3:00-4:00 p.m.	2000-2100	WYFR Family Radio	A	21615, 21525, 15130, 11830
3:00-4:15 p.m.	2000-2115	BBC	A	15260, 15070, 11750
3:00-12:00 p.m.	2000-0500	R. Moscow (via Cuba)	C	600
3:10-4:40 p.m.	2010-2140	R. Habana Cuba	A	15155 or 11920
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21685, 17695, 17605, 15220, 9715
3:30-4:30 p.m.	2030-2130	V. of Vietnam	C	15012, 10040†
3:30-4:30 p.m.	2030-2130	V. Turkey	C	9725†
3:45-5:30 p.m.	2045-2230	All India R.	C	15110
3:50-4:00 p.m.	2050-2100	R. Free Europe	C	17835, 15420 or 15290, 11825 † (Fri., one hour later in March)
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 9770
4:00-4:15 p.m.	2100-2115	R. Japan	B	15270
4:00-4:30 p.m.	2100-2130	R. Algiers	C	21725 or 21635, 15307 (varies)† (one hour earlier from May)
4:00-4:50 p.m.	2100-2150	R. RSA	B	17775, 15155, 11900
4:00-5:00 p.m.	2100-2200	V. of Nigeria	C	15185, 15119, 17800
4:00-5:00 p.m.	2100-2200	R. Moscow	C	21530, 15455
4:00-5:00 p.m.	2100-2200	WYFR, Family Radio	A	21615, 21525, 15170
4:15-6:00 p.m.	2115-2300	BBC	A	15260, 15070, 9510, 6175
4:15-7:30 p.m.	2115-2430	R. Free Grenada	B	15045 (time varies)
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17820, 17875, 15325, 15150, 11945
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	C	15280
4:30-5:00 p.m.	2130-2200	HCJB Ecuador	C	26020, 21480, 17790, 15295†
4:30-5:00 p.m.	2130-2200	R. Sofia	B	15135, 11860†
4:30-5:30 p.m.	2130-2230	R. Baghdad	C	9745
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15270, 11825
4:45-5:15 p.m.	2145-2215	Swiss R. International	B	21585
4:50-12:30 p.m.	2150-0530	R. New Zealand	C	17860
5:00-5:15 p.m.	2200-2215	R. Japan	B	17755, (via Portugal 11790†)
5:00-5:30 p.m.	2200-2230	R. Argentina	C	11710 (Mon.-Sat.)
5:00-5:30 p.m.	2200-2230	R. Norway	C	15345, 15135 (Sun. only)
5:00-6:00 p.m.	2200-2300	WYFR, Family Radio	A	21525, 15130, 11855, 9535
5:00-6:00 p.m.	2200-2300	CBC Radio	A	17875, 15325, 11780 (Mon.-Fri.) (from 2100 as of Apr. 27)
5:00-6:00 p.m.	2200-2300	R. Moscow	B	21530, 15455, 11860
5:00-6:00 p.m.	2200-2300	V. of Turkey	B	9725, 7215†
5:00-6:00 p.m.	2200-2300	R. Clarin, Dom. Rep.	B	11700 (Sat. & Sun.; irregular)
5:00-7:00 p.m.	2200-2400	AFRTS	A	25615, 21570, 15430, 15330, 15345
5:00-11:30 p.m.	2200-0430	VOA	A	21460, 17740, (26000 – 2400), (17820 0100)
5:15-5:30 p.m.	2215-2230	R. Yugoslavia	C	9620
5:30-6:00 p.m.	2230-2300	Kol Israel	A	15584, 11638, 9815
5:30-6:25 p.m.	2230-2325	R. Mexico	B	15430 (Sun. time varies)
5:45-6:00 p.m.	2245-2300	SODRE, Uruguay	C	11885, 9515 (time varies)
5:45-6:00 p.m.	2245-2300	UN Radio	A	15225, 11830 (Fri.)
6:00-6:30 p.m.	2300-2330	R. Japan	C	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	B	11705, 9695
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	15405, 11735†
6:00-7:00 p.m.	2300-2400	4VEH, Haiti	B	11835, 9770
6:00-7:00 p.m.	2300-2400	WYFR, Family Radio	A	21525
6:00-7:00 p.m.	2300-2400	R. Mexico	B	15430 (Thurs. time varies)
6:00-7:30 p.m.	2300-2430	BBC	A	15260, 15070, 11910, 9590, 9580, 9410, 7325, 6175, 6120, 5975
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	9977
6:00-8:00 p.m.	2300-0100	CBC Southern Service	A	9755, 5960 (Sat. - 2330 and Sun.- 2400) (one hour earlier from Apr. 26)
6:00-8:00 p.m.	2300-0200	R. Moscow	A	21530, 17720, 15455, 15140, 12050, 12010, 11960, 11860, 11780, 11735, 9765, 9710, 9685, 9610
6:00 p.m.-1:07 a.m.	2300-0607	CBC Northern Service	B C	9625, 6195 (not all English) (until 0507 as of Apr. 27)
6:25-7:00 p.m.	2325-2400	SODRE, Uruguay	C	11885, 9515 (time varies)
6:30-7:00 p.m.	2330-2400	HCJB Ecuador	B	26020, 15350
6:30-7:00 p.m.	2330-2400	V. of Vietnam	C	12035, 10080, 10040, 10010
6:45-7:45 p.m.	2345-2445	R. Japan	C	17825, 15270
7:00-7:15 p.m.	0000-0015	R. Japan	C	17755
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	R. Mexico	C	17765, 15430, 11770 (Sat.; freq. time changes)
7:00-7:30 p.m.	0000-0030	R. Canada International	A	9755, 5960 (from Apr. 27)
7:00-7:30 p.m.	0000-0030	Kol Israel	A	15584, 11638, 9815
7:00-7:30 p.m.	0000-0030	R. Norway	C	11870, 9590 (Mon. only)
7:00-7:45 p.m.	0000-0045	R. Berlin International	C	11970, 9730 (one hour later in March)
7:00-7:55 p.m.	0000-0055	R. Peking	B	17855, 17680, 15125
7:00-8:00 p.m.	0000-0100	WYFR, Family Radio	A	17845, 5985
7:00-8:00 p.m.	0000-0100	R. Sofia	B	9705 or 15330
7:00-8:00 p.m.	0000-0100	AFRTS	A	25615, 21570, 15330, 15345, 11790
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090 (Time varies)
7:00-9:00 p.m.	0000-0200	VOA	A	17730, 15205, 11740, 9650, 6130, 5995
7:00-12:00 p.m.	0000-0500	R. Moscow (via Cuba)	A	9600 or 6115
7:00-12:00 p.m.	0000-0500	FEBC Philippines	C	17810
7:00 p.m.-4:00 a.m.	0000-0900	UN Radio	A	6055 (when in session)
7:05-8:55 p.m.	0005-0155	Spanish Foreign R.	B	11880, 9630
7:15-8:00 p.m.	0015-0100	BRT, Belgium	C	15385 or 11695; 15175
7:25-7:40 p.m.	0025-0040	SODRE, Uruguay	C	11885, 9515 (time varies)
7:30-8:00 p.m.	0030-0100	R. Prague	C	6055
7:30-8:00 p.m.	0030-0100	R. Kiev	B	17870, 15240, 15100, 11790, 11770
7:30-8:00 p.m.	0030-0100	R. Budapest	B	17710, 15220, 11910, 9835, 9585 (Wed. and Fri.) (one hour later in March)
7:30-8:00 p.m.	0030-0100	La Cruz del Sur, Bolivia	D	4875 (Mon. only)
7:30-9:00 p.m.	0030-0200	HCJB, Ecuador	A	15155
7:30-9:30 p.m.	0030-0230	BBC	A	15260, 11835, 11750, 9580, 9410, 7325, 6175, 6120, 5975
7:35-9:30 p.m.	0035-0230	HCJB, Ecuador	B	26020, 15355, 9745
7:55-8:35 p.m.	0055-0135	TWR-Bonaire	B	11745†
8:00-8:15 p.m.	0100-0115	R. Japan	C	17755

apple computer

Complete Microprocessors line, peripherals & Terminals.

APPLE II PLUS, 48K	$1215.00	Disk130K controller	$575.00
LANG SYS W/PASCAL	395.00	SOROC IQ140	1295.00
Z-80 SOFT CARD	299.00	TI-99/4	499.00
TI-745	1440.00	TI 810	1715.00

Texas Instruments

Invest Anal	$ 44.95	Speak & Spell	$49.95
TI-55	29.95	Spelling Bee	29.95
Accessories	call us	TI Programmer	52.50
TI-58C	84.50	MBA	52.50
PC100C	149.95	TI 5100	37.50
TI-59	199.00	TI-5015	59.00
Bus Anal II	35.50	TI 5025	61.95
Lang	160.00	TI 5040	65.00

HEWLETT-PACKARD

HP-67	$299.00	HP-41C Prog	189.00
HP-97	579.00	HP 41C Printer	289.00
HP 33C	75.00	HP-41C CRD RDR	169.00
HP-34C	122.00	HP 41C Mem Module	26.00
HP-38C	114.99	HP 32E	49.00

HP-83, HP-85 and accessory - call us for prices
HP-41CV, Sys I and II and Quad Ram - call us for prices

SCM TYPEWRITER SPECIALS

SCM 2200	$269.00	INTREPID	$274.00
SCM-2500	285.00	CLASSIC 12	144.00

All units shipped in original cartons with accessories according to manufacturer's specification. Send money orders, personal check (2 weeks to clear). In Illinois add 6% sales tax. Add $5.95 minimum shipping & handling charges per unit. We ship UPS. Subject to availability. Written warranty for specific products can be obtained free upon request. Above prices are for mail order and prepaid only. Prices and specifications subject to change without notice. Send mail orders

Nabih's, Inc.

519 DAVIS, EVANSTON, ILL. 60201 TEL.: 312-869-6144

AMAZING DEVICES

(((((PHASERS)))))

PPF-1 *PHASER PAIN FIELD* — This device recently developed and patented in our labs is being evaluated by law enforcement agencies for riot and crowd control. It is now available but soon will come under the jurisdiction of weapons and internal machine control making it unavailable to the public. The device is hand-held and looks like a BUCK ROGERS ray gun. It is hazardous if not used with discretion.
PPF-1 PLANS **$15.00**

IPG-1 *INVISIBLE PAIN FIELD GENERATOR* — This amazing, simple hand-held device is about the size of a pack of cigarettes and generates a directional field of moderate to intensive pain in the lower part of the head up to a range of 50'. Device is simple and economical to make.
IPG-1 PLANS **$8.00** **IPG-1K** ALL PARTS **$39.50**
IPG-10 ASSEMBLED & TESTED FOR ANIMAL CONTROL **$49.50**

LASERS

RUBY LASER RAY PISTOL — Produces highly intense red beam capable of burning. A hazardous device. PLANS PARTS SOURCES **$15.00**

HIGH POWERED CARBON DIOXIDE BURNING AND CUTTING Complete plans and all parts sources **$15.00**

SOLID STATE IR 12 WATTS with built in power supply plans **$8.00** Complete kit with collimator **$74.00**

POCKET LASER pulsed, visible red plans **$7.00** Complete kit **$59.50** Also complete plans and parts sources for RUBY, YAG, NEODYNIUM, HeNe, ARGON, DYE, NITROGEN and many more lasers

SECURITY

SNP-2 *SNOOPER PHONE* — Dial home or office phone while on vacation activating sensitive mike without phone ringing. Excellent property protection and intrusion device.
SNP2 PLANS **$7.00**
SNP2K ALL PARTS **$49.50**
SNP20 ASSEMBLED AND TESTED **$89.50**

LONG RANGE XMTR PLANS **$6.00**
SEE-IN-THE-DARK PLANS **$8.00**
DIRECTIONAL SHOTGUN MIKE PLANS **$7.00**
SUPER SENSITIVE PARABOLIC MIKE PLANS **$7.00**
SOUND & TELEPHONE OPERATED TAPE RECORDER **$6.00**
CATALOG ON PLANS, KITS & FINISHED UNITS **$1.00**

Send check or money order to
SCIENTIFIC SYSTEMS, Dept. Q1, Box 716
AMHERST, N.H. 03031

CIRCLE NO. 49 ON FREE INFORMATION CARD

NEW INDOOR ACTIVE ANTENNA

Covers 300 KHz - 30 MHz. For SWL, BCL, VLF DXers.

Rivals long wires

$79.95 (+ $4.00 shipping)

MFJ-1020 NEW INDOOR ACTIVE ANTENNA sits on your desk ready to listen to the world. Rivals, can often exceed, reception of outside long wire. Unique **Tuned** Active Antenna minimizes intermod, provides RF selectivity, reduces noise outside tuned band. Also use as preselector for external antenna. Covers 300 KHz to 30 MHz in five bands. Adjustable telescoping antenna. Controls: Tune, Band Selector, Gain, On-Off/Bypass. LED. FET, bipolar circuitry. Phono jack for external ant. 6x2x6 inches. 9-12 VDC or 9 V battery for portable use. 110 VAC with optional AC adapter. $7.95.

Order from MFJ and try it. If not delighted, return within 30 days for refund (less shipping).

One year unconditional guarantee.

Order yours today. Call toll free 800-647-1800. Charge VISA, MC. Or mail check, money order.

CALL TOLL FREE ... 800-647-1800

MFJ Enterprises, Inc.
BOX 494, MISS. STATE, MS 39762

CIRCLE NO. 37 ON FREE INFORMATION CARD

FIREWORKS

NO MINORS

MAJOR CREDIT CARDS ACCEPTED

THOUSANDS OF ITEMS TO CHOOSE FROM

Full Color Catalog Kit
$2.00
Refundable with First Order

CALL TOLL FREE 1-800-321-6001

FIREWORKS UNLIMITED
8550 ROUTE 224
DEERFIELD, OHIO 44411

CIRCLE NO. 19 ON FREE INFORMATION CARD

8:00-8:15 p.m.	0100-0115	Vatican R	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	11800, 9575
8:00-8:25 p.m.	0100-0125	Kol Israel	A	15584, 11638, 9815
8:00-8:30 p.m.	0100-0130	R. Argentina	B	11710 (not Mon.)
8:00-8:00-8:30 p.m.	0100-130	R. Mexico	B	15430 (Sun., time varies)
8:00-8:30 p.m.	0100-0130	R. Budapest	B	17710, 15220, 11910, 9835, 9585 (not Mon.) (one hour later in March)
8:00-8:30 p.m.	0100-0130	R. Canada International	A	17820, 9755, 5960
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 9740, 9540, 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	17855, 17680, 15125
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15345, 11825
8:00-9:00 p.m.	0100-0200	AFRTS	A	25615, 21570, 11790, 6030
8:00-9:00 p.m.	0100-0200	WYFR, Family Radio	B	11710
8:00-10:30 p.m.	0100-0330	R. Australia	B	21740, 17795
8:00-11:50 p.m.	0100-0450	R. Habana Cuba	B	11930, 11725
8:20 p.m.-12:10 a.m.	0120-0510	R. Belize	C	3285, 834
8:20-8:50 p.m.	0120-0150	V. of Germany	A	15105, 11865, 9565, 9545, 6145, 6100, 6085, 6040
8:30-8:45 p.m.	0130-0145	V. of Greece	B	11730, 9655, 9515 (not Sun.)
8:30-8:55 p.m.	0130-0155	Austrian Radio	B	9770, 5945
8:30-8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
8:30-9:15 p.m.	0130-0215	R. Berlin International	C	11970, 9730 (one hour later in March)
8:30-9:30 p.m.	0130-0230	R. Japan	C	21640, 17825, 17725, 15235
8:45-9:15 p.m.	0145-0215	Swiss R. International	A	15305, 11715, 9725, 6135
9:00-9:15 p.m.	0200-0215	R. Japan	C	17755
9:00-9:25 p.m.	0200-0225	Kol Israel	A	15584, 11638, 9815
9:00-9:30 p.m.	0200-0230	R. Canada International	A	11940, 9605, 5960
9:00-9:30 p.m.	0200-0230	R. Norway	B	11850, 9685, 9590 (Mon. only)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6000†
9:00-9:40 p.m.	0200-0240	R. Polonia	C	15120, 11815, 9525, 7270, 7145, 6135, 6095 (length varies)
9:00-9:50 p.m.	0200-0250	R. RSA	B	15325, 11900, 9585
9:00-9:55 p.m.	0200-0255	R. Bucharest	C	11940, 11840, 11735, 9690, 9570, 5990
9:00-9:55 p.m.	0200-0255	R. Peking	B	17855, 17680, 15120
9:00-10:00 p.m.	0200-0300	WYFR, Family Radio	A	11710, 5985
9:00-10:00 p.m.	0200-0300	R. Nacional, Brazil	A	15290, 17830
9:00-10:30 p.m.	0200-0330	R. Cairo	B	12050, 9475
9:00-11:00 p.m.	0200-0400	R. Moscow	A	17720, 15455, 15140, 12050, 12010, 11960, 11860, 11780, 9765, 9710, 9700, 9685, 9610, (9580 from 0330), 9530
9:00-11:00 p.m.	0200-0400	VOA	A	15205, 9650, 5995
9:00-11:30 p.m.	0200-0430	AFRTS	A	21570, 17765, 11790, 6030
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17835, 21745†
9:30-9:45 p.m.	0230-0245	UN Radio	A	15240, 6035, 15685-SSB 10869-SSB (Sat.)
9:30-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
9:30-10:00 p.m.	0230-0300	R. Lebanon	C	15170 or 11820† (time varies)
9:30-10:00 p.m.	0230-0300	R. Finland	C	11735, 9645 or 15400† (one hour earlier in March)
9:30-10:00 p.m.	0230-0300	R. Sweden	C	11705, 9695
9:30-10:15 p.m.	0230-0315	R. Berlin International	B	11975, 11890, 11840 (one hour later in March)
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
9:30-10:30 p.m.	0230-0330	R. Korea	C	15575, 11810
9:30-10:30 p.m.	0230-0330	BBC	A	11750, 9580, 9410, 7325, 6175, 6120, 5975
9:30-12:00 p.m.	0230-0500	HCJB, Ecuador	A	15155, 9745, 11915, 26020
10:00-10:15 p.m.	0300-0315	R. Japan	C	17755
10:00-10:15 p.m.	0300-0315	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6000† (Wed. & Fri.; Mon. -0430) (one hour later in March)
10:00-10:25 p.m.	0300-0325	R. Polonia	C	15120, 11815, 9525, 7270, 7145, 6135, 6095 (length varies)
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11940, 11845, 9605, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11925, 6185 or 15125†
10:00-10:30 p.m.	0300-0330	R. Kiev	B	17870, 15100, 15240, 11790, 9665
10:00-10:30 p.m.	0300-0330	R. Australia	C	15260 (Fri.)
10:00-10:50 p.m.	0300-0350	V. of Free China	C	17890, 15270, 11825
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9740, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17855, 17680, 15120
10:00-11:00 p.m.	0300-0400	TIFC Costa Rica	C	9645, 5055, (Mon. 0235-0435)
10:00-11:00 p.m.	0300-0400	R. Baghdad	D	11935
10:00-11:15 p.m.	0300-0415	R. Uganda	B	15325 (irregular)
10:00-11:26 p.m.	0300-0426	R. RSA	B	15220, 11900, 9585, 7270
10:00-11:30 p.m.	0300-0430	R. Cultural, Guatemala	B	3300 (Mon. 0030–)
10:00 p.m.-1:00 a.m.	0300-0600	HRVC, Honduras	B	4820
10:00 p.m.-1:00 a.m.	0300-0600	WYFR, Family Radio	A	11810, 5985
10:00 p.m.-2:30 a.m.	0300-0730	VOA	A	15330, 15245, 9670, 6040, 6035, 5995
10:25 p.m.-fade	0325-	R. One, Zimbabwe	C	3396 (exc. Sun.)
10:30-10:45 p.m.	0330-0345	U.A.E. Radio Dubai	B	21700, 11755, 9505
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 5945
10:30-11:00 p.m.	0330-0400	R. Australia	B	21680, 17890, 17870, 17795, 17725
10:30-11:45 p.m.	0330-0445	BBC	A	9410, 6175, 6120, 5975
10:30-12:00 p.m.	0330-0500	AWR Guatemala	C	5980†
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760, 11725
10:40-10:47 p.m.	0340-0347	V. of Greece	B	11730, 9650, 9515 (not Sun.)
10:50-11:10 p.m.	0350-0410	RAI, Italy	C	11905, 17795, 15330
10:51-10:58 p.m.	0351-0358	V. of Yerevan	C	17870, 15405, 15100
11:00-11:15 p.m.	0400-0415	R. Japan	C	17755
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	11940, 11840, 11735, 9690, 9570, 5990

