$1.25 ■ AUG. 1979

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

34140

ADAPTIVE NOISE FILTER
Hi-fi add-on you build

SATELLITE TV RECEPTION
A new DX craze

Build your own
AC POLARITY CHECKER
Don't get zapped!

TV ADD-ON GADGETS
Do they really work?

WIRING SYSTEMS
Easy ways to build projects

Build this 4½-digit
PRECISION DMM
with true RMS and temperature

PLUS:
★ New FM Tuner Circuits
★ 2 R.E.A.L. Lab Test Reports
★ Hobby Corner ★ Equipment Reports ★ Service Clinic

RETAILER: SEE PAGE 102 FOR SPECIAL DISPLAY ALLOWANCE PLAN

Value where it counts.

Count up to 550 MHz or more, count down to $69.95.* Smaller size, lower prices and professional accuracy help make CSC portable frequency counters the best in the business.

MAX-550 lets you count up to 550 MHz on your fingers! This amazing counter is as small as some pocket calculators, yet offers continuous six-digit readings from 30 KHz to 550 MHz, updated six times a second to speed your work. Battery powered, it's just $149.95.*

MAX-100 measures down to the last Hertz from 20 Hz to past 100 MHz, displaying the count on eight big 0.6" LED digits. It's battery operated, portable, and perfect for professional precision applications—and just $134.95.*

MAX-50 in its calculator-sized case lets you grab ahold of 100 Hz to 50 MHz and displays the count on six bright LED digits. Its accessory mini-whip antenna even lets you pick up RF fields when a cable is inconvenient. And it's a speed reader, with six updates per second. All for just $69.95.*

PS-500 is our very capable Buffered Prescaler, which extends the range of almost any frequency counter ten times, up to 500 MHz. Its buffered 400 mV output can drive even tired old counters reliably. And you can add this extra capability for just $59.95.*

We have a full line of accessories, too, including cables, battery charger/eliminators and more.

From audio to UHF, microprocessor to radio control, whatever your application, you can count on CSC frequency counters for performance—and value—where it counts.

CONTINENTAL SPECIALTIES CORPORATION

CSC

70 Fulton Terr., New Haven, CT 06509 (203) 624-3103, TWX 710-465-1227
OTHER OFFICES: San Francisco (415) 421-8872, TWX 910-372-7992
Europe: CSC UK LTD. Phone Saffron-Walden 0799-21682, TLX 817477
Canada: Len Finkler Ltd., Ontario

Call toll-free for details
1-800-243-6077

Smarter tools for testing and design.

* Suggested U.S. resale. Available at selected local distributors. Prices, specifications subject to change without notice.

CIRCLE 12 ON FREE INFORMATION CARD

Don't take our word for it.

"We can heartily recommend the Superboard II computer system for the beginner who wants to get into microcomputers with a minimum of cost. Moreover, this is a 'real' computer with full expandability."

Popular Electronics March, 1979

"(Their) new Challenger 1P weighs in at $279 and provides a remarkable amount of computing for this incredible price."

Kilobaud Microcomputing February, 1979

"Over the past four years we have taken delivery on over 25 computer systems. Only two have worked totally glitch free and without adjustment as they came out of the carton: The Tektronic 4051 (at $7,000 the most expensive computer we tested) and the Ohio Scientific Superboard II (at $279 the least expensive) . . . The Superboard II and companion C1P deserve your serious consideration."

Creative Computing January, 1979

"The Superboard II and its fully dressed companion the Challenger 1P series incorporate all the fundamental necessities of a personal computer at a very attractive price. With the expansion capabilities provided, this series becomes a very formidable competitor in the home computer area."

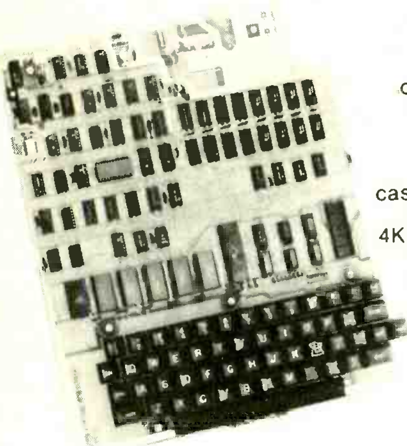
Interface Age April, 1979

"The graphics available permit some really dramatic effects and are relatively simple to program . . . The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. Everything is there that you need; you simply build on to what you already have. You don't have to worry about trading off existing equipment to get the system that will really do what you want it to do. At $279, Superboard II is a tough act to follow."

Radio Electronics June, 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."

Byte May, 1979



SUPERBOARD II
$279.00
The world's first complete computer system on a board including full keyboard, video display, audio cassette interface, 8K BASIC-in-ROM and 4K RAM. Expandable. Requires +5V at 3 amp power supply.

C1P $349.00
Complete with enclosure and power supply. All features of Superboard II. Easy to expand to more memory and floppy disk.

C1P MF $995.00
The first floppy disk based computer system the world has ever seen for under $1,000. 8K BASIC-in-ROM, 12K RAM. Expandable to 32K RAM.

OHIO SCIENTIFIC
1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

See your Ohio Scientific dealer for full details.

CIRCLE 3 ON FREE INFORMATION CARD

WHEN THE GOING GETS TOUGH, BECKMAN'S NEW DIGITAL MULTIMETERS KEEP GOING.

Featuring new continuity function.

If you've ever been troubled by a faulty multimeter—or had to use one that wasn't quite up to the tougher jobs—your troubles are over. Now there's the Beckman line of digital multimeters. A new generation of 3½-digit models that combine superior reliability with highly versatile features.

Features like a unique continuity test function. With Beckman's new Insta-Ohms™ quick continuity indicator, you no longer need an analog VOM for fast, convenient continuity checks.

There's also 10-amp current ranges, in-circuit resistance measurement capability in all six-ohm ranges, a dedicated diode test function, and up to two years normal operation from a common 9V battery.

The Model TECH 310 with all these features, 7 functions, 29 ranges, and 0.25% Vdc accuracy is only $130.

The Model TECH 300 with 0.5% Vdc accuracy, but without the continuity function or the 10-amp current ranges, is just $100.

Whichever model you choose, you get a multimeter that won't let you down. There's exceptional overload and 6kV transient protection, plus ruggedness to take a 6-foot fall and to come up working.

So get the Beckman digital multimeter that performs and keeps on performing. No matter how tough the going gets. For information on the complete line and accessories, write or call your local distributor or the Advanced-Electro Products Division, Beckman Instruments, Inc., 2500 Harbor Boulevard, Fullerton, CA 92634, (714) 871-4848, ext. 3651.

BECKMAN

CIRCLE 51 ON FREE INFORMATION CARD

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

AUGUST 1979 Vol. 50 No. 8

BUILD ONE

37 **4½-Digit Precision DMM**
Lab grade instrument with true-RMS and temperature.
by Bill Owen

43 **Adaptive Noise Filter**
Add-on for your hi-fi system reduces noise by 14-dB.
by Tim Skormond and Gene Garrison

53 **AC Polarity Checker**
Don't get zapped! Simple device checks AC outlet sockets for correct polarity and ground connections.
by William D. Kraengel, Jr.

VIDEO

47 **Home TV Reception Via Satellite**
The TV satellite network—broadcasts and frequencies.
by Robert Cooper

50 **TV Add-On Gadgets—Do They Really Work?**
A look at ghost eliminators, interference filters, etc., and their effectiveness.
by Robert B. Grove

72 **Service Clinic**
Don't forget the filter capacitors.
by Jack Darr

72 **Service Questions**
R-E's Service Editor solves technician problems.

AUDIO

57 **New FM Tuner Circuits**
A look at the circuitry behind the super performance and features of today's FM tuners.
by Len Feldman

60 **R.E.A.L. Sound Lab Tests Sony STR-V7 Receiver**
Sony's most powerful receiver.

63 **R.E.A.L. Sound Lab Tests dbx Model 2BX Expander**
2 band expander increases dynamic range.

TECHNOLOGY

4 **Looking Ahead**
Tomorrow's news today.
by Dave Lachenbruch

54 **Wiring Systems For Projects**
A look at the different ways you can wire your projects.
by Earl "Doc" Savage, K4SDS

66 **Hobby Corner**
How to modify an alarm clock for multiple alarms.
by Earl "Doc" Savage, K4SDS

68 **Communications Corner**
Are computerized CB's really computerized?
by Herb Freidman

70 **Computer Corner**
A look at the 8085 and how it compares to the 8080.
by P. Rony, C. Titus, D. Larsen and J. Titus

EQUIPMENT

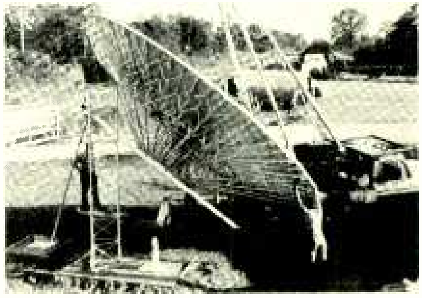
24 **Sinclair Radionics Model DM350 DMM**
24 **PTS Model 8001 Component Analyzer**
26 **Apple Disk II Floppy Disc System**
33 **Realistic Model DX-300 Receiver**

DEPARTMENTS

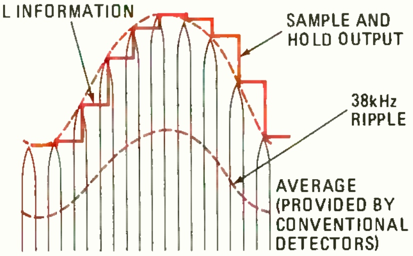
102 **Advertising Index**
6 **Advertising Offices**
76 **Communication Products**
75 **Computer Products**
6 **Editorial**
103 **Free Information Card**
12 **Letters**
82 **Market Center**
81 **New Books**
74 **Stereo Products**

ON THE COVER

Precision 4½-digit DMM has lab-grade performance and features, including true-RMS and temperature measurement. Basic DC accuracy is better than .05%. Internal rechargeable nickel-cadmium battery pack provides portability. Sounds interesting? Construction details start on page 37.



SATELLITE RECEIVING ANTENNA being mounted on posts in authors' backyard. To find out what's being broadcast and the frequencies, turn to page 47.



SAMPLE-AND-HOLD STEREO DECODING circuit is just one of the new circuits manufacturers are using for increased FM tuner performance. To find out what the circuits look like and how they work, turn to page 57.

Radio-Electronics, Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Controlled Circulation Postage Paid at Concord, NH. One-year subscription rate: U.S.A. and U.S. possessions, $9.98, Canada, $12.98. Other countries, $14.98. Single copies $1.25. © 1979 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A. **(ISSN 0033-7862)**

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

looking ahead

9-hour VCR? Things have changed in just 30 days' time. Last month, the Beta group announced that they had finally overtaken the VHS group in recording time per cassette, by means of a third (slower) speed and a cassette containing more tape. This combination provides five hours, as compared with four hours for the longest recording per cassette with the VHS system.

The VHS camp lost no time in adding a third speed of its own, which it calls "super long play" or SLP. Like Beta's new speed, this is one-third slower than the previous slowest tape movement in this format. Thus, VHS recorders push recording duration to six hours on the same cassette that will record for two hours on the original speed and four hours on the LP speed. But one technique employed by the Beta group is yet to be tried by VHS—longer and thinner tape. This is currently under development, however, and could expand the recording time to nine hours per cassette.

The first super-long-play VHS recorder will be a Matsushita-built programmable machine to be offered by RCA, but the third speed is expected to be added eventually to all VHS brands. Among other new VCR's is a Betamax by Sony, and a similar unit from Zenith, that offer stop motion, visible rewind and visible fast-forward (the latter function valuable for speeding through commercials without missing any of the program), all controlled from a wired remote panel.

TV for the deaf: A government-sponsored "closed-captioning" project is designed to make television more meaningful for America's 14 million hearing-impaired citizens. The system approved by the FCC uses one line of the vertical blanking interval, doesn't affect the picture seen by those viewing in the normal way, but superimposes a caption on the screen of those using special decoders. The Public Broadcasting System will supply 10 hours of programming weekly, ABC and NBC will supply five hours each to a new nonprofit National Captioning Institute that will encode the broadcast material for captions. The captioning decoders, using a Texas Instruments IC, initially will be manufactured by Sanyo Manufacturing Co. in Forrest City, AK. Decoders will be sold by Sears Roebuck next year at $225 to $250 and 19-inch color sets with built-in decoding capability will retail at about $500. The National Captioning Institute will be supported by captioning fees paid by the networks and an eight-dollar royalty on each decoder or decoder-equipped TV set. CBS has declined to join the other networks in using the captioning system because it believes captioning should be but one of the features of a more all-inclusive teletext system. The other networks agree that teletext systems can accomplish more and conserve vertical-interval space, but say it could be many years before such services are available, while captioning can start early next year. They also argue that teletext decoders will be far more expensive than simple captioning attachments.

Farewell to dots: The phosphor dots and delta guns that were important parts of the first practical color TV tube, as introduced by RCA 25 years ago, will fade into history before the end of this year. Tube makers are now phasing out the last of these tubes in favor of slot-mask tubes with in-line electron guns. In the latter, instead of phosphor dots there are strips of colored phosphors. Europe and Japan have already switched over, and in the U.S. the change is almost complete. Manufacture of delta-gun tubes will be confined to the replacement market.

Slot-mask in-line-gun tubes simplify the TV set manufacturing process and are more reliable because they eliminate most convergence adjustments. Until recently, their use was principally confined to small-screen tubes because of resolution problems involved in their use in larger tubes. But new electron gun designs have increased the resolution to the point where it is claimed to be better than that of delta-gun tubes. The new tubes in 19- and 25-inch sizes generally employ 100-degree deflection, which also helps increase resolution and makes the set about two inches slimmer from front to back. Most manufacturers are expected to change over their entire large-screen lines to 100-degree deflection.

Computers & games: Consumer logic and data-storage devices keep getting more sophisticated. Although computers as such have failed to catch on with the general non-sophisticated public, there's no doubt they will when somebody finds the correct formula. Mighty Texas Instruments is betting that it has that formula, although it hasn't yet announced what it is—only that it will have a home computer TV attachment for under $500 with color graphics and a 16-bit MPU.

Semi-computers and video games *have* caught on, though, and their sophistication grows every day. Portable storage and retrieval devices—such as the language translators by Craig and Lexicon—are being snapped up almost as fast as they can be made. Now Texas Instruments has come up with its own version, a *talking* language translator which gets the accent right every time. It has combined a translator with a voice synthesizer. You merely punch in the word in English, and the translation comes out the loudspeaker while the proper spelling is displayed. The hand-held unit accommodates modules containing 1,000-words, of which half the words can be pronounced by the unit, all of them displayed. English and Spanish modules (150 each) are scheduled for marketing in September, along with the under-$500 translator, with French, German, Japanese and Chinese modules due later.

A video game that is programmed by cable TV is the new "Playcable" by Mattel and Jerrold, which will be tested by four CATV systems. Two-way cable systems aren't required. For $50, an "emulator" cartridge is inserted into the standard Mattel video game, the user selecting the program he wishes from a catalog of 20 to 40 games stored in the cable system's head-end computer—for a monthly fee. After the initial games are tried, computer programs are expected to become available.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

editorial

What's Special About Radio-Electronics?

I was asked that question recently by a prospective reader. It's a simple question; a good one and it requires much more than just a simple response.

The answer starts off simply enough—***Everything!***

But that's only the start. Let's look at the issue you are now reading. There are six major articles. They range from a full-blown detailed story on how you can build your own 4½-digit precision DMM, to a newsbreaking article on tuning in television satellites to a how-to story on wiring systems to use when building projects. There are also a variety of features including an article on new FM tuner circuits, two R.E.A.L. Sound reports and numerous columns, equipment reports and product previews.

All of the material in this issue was carefully selected with your specific interests in mind. There is a variety of material because you have a variety of interests. Sure, some will like one article more than another and all of you may find some particular story that doesn't appeal to you at all. But what has been done is to put together a package of information deliberately designed to keep you up to date on what is happening in our industry.

When the computer came along, Radio-Electronics presented the first article to ever tell readers how to build one for themselves. When the Videodisc was announced, Radio-Electronics presented a group of three articles to show how the player works. When flat-screen or 3-D color TV comes along we'll tell you about that too.

In this issue, our story on Satellite TV Reception is a first. The satellites have been there for quite some time. Now you will discover just what is being broadcast, how it is being broadcast; and in the next few months, how you can tune in on these broadcasts—direct from space to your home.

That's the kind of magic that makes Radio-Electronics special. That's how we have kept Radio-Electronics special and young and growing. That's why in October 1979 we will celebrate 50 years of publication; 50 years of new events and happenings; 50 years of excitement in a never-dull field. That's why we are special and that's why we will continue to be special.

We don't promise to make all of our readers happy all of the time. We do promise to deliver the best and most authorative electronics magazine you can purchase.

Larry Steckler

LARRY STECKLER
Editor

Radio-Electronics®

Hugo Gernsback (1884-1967) founder

M. Harvey Gernsback, editor-in-chief and publisher

Larry Steckler, KTX-3644, CET, editor

Arthur Kleiman, KTZ-3288, managing editor

Robert F. Scott, CET, W2PWG, KXK-8533, technical editor

Jack Darr, CET service editor

Leonard Feldman contributing high-fidelity editor

Karl Savon, semiconductor editor

Herb Freidman, communications editor

David Lachenbruch, contributing editor

Earl "Doc" Savage, K4SDS, hobby editor

Ruby Yee, production manager

Robert A. W. Lowndes, production associate

Marie J. Stolfi, production assistant

Gabriele Margules, circulation director

Arline R. Bailey, advertising coordinator

Cover design by Louis G. Rubsamen
Cover photo by Walter Herstatt

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

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

ADVERTISING SALES

Paul McGinnis
Director of Marketing

EAST

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

MIDWEST/Texas/Arkansas/Okla.

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

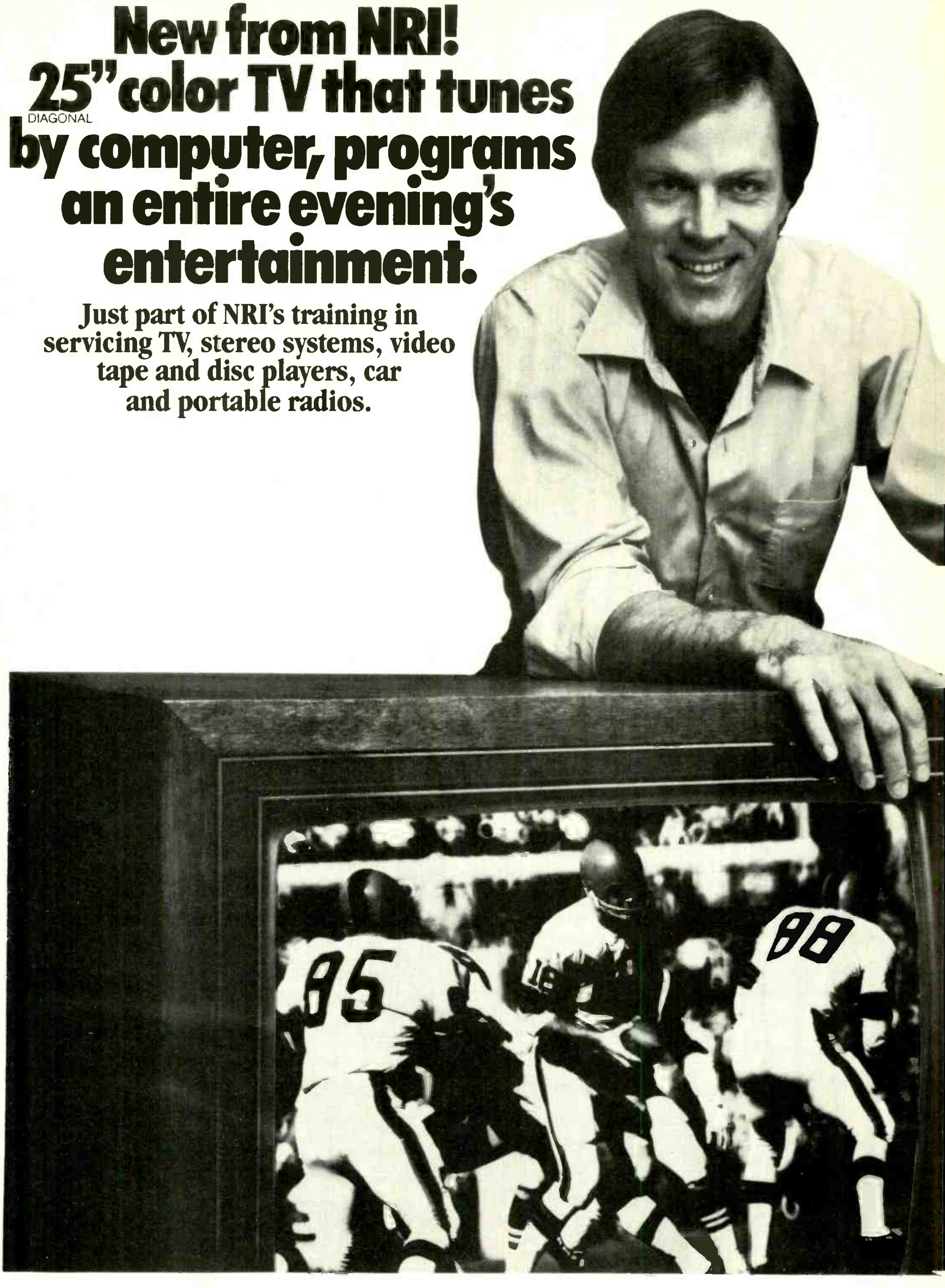
PACIFIC COAST
Mountain States

Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd.,
4th Floor,
Los Angeles, CA 90069
(213) 659-3810

Sales Mart Building
1485 Bayshore Blvd., Box 140
San Francisco, CA 94124
(415) 467-0125

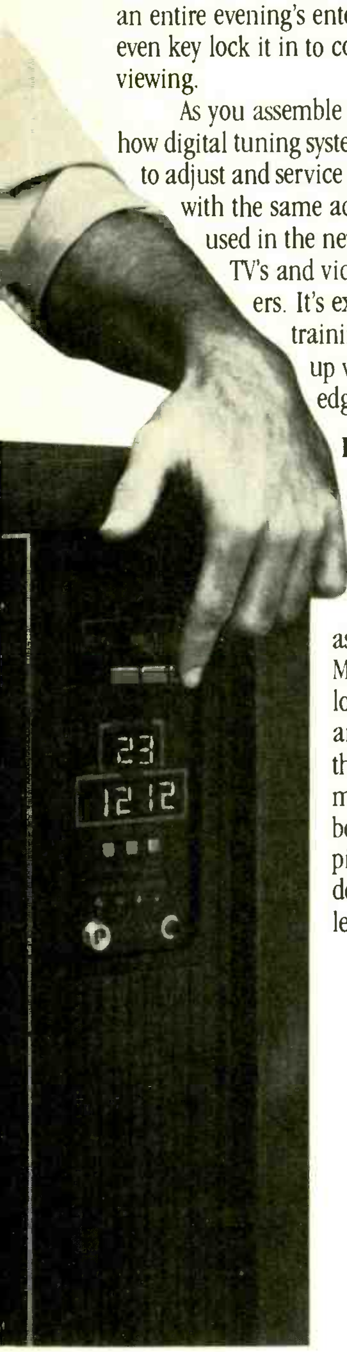
New from NRI! 25" DIAGONAL color TV that tunes by computer, programs an entire evening's entertainment.

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



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.

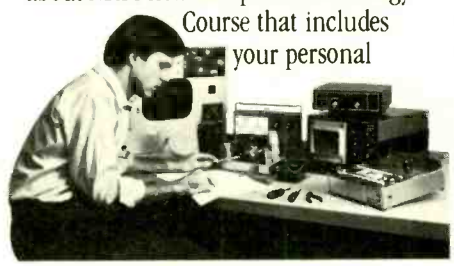
Complete, Effective Training Includes Video Systems

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 McGraw-Hill

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

letters

3 UNIQUE PROJECTS

The "3 Unique Projects" article (April 1979 issue, page 48) has been a godsend.