www.americanradiohistory.com

11:00-11:30 p.m.	0400-0430	R. Canada International	A	11845, 9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	C	11895, 6185 (Mon. only)
11:00-11:30 p.m.	0400-0430	R. Mozambique	C	4855, 3265
11:00-11:55 p.m.	0400-0455	R. Peking	B	17680, 15230, 15120
11:00-12:00 p.m.	0400-0500	R. Australia	B	21680, 21650, 21525, 17890, 17870, 17795, 17755, 17725, 15320, 15240, 15160
11:00 p.m.-1:00 a.m.	0400-0600	R. Moscow World Service	B	17880, 15460, 9800, 9610,
11:00 p.m.-3:00 a.m.	0400-0800	R. Moscow	B	15470, 15455, 12050, 12010, 9580
11:05-11:50 p.m.	0405-0450	FEBA, Seychelles	C	11850†
11:30-11:55 p.m.	0430-0455	Austrian R.	B	12015
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	11715, 9725
11:30-12:00 p.m.	0430-0500	R. Sofia	B	9765 or 9530 or 11750†
11:30 p.m.-2:00 a.m.	0430-0700	AFRTS	A	11790, 6030
11:45-12:00 p.m.	0445-0500	Vatican Radio	C	6210 or 6190 (one hour later in March)
11:45 p.m.12:45 a.m.	0445-0545	BBC	A	9510, 6175, 5975, 9410
11:55 p.m.-1:00 a.m.	0455-0600	V. of Nigeria	C	7255
12:00-12:15 a.m.	0500-0515	Kol Israel	B	15105, 11960, 11638, 9009†
12:00-12:15 a.m.	0500-0515	R. Japan	C	15270
12:00-12:30 a.m.	0500-0530	R. Portugal	B	9575 or 11925, 6185
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17890, 17870, 17725, 15240, 15160
12:00-2:00 a.m.	0500-0700	HCJB, Ecuador	B	9745, 6095, 11915, 26020
12:00-3:00 a.m.	0500-0800	R. Kuwait	C	21545
12:00-5:00 a.m.	0500-1000	V. of Cuba	B	550 or 600
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	11880, 9630
12:22-12:30 a.m.	0522-0530	UN Radio	A	9540, 6055 (Tue.-Sat.)
12:30-12:40 p.m.	0530-0540	R. Garoua, Cameroon	C	5010
12:30-12:50 a.m.	0530-0550	V. of Germany	A	11905, 9650, 9545, 6100, 5960
12:30-fade	0530-	R. Ghana	C	3366, 4915
12:30-1:25 a.m.	0530-0625	R. Nederland	B	9715, 6165
12:40-7:15 a.m.	0540-1215	R. New Zealand	C	11945
12:45-1:00 a.m.	0545-0600	UN Radio	A	9540, 6055 (Tue.-Sat.)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 11860, 9640, 9510, 9410, 7150, 6175
1:00-1:15 a.m.	0600-0615	R. Japan	C	15270
1:00-1:30 a.m.	0600-0630	V. of Germany	C	17875, 15275, 11905, 11765, 9700
1:00-1:30 a.m.	0600-0630	R. Norway	B	9645, 15175 (Mon. only)
1:00-1:30 a.m.	0600-0630	R. Australia	C	21680, 21525, 17870, 17795, 17755, 17725, 15240, 15160
1:00-3:00 a.m.	0600-0800	V. of Nigeria	C	15185, 15119, 17800
1:15-1:30 a.m.	0615-0630	R. Canada International	B	17860, 15265, 11960, 11825, 9760, 9590, 6140, 6045 (Mon-Fri)
1:25-3:00 a.m.	0625-0800	TWR, Monte Carlo	B	9495† (one hour later in March)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Australia	B	21680, 17870, 17725, 15240, 15115
1:30-2:00 a.m.	0630-0700	Radio Polonia	B	9675, 7270
1:30-2:30 a.m.	0630-0730	R. RSA	B	21535, 17780, 15220
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:45-2:00 a.m.	0645-0700	R. Canada International	B	17860, 15265, 11960, 11825, 9760, 9590, 6140, 6045 (Mon-Fri)
1:45-2:00 a.m.	0645-0700	UN Radio	A	15125, 11735 (Sat.)
1:57-4:55 a.m.	0657-0955	V. of Philippines	C	9578 (not all English)
2:00-2:15 a.m.	0700-0715	R. Japan	C	15270, (15130† via Portugal)
2:00-2:30 a.m.	0700-0730	Swiss Radio Int.	C	21520, 15305, 9535, 6165
2:00-3:00 a.m.	0700-0800	Xandir Malta	C	9670 (Sat.) (irregular)
2:00-3:00 a.m.	0700-0800	ELWA, Liberia	C	11830
2:00-3:00 a.m.	0700-0800	V. of Vietnam	C	7512, 9840, 6383
2:00-3:30 a.m.	0700-0830	HCJB, Ecuador	C	11835, 9760†
2:00-4:00 a.m.	0700-0900	R. Australia	B	21680, 17725, 15115, 11740, 9570
2:00-5:30 a.m.	0700-1030	HCJB, Ecuador	C	11900, 9745, 6130
2:07-2:15 a.m.	0707-0715	UN Radio	A	17815, 15195 (Sat.)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510
2:30-6:30 a.m.	0730-1130	Solomon Isl. Broadcasting	C	9545 or 5020 (Not all Eng.)
2:30-9:00 a.m.	0730-1400	NBC, Dapua, N. Guinea	C	4890, 3925 (not all Eng.)
2:30-9:02 a.m.	0730-1402	ABC Melbourne	C	9680
2:37-2:45 a.m.	0737-0745	UN Radio	A	17815, 15195 (Sat.)
2:45-4:30 a.m.	0745-0930	KTWR, Guam	B	11840
2:55 a.m.-fade	0755-	Action Radio, Guyana	C	5950
2:55-3:05 a.m.	0755-0805	V. of Guatemala	B	6180, 640 (time varies)
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:00-3:30 a.m.	0800-0830	R. Norway	C	9590 (Sun.)
3:00-315 a.m.	0800-0815	UN Radio	A	17860, 15235, 15125, 11735 (Sat.)
3:00-4:00 a.m.	0800-0900	R. Korea	B	15575, 11810, 9870
3:00-9:00 a.m.	0800-1400	R. East Coast Commercial	D	11578† (Sat.)
3:30-3:35 a.m.	0830-0835	UN Radio	A	15250, 10385, 9565 (Sat.)
3:30-3:45 a.m.	0830-0845	R. Vanuatu	C	7260, 3945
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715
3:30-5:00 a.m.	0830-1000	FEBC, Philippines	C	11890 or 11765
24 Hours	24 Hours	CFRX, Toronto	C	6070

Explanatory Notes.

1. Times in first column are EST/CDT. For AST add 1 hour, CST/MDT, subtract 1 hour, MST/PDT, subtract 2 hours, PST, subtract 3 hours. Days of week are in GMT.
2. Quality.A–strong signal and very reliable reception. B–regular reception. C–occasional reception under favorable conditions. D–rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" on R. Canada International for late changes. Saturday at 2130; Sunday at 1930; GMT Mondays at 0100 (from April 27, 0060 and 0400.
4. R.–Radio; V.–Voice

† = frequent changes

SEE YOUR DEALER TODAY

DEMAND THE ORIGINAL

'Firestik®'

The #1 Helically Wire-Wound and Most Copied Antenna in the World!

CITIZEN BAND

2 METER • MARINE TELEPHONE
LAND MOBILE TELEPHONE

FIBERGLASS ANTENNAS AND ACCESSORIES.

CORDLESS TELEPHONE ANTENNA INCREASES DISTANCE 5 TO 10 TIMES! NEW MODEL 49 V.I.P.

SPECIAL QUOTES! ON 27 TO 1000 MHZ FIBERGLASS ANTENNAS ANYWHERE IN THE WORLD!

Dealer & Distributor Inquiries Invited
SEND FOR FREE CATALOG

'Firestik' Antenna Company
2614 East Adams/Phoenix, AZ 85034

Name ____
Street ____
City ____
State ____ Zip ____

Serving the CB and Communications Market Since 1962

5-YEAR REPLACEMENT WARRANTY

CIRCLE NO. 18 ON FREE INFORMATION CARD

Waiting for a lead synthesizer that has it all?

Your wait is over!

PROTEUS I™
PROGRAMMABLE PRESET LEAD SYNTHESIZER

You've always had a lot of options.

You could have the convenience and easy operation of a normalized synthesizer if you were willing to give up the versatility of modular equipment.

Or the unlimited spectrum of tone colors and timbres of modules if you didn't mind the cumbersome patch cords and time required to set up or change a patch.

You could have programmable presets if you could raise the bucks, or low-cost equipment if you could stand the snap-crackle-pop.

You could even have such technically innovative features as computer control of voice and sequence if you had the technical savy to design it all and make it work.

Now you have another option. YOU CAN HAVE IT ALL. Wide range, precise, low-noise, presets, meaningful patch bay and an easy-to-use computer interface.

All at a price that's nothing but unbelievable

Want to know more? Proteus I's Using/Assembly manual which includes a demo tape will answer all of your questions. The price, $10.00 is refundable upon purchase of either the kit or assembled model.

PART OF THE NEW GENERATION FROM

PAiA Electronics, Inc.

1020 W. Wilshire, Oklahoma City, OK 73116 - (405)843-9626
CHARGE ORDER? Call our 24 hour Demo/Order line 405-843-7396

☐ I'm convinced, send Proteus I. $699.00 enclosed. (shipped Freight Collect)
☐ Send the easy-to-assemble Proteus I Kit, $499.00 enclosed. (Freight Collect)
☐ Tell me more, Rush the Assembly/Using manual & demo tape for Proteus I. ($10.00 enclosed, refundable)
☐ Send free catalog

Name: ____
Address: ____
City: ____ State: ____ Zip: ____
Visa ____ MC ____ Card No.: ____

PAIA Electronics, Dept. 4P, 1020 W. Wilshire, Okla. City, OK 73116

CIRCLE NO. 44 ON FREE INFORMATION CARD

www.americanradiohistory.com

PROJECT OF THE MONTH

By Forrest M. Mims

A Liquid-Level Indicator for the Blind

HAVE you ever wondered how a blind person knows when to stop pouring liquid into a glass or cup? The blind people I have known usually insert a finger into the cup to the desired depth. Then they pour until they feel the liquid with their fingertip. Unfortunately, this procedure can cause discomfort if the liquid is hot, and can be socially awkward if a blind host is serving sighted guests.

The simple circuit shown in Fig. 1 will help your blind friend or relative pour liquids with relative ease and without having to touch the liquid. The circuit is inexpensive to build and uses an LM3090 LED-flasher chip as an audio oscillator. The circuit emits a tone whose frequency in part depends on the value of *C1*. When the probe leads, which parallel *C1*, are bridged by a low-to-moderate resistance, the frequency of oscillation suddenly increases. Such a probe, shown in Fig. 2, can be connected to the audio generator by a suitable length of flexible two-conductor wire.

With the value of *C1* as shown, the frequency of oscillation is about 1.6 kHz. When the probe clips were attached to the rim of a plastic cup and tap water was poured into the cup to the level of the probes, the frequency of the tone increased to approximately 3 kHz. The frequency change that your circuit exhibits might differ from these values. Different beverages have various values of conductivity and can produce different frequency changes. In any event, you will hear a distinct tone change when the liquid bridges the probe tips.

If you build this circuit for a blind friend, house it in a small plastic box. Make sure the battery holder is readily accessible, as the cells must be easily replaced by one who cannot see.

Be sure to place a raised marker at the positive end of the battery holder to indicate the correct battery orientation. A drop of paint or glue will do. Your blind friend should have little difficulty replacing the cells if *you* can do it blindfolded.

Incidentally, the liquid-level indicator can be designed to emit a tone *only* when liquid bridges the probes. I prefer the two-tone approach because the blind user always knows when the unit has been switched on and therefore will remember to turn it off when he has finished using it.

Going Further. You can add a volume control or alter the frequencies that the circuit generates or both. The former is easily accomplished by reducing the value of *R1* to 47 ohms and inserting a 1-kΩ potentiometer in series with *R1*. To alter the tone frequencies, try different values for *C1*. Increasing the value of *C1* will lower the frequency and reducing the capacitance will raise it.

The entire circuit should be self-contained and complete with battery and miniature acoustic transducer. The LM3909 can even be powered by a single 1.5-volt silver-oxide cell of the type used to power digital watches. This will allow you to assemble a miniature unit. The audio output could be provided by a miniature earphone salvaged from a discarded hearing aid. Alternatively, you can use a midget transistor-radio earphone. ◇

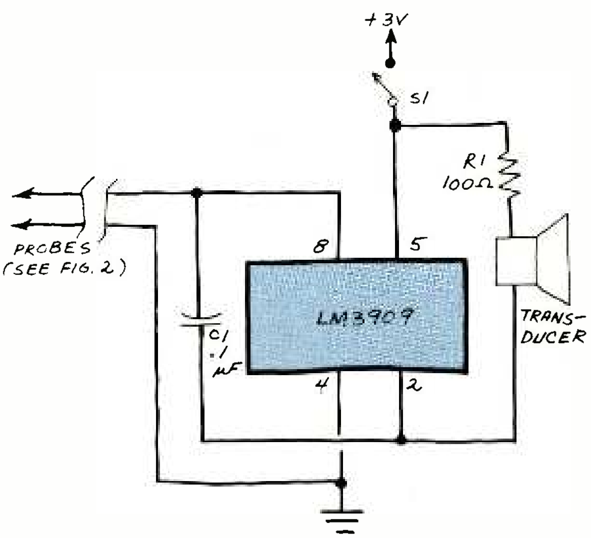


Fig. 1. Schematic diagram for a simple liquid level indicator circuit for the blind.

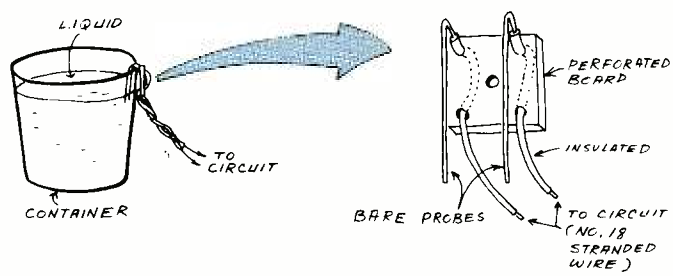


Fig. 2. How to assemble a liquid level indicator probe to fit over the edge of a container.

www.americanradiohistory.com

OPERATION ASSIST

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Howard radio model A-450. Need service manual. Stephan Selby, 7555 Decatur Road, Lot 38, Ft. Wayne, IN 46816.

Supro model S6422TR guitar amplifier. Need schematic diagram. Ed Arnold, 316 Division St., Jackson, TN 38301.

Telefunken 2550 stereo. Need schematic diagram and service information. T.F. Lindstrom, Star Route 1, Box 119AA, Bonners Ferry, ID 83805.

Kaar Engineering Corp. model TR237B radio telephone. Need manual, schematic or information on 12.6V power supply. Paul Swanson, Rt. 1, Box 78, Mason, WI 54856.

Sears model 4168 silvertone color TV. Need technical manual #94-4341.Mr. H. Singer, Box 148, Jamesburg, NJ 08831.

Accurate Instrument Co. model 257 TV. Need operations manual and instructions for testing picture tubes. Larry R. Cook, 362 East South St., Richland Center, WI 53581.

Philco model TRR-76BK tape recorder. Need motor, part #325-0076-58 or parts source. Anthony Estatico, Jr., 610 Fourth Ave., Pelham, NY 10803.

Paco model M-40 VOM. Need schematic and service manual. Bayir Sokak, 40/2, Tesvikiye, Istanbul, Turkey.

Hallicrafters model WR-600 receiver. Need operation and service manual. Robert Anderson, Area Fac Engineer, Yongan, APO San Francisco, CA 96301.

Imperial Electronics model R390-A/URR receiver. Need manual or operating instructions. M. Bloom, 311 Weymouth St, Dix Hills, NY 11746.

Webcor Regent model ED-2950 tape recorder and **Metz** stereophonic multiband console. Need schematic diagrams for both. T. Crawford, 1121 28th St., N., Fargo, ND 58102.

Crown model 5HC-47F tape recorder. Need schematic. Rodney Ring, 1690 Merchant St., S. Parks, NV 89431.

Simpson 260, series 5, VOM. Need operations manual. James Humphrey, 1006 E. 28th St., Los Angeles, CA 90011.

Hallicrafters model S-120 receiver and **Knight** star roamer. Need manuals, schematics and service information. L.R. Oliver, 4046 Twining, Riverside, CA 92509.

Cubic model V-46 APS digital voltmeter. Need schematic and operation manual. J.L. Bartha, 1539 W. Holtz Ave., Addison, IL 60101.

Army surplus RCV-XMTR RT-175A/PRC-9. Need schematic, manual or any information available on the battery for this unit. Dan Kuiper, 10562 Brewer Dr., Northglenn, CO 80234.

Zenith model 1005 radio. Need service manual, schematic and owner's manual. Stephen Marano, 290 Zimmerman Blvd., Kenmore, NY 14223.

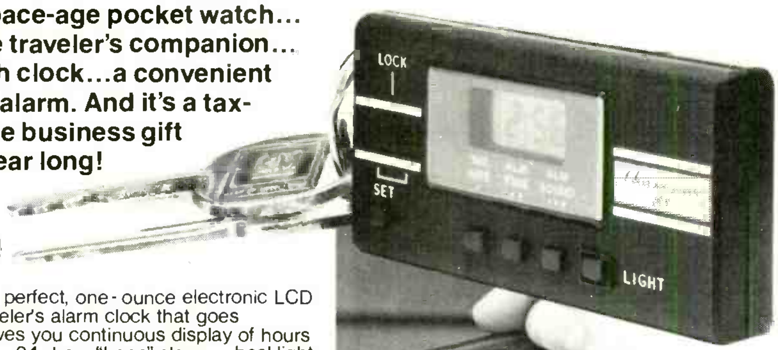
Siemens 560WO radio. Need schematic, service and assembly manuals. Andrew Rhodd, Rosemount, Linstead, St. Catherine, Jamaica, W.I.

Hy-Gain model 628 vhf-uhf monitor scanner. Need schematic. N.J. Ward, 2811 Schumacher, Mishowaka, IN 46544.

An ounce of time.

The amazing mini travelers' clock for under $20.

It's a space-age pocket watch... a bedside traveler's companion... a car dash clock...a convenient personal alarm. And it's a tax-deductible business gift idea all year long! Order a six-pack and save!



Look... the perfect, one-ounce electronic LCD read-out traveler's alarm clock that goes anywhere! Gives you continuous display of hours and minutes... 24-hour "beep" alarm... backlight for night viewing — all in a tiny, black and silver alarm clock with quartz crystal accuracy to within 20 seconds a month! And it operates on a long-life battery!

You expect $39.95? No. It's only **$19.95** plus $1.95 shipping and handling. And it's such an intriguing gift idea, we're offering a six-pack for only $99.95 plus $4.95 shipping and handling — you save $19.75! Use your Diners Club or other major credit card and call toll-free or send your check to Roy Thomas & Associates, at the address below. (Illinois residents add 6% sales tax.) You must be completely satisfied or return for a full refund after 15 days.

ACTUAL SIZE ONLY 2 9/16" x 1 1/4" x 7/16"

INCLUDED . . . matching, slip-in dash mount for your car, van or boat with adhesive backing — no electrical connections

CALL 800-621-5839
(In Illinois, call 800-972-5858)

For faster service, give this number 72-3600 when operator answers. Call 7 days, 24 hours.

RT ROY THOMAS & ASSOCIATES INC.
701 E. Prospect Avenue, Dept. 72-3600
Mount Prospect, IL 60056

A R K O N   K I T S

LED POWER METER

Uses the popular LM3915 display driver. Features switch selectable peak or average peak power level indication. The front end utilizes precision half wave rectification. LED displays included 30 db (−24 db to +3db) dynamic range $24.95

LED VU/POWER METER

Same as LED power meter but uses NSM series display. Two types: NSM 3915 — 30 db (−24 db to +3 db power) NSM 3916 — 23 db (−20 db to +3 db VU) $29.95

THE BRUTE 300 WATT AMP

This kit is not recommended for beginners or inexperienced constructors. Power output; 200 watts RMS, 8 ohms, 310 watts RMS, 4 ohm. Input sensitivity; IV for total output. This kit uses all standard parts and comes complete with instructions and printed circuit board (mono). (transformer required 100 VCT 5 amps. is available for $51.00 #167P100 .... P.C. Board $11.25

COLOUR MODULATOR

This video modulator has been designed to complement the small home computer. It allows the standard colour television to be used as a high quality colour video monitor. Uses state of the art integrated circuit technology. Direct coupling is employed to provide white level compensation in the vestigal sideband output. The gain device of the LM1889's croma oscillator is used to buffer, level shift, and invert the incoming composite colour input. The signal then passes to the RF modulator where a channel 7 carrier is provided. Requires 12 volt DC for operation $24.95

VIDEO TO RF MODULATOR

Converts a video signal to a RF signal. The RF output terminals connect to the antenna of your TV. Connecting in the video and supplying 5 to 10 volts DC is all that is needed. You turn your channel selector to 4, 5 or 6 (whichever is not used in your area) and tune the adjusting coil for a suitable display $8.95

ASCII KEYBOARD KIT

60 Key complete ASCII character set. Highest commercial quality key switches. Uses a KR2376 ST encoder IC. Output compatible with TTL. Caps lock for upper case alpha characters. Repeat key parity/data invertable. Positive and negative key pressed and strobe signals. Requires +5 volts to +30 volts at 100ma $99.95

ARKON LOGIC PROBE LOGIC I

Easy to build Logic Probe kit. A full performance logic probe. With it, the logic levels in a digital circuit translates into light from the Hi or Lo LED. Pulses as narrow as 300 nano seconds are stretched into blinks of the pulse LED's. Specs — 300K ohm imp. Power — 30ma at 5 volts, 40ma at 15 volts, 15 volts max. *Max. Speed* — 300 nano seconds 1.5 MHZ. Input Protection — +50 volts DC continuous, 117 volts AC for 15 seconds. (case included) $24.95

Send certified cheque, money order, Chargex, Master Charge...include expiry date, card number and signature. We process only prepaid orders. Minimum order $10.00 Add 5% (minimum $2.00) for shipping and handling. Ontario residents add 7% sales tax. All prices subject to change.
Dealer inquiries welcome.

arkon electronics ltd

409 Queen Street West, Toronto, Ontario Canada M5V 2A5. Tel. (416) 868-1315

CIRCLE NO. 54 ON FREE INFORMATION CARD

www.americanradiohistory.com

DIODES/ZENERS

QTY				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	15
	1N4148	75v	10mA	05
	1N4733	5.1v	1 W Zener	25
	1N4749	24v		25
	1N753A	6.2v	500 mW Zener	25
	1N758A	10v	"	25
	1N759A	12v	"	25
	1N5243	13v	"	25
	1N5244B	14v	"	25
	1N5245B	15v	"	25
	1N5349	12v	3W Zener	25

SOCKETS/BRIDGES

QTY					
	8-pin	pcb .20	ww	40
	14-pin	pcb 25	ww	.60
	16-pin	pcb 30	ww	.70
	18-pin	pcb 35	ww	.95
	20-pin	pcb .45	ww	1.05
	22-pin	pcb .50	ww	1.15
	24-pin	pcb .55	ww	1 25
	28-pin	pcb 60	ww	1 45
	40-pin	pcb 70	ww	1.75
	Molex pins .01	To-3 Sockets		.35
	2 Amp Bridge	200-prv		1.35
	25 Amp Bridge	200-prv		2.25

TRANSISTORS, LEDS, etc.

QTY			
	2N2222M (Metal)	25 (2N2222 Plastic .20)	
	2N2222A	NPN	.35
	2N2907A	PNP	.35
	2N3906	PNP (Plastic)	.25
	2N3904	NPN (Plastic)	25
	2N3054	NPN 4A 90v	60
	2N3055	NPN 15A 60v	.75
	T1P125	PNP Darlington	1.95
	LED	Green Red Clear Yellow	19
	DL747	7 seg 5/8" High com-anode	2 25
	DL 728B	doub 7 seg 5" com-cathode	2.50
	MA6740	doub 7 seg 5" com-cathode	2.50
	MAN72	7 seg com-anode (Red)	1.50
	MAN3630	7 seg com-anode ±1	1.00
	MAN82A	7 seg com-anode (Yellow)	1.50
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.50

9000 SERIES

QTY			QTY		
	9301	1.95		9322	.65
	9309	1 25		9601	.40
	9316	1.50		9602	1.35

MICROs, RAMS CPUs, E-PROMS

1771 Disc Controller	$29 50
8T13	1.50
8T23	2 50
8T24	3 00
8T97	1 50
74S188	6.50
1488	1.75
1489	1 75
1702A	8.50
AM9050/TMS4050	5.00
ICM7207	6.95
ICM7208	13.95
MM5314	4.50
MM5311	4 50
MM5316	4 50
MM5387	4.50
MM5369	3 95
TR1602B/6011	4.95
UPD414/TMS4027	3.50
Z80A	15.00
Z80	9.50
Z80PIO(A)	10 50
2102	1.45
2102L	1 75
2107B-4	5.95
2114	5.00
2513 (5V) Up/Lo	9.50
2708	6.95
2716TI	9.00
2716(5V)	12.00
TMS2532/2732	35.00
3242	12.50
4116	6.50
6800	11.50
6802	15.50
6820/6520	8.00
6850	9 95
8080	5.50
8085	14.50
8212	3.50
8214	4.95
8216	4.50
8224	4.25
8228	5.95
8251	9.50
8253	14.50
8255	9.50
TMS4044	9.95

— TTL — 4/1/81

QTY			QTY			QTY			QTY		
	7400	.35		7493	.60		74H11	.45		74LS74	.95
	7401	.25		7494	.75		74H15	.45		74LS75	.95
	7402	.35		7495	.60		74H20	35		74LS76	.90
	7403	.35		7496	.55		74H21	.35		74LS86	.95
	7404	45		74100	2.75		74H22	40		74LS90	1.85
	7405	.35		74107	.55		74H30	.40		74LS93	1.00
	7406	.55		74121	.55		74H40	.45		74LS107	.90
	7407	.65		74122	55		74H50	40		74LS109	1.00
	7408	50		74123	.70		74H51	.40		74LS123	1.20
	7409	.35		74125	75		74H52	.40		74LS138	1.00
	7410	.35		74126	.75		74H53	.45		74LS151	1.00
	7411	.35		74132	.75		74H55	45		74LS153	1.15
	7412	.35		74141	90		74H72	.45		74LS154	2.00
	7413	.45		74145	1.35		74H74	1.50		74LS157	1.75
	7414	.65		74150	1.15		74H101	.95		74LS160	1 65
	7416	.35		74151	.95		74H103	55		74LS161	1.50
	7417	.40		74153	.95		74L00	.60		74LS164	1.90
	7420	.45		74154	1.40		74L02	.75		74LS193	2.00
	7426	.35		74156	.70		74L03	35		74LS195	2.00
	7427	.40		74157	.95		74L04	.90		74LS196	2.50
	7430	.40		74161	1.50		74L10	.30		74LS244	1.50
	7432	.65		74163	1.50		74L20	.45		74LS245	3.50
	7437	.55		74164	1.50		74L30	.55		74LS253	1.95
	7438	.70		74165	1 10		74L47	1.95		74LS298	1.50
	7440	40		74166	1.10		74L51	.65		74LS367	1.50
	7441	.95		74175	.95		74L55	.85		74LS368	1.95
	7442	.95		74176	1.15		74L72	.65		74LS373	1.50
	7443	.75		74177	1.10		74L73	.70		74S00	.70
	7444	.75		74180	1.10		74L74	1.95		74S02	.90
	7445	75		74181	2.25		74L75	1.05		74S03	.45
	7446	90		74182	75		74L85	3.00		74S04	.70
	7447	1 50		74190	1 25		74L93	2.95		74S05	.65
	7448	1 50		74191	1 25		74L123	2.95		74S08	1.80
	7450	.35		74192	1.50		74LS00	.50		74S10	95
	7451	25		74193	1 50		74LS01	.60		74S11	.75
	7453	25		74194	.95		74LS02	.50		74S20	.75
	7454	.35		74195	95		74LS03	.60		74S22	.75
	7460	.40		74196	1.75		74LS04	.60		74S40	.70
	7470	.35		74197	.95		74LS05	.60		74S50	.70
	7472	.40		74198	1.50		74LS08	.60		74S51	.75
	7473	.40		74221	1.50		74LS09	.60		74S64	35
	7474	.45		74298	2.50		74LS10	.60		74S74	1.50
	7475	.45		74367	1.15		74LS11	.60		74S86	1.25
	7476	.95		75107A	1.50		74LS20	.65		74S112	1.90
	7480	.60		75451	.85		74LS21	.50		74S114	.85
	7481	.95		75452	.85		74LS22	.45		74S133	85
	7482	.95		75491	1.50		74LS27	.60		74S140	95
	7483	.75		75492	1.50		74LS32	.80		74S151	1.50
	7485	.95		74H00	.50		74LS37	.60		74S153	2.25
	7486	55		74H01	.50		74LS38	.95		74S157	2.95
	7489	1.95		74H04	90		74LS40	.70		74S158	1 75
	7490	75		74H05	55		74LS42	.75		74S194	1.75
	7491	.60		74H08	.90		74LS47	1.95		74S196	2 00
	7492	.50		74H10	.45		74LS51	.95		74S257(8123)	1.95
										74S287	5.95
										8131	2 75

C MOS

QTY			QTY			QTY			QTY		
	4000	40		4019	1.15		4041	1.15		4081	.55
	4001	.35		4020	.95		4042	.65		4082	.60
	4002	35		4021	75		4043	.90		4093	.90
	4006	1.50		4022	75		4044	.90		4098	2.25
	4007	.30		4023	35		4046	1.50		4507	.95
	4008	75		4024	.95		4047	2 50		4511	1.50
	4009	.40		4025	.35		4048	2 50		4512	1.25
	4010	35		4026	1 95		4049	.50		4515	2 95
	4011	.65		4027	.65		4050	.65		4519	85
	4012	.25		4028	95		4052	75		4522	1 10
	4013	.65		4029	1.50		4053	1.50		4526	95
	4014	75		4030	.45		4066	.75		4528	1.50
	4015	.75		4033	1.50		4069/74C04	.45		4529	95
	4016	55		4034	2.75		4070	.60		MC14409	14 50
	4017	1 50		4035	95		4071	.40		MC14419	4.85
	4018	95		4040	1.50		4072	.50		74C151	2.50

I²L, LINEARS, REGULATORS, etc.

QTY			QTY			QTY		
	MCT2(E)	1.25		LM320K24	1.65		LM373	3.95
	8038	4.50		LM320T5(7905)	1.65		LM377	2.95
	LM201	2.00		LM320T12	1.65		78L05	.95
	LM301	.95		LM320T15	1.65		78L12	.95
	LM308	1 25		LM323K	7.95		78L15	.95
	LM309H	1.50		LM324	1.00		78M05	95
	LM309(340K-5)	1.50		LM337T	2.25		LM380(8-14Pin) 386N	1.19
	LM310	.85		LM339	.95		LM709(8-14Pin)	.75
	LM311(8-14Pin)	1.50		7805(340T5)	1.50		LM711	.45
	LM317T	2.25		LM340T12	1.50		LM723	.75
	LM318N	2.15		LM340T15	1.50		LM725	3.95
	LM320H6	.89		LM340T18	1.50		LM739	1.50
	LM320H15	.89		LM340T24	1.50		LM741(8-14)	.75
	LM320H24	.89		LM340K12	1.50		LM747	1.25
	LM320K5	1.65		LM340K15	1.50		LM1307	1.75
	LM320K12	1.65		LM340K18	1.50		LM1458	.65
	LM320K15	1.65		LM340K24	1.50		LM3900	.75
							LM3909	1.50
							NE555	.50
							NE556	1.00
							NE565	1.50
							NE566	1.75
							NE567	1.50
							TA7205	4.95
							76477	2.95
							95H90	9.95
							TL081CP	.75

INTEGRATED CIRCUITS UNLIMITED, INC.

7889 Clairemont Mesa Blvd., San Diego, California 92111

Out of State 1-800-854-2211
California 1-800-542-6239

(714) 278-4394

Telex: 697-827
TWX 910-335-1577

Name ______________________________

Street Address ______________________________

City ______________________ State ______________ Zip ______________

Phone ______________ Charge card # AE VISA BA MC ______________ Exp. Date ______________

☐ C.O.D. ☐ Will Call ☐ UPS ☐ Post ☐ Net 30 Days ☐ P.O. # ______________

Add $2.00 Shipping on all U.S. Orders - $5.00 Minimum - C.O.D. Orders Accepted - Most Orders Shipped Same Day

Commercial Accounts Invited - California Residents Add 6% Sales Tax - PRICES SUBJECT TO CHANGE WITHOUT NOTICE

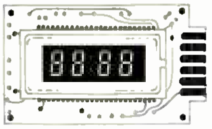
24 Hour Phone Service - We Accept American Express/Visa/BankAmeriCard/Master Card/Barclay Card/Access • 15% Restocking Charge After 10 Days

All Prices in U.S. Dollars - Foreign Orders F.O.B. San Diego

CIRCLE NO. 30 ON FREE INFORMATION CARD

www.americanradiohistory.com

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95

National Semiconductor

RAM SALE

MM5290N-4 (MK4116/UPD416) . . $4.95 each
16K DYNAMIC RAM (250NS)
(8 EACH $39.95) (100 EACH $450.00/lot)

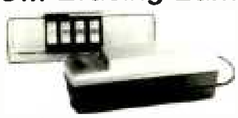
MM5290J-2 (MK4116/UPD416) . . $6.95 each
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550.00/lot)

MM5298J-3A .... $3.25 each
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH $23.95) (100 EACH $250.00/lot)

MM2114-3 .... $5.95 each
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... $6.25 each
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44.95) (100 EACH $475.00/lot)

EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E $79.95

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit

- Bright .300 ht. comm. cath-ode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3 1/8" x 1¾"

JE701 .... $19.95

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to ±15VDC.
- Power Output (each supply) 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3 terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3 1/2"w x 5 1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200	Reg. Power Supply Kit (5VDC, 1 amp)	$14.95
JE205	Adapter Brd. (to JE200) ±5,±9 & ±12V.	$12.95
JE210	Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	6.50
DP8212	8 Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	8.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8300	Octal Bus Receiver	6.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU 4-Bit Slice (Com. Temp. Grade)	19.95
MC S6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-4	MPU 8 Bit (6MHz)	16.95
INS8039N-4	CPU Sgl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-4	CPU (256 Bytes RAM)	24.95
INS8070N	CPU 64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM1402	256-Bit Dynamic	3.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5024N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024 Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512 Bit Dynamic	.99
2525V	1024 Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	19.95
LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.500m/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8 Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY 5 1013	30K BAUD UART	5.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384x1 Dynamic 350ns (house marked)	4.95
4116 (UPD416)	16K Dynamic 250ns	4.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290J-2 (4116)	16K Dynamic 150ns (UPD416)	6.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	4.95
7489	16x4 Static	1.75
UPD410/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4045	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	9.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	17.95
2732 Intel (2532) TI	32K EPROM	49.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123 (74S288)	32x8 Tri State Bipolar PROM	4.95
82S185	8K PROM	29.95

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95
2516N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2661N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32 Seg VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	10.95
AY 5-9200	Repertory Dialer	10.95
AY-5-9500	CMOS Clock Generator	4.95
AY 5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures

- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.

Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance

Spec Sheets — 25¢
Send 41¢ Postage for your FREE 1981 JAMECO CATALOG

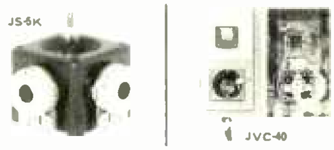
NEW 1981 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
4/81 PRICES SUBJECT TO CHANGE

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case . . .	$5.95

AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application

Part No.	Input	Output	Price
AC 200	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC1000	117V/60Hz	12 VAC 1 amp	$5.95
AC1700	117V/60Hz	9 VAC 1.7 amp	$6.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

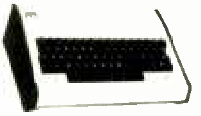
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
★ Documentation for Conversion

TRS-16K2 *150 NS $49.95
TRS-16K4 *250 NS $39.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18 pin edge connector. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (as pictured above) . . . **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . . . . **$ 79.95**
K62 62-Key Keyboard (Keyboard only) . . . **$ 34.95**
DTE-AK (case only — 3¾"Hx11"Wx8¾"D) **$ 49.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT
19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8 bit latched output for microprocessor use. Three user define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16 pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only — 3½"Hx8¾"Wx8¾"D) **$44.95**

CIRCLE NO. 32 ON FREE INFORMATION CARD

www.americanradiohistory.com

DIGI-KEY CORPORATION 800-346-5144

In Mn., Ak., Hi. Call 218-681-6674

VISA

Capacitors•Real-Time Clock/Calendar• E F Johnson •Terminal Strips•T.I. Connectors•Wire Wrapping Supplies•CMOS•Rectifiers•Powerace•Sams Books•Diamond Tools•Panavice AP Products•Batteries•ZNR's•Books•Zenier Diodes•Breadboarding•Wire•Buzzers•Vises •Templates•Diodes•Switches•Drafting Aids•Soldering Supplies•Edge Connectors•IC Socket •Enclosures•Resistors & Resistor Networks•Hardware•Power Supplies•Hobby Blox•Phono Plugs & Jacks•Integrated Circuits•Optoelectronics•Lamps•Multimeter•LED's•Data Books Microprocessor & Support•Luxo Lamps•Clock Bezels•PC Layout Supplies•Lithium Batteries•Tantalum Capacitors•Time-Temperature Clock•A/D & D/A•Nickle-Cadmium Batteries Electrolytic Capacitors•Potentiometers•Car Clock•Transistors•Home Clock Kits•Tools • Fuse Holder Boards•Ungar Products•Heat Sinks & Accessories•Solder Wick•AND MORE

master charge

DIGI-KEY — DIGI-KEY — DIGI-KEY — DIGI-KEY — DIGI-KEY — DIGI-KEY — DIGI-KEY — DIGI-KEY

The Big DIGI-KEY Discount makes a Big Price Difference (SEE BELOW)

INTEGRATED CIRCUITS

7400 TTL | 74LS00 LS TTL | 4000 CMOS | LINEAR I.C.S

A/D & D/A CONVERTERS & MISCELLANEOUS

MEMORY

MICROPROCESSORS

INTERFACE I.C.'S

DIP IC INSERTION TOOLS WITH PIN STRAIGHTENER

INSERTION & EXTRACTION KIT

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

RS125 ... $9.90

RS225 ... $9.90

½ WATT RESISTORS ASSORTMENTS

RS150 ... $9.90

RS250 ... $9.90

E.F. JOHNSON ALUMINUM SPACERS

Round Tubular

Round Threaded

Hex Threaded

MOLEX I.C. SOCKET PINS

.95/C	9.10/M	42.00/5M	300.00/50M

TEXAS INSTRUMENTS I.C. SOCKETS

SOLDER TAIL DIP SOCKETS

- Low profile
- Face grip design for maximum retention force
- Redundant contact points
- YOUR CHOICE ... TIN OR GOLD

TIN INLAY SOLDER TAIL

GOLD INLAY SOLDER TAIL

WIRE WRAP DIP SOCKETS

- Standard profile
- Universal mounting and packaging capabilities
- Wire wrap posts hold true position
- YOUR CHOICE ... TIN OR GOLD

TIN PLATED WIRE WRAP

GOLD INLAY WIRE WRAP

SILICON TRANSISTORS

ITT RECTIFIERS

ITT SILICON ZENER DIODES

Call or Write for your Free DIGI-KEY Catalog

HOBBY-BLOX

THE NEW MODULAR CIRCUIT BUILDING SYSTEM

BASIC INTEGRATED CIRCUIT STARTER PACK

INTEGRATED CIRCUIT STARTER PACK COMPONENTS

BASIC DISCRETE COMPONENT STARTER PACK

DISCRETE COMPONENT STARTER PACK COMPONENTS

SUPER-STRIPS

UNIVERSAL BREADBOARDING ELEMENTS WITH SOLDERLESS PLUG-IN TIE POINTS

POWERACE

For complete AP Products specifications get your FREE DIGI-KEY catalog today

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab | Solder Eye | Wire Wrap

RELIABLE, COST EFFICIENT CONTACT DESIGN

- Copper nickel-tin CA 725 alloy
- Bifurcated contact points
- Preloaded, cantilever spring design
- Contacts are user removable

H4 SERIES .100"×.200" EDGEBOARD CONNECTORS

H4 SERIES .125"×.250" EDGEBOARD CONNECTORS

H4 SERIES .156"×.200" EDGEBOARD CONNECTORS

ELECTRONIC HARDWARE KIT

CAT. NO. 1600 KIT $14.95

'NEW' MA1032 Clock

Digital LCD Clock Module

- Operates from a single 1.5V Battery
- 0.5" LCD Display

Instructions Included In All Orders

- User selectable 12 or 24 hour mode
- 24 hour alarm with ON-OFF control
- Presettable 59-minute sleep timer with reset to zero
- 7-minute snooze timer
- Fast/Slow setting controls
- Seconds display
- 90 mA hour battery will typically last one year
- Minimum external parts required for travel clock/clock radio
- Backlighted Display

MA1032M	LCD Clock Module only	$24.95
MA1032C	Switch for MA1032M	2.85
MA1032B	MA1032M, MA1032C, & AA battery holder	28.20

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:

FEATURES

THE "PROGRAMMABLE" CLOCK MODULES

USER PROGRAMMABLE FOR:

NEW! Two Giant Sizes — 0.7" and 0.84"

FEATURES:

MA1023 — 0.7" HIGH DIGITS

MA1026 — 0.84" HIGH DIGITS

DIGITAL CLOCK BEZEL

THE J.M.J. DIGITAL DISPLAY BEZEL WITH RED FILTER

UNIVERSAL SIZE HANDLES MOST REQUIREMENTS

Be Sure to Order the Proper Adapter for Your Digital Clock

DIGI-CLOCK KIT

12 VDC — Ideal for Car, Van or Boat!

Part No. 5001R ONLY $24.95

Do you need spacers, Banana plugs and jacks or tip plugs and jacks? You can get these and more E. F. JOHNSON products from DIGI-KEY

HEAT SINKS from TO 92 2W coolers to TO 3 100W sinks.

PANASONIC ELECTROLYTIC CAPACITORS

Axial | Radial

PANASONIC METALLIZED POLYESTER CAPACITORS

NEW! KIT — CAT. NO. E-KIT ONLY $54.95

PANASONIC K SERIES CAPACITORS

PANASONIC POLYESTER CAPACITORS

NEW! KIT — 150 POLYESTER CAPACITORS — CAT. NO. M-KIT ONLY $34.95

ASSORTMENT OF 15 POPULAR VALUES

PLESSEY "MINI-BOX"

140 CAPACITORS — CAT. NO. 3050P-Kit ONLY $35.95

ASSORTMENT OF 14 POPULAR "MINI-BOX" CAPACITORS

PANASONIC ELECTROLYTIC KIT

150 CAPACITORS — Cat. No. P6200-Kit ONLY $35.95

ASSORTMENT OF 15 POPULAR CAPACITORS

E. F. JOHNSON PLUG & JACK KIT

150 COMPONENTS — Cat. No. J100-Kit ONLY $69.95

ASSORTMENT OF 150 POPULAR JACKS & PLUGS

PANASONIC DISC CAPACITORS

NEW! KIT — 310 DISC CAPACITORS — CAT. NO. DH KIT ONLY $24.95

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

NEW! KIT — 100 TANTALUM CAPACITORS — CAT. NO. F-KIT ONLY $79.95

DIGI-KEY Precut/Prestripped Wire

Precut/Prestripped 100 Wire Package — Bulk Wire Wrap Wire

PRECUT/PRESTRIPPED WIRE 100 Wires/Package

30 AWG Kynar Insulated in Bulk Continuous Length

Part No.	Color	Length	Cost
100 RD	Red	100 feet	$3.10
100 BK	Black	100 feet	3.10
100 BU	Blue	100 feet	3.10
500 RD	Red	500 feet	13.50
500 BK	Black	500 feet	13.50
500 BU	Blue	500 feet	13.50
1000 RD	Red	1000 feet	23.75
1000 BK	Black	1000 feet	23.75
1000 BU	Blue	1000 feet	23.75

The Digi-Key volume discount and Service charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the Service charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when payment accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

You may pay by check, money order, Master Charge, VISA or C.O.D. ***DIGI-KEY GUARANTEE:*** Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice.