We built two of the One-Station Intercoms and installed them in Sales and Engineering; communications between the two are now on an order of magnitude better than before! The next two we build will go to Production and Quality.

Our Engineering Director has been complaining that he doesn't get "hands-on" duties since his promotion, so we gave him the Solar-Powered Night Light to debug: A glitch you failed to notice is the unit's behavior in semidarkness—when the lamp light reflects from our receptionist's jewelry onto the solar cells, which in turn increases drive to the lamp, etc. This feedback ultimately results in broadband oscillations centered just below 10^{15} Hz. Our Engineering Director solved the problem by replacing the lamp with one of National's Dark-Emitting Arsenide Diodes (DEAD's).

Finally, the Single-Shot Logic Indicator with Memory ended our long search for a readout device for Signetics' 25120 Write-Only Memory (WOM). Due to the WOM's unique architecture (all inputs are wired-don't-care), we've had trouble remembering if we had loaded a given IC with the program, and if so, with *which* program. The Logic Indicator worked so well in this application, it's no exaggeration so say it left us with stars in our eyes.

DOUG PRUNER
Genisco Technology
Compton, CA

I have been a subscriber to **Radio-Electronics** since 1956. I received my April issue and, with trepidation derived from past experience, examined the index, and was immediately drawn to the construction articles on pages 48 and 49.

I think the authors of these articles should be admonished on two counts:

1. They failed to emphasize the main outstanding feature of the One Station Intercom—its portability over all other systems.

2. The Solar-Powered Night Light would be a great boon on polar expeditions. With suitable modifications to maintain orientation, it should operate at full brilliance for six months at zero degrees, north or south latitude. The cells should be oriented to the noon sun and the light 180 degrees away, illuminating the midnight area.

I will not construct the Logic Indicator as searching for logic in this day and age is an exercise in futility.

JOHN MOON
Brossard, Canada

The Solar-Powered Night Light in the April 1979 article contains a philosophical error, which I figured out as soon as I built it. Those charlatans, Weinstein and Gartman, don't *really* care about energy conservation. That's why the lamp runs wastefully all the time even when it is not needed.

continued on page 14

Build better value with world-famous Heathkit Electronic Products

SEND FOR YOUR NEW FREE HEATHKIT® CATALOG

Read about the world's largest selection of fun-to-build, money-saving electronic kits – plus educational programs so effective they're guaranteed!

Every Heathkit product is quality designed and engineered, and gives you extra value because you build it yourself. Our world-famous instruction manuals take you step-by-step from unpacking the kit to final plug-in. They're marvels of technical accuracy and thoroughness. Find out about the pride, satisfaction and savings you can get by building your own electronic kits. Send for your catalog today!

NEW! All-In-One Computer System
Desktop computer with Terminal, Floppy Disk, and Keyboard in one compact unit.

NEW! One-Button Dialer
Real convenience for any telephone.

NEW! Deluxe Metal Locator
Adjustable discrimination for finding any kind of metal.

NEW! DC to 5MHz Oscilloscope
Low-priced scope great for TV service.

NEW! Low-Priced Multimeter
Great for hobbyist or service bench.

NEW! CW Transmitter
Deluxe transmitter with famous Heath value.

NEW! Auto-Ranging Digital Multimeter
Automatically selects proper range for best measurements.

NEW! X-Y Chart Recorder
Two channels for comparison plotting.

Nearly 400 quality electronic kits including:

• Hobby and Business Computers • Color TV • Stereo Components • Test Instruments • Amateur Radio Gear • Metal Locators • Automotive Instruments • Marine Gear and Accessories • Aircraft Instrumentation • Home Convenience Items • Security • R/C Modeling Equipment • Clocks • Weather Instruments • Tools... and much more

Send for it TODAY

HEATH
Schlumberger

Heath Company, Dept. 020-560
Benton Harbor, Michigan 49022

FREE CATALOG!

Please send me my FREE Heathkit Catalog.
I am not currently receiving catalogs.

Name ______

Address ______

City ______ State ______

CL-708 Zip ______

If coupon is missing, write:
Heath Company, Dept. 020-560 Benton Harbor, MI 49022

Heathkit products are displayed, sold and serviced coast-to-coast at Heathkit Electronic Centers (Units of Schlumberger Products Corporation). See the white pages of your phone book.

CIRCLE 100 ON FREE INFORMATION CARD

LETTERS
continued from page 12

So I added an ON-OFF switch in series with the circuit (at the risk of increasing circuit complexity and operating-procedure confusion). I refrained from the temptation to use a momentary-on pushbutton switch as that would increase the number of on-off surges and lead to short bulb life. This disadvantage would offset the automatic-off mode's advantages.

The ON-OFF switch is also essential in case of extreme positive feedback from the lamp output back to the cells, which could happen if you carried the night light into a well-mirrored bathroom, for example. Turning the switch promptly OFF can prevent the familiar motorboating condition or the dread *runaway* situation.

By the way, I was able to increase the usefulness of the night light by simply connecting about 10,000 miles of twisted pair in the circuit. Just put the solar cells either east or west of the lamp location.
ROBERT A. PEASE
Transtronics
San Francisco, CA

VIDEODISC SYSTEMS

Regarding the article that appeared in the April 1979 issue on the competing Magnavox and RCA videodisc systems, there are several points that should be made. No matter how biased my statements may sound, I am *not* professionally connected with any companies involved in promoting either system, although I do own and enjoy a Magnavox optical videodisc player and an assortment of the programs.

The author makes the point that several Japanese manufacturers (Panasonic and JVC) have already joined RCA in promoting the capacitive format. This has not yet occurred; and the JVC *Visc* system has so many obvious advantages over RCA's approach that if there is to be any standardization between these three companies, it may well be that RCA will join them.

Also, while the article states that these companies are at least talking with RCA about standardization, no mention is made of the fact that there is presently a partnership between MCA and Pioneer Electronics (under the name of Universal-Pioneer) to market optical videodisc players, and that General Motors has already placed an order for a *minimum* of 7000 players from the new company.

Although the article points out that due to the laser scanning of the MCA discs there is no deterioration from repeated playing, it does not tell us that with the RCA capacitive design, the discs wear out after about 200 plays and that the stylus that tracks RCA's grooves must be replaced after (approximately) 300 hours of use.

The paragraph that states that MCA is supplying the discs for the optical system reads as if MCA is the only source of feature movies. It is true that MCA is the only manufacturer of the discs; however, the initial program catalog includes feature films licensed to MCA from other studios, including Paramount, Disney and Warner Brothers.
ALFRED W. MYERS
White Plains, NY

EXPERIMENTERS' GROUP

I am a longtime reader and subscriber to your magazine, and it goes without saying that I like it very much. The articles give a very rounded insight into many aspects of electronics.

Being an experimenter by nature, I have felt there was a need for an organization to bring amateur scientists together. Now that need has been filled—the Amateur Scientists Research Organization has been formed. Interested persons can find out more by writing to ASRO, P. O. Box 4, McMechen, WV 26040. The latest newsletter and bulletin will be sent free with no obligation.
RICHARD S. MEYER
McMechen, WV

ON-SCREEN DIGITAL CLOCK

This is in reply to J. G. Ash's letter in the March 1979 issue regarding construction of the on-screen digital clock (July 1977 issue).

It appears to me that if S1 is held down longer than the C9–R13 time constant, the clock will be permanently on. This is because when S1 is initially closed, a ground is applied not only to pins 4 and 5 of IC2-b, but also to the negative side of C8. This will cause C8 to charge more or less instantly to pin 3's level, which is now going low. After C9 charges (from 4 to 6 seconds), current ceases to flow through R13, causing pins 1 and 2 to go low and pin 3 to go high. At this point, if S1 is still depressed,
continued on page 16

LETTERS

continued from page 14

C8 will charge instantly to this new level and will stay there even if S1 is released. We now have a stable state and the clock will stay on indefinitely.

My solution was to place an SPST toggle switch in parallel with C9. Closing the switch and activating S1 will cause the clock to stay on indefinitely (for setting purposes). After the clock is set, open the switch and the display will turn off after 4 to 6 seconds. I call this switch "Display Hold" on my clock.

D. A. TABBUTT
Las Vegas, NV

BURGLAR ALARM FLAW

Several years ago I built and installed a burglar alarm from an article in **Radio-Electronics** ("Anti-Theft Devices," R.M. Marston, November, December 1976). The circuit was ingenious and worked well—so well that I later built several for friends. But recently I discovered a basic and serious flaw in this design that applies to any other circuits using CMOS gates as sensitive switches.

The circuit takes advantage of the very high input impedance of CMOS gates, in order to use the series loop of normally closed switches with very low standby current. The switches are in series with a 22-megohm resistor. If all switches are closed, the input to the gate is pulled high; if any switch opens, the 22-megohm resistor pulls the input low, triggering the alarm.

The system I installed in my apartment uses conventional magnetic reed switches with exposed screw terminals. The apartment was painted recently by a sloppy housepainter using water-based latex paint. Several days afterward, quite by accident I discovered the alarm would *not* trigger if a particular door was opened.

A careful investigation revealed some paint had been slopped over the screw terminals of the reed switch. While the top surface of the paint was dry and measured infinite resistance, the underside of the peeled-off chip was evidently still damp and showed a series resistance of only 300K across the 1-inch span between terminals.

Since this 300K resistance was shunting the open switch, the alarm system interpreted it as a closed door. I don't know how long it would take for the paint to dry enough to increase its resistance to the 30 megohms or so that would be required to allow the circuit to function normally.

But this suggests a more serious problem. *Any* moisture across the screw terminals would shunt the open switch to the point where the circuit would not trigger! Readers who have installed alarms using this circuit should be warned to do one of two things:

1. Decrease the value of the pulldown resistor from 22 megohms to no more than 50K. Unfortunately, this will increase standby current to about 250 μA, but it *will* prevent dampness and condensation from defeating the system. OR . . .

2. Paint, spray or otherwise completely insulate the terminals on all sensor switches with a *non*-water-based paint or lacquer to prevent them from being shunted by moisture.

ROBERT R. LEVINE
New York, NY

CB REPAIR INFO WANTED

Your Jack Darr service format is one of the finest columns in any electronics magazine. I have been using the column for years in my TV servicing and have found many service troubles, thanks to Mr. Darr.

Now I have branched off into CB repair, and the same type of service format would be very useful. You definitely don't have enough information (in some months, none at all) or articles regarding CB's. I would think there would be more readers interested in CB's than in microprocessors, etc. Please stick more with the items the consumer on the street is likely to have.

CHET WHEELER
Bethlehem, PA

FUTURE DEVICES

Your April 1979 editorial was a well-produced mini-history lesson that many have probably taken for granted. Concerning the last paragraph about future products, I would probably not be able to fill the bill on dreaming; however, since you did ask:

I have been visualizing the day when our energy problems could be reduced to perhaps 10% of what they are now. To help this

continued on page 22

sophisticated soldering of space-age heat- & voltage-sensitive components

DEMANDS THE RELIABILITY OF

Weller® controlled output irons and stations

Modern, ultra-sophisticated electronic technology calls for totally dependable soldered connections. This requires not only sensing the soldering tip temperature, but applying and removing wattage at precisely the right moment to control the selected operating range of the iron.

That, in a nutshell, is what the Weller family of Controlled Output Soldering Equipment is all about. And that explains how it can avoid defects in soldered connections and damage to heat- and voltage-sensitive components and substrates, as well as deteriorating over-exposure from needlessly long soldering contact. In other words, dependence on the human element is eliminated. But there are other significant benefits from the Weller controlled output soldering technique. Soldering tips last longer. Much longer. And power consumption is less than that of uncontrolled irons.

What's the secret of Weller's controlled output? It's really no longer a secret. Today it's a time-proved principle: Closed loop, low voltage circuitry and a ferromagnetic sensor control temperature at a pre-selected range. Sounds simple? It is. That's why it's totally reliable!

Ready to meet the whole Weller Temperature Controlled family? This way, please for a brief introduction to the members presented below.

LINE VOLTAGE PORTABLE IRONS

Models W60 and W100: 60 and 100 watts. Operate from 120V outlet. Interchangeable 600, 700, and 800°F tips, grounded and non-grounded, available in 9 sizes. Optional de-soldering adaptor and non-heat-sinking tool holders.

COMPLETE SOLDERING AND DE-SOLDERING STATIONS

Include iron holder, tip-wiping sponge and receptacle, power on-off switch with indicator light, stepdown transformer dropping power to 24V in heating element, positive tip-grounding to prevent build-up of electrostatic charges that injure delicate components, non-burnable silicone rubber cord, and dozens of other Weller quality features.

Model WTCPN: Plug-in pencil soldering iron with comfort-cool heat shield, 17 available styles and sizes of interchangeable tips for 600, 700, and 800°F temperature control, integral tip storage tray. 120V, 60Hz, 60W. Optional de-soldering adaptor.

Model MP: For precision soldering of miniaturized electronics, especially PC work. Plug-in, true pencil shape 650 or 750°F iron with ⅛" diam. tips available in 8 sizes and styles. 120V, 60/40Hz, 22W.

CIRCLE 13 ON FREE INFORMATION CARD

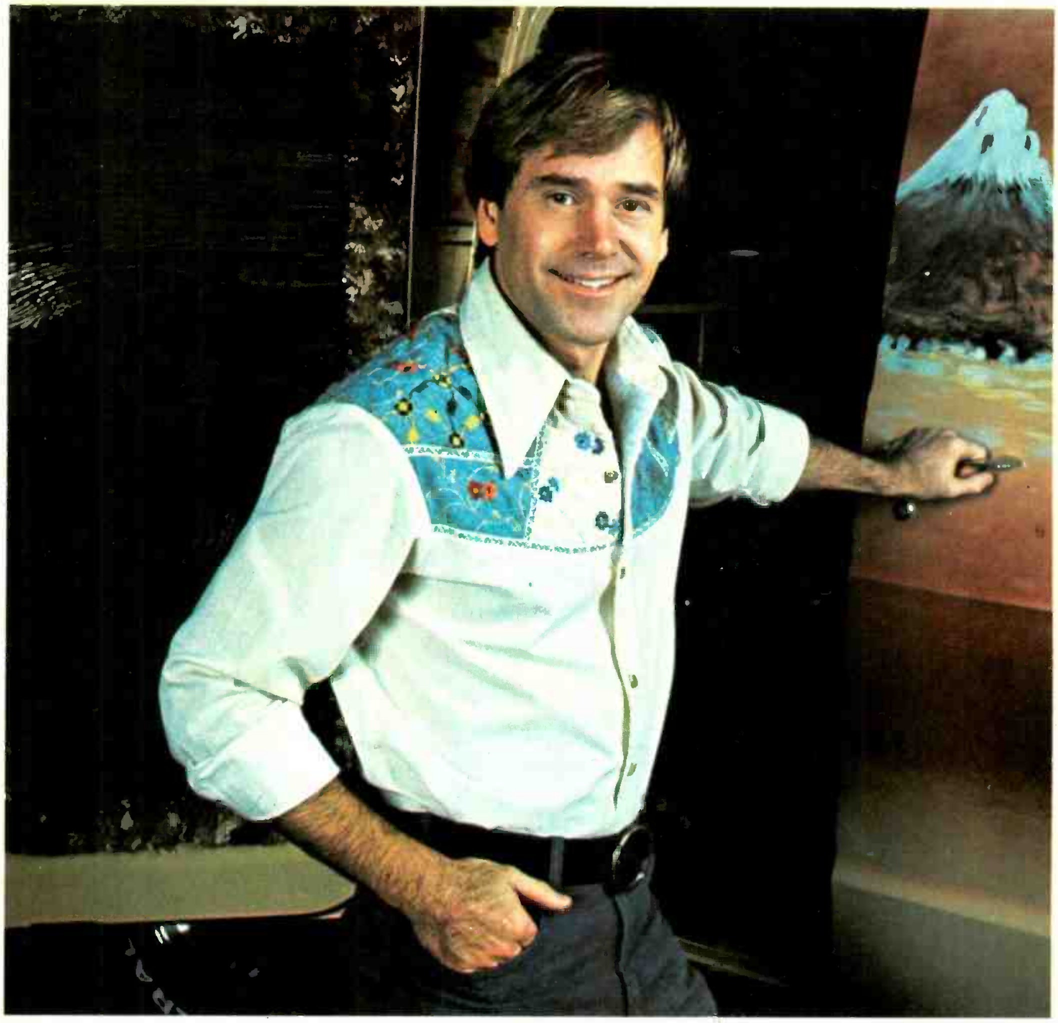
Model DS100: De-soldering and re-soldering unit designed for PC board repair and re-work lines. Utilizes interchangeable 600, 700, and 800°F soldering tips and interchangeable 700 or 800°F de-soldering heads. Complete with footswitch, twin safety tool holder, vacuum adjustment gauge, and cleanable, replaceable see-thru solder collector. 8 de-soldering tiplet sizes and 17 soldering tip styles (in 3 temps) available. Operates from factory air and line voltage.

Yes, of course, the entire family is UL listed and OSHA compliant. Now that you've been introduced, any leading electronic distributor will display the units and fill you in on all the features. For technical information and consultation, write the factory on your company letterhead.

COOPER INDUSTRIES

The Cooper Group
Electronics Division
WELLER®• WISS®• XCELITE®
P.O. BOX 728, APEX, NORTH CAROLINA 27502, 919/362-7511

You gotta shop around.



When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

When you shop around for tires, you look for a bargain. After all, if it's the same brand, better price—why not save money?

Education's different. There's no such thing as "same brand." No two schools are alike. And, once you've made your choice, the training you get stays with you for the rest of your life.

So, shop around for your training. Not for the bargain. For the best. Thorough, professional training to help give you pride and confidence.

* * *

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

Why you should shop around yourself.

We hope you'll shop around. Because, frankly, CIE isn't for everyone.

There are other options for the hobbyist. If you're the ambitious type—with serious career goals in electronics—take a close look at what we've planned for you at CIE.

What you should look for first.

Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

Here are ways some of CIE's troubleshooting programs help you get your "hands-on" training...

With CIE's Experimental Electronics Laboratory... you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!

When you build your own 5 MHz Triggered-Sweep, Solid-State Oscilloscope you take your first real professional step. You use it as a doctor uses an X-ray machine—to "read" waveform patterns... lock them in... study, understand and interpret them!

When you get your Zenith 19-inch Diagonal Solid-State Color TV you apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!

Pattern simulated.

When you work with a completely Solid-State Color Bar Generator—actually a TV signal transmitter—you study up to ten different patterns on your TV screen... explore digital logic circuits... observe the action of a crystal-controlled oscillator!

Of course, CIE offers a more advanced training program, too. But the main point is simply this:

All this training takes effort. But you'll enjoy it. And it's a real plus for a troubleshooting career!

Do you prepare for your FCC License?

Avoid regrets later. Check this out before you enroll in any program.

For some troubleshooting jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of specific knowledge and skills!

More than half of CIE's courses prepare you for the government-administered FCC License exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

Shop around... but send for CIE's free school catalog first!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name and date of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information!

For your convenience, we'll try to have a representative contact you to answer your questions.

Mail the card or coupon—or write: CIE, 1776 East 17th St., Cleveland, OH 44114.

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

☐ **YES...** I'm shopping around for the **right** kind of career training in electronics troubleshooting—and CIE sounds well worth looking into. Please send me my FREE CIE school catalog—including details about troubleshooting courses—plus my FREE package of home study information! **RE-69**

Print Name ______

Address ______ Apt. ______

City ______

State ______ Zip ______

Age ______ Phone ______ (area code)

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

Mail today!

LETTERS
continued from page 16

become fact, a better system of transportation would be the chief ingredient—how about a transport system that operates over the phone lines. Sounds a little like "Star Trek," doesn't it? California to New York in two minutes? Remember, you said—dream!! If I get busy this week, maybe I'll have it in operation by, say, 2190. [The article on page 6 ("New & Timely") concerning the light-powered phone gave me the idea.]

And we just loved the Solar-Powered Night Light. As I see it, this should be the first practical perpetual motion machine.

Now, how about an LED on a giant scale to be used for illumination? What a savings in power consumption for street lights, home lighting, etc. And then, how about a fiber-optic cable system to reduce power even more for street lights by putting one LED cluster in a 10-block sector and cabling to the immediately surrounding blocks?

DAVID HARTMAN
Portsmouth, VA

WIRE-WRAP TECHNIQUES

Thank you for an excellent presentation of my article "PC/Wire-Wrap—New Construction Technique" (**Radio-Electronics**, February, 1979).

However, while all basic principles of combined wire-wrap and PC board design of tri-level techniques have been included in the article, your drawing of the 2102 PC board on page 54 (Fig. 1) does not make clear the breakpoints of the *data-in* and *data-out* pins. The top side of the PC board design shows clearly the breakpoints for 1K (18 IC's) enable lines, but the drawing will still have to show the breakpoints for each data input/output pin. A drawing of the bottom side of the PC board for the 2102 memory IC would have made this important detail clear.

Each 2102 IC must have an isolated wire-wrap foil pad. These pads are made by cutting the final etched PC line, just as the enable lines were separated. The final data lines are then connected for each input or output data bit by wire-wrap process. The data-bit 1 input requires eight wire-wrap connections, and the data-bit 1 output also requires eight wire-wrap connections.

Also the drawing of the edge connections in Fig. 1 for the wire-wrap circuits is misleading. The correct edge-connection pattern would have the following connecting points: 10 address lines, 1 positive line, 1 ground line, 8 enable lines for an 8K board by 1K increments, 8 Data Input Lines and 8 Data Output lines. The correct edge-connector pattern, then, is 36 individual connections for the wire-wrap points.

I hope this omission can be corrected since Fig. 1 only lacks the data line breakpoints of the bottom side of the PC board and the correct 36-line edge connections. Readers who use the drawing as shown will not have all the data that is needed to make this tri-level technique work; corrected drawings will help them beat the "wire-wrap jungle."

JAMES E. TEMPLE

ELECTRONIC EQUATION

Mr. Ecklin's letter ("Letters," **Radio-Electronics,** April, 1979) about the "electronic equation" appears to correctly challenge the now-sacred law for the conservation of energy. Today's permanent magnets last for decades and off-the-shelf magnets easily lift 25 times their weight in iron, while most lodestones could not lift their own weight.

We now have tiny IC's for 16-bit computers with many thousands of active circuits on them that draw a total current in milliamperes. Even with this high efficiency, IBM is researching superconducting devices for even higher efficiency and speed. It is hard to guess how little power would be required to stop a magnetic field with a superconductor as Mr. Ecklin has suggested. It is also difficult to imagine a direct correlation between a 25-lb. magnet that could cause antigravity to over 600 lbs. of iron, and turning a superconductor on and off below the magnet's pole faces.

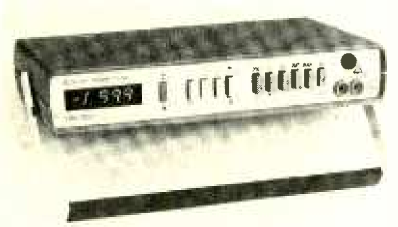
Maybe a magnet can store an unending supply of potential energy if we can divert or stop its magnetic field at will. So far we know of no way to stop or divert a gravitational field to create perpetual motion devices. One paragraph in a letter to **Radio-Electronics** may solve our energy crisis in spite of a well-proven law of science.

(By the way, Mr. Ecklin has informed me that the Doppler equation as shown in his letter was wrong; the last equal sign should have been a minus sign—i.e., $d = wf - c$.)

DALE BERG
Annapolis, MD R-E

equipment reports

Sinclair Radionics Model DM350 DMM



CIRCLE 101 ON FREE INFORMATION CARD

THE NAME OF SINCLAIR RADIONICS HAS BEEN familiar in England for quite a while. Now it's appearing in the U.S. The company is Sinclair Radionics, Inc., 66 Mt. Prospect Avenue, Clifton, NJ 07015.

The unit I tested was the *model DM350* bench digital multimeter (shown). This unit is one of a pair; the *model DM350* has a 3.5-digit display and the *model DM450* has a 4.5-digit display. Otherwise, the meters are identical, except for the greater resolution of the 4.5-digit model.

The meters measure AC or DC voltages from 200 mV up to 1200 volts DC or 750 volts AC in six ranges; AC or DC currents from 2.0 μA to 10A. A separate input jack is included that can handle up to 20A for up to 10 seconds. Resistance can be measured from 200 ohms to 30 megohms on six ranges. Overrange is indicated by the display being blanked, except for the left-hand digit that displays a "1."

Some unusual switching is used. When you read "6 ranges" and then notice there are only five voltage pushbuttons on the range selector, you start wondering. Then you read the instructions, and the mystery clears up. A special 2000-mV range can be used that has a tremendously high input impedance—greater than 1000 megohms. To set up this range you press both the volts and milliampere buttons simultaneously, and then you release all the range pushbuttons. The display is in millivolts divided by 10.

On DC and AC current ranges, you do the same thing: the lowest range pushbutton is 200 μA. A 2-μA scale is produced by pressing the V and the mA pushbuttons in plus the 200-μA pushbutton. For a 20-μA scale, press the 20V pushbutton.

Autozeroing is used on all ranges. On the lowest resistance range, shorting the test leads displays the lead resistance—typically 0.3 ohm. For precise readings, subtract this value. Accuracy on the DC voltage ranges is 0.1% on the three lowest ranges and 0.25% on the higher ranges; for AC voltages, 0.25% on the low range and 0.4% on the higher ranges; and for AC or DC currents, accuracy is typically 0.2%. Ohmmeter accuracy is 0.2% on all ranges.

The *model DM350* provides overload protection up to 1200 volts DC on all ranges, and to 750 volts AC on the AC ranges. The ohmmeter withstands up to 400 volts peak AC. Current ranges are protected by a 2A fuse (located in the back panel) except for the 10-amp range, which is not fuse protected.

The *model DM350* is housed in a small flat plastic case that measures 10 inches wide but is only 1.5-inches high. Despite the compactness of the DMM, the panel is easily accessible, and the pushbuttons are large enough and spaced far enough apart so that they are easy to hit. The displays are 7-segment LED's that are bright enough to read at any practical distance. The test leads (which are included) plug into three jacks at the far right of the panel, out of the way. A bail-type carrying handle doubles as a bench rest to hold the panel at the best viewing angle.

Power is provided by four built-in dry "C" batteries or from an AC adapter. The batteries are located under a sliding cover on the back of the unit. A selector switch on the back allows you to choose either disposable or rechargeable batteries. When the switch is in the disposable position, the internal batteries are disconnected when the AC adapter is plugged in. If rechargeable batteries are used, just set the switch to the rechargeable position, and the battery charge is maintained while the unit is plugged in. A low-battery condition is indicated by the whole display flashing; this means the batteries are down to 4.4 volts. However, accurate measurements can still be made for a few minutes before errors occur.

These DMM's are manufactured in England, and the workmanship looks good. Incidentally, if you misplace the manual, a label on the bottom of the case gives complete information on all ranges and functions. This is a very handy little instrument, at a reasonable price—$139.

PTS Model 8001 Component Analyzer

CIRCLE 102 ON FREE INFORMATION CARD

PTS ELECTRONICS, INC., (BOX 272, BLOOMINGTON, IN 47401) has added test equipment to its TV tuner repair and module rebuilding services. There are several units. One of these is the *model 8001* Component Analyzer. It's a compact instrument that is easy to run. All you need is a scope (of any kind) and connect the *model 8001* to its vertical and external horizontal inputs and off you go. Calibration and setup are fast. Adjust the scope's vertical gain plus the horizontal calibration control on the analyzer and there you are.

The *model 8001* can be used for tests on all solid-state components, such as transistors, diodes, etc. On a good diode or transistor junction, the analyzer shows a sharp right-angle pattern. A rounding of the angle shows there is leakage. A straight vertical line indicates shorted parts; open circuits show up as a horizontal line. Here's a quick check before starting: short the test leads together, a vertical line shows. If the circuit's open, then a horizontal line appears.

The *model 8001* can be used for in-circuit transistor testing. The patterns will differ from the out-of-circuit patterns, but the characteristic sharp angle will be there. The patterns are distinctive enough to indicate whether the component is bad or good. Several manufacturers have adopted this testing method, and their service manuals show the typical patterns that are found in various stages.

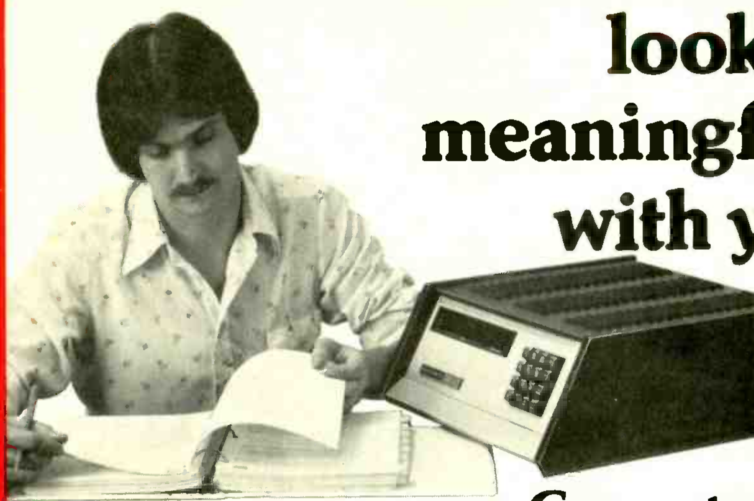
A good resistor shows a straight diagonal line. The angle varies with the value of resistance. A good capacitor will show an oval or a round pattern. Large capacitors have very low impedance. The *model 8001* has a LOW-MED-HIGH range switch to check any size. Many low-frequency inductors, such as power transformers, vertical-output transformers, chokes, etc., can be checked for shorts. If the winding is good, the analyzer will show a definite ellipse or even a circle if the inductance is high enough. If the component has shorted turns, a straight vertical line appears, and you cannot get a loop at any range-switch setting. Check the analyzer on a few good parts and you'll discover what to look for.

This instrument is useful for making A–B comparisons between identical circuits. In a stereo amplifier with one bad channel (a common fault), the same stage and junctions can be cross-checked between the working channel and the bad one. Here again, check some working circuits and observe what the patterns look like.

The front panel of the *model 8001* contains all the controls. The scope is connected to the horizontal and vertical jacks, and the test leads (provided) go to two universal binding posts. These binding posts are colored red and black, but the *model 8001* has no polarity. Hook up the leads one way, the angle goes up and to the right; reverse the leads, the angle goes down and to the left; but the sharp angle remains. The scope's vertical-gain control sets the length of the vertical line; the horizontal calibration control on the *8001* front panel adjusts

continued on page 26

looking for a more meaningful relationship with your computer?



Learn to speak its language with easy-to-use Heathkit® Computer Language Programs.

Heathkit Self-Instruction Program for ASSEMBLY Language Programming.

- Use the full capacity of your computer.
- Execute programs faster.
- Store more in less space.

ASSEMBLY Language lets you do *everything* your computer is capable of doing. It's the most versatile, most powerful language you can use.

ASSEMBLY includes a mnemonic for every machine operation. No time is wasted interpreting, so programs run much faster.

ASSEMBLY makes more efficient use of memory. It stores in less space because codes are shorter, more explicit.

The Heathkit Self-Instruction Program teaches you to program your computer in ASSEMBLY Language. You learn at your own pace through a special text designed for self-study. An exercise workbook provides hands-on experience with programming exercises performed by you on your computer. You learn in a way that's fast, fun and thorough.

The Heathkit Program is designed for computers using the popular 8080/8085/Z80 microprocessor series. This includes the Heathkit H8, H88 and H89 Computers. The concepts of the program, however, can be applied to any computer.

Now's the time to learn the language that puts you in total command of your computer's full potential. Send today for the Heathkit Self-Instruction Program for ASSEMBLY Language.

Order No. EC-1108: $49.95, plus shipping and handling.

Heathkit Self-Instruction Program for BASIC Language Programming.

- Easiest of all languages to use.
- Now easiest of all to learn.

More programs are written in BASIC than any other language. Because it uses English statements and commands, it's the easiest to learn and the easiest to use.

When you know BASIC you can adapt and run hundreds of existing programs. You can exchange programs with others. And you can write your own programs for your specific needs.

In 14 easy-to-follow segments, the Heathkit Program covers all formats, commands, statements and procedures. A special workbook provides programming instructions and experiments performed on your computer. You learn practical problem-solving techniques.

Until you know BASIC, you're missing the full selection of programs available to you. Send today for the Heathkit Self-Instruction Program for BASIC Language.

Order No. EC-1100: $39.95, plus shipping and handling.

Send Today or Phone for faster service on VISA and Master Charge. 616-982-3411

Heath Company, Dept. 020-562, Benton Harbor, MI 49022

SHIP MY ORDER TO:

Name ______________________
(please print)

Address ______________________

City ______________ State ________

Zip ________

HEATH
Schlumberger

Heath Company
Dept. 020-562
Benton Harbor, MI 49022

PLEASE RUSH ME:

☐ ASSEMBLY Language
EC-1108 .... **$49.95, plus $2.60 shipping & handling.**

☐ BASIC Language
EC-1100 .... **$39.95, plus $2.40 shipping & handling.**

Total price .... ________

Michigan residents add
4% sales tax .... ________

Add shipping & handling ... ________ ← ________

Total enclosed .... ________

☐ check ☐ money order ☐ Heath Revolving Charge Or charge my ☐ VISA/BankAmericard ☐ Master Charge

Account No. ______________ Expiration Date ______________

Signature × ______________________
(NECESSARY TO SEND MERCHANDISE)

Prices are mail order and subject to change without notice

ED-125

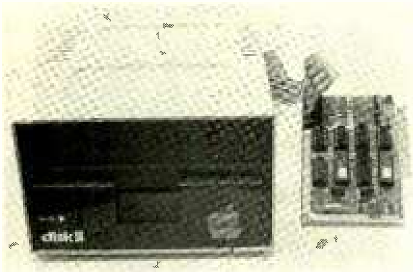
MONEY-BACK GUARANTEE OF SATISFACTION

If you are not completely satisfied with the EC-1100 BASIC Program or the EC-1108 ASSEMBLY Program, simply return programs for a full refund of purchase price.

the length of the horizontal line. The pattern will get smaller as you switch from HI to LOW on the RANGE switch. If the pattern becomes too small, just reset the horizontal calibration and vertical gain controls. The size makes no difference.

This is a simple but handy instrument that can be very accurate when used properly. It doesn't take long to set up, and it is priced at $54.95. **R-E**

Apple Disk II Floppy Disc System



CIRCLE 103 ON FREE INFORMATION CARD

OWNERS OF THE APPLE II COMPUTER (APPLE Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014) now have an alternate to their cassette tape system for saving programs and data. The *Disk II* system allows fast, reliable storage on standard 5¼-inch minifloppy diskettes. Up to 14 disc drives can be connected to the Apple II for access to nearly 1.6M bytes of data. The DOS (*D*isc *O*perating *S*ystem) is activated via a PROM-based bootstrap loader and master diskette supplied by Apple. The DOS adds the following commands: OPEN, CLOSE, READ, WRITE, SAVE, LOAD, EXEC, RUN, APPEND, RENAME, POSITION, VERIFY, CHAIN, LOCK, UNLOCK, DELETE, MON, NOMON, MAXFILES, CATALOG, INIT, BSAVE, BLOAD, BRUN, FP, and INT.

The *Disk II* consists of a controller card that plugs into one slot of the Apple II motherboard, a modified Shugart SA-400 disc drive, a system software diskette, a blank diskette and instructions. The packaging of the drive is excellent; the color-coordinated steel cabinet fits nicely on top of the computer. One controller card handles two drives; so up to a maximum of seven controllers can be used. Each drive is then referred to by its number, D, and by its controller's slot number, S (e.g., D1 and S6). Once a drive has been accessed, these values default to that drive until they are explicitly changed. Included on the software diskette is a game program, ANIMALS that demonstrates very nicely how the disc can be used to store data.

Using the *Disk II* is a breeze. Programs save and load by name, and about 10 times faster than by cassette. Thus, to store a program on the disc, you simply type SAVE <file name>, where <file name> is any name you select for the program. The DOS automatically keeps a directory of all files; these files can be seen by using the CATALOG command. The CATALOG command also shows the nature of the file (BASIC, Applesoft, machine code, or text), whether the file is protected, and also gives you some indication of the file length. Using the LOCK command protects files from accidental change or deletion.

The command list gives a fairly good indication of the power of the disc system. Particularly noteworthy are the EXEC, FP and INT commands. The EXEC command is similar to a RUN command except that the indicated file may contain entries not normally allowed in a BASIC program; for example, the HIMEM: command used to run many programs (i.e., the Apple Startrek game). Normally, such a program must be loaded into the computer and a HIMEM: command issued to set memory pointers correctly before it is run. Using the EXEC command allows such a program to be run from the disc just like any other program.

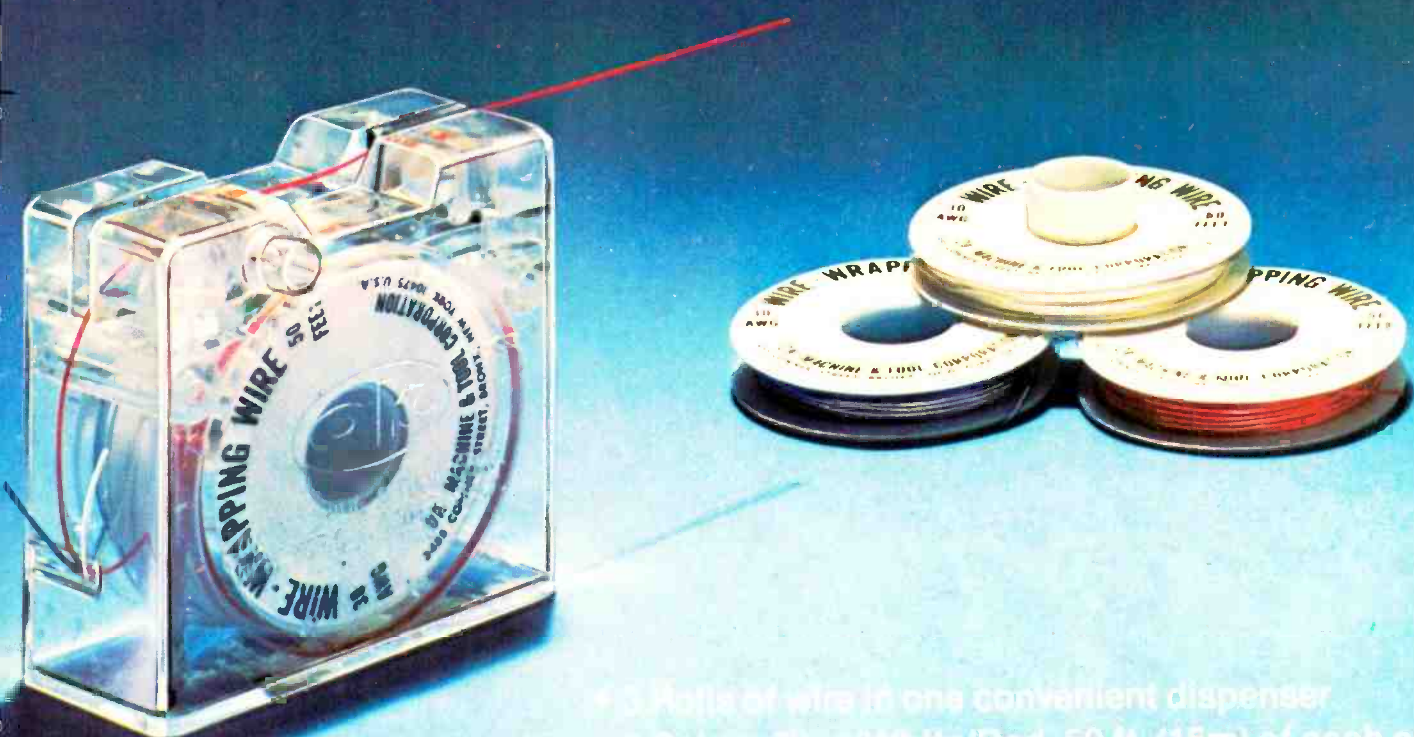
Another good feature of the disc is that the floating-point BASIC (Applesoft) is always handy and can be loaded within 8 seconds. For convenience, the commands FP and INT are used to switch between BASIC's. When a program is loaded from the disc, the computer checks which BASIC it was written in, and then loads Applesoft (or selects the Applesoft firmware card when installed) if necessary. Incidentally, this Applesoft is actually Applesoft II, an improvement over the original version. The DOS also allows a program to begin executing immediately after booting for a turnkey type of operation.

The DOS however has two flaws; its inability to CHAIN Applesoft programs, and the lack of any password security for files. While this last feature is of little value to most home-computer hobbyists, it is very important in

continued on page 33

TRI-COLOR

WIRE CUTTING AND STRIPPING DISPENSER



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

Model No. WD-30-TRI
Patent Pending

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

Kynar® Pennwalt

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

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

CIRCLE 24 ON FREE INFORMATION CARD

Train with NTS for the

MicroComputers, digital the first name

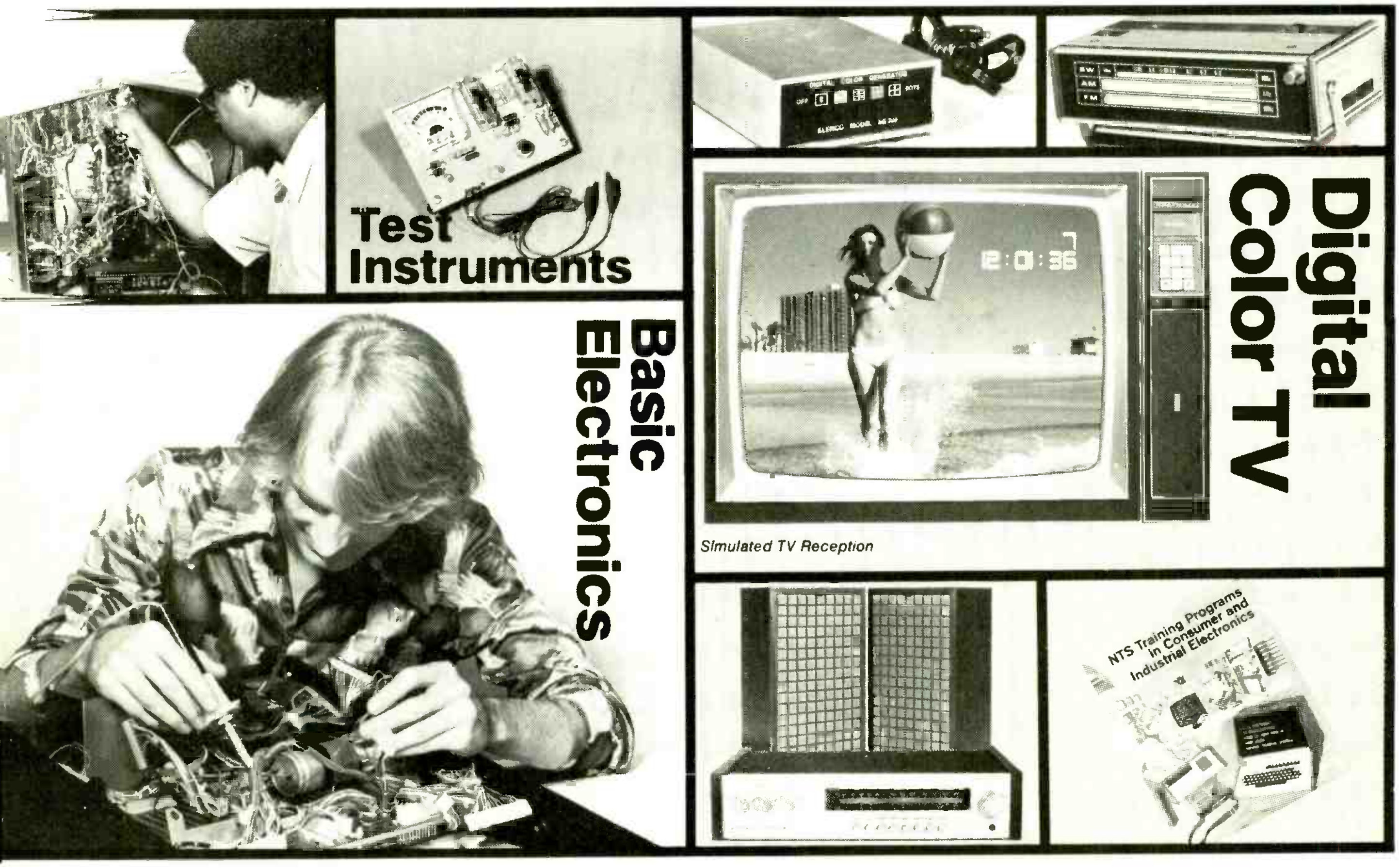
The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

The equipment you receive with NTS training programs is selected to provide you with a solid background in electronic systems. Kits and lessons are designed to work together to demonstrate electronic principles and applications. The kit-building not only shows you how electronic hardware functions, but how various circuit designs accomplish different purposes. Your lessons guide you through any number of experiments associated with many projects. This is the Project-Method, and it works. Step-by-step, you learn how and why digital electronics has become a part of our world, and the even bigger role it is sure to play in the future.

Whether you are looking for training in Consumer, Commercial, or Industrial electronics, NTS offers fourteen courses, some basic, many advanced, in several areas of electronics. An all-new full-color NTS catalog shows you what each course covers,

electronics of the future.

systems and more...from in home study.



Simulated TV Reception

and every piece of equipment included.

Send for it today, and see for yourself what's really happening in electronics training technology at NTS. Find out how much has changed, and what new directions the field is taking. You'll probably want to be a part of it.

It's free. Just mail the card or coupon. Today.

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

NATIONAL TECHNICAL SCHOOLS

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

NATIONAL TECHNICAL SCHOOLS Dept. 206-089
4000 South Figueroa Street, Los Angeles, California 90037

Please send FREE Color Catalog and Sample Lesson.

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

Name ____________________

Address ____________________

Apartment Number ____________ Age ________

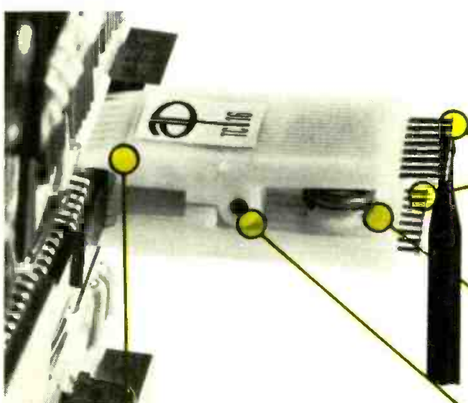
City ____________________

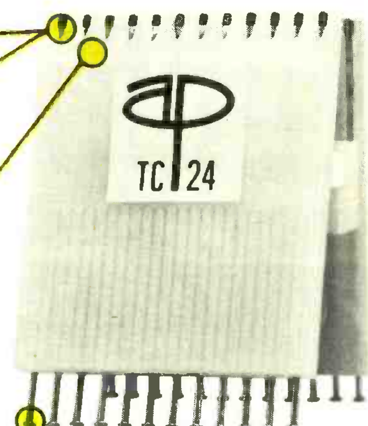
State ____________ Zip ________

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

NEW.

Meet Super Grip II, the great new test clip from A P Products.





New "duck bill" contacts are flat, won't roll off IC leads.

Open-nose construction enables probe at IC leg.

Pin rows are offset for easy attachment of probes.

Contacts are gold-plated phosphor bronze. "Contact comb" construction separates contacts with precision. No shorts.