SERVICE	CHARGES	VOLUME DISCOUNT	
$0.00-$9.99	Add $2.00	$0.00-$99.99	NET
$10.00-$25.00	Add $0.75	$100.00-$249.99	Less 10%
$25.00-$49.99	Add $0.50	$250.00-$499.99	Less 15%
$50.00-$99.99	Add $0.25	$500.00-$999.99	Less 20%
$100.00 & Up	No Charge	$1000.00 & Up	Less 25%

www.americanradiohistory.com

DIGI-KEY CORPORATION 800-346-5144

In Mn., Ak., Hi. Call 218-681-6674

VISA

Capacitors•Real-Time Clock Calendar• E F Johnson •Terminal Strips•T.I. Connectors•Wire Wrapping Supplies•CMOS•Rectifiers•Powerace•Sams Books•Diamond Tools•Panavice AP Products•Batteries•ZNR's•Books•Zenier Diodes•Breadboarding•Wire•Buzzers•Vises •Templates•Diodes•Switches•Drafting Aids•Soldering Supplies•Edge Connectors•IC Socket •Enclosures•Resistors & Resistor Networks•Hardware•Power Supplies•Hobby Blox•Phono Plugs & Jacks•Integrated Circuits•Optoelectronics•Lamps•Multimeter•LED's•Data Books Microprocessor & Support•Luxo Lamps•Clock Bezels•PC Layout Supplies•Lithium Batteries•Tantalum Capacitors•Time-Temperature Clock•A/D & D/A•Nickel-Cadmium Batteries Electrolytic Capacitors•Potentiometers•Car Clock•Transistors•Home Clock Kits•Tools• Fuse Holder Boards•Ungar Products•Heat Sinks & Accessories•Solder Wick•AND MORE

master charge

DIGI-KEY — DIGI-KEY — DIGI-KEY — The Big DIGI-KEY Discount makes a Big Price Difference (SEE BELOW) — DIGI-KEY — DIGI-KEY

Multi-Digit LED Numeric Series

DEVICE TYPE	DIGIT SIZE	FORMAT	DRIVE	PRICE
NSN374			CA DIRECT	$3.00
			CC DIRECT	$3.00
	0.3		CA DIRECT	$3.00
	Red		CC DIRECT	$3.00
			CC MULTI	$3.00
			CA MULTI	$3.00
			CA DIRECT	$3.50
			CC MULTI	$3.50
	0.5		CA MULTI	$3.50
	Red		CC DIRECT	$3.50
			CA DIRECT	$3.50
			CA DIRECT	$4.00
			CC MULTI	$4.00
			CA MULTI	$4.00
	Red		CC DIRECT	$4.00
			CA DIRECT	$4.00
			CA MULTI	$5.50
			CC MULTI	$5.50
	Red		CA MULTI	$5.50
			CA MULTI	$6.50
			CC MULTI	$6.50
	Red		CA MULTI	$6.50
			CA MULTI	$7.50
			CC MULTI	$7.50
			CA MULTI	$7.50

Red LED Lamps

Bar/Dot Display Driver

Linear Display NSM 3915
Logarithmic Display NSM 3916
Logarithmic Display
$8.95 each
$77.50/10

Panasonic Batteries

CARBON ZINC BATTERIES

ALKALINE BATTERIES

NICKEL CADMIUM BATTERIES

OK Machine model BC-3 115 Ni-Cad Battery Charger
INPUT: 110-120 VAC 60Hz
OUTPUT: 2.9 VDC at 200 mA
CAPACITY: 2 or 4 size AA, C or D Ni-Cad
Part No. K251-ND $15.95

Ni-Cad batteries can typically be re-charged 100 times and will replace from 100 to 300 regular batteries

GELLED ELECTROLYTE LEAD ACID BATTERIES

LITHIUM BATTERIES

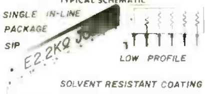
CRYSTALS

Cat. No.	Freq./MHz	Lead Length	Package	Price
X001	2.000	250	HC-6/U	$3.20
X002	2.097	200	HC-6/U	3.50
X003	2.560	250	HC-6/U	2.15
X004	3.145	500	HC-6/U	2.40
X005	3.579	200	HC-6/U	2.95
X006	4.000	200	HC-6/U	2.95
X007	4.194	750	HC-6/U	2.89
X008	3.640	250	HC-6/U	2.80
X009	3.940	750	HC-6/U	2.80
X010	3.859	250	HC-6/U	2.80

ELECTRONIC HARDWARE STEEL/ZINC PLATED

Panasonic

5% RESISTOR NETWORKS TYPICAL SCHEMATIC



SOLVENT RESISTANT COATING

MEETS REQUIREMENT MIL-R-83401

SWITCHING POWER SUPPLIES

Model Number	Output	Power	Price
ETU 5/40H	5V 4A	20W	$69.00
ETU 12/18H	12V 1.8A	20W	$69.00
ETU 15/15H	15V 1.3A	20W	$69.00
ETU 24/10H	24V 1A	20W	$69.00

DIGI-KEY ... books by the following publishers:

ADAM OSBORNE · HAYDEN · SYBEX · TAB · SAMS

Get your free DIGI-KEY catalog for the complete list of titles.

NATIONAL SEMICONDUCTOR DATA BOOKS

CRIMP TOOL SET

CRIMP TOOL SET

CRIMP TOOL SET includes high quality crimp tool & as well as a special ... and connectors (pictured at right). Set is designed for wire sizes 16 through 22 gauge

NF-KIT **$19.95**

NEW UNGARmatic

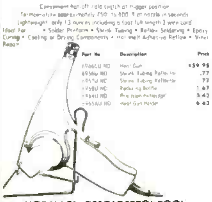
Temperature Controlled Soldering Station

THREAD-TOGETHER MODULAR DESIGN FOR QUICK, ON-LINE HEATER OR TIP CHANGE

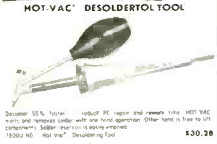
5050-ND $76.58

- Closed loop, non-magnetic control
- Low voltage system 3 wire grounded
- Bi-mechanical designed handle with cool grip for operator comfort. Cord is super flexible 3 wire grounded heat resistant
- Large capacity snap-on tray and sponge, removable for optional placement
- Long life interchangeable tips, iron clad chrome plated pre-tinned
- Designed for use on sensitive components

HEAT GUN



HOT-VAC DESOLDERTOL TOOL



Replacement tips, solder, and other soldering equipment from UNGER

AP PRODUCTS INCORPORATED

ACE 218
Part No. 923326 $46.95

ACE 227
Part No. 923325 $59.95

ACE 236
Part No. 923324 $79.95

ACE 200-K
Part No. 923333 $18.95

ACE 208
Part No. 923332 $28.95

ACE 201-K
Part No. 923334 $24.95

ACE 212
Part No. 923331 $34.95

BREADBOARD JUMPER WIRE KIT

INTERFACE YOUR TRS-80 TO THE REAL WORLD

JUMPER HEADERS

STRAIGHT

RIGHT ANGLE

MALE and FEMALE HEADERS

LOGIC TIMING CHART

OK MACHINE & TOOL CORPORATION

PRB-1 DIGITAL LOGIC PROBE

PLS-1 LOGIC PULSER

BATTERY WRAP TOOL

HOBBY WIRE WRAPPING TOOL BATTERY POWERED

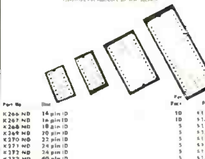
RIBBON CABLE

OK Machine and Tool Corporation has done it again. Now you can get

ELECTRONIC HOBBY KITS

Quick Reaction
Electronic Organ
Digital Roulette
Electronic Dice
Morse Code Practice

SOCKET-WRAP I.D.



PC CARD GUIDES & BRACKETS

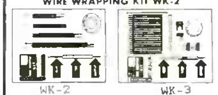
OK MACHINE & TOOL CORPORATION

TERMINALS

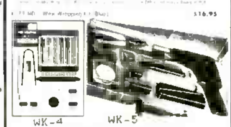
TERMINAL INSERTING TOOL

P C B TERMINAL STRIPS

WIRE WRAPPING KIT WK-2



WIRE WRAPPING KIT WK-3



WIRE WRAPPING KIT WK-4

WIRE WRAPPING KIT WK-5

TRI-COLOR DISPENSER

DISPENSER REPLACEMENT ROLLS

WIRE DISPENSER

DISPENSER REPLACEMENT ROLLS

HOBBY WRAP TOOLS

JUST WRAP... KITS, UNWRAP TOOL

WHY CUT? WHY STRIP? WHY SLIT? WHY NOT JUST WRAP

JUST WRAP REPLACEMENT ROLLS

UNWRAP TOOL FOR JUST WRAP

JUST WRAP KIT

ADJUSTABLE WIRE DISPENSER

DISPENSER REPLACEMENT ROLLS

REPLACEMENT STRIPPING BLADES

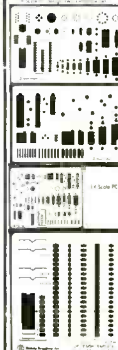
"CLIP AND STRIP" TOOL

JUMPER WIRES

Get your free catalog for the complete OK Listing.

MODULAR TERMINAL STRIPS

Bishop Graphics



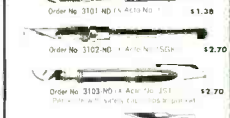
DUAL IN-LINE TEMPLATE

STANDARD LOGIC SYMBOLS FOR DIGITAL DESIGN

SCETCH MATE
Cat. No. 3300-ND $2.25

METRIC SKETCH MATE
Cat. No. 3301-ND $2.75

X-ACTO KNIFE



Order No. 3101-ND X-Acto No. 1 $1.38

Order No. 3102-ND $2.70

Order No. 3103-ND $2.70

Order No. 3108-ND 5 blade pack $1.08

Order No. 3110-ND (5 blade pack) $1.08

SEQUENTIAL ALPHABET KITS

QUANTITY: 20 SETS PER PACKAGE (One Of Each Letter Per Set)

SEQUENTIAL NUMBERS KITS

Price Per Package (Black)—$13.65

DONUT PADS

DUAL IN-LINE PACKAGE

Precision Slit PC Artwork Tape

These and Other
BISHOP GRAPHICS
Items Can Be Found In
Your Free DIGI-KEY Catalog

The Digi-Key volume discount and Service charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix -ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the Service charge. We pay all shipping and insurance to destinations in the U.S.A., Canada and Mexico when payment accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

You may pay by check, money order, Master Charge, VISA or C.O.D. **DIGI-KEY GUARANTEE:** Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice.

SERVICE	CHARGES
$ 0.00-$ 9.99	Add $2.00
$ 10.00-$24.99	Add $0.75
$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
$100.00 & Up	No Charge

VOLUME DISCOUNT	
$ 0.00-$ 99.99	NET
$ 100.00-$249.99	Less 10%
$ 250.00-$499.99	Less 15%
$ 500.00-$999.99	Less 20%
$1000.00 & Up	Less 25%

www.americanradiohistory.com

NEED YOUR ORDER SHIPPED TODAY?

CALL TOLL FREE **800-538-5000**

CALL US FOR VOLUME QUOTES. ALL MERCHANDISE 100% GUARANTEED.
WE WILL BEAT ANY COMPETITORS PRICES. GIVE US A CALL AND WE'LL PROVE IT.

MEMORY SALE

4116—300NS	8/19.95	100/2.25ea
4116—200NS	8/27.95	100/3.00ea
2114L—300NS	8/29.95	100/3.00ea
2708—450NS	4.95ea	8/4.80ea
2716—5V 450NS	7.95ea	8/6.95ea
2732—INTEL	29.95ea	CALL
2532—TI PIN OUT	21.95ea	CALL

THESE PRICES GOOD FOR PE READERS ONLY—TO GET THESE UNHEARD OF PRICES YOU MUST STATE WHEN ORDERING:APRIL PE MEMORY SALE—SALE ENDS APRIL 30, 1981

T.V. DECODER CIRCUITS

MC1330	1.89
MC1350	1.29
MC1358	1.79
LM380	1.29
LM565	.99
LM741	.29
LM1310	1.90
LM1800	1.99
LM1889	2.49

8038 INTERSIL FUNCTION GENERATOR
3.99ea 5/17.50

LS SERIES — LOOK AT THIS LS PRICING!

74LS00	.32	74LS73	.44	74LS156	.95	74LS251	1.32
74LS01	.28	74LS74	.48	74LS157	.79	74LS253	.89
74LS02	.38	74LS75	.58	74LS158	.82	74LS257	.89
74LS03	.32	74LS76	.50	74LS160	.94	74LS258	.89
74LS04	.35	74LS78	.59	74LS161	.99	74LS259	2.89
74LS05	.28	74LS83	.90	74LS162	.99	74LS260	.68
74LS08	.38	74LS85	1.23	74LS163	.99	74LS266	.68
74LS09	.38	74LS86	.45	74LS164	.99	74LS273	1.69
74LS10	.32	74LS90	.70	74LS165	.99	74LS275	3.39
74LS11	.29	74LS92	.82	74LS166	2.40	74LS279	.59
74LS12	.29	74LS93	.71	74LS168	1.79	74LS283	1.03
74LS13	.38	74LS95	1.11	74LS169	1.79	74LS290	1.25
74LS14	.99	74LS96	.86	74LS170	1.89	74LS293	1.89
74LS15	.35	74LS107	.43	74LS173	.82	74LS295	1.09
74LS20	.26	74LS109	.49	74LS174	1.19	74LS298	1.24
74LS21	.30	74LS112	.48	74LS175	1.09	74LS352	1.59
74LS22	.34	74LS113	.48	74LS181	2.19	74LS353	1.59
74LS26	.40	74LS114	.55	74LS190	1.15	74LS363	1.39
74LS27	.35	74LS122	.55	74LS191	1.31	74LS365	.99
74LS28	.39	74LS123	.99	74LS192	.88	74LS366	.99
74LS30	.35	74LS125	.99	74LS193	.98	74LS367	.99
74LS32	.39	74LS126	.88	74LS194	1.80	74LS368	.99
74LS33	.54	74LS132	.69	74LS195	1.39	74LS373	1.85
74LS37	.78	74LS136	.58	74LS196	.82	74LS374	1.81
74LS38	.39	74LS138	.79	74LS197	.82	74LS377	1.48
74LS40	.25	74LS139	.79	74LS221	1.28	74LS385	1.90
74LS42	.79	74LS145	1.19	74LS240	1.89	74LS386	.65
74LS47	.78	74LS148	1.39	74LS241	1.89	74LS390	1.90
74LS48	.78	74LS151	.79	74LS242	1.89	74LS393	1.90
74LS51	.35	74LS153	.79	74LS243	1.89	74LS395	1.69
74LS54	.35	74LS154	2.39	74LS244	1.79	74LS670	2.20
74LS55	.32	74LS155	1.19	74LS245	2.89		

LINEAR IC'S

LM301V	.34	LM380	1.29	LM747	.79
LM309K	1.49	LM555V	.39	LM1310	1.90
LM311V	.64	LM556	.69	LM1458V	.69
LM317T	2.29	LM565	.99	LM1488	1.39
LM323K	4.95	LM566V	1.49	LM1489	1.39
LM324	.59	LM567V	1.29	LM1800	1.99
LM339	.99	LM723	.49	LM1889	2.49
LM377	2.29	LM741V	.29	LM3900	.59

VOLTAGE REGULATORS

7805T	.89	7812K	1.39	7905K	1.49
7812T	.89	7905T	.99	7912K	1.49
7805K	1.39	7912T	.99	78L12	.69

V = 8 PIN K = TO-3 T = TO-220

8080 SUPPORT

8212	2.75
8214	5.25
8216	2.75
8224	2.95
8226	3.49
8228	4.95
8238	5.50
8251	6.95
8253	12.95
8255	6.50
8257	16.95
8259	14.95
8275	49.95
8279	15.95

Z80

Z80-CPU	8.45
Z80A-CPU	9.45
Z80-DMA	18.00
Z80-SIO/2	27.50
Z80-SIO/9	20.50
Z80-CTC	7.65
Z80-PIO	7.60

DIP SWITCHES

4 position	.99
5 position	1.02
6 position	1.06
7 position	1.09
8 position	1.14

IC SOCKETS

8 PIN	10/1.29
14 PIN	10/1.49
16 PIN	10/1.69
18 PIN	10/1.99
20 PIN	10/2.89
22 PIN	10/2.99
24 PIN	10/2.99
28 PIN	10/3.99
40 PIN	10/4.99

MA1012A CLOCK MODULE

Complete alarm clock module with special transformer and spec sheets included. Just add switches.

8.99 ea. 3/24

JDR MICRODEVICES, INC.

1101 South Winchester Blvd.
San Jose, California 95128
408-247-4852
800-538-5000

TERMS: Include $2 for shipping. $10 minimum order. Send SASE for complete catalog. Bay Area Res. add 6½% sales tax Calif. Res. add 6% sales tax. We reserve the right to limit quantities and substitute manufacturer. Prices subject to change without notice.

master charge VISA®

BULLET ELECTRONICS, Inc.

P.O.BOX 401244P,GARLAND,TX.75040

Super Music Maker Kit $24.95

REVISION 2

Now you can play hundreds of songs using the Bullet **Super Music Maker**. The unit features a single factory programmed microprocessor IC that comes with 20 pre-programmed short tunes. By adding the additional PROMS (2708's) the system can be expanded to play up to **1000 notes per PROM**. Just think a compact electronic instrument that will play dozens, hundreds or even thousands of selections of music. The kit comes with **all electronic components (less the PROM)**, and a drilled, plated and screened PC Board which measures 4" x 4¾". The **7 watt amplifier** section is on the same PC board and drives an 8 ohm speaker (not included), from a whisper to ear splitting volume. Since the unit works on **12 VDC** or **12 VAC***, vehicle or portable operation is possible. **What do you get for $24.95? Everything but a speaker, transformer,** case, switches, and **PROM**. Additional 2708 albums containing popular tunes are available for **$15.00** each or you can program your own PROMS using information provided with the kit instructions. Lists of available PROM albums are available on request. *(Note: Unit plays electronic music one note at a time, it is not possible to play chords or a melody with harmony simultaneously.)*

OPTIONAL ACCESSORIES

DIP Switches One 8 pos., One 5 pos. (Can be **directly soldered** to PC Bd. to access tunes)		2.00/Set
Rotary Switches Two 5 position (For **remote wiring** to PC Bd. to access tunes)		2.50/Set
Attractive Black Plastic Case		6.50
Wallplug Transformer (For operation on 117VAC house voltage)		3.00

Sound Effects Kit $18.50

The **SE-01 Sound Effects Kit** is a complete kit, all you need to build a programmable sound effects machine except a battery and speaker. Our kit is designed to really ring out the **TI 76477** Sound Chip. Only the SE-01 provides you with additional circuitry that includes a **PULSE GENERATOR, MUX OSCILLATOR and COMPARITOR** to make more complex sounds a snap. We help you in building the kit with a clear, easy-to-follow construction manual and we show you how to easily program the unit. Other dealers will sell you the chip or a "kit" of parts but you are on your own to do the most difficult part - make neat sounds! Within a short time after you build the SE-01 you can easily create **Gunshots, Explosions, Space Sounds, Steam Trains** and much more. We think the Bullet SE-01 is the best deal on the market but don't ask us, — ask the **15,000** happy SE-01 owners!

Complete Kit With Quality Plated PC Board $18.50
(Less battery & speaker)

7 Watt Audio Amp Kit $5.95

SMALL, SINGLE, HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT

AY3-8910 PROGRAMMABLE SOUND GENERATOR

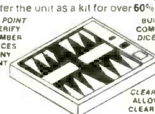
The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

12.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples. **$3.00 extra**

BANKRUPT Game Manufacturer Dumps Computer Backgammon Game $39.95

Includes Case
Does not include player pieces

The Engineers designed this one too good, making it too costly to be competitive. Result — Chapter XI. We bought all the parts and can offer the unit as a kit for over **60% off retail!**



You get
Double sided glass PC Board
Powerful 8035 Micro Processor Chip
Two 2716 style mask ROMS
RAM Chips, LED readouts, Keyboard, Instructions
AC Plug transformer

8035 and program ROMS only with schematics **$12.00**

COMPONENTS

*INDICATES ITEM IS "HOUSE NUMBERED"

301 OP AMP 8 LEAD CAN	3/1.00		
723 VOLT REG. 10 LEAD CAN	.39	*MC1351P FM IF, DISC IC	.50
723 14 PIN DIP	.50	TL490 BAR GRAPH DRIVER	2.50
741 OP AMP MINI DIP	4/1.10	7805 5V 1A REGULATOR	.99
30,000 @ 15V COMPUTER GRADE	2.10	*78M05 ½A 5V REG. TO-5	.60
2N4402 PNP COMPLIMENT	8/1.00	LM3911 TEMP. TRANSDUCER IC W/SPECS	1.10
2N6028 P.U.T. W/SPECS	.50	LM3302 QUAD COMPARATOR IC	.50
LM380 2W AUDIO IC W/SPECS	1.09	555 TIMER IC	.49
LM377 DUAL LM380 W/SPECS	2.50	*MC3401 QUAD NORTON AMP	.39
LM3900 QUAD NORTON AMP	.69	MC3340 ELECTRONIC ALTERNATOR W/SPECS	.75
LM324 QUAD OP AMP	.55		
7812 1A 12V REG	.95		
IL 1 OPTO ISOLATOR MINI DIP	.60	LED'S	
*MEM 631 DUAL GATE MOSFET. DIODE PROTECTED, SIMILAR TO 40673	.50	JUMBO GREEN	4/.89
MV1624 VARICAP DIODE 10 PFD	.39	JUMBO RED	5/.89
IN5148 VARICAP DIODE 47 PFD NOM. 3:1 RATIO	.49	MEDIUM RED (⅛")	.15
		MEDIUM GRN OR YELLOW	.16

Call or write for FREE catalog.