Heavy-duty, industrial-grade springs for firm contact pressure—and a good grip when pulling ICs. They'll keep their spring indefinitely. No intermittents.

Steel pivot pin. Engineering-grade thermoplastic body molded around contact pins. Made to last!

New narrow-nose design makes it easy to attach on high-density boards. And now you can test ICs with only .040" between opposing legs.

New button-head pins keep probes from sliding off. (Straight pin models for logical connections.)

The new A P Super Grip II is, without question, the best way there is to troubleshoot DIP ICs.

You get positive contacts. No intermittents. No shorts. Ever.

So it's endlessly useful to you—and it's built to stay useful indefinitely.

Try one. You'll find 8, 14, 16, 16 LSI, 18, 20, 22, 24, 28, 36 and 40-pin models at your nearby A P store. (Make sure it's your A P store.)

Need the address? Call (toll-free) 800-321-9668. And ask for our complete A P catalog, The Faster and Easier Book.

A P PRODUCTS INCORPORATED
Box 110B • 72 Corwin Drive
Painesville, Ohio 44077
Tel. 216/354-2101
TWX: 810-425-2250

Faster and Easier is what we're all about.

CIRCLE 52 ON FREE INFORMATION CARD

EQUIPMENT REPORTS
continued from page 26

multiuser systems such as schools or businesses (where many Apple II's are currently found). Without such file security, a programmer could inadvertently (or even purposely!) change or destroy another programmer's files. Since the DOS resides in RAM, undoubtedly Apple and other computer companies will supply improved versions in the near future.

Overall, the *Disk II* performed very well. I have transferred all my programs from tape to disc, which quickly filled up more than six diskettes (over 600K bytes), and the disc has operated flawlessly. Indeed, the *Disk II* appears to be up to the high standards that the company has shown in the Apple II computer.

The *Disk II* costs $595, including the controller card. Additional drives (without controller) cost $495. It should be noted that due to high demand, delivery may be quite slow for a while. **R-E**

Realistic Model DX-300 Receiver

CIRCLE 104 ON FREE INFORMATION CARD

AFTER A PROLONGED PROMOTION PERIOD, REAListic (Radio Shack) has now made available its newest entry into the hobby listening market: the *model DX-300* general-coverage receiver.

This receiver is continuously tuneable from 10 kHz through 30 MHz and features a large, bright digital-frequency display, a frequency synthesizer and triple conversion. Specifications include: a shortwave sensitivity better than 1 mV; an image ratio 70–80 dB down; AM/LSB/USB/CW detection modes; a selectivity of ±3 kHz (−6 dB) and (±70 dB); and less than 1-kHz drift after a one-hour warmup period.

The receiver's appearance is exceptionally attractive with a military black finish, aluminum knobs and colorfully illuminated dials.

Since we are aware that packaging is an important part of salesmanship, we were eager to test the receiver to see whether its looks were deceiving. Our first reaction was one of disappointment. The drift rate on the sample receiver we tested was very rapid; it was virtually unusable in the single-sideband or continuous-wave modes until after a lengthy warmup period (the specifications warn the user of this).

Proper adjustment for each frequency range (it tunes in 1-mHz increments) is cumbersome: After the frequency range to be tuned is selected, the megahertz dial ring must be tuned for best signal, and then the preselector must be tuned.

Although the importance of proper adjustment of the megahertz tuning knob is not emphasized in the manual, the setting of this knob is *crucial* to acceptable performance.

continued on page 34

EQUIPMENT REPORTS

continued from page 33

Intermediate frequency feedthrough (i.e., the same interfering station is heard in the background, regardless of the setting of the tuning dial) is frequently present; this interference can be reduced by carefully adjusting the megahertz tuning knob and peaking the preselector. An external tuner or preselector would be very helpful here. "Birdies" (spurious signals generated by the synthesizer circuit) are present but no more troublesome than those found on similar receivers employing frequency synthesis.

Our particular sample receiver had a bad AC hum that could have resulted from shipping damage; also, the antenna screw-terminal was nonfunctional, as though it were disconnected internally. A subsequent inspection confirmed that a cold-soldered antenna-coupling capacitor was dangling loose in its solder pad.

Sensitivity was good above 150 kHz or so; below 150 kHz, the sensitivity became progressively worse. The receiver was virtually useless below approximately 70 kHz, even when using an external antenna tuner for optimum signal coupling. The VLF range was very unstable and full of oscillations.

Although the receiver can provide signal-copying capability without a tuner in the low-frequency range down to about 200 kHz, an external antenna-matching circuit is strongly recommended.

The IF selectivity is not adjustable, and some adjacent interference from the crowded frequency spectrum should be expected.

Make sure to read the instruction manual thoroughly while acquainting yourself with the receiver, or you may become very discouraged; with some practice, optimum tuning and adjustments will become automatic.

A company spokesman told us that the receiver is intended for general-purpose use; it is *not* a communications receiver. Now the receiver looks much better to us.

The reception on the AM band is excellent; the audio is crisp and a three-position tune control is provided for customizing the sound. The internal speaker works well without producing acoustic feedback at high volume. The ANL (*A*utomatic *N*oise *L*imiter) circuit is highly effective; in a particularly noisy environment, the hash noise was virtually eliminated without degrading the desired audio signal.

The tuning has a particularly good feel; a spinner dial coupled with silicone damping gives a professional touch to the tuning mechanism. A three-way power supply allows 120 VAC, 12 VDC, or battery operation (self-contained; the batteries are optional).

For the international broadcast enthusiast, the *model DX-300* is excellent. When you dial up the proper frequency, you know that you are right on target (within 1 kHz). Single-sideband stations will be offset by several kHz (the manual indicates 3 kHz, but our sample receiver was off by 5 kHz).

The built-in code-practice oscillator could be considered a handy device by an aspiring ham, or just a gimmicky toy by a more serious listener; it depends upon your point of view!

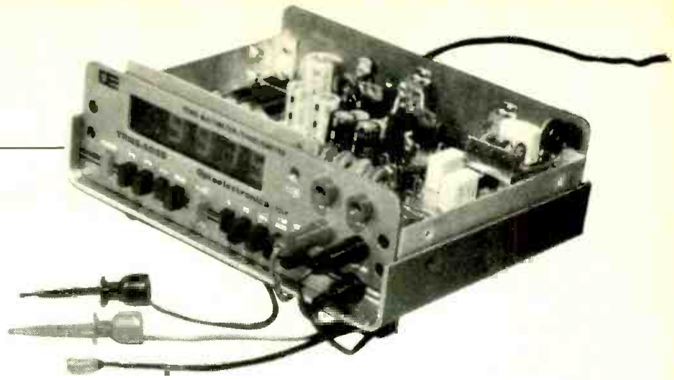
The manual provides several helpful charts, including Morse Code, common radio terms overheard on the air, and the "Q-signals" that are used to expedite communications over the air. The manual also contains a list of public safety "10-code" signals.

All in all, the receiver is a satisfactory addition to the casual hobby radio market. It is recommended for AM broadcast and shortwave listeners who would like to be able to occasionally copy continuous-wave and single-sideband signals.

We are certain that enterprising experimenters will devise improvements and modifications to increase the receiver's performance. The Realistic *model DX-300* costs $379.95 and is available from Radio Shack, 1400 One Tandy Center, Fort Worth, TX 76102. (As of this writing, Radio Shack has informed us that several improvements have been made in the *model DX-300*, particularly in frequency stability. We advise our readers therefore to make sure they purchase the most recent model.—*Editor*) **R-E**

There's something wrong with this digital readout—it's nothing but a bunch of numbers.

BUILD THIS



4½ Digit Precision DMM

This digital multimeter is ideal for the experimenter, engineer and service technician. Its basic accuracy is 0.05% and includes temperature and true-RMS capability.

BILL OWEN*

THE TRMS-5000 IS A FULL-FUNCTION, state-of-the-art 4½-digit multimeter with many extra features that usually cost hundreds of dollars as options and accessories. In addition to the industry standard AC/DC amperes, AC/DC volts and resistance ranges, a precision temperature probe gives a switch selectable Celsius and Fahrenheit readout to .01°. A true-RMS-to-DC converter is used for accurate AC voltage and current measurements of complex waveforms from near DC to over 250 kHz. A 10-amp AC/DC current range is available through a separate protected input jack.

Lab bench multimeter features include jumbo ½-inch LED digits, uncluttered pushbutton controls and a rugged, yet attractive, aluminum case. Portability is maintained, however, by the convenient size and the optional rechargeable NiCad batteries. A precision band-gap Zener voltage reference and temperature tracking input attenuator network give better than .05% DC accuracy.

The heart of the multimeter is a new analog-to-digital converter IC set from Texas Instruments. The TL500C and TL502C 4½-digit converter features auto zero and true differential high-impedance inputs with autopolarity and overrange indication. A complete list of specifications appears in Table 1.

Theory of operation

The heart of this digital multimeter is the analog-to-digital converter (ADC).

*Product Engineer, Optoelectronics, Inc., Fort Lauderdale, Florida

TABLE 1—TRMS-5000 DMM / THERMOMETER SPECIFICATIONS

DC VOLTAGE

Range	Max. Reading	Accuracy 18°-28°C, 1 Year
2V	1.9999V	.04% ± 1d*
20V	19.999V	.04% ± 2d
200V	199.99V	.04 ± 2d
1000V	1000.0V	.04 ± 2d

Maximum Input Voltage: 1040V

AC VOLTAGE

Range	Max. Reading	Accuracy 18°-28°C, 1 Year: 45 Hz-10 kHz	10 kHz-40 kHz	40 kHz-250 kHz
2V	1.9999V	.35% + 15d	.35% + 15d	3DB
20V	19.999V	.35% + 15d	1% + 15d	3DB
200V	199.99V	.35% + 15d	1% + 15d	3DB
1000V	1000.0V	.35% + 15d	2% + 15d	3DB

Crest Factor: 3
Maximum Input Voltage: 1040V

RESISTANCE

Range	Maximum Reading	Accuracy 18°-28°C, 1 Year: High Ohms	Low Ohms
2K ohm	1.9999K ohm	± .05% + 1d	± .10% + 15d
20K ohm	19.999K ohm	± .05% + 1d	± .10% + 15d
200K ohm	199.99K ohm	± .05% + 1d	± .10% + 15d
2 megohm	1.9999 megohm	± .1% + 1d	± .15% + 15d
20 megohm	19.999 megohm	± .3% + 2d	± .3% + 15d

Maximum Voltage Output: High 1.5V Low .5V
Maximum Input Voltage: 150V RMS
Settling Time: 2 seconds to ± 1 digit of final reading except 10 seconds on megohm range.

Specifications continued on page 39

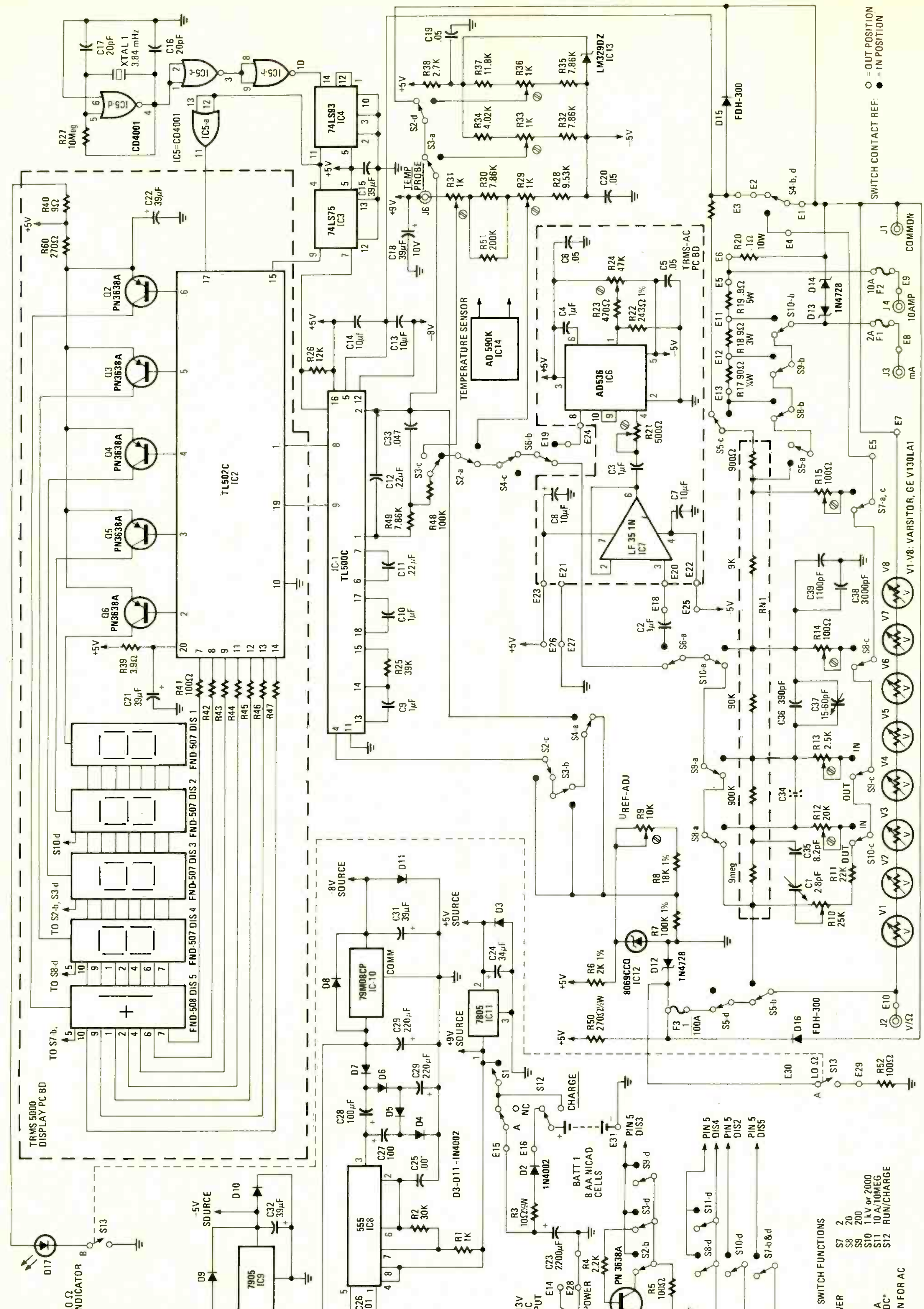


FIG. 1—SCHEMATIC DIAGRAM of the TRMS-5000 digital multimeter. One ususual feature is that on AC, it displays the true RMS value of any waveform, regardless of its complexity.

The ADC converts DC voltages between −2 and +2 volts applied to its input terminals into a digital count from −20,000 to +20,000. A display of 10,000 results from a one-volt input to the ADC.

The ADC employs the dual-slope method of conversion. The TL500C performs the analog processing while the companion TL502C digital processor provides the logic control signals for the TL500C as well as the counter and LED display drivers.

The entire conversion cycle timing is tied to the clock frequency generated by an external oscillator consisting of XTAL1, IC3, IC4 and IC5 (see Fig. 1). The 3.84-MHz crystal is divided down to 240 kHz by IC4. The resultant 240 kHz is a multiple of 60 Hz and is used to reject power-line-frequency interference. IC3 protects against false comparator triggering due to clock-frequency interference on the comparator input.

The precision voltage reference used is an Intersil 8069CCQ 1.2-volt band-gap Zener. Resistors R7, R8 and R9 form an adjustable divider to obtain 1.0000 volt for the reference input. Resistor R6 limits current through the reference to 2 mA.

Voltage measuring circuits

Because the ADC input is limited to +2 volts DC, additional signal-conditioning circuitry must be used for the extended multimeter functions and ranges. A voltage divider is used to extend the input voltage range up to ±1000.0 volts while on any one range the ADC will see less than ±2 volts.

The voltage divider consists of nine resistors connected in series across the multimeter's input terminals. Five are in the precision decade divider network RN1; the others are R17–R20. The total divider resistance is 10 megohms with each resistor having one-tenth the value of the resistor in series above it. When a voltage is applied to the multimeter's input terminals a current flows through the divider, producing a voltage across each resistor that is proportional to its resistance. Thus if 100 volts is applied across the divider, then 10 volts will be measured between the first and second resistors and 1 volt between the second and third and so on. Figure 2 shows the voltage divider with range switches to select the appropriate ratio; 1× for the 2-volt range, 10× for the 20-volt range and so on. A separate pole on each range switch is used to activate the appropriate decimal point in the LED display.

The multimeter's accuracy is dependent upon the ratio stability of the divider resistors. The first five decade resistors are contained in a thick-film network (RN1) in which the resistors track together to maintain their ratios over wide temperature variations. The bottom four discrete resistors plus the 900-ohm section of RN1 are used as shunts in the current-measuring ranges.

For AC measurements, a converter circuit generates a DC voltage equal to the RMS (*R*oot *M*ean *S*quare) value of the applied AC voltage. Two poles of AC switch S6 are used to insert the converter in series with the ADC inputs. Most multimeter converter circuits simply compute the average rectified value of the input signal and are calibrated to display the equivalent sinewave RMS value. For other types of waveforms (square, triangle, pulse, complex, etc.) this type of conversion is inaccurate. The TRMS-5000 uses a true RMS converter that computes the RMS value of *any* complex waveform. This is a much more useful measurement because it is based upon the equivalent effective DC heating value of the AC voltage. The integrated circuit that performs this conversion is the Analog Devices AD536JH which actually solves the equation:

$$V_{rms} = \text{Avg.}\left[\frac{V_{IN}^2}{V_{rms}}\right]$$

The AD536JH (IC6) measures AC signals from 10 Hz to over 100 kHz. This wide frequency range (many multimeters have only a few kilohertz of bandwidth) greatly enhances the usefulness of the multimeter in making AC measurements at not only power line frequencies but throughout the audio frequency spectrum and beyond.

Current measurements

Both alternating and direct current measurements are made by placing a known resistor in the current path and measuring the voltage drop across it. The bottom five divider resistors shown in Fig. 2 are used for current measurements. A separate current input is used with the current-range switches. Because there is almost no current flowing into the ADC's analog inputs (input resistance is 10^9 ohms) the voltage across the current shunt resistors is seen through the 10 megohms in series with the inputs. The 10-AMP current range has a direct input, so that a 10-ampere current will not have to be switched. The power ratings of the current shunt resistors range from 3.6 milliwatts for the 900-ohm section to 10 watts for the 0.1-ohm resistor.

Resistance measurements

The TL500C ADC actually has two sets of analog inputs if the reference voltage and common inputs are considered. The ADC compares the unknown voltage at the input terminals to the known voltage at the reference input when making a

DC AND TRMS AC CURRENT

		Accuracy 18°-28°C, 1 Year		
Range	**Max. Reading**	**DC**	**45 Hz-10 kHz**	**10 kHz-40 kHz**
2 mA	1.9999 mA	.6% + 2d	1% + 2d	1.5% + 2d
20 mA	19.999 mA	.6% + 2d	1% + 2d	1.5% + 2d
200 mA	199.99 mA	.6% + 2d	1% + 2d	1.5% + 2d
2000 mA	1999.9 mA	.6% + 2d	1% + 2d	1.5% + 2d
10 Amp	10.000A	.6% + 2d	1% + 2d	1.5% + 2d

Maximum Burden Voltage: 2V
Crest Factor: 3

TEMPERATURE

	Celsius	**Fahrenheit**
Range:	−50.00° to +150.00°	−67.00° to +199.99°
Resolution:	.01°	.01°
Accuracy:	± .5°	+.9°

Voltage Standoff: Sensor tip to voltmeter common ±200 volts

GENERAL

Display: Five 0.5″ Red LED Digits
Conversion Period: .1664 Sec
Power Supply: Wall Plug Transformer-input 105-125 VAC; output 9 DVC @ 300 mA
Dimensions: 3¼″H × 7¼″W × 6¾″D
Weight: Approximately 2 pounds
Input Impedance: 10 megohm shunted by less than 80 pF

BATTERY OPTION

Type: 8, AA NiCAD cells in holders, mounting inside the multimeter cabinet. Charge/operate switch mounts on rear of multimeter cabinet.
Operation: 2 hours from full charge
Charge Period: 12 hours

* ±% of reading + digits

measurement. This voltage ratio measuring ability of the converter is used in making resistance measurements. As shown in Fig. 3, a known reference resistor (one of the precision attenuator resistors) is placed in series with the unknown resistor at the input terminals. A precise 3.3 volts from Zener diode D12 is placed across the reference and unknown resistors and a current flows through them. The voltage drop across the known resistor is applied to the voltage reference and common inputs of the ADC while the voltage drop across the unknown resistor is applied to the analog + and − inputs. The meter's output then becomes the ratio between the reference resistor and the unknown resistor. For different ranges the reference resistor is changed from 1K up to 10 megohms.

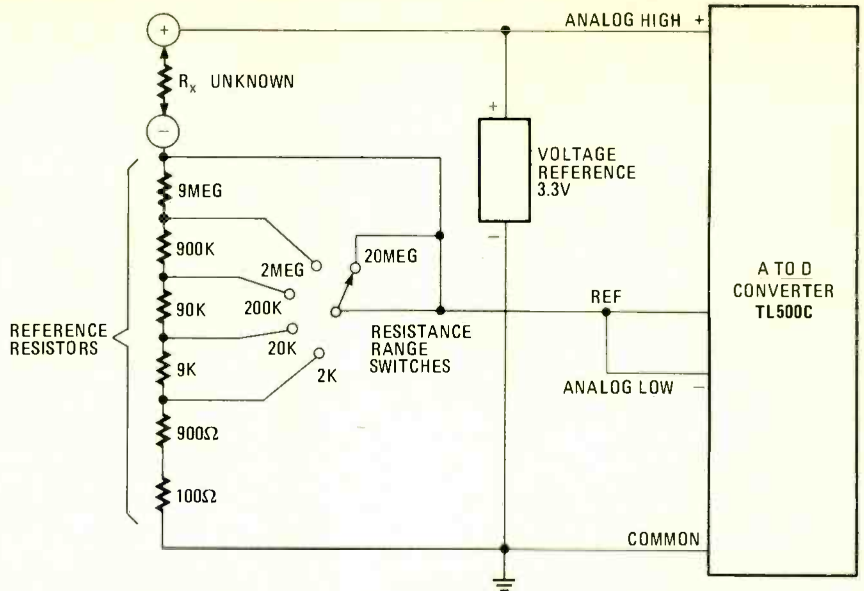


FIG. 3—WHEN MEASURING RESISTANCE, the unknown is in series with a selected known resistor across a precise reference voltage. The A/D converter determines the unknown value.

Temperature

The TRMS-5000 can measure temperature using an external sensor probe that plugs into a front panel jack (J6). The sensor is an Analog Devices AD590K temperature-dependent current source that generates 1 μA-per-degree-Kelvin. The Kelvin temperature scale starts at absolute zero and has Celsius-sized degrees such that 0°K = −273.2°C. The temperature sensor's current output is converted to a voltage, using scaling resistors R28, R29, R30 and R31. The output voltage (referenced to the −5-volt supply) from R29 is equal to 10 mV-per-degree-Kelvin while the output voltage from R31 is equal to 10 mV-per-degree Rankine (the Rankine temperature scale starts at absolute zero and has Fahrenheit-sized degrees). To generate Celsius and Fahrenheit output voltages, the Kelvin output must be offset by 2.732 volts and the Rankine output offset by 4.595 volts. IC13 is a 6.9-volt integrated circuit Zener reference. Its output is divided by R35, R36 and R37 to generate the Celsius offset and by R32, R33 and R34 to generate the Fahrenheit offset voltage.

When either the °C or °F switch is depressed, the ADC's analog inputs are switched to the correct temperature and reference voltage as shown in Fig. 4. A temperature range of −50.00°C (−60.00°F) to 199.99°C or °F is obtained with the 4½-digit ADC. The sensor can be calibrated to within ±.2°C from 0° to 100° using trimmers R29 and R31. Because the AD590K sensor is a current source, it requires only a two-conductor cable and can be located over hundreds of feet away from the multimeter because it is not affected by voltage or noise pickup.

The multimeter (see complete schematic in Fig. 1) uses a 9-volt DC plug transformer/power supply to keep the 60-Hz line frequency outside of the instrument case. The circuit operates from three regulated power supplies, one positive and two negative. A 7805 voltage regulator (IC11) supplies +5 volts to the circuit, and because it supplies over 200 mA of current it is heat sunk to the cabinet's rear panel. A 555 timer (IC8) generates a 20-kHz squarewave that is AC-coupled and diode-clamped by a voltage doubler circuit to produce approximately −11 volts. A 79MO8CP regulator supplies −8 volts to the TL500C analog processor (IC1) and a 7905 regulator supplies −5 volts to the AD536 RMS-to-DC converter and the temperature circuit. An optional 10-volt NiCad battery pack consisting of eight size-AA cells is charged through R3 and automatically switched in on the absence of line power by D2. Diode D1 prevents battery discharge through the plug transformer.

The multimeter readout consists of four Fairchild FND507 ½-inch common-anode red 7-segment LED digits with one FND508 ±1 digit. The LED digits are multiplexed by the TL502C that directly drives the segments through current limiters R41 through R47 and drives the digits through external digit drive transistors Q2 through Q6.

Overvoltage protection

A series string of eight metal-oxide varistors across the input divider will provide a short circuit path if 1040 volts or more is applied. Each varistor maintains a very high impedance until 130 volts is applied across it causing it to conduct. The varistors will pass 10 amps and fail as a short circuit if continuous overvoltage is applied.

Both the 2-amp (MA) and 10-AMP current inputs are fused and the 2-amp input

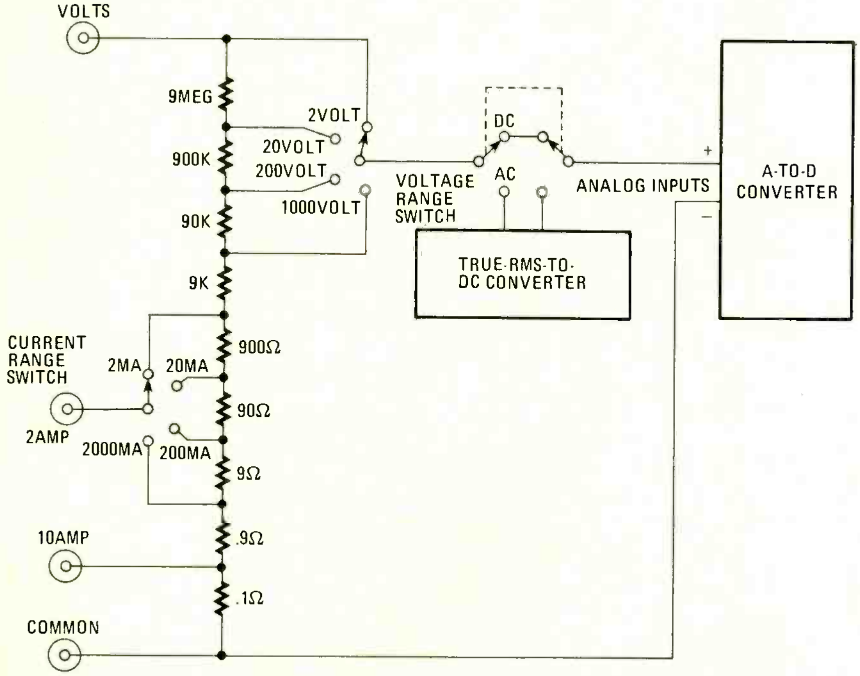


FIG. 2—VOLTAGE DIVIDER AND CURRENT SHUNTS. Resistor string is proportioned so maximum voltage applied to the A/D converter is 2 volts on any voltage or current range.

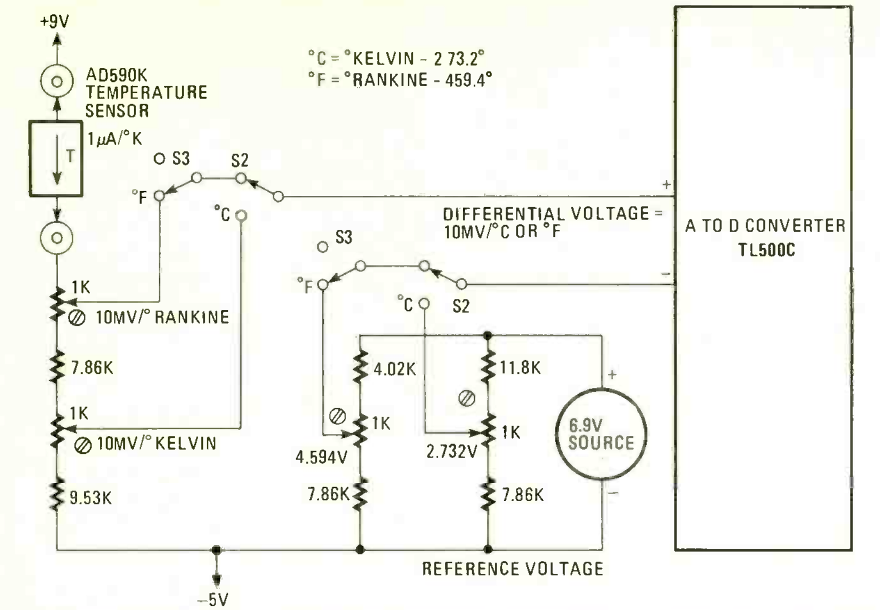


FIG. 4—BASIC DIAGRAM of circuit used for temperature measurement. The temperature sensor is a current source; passing 1 μA-per-degree Kelvin. Readout is in °C and °F.

is diode clamped as well to blow the fuse if an overvoltage is applied to the low-current range shunts.

The ohmmeter circuit is fused for 1/100 ampere. Low-leakage diodes (D15, D16) steer currents around the reference resistor if a voltage is applied to the input terminals while measuring resistance.

Making it work

The design of the multimeter's printed circuit board takes into account several factors that would otherwise seriously degrade performance. Ground paths are kept separate to prevent ground loops that cause offset errors that the ADC's autozero circuit cannot remove. Ground planes are used (where possible) to keep resistance in the ground returns as low as possible. The layout avoids putting supply or ground paths close enough to the high-impedance inputs or to the 10-megohm divider to allow leakage currents to cause offset errors. All insulation materials have extremely high resistance to prevent leakage paths. Digital and analog signal paths are kept apart and not parallel to each other on the PC board. The ADC's comparator output causes a problem if there is a path from it to any of the analog lines.

The multimeter's high-impedance input is susceptible to noise pickup, especially 60 hertz, which is almost universally present in our environment. The AC converter circuit's wide bandwidth makes it susceptible not only to 60-hertz pickup but to audio as well as RF frequencies. The TRMS-5000's heavy-gauge aluminum case provides shielding against noise pickup. There is also a filter on the analog inputs to the ADC, consisting of R48, R49, C12, and C33, that rejects 60-Hz voltages.

Assembly

The TRMS-5000 multimeter is built on three PC boards. The main board and the TRMS-to-DC converter board are double-sided. The foil patterns for the main board are in Figs. 5 and 6 and the parts layout is in Fig. 7. The two foil patterns for the TRMS board are in Figs. 8 and 9 and the parts are positioned as in Fig. 10. The four 7-segment displays and the polarity and overflow display are on a separate board. The foil pattern in Fig. 11 and the assembly diagram in Fig. 12 show how the readout goes together.

Begin assembly by soldering the components on the display, TRMS-AC and main printed circuit boards. Use the component placement drawings and the parts list to aid assembly. It is helpful to install jumper wires, diodes and resistors before the larger capacitors, trimmers, etc. The TRMS-AC PC board is double-sided but *not plated through, so component leads must be soldered to the foil on both sides wherever the foil comes right up to the lead.* The three PC boards are mated before the switches are installed. Assemble the front panel, rear panel and side

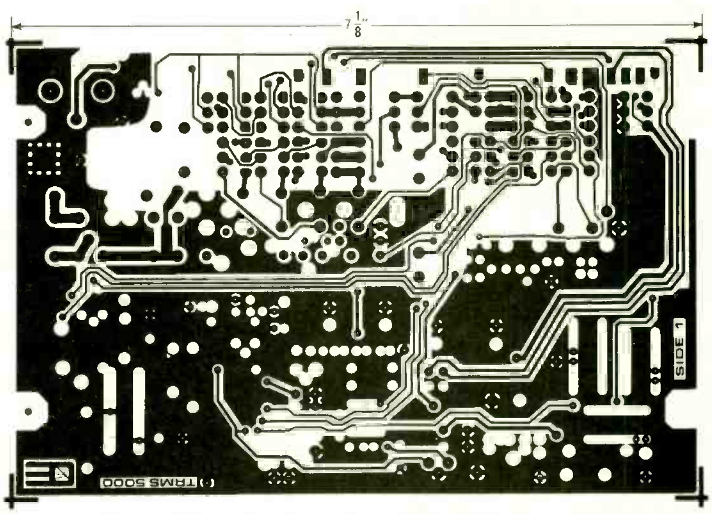


FIG. 5—FOIL PATTERN for Side 1, the top surface of the main board. Pattern is approximately one-half size. Enlarge to 7⅛ inches across.

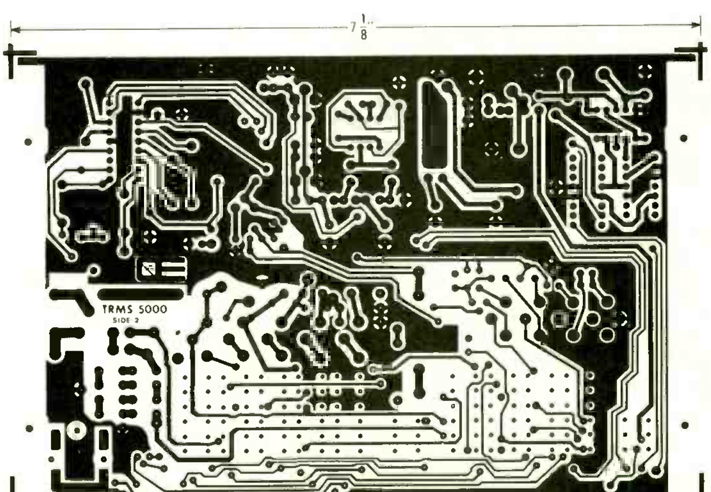


FIG. 6—PATTERN for the under side of the main PC board shown half-size. The pushbutton range and function switches are on this side.

PARTS LIST

Resistors, ¼ watt, 5% unless noted
R1—1000 ohms
R2—30,000 ohms
R3—10 ohms
R4—2200 ohms
R5, R41-R47—100 ohms
R6—2000 ohms, 1%
R7, R48—100,000 ohms, 1%
R8—18,000 ohms, 1%
R9—10,000 ohms, 10-turn trimmer
R10—25,000 ohms, trimmer
R11—22,000 ohms
R12—20,000 ohms, trimmer
R13—2500 ohms, trimmer
R14, R15—100 ohms, trimmer
R16—100 ohms, 1%
R17—90 ohms, 1%, factory calibrated
R18—9 ohms, 1%, 3 watts, factory calibrated
R19—0.9 ohm, 1%, 5 watts, factory calibrated
R20—0.1 ohm, 1%, 10 watts, factory calibrated
R21—500 ohms, trimmer
R22—243 ohms, 1%
R23—470 ohms
R24—47,000 ohms, trimmer
R25—39,000 ohms, 1%
R26—12,000 ohms
R27—10 megohms
R28—9530 ohms, 1%
R29, R31, R33, R36—1000 ohms, trimmer
R30, R32, R35—7860 ohms, 1%
R34—4020 ohms, 1%
R37—11,800 ohms, 1%
R38—2700 ohms, 1%
R39—3.9 ohms
R40—9 ohms, 3 watts, 1%
R49—10,000 ohms
R50—270 ohms, ½ watt
RN-1—Temperature tracking precision resistor attenuator (Caddock 1776-231 7849)

Capacitors
C1—2-8 pF, trimmer
C2, C3, C9, C10—1 μF, Mylar
C4—4.7 μF, tantalum
C5, C6, C19, C20, C26—.01 μF, disc ceramic
C7, C8, C13, C14—10 μF, 10 volts, tantalum
C11, C12—0.22 μF, Mylar
C15, C18, C21, C22, C24, C31, C32—39 μF, 10 volts, tantalum
C16, C17—20 pF, disc ceramic
C23—2200 μF, 25 volts, electrolytic
C25—.001 μF disc ceramic
C27, C28—100 μF, 25 volts, electrolytic
C29, C30—220 μF, 25 volts, electrolytic
C33—.047 μF, polypropylene
C34—470 pF, disc ceramic
C35—8.2 pF
C36—390 pF
C37—15-60 pF, trimmer
C38—3000 pF
C39—1100 pF

Semiconductors
Q1-Q6—PN3638A (National) or MPS 3638 (Motorola)
D1, D2—3-amp, 100 PIV diode
D3-D11—1N4002
D12-D14—IN4728, 3.3-volt Zener diode
D15, D16—FDH-300 low-leakage diode (Fairchild only)
D17—miniature red LED
V1-V8—V130LA1 varistor (GE)
DIS1-DIS4—FND570, 7-segment LED
DIS5—FND508, +1 LED display
IC1—TL500C analog processor (TI)
IC2—TL502C digital controller (TI)
IC3—74LS75 D-type flip-flop
IC4—74LS93 counter
IC5—CD4001—quad 2-input NAND gate
IC6—AD536JH—RMS-to-DC converter (Analog Devices)
IC7—LF351N bi-FET op-amp
IC8—555 timer
IC9—7905 –5-volt regulator
IC10—79MO8CP –8-volt regulator (National)
IC11—7805 5-volt regulator
IC12—ICL8069CCQ 1.22-volt reference
IC13—LM329DZ 6.9-volt reference (National only)
IC14—AD590KH temperature sensor (Analog Devices)

Miscellaneous
S1, S6—2PDT pushbutton switch
S2-S5—4PDT pushbutton switch, interlocked
S7-S11—5PDT pushbutton switch, interlocked
S12, S13—D PDT miniature slide switch
J1—banana jack, black
J2-J4—banana jack, red
J5—pin-type DC power receptacle
J6—PC mount right-angle phono jack
XTAL1—3.84 MHz crystal
F1—2 ampere fuse
F2—10 ampere fuse
F3—¹⁄₁₀₀ ampere fuse
Thermometer test cable, power transformer—9 VDC, 300 mA plug type with hollow-pin plug. IC sockets: 2 8-pin, 2 16-pin, 1 18-pin, 1 20-pin, 1 14-pin. PC boards, cabinet and assorted hardware.

Note: The following are available from Optoelectronics, 5821 N.E. 14th Ave., Ft. Lauderdale, FL 33334. Factory-assembled multimeter with 1-year guarantee (TRMS-5000) $279.95; complete kit (TRMS-5000K) $199.00. Set of three PC boards—all boards are glass epoxy, solder-plated with screened printed component layout—$28.50. Set of all switches (13) $20.00. TL500C and TL502C IC's $16.95.
Include 5% for shipping, handling and insurance (to a maximum of $10) with all orders. Florida residents add 4% sales tax.

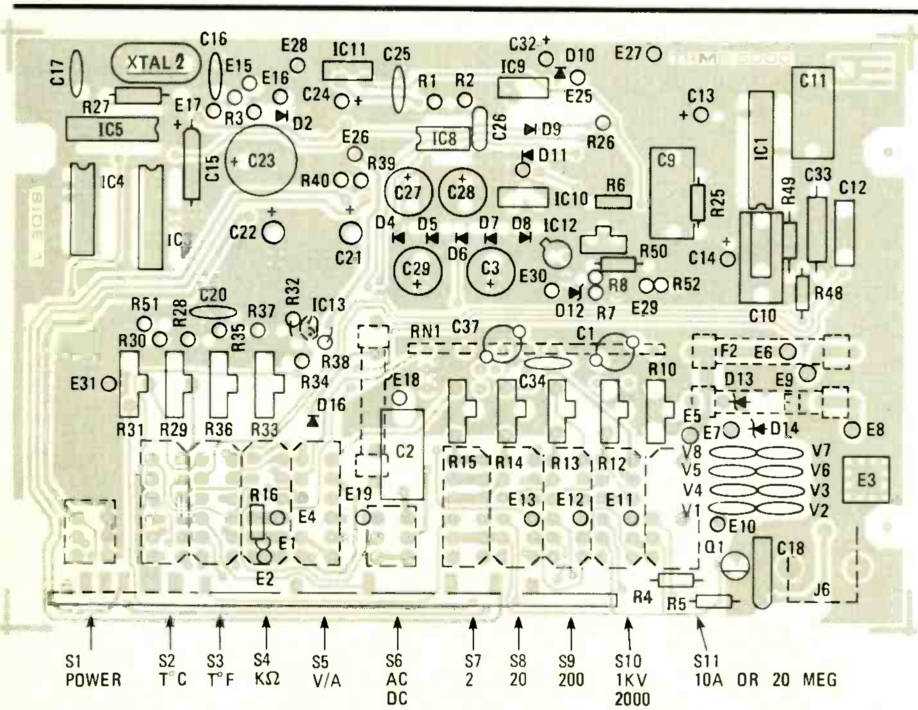


FIG. 7—WHERE PARTS ARE PLACED on the main PC board. Most are on Side 1—the top side. Parts on the underside are outlined in dashed lines.

rails, and then bolt the main PC board to the side rails. Align the foil fingers on the display board to the pads on the main PC board, and after checking alignment solder them together. The TRMS-AC PC board installs in the same way over the S6 switch area. Install the switches and then use No. 14 or No. 16 hookup wire to make the following connections:

From	To
J1	E1
J2	E10
J3	E8
J4	E9
E2	E3
E4	E5

Connect the following resistors between the points indicated below:

R20—0.1 ohm 10W - E1, E6
R19—0.9 ohm 5W - E11, E6
R18—9 ohm 3W - E12, E11
R17—90 ohm ¼W - E13, E12

Use hookup wire to connect the center pin of the power input jack to E10 and the bracket to E11.

Before applying power to the multimeter, check all parts for correct place-

continued on page 79

Adaptive Noise Filter

Simple to construct and operate, this dynamic variable-cutoff low-pass filter removes the snap crackle, and pop from your favorite records and tapes.

TIM SKORMOND AND GENE GARRISON

MANY POPULAR NOISE-REDUCTION SYSTEMS are complementary in nature; i.e., the signal is processed by some compression technique prior to being recorded and then decoded by the equivalent expansion technique during playback. This leaves a large quantity of older recorded material, both disc and tape, unable to benefit from the noise-reduction circuits built into many hi-fi systems. Since many of us have treasured recordings that fall into this category, the need exists for a single-ended, add-on Adaptive Noise Filter that will permit us to enjoy these recordings at the same quality level we expect from encoded material.

A great deal of the noise in tape and FM sources is located in the frequency band from about 1 kHz to 7 kHz. This frequency band is also the area in which the human ears are most sensitive. Fortunately, when musical signals are also present in this same frequency band, at a few dB higher level, they effectively mask the noise. This makes it possible to use a variable-frequency low-pass filter in the audio channel to reduce the noise without audibly affecting the dynamics of the desired signal. If no signal is present, between musical passages for instance, a low-pass filter with a cutoff frequency of 800 Hz will substantially reduce the level of the audible noise. When music of sufficient amplitude is present at frequencies above 800 Hz, the filter opens to pass the music, and since the noise and music occupy the same spectral area, the noise is masked and the music faithfully reproduced.

About the circuit

A block diagram of a suitable circuit is shown in Fig. 1. The circuit consists of three major sections: a signal path, a control path and an LED bar-graph display.

The signal path is straightforward, consisting of two (one per channel) current-controlled low-pass filters with 6-dB-per-octave slopes. The two filters are designed to roll off at a corner frequency of 800 Hz with no input and at a corner frequency of 30 kHz when fully driven by the common control voltage.

Figure 2 gives a detailed look at the actual current-controlled filter circuits. Most existing variable filter designs use one or more field-effect transistors as voltage-controlled resistors in an active or passive filter configuration. This can lead to two troublesome problems. One is the need for some means of offsetting the difference in pinch-off voltages between individual FET's. A trimmer from each gate to a fixed bias voltage must be adjusted to calibrate each device. The second problem is the modulation of the drain-to-source resistance with moderately large input signals. This modulation quite often results in excessive distortion at the filter output and, in some cases, will require another trimmer from each gate to minimize the effect.

Both of these pitfalls are successfully avoided in this circuit by using a new operational transconductance amplifier (OTA) as the controlled device. National Semiconductor has recently introduced the LM13600, a dual OTA with Darlington buffers and input linearizing diodes in a single 16-pin DIP package. The linearizing diodes compensate for the logarithmic characteristics of the input stage of the OTA, enabling it to pass relatively large signals with low distortion. (OTA circuits in the past have required very small input signals to obtain respectable distortion levels.)

The transconductance of the OTA's is set by the amplifier bias current (supplied to pins 1 and 16 in the case of the LM-13600). The signal path of Fig. 2 uses this variable transconductance (conductance being the inverse of resistance) to implement a current-controlled filter (CCF).

The filter cutoff frequency is initially set at 800 Hz by the current through

TABLE 1—SPECIFICATIONS (typical)

Attack time (to within 10% of final value):	1 ms
Decay time (to within 10%)	50 ms
Minimum bandwidth:	800 Hz
Maximum bandwidth:	30 kHz
THD (1 kHz, 1 V_{RMS}, max. sensitivity):	0.11%
S/N ratio re: 1 V_{RMS}:	
800 Hz, BW, 20 Hz to 20 kHz:	−88 dBV
CCIR/ARM weighted:	−98 dbV
30 kHz, BW, 20 Hz to 20 kHz:	−85 dBV
CCIR/ARM weighted:	−87 dBV
Effective noise reduction (CCIR/ARM weighted cassette tape noise):	14 dB

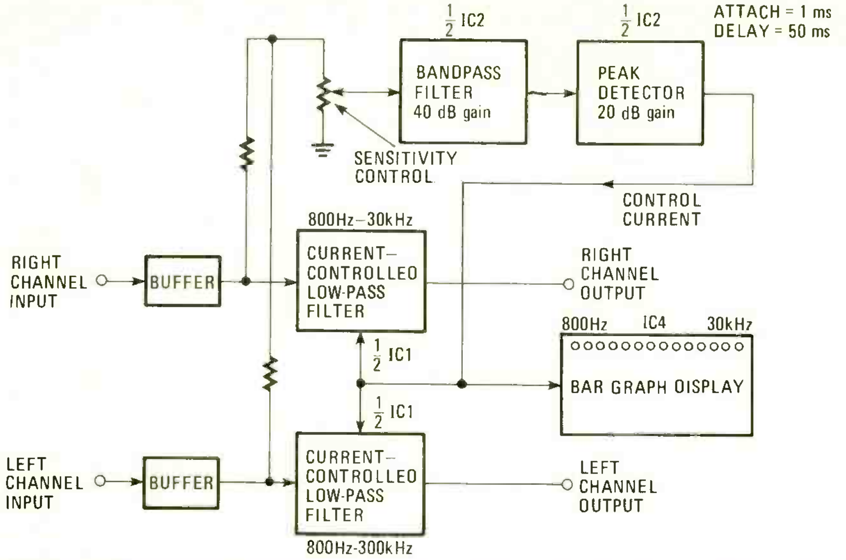


FIG. 1—BLOCK DIAGRAM of the adaptive noise filter. Audio signals are summed into the bandpass filter and then rectified to develop a control current that varies with noise in the signals.

R15. Additional current supplied through R16 by the control path circuitry increases this −3-dB frequency to as high as 30 kHz, this bandwidth being directly proportional to the applied current. Figure 3 shows the filter bandwidth vs. the amplitude of an 8-kHz input signal.

The control path consists of two basic stages: a bandpass filter with 40-dB gain and a specially configured peak detector with 20-dB gain. The LM387 operational amplifier was chosen because of its high-gain capability at 20 kHz and its high slew rate (required at the output of the peak detector).