POLICIES

NO C.O.D.'s SEND CHECK, MONEY ORDER, CREDIT CARD # ADD 5% FOR SHIPPING. TX RES. ADD 5% TAX. FOREIGN ORDERS (EXCEPT CANADA) ADD 10% (20% AIRMAIL) U.S. FUNDS ONLY
PHONE ORDERS ON MASTER CHARGE & VISA ONLY
(214) 278-3553

www.americanradiohistory.com

Quest ELECTRONICS

P.O. Box 4430C
Santa Clara, CA 95054
Will calls: 2322 Walsh Ave.
(408) 988-1640 TWX 910-338-2139

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

74LS00 TTL	
74LS00N	29
74LS02N	29
74LS04N	35
74LS05N	25
74LS08N	35
74LS10N	35
74LS13N	55
74LS14N	1 00
74LS20N	35
74LS22N	35
74LS28N	35
74LS30N	35
74LS33N	60
74LS38N	50
74LS74N	85
74LS75N	65
74LS90N	60
74LS93N	75
74LS95N	1 00
74LS107N	45
74LS112N	45
74LS113N	45
74LS132N	89
74LS136N	50
74LS151N	90
74LS155N	1 10
74LS157N	1 10
74LS162N	1 10
74LS163N	1 10
74LS174N	1 25
74LS190N	1 25
74LS221N	1 25
74LS258N	1 00
74LS367N	75

MOS/MEMORY RAM	
2101-1	2 85
2102 1	95
2102AL 4	1 45
2102AN 2L	1 65
2104A-4	4 95
2107B-4	3 75
2111 1	3 75
2112 2	3 95
2114	3 75
2114L 300ns	4 25
2114L 450ns	4 00
4116 200ns	5 50
8 4116 200ns	35 00
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D 3	4 00
PD411D 4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165 5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM66751A	9 95
9368	3 50
4100	10 00
416	16 00

PROM	
1702A	4 95
2708	7 30
2716T1	18 00
2716 5 Volt	13 50
8 2716 5 Volt	89 00
2732	55 00
2758	19 50
8741A	55 00
8748	55 00
8748-8	55 00
8755A	55 00
N82S23	2 95
N82S123	6 50
N82S126	3 75
N82S129	8 50
N82S131	8 50
N82S136	8 75
N82S137	8 75
DM8577	2 90
8223	2 90

INTERFACE	
8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69

MICROPROCESSOR	
6502	10 95
6504	9 95
6522	9 95
6800	6 95
6802	11 95
6820	4 95
6850	5 95
8080A	5 95
8085	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3 95
8216	2 90
8224	3 45
8228	4 95
8251	6 95
8253	15 00
8255	5 75
8257	10 95
8259	14 95
1802CP plas	13 95
1802DP plas	17 95
1861P	9 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1816P	7 95

RESISTORS ¼ watt 5%	
10 per type	03
25 per type	025
100 per type	015
1000 per type	012
350 piece pack 5 per type	6 75

½ watt 5% per type 05

IC SOCKETS Solder Tin Low Profile			
PIN	1 UP	PIN	1 UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3			
PIN		PIN	
14	37	24	86
16	39	28	1 00
18	57	40	1 23

CRYSTALS	
1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 Hz	4 00
1 8432 MHz	4 50
3 5795 MHz	1 20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4 50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

DISPLAY LEDS			
MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72 74	CA CA	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1 00
DL727 728	CA CC	500	1 90
DL747 750	CA CC	600	1 95
FND359	CC	357	70
FND500 507	CC CA	500	1 35
FND503 510	CC CA	500	90
FND800 807	CC CA	800	2 20
3 digit Bubble			60
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	35
MAN6740	CC	60	1 35

KEYBOARDS	
56 key ASCII keyboard kit	$67 50
Fully assembled	77 50
53 key ASCII keyboard kit	60 00
Fully assembled	70 00
Enclosure Plastic	14 95
Metal Enclosure	29 95

Linear CMOS and 7400 complete lines in stock. Send for catalog.

RCA Cosmac 1802 Super Elf Computer Kit $106.95

The Quest Super Elf is the right choice for the person who has a need to learn more about computers, from an understanding of the hardware and how it goes together to beginning programming with machine language on up through basic.

Tremendous Value

The Super Elf is a tremendous value as it combines video, digital displays, LED displays, and music, all on a single board for $106.95. Its unique ability for single step debugging, display of state and mode of the computer and display of addressing as an inexpensive option gives it an "easy to use" capability not available anywhere at the price.

Inexpensive Expansion

The Super Elf expansion capability is virtually unlimited and you can do it inexpensively one step at a time. Expansion includes cassette interface, additional memory, color video, Basic, ASCII keyboard, printer, floppy, S-100 bus, RS232, etc.

Strong Software Support

The Super Elf comes complete with power supply and detailed 127 page instruction manual which includes over 40 pages of software, including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D. A monthly newsletter, Questdata is devoted exclusively to software for the Super Elf and there are many software books available at low cost. You can do a tremendous amount with the software available and there is more coming every day. Of course, you can do your own programming which is fun and very rewarding.

Free 14 Page Brochure

Send or call for a free brochure on all details and pricing of the Super Elf and its expansion. We will get it right out to you.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included. Bd. only $17.00.

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50. Full Kit $99.00. Monitor $20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

Video Modulator Kit $9.95

Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option. ±5v, ±12v are regulated. Basic Kit **$29.95.** Kit with chassis and all hardware **$43.95.** Add $4.00 shipping. Kit of hardware **$14.00.** Woodgrain case **$10.00.** $1.50 shipping.

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Rockwell AIM 65 Computer

4K version $450.00

Ohio Scientific Computer Products

C1P Series 2 **$459.00**
with monitor TV combo **$599.00**
C1PMF Series 2 **$1225.00**
with monitor TV combo **$1349.00**

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
$10.00 min. BankAmericard and Master Charge accepted. $1.00 insurance optional.
Postage: Add 5%. C.O.D. $10.00 min. order.

FREE: Send for your copy of our NEW 1980 QUEST CATALOG. Include 48¢ stamp.

CIRCLE NO. 48 ON FREE INFORMATION CARD

APRIL FOOLISHNESS!

No, we're not crazy. . .we just have a lot of parts we want to move, and you're the one who benefits. Stock up now; quantities are limited on most items. You must include the -S suffix when indicated, or you will be charged our regular prices for these parts.

TTL

7403-S	Quad 2 input OC	21/$2
7410-S	Triple 3 input NAND	21/$2
7413-S	4 to 16 line decoder/demux	6/$2
7428-S	Quad 2 in NOR buffer	13/$2
7438-S	Quad 2 input NAND OC	21/$2
7444-S	Gray to decimal decoder	8/$2
7450-S	And-or-invert	21/$2
7472-S	JK M-S flip flop	21/$2
7493-S	4 bit binary counter	10/$2
7496-S	5 bit shift register	12/$2
74122-S	Retriggerable one-shot	18/$2
74151-S	8 channel mux	8/$2
74155-S	Dual 2/4 demux	8/$2
74159-S	4 to 16 line decoder/demux OC	4/$2
74161-S	Synchro 4 bit binary counter	8/$2
74163-S	Synchro 4 bit binary counter	8/$2
74164-S	8 bit shift register	6/$2
74190-S	Up/down decade counter	4/$2
74192-S	Up/down binary counter	4/$2
74194-S	4 bit bidirectional shift reg	4/$2
74195-S	4 bit parallel shift register	6/$2
74198-S	8 bit shift register	4/$2

CMOS

4012-S	Dual 4 input NAND	12/$2
4020-S	14 stage counter	4/$2
4023-S	Triple 3 input NAND	12/$2
4044-S	Quad R-S latch	4/$2
4046-S	Phase locked loop	2/$2
4071-S	Quad 2 input OR	12/$2
4093-S	Quad 2 in NAND Schmitt trig	4/$2
4507-S	Quad EX-OR	4/$2
4510-S	BCD up/down counter	2/$2
4511-S	BCD to 7 seg decode/drvr	3/$2
4512-S	8 channel data selector	4/$2
5101-S	CMOS 1K low power memory	10/$17.50

NEW 16K dynamic RAMs – PRICE BREAK: 8 $29!

These top quality, low power, high speed (200 ns) parts expand memory in TRS-80* -I, -II, and -III computers (color machine, too) as well as machines made by Apple, Exidy, Heath, newer PETs, etc. Backed by 1 year limited warranty. Add $3 for two dip shunts plus TRS-80* conversion instructions.

*TRS-80 is a trademark of the Tandy Corporation

LINEARS

(package type: H = TO99, M = minidip, D = dip, TK = TO66)

201H-S	Improved 301 op amp	10/$2
308H-S	Micropower op amp	6/$2
703H-S	RF/IF amp	6/$2
723D-S	Voltage regulator	6/$2
741M-S	Compensated op amp	15/$2
1458M-S	Dual 741	10/$2
4558M-S	Dual 741	12/$2
4195TK-S	Dual track 15V reg w/data	2/$2

TO-220 negative voltage regulators

7906	-6V regulator	2/$2
7908	-8V regulator	2/$2
7912	-12V regulator	2/$2
79M15	-15V regulator	2/$2
7918	-18V regulator	2/$2
7924	-24V regulator	2/$2

soldertail SOCKETS

8 pin 100/$5.95
14, 16 & 18 pin 50/$4.95
20 pin 40/$4.95
24, 28 pin 30/$4.95
40 pin 20/$4.95

DC Robot Motor SPECIAL

DC fractional horsepower motor runs on about 1 to 5V. Not a servo motor by any means, but good for experimenting with robots, toys, games, etc. 10/$2.95

MISCELLANEOUS

1000 uF 35V axial capacitor	10/$2.00
10,000 uF 10V axial capacitor	5/$2.00
S-100 card edge connectors	10/$29.50
Resistor asst. (cut & bent leads)	1000/$5
RCA phono jacks - these are super quality, closed circuit jacks that are the best we've seen in years. American made.	20/$1.95
2102 low power 1K static RAM	10/$9.90
General purpose silicon signal diodes	50/$2
GT5306 NPN darlington, min gain 7000, 25V 200 mA, TO92 package	100/$8.95
NPN transistor similar 2N3904	100/$7.95
PNP transistor similar 2N3906	100/$8.95
4N28 opto-coupler 6 pin minidip, MCT-2/IL-1 pinout	5/$2
SN76477 complex sound generator	1/$2.50
New low price! MA1003 12V DC clock module: $10.95, matching case $3.95.	
Opto-isolator Grab Bag - 50 mixed opto-isolators from a major manufacturer. Unmarked 6 and 8 lead minidips include single and dual types with diode, transistor, and darlington outputs, test them yourself and save! Not recommended for beginners.	50/$4

WHAT'S A COMPUPRO? It's a division of Godbout Electronics that manufactures some of the finest - and most innovative - computer peripherals available in the world today. Feeling limited by an "all-in-one" system? Send for data on our modular, expandable, high throughput S-100 system components.

TERMS: [illegible] All w/5 [illegible] shipping [illegible] refunded. Orders [illegible] $15 add $2 handling. VISA [illegible] and Mastercard [illegible] orders for 16K RAMs only [illegible] (415) 562-0636, 24 hrs. Please include street address for UPS delivery. Prices subject to change without notice.

FREE CATALOGUE: Find out more about our exceptional product line. For 1st class delivery, add 41 cents in stamps; foreign orders add $2 (refundable with order).

GODBOUT ELECTRONICS
OAKLAND AIRPORT, CA 94614

CIRCLE NO. 22 ON FREE INFORMATION CARD

www.americanradiohistory.com

YOU CAN BUY AT THESE PRICES TOO!

AND THESE ARE NOT "FALL-OUTS", "REJECTS", "FUNCTIONAL-ONLYS", "COSEMETIC DEFFECTS", "DOUBLE-MARKS", ETC.; BUT ALL ARE PRIME ICs. WITH FULL MANUFACTURER'S MARKING, AND 100% TESTED PER SPECIFICATIONS. THERE IS ALSO, NO TIME LIMITS, MINIMUM ORDER AMOUNT, OR OTHER CONDITIONS. AS A MEMBER OF ELECTRONIC BUYERS CLUB, YOU CAN BUY YOUR ICs OR OTHER COMPONENTS SUCH AS CAPACITORS, RESISTORS, DIODES, SOCKETS, EDGE-CONNECTORS, BREADBOARDING COMPONENTS AND EVEN MICRO-COMPUTERS AT PRICES THAT ARE WELL BELOW ANYTHING YOU HAVE EVER SEEN BEFORE. IF YOU BUY ONLY $50 WORTH OF COMPONENTS A YEAR, YOUR SAVINGS WILL COVER THE ANNUAL MEMBERSHIP FEE OF $25.00. AND FROM THERE ON IT WILL BE NET PROFITS. SO DON'T DELAY, AND JOIN IN. IN ORDER TO GIVE YOU SUCH LOW PRICES, WE HAVE A VERY LIMITED ADVERTISING BUDGET, AND YOU WILL NOT SEE THIS "AD" EVERY MONTH. FOR INFORMATION ON HOW TO JOIN AND TO FIND OUT HOW THE CLUB OPERATES, CIRCLE 'READER SERVICE INQUIRY NUMBER' OF THIS AD OR SEND A POST CARD WITH YOUR NAME AND ADDRESS TO: E.B.C. P. O. Box 617, Columbia, MO, 65205.

PLEASE NOTE: ONLY MEMBERS OF ELECTRONIC BUYERS CLUB ARE ELIGIBLE TO ORDER AT PRICES LISTED BELOW.

74xx

7400	$0.15
7401	0.15
7402	0.15
7403	0.15
7404	0.17
7405	0.17
7406	0.21
7407	0.21
7408	0.17
7409	0.17
7410	0.15
7411	0.17
7412	0.17
7413	0.24
7414	0.41
7416	0.20
7417	0.20
7420	0.15
7421	0.17
7423	0.18
7425	0.18
7426	0.18
7427	0.18
7430	0.15
7432	0.18
7437	0.18
7438	0.18
7439	0.18
7440	0.15
7441	0.60
7442	0.35
7443	0.50
7444	0.50
7445	0.50
7446	0.46
7447	0.46
7448	0.46
7450	0.15
7451	$0.15
7453	0.15
7454	0.15
7459	0.15
7460	0.15
7470	0.21
7472	0.21
7473	0.21
7474	0.21
7475	0.30
7476	0.21
7480	0.22
7482	0.34
7483	0.46
7485	0.50
7486	0.20
7489	0.95
7490	0.30
7491	0.47
7492	0.30
7493	0.30
7494	0.38
7495	0.38
7496	0.38
7497	1.58
74107	0.20
74109	0.22
74120	0.60
74121	0.26
74122	0.27
74123	0.38
74125	0.30
74126	0.30
74132	0.39
74141	0.53
74145	0.45
74147	0.89
74148	0.62
74150	0.54
74151	0.38
74152	0.38
74153	$0.38
74154	0.53
74155	0.38
74156	0.38
74157	0.38
74158	0.38
74160	0.48
74161	0.48
74162	0.48
74163	0.48
74164	0.51
74165	0.51
74166	0.54
74167	1.06
74170	0.84
74173	0.58
74174	0.46
74175	0.45
74176	0.47
74177	0.47
74178	1.04
74179	1.04
74180	0.48
74181	1.02
74182	0.53
74184	1.06
74185	1.06
74188	2.10
74190	0.50
74191	0.50
74192	0.50
74193	0.50
74194	0.48
74195	0.44
74196	0.47
74197	0.47
74198	0.63
74199	0.63
74221	0.50
74251	0.57
74279	0.36
74283	$1.20
74290	0.54
74293	0.54
74298	0.50
74365	0.36
74366	0.36
74367	0.36
74368	0.36

74LSxx

74LS00	$0.15
74LS01	0.15
74LS02	0.15
74LS03	0.15
74LS04	0.17
74LS05	0.17
74LS08	0.16
74LS09	0.16
74LS10	0.15
74LS11	0.17
74LS12	0.17
74LS13	0.30
74LS14	0.60
74LS15	0.15
74LS20	0.15
74LS21	0.15
74LS22	0.15
74LS26	0.18
74LS27	0.16
74LS30	0.13
74LS32	0.17
74LS37	0.18
74LS38	0.18
74LS40	0.15
74LS42	0.42
74LS47	0.60
74LS48	0.51
74LS49	0.54
74LS51	0.15
74LS54	$0.15
74LS55	0.15
74LS73	0.21
74LS74	0.21
74LS75	0.30
74LS76	0.23
74LS78	0.24
74LS83	0.47
74LS85	0.54
74LS86	0.24
74LS90	0.33
74LS92	0.33
74LS93	0.33
74LS95	0.54
74LS107	0.22
74LS109	0.22
74LS112	0.24
74LS113	0.24
74LS114	0.24
74LS122	0.41
74LS123	0.47
74LS125	0.33
74LS126	0.33
74LS132	0.47
74LS133	0.26
74LS136	0.26
74LS138	0.45
74LS139	0.15
74LS151	0.41
74LS152	0.41
74LS153	0.41
74LS154	0.72
74LS155	0.41
74LS156	0.41
74LS157	0.41
74LS158	0.41
74LS160	0.51
74LS161	0.51
74LS162	0.51
74LS163	0.51
74LS164	0.51
74LS168	$0.57
74LS169	0.57
74LS170	0.84
74LS173	0.60
74LS174	0.47
74LS175	0.47
74LS181	1.36
74LS190	0.58
74LS191	0.56
74LS192	0.56
74LS193	0.56
74LS194	0.74
74LS195	0.74
74LS196	0.56
74LS197	0.56
74LS221	0.58
74LS240	1.23
74LS241	1.23
74LS244	1.23
74LS251	0.54
74LS253	0.54
74LS257	0.41
74LS258	0.41
74LS259	0.41
74LS260	0.21
74LS266	0.27
74LS279	0.29
74LS283	0.47
74LS290	0.58
74LS295	0.54
74LS298	0.54
74LS365	0.33
74LS366	0.33
74LS367	0.33
74LS368	0.33
74LS373	0.96
74LS374	0.96
74LS386	0.28
74LS390	0.93
74LS393	0.93
74LS490	1.02
74LS670	$1.14

74Sxx

74S00	$0.23
74S01	0.23
74S02	0.23
74S03	0.23
74S04	0.24
74S05	0.24
74S08	0.24
74S09	0.24
74S10	0.23
74S11	0.23
74S15	0.23
74S20	0.23
74S21	0.24
74S22	0.23
74S30	0.23
74S32	0.38
74S40	0.24
74S50	0.24
74S51	0.24
74S60	0.24
74S64	0.24
74S65	0.24
74S74	0.36
74S76	0.36
74S78	0.36
74S86	0.36
74S112	0.36
74S113	0.36
74S114	0.36
74S132	0.52
74S133	0.23
74S134	0.24
74S135	0.42
74S138	0.49
74S139	0.98
74S140	0.26
74S151	$0.66
74S153	0.66
74S157	0.66
74S158	0.66
74S174	1.04
74S175	0.95
74S189	1.83
74S194	1.17
74S206	2.48
74S240	1.29
74S253	0.63
74S257	0.78
74S258	0.78
74S280	1.14
74S287	1.92
74S289	3.11
74S387	2.98
93S00	1.08
93S05	1.25
93S10	1.88
93S12	0.74
93S16	1.85
93S41	2.73
93S42	0.82
93S43	3.24
93S46	0.84
93S62	1.44

74Cxx

74C00	$0.20
74C02	0.20
74C04	0.20
74C08	0.20
74C10	0.20
74C14	0.46
74C20	0.20
74C30	0.20
74C32	0.20
74C42	0.72
74C48	$0.96
74C73	0.46
74C74	0.46
74C76	0.44
74C83	0.89
74C85	0.89
74C86	0.23
74C89	2.42
74C90	0.71
74C93	0.71
74C95	0.82
74C107	0.44
74C151	1.37
74C154	2.01
74C157	1.37
74C160	0.71
74C161	0.71
74C162	0.71
74C163	0.71
74C164	0.71
74C165	0.77
74C173	0.65
74C174	0.65
74C175	0.65
74C192	0.72
74C193	0.72
74C195	0.71
74C200	4.08
74C221	0.96
74C901	0.34
74C902	0.34
74C903	$0.34
74C904	0.34
74C905	5.10
74C906	0.34
74C907	0.34
74C908	0.76
74C909	1.38
74C910	3.27
74C911	0.78
74C918	0.89
74C925	3.90
74C926	3.90
74C927	3.90
74C928	3.90

4xxx

4000	$0.20
4001	0.17
4002	0.17
4006	0.71
4007	0.20
4008	0.65
4009	0.27
4010	0.27
4011	0.17
4012	0.17
4013	0.30
4014	0.54
4015	0.54
4016	$0.28
4017	0.51
4018	0.51
4019	0.27
4020	0.63
4021	0.56
4022	0.56
4023	0.17
4024	0.47
4025	0.17
4026	0.99
4027	0.36
4028	0.50
4029	0.58
4030	0.23
4031	1.12
4034	1.30
4035	0.71
4040	0.63
4041	0.51
4042	0.54
4043	0.54
4044	0.54
4045	0.89
4046	0.63
4047	0.61
4048	0.28
4049	0.28
4050	0.28
4051	0.54
4052	0.51
4053	$0.54
4060	0.59
4066	0.27
4068	0.21
4069	0.17
4070	0.23
4071	0.17
4072	0.17
4073	0.17
4075	0.17
4076	0.53
4077	0.38
4078	0.24
4081	0.17
4085	0.12
4086	0.42
4089	1.07
4093	0.36
4099	0.80
4502	0.23
4503	0.36
4507	0.42
4508	1.64
4510	0.59
4511	0.65
4512	0.68
4516	0.59
4518	0.59
4519	0.30
4520	0.59
4527	0.71
4528	$0.71
4539	0.74
4555	0.48
4556	0.59
4582	0.59
4584	0.43
4702	3.87
4703	1.50
4704	3.98
4705	5.04
4706	5.32
4720	3.78
4723	0.78
4724	0.78
4725	2.15
40014	0.46
40085	0.89
40098	0.38
40106	0.46
40160	0.71
40161	0.71
40162	0.71
40163	0.71
40174	0.65
40175	0.65
40192	0.72
40193	0.72
40194	0.71
40195	0.71

ELECTRONIC BUYERS CLUB, INC.

A SUBSIDIARY OF ECI-USA, INC.

P. O. Box 617
Columbia, MO 65205

CIRCLE NO. 31 ON FREE INFORMATION CARD

MODEL II

11% DISCOUNT

Off List

64K 1 DRIVE $3440.00

No Taxes on Out of State Shipments

Immediate Shipment On Most Items

$ DISCOUNT $

TRS-80®

DEALER A301

FREE COMPUTER CATALOG UPON REQUEST

COMPUTER SPECIALISTS

26-3001 4K Color	$360.00
26-1145 RS-232 Board	84.00
26-1140 "O" K Interface	249.00
26-1160 Mini Disk	419.00
26-1171 Telephone Modem	169.00
Fast 100 CPS Centronics 730 Printer	577.00
Text Quality Centronics 737 Printer	737.00
CAT Modem	149.00

26-1061 4K I	$630.00
26-1062 16K III	888.00
26-1063 32K III 2-Drives, RS232	2225.00

1-800-841-0860 Toll Free Order Entry

MICRO MANAGEMENT SYSTEMS, INC.

DOWNTOWN PLAZA SHOPPING CENTER
115 C SECOND AVE. S.W.
CAIRO, GEORGIA 31728
GA. PHONE NO. (912) 377-7120

Largest Inventory in S.E. U.S.A.