The left and right input signals are summed together by resistors R17 and R18. Capacitor C7 provides a rolloff above 16 kHz, while a rolloff below 1.6 kHz is provided by C8. This low-level input signal is then amplified by the first half of IC2, whose gain is attenuated below 4.8 kHz by C10 with R20. R22, C11, C12, L1 and C13 couple the signal into the peak detector and provide additional frequency shaping, L1 being tuned to provide a filter notch at 19 kHz for use with FM stereo sources. Figure 4 shows the response of the control path.

R-E TESTS IT

LEN FELDMAN

THE NR-2 NOISE FILTER WAS EVALUATED IN our laboratory, both for its measured characteristics and its performance as a single-ended noise reduction filter. Its principle of operation depends upon signals passing through variable-bandpass filters whose cutoff frequencies are made to vary between 800 Hz and 30 kHz, depending upon a control current derived from the original audio signal. While this is certainly not an original concept, the execution of the design is excellent. Attack time (confirmed as approximately 1 millisecond) and decay times (around 50 milliseconds) are ideally chosen so that, in use, the action of the filter is almost inaudible—except of course for the great audible improvement in noise. The NR-2 can be used to reduce noise in program sources such as records, weak FM signals and, most significantly, playback of cassette tapes that have not had the benefit of a two-sided noise reduction system such as Dolby or dbx encoding and decoding.

Figure 1 illustrates how different *levels* of swept signals (from 20 Hz to 20 kHz) affect overall response of the device. We see that when the device "senses" low-level signals

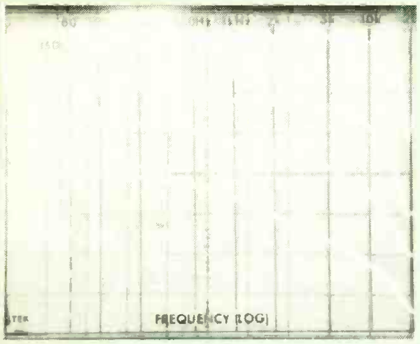


FIG. 1

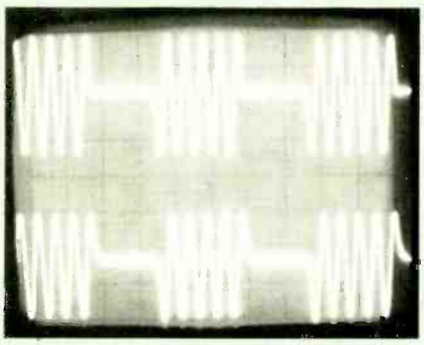


FIG. 2

(equivalent to *noise*) bandwidth is restricted. On the other hand, when high-amplitude signals, corresponding to musical signal content, are fed through the device, bandwidth is fully restored so that overall frequency response is virtually flat to 20 kHz.

Figure 2 illustrates the attack and decay times of the device. A tone burst, consisting of several cycles at 1 kHz, was fed through the filter. Upper trace is the input signal, while lower trace is the output signal. Note that the first cycle of each burst, whether negative going or positive going, is accurately reproduced at the output, while the *last* cycle in each burst is somewhat retarded in the output trace, indicating the slower but desired decay time of the device.

Table 1 summarizes our measured findings as compared with the author's claimed specifications.

TABLE I

SPECIFICATIONS	DESIGNERS' CLAIM	MEASUREMENTS
Attack Time (ms)	1.0	0.8
Decay Time (ms)	50.0	40.0
Minimum Bandwidth (Hz)	800	800
Maximum Bandwidth (kHz)	30	30
THD (1V, Max. Sensitivity) (%)		
1 kHz	0.11	0.12
20 Hz	N/A	0.3
20 kHz	N/A	0.11
S/N (re: 1V)		
800 Hz B.W.	88 dB (98 Wt'd)*	90 dB (95 W'td)
30 kHz B.W.	85 9B (87 W'td)*	85 dB (90 W'td)
Effective Noise Reduction (tested with cassette tape)	14 dB (Wt'd)*	12 dB (Wt'd)*

* Small differences in weighted results arise from the fact that the author used CCIR/ARM weighting whereas we used IHF "A" weighting, but, as can be seen, unweighted results are as good or better than claimed.

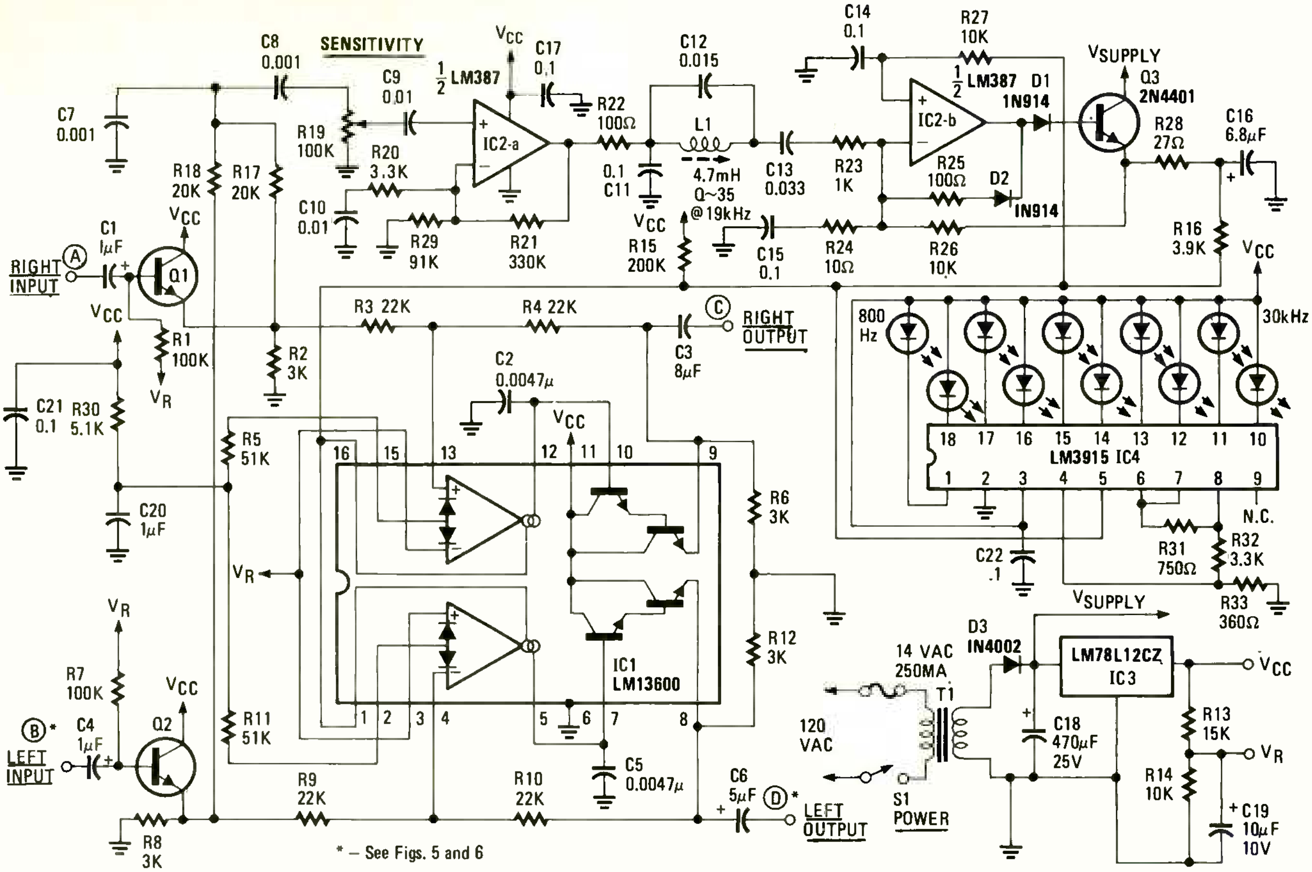


FIG. 2—SCHEMATIC DIAGRAM of the current-controlled variable-bandwidth low-pass filter circuits. Bandwidth is controlled by a current developed from the input signal.

The peak detector amplifies the AC output from the frequency-selective control amplifier and converts it into a DC voltage at the emitter of Q3. Resistor R28 sets the system attack time or charging rate into the peak-detector storage capacitor, C16. Capacitor C16 is discharged at a much slower rate (decay time) by the current drains of the two CCF's through resistor R16. Resistor R27 sets the initial no-signal DC level at the peak-detector output.

The attack and decay times and response characteristics were chosen with great care as they determine the subjective effects of the filter. An attack time of 1 ms was selected because it is fast enough to accommodate the response time of the human ear and yet slow enough to be relatively insensitive to "clicks" and "pops" on the record surface. The decay time was set at 50 ms so the filter could close quickly after the passing of high-frequency musical information and thus pass a minimum of noise. A shorter decay time would cut into the natural reverberation time of some program sources, making them sound "sterile" or flat.

The third section of the Adaptive Noise Filter is the bandwidth bar-graph display. A bar graph was used instead of a meter because of the millisecond response time of the control signal. The National LM3915 bar-graph display driver was chosen as it requires only a few external parts and contains all the necessary circuitry for a 10-point logarithmic bar-graph display. The common control voltage at the top of R16 has upper and lower limits of 9.3 VDC and 1.1 VDC, respectively. Therefore, the upper and lower limits of the LM3915 are set accordingly at pins 4 and 6 (internal logarithmic resistor string between these two pins sets the DC levels at which each of the internal comparators drives its associated LED). The left-hand LED corresponds to an 800-Hz bandwidth and the right-hand LED corresponds to a 30-kHz cutoff. The LED's between these two extremes represent steps of approximately 1.5 times the frequency display by the preceding step.

A logarithmic display was selected because it was most indicative of the audible

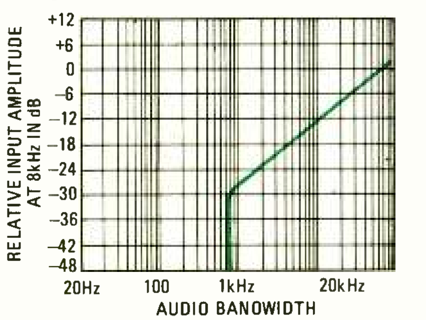


FIG. 3—FILTER BANDWIDTH and how it varies with the input of an 8-kHz signal.

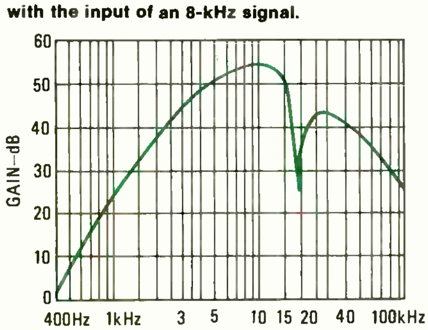


FIG. 4—RESPONSE of the final control path sensitivity vs. input frequency.

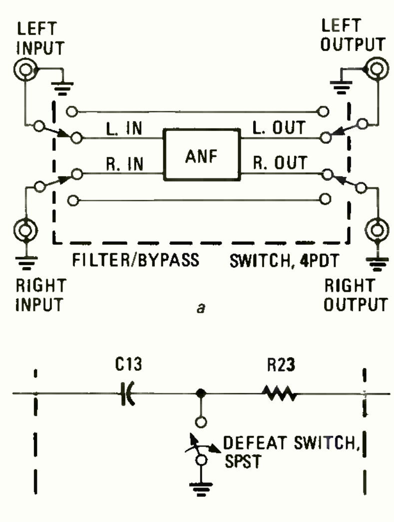


FIG. 5—CONTROL SWITCHING illustrating how the adaptive noise filter can be switched in and out of play-only circuit.

PARTS LIST

All resistors 5%, ¼ watt unless otherwise noted

R1, R7—100,000 ohms
R2, R6, R8, R12—3000 ohms
R3, R4, R9, R10—22,000 ohms
R5, R11—51,000 ohms
R13—15,000 ohms
R14, R26, R27—10,000 ohms
R15—200,000 ohms
R16—3900 ohms
R17, R18—20,000 ohms
R19—100,000 ohms, miniature pot, audio taper (Clarostat 389 N 100K-Z)
R20, R32—3300 ohms
R21—330,000 ohms
R22, R25—100 ohms
R23—1000 ohms
R24—10 ohms
R28—27 ohms
R29—91,000 ohms
R30—5100 ohms
R31—750 ohms
R32—360 ohms

Capacitors

C1, C4, C20—1 μF, 16 volts electrolytic, radial leads
C2, C5—.0047 μF, 50 volts, Mylar, 10%
C3, C6—5 μF, 10 volts, electrolytic, radial leads
C7, C8—.001 μF, 50 volts, ceramic disc
C9, C10—.01 μF, 50 volts, ceramic disc
C11, C14, C15, C17, C21, 022—0.1 μF, 50 volts, Mylar
C12—.015 μF, 50 volts, Mylar, 5%
C13—.033 μF, 50 volts, Mylar
C16—6.8 μF, 25 volts, tantalum, 10%, radial leads
C18—470 μF, 25 volts, electrolytic, radial leads
C19—10 μF, 10 volts, electrolytic, radial leads

Semiconductors

D1, D2—1N914
D3—1N4002
Q1, Q2, A3—2N4401
IC1—LM13600 dual operational transconductance amplifier (National)
IC2—LM387N dual low-noise preamplifier (National)
IC3—LM78L12CZ (National)
IC4—LM3915N logarithmic bar-graph display driver (National)
LED1-LED10—NSL57124 rectangular LED for bar graph (National)

Miscellaneous

S1—miniature SPST toggle switch
S2, S3—miniature 4PDT toggle switch
T1—power transformer, 14 VAC, 250 mA (Triad F-112X)
L1—adjustable inductor, 4.7 mH, Q = 35 at 19 kHz (TOKO CLN20 740 HM)
J1-J8—panel-mount RCA-type phono
F1—¼-amp slow-blow fuse
Fuse holder, line cord, PC boards, control knobs, hardware

The following parts are available from Advanced Audio Systems, PO Box 24, Los Altos, CA 94022:

DX-244 (NR-2) complete kit including case—$69.95

DX-245 (NR-2) main and display PC boards—$19.95

DX-247 (NR-2) component kit; includes D1, D2, D3, IC1, IC2, IC3, IC4, Q1, Q2, Q3 and L1—$27.50

California residents add state and local taxes, as applicable.

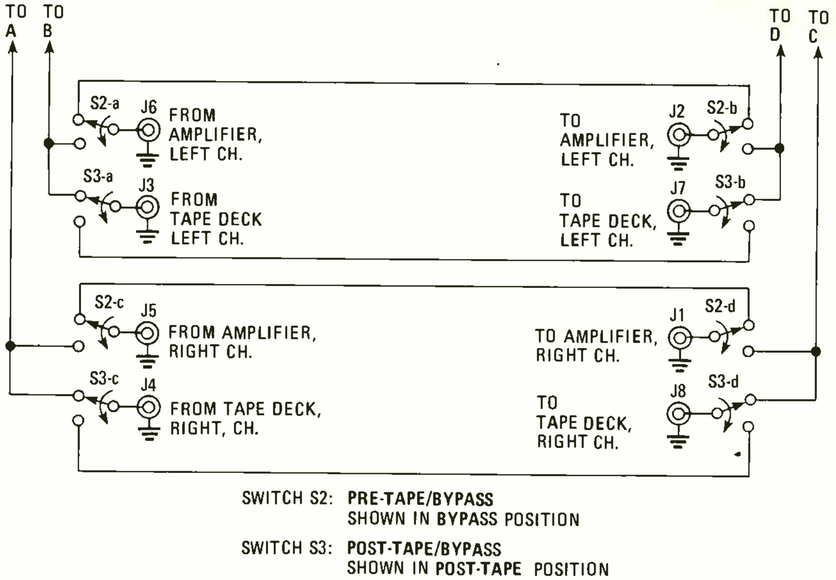
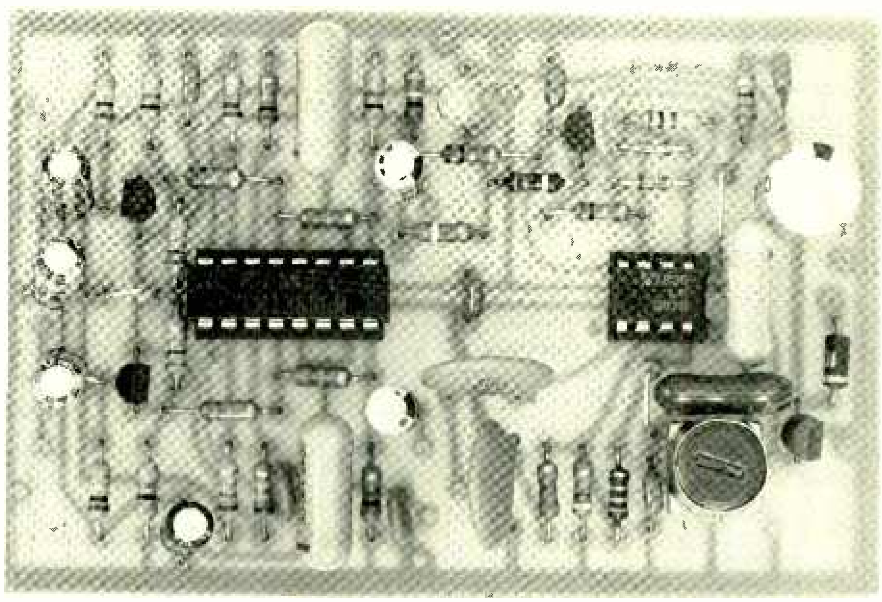


FIG. 6—IDEAL SWITCHING ARRANGEMENT is simple and flexible. User must be careful not to place both switches in non-bypass positions simultaneously.



TOP VIEW OF THE PC BOARD shows the locations of most of the components. Parts not shown include the bar-graph display and power supply.

action of the filter. It should be noted that the LED bar graph does not indicate signal level, but rather the instantaneous bandwidth of the two filters and, as such, should not be used as a signal-level indicator.

If the Adaptive Noise Filter is used for only one source, such as for tape playback, then a BYPASS switch will be the only switching needed in addition to the power switch. Figure 5-a shows a suitable arrangement. Alternatively, the filter may be defeated by switching the junction of C13 and R23 (Fig. 2) to ground, as shown in Fig. 5-b, thereby forcing the filter to a constant 30-kHz bandwidth. This approach has the advantage of requiring only a single-pole switch as opposed to the four-pole switch and associated wiring required for the straight-wire bypassing.

A more flexible system, as used in the prototype model, can be obtained by providing for insertion of the filter either before or after the tape deck (record or playback). The rather unusual switching scheme shown in Fig. 6 was selected for its relative simplicity. A setup having a PRE TAPE/POST TAPE and a FILTER/BYPASS switch would require one four-pole and one eight-pole switch. The scheme of Fig. 6 only requires two four-pole switches, but the user should be careful not to place both switches in the non-bypass positions simultaneously.

Printed-circuit construction techniques are used in the assembly of the prototype adaptive noise filter. Foil patterns for the printed-circuit boards used for the filter and associated display board will be published next month along with complete construction details and calibration and operating instructions.

continued next month

Home Reception *via* SATELLITE

An introduction to domestic satellite communications; with details on how those illusive TV signals are pulled from spa

ROBERT B. COOPER, JR.

YOU MAY BE TOO YOUNG TO HAVE BEEN A PART OF THE EXCITING 1946–1952 "dawn of television era." I was a youngster in upstate New York who spent his high school years souping up 630-type chassis, building cascade and cascode signal boosters with 6BQ7's and trying out every antenna I could lay my design hands on—from stacked 10-element Yagi arrays to 12 wavelength rhombic antennas.

Television happened for me at an infectious age. A paper route helped me maintain a library of that era's **Radio-Electronics** and a host of other valuable trade magazines that were documenting the fast changing world of television technology. Summer odd jobs and caddying at the golf course enabled me to buy aluminum tubing, wire, electronics parts and bargain-basement-priced 630 chassis. In later years I would sometimes wish that I had been born "only five or ten years sooner" so that I would have been old enough by 1950 to have really been in a position to participate fully in the television revolution. "But alas" I would say to myself "that's it for the television revolution. Now that it's established nothing will come along to change it 'that much' so I'll just have to find my nitch someplace else."

And so it was until 1975 when I discovered a whole new television revolution just getting underway—satellite TV transmission and reception. And I have been tracking it, playing an active part in it and enjoying it ever since.

Forget everything you know

If you are in the television business to make a living, you probably think you know all there is to know (or need to know) about reception techniques and equipment. You've tracked down ghosts and explained away weather-caused co-channel interference. You've doped out MATV systems and traced bad components. You've been stuck with an inventory full of "brand name" parts that overnight went off the market, and you own every Sams *Photofact* that they ever printed. Forget it all!

First, let me tell you a bit about the TV reception in my present home, some 20 miles outside of Oklahoma City. We have the usual three major networks as well as PBS (*P*ublic *B*roadcasting *S*ystem). And like a good majority of the United States, that is all we have (or *had* until the fall of 1977).

In August 1977 I placed some 1 × 2 stakes in our sidelawn and backhoed enough clay to let me refill the holes with a few pieces of properly formed steel and around 4 yards of concrete. Then, in September 1977, I brought in a crew of friends and this funny-looking, 3000-lb., all-steel saucer-shaped apparatus, and in about eight hours we had the saucer mounted on a set of steel posts. (See Fig. 1.) The saucer pointed more or less south of us and up into the sky.

The same evening I sat down with a special receiver and watched the evening news live from Vancouver, British Columbia; a baseball game from Atlanta, GA; and a movie via some-

FIG. 1—SATELLITE RECEIVING ANTENNA as it is being installed on steel mounting posts.

thing called HBO (*H*ome *B*ox *O*ffice).

My home is located just 18 airline miles from our local network and PBS stations, and I had always been able to receive the best-looking TV pictures this side of a network monitor, up until that fabled September 1977 evening. Until you have had a high-quality color monitor plugged directly into the video output of a satellite TV receiver and observed 54-dB signal-to-noise-ratio video produced by people who really care about how good it looks when it leaves their studio, you simply have not seen how good NTSC color reception can really be!

Let me digress a bit and explain what satellite television is all about, how it works and why it works the way it does.

How it began

The first man-made satellite was Russia's SPUTNIK (1) in the fall of 1957. It shook a lot of people up as you may recall. The idea of a ton or so of steel and electronics going around and around the world and crossing our country beeping in Morse code and doing who knows what else spurred the U.S. into the space race. We responded by launching a U.S. Airforce satellite named SCORE in December 1958, and to one-up the Russians, we added a prerecorded message from the President of the United States who welcomed in the American space age and the Christmas season.

TABLE 1—INTELSAT GEOSTATIONARY satellites operating in the 3.7- to 4.2-GHz downlink frequency band are clustered in three separate areas.

Longitude (west)	Name	Year Launched	Service Status
1°	I-IV-F7	1973	Secondary
4°	I-IV-F2	1971	Reserve
19.5°	I-IVA-F4	1977	Reserve
24.5°	I-IVA-F1	1975	Primary
29.5°	I-IVA-F2	1976	Reserve
34.5°	I-IV-F3	1971	Secondary
181°	I-IV-F4	1972	Reserve
186°	I-IV-F8	1974	Primary
297°	I-IVA-F3	1978	Primary
298.6°	I-IV-F1	1975	Primary
300°	I-IV-F5	1972	Reserve
300°	I-IV-F6	1978	Reserve

SPUTNIK, SCORE and all the satellites that followed them through 1963 had one common fault. They were launched into a "low orbit' and (with reference to a point on earth) they were always moving. To receive messages from or transmit messages to these "low orbit birds" required that the stations working with the satellite know rather precisely its orbit path and the timing of that path, and then be prepared to track the satellite as it came over one horizon, moved in an arc through the sky and finally disappeared beyond the opposite horizon.