CIRCLE NO. 39 ON FREE INFORMATION CARD

SAVE! SAVE! SAVE!

Pan American Electronics

Incorporated

We have discounts, free shipping and a TOLL FREE NUMBER available

Call Us! **800/531-7466**

ON **TRS-80** Computers

MasterCard VISA

Telex Number 767339

TOLL FREE ORDER NUMBER 800-581-7466

Texas & Principal Number 512-581-2765

Dept PE, 1117 Conway, Mission, Texas 78572

Radio Shack

AUTHORIZED SALES CENTER

CIRCLE NO. 45 ON FREE INFORMATION CARD

www.americanradiohistory.com

THE MICROCOMPUTER MART

MICROCOMPUTER MART RATE: 1" x 1 Column (1-5/8") $150. 1-1/2" x 1 Column (1-5/8") $225.00. 2" x 1 Column (1-5/8") $300.00. **GENERAL INFORMATION:** Frequency rates available. Payment must accompany copy except credit card—Am. Ex., Diners, MC, VISA (supply Expiration date)—or accredited ad agency insertions. Orders are not acknowledged. They will appear in next available issue after receipt. Closing date: 1st of the 2nd month preceding cover date (for example, April issue closes February 1st). Send order and remittance to MicroComputerMart. **POPULAR ELECTRONICS,** One Park Avenue, New York, NY 10016. Direct inquiries to (212) 725-3485.

CALIFORNIA

OHIO SCIENTIFIC MICRO-COMPUTERS
A.A. Office Equipment Company
2140 American Avenue
Hayward, CA 94545
(415) 782-6110

The Original ByteShop®
1415 W. El Camino Real
Mountain View, CA 94040
(415) 969-5464

OVER 4000
Microcomputer parts, boards, peripherals, systems, and software . . . .
IN STOCK
Send for your free 1981 catalog
JADE *Computer Products*
4901 West Rosecrans Ave.
Hawthorne, California 90250
(213) 973-7707
(800) 421-5500

Disc/3 MART, INC.
WE SPECIALIZE IN LOW COST PRINTERS
Call Us For Quotes On Centronics, Anadex, Epson And Any Others. Try Us For The Best Prices On Diskettes, Cartridges And Accessories

Centronics Printer 737 (Parallel)	$825.00
Anadex Printer DP-9500 9501	$1,425.00

1840 Lincoln Blvd
Santa Monica, CA 90404
(213) 450-5911

FLORIDA

LEARN TO REPAIR COMPUTERS
"Training For Tomorrow Today"
Now there is within your reach, training to help you enter the fast growing computer field service industry. Let us help you shape your future. 8 week course. Must have electronics background to qualify. Write or call for FREE catalog.
Systems Technology Institute,
775 Kirkman Rd., Suite 113-P,
Orlando, FL 32811. (305) 299-6535.

ILLINOIS

FARNSWORTH COMPUTER
Apple, Hewlett-Packard
I.D.S. Printers
Monthly Specials
1891 N. Farnsworth Ave.
Aurora, IL 60505. (312) 851-3888

APPLE, ATARI, TI 99/4
HARDWARE/SOFTWARE/PERIPHERALS
COMPUTERLAND
136 Ogden Ave.,
Downers Plaza,
Downers Grove, ILL 60515
(312) 964-7762

TEXAS

TEXAS COMPUTER SYSTEMS
Radio Shack Authorized Sales Center. OFFERS
LOWEST PRICES on
TRS-80 COMPUTERS
Call TOLL FREE for the BEST PRICES on all Radio Shack Computers and accessories
- ★ FREE SHIPPING on most items
- ★ No out of state sales tax charged

NEW—Percom DOUBLE DENSITY for Model I. Twice the disk space. Easy to install, no modifications. Copies single density to DOUBLE DENSITY to convert existing software. Less than $200
TOLL FREE 800-351-1473
Texas Residents 915 597 0673
TEXAS COMPUTER SYSTEMS
106 E. 10th Brady Tx 76825
Radio Shack Authorized Sales Center

NEW HAMPSHIRE

As advertised in 73 Amateur Radio, 80 Microcomputing & Kilobaud Microcomputing magazines
COMPUCRUISE
WITH CRUISE CONTROL
Regular list $199.95 **$159.95** + $8.00
FREE CATALOG shipping & handling
MOM'S MAIL ORDER MICROS
Dept. P7 603-924-3041
PO Box 427 Marlboro NH 03455

- Northstar
- Exidy
- OSI
- TRS-80
- Apple
- PET
- Heath
- TI 99/4
- Atari

Free Software Catalog
Instant Software Inc.
Dept. PE-1
Peterborough, NH 03458

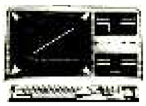
RHODE ISLAND

WHOLESALE COMPUTER PRICES DIRECT TO THE PUBLIC!
Apple • Atari • HP-85 • Intertec • Soroc • TRS-80II • NEC Spinwriter
CALL TOLL FREE
1-800-556-7586
ΩMEGA Sales Co.
12 Meeting St.
Cumberland, RI
(401) 722-1027

PRIME 16K DYNAMIC RAMS
$35.00 for Memory Expansion Kit
- TRS-80 (Tandy Corp. ™), Exidy, Heath, Apple, Pet
- No special tools required
- 100% Guaranteed

APPLICATIONS ENGINEERING
2 Maria St., Lincoln, R.I. 02865

MASSACHUSETTS



Model 111 16 K • $859
TOLL FREE 1-800-343-8124
THIS is only one of hundreds of unusual values . . .
Get your **FREE CATALOG** today!
computer plus
245A Great Road
Littleton,
MA 01460

NEW JERSEY

COMPUTER MART OF NEW JERSEY
501 Route 27 Iselin, N.J. 08830
(201) 283-0600
The Microcomputer People®

NEW YORK

SOFTWARE FOR TRS-80 APPLE, ATARI, & PET
AT DISCOUNT PRICES
SOFTWARE CITY
31 E. 31st St.
N.Y., N.Y. 10016
(212) 889-8975

WISCONSIN

OHIO SCIENTIFIC SYSTEMS
We'll Beat Any Price!
Write or Call for Catalog
Toll Free
(800) 558-0870
COMPUTERS PLUS, INC.
2749 South 108th St.
Milwaukee, WI 53227
(414) 321-1770

MICROCOMPUTER MART ORDER FORM

Please Print Clearly or Type Copy in Space Below
(Indicate position of any illustration in ad & supply B&W photo)

Please refer to heading on this page for rates & ad placement information

OF INCHES ________ # OF INSERTIONS ________

☐ PAYMENT ENCLOSED $________
☐ CHARGE: You will be billed monthly ☐ Amex ☐ Diners ☐ Visa ☐ MC-Interbank # ________

Account # ________ Exp.Date ________

SIGNATURE ________

PRINT NAME ________

ADDRESS ________

CITY ________ STATE ________ ZIP ________

www.americanradiohistory.com

Electronics Classified

CLASSIFIED RATES: Per Word, 15 Word Minimum. **COMMERCIAL:** $3.00. **EXPAND-AD®:** $4.50. **DISPLAY:** 1" x 2¼", $370.00. 2" x 2¼", $740.00. 3" x 2¼", $1,110.00. **GENERAL INFORMATION:** Frequency rates and prepayment discounts available. Payment must accompany order except credit card — Am. Ex., Diners, MC, VISA (include exp. date) — or accredited ad agency insertions. Copy subject to publisher's approval; must be typewritten or printed. First word set in caps. Advertisers using P.O. Boxes MUST supply permanent address and telephone number. Orders not acknowledged. They will appear in next available issue after receipt. Closing date: 1st of the 2nd month preceding cover date (e.g., Mar. issue closes Jan. 1). Send order & remittance to: Classified Advertising, Popular Electronics Magazine, 1 Park Avenue, New York, NY 10016. Direct inquiries to (212) 725-3926.

FOR SALE

FREE! Bargain Catalog — I.C.'s, LED's, readouts, fiber optics, calculators parts & kits, semiconductors, parts. Poly Paks, Box 942PE, Lynnfield, Mass. 01940.

GOVERNMENT and industrial surplus receivers, transmitters, snooperscopes, electronic parts. Picture Catalog 25 cents. Meshna, Nahant, Mass. 01908.

ELECTRONIC PARTS, semiconductors, kits. FREE FLYER. Large catalog $1.00 deposit. BIGELOW ELECTRONICS, Bluffton, Ohio 45817.

RADIO — T.V. Tubes — 49 cents each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction plans — Complete, including drawings, schematics, parts list with prices and sources . . . Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch Tone Dial — Quadraphonic Adapter — Transistorized Ignition — Burglar Alarm — Sound Meter . . . over 60 items. Send $1.00 (no stamps) for complete catalog. Technical Writers Group, Box 5994, University Station, Raleigh, N.C. 27650.

SOUND SYNTHESIZER KITS — Surf $16.95, Wind $16.95, Wind Chimes $22.95, Musical Accessories, many more. Catalog free. PAIA Electronics, Box J14359, Oklahoma City, OK 73114.

TELETYPE EQUIPMENT: Copy Military, Press, Weather, Amateur, Commercial Transmissions. Catalog $1.00. WEATHER MAP RECORDERS: Copy Satellite Photographs, National-Local Weather Maps. Learn How! $1.00. Atlantic Sales, 3730 Nautilus Ave., Brooklyn, NY 11224. Phone: (212) 372-0349.

BUILD AND SAVE TELEPHONES, TELEVISION, DETECTIVE, BROADCAST Electronics. We sell construction plans with an Engineering Service. Speakerphones, Answering Machines, Carphones, Phonevision, Dialers, Color TV Converters, VTR, Games, $25 TV Camera, Electron Microscope, Special Effects Generator, Time Base Corrector, Chroma Key. Engineering Courses in Telephone, Integrated Circuits, Detective Electronics. PLUS MUCH MORE. NEW Super Hobby Catalog PLUS year's subscription to Electronic News Letter, $1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

UNSCRAMBLERS FOR any scanner. Several models available. Free literature. Capri Electronics, 8753T Windom, St. Louis, MO 63114.

UNSCRAMBLERS, seven models available to decode police, ambulance, and fire coded transmissions. Other scanner devices. Tone encoders/decoders. Telephone accessories, etc. Free Catalog. KRYSTAL KITS, Box 445, Bentonville, AR 72712. (501) 273-5340.

POLICE/FIRE SCANNERS, crystals, antennas, CBs, Radar Detectors. HPR, Box 19224, Denver, CO 80219.

PRINTED CIRCUIT supplies, chemicals, tools, artwork, plating solutions. Major credit cards. Catalog $2.00, refundable. CIRCOLEX, Box 198, Marcy, NY 13403.

RECONDITIONED TEST EQUIPMENT $1.00 for catalog. WALTER'S TEST EQUIPMENT, 2697 Nickel, San Pablo, CA 94806, (415) 758-1050.

Buy Gov't Surplus SAVE To 85%

Send 60¢ For Big Bargain Catalog

1000's Of Bargains; Surplus, Excess Inventory, Brand Name New Equipment

COMPRESSORS • WINCHES • GEAR MOTORS • TELEPHONES • WELDERS • POWER PLANTS • SURVEYING INSTRUMENTS • ELECTRONICS • FIRE/BURGLAR ALARMS • PAINT GUNS • TARPS • BINOCULARS • TOOL BOXES • HYDRAULICS • AIR TOOLS • PUMPS

SURPLUS CENTER Box 82209-PE Lincoln, Nebraska Zip Code 68501

NEW ELECTRONIC PARTS. Continuously stocked. Stamp brings catalog. Daytapro Electronics, 3029 N. Wilshire Ln., Arlington Hts., IL 60004.

ELECTRONIC CATALOG. Over 4,500 items. Parts & components. Everything needed by the hobbyist or technician. $2.00 (U.S. funds) $4.00 Foreign Postage & handling, refundable with first $15.00 order. T & M Electronics, 472 East Main St., Patchogue, NY 11772. (516) 289-2520.

SPEAKERS SAVE 50%. Build your own speaker system. Write: McGee Radio Electronics, 1901 McGee Street, Kansas City, Missouri 64108.

PRINTED CIRCUIT BOARDS, your artwork. Quick delivery. Reasonable. Atlas Circuits, Box 974, Waynesville, NC 28786. (704) 456-3739.

HAMS, CBERS, SWLS, ELECTRONICS BUFFS! Parts, kits and plans now available for Popular Electronics projects. MORSE-A-WORD: Circuit boards $24.00; Essential parts kit $99.95; Complete four character kit $149.95; Eight character kit $169.95; Wired $249.95. RTTY READER: Boards $24.00; Complete kit $189.95; Wired $269.95. S&H $5.00 kits; $1.50 boards. Use VISA Mastercard. (414) 241-8144. Write for catalog. MICROCRAFT, POB 513PE, Thiensville, WI 53092.

CABLE TV DESCRAMBLERS AND CONVERTERS. MICROWAVE ANTENNAS AND DOWN CONVERTERS. Plans and parts. Build or buy. For information send $2.00. C&D Company, P.O. Box 21, Jenison, MI 49428.

FIBER OPTIC SPECIALS — 100 foot spool of fiber $3.00 — Experimenter's kit $6.00 — High Power LED with matched Detector $10.00 — Data Link construction plans (detailed) $5.00. Catalog with samples $1.00. FIBERTRONICS, Box 322-A, Primos, PA 19018.

SCRAMBLED TELEVISION — Encoding/Decoding. New publication. Complete theory, circuits. $9.95. Workshop. Box 393PEF, Bethpage, NY 11714.

RARE OUT-OF-PRINT ALBUMS. 25,000 in stock (FS). List $2.00 refundable. Record Warehouse, Box 4617, Dept. PE, Rochester, NY 14613.

Telephone Listening Device

Record telephone conversations in your office or home. Connects between any cassette or tape recorder and your telephone or telephone LINE. Starts automatically when phone is answered. Records both sides of phone conversation. Stops recorder when phone is hung up. This device is not an answering service.

Size 1cu

Each $18.95

Qty Disc Avail

Super Powerful Wireless Mic

10 times more powerful than other mics. Transmits up to ¼ mile to any FM radio. Easy to assemble kit. 15V battery (not incl.)

Size 2 x3 x

Call (305) 725-1000 or send $18.95 + $1.00 shipping per item to USI Corp., P.O. Box PE-2052, Melbourne, FL 32901. COD's accept. For catalog of transmitters, voice scramblers and other specialty items, enclose $2.00 to USI Corp.

CHEMICALS, Apparatus, Project Books, Wide Selection. Catalog send $1.00 to Pioneer Corp., 14a Hughey Street, Nashua, NH 03060.

TEST EQUIPMENT, new and used. Catalog $1.00. PTI, Box 8756; White Bear Lake, MN 55110.

QUALITY AUDIO COMPONENTS, Multi-Track Equipment, Programmable Calculators, Accessories. Competitive Pricing! Prompt Delivery! Knowledgeable staff! Service Facility! Credit Cards accepted. FREE catalog. SOUND IDEAS, Dept. SR, PO Box 340, Cary, N.C. 27511. 1-800-334-2483 (N.C. 919-467-8462).

SATELLITE TELEVISION INFORMATION — Build or buy your own Earth Station. U.S.$4.00 Satellite Television, RD 3, Oxford, NY 13830.

ELECTRO-VOICE Hi Fi component loudspeakers. Building your own Speaker System? Use the best Free discount catalog. SONIX, Dept. PE, Box 58, Indian Head, MD 20640. (301) 753-6432.

VIDEO TAPES - L500 2/$21.50, L750 2/$27.50. JVC-T120 2/$28.00. Order TOLL-FREE (800) 221-0400. FREE CATALOG. Also RCA, Zenith, G.E., Sony, Panasonic, T.V. parts. Mannfred Electronics, 60-10 Kissena Blvc., Flushing, NY 11355. (212) 762-7777.

SURPLUS CATALOG 8,000 items: Electronics, Stereos, Speakers, Alarms, Tools, Games, Solar, Auto-Home, 8 Issues $2.00, BNF(X), 119 Foster St., Peabody, MA 01960.

UNSCRAMBLE CODED MESSAGES from police, fire and medical channels. Also telephone recording adaptor. Same day service. Satisfaction guaranteed. Don Nobles Electronics, Inc. Rt. 7, Box 610-A, Hot Springs, AR 71901. (501) 623-6027.

SHORT WAVE LISTENERS! Free new catalog #5 of short wave receivers, digital frequency displays, Colins filters, active All-Band receiving antennas, loop antennas, scanners and special DX modifications! Kenwood — Yaesu — Drake — Sony — Panasonic — Grundig. Radio West, 3417 Purer Road, Escondido, CA 92025. (714) 741-2891.

$9.95 **LCD DIGITAL CLOCK CALENDAR**

12:00

Digits 6.1mm Dia. 30mm

Alternating date and time. Great for cars, boats, airplanes. Long life battery. 4year calendar. One year guarantee. Magnetic pieces for mounting. Other modules and products available.

LCD. Suite E-428, Fifth Avenue Scottsdale, AZ 85253

SATELLITE TELEVISION . . . HOWARD/COLEMAN boards to build your own receiver. For more information write . . . ROBERT COLEMAN, Rt. 3, Box 58-APE, Travelers Rest, S.C. 29690.

YOUR NAME TO ALL FREE CLASSIFIED'S under headings you mark. $1.00. FUTURE, P.O. Box 605, Dept 1, Alabaster, AL 35007.

REMODULATOR (LM 1889)-audio & video inputs - output R.F. switched for T.V. channel 3 or 4 $29.00. UHF and MICROWAVE units connect to T.V. antenna for commercial free movies at home $300.00. These are not kits. VIDEO GALLERY INC., 2270 Wyandotte W., Windsor, Ontario, Canada N9B IK2 (519) 254-2001. Visa & M.C. U.S. Inquiries.

RESISTORS ¼W, ½W5%C.F. 3cea. NO MINIMUMS. Send for details. Bulk pricing available. JR Industries, 5834-C Swancreek, Toledo, Ohio 43614.

BUILDING A ROBOT? Using stepper motors? SASE: Sparky Electronics, 64-62 Dry Harbor Rd., Middle Village, NY 11379.

HIGH FIDELITY COMPONENTS AND CAR TAPE PLAYERS. Buy top name brand equipment at the same price many dealers pay. 130,000 customers nationally. IN BUSINESS 29 YEARS. TOLL FREE 1-800-638-8806 or 1-301-488-9600.

DECODER KIT. TV UHF CHANNELS. Sine Wave Encoder System. Model 7 + 11 Mark I, complete kit $139.00, plus 5% for shipping and handling. Also parts etc. Catalog $1.00. Visa, Master Charge acceptable. Simple Simon Electronic Kits, 11852 S. Hawthorne Blvd., Hawthorne, California 90250. TEL: (213) 675-2335.

PCB as low as 15¢ sq-in. FREE DRILLING. International Enterprise, 6452 Hazel Circle, Simi Valley, CA 93065.

RF POWER TRANSISTORS/TUBES! MRF454 - $18.00. MRF455A - $14.50. 8950 - $9.75. 6LF6/6MH6 - $5.50. Catalog and cross-reference help available. WESTCOM, 1320 Grand, San Marcos, CA 92069. (714) 744-0728.

SUBSCRIPTION TELEVISION EDUCATION MANUAL! Two scrambling decoding systems, theory, circuits. Decoder dealers listed. $14.95. Kits available. Satisfaction guaranteed. ABEX, P.O. Box 26601-P4, San Francisco, CA 94126.

PSYCHEDELIC LIGHT DRIVER KIT 3 channel, 200 watts per channel. Just plug in your light strings and audio input. Easy to build. $24.95 plus $1.50 postage. QUEST ELECTRONICS, Box 1722, Costa Masa, CA 92627.

www.americanradiohistory.com

TELEVISION DOWNCONVERTERS and decoders $99.95 up. Details for SASE. GW Electronics POB 688, Greenwood, IN 46142.

TV/FM ANTENNA. UHF/VHF/FM, for fringe reception of color and HiFi. Patented inside outside installation slotted array. Nothing else needed. Order postpaid. Guaranteed, insured, airmail. Cash, COD, Mastercharge, Visa, for $20 from: SADCO, 11621 Hughes NE, Albuquerque, New Mexico USA 87112.

MICROWAVE ANTENNA SYSTEM. Complete ready to install 2300 MHz unit, $279.95. Detailed plans, $2.95 refundable toward antenna purchase. AMA, 45 Madrid Plaza, Mesa, AZ 85201. Dept. SS-12.

SAVE UP TO 50% on name brand test equipment. Free catalog and price list. Salen Electronics, Box 82, Skokie, IL 60077.

POLICE SCANNERS AT WHOLESALE PRICES. VISA MC Phone orders accepted. (415) 573-1624. Free catalog write: Scanners Unlimited, 1199A Laurel Street, San Carlos, CA 94070.

ELECTRONIC GRAB BAG - Transistors, Diodes, Resistors, Caps Fixed, VAR, Chokes, Crystals - Ten pieces only $1.69 plus 25¢ handling. REAL REP, 20335 Patterson, Perris, CA 92370.

SATELLITE TELEVISION receivers $300, dishes $100, LNAs, downconverters. Catalog $5.00. Satellite Systems Development, 1271 Traughber St., Milpitas, CA 95035.

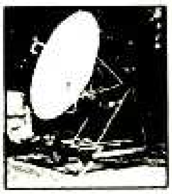
SATELLITE VISION

We manufacture the highest spec 3-meter data & video dish in the world 41db gain! We also sell direct. Immediate delivery or you pick up. Complete details including satellite TV information, aiming service and discount schedule. Send $1.25 for postage & handling to TIGER TENNAS P.O. Box 561 Casselberry Florida 32707

Satellite TV

FOR THE HOME

Sick of Network TV?



Our receiver lets you get over 75 channels of television directly from earth-orbiting cable TV satellites!: HBO Showtime, super stations, sports and movies worldwide.

We don't just sell information! We Manufacture Hardware!

From offshore oil rigs, data links to hotels and backyard installations, we wrote the book. Constantly updated, our **94 Page** technical information book and catalog gives you all the facts. Inexpensive dishes, feeds, telemetry software, kits and more. Recommended reading by NASA, The Office of Consumer Affairs and quality companies like Rockwell/Collins. Send $7.95 today!

CALL 24-hrs. C.O.D. Hotline (305) 339-7600

© SPACECOAST RESEARCH CORPORATION
P.O. Box 442-A, Altamonte Spgs, FL 32701

PICTURE TUBE REBUILDING equipment new and used. ATOLL TELEVISION, 6425 Irving Park, Chicago, Illinois 60634.

ELECTRIC CAR CONVERSIONS drawings, pictures, and prices $2.00 to CONVERSIONS, 2103 Leeway, Roseville, CA 95678.

ANTI-GRAVITY Solid-State Electronic Levitation. No moving parts, magnets, gases, exotic fuels. Data, Schematics, Diagrams, 78 pages 8x10 mimeo $15 ppd. Guaranteed! Visa Master Charge; Foreign add 20%. A.E.S., Box 132-M, Eureka Springs, AR 72632.

SUBSCRIPTION TV. 2300MHz Microwave Antenna Plans. Fully Guaranteed. $9.95. DynaComp Electronics, Dept. GF-1, P.O.B. 4181, Scottsdale, AZ 85258.

TUBES, IC'S, ni-cads, Firestick antennas, multimeters, amateur-short wave receivers, scanners, radar, and metal detectors, A.M.E. C.O.D.'s 1-800-531-5405.

TELEVISION DECODER complete kit $79.95. Assembled and tested $179.95. Hobbi Shack, P.O. Box 235, Jersey City, NJ 07303.

HARD to find components for the audio or music experimenter. Electronic Music Consultants, 533-P San Blas Pl., Santa Barbara, CA 93111.

HP-41C Income Tax programs. SSAE brings price list. AAV, 2007 Alban Lane, Bowie, MD 20716.

SUBSCRIPTION T.V. MICROWAVE ANTENNAS - Parabolic dish system. Down converts microwave signals to VHF television band (45 mile range). Send $9.95 for plans or $199.95 for complete unit-includes freight (unconditionally guaranteed 10 days-return for full refund). Substantial quantity discounts available-dealer inquiries invited. Send to: MICOM COMMUNICATIONS, P.O. Box 18401-17GA, Las Vegas, Nevada 89102.

MICROWAVE ANTENNAS. High quality commercial units available. Also complete plans and instructions for amateur microwave antennas, satellite T.V. and radar detectors. MICROTRONICS, P.O.B. 32357, Washington, D.C. 20007.

ETCHING SOLUTION: Safe and Economical. Why ship water when you save by mixing your own? Mix ½ lb. to make one gallon solution. Ammonium Persulphate. A pound makes two gallons. $2.85/lb. (Money Back Guarantee) Include $1.00 for P&H for first pound .50 for additional pounds. Minimum order $5.00. ATTENTION HOBBYIST: "How to Make Your Own Etching Machine." Two different sets of plans, complete with photos and instructions. One model can be made for under $10. Deluxe model for under $50. Send $9.95 to: E V Electronics, PO Box 247, Perryville, MO 63775.

TOP QUALITY SPEAKERS AND KITS. Send $2.00. Speaker Warehouse, 809 North Route 441, Hollywood, FL 33021.

PERFECT BOARDS EVERYTIME, technical breakthrough, cheap, safe, fast, easy. Info: COVAL, 2706 Kirby, Champaign, IL 61820.

AMATEUR RADIO

MADISON DEEP HAM DISCOUNTS. Kenwood, Yaesu, Icom, Drake, Accessories—Stock. FREE flyer. Madison Electronics, 1508-P McKinney, Houston, TX 77010. (713) 658-0268.

RADIO AMATEUR CALLBOOKS 1981 Directories of Radio Amateurs around the world. U.S. Callbook $20.50; Foreign Callbook $19.50, shipping included. See your dealer or write for FREE catalog. Radio Amateurs Callbook, Dept. PE, 925 Sherwood Dr., Lake Bluff, IL 60044.

PLAY YOUR TAPES, records, T.V. on any F.M. radio in your house - wireless - simple hook-up. Satisfaction guaranteed, $24.95. Port-o-Sound Co., Box 279A, Howard Beach, NY 11414.

COMPUTER EQUIPMENT

SURPLUS COMPUTER PERIPHERALS: "Selectric" I/O typewriter bargains. World's largest selection. Send 25¢ for bargain-packed flyer. CFR, Box 144, Newton, NH 03858.

CURRENT - LOOP INTERFACE ADAPTER for your terminal or computer, $99.00. For specifications write or call: DURACOM, 7300 North Crescent Blvd., Pennsauken, NJ 08110, (609) 662-7295.

LEARN MICROCOMPUTERS on your own computer. Send $5.00 for 2 complete instruction manuals. Paccom, 14905 NE 40th, Dept. MPE021, Redmond, WA 98052.

SERVICE. Maintenance and repair for all microcomputers and peripherals. Fast, reasonable. Prairie Micro Clinic. Box 325, Herington, KS 67449. (913) 258-2179.

WANTED — Sell your unwanted computer through us. Big savings for buyers in pre-owned equipment. Buyers/sellers — Send SASE or 25¢ for details, Autocomp, Box 246, Glenham, NY 12527.

RF MODULATORS! Special versions for SATELLITE TELEVISION, COMPUTERS, CCTV. Also Monitors, Cameras, Kits. FREE catalog. Phone (402) 987-3771. Dealers welcomed. ATV RESEARCH, 13-P Broadway, Dakota City, NE 68731.

TRS-80 COLOR COMPUTER Complete 16K. Memory Conversion Kit for the 4K. System $59.95. Instructions only $12.00. Culpeper Computer, 502-B South East St., Culpeper, VA 22701.

THINKING BASIC? 50 BASIC Computer Programs - Only $7.98! Money Back Guarantee! Timothy O'Malley, 426 Park Ave., Dunkirk, New York 14048.

6800 MICROCOMPUTER KIT, ONLY $79.50. 1K bytes ram, 256 bytes rom, hex keyboard, display, and power supply. For additional information or to order, write: SIERRA ELECTRONICS, BOX 5880, Lubbock, Texas 79417.

INTERACT COMPUTERS — Software, service. Best prices. Send for catalog: MICRO VIDEO, Box 7357, Ann Arbor, Michigan 48107.

FREE COMPUTER SUPPLIES CATALOG - 1600 field-proven products compatible with any mini or microcomputer. Tapes, disks, floppies, cartridges, cables, furniture, ribbons, more. Order by mail, phone. 24 hour shipment. Inmac, 2465 Augustine Drive, Dept. 200, Santa Clara, Cal. 95051. Call Sandy (408) 727-1970.

COPYCOMP SINGLE BOARD COMPUTER 2758 eprom, 64 word ram, 4 digit display, 6 inputs with restart, interrupt, 7 outputs, 3 level stack, counter-timer, power. COPYPROM eprom programmer available soon, schematics, software included with COPYCOMP. Book $10, Kit $100. Finished $120. COPYCATCO, 521 E. Clearview, Worthington, Ohio 43085. (614) 436-3849.

COMPUTERISTS AND COMPUTER CLUBS! Why pay full price for software? We have it all for most any system and will not be undersold! Guaranteed! Write for free listings. Pacific Discount Software, 3205 Production Circle, Oceanside, Cal. 92054. 714-439-6201.

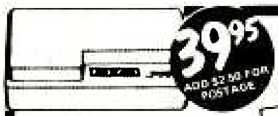
C.B. EQUIPMENT

GET MORE CB CHANNELS AND RANGE! Frequency Expanders, boosters, speech processors, how-to-books plans, modifications. Catalog $1. CB CITY, Box 31500PE, Phoenix, AZ 85046.

PALOMAR - PRIDE - ATLAS: Exclusive Repair Facility. Factory trained technicians, all work guaranteed. Palomar Electronics Repair Service, 1320 Grand, San Marcos, Cal 92069. (714) 744-0720.

CABLE TV

500 PHILIPS 32 CHANNEL CABLE TV converters and VCR programmers, $17,800 prepaid to your door. Sample $48. Birnbom, 3655 Ridgewood, Suite 103, Montreal, Canada H3V 1B4. (phone 514-739-0614). (U.S. inquiries).



$39.95 ADD $2.50 FOR POSTAGE

30 CHANNEL CABLE TV CONVERTER

ORDER No. 198AE047

ETCO ROUTE 9N, PLATTSBURGH, N.Y. 12901
Tel.: (518) 561-8700

FREE! UNUSUAL 96 PAGE ELECTRONIC PARTS & IDEAS CATALOG!

PLANS AND KITS

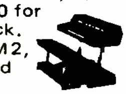
PRINTED CIRCUIT Boards from sketch or artwork. Kit projects. Free details. DANOCINTHS Inc., Dept. PE, Box 261, Westland, MI 48185.

LASERS HANDBOOK with burning, cutting, Ruby Reds, CO's complete plans, books, and parts. Send $4.00 to: Famco, Dept. PE, Box 1902, Rochester, NH 03867.

GIANT SCREEN TV projection system converts any television into 7-foot picture. Lens & instructions $14.95. (Dealers welcome). Bell Video, 4616 Belair Rd., Baltimore, MD 21206.

BUILD AN ORCHESTRA THE WERSI WAY

Preview the world's most advanced Do-It-Yourself Organs, Pianos, Synthesizers, Amps, etc. Send $6.00 for our famous "Sight & Sound" pack. WERSI Electronics, Inc., Dept.M2, P.O. Box 5318, 1720 Hempstead Rd., Lancaster, PA 17601.



KILL OBNOXIOUS LOUD TV commercials automatically. Complete plans $5.00. Bridges, 1248 N. Denver, Tulsa, OK 74106.

STEPPER MOTOR EVALUATION KIT contains Stepper Motor, Driver Board, Instructions. Ideal for hobbyists, Robot builders. $74.69, SES, Inc., 64-62 Dry Harbor Rd., Middle Village, NY 11379.

IN-GROUND SWIMMING POOL KIT — Blue-prints — Vinyl Liner—Side-Walls—Skimmer—Filer—Pump—All materials Necessary for Construction — Except Local Materials — 16'x32' $1,995.00-FOB. Cheswick Pool Sales Inc., Rte. 28, Cheswick, PA 15024. (412) 274-6400. Call Collect.

SUBSCRIPTION TV DECODER KIT. $39.00. Includes parts, manual and etched board. Manual only $4.60. JOE, P.O. Box 61, Cumberland, R.I. 02864.

BUILD SCOPEBOX® - eight trace shortage oscilloscope for fraction of a month's rent, DISPLAY ON ANY TV. For the information and A.N. send $5.00, refundable toward purchase of parts. CONCORD INSTRUMENTS, P.O.B. 1044, Melville, NY 11747.

HAVE THE URGE to build something? Write to Plans & Projects, 837 Summit Ave., Westfield, NJ 07090 for free catalog.

PAY-TV UNSCRAMBLER. Build your own. Fits all TV sets. Complete plans, $6.95. PCEP Enterprises, Box 837-S, New York, NY 10274.

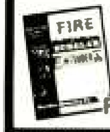
www.americanradiohistory.com

UNIQUE TV DECODER plugs between UHF and VHF tuners on tube or solid-state sets. Plans $3.95; DECODER ANTENNA receives multi-polarized signals. Plans $3.95; Antenna Kit $19.95. Helco, P.O. Box 304, Bridgewater, MA 02324.

PRINTED CIRCUIT BOARDS, send your sketches or artwork, kit projects. Quick Service. Free Estimates. ELECTRONIC DESIGN CONCEPTS, 2780 Skyline Circle, Memphis, TN 38127.

ALARMS

Burglar-Fire Protection



Protect Your Life, Home, Business, Auto, etc.

• Our catalog shows how install your own alarm systems and devices and save $$$$. We offer FREE write-in engineering service.

FREE CATALOG

Burdex Security Co. Box 82802-PE Lincoln, Ne. 68501

BURGLAR, FIRE, CAR! Finest equipment! Save! Free Catalog. Refundable! AAS, 186A Oxmoor Road, B'ham, AL 35209.

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado, Audio Technica, Osawa, Satin and ADC. Send for free catalog. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218. Toll Free 800-221-0906 9AM - 8PM except Sunday.

193 MARANTZ SQA-2 and 156 Marantz CD400B quad adapters. Original sealed factory cartons. $5950 the lot. Ridgewood, BOX 777, Champlain, NY 12919.

A SINGER'S DREAM!

REMOVES VOCAL FROM MOST STEREO DISCS

The Thompson Vocal Eliminator can actually remove most or virtually all of a solo vocalist from a standard stereo record and yet leave most of the background music untouched! Not an equalizer! We can prove it works over the phone. Write for a brochure and demo record below. COST: $249.00

YOU SHOULD SEE US

For:

- Time Delay/Ambience
- Studio Echo/Reverb
- Tape Noise Reduction
- Parametric Equalization
- Electronic Crossovers
- Compressor/Expanders
- Mic Preamp/Mixers

We manufacture a full line of high quality audio and recording equipment. You will probably have to pay twice as much elsewhere to obtain comparable quality. Only Direct Sales make our prices and quality possible. Send $1 for a 20 page brochure and 20 minute demonstration record.

Write to: LT Sound, Dept. PE, P.O. Box 338, Stone Mountain, GA 30086, Phone (404) 493-1258

WANTED

GOLD, Silver, Platinum, Mercury, Tantalum wanted. Highest prices paid by refinery. Ores assayed. Free circular. Mercury Terminal, Norwood, MA 02062.

TUBES

RADIO & T.V. Tubes — 49 cents each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

TUBES: "Oldies". Latest. Supplies, components, schematics. Catalog Free (stamp appreciated). Steinmetz, 7519-PE Maplewood, Hammond, Ind. 46324.

TUBES-RECEIVING, Industrial and Semiconductors Factory Boxed. Free price sheet including TV, Radio and audio parts list. Transleteronic, Inc., 1365 39th St., Brooklyn, New York 11218. Telephone: (212) 633-2800. Toll free: 800-221-5802.

TUBES-TUBES-TUBES: Radio-TV-Industrial, Antique & Obsolete tubes our specialty. Send $1.00 for comprehensive listing. Vacume Tubes, P.O. Box 13271, Tucson, Arizona 85732. (602) 299-5730.

HUGE INVENTORY! Thousands of types. Wholesale prices. FREE CATALOG! ETCO Electronics, DEPT. 290, Plattsburgh, NY 12901.

GOVERNMENT SURPLUS

MANUALS for Govt Surplus radios, test sets, scopes. List $1.00 (cash). Books, 7218 Roanne Drive, Washington, D.C. 20021.

JEEPS — $19.30!! — CARS — $13.50!! — 650,000 ITEMS!! — GOVERNMENT SURPLUS!! — Most COMPREHENSIVE DIRECTORY AVAILABLE tells how, where to buy!! — YOUR AREA — $2. — MONEYBACK GUARANTEE!! — Government Information Services", Department GE-76, Box 99249, San Francisco, California 94109.

"GOVERNMENT SURPLUS DIRECTORY." Buy 500,000 items (including Jeeps) . . . low as 2c on dollar! Most complete information available — $2.00. Surplus Disposal, Box 19107-HD, Washington, DC 20036.

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence, illustrated brochure free. Hermes-Verlag, Box 110660 Z, D-1000 Berlin 11, W. Germany.

PENFRIENDS — ENGLAND — USA, through correspondence. Send age, interests. Free reply. Harmony, Box 89PE, Brooklyn, New York, 11235.

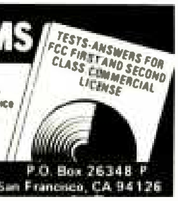
CORRESPONDENCE FOR FRIENDSHIP IN PHILIPPINES, MALAYSIA. Free information. AACC-(PE), Box 1542, Canoga Park, Calif. 91304.

INSTRUCTION

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, Ph.D.'s. Free revealing details. Counseling, Box 317-PE04, Tustin, California 92680.

LEARN WHILE ASLEEP! HYPNOTIZE! Astonishing details, strange catalog free! Autosuggestion, Box 24-ZD, Olympia, Washington 98507.

PASS FCC EXAMS



The Original FCC Tests-Answers exam manual that prepares you at home for FCC First and Second class Radiotelephone licenses. Newly revised multiple-choice exams cover all areas tested on the actual FCC exam. Plus "Self-Study Ability Test." Proven! $9.95 postpaid. Moneyback Guarantee.

COMMAND PRODUCTIONS, P.O. Box 26348 P, San Francisco, CA 94126

MEDICAL ELECTRONICS TECHNOLOGY, home study. Troubleshoot medical instruments. MDC, P.O. Box 124, Pinedale, CA 93650.

LEARN TELEVISION-Complete theory in really simple language. Many illustrations and complete transmitter & receiver circuits. $6.50 post paid in USA. Aptron Laboratories, P.O. Box 323, Bloomington, IN 47402.

COLLEGE DEGREES BY SPECIAL EVALUATION of EXISTING Credentials & Job Experience. Fast. Inexpensive. (614) 863-1791. Guidance, Box 13151-A4, Columbus, Ohio 43213. Be Specific.

YOU CAN NOW EARN A Bachelor, Master, or Doctoral Degree without leaving home. Courses are under faculty guidance. Kensington University, (P.O. Box 2036-M), 512 E. Wilson, Glendale, CA 91209.

TECHNICIAN? ENGINEER? AMBITIOUS? Want to become TOP-NOTCH? A TROUBLE SHOOTING & PROBLEM SOLVING ACE? A costly industrial seminar is now available in manual form for only $15 written by an expert for experts. It contains the most effective insights to TOP PERFORMANCE. Order now. The MASTERMIND from the author at full-refund, ONE YEAR-TRIAL, guarantee. Alex Botai, 4020 10 Brandongate L4T 3W8 Ont., CND. U.S. Inquiries.

ATTENTION ELECTRONIC TECHNICIANS

Highly Effective Home Study BSEE Degree Program for Experienced Electronic Technicians. Our New Advanced Placement Program grants Credit for previous Schooling & Professional Experience. Advance Rapidly! Our 36th Year! Free Descriptive Literature.

COOK'S INSTITUTE OF ELECTRONICS ENGINEERING

Desk 15 • P O Box 20345 • Jackson MS 39209

INCREASE THE VOLUME of your T.V. Stereo Service Business 50-100%! Send $14.00 to INSTRUCTIONS, Box 452, Royal Oak, MI 48067.

SMART MOVES! Use your calculator efficiently. Instructional units. $5.00. HMI-1A, Box 514, Gainesville, TX 76240.

LEARN ELECTRONIC ORGAN SERVICING at home. Completely revised course covers latest models including digital, LSI's, synthesizers, etc. NILES BRYANT SCHOOL, PO Box 20153, Sacramento, CA 95820.

Be an ELECTRICIAN

• MAINTENANCE • CONTRACTOR • CONSTRUCTION

Make more money! Check out Electrician's wages against the kind of money you make now!

TRAIN AT HOME IN SPARE TIME

Make extra money in spare time while you train for a full-time job. Do odd jobs for friends and neighbors. Save money doing your own electrical work. Learn everything from repairs and maintenance to complete electrical installations. No previous experience needed. Everything explained in easy-to-understand language with plenty of drawings, diagrams and photos. Tools, materials, test equipment included with course. Approved for Veterans and G.I.'s. Be ready to take almost any electrician licensing examination offered by state, city or county. No cost, no obligation, no salesman will call!

MAIL COUPON TODAY!

ICS SINCE 1891 Electrician School, Dept. PD031 ICS Center, Scranton, PA 18515

Rush free facts that tell how I can train at home in spare time to be an electrician

NAME ____________

ADDRESS ____________

CITY/STATE/ZIP ____________

FOR INVENTORS

PATENT AND DEVELOP Your invention. Registered Patent Agent and Licensed Professional Engineer. Send for FREE PATENT INFORMATION every inventor should have. Richard L. Miller, P.E., 3612 Woolworth Building, New York, NY 10007. (212) 267-5252.

INVENTIONS WANTED

FREE CONSULTATION ● NO IDEA TOO SMALL

Disclosure registration. Potential cash or royalties from manufacturers seeking new ideas. For free information on how to register your ideas. Call or write

AMERICAN INVENTORS CORP.

59 Interstate Dr. Dept PE
West Springfield, MA 01089 (413) 737-5376
A Fee Based Service Company

MANUFACTURER SEEKING Patented, Unpatented Inventions. Generous royalties. Advantek International, 1100 17th NW, Washington, DC 20036.

IDEAS, INVENTIONS, new products wanted! Write for Kit-Pe, IMI, 701 Smithfield, Pittsburgh, PA 15222.

BUSINESS OPPORTUNITIES

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

MECHANICALLY INCLINED individuals desiring ownership of Small Electronics Manufacturing Business — without investment. Write: BUSINESSES, 92-K4 Brighton 11th, Brooklyn, New York 11235.

MECHANICALLY INCLINED INDIVIDUALS

Assemble electronic devices in your home. Knowledge, or experience not necessary. Get started in spare time. Above average profits. $300 - $600/Wk possible. Sales handled by others. No investment — Write for free details.

ELECTRONIC DEVELOPMENT LAB
Box 1560PE, Pinellas Park, FL 33565

ERASE DEBTS with little-known law — create wealth!! Details FREE — Blueprints, No. EE4, LaGrangeville, NY 12540.

BORROW $25,000 "OVERNIGHT." Any purpose. Keep indefinitely! Free Report! Success Research, Box 29263-GD, Indianapolis, IN 46229.

FREE BOOK "2042 Unique Proven Enterprises." Fabulous "unknowns," second inflation income. Haylings-M, Carlsbad, CA 92008.

YOU CAN EARN $1,000 $3,000 WEEKLY rebuilding CRTs with Lakeside equipment. Lakeside, 4071 Elston, Chicago, Ill 60618. (312) 583-6565.

NEW TAX LOOPHOLES DISCOVERED. Everyone Eligible. Free sample newsletter. Write ULC, Box 179-BA, Clarkston, GA 30021.