In 1963 space technology and rocket power progressed, and SYNCOM, designed and built by the Hughes Aircraft Corporation, was launched—the world's first geostationary (or geosynchronous) satellite. (A geostationary satellite has an orbit directly above the equator and an orbital velocity that matches the rotational velocity of the earth. (See Fig. 2.) In this way, the satellite appears to remain stationary in the sky with respect to a point on the earth.) SYNCOM was an experiment. It provided the capacity to relay either a *single* TV channel or *50* separate telephone conversations; from its orbit above the Equator between Africa and South America, it interconnected North America and Europe with their first real-time (live) television transmissions. By 1965 the geostationary satellite looked like a winner, and 19 countries joined to form something called Intelsat, a consortium of nations that would fund the launching of a series of satellites.

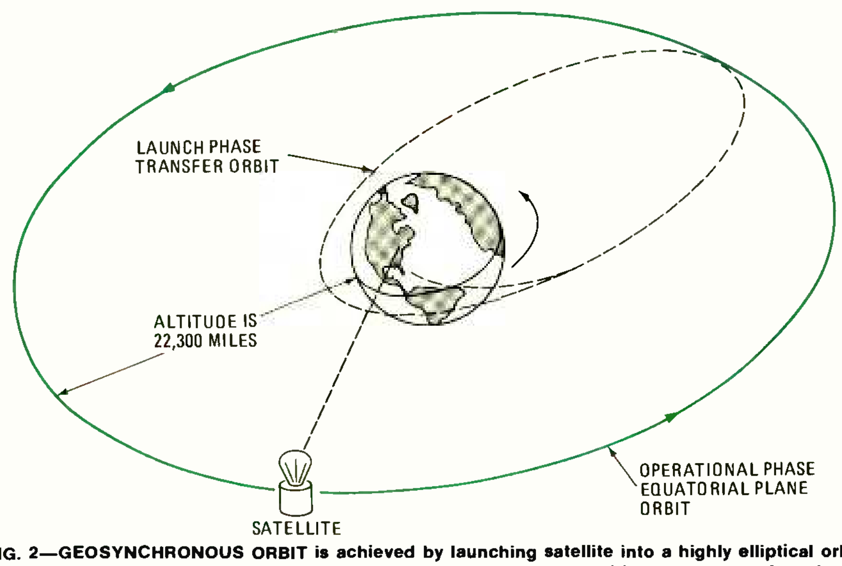


FIG. 2—GEOSYNCHRONOUS ORBIT is achieved by launching satellite into a highly elliptical orbit that is followed by a transfer to an equatorial plane orbit. Satellite's position over equator is typically maintained to ±0.1 degree.

The Intelsat world

With nearly 14 years to grow, the Intelsat system is relatively mature. Today, more than 100 nations belong to the system, which consists of 12 separate satellites located in three distinct "groups." Commercial Intelsat installations cost in the megabuck region, but amateur builders of backyard terminals have successfully tapped into the Intelsat circuit, using surplus-salvaged parabolic antennas as small as 8 feet in diameter and with investments well under $500, as we'll discuss in some detail.

As mature as Intelsat is today, it is in a constant state of evolution. The present satellite series is generally of the so-called Number IV (or "4") class, indicating there have been three previous series. Table 1 lists where they are located; a sharp eye will spot the three "clusters" in operation: One is over the Equator in the Pacific Ocean; another over the Indian Ocean north of the Seychelles Islands; and a third between the tip of Africa and the tip of South America. Each location has as a minimum a "primary" and a "reserve" satellite, but heavy Atlantic and Indian Ocean traffic has resulted in additional satellites in these areas. In 1971 the Intelsat consortium agreed that identical-frequency satellites should be spaced over the equator in 4- to 5-degree increments. In this fashion the large parabolic ground-receiving antennas could intercept the desired satellite's signals without interference from adjacent-position satellites, even though both would be operating on the same frequency simultaneously. The present series IV satellites will begin to be replaced with a new, advanced family of satellites during 1979, the Intelsat V series. We'll look at these later on.

GADGETS—EALLY WORK?

feedline for coupling had no effect. Interference bars were again apparent on several TV channels, with or without the CB filter attached. The trap circuitry is a series L–C filter, designed to short-circuit much of the 27-MHz CB signal, but it has no effect at TV frequencies. The schematic is shown in Fig. 3. Similar to the filter described above, it would be effective only in preventing front-end overload by a powerful 27-MHz CB signal. In fact, if an interference filter were designed to attenuate interfering signals on TV channels, it would also diminish the TV signals since they occupy the same frequencies.

Ghost eliminator

Phantom borders that accompany the TV picture as a smear or additional outline alongside the primary image are due to phase delay—two identical picture signals arriving slightly apart in time. As a result, the sweep lines that draw the picture on your screen trace two sets of images; one is usually weaker because ghosts are caused by a reflection of the signal from nearby objects, arriving at the antenna both weaker and at a later time than the direct signal from the broadcasting station.

The ghost eliminator shown in Fig. 4 was installed and adjusted as directed; the ghosts were unaffected. Suspecting that the unit was labeled backwards, I reversed the leads, but the ghosts remained.

FIG. 4—GHOST ELIMINATOR is inserted in antenna lead-in and adjusted for best picture.

The ghost eliminator is an L-pad (see Fig. 5) consisting of carbon resistances that remain essentially noninductive throughout the VHF range; UHF performance is unpredictable. Because the device is a variable attenuator, it makes signals weaker; and weaker signals are more vulnerable to electrical

FIG. 5—GHOST ELIMINATOR is actually an L-pad attenuator as shown in *a*. Equivalent circuit when adjusted for minimum signal is shown in *b*. When adjusted for maximum signal, equivalent circuit is shown in *c*.

interference. Although it is stated on the eliminator's blister pack that the unit remains at a constant 300 ohms, it does not; the resistance of the device I tested varied from 300 to 7000 ohms at the TV terminals.

While it is dangerous to make generalizations, no inexpensive add-ons can take the place of a good antenna system; an outside antenna is always better than an inside antenna; interference is best eliminated at its source.

This article is not meant to be a blanket indictment of all TV accessories. High-quality picture-enhancing devices such as antenna preamplifiers, cavity wavetraps, etc., are available but at a substantially higher cost. However, the bottom line is: Use a good antenna and transmission line, and additional gadgets will rarely be necessary.

TV/FM splitters

A splitter is a coupling device that permits you to hookup two sets to one antenna. Since most TV antennas are rather broadband in nature, they work quite well on the FM broadcast band as well as on TV channels; so why not use this feature for your benefit? Since most stereo receivers have a 300-ohm (two screws) antenna input, it is a simple matter to run a length of TV twin-lead from the receiver to the TV antenna splitter and enjoy greater quieting, stronger distant reception, and less flutter and fade. Of course, the FM reception is enhanced in the same direction as the TV antenna is pointed. The TV reception will be virtually unaffected, since splitter loss is minimal. Acceptable units are mass-produced for most retail outlets and large chain discount houses. They are all fairly identical (see Fig. 6) so shop for price; the average price for a typical two-set coupler is from $3.50–$4.00. (Be aware that some of the better TV antennas are designed to trap out FM signals—thus eliminating them as a source of interference.—*Editor*)

Privacy earphone attachments

Although not all TV sets come with earphone jacks, many imported portable sets do. Make sure that the plug size is compatible with the jack on your set (most measure ⅛ inch, and adapters are available). If there's no earphone jack on your set, it is a relatively straightforward procedure to cut off the speaker

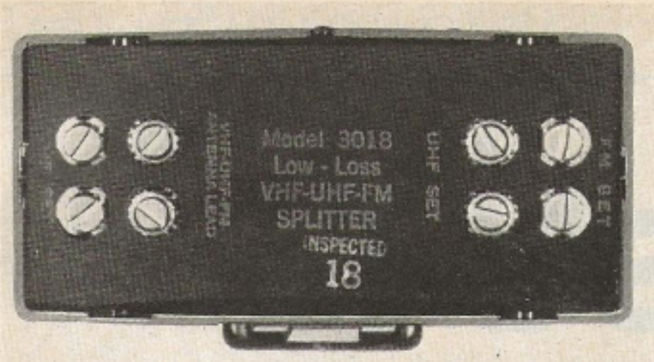


FIG. 6—TYPICAL TV/FM SIGNAL SPLITTER manufactured by the Finney Company.

lead inside the TV set and attach the adapter; before undertaking this minor surgery make sure instructions are included with the adapter. (Modern TV sets frequently do not have power transformers and, therefore, have a "hot" chassis. The audio output stages are similarly transformerless and the speaker leads can present a potentially dangerous shock hazard.—*Editor*)

Such units are sold for convenience, not hi-fi quality. They are available from the same sources as TV/FM splitters.

Antenna boosters

These little preamplifiers make a weak signal stronger, and *strong* signals stronger. They improve a snowy picture. Outdoor antenna-mounted preamplifiers are recommended over indoor antenna boosters, since you want a stronger signal to come down the antenna transmission line and don't want to amplify the

FIG. 7—TYPICAL ANTENNA BOOSTER that is mounted on the antenna mast itself. Made by Channel Master.

interference picked up by the lead-in itself. A typical booster is shown in Fig. 7.

If you are plagued with weak-signal reception, a booster will probably help. Make sure that you purchase one that is weatherproof, with all-channel capability (if you watch UHF transmissions), and that you cover the terminals with a good lacquer or silicone rubber caulk to retard corrosion after you have installed and tested the booster. Unit prices vary from $30 to $70.

Line-noise filters

Noise from motors, fluorescent lights and dimmers, and other sources of AC line interference constantly arrive at the TV line plug as voltage spikes. These interfering electrical pulses may not get filtered out by the TV set's power-supply circuitry and, as a result, show up as a tearing of the picture, or may be even heard through the speaker.

Inexpensive ($1.50–$6.00) filters usually consist of a plug and receptacle housing containing a capacitor or two. The TV line plug is inserted into the receptacle, and the unit is plugged into the wall. The line-noise filters are almost always either totally ineffective or inadequate because most electrical interference arrives through the antenna. An external ground should always be present (and rarely is); more sophisticated (and more expensive) units containing inductor coils are more likely to provide some relief from power-line noise.

Color purifiers

Color TV pictures are very sensitive to magnetic fields. Iron picture-tube envelopes, nearby steel hardware, etc., all may cause potential color distortion. If a TV set has been recently moved, transported for repair, exposed to strong electric motor fields, exposed to a nearby lightning strike or a host of other unexpected sources of magnetic energy, its components may have become magnetized and could degrade the purity of color distribution on the face of the picture tube. Color purifiers (also called *degaussers*) are simply multiturn loops of wire which, when plugged into the AC power line, produce a strong, fluctuating magnetic field capable of neutralizing the vestigial magnetism on the chassis parts.

At a cost of $5 or $6, this device is not a bad investment if it is properly designed and can deliver a strong enough demagnetizing field. Only a test of the unit will confirm this.

Wall-plate terminals

Many houses are built with TV lead wire "stubbed in"—i.e., twin-lead is left dangling through a hole in the wall for connection. Alternately, a more cosmetic plastic cover plate is connected to the lead-in and affixed to the wall to cover the hole. Connections are then made to the TV set by a short length of twin-lead that is either attached to screw terminals or plugged into the wall plate.

The wall-plate terminals offer very little loss to the TV signals, and are relatively inexpensive. They are worthwhile if you want to give a finished look to the TV installation. Some wall plates contain internal splitters for FM reception as well.

Wall-through tubes

There are many ways to bring a transmission line into a house from an external antenna: through a louvered vent, a hole under the eaves, or via a hole in the wall. But along with the hole comes another problem: How do you keep bugs, rain, or even intemperate air from penetrating the house? The wall-through tube provides a seal. (See Fig. 8.) Consisting of a plastic tube with

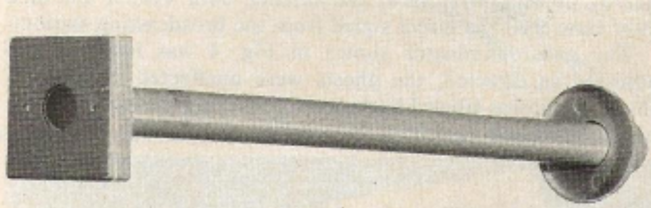


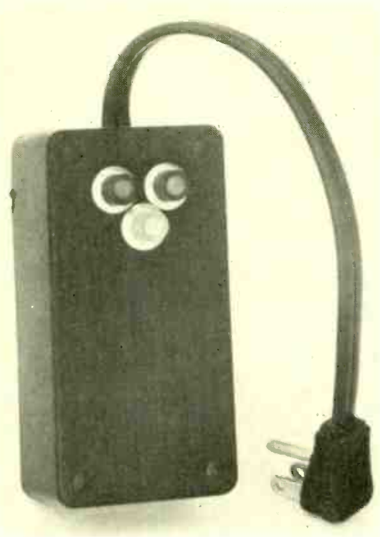
FIG. 8—THROUGH-WALL TUBES serve a dual purpose—they protect the lead-in at the point of entry into the house, while covering the hole in the wall. Available from several sources.

finished and adjustable ends, the unit is used to line the hole drilled for the lead-in. Of course, a larger hole must be drilled than would be required for the wire alone, but the device provides isolation and insulation from both the wall and the outside. At a cost of $2, it is a worthwhile investment.

Lightning arresters

Solid-state TV sets are far more vulnerable to failure from high-voltage spikes than the old tube sets. Even a nearby lightning stroke can induce enough voltage in a TV antenna line to destroy tuner components. A lightning arrester probably won't protect your set from a direct hit, but it should guard it from nearby lightning during an electrical storm.

A variety of arresters are available for $3–$5. Make sure to follow directions to insure both TV protection and efficient signal transfer. A well-grounded antenna mast is mandatory in *any* TV installation! If your reception seems to be a little weaker than usual, check the lightning arrester, perhaps even replace it after a stormy season. **R-E**



AC OUTLET CHECKER

Is the ground grounded or ungrounded? Your life can depend on the answer!

WILLIAM D. KRAENGEL, JR.

DO YOU KNOW IF YOUR 3-WIRE AC OUTLETS are functioning properly? If you accept the premise that the purpose of a 3-wire system is to provide an additional margin of safety (with a grounding conductor to which frames, cabinets, housings, etc., are separately grounded), it is necessary to be able to verify that the system is indeed working as designed; i.e., that the ground is really grounded.

How can this be done easily? You can use the Outlet Polarity Checker described in this article. With a little additional sleight-of-hand, the unit can be used to check 2-wire systems to determine if they can be used safely with a 2- to 3-wire adapter. (I don't like them—as shall be seen later, these can lead to a false sense of security!) And it can also be used to check an appliance that has a 3-blade plug.

The checker consists of three neon lights (see Fig. 1) wired so that they light in different combinations according to circuit conditions. Since only one combination of lights (the ones labeled "O" and "K") indicate a correctly wired outlet, the other combinations indicate various faults. Table 1 lists these possible light combinations and their causes. In most cases, but not always, any trouble will be due to an incorrectly wired outlet. However, the entire branch circuit can be incorrectly wired, especially if it has been installed by nonqualified personnel.

When 3-wire systems are working properly, they do provide an extra margin of safety. But what happens when a homeowner wants to use a new 3-wire appliance with an existing 2-wire system? He sometimes buys an adapter or uses the one that is conveniently furnished with many new 3-wire appliances. He hooks the adapter up according (sometimes) to the instructions (if any). He now blithely assumes that he has successfully converted his old 2-wire system into a safe, grounded 3-wire system—but has he? Unless he has actually *grounded* the green lead of the adapter, he hasn't! Just fastening the green lead under an outlet-plate mounting screw grounds the appli-

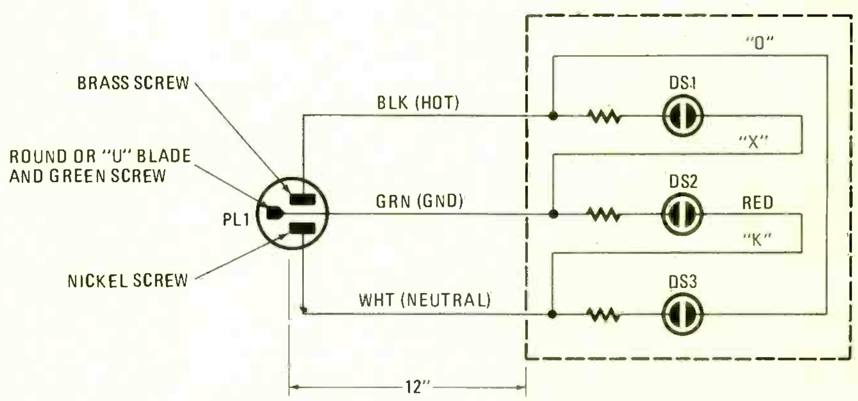


FIGURE 1—OUTLET POLARITY CHECKER. A simple and sure way of knowing if the outlet that you are about to plug into is functioning properly.

TABLE 1 - SIGNAL LIGHT COMBINATIONS

LIGHTS ○ OFF ● ON			CIRCUIT CONDITIONS
O	K	X	
○	○	○	OFF - FUSE OR CIRCUIT BREAKER OPEN
●	●	○	OK (SAFE!)
●	○	○	NEUTRAL OPEN - DANGER!
○	●	○	GROUND OPEN - DANGER!
○	○	●	HOT TERMINAL OPEN AND HOT ON NEUTRAL TERMINAL - DANGER!
●	○	●	HOT AND GROUND REVERSED - DANGER!
○	●	●	HOT AND NEUTRAL REVERSED - DANGER!
●	●	●	(NOT POSSIBLE)

PARTS LIST

DS1, DS3—Amber neon lamp assembly (Lafayette No. 99A62259 or equal)
DS2—Red neon lamp assembly (Lafayette 99A62267 or equal)
P1—3-wire polarized plug and cord
Misc.—*Bakelite* case (Lafayette No. 99E80780 or equal); grommet to fit cord.

continued on page 78

Wiring Syst For Proj

A comparison look at four different ways you can wire your projects. Selecting the right one for your next construction project will make the task easier and more pleasurable.

EARL "DOC" SAVAGE, K4SDS
HOBBY EDITOR

NOT SO LONG AGO THERE WAS ONLY ONE WAY TO WIRE AN ELECTRONIC project; and too many people believe there is *still* only one way.

Today there are *four* major wiring systems from which to choose. If you are not familiar with these systems and their advantages and disadvantages, you are likely to spend too much time constructing and correspondingly less time designing and using your projects.

To avoid wasting time, a knowledge of available wiring systems is a *must*. Although it is equally important to be able to *use* all systems, first you must be able to choose which one is best for a given project. So let's examine and compare the four major wiring systems.

CSH wiring

This wiring system has been in use for many years. It is conventional or traditional wiring, but many call it CSH (*C*ut/*S*trip/*H*ook). The name itself shows how slow and tedious it is.

We'll review the CSH wiring system, briefly, but, first, since every project must be built *on* something let's see what's available.

Figure 1 shows several types of perforated boards that are used with the CSH system. A plain perforated board is often chosen. Three types of universal PC boards are also shown. Depending upon the nature of the project circuit, a universal PC board can ease the wiring task.

The cut/strip/hook wiring method started when components projects were large. Even so, it is still used on modern small board-mounted projects. Figure 2 shows the tools and materials used in this system. It's the cutting, stripping and hooking that takes so much time; and the hooks must then be clamped to the joints. The final step is soldering, and, a very small iron tip is essential. Note that components can be wired directly or sockets can be used.

The overwhelming disadvantage of this wiring system is the great amount of time and effort it requires. This fact will become more apparent as we look into the following systems.

However, the other side of the coin is that there is no limit to the size wire you can use. When constructing high-current and/or high-voltage circuits, this can be an advantage. The CSH wiring method is generally used in constructing power supplies and high power amplifier stages. Of course, it is standard in tube circuits.

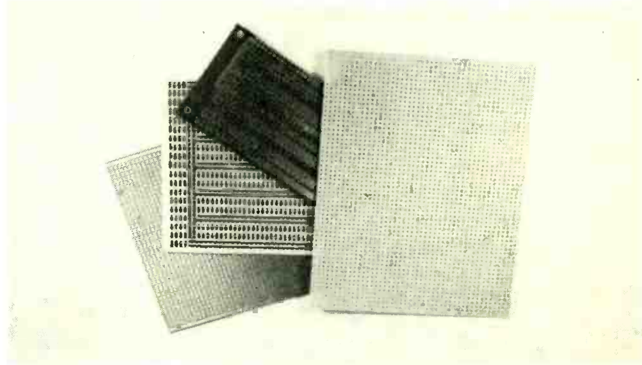


FIG. 1—PERFORATED BOARDS are used with the cut/strip/hook and wire-wrap wiring methods. Also shown is a universal-type printed-circuit board.

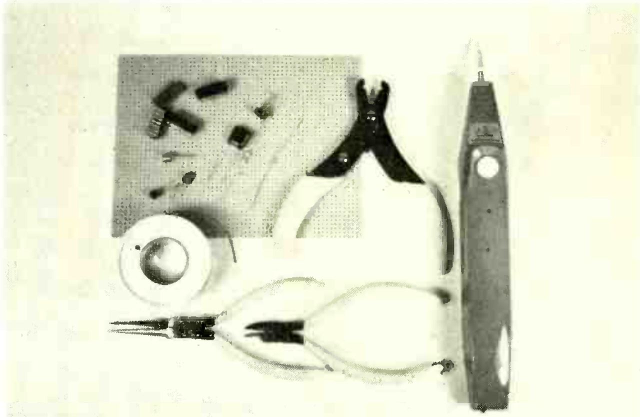


FIG. 2—TOOLS AND MATERIALS required for the cut/strip/hook wiring method.

Pencil wiring system

Figure 3 shows the tools and materials used in the *pencil* (or *pen*) wiring system. This type of wiring is very much like drawing with a regular pencil. The pencil contains a roll of special wire at one end that passes down the shaft and is dispensed through a small metal point.

The wire is wrapped three or four times around a component lead or socket tail, then fed to the next component and so forth, daisy-chain fashion. At the end of the chain, you cut the wire by

A series of four ½-inch videotapes describing various aspects of satellite television communications are available from *Satellite, Television Technology*, P.O. Box G, Arcadia, OK 73007:

Tape HTS-1, "How The Home Terminal works"

Tape HTS-2, "Private Terminals Today"

Tape HTS-3, "TV Terminal Technical Topics"

Tape HTS-4, "How The Bird Flies"

Tapes are ½-inch and run from 70 to 110 minutes and are in full color. Specify either VHS or Beta format when ordering and enclose payment with order. Price is $50, each in Beta format; $55, each in VHS format.

Also available is a "Satellite Study Package," including a 52-page booklet explaining private terminals, a 22 by 35 four-color wall chart showing all satellites in operation and how the receive terminal is designed and installed, and a copy of a recent issue of *CATJ* (the worldwide monthly publication dealing with satellite terminal systems) is available for $13 postpaid ($16 outside the U.S.

The first national seminar conference dealing with practical technology for building and operating your own private television receive satellite terminal will be held August 14, 15 and 16 in Oklahoma City.

This conference will feature worldwide experts in the field of private (low cost) satellite terminals demonstrating their equipment design and construction techniques. Numerous operating terminals from 6 to 20 feet in size will be on hand and several firms marketing equipment in this field will be on hand to explain their marketing approaches to home terminal installations. Firms interested in acting as area marketing, servicing and installation affiliates of the national suppliers in this field will have the opportunity to learn about the various products being offered in this field.

Among the systems to be demonstrated will be ten foot terminal systems operating without any LNA devices (utilizing new technology in the receiver area), various approaches to low cost privately built receivers and antenna sub-systems, and a series of sessions on the projected growth and activity in this fast moving area.

Attendance is by advance registration only; for full information contact Satellite, Television Technology, P.O. Box G, Arcadia, OK 73007 (405) 396-2574

FIG. 3—DOMESTIC SATELLITE "parking" spots. Ten domestic satellites are currently active—3 Canadian and 7 U. S. A. A third WESTAR satellite should have been launched by the time you read this and a third SATCOM is due for launch between October and December of this year.