MAILORDER OPPORTUNITY! Start profitable home business without experience or capital. Write for free book, case histories, plus complete details. No obligation. Mail Order Associates, Dept 719, Montvale, NJ 07645

MAKE DURABLE BUILDING Plastic easily. Waterproof, Fireproof, Economical. Bays Laboratory, 2086-2075 Drive, Cedaredge, CO 81413.

www.americanradiohistory.com

BIG MONEY IN BUSINESS PRINTING! 25% COMMISSION PLUS BIGGEST CASH BONUS! Build your own profitable year around business. Show tremendous line of salesbooks, register forms, unit sets, letterheads, envelopes, invoices, statements, business cards and dozens of other printed products. Lowest prices in industry. Something for every business and professional person. Free sales kit includes ad specialties, calendars, signs and ad matches. No experience needed. Our catalogs are easy to understand. We're over 50 but still young and aggressive, so we can show you the road to a very profitable full or part time career. Free sales kit. National Press, Dept. 139, North Chicago, IL 60064.

PROJECTION TV . . . Make $200.00 + per evening assembling Projectors . . . Easy . . . Results equal to $2,500 projectors . . . Your total cost less than $15.00 . . . PLANS, LENS & Dealer's information $14.00 . . . Illustrated information FREE . . . Macrocomchx, Washington Crossing, PA 18977.

BORROW $30,000 without interest! All eligible. Repay anytime. Free details. Infohouse-PE4, Box 1004, New York, NY 10003.

SEND $10 for a list of 100 Calif. employers wanting to hire technicians to: MEU, P.O. Box 3509, Santa Rosa, CA 95402.

WANT YOUR OWN RADIO STATION? Investment experience unnecessary. Free information. "Broadcasting", Box 130-A4, Paradise, CA 95969.

EMPLOYMENT OPPORTUNITIES

ELECTRONICS AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240E, Northport, New York 11768.

JOBS OVERSEAS - Big money fast. $20,000 to $50,000 plus per year. Call 716-842-6000, ext. 111A.

ELECTRONICS Employment Directory 500 companies with addresses. Excellent jobs available. $10.00. UNI-LIST, 280 Main St., Massena, NY 13662.

REPAIRS & SERVICES

TV TUNERS REBUILT, VHF or UHF only $11.90. Send for free mailing kit. JW Electronics, Box 51A, Bloomington, IN 47402.

ALL T V TUNERS repaired $11.95. Also repair Modules. Fast, quality work. MIKE'S T.V. TUNER SERVICE, Box 187, Bean Station, TN 37708. (615) 581-6393.

REAL ESTATE

BIG . . NEW . . . FREE SUMMER CATALOG! Over 2,800 top values coast to coast! UNITED FARM AGENCY, 612-EP West 47th, Kansas City, MO 64112.

RUBBER STAMPS

RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog Jackson's, E-100, Brownsville Rd., Mt Vernon, Ill. 62864.

RUBBER STAMPS - 3 line $2.00. Self-Inking $9.95 Printing catalog Dale's, 4725 45th N.E., Seattle 98105.

MUSICAL EQUIPMENT

MUSICAL INSTRUMENTS' HOT LINE! Incredible prices Amps, PA gear. All instruments. Huge selection Sam Ash, established 1924. 800-645-3518. NYS: (212) 347-7757.

BOOKS AND MAGAZINES

ELECTRONICS BOOKS AVAILABLE. World publishers. Lowest prices. Ask catalogue. Business promotion. Lajpatrai Market, Delhi, India.

ELECTRONIC MUSIC and home recording in Polyphony magazine. Advanced applications, interviews, projects, computer music. Sample $1.50. Subscription (6 issues), $8.00 US $10.00 foreign. POLYPHONY, Box P20305, Okla. City, OK 73156

THE SUPERMARKET OF ELECTRONICS — thousands of items for sale or trade each month. Free classified ad with subscription. Only $5.00 to Nuts & Volts, POB 1111-P, Placentia, CA 92670.

SHORTWAVE Hobby Equipment Review, 180 pages descriptions, user's reports, evaluations, modifications, receivers & hobby gear, contemporary & old favorites, non-tech language includes latest CRF-1, NRD-515, FRG-7700, RF-9000 etc. $4.95 ppd SDDXC, 1826 Cypress, San Diego, CA 92154.

TWENTY FREE Electronic Magazine Subscriptions, if qualified. Send $1.95 for complete information. Graham Associates, Box 38, Old Bethpage, NY 11804.

RECORDS & TAPES

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. 5-0481, New Rochelle, NY 10801.

DO-IT-YOURSELF

PROJECTION TV . . . Convert your TV to project 7 Foot picture. Results equal to $2,500 projector. Total cost less than $20.00. PLANS & LENS $16.00. Illustrated info. FREE: Macrocomch, Washington Crossing, PA 18977. MC VISA 215-736-3979.

HYPNOTISM

FREE Hypnotism, Self-Hypnosis, Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

MISCELLANEOUS

MPG INCREASED! Bypass Pollution Devices easily. REVERSIBLY!! Free details — Posco GEE4, LaGrangeville, NY 12540.

AUTOMOBILE RE-TUNING FOR MAXIMIZED ECONOMY. Details FREE! Techneering, Box 12191DD, Norfolk, VA 23502.

PROTECT YOURSELF from armed robbery! Guard against assault, $1.00. Central Mail, 3308 Midway Dr., #191, San Diego, CA 92110

MICROFILM EDITIONS AVAILABLE

Copies of **POPULAR ELECTRONICS** Magazine are available on microfilm from Xerox University Microfilms, Ann Arbor, Michigan; Microfiche from Bell & Howell, Micro Photo Division, Wooster, Ohio.

Popular Electronics

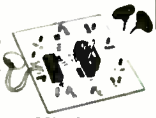
ADVERTISERS INDEX

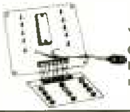
HAND HELD GAME BOARD SPECIALS

These are the complete functional circuit boards from popular hand held games — no case or batteries supplied.

Computer Perfect

Has 10 LEDS and tone signals. You try to guess correct button sequence to light LEDS in order. Requires two 9V batteries. With instructions. C24404 **$4.50**





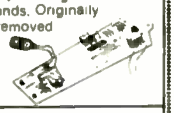
Computer Mind

You guess the secret number stored in computer chip memory. Has 10 LEDS and keyboard. Requires one 9V battery. With instructions. C24405 **$3.75**

Starsound Board

Unique board uses IC circuitry and gravity switch to produce space engine sounds. Point the board downwards and it produces "idle" sounds. Point upwards and the sound increases in pulsating frequency to produce "Blastoff" sounds. Originally had LED circuitry but this has been removed. Sound portion is 100% perfect. Requires 9V battery and speaker C24406 **$2.50**

2" Speaker for above C24311 99¢

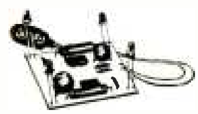


120 VAC Xenon Strobe Kit

Complete variable rate strobe light kit. Contains all parts, PC board, line cord and instructions. C23071 **$7.50**

Super LED Flasher Kit

Great for Robot projects this simple to build kit uses IC circuitry to randomly flash 4 LEDS, 2 red, 1 yellow, 1 green. Complete with all parts, PC board and instructions. Size 2" x 2". Operates on 9VDC. C24407 **$4.98**



CHANEY electronics inc.
P.O. BOX 27038
DENVER, COLORADO 80227

Phone Orders 303 781-5750

- Minimum AD Order $6.00
- Please include $1.50 for postage
- VISA MC accepted
- Phone orders are welcome

Send for our free catalog of unique items

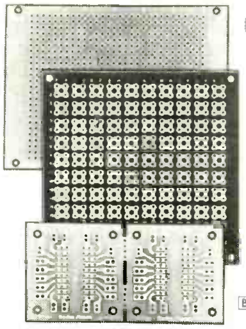
CIRCLE NO. 6 ON FREE INFORMATION CARD

www.americanradiohistory.com

Radio Shack is America's Parts Place™

No Minimum Order! No Waiting! Low Prices!

Phenolic PC Boards for Prototyping and Projects



NEW!

Low As 1.49

- *Pre-Drilled Mounting Holes at Corners*
- *Indexed for Fast, Accurate Layouts*

Ⓐ **Grid Board.** Has .100x.100 centers for DIP ICs and headers. 750 indexed contact points, labeled on both sides. 2¾x3¾." 276-158 .... 1.95

Ⓑ **Dual IC Board.** Accepts 8 to 20-pin DIP ICs and provides 4 contact points for each IC pin. 1¾x3⅝" 276-159 .... 1.49

Ⓒ **Component Board.** 100 pads with four contact points each. 5/32x5/32" centers for general use. 3½x3½" overall. 276-160 .... 1.95

Hand-Held Digital Logic Probe

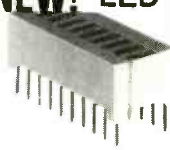
For All Logic Families, 5 to 15VDC

26.95

Displays logic levels, pulses and transients with bright LED indicators. Min. pulse width: 300 ns. 36" power leads with coded clips. 22-300 .... 26.95

NEW! LED Bar-Graph Display

Ideal for Power and Level Metering!



3.79

Bright red 10-step display in a 20-pin DIP. Use with driver chips, below. 276-081 .... 3.79

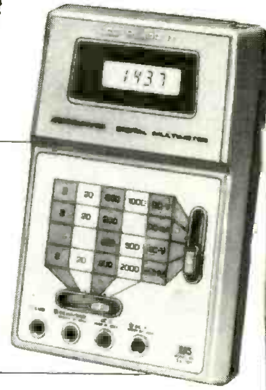
LM3914. Ten adjustable analog steps, bar or dot display modes. 18-pin DIP. 276-1707 .... 4.99

LM3915. As above, but with 3 dB log steps. 276-1708 .... 4.99

Sensitive 13-Range, LCD-Readout Digital Multimeter

- *10-Megohm Input*
- *.25"-High Display*

59.95



Deluxe Case

Only 5.95

Check the features! Automatic polarity and zero adjust, plus over-range and low-battery indicators. RANGES. AC Volts: 0—200, 500. DC Volts: 0—2, 20, 200, 1000. DC Current: 0—2, 20, 200 mA. Resistance: 0—2k, 20k, 200k, 2000k ohms. Size: 3 5/16x2⅛x1 5/16." With leads, instructions. Requires 9V battery or AC adapter. 22-197 .... 59.95

Vinyl Case. 22-154 .... 5.95

AC Adapter. U.L. listed. 273-1431 .... 4.95

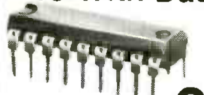
Super-Bright Xenon Flashtube

2.99 With Data

For projects, replacements. 272-1145 .... 2.99

Trigger Coil for above. 272-1146 .... 1.39

Sound-Maker IC With Data



6.99

A wide variety of sounds with a minimum number of external parts. 28-pin DIP. 276-1766 .... 6.99

Loud Miniature Piezo Buzzzzer

2.99 With Leads

Low Current Drain!

Ideal for battery-powered alarms. 4.8 kHz output. 1.5-20VDC. 273-060 .... 2.99

Infrared Optocoupler

1.99 Each

TTL Compatible

6-Pin DIP

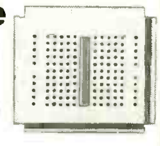
TIL-111. 5 ms switch time (typ.) 276-132 .... 1.99

TIL-119. Trans. ratio 300% min. 276-133 .... 1.99

IC Socket Breadboard

Save 30%

2.99 Reg. 4.49



Accepts ICs (up to 22 pin) for quick circuit development. 276-176 .... Sale 2.99

16K Dynamic RAM

Save $4 Reg. 13.95 9.95

4116. Our popular 100% prime hobby RAM. Under 250 ns access time. 1 ms refresh. 276-2505 .... Sale 9.95

9V Rectangular Battery Holder

NEW! 59¢

Metal clips keep 9V transistor battery in place! Requires #6 machine screw. 270-326 .... 59¢

0-37V Voltage Regulators

3.99 TO-220 Case

Up to 1.5A with heatsink.

LM317. Pos. 276-1778 .... 3.99

LM337. Neg. 276-1779 .... 3.99

Micromini Red LEDs

Save 26%

Reg. 1.19 88¢ Pkg. of 4

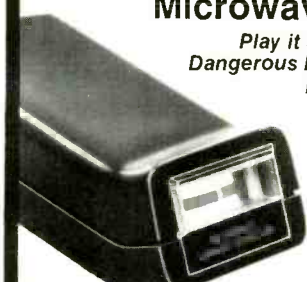
TLR-121. Hi brightness, yet only ⅛x1/16x⅛." 276-032 Sale, Pkg. of 4/88¢

Package of 3 DC Motors

NEW! *Only* 1.49

For 1½-6VDC. No-load RPM: 3500. Great for models! 273-208 .... 3/1.49

Microwave Leakage Detector



Play it Safe! Now You Can Spot Potentially Dangerous Leakage from Any Microwave Oven. Requires No Batteries or AC Power.

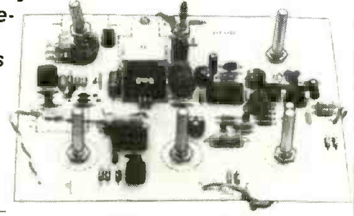
NOT A CERTIFICATION INSTRUMENT 14.95

Microwave leakage can cause serious health problems. Protect yourself and your family with this easy to use monitor. With complete instructions. 1 1/16x1⅞x4½." 22-2001 .... 14.95

Stereo Reverb Project-Board™

Adds Echo, Reverb and Phase-Shift Effects to Hi-Fi and Musical Instrument Amplifiers

9.95



SHOWN BUILT WITH RECOMMENDED PARTS

Uses SAD-1024 dual analog delay IC. Package includes pre-drilled, labeled board, parts list and complete instructions. PARTS EXTRA—all available at Radio Shack. For 120VAC. 277-132 .... 9.95

The Most-Popular Parts In-Stock! Start Your Next Project at The Shack®

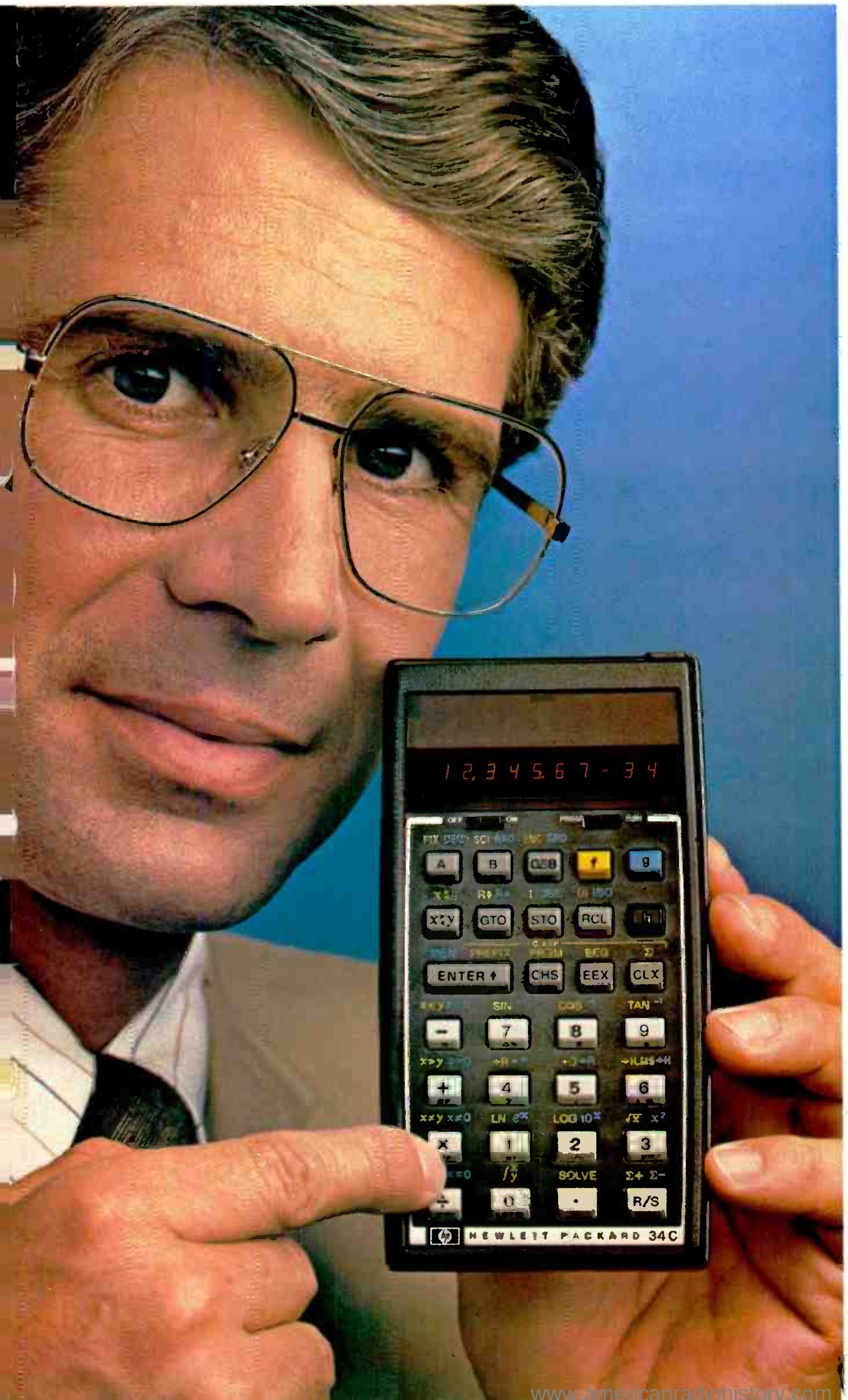
Prices may vary at individual stores and dealers

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7500 LOCATIONS IN 40 COUNTRIES

www.americanradiohistory.com

HP-33C, 34C, & 38C with Continuous Memory. They're ready when you are.



These advanced programmable calculators from Hewlett-Packard retain your data and programs even after they've been turned off. Just think how much more quickly and easily you'll be able to solve your business or scientific problems.

But these remarkable calculators do more than just remember. Consider the HP-34C, for instance. It provides up to 210 program lines. Up to 3 keystroke instructions are automatically merged into one program line, expanding memory to the equivalent of 370 program lines. And editing is a snap. The HP-34C's editing features let you review your programs and insert or delete instructions as needed. The HP-34C also has two special function keys, Solve and Integrate, to determine the roots of an equation or compute the definite integrals of a function.

Hewlett-Packard supports the HP-33C, 34C and 38C with the most comprehensive instruction manuals and software solutions to problems for science, engineering and business applications.

Visit a Hewlett-Packard dealer now and experience the advantages of Continuous Memory in one of these outstanding calculators.

HP-33C	Programmable Scientific with Continuous Memory. *New low price*	$90*
HP-34C	Advanced Programmable Scientific with Continuous Memory	$150*
HP-38C	Advanced Financial Programmable with Continuous Memory	$150*

For details and the address of your nearest HP dealer, CALL TOLL-FREE 800-547-3400, Department 254Y, except from Hawaii or Alaska. In Oregon, call 758-1010. Or write to Hewlett-Packard, 1000 N.E. Circle Blvd., Corvallis, OR 97330, Dept. 254Y.

*Suggested retail price excluding applicable state and local taxes—Continental U.S.A., Alaska and Hawaii. Display photographed separately to simulate typical appearance.

610/13

HEWLETT PACKARD

www.americanradiohistory.com

DISCWASHER®
AUDIOSCIENCE™ SERIES

Record Care, Part 2: A Record Life Study

How long will your phonograph records last?

How many times can you safely play records without degrading sound quality?

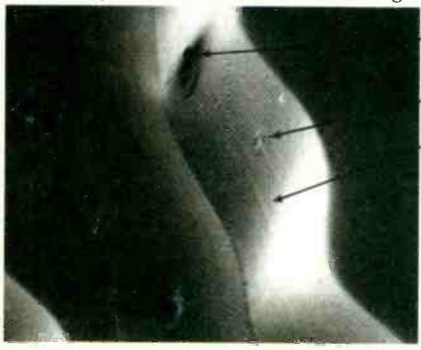
Using quality playback equipment, the factors of Record Longevity are twofold and closely interrelated: the record must be kept free of contamination, and the stylus must be kept clean during playback.

Scanning electron microscopy clearly shows the need and contribution of both record cleaning and stylus care.

Exhaustive research shows that with proper record/stylus care, an entire "life span" of 200 play events will not damage record surface quality or fidelity. (Most albums are played a total of 50 times or less.)

---

200 Plays Without Record Cleaning



Pit from dust abrasion.

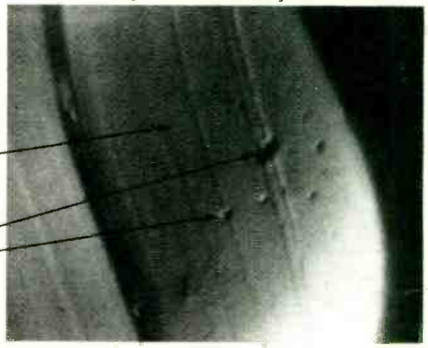
Ground-in microdust.

Prominent dust abrasion.

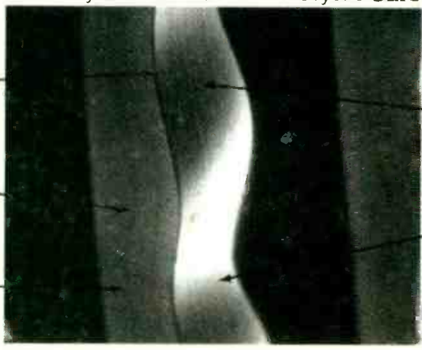
Prominent stylus path from abrasive-coated diamond face.

Vinyl particles welded by contaminated upper area of stylus.

200 Plays Without Stylus Care



200 Plays With Record and Stylus Care



Results of D4 Record Care:

Clean central radius due to capillary attraction of D4 Fluid into D4 pad fabric.

Microdust-free stylus path due to exclusive D4 "spiral fiber" particle holding.

No wall-slurry of "lubricant" products.

Results of SC-2 Stylus Care:

Reduced wall abrasion due to uncontaminated diamond face.

Cleaned stylus leaves no welded-in particles.

There is no substitute for the valid research you get with Discwasher products. Ask for them where better dealers take interest in a longer "life span" for you.

discwasher®
PRODUCTS TO CARE FOR YOUR MUSIC

Discwasher, Inc., 1407 N. Providence Rd., Columbia, MO 65201

CIRCLE NO. 12 ON FREE INFORMATION CARD

www.americanradiohistory.com