Domestic satellites

As needed as the Intelsat-type satellites are, they cannot serve all the communications needs of all countries. Some nations, such as the U.S., Canada and Russia, have unique internal needs that in sheer message volume (or circuits required), far outstrip Intelsat's services. For example, in the Atlantic Intelsat cluster five separate satellites have a total flat-out capacity of 100 separate "channels" or transponders. A single transponder can provide (typically) up to 900 voice or message circuits, or one TV channel circuit. Obviously, not all these circuits are used full time, so satellite communications planners take advantage of what are called "peak load times." They attempt to have enough circuits available to handle peak or maximum traffic-time loads. In the long haul, the average number of circuits in use would be somewhat less than 50% of the total capacity available.

Some smaller nations, such as Nigeria, Sudan, Uganda, etc., lease one or more transponder/channels full time from Intelsat to provide ground-to-satellite-to-ground communications for circuits wholly within their own countries (except for the satellite link). Other countries such as Spain, lease full-time circuits to maintain ground-to-satellite-to-ground communications with distant outposts of their nation, for example, television, telephone and data circuits with the Canary Islands.

In 1970–1971 individual countries with projected satellite circuit needs for exceeding Intelsat's capability persuaded other Intelsat nations to allow some portions of the equatorial orbit belt to be reserved for non-Intelsat geostationary satellites, or for domestic satellites. In the interim so-called Domestic Satellite Systems have been activated for Indonesia, Canada, Russia and the U.S. although actually the Russian system was first made operational back in 1965.

In North America the orbit parking region from 70 degrees west longitude (a point due south of New England) to around 135 degrees west (roughly due south of the Alaskan peninsula) is reserved for North American domestic satellites. (See Fig. 3.) Canada was the first to launch a domestic satellite into this region (ANIK I in 1972); and in seven years, 10 other Canadian or U.S. domestic satellites have joined ANIK I. An additional pair of U.S. domestic satellites will join the crowd before 1979 is over. There are 13 satellites in all, and all are parked between 70 degrees west and 135 degrees west.

On a transponder or channel-capacity basis, the North American satellites have the full-load capability to provide as many as 228 separate TV channels, or more than 200,000 telephone voice channels simultaneously—more than twice that available on the Intelsat system. With all that capacity available, you might suspect there is some extremely interesting, perhaps even downright enticing, "television" up there.

Indeed there is. There's a lot of good watching—more than 40 channels worth—to be had from those U.S. And Canadian domestic birds. Next month, we'll take you channel-by-channel, bird-by-bird as we scan programming available to TV viewers in other locations throughout North America. **R-E**

TV ADD-ON DO THEY R

As we strive for improved TV reception, we are offered innumerable gadgets that promise us a near-perfect picture. Not all work as well as the sellers claim that they do.

ROBERT B. GROVE

WE ARE ALL TEMPTED—AT ONE TIME OR ANOTHER—BY THE quick-and-easy-remedy syndrome: Gas-tank additives, pill-popping medication, flea collars, spray deodorants. Even the family TV set is besieged with handy accessories that promise fantastic results for a minimum investment in time and money.

The TV gadget syndrome began soon after World War II, when small-screen black and white TV was just catching on, and families, friends and neighbors clustered for hours around the magic box, squinting at teeny-tiny pictures.

A few enterprising souls decided to capitalize on the small screen problem by selling attachable magnifiers: A clear, convex cell of mineral oil was braced in front of the tiny screen; if the viewer sat directly in front of the screen, he could view an enlarged (albeit blurry) picture. The hapless souls who had to view the magnified image from an angle were plagued by incredible distortion. The magnifiers finally went the way of the dinosaurs!

Another item that appeared was the color-filter adapter, an incredible hoax consisting of alternating horizontal bands of colored plastic film stuck to the face of the picture tube. True, your black and white TV set could then show color . . . if you didn't mind seeing Ed Sullivan with red eyes, green nose, blue lips and a yellow chin!

Accessory gadgets are still in popular demand, but do they really work? I decided to find out. A trip to my local electronic store provided several devices intended to improve TV picture quality. Interestingly enough, *none* carried a guarantee of any kind!

The devices were tested on two separate TV sets in two different locations, and the results were disturbing. Here's what I found:

TV interference filters

These devices are advertised as being effective against neon signs, fluorescent lights, auto ignition noise, airplanes, appliances, amateur radio transmitters, medical and X-ray equipment, electric razors, and oil burners. I purchased the filter shown in Fig. 1 and tested it using a CB transceiver; the filter did not reduce the interference on either set. Further experiments using an RF signal generator radiating local interference on TV channels also resulted in no improvement with the filter attached. The filter was then tested for its effectiveness in suppressing the spark-tearing of the picture caused by electrical appliances; again, no improvement.

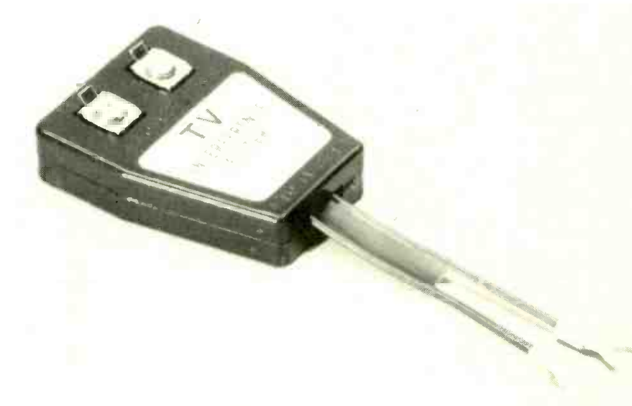


FIG. 1—TV INTERFERENCE FILTER is inserted in the antenna lead-in.

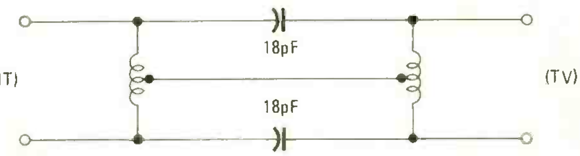


FIG. 2—INTERFERENCE FILTER is a high-pass filter that attenuates signals below 54 Hz.

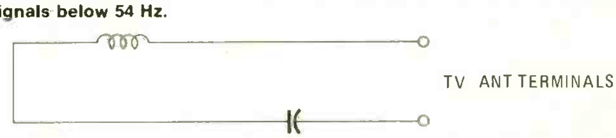


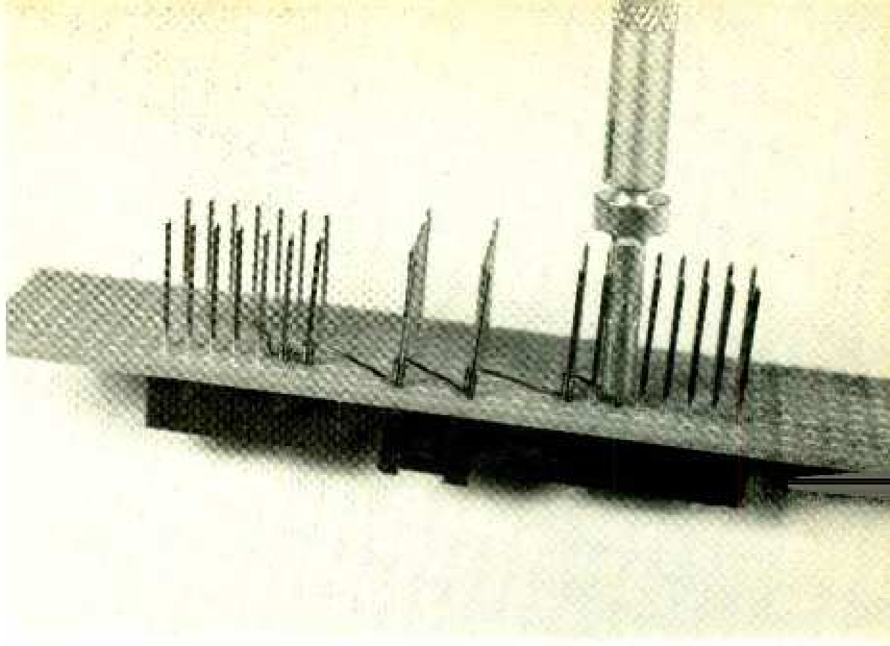
FIG. 3—CB TRAP is a series filter that eliminates 27-MHz CB signals.

Internally, the TV interference filter is a constant-k high-pass filter, attenuating all signals below 54 MHz (Channel 2). The schematic diagram is shown in Fig. 2. It should be effective in preventing front-end overload from signals below 54 MHz, but it has no effect on interfering signals *in* the TV frequency bands, which is where the majority of interference originates!

CB interference trap

Turning the CB transceiver on transmit next to the antenna

ems
ects



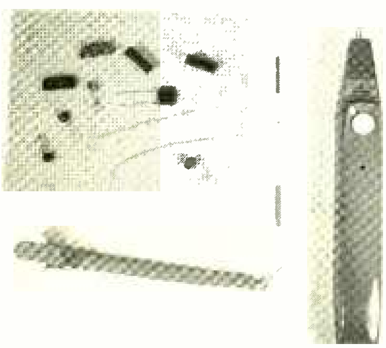


FIG. 3—PENCIL WIRING SYSTEM also requires perforated board and soldering iron.

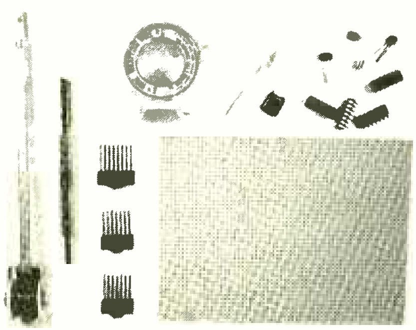


FIG. 4—TWO TECHNIQUES are available for wire-wrap construction. The tools and materials required for both techniques are shown.

pinching it against the board using a chisel-like tool or an *Xacto* knife or other type of blade.

So far, we have not mentioned stripping the wire. This is because the wire has a special insulation that *vaporizes* at a temperature of about 750°F, making wire-stripping unnecessary. You only have to touch the wire with a hot iron to melt the insulation so that solder can be applied.

Quite obviously, the great advantages to the pencil wiring method are its simplicity and speed. It is ideal for most modern digital and analog circuits. As you might expect, the disadvantage is the limited wire size—gauges No. 32 through No. 38 are usually available. Therefore, pencil wiring would not be suitable for constructing a 2-amp power supply.

Wire-wrapping

There are two wire-wrapping methods, and the tools and materials for both are shown in Fig. 4. One method (Type 1) resembles the CSH system, although it is much faster.

The first wire-wrapping method (Type 1) requires that the wire be cut and stripped. Fortunately, these operations are simplified by the wire dispenser and stripper shown in Fig. 5. OK Machine and Tool's refillable wire dispenser has a built-in cutter and stripper that saves a lot of time. The other device has a stripper built into the handle of the double-ended wrap/unwrap tool. Kits are also available containing various lengths of precut and prestripped wire.

Wiring is performed by simply wrapping the wire around the terminal. In case of error or modification, the other end of the tool can be used to *un*wrap the connection.

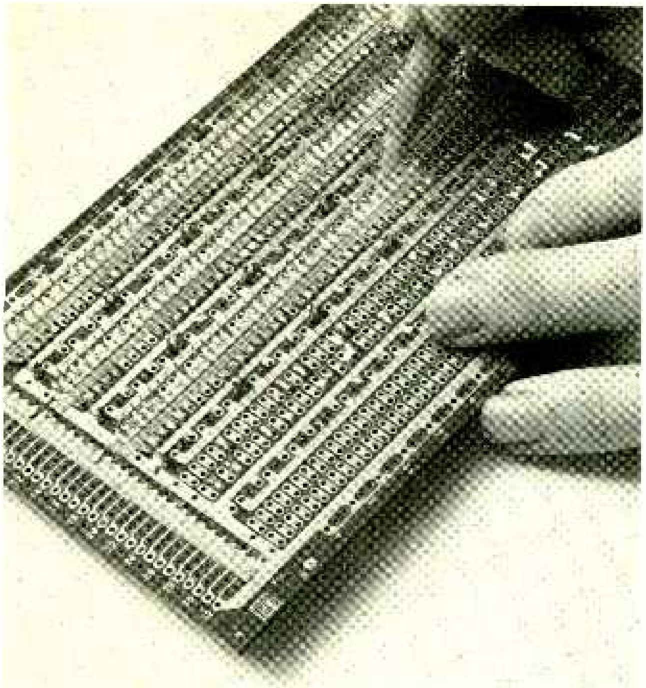
The second wire-wrapping method (Type 2) is called slit-and-wrap wiring and is accomplished with a tool from Vector Electronics that resembles a wiring pencil. This wire is also contained in a spool mounted on one end of a hollow shaft through which the wire passes. The business end of the tool not only wraps the wire but *slits* the insulation as it does so, allowing contact to be made with the terminal.

The slit-and-wrap technique has two decided advantages over the Type 1 method. First, cutting and stripping are *not* required. Second, continuous daisy-chain connections can be made (see Fig. 6). These two factors greatly improve convenience and time-saving (and there are also motor-driven wrapping tools).

You will note that no mention has been made of soldering. The ultra-speed of the wire-wrapping system (the slit-and-wrap technique especially) results from the fact that there is *no soldering*. As strange as it may seem, a properly wrapped connection is *at least* as stable mechanically, and has as low a resistance as a soldered connection.

The wire-wrapping system is not a cure-all, however. It has some disadvantages: The wire is of limited size, although typically a little heavier than pencil wire (but, as previously noted, this is seldom a problem). What is more important is that connections must be made on special wrapping posts.

Wire-wrapping *cannot* be performed on component leads. The wrapping posts must have sharp edges to dig into the



UNIVERSAL PC BOARD and wiring pen manufactured by Vero Electronics, Inc.

wrapped wire. This means using special wire-wrapping sockets and through-board posts for mounting discrete components.

Printed-circuit boards

There is some confusion about the meaning of the term PC board because both *universal* and *dedicated* boards can be called PC boards. In order to distinguish between the two types, the adjective "universal" is included for that type of board. (An unqualified PC board generally refers to a dedicated board—that is, one designed for use with a specific circuit.)

The PC board wiring technique is the simplest and quickest technique of all. It would win hands down over the others except for two factors: First, modifications are more difficult (although not impossible) to make on PC boards. It is just a matter of cutting the traces and substituting actual wires, and, with reasonable care, this procedure works quite well.

The more important difficulty is making the PC board itself. At the outset, the copper-clad board is plain and undrilled. Somehow the circuit must be placed on the board—either by drawing, transferring, pasting-up, or using a photosensitive process. Next, the unwanted copper must be removed—by etching, grinding, or even sawing. Finally, the PC board must be drilled for component mounting.

Several excellent methods have been devised for constructing PC boards. Everyone should become familiar with them in order to be able to select the correct one. However, there is *no* presently available *fast* method of doing the job.

Time can be saved only when a quantity of identical boards must be constructed, which is a rare situation for the individual builder. Even ordering a preconstructed board takes time. In spite of all this, time and effort are not always the most important considerations, so PC board wiring should not be overlooked.

Material sources

For your convenience, some of the manufacturers of tools and materials needed for the various wiring systems are listed in Table 1. Listed under each name are applicable tools, identification numbers and the latest prices (subject to change). Each manufacturer also produces materials and accessories, so request a catalog from each one.

You can sometimes find these items in many mail-order catalogs. There may also be sources in your own area, such as retail stores and electronic supply distributors. If you cannot locate what you need, you can write the manufacturer.

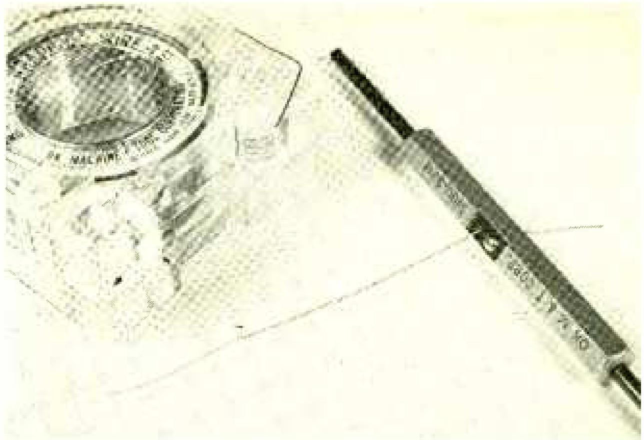


FIG. 5—WIRE DISPENSER and wrap/unwrap tool available from OK Machine and Tool Corp.

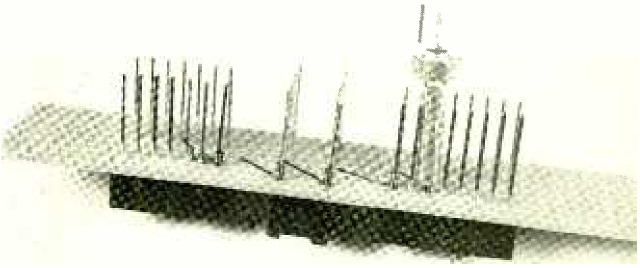


FIG. 6—SLIT-N-WRAP tool from Vector Electronics has wire stripper built-in so the wire is automatically stripped as it is wrapped.

TABLE 1—MANUFACTURERS of tools and materials for various wiring systems

OK Machine & Tool Corp., 3455 Conner St., Bronx, NY 10475: CIRCLE 148 ON FREE INFORMATION CARD
WSU-30—Wrap/unwrap tool, $6.95, plus materials, accessories, boards.
JWK-6—Just Wrap kit, $24.95.
Vector Electronics Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342: CIRCLE 149 ON FREE INFORMATION CARD
P-178-1—Wiring pencil, $7.95.
P-183—Chisel knife and forming tool, $1.95.
P-180—Slit-N-Wrap tool, $24.50, plus materials, accessories, boards, kits.
Vero Electronics, Inc., 171 Bridge Rd., Hauppauge, NY 11787: CIRCLE 150 ON FREE INFORMATION CARD
79-1732G—Wiring pen, $8.00.
58-2808J—Wrap tool, $21.70, plus materials, accessories, boards, kits.

Summary

Knowledge is, indeed, a powerful thing. You can save yourself much "fussin' an' cussin' " if you know enough about the four major wiring systems to pick the right one at the right time. Choosing the wrong one can result in anything from frustration to disaster. After all, old Murphy's Law says that something will go wrong anyway—you don't have to make it worse by selecting the wrong one from the start!

Every electronics hobbyist should not only read about, but *try out* each wiring system. That way, you *really* know. Don't take someone else's word—even mine—because we may have different expectations. Try all of them and then you can choose the system you need when you need it. **R-E**

New FM Tuner CIRCUITS

During the last few years the sound quality developed by the FM detector and stereo decoder has improved noticeably. Here is a look at some state-of-the-art circuits that make this possible.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IT WASN'T VERY LONG AGO THAT AN FM tuner capable of delivering an audio signal with less than 1.0% total harmonic distortion at the output of its ratio detector or discriminator was considered to be a very high-quality product. Today, it is not uncommon to find FM tuners with distortion as low as 0.1%, even in the stereo FM mode. Despite such giant reductions in overall distortion of FM signal reception, some manufacturers continue to explore other innovative ways to improve FM reception.

For example, Kenwood Electronics (1315 E. Watsoncenter Rd., Carson, CA 90745) has developed a separate tuner, the *model KT-917*, that achieves a distortion rating of 0.05% in the monophonic mode and 0.09% in the stereophonic mode at any audio frequency from 50 Hz to 10 kHz. Several new and unusual circuits are responsible for this additional lowering of overall distortion; we'll examine four of these new circuits.

Pulse-count detector

Conventional discriminators and ratio detectors, which have been in use since FM broadcasting began, use tuned circuits which first convert the FM signal into one that varies in amplitude. Nonlinear devices (diodes) then rectify the frequency-dependent AM signal to recover the original audio modulation. Both steps in this process are inherently nonlinear. The discriminator (or ratio-detector) S-curve, formed by transformer-coupled tuned circuits, is a continuous curve (see Fig. 1). It is this curve that converts frequency variations into varia-

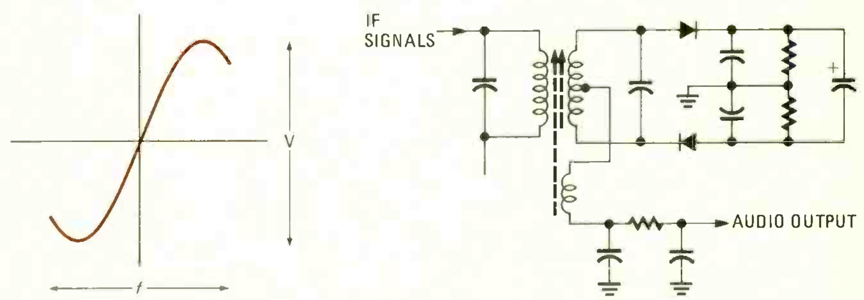


FIG. 1—CONVENTIONAL DISCRIMINATOR has a nonlinear S-curve characteristic to convert FM signals into AM signals.

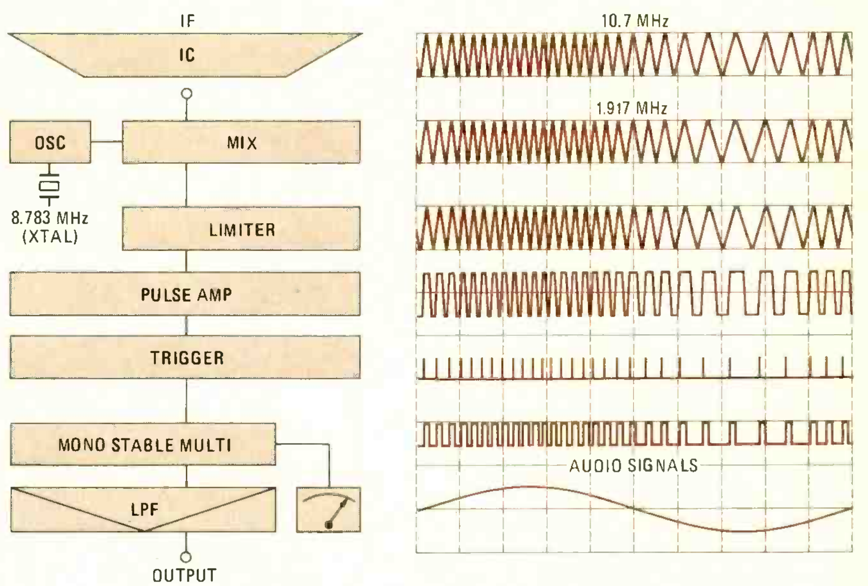


FIG. 2—PULSE COUNT DETECTOR is a digital circuit that performs the function of a conventional discriminator but with much less distortion.

tions in amplitude. By restricting the FM deviation to a portion of this curve, linearity is approached but not fully realized. The second step in the demodulation process uses a diode's nonlinear characteristics for rectification. Here, with careful attention given to input-signal amplitude, linearity is again approached but not totally realized.

A pulse-count detector system, on the other hand, is theoretically linear. In this system each individual waveform (at the IF) is converted to a pulse of uniform amplitude and duration. An integrating circuit counts these pulses and averages the count over a given time interval; the output is proportional to the pulse count. A block diagram of the Kenwood pulse-count detector system is shown in Fig. 2. The pulse count rises as a linear function of frequency, and the counting process remains linear until there is no space left between pulses. This point of saturation occurs far beyond maximum deviation. The system uses no nonlinear analog elements. It is a digital system in that the precision-pulse formers use digital techniques. The pulse counter is a form of digital-to-analog converter.

In applying this technique to FM demodulation, Kenwood found that the best detector efficiency can be achieved when demodulation occurs at a frequency much lower than 10.7 MHz (the normal FM IF). Therefore, a second converter is incorporated to heterodyne the IF down to 1.96 MHz. This causes the deviation to be much greater compared with the center frequency, and suits the operating characteristics of the digital processors. Referring to Fig. 2, note the 1.96-MHz signal is shaped into narrow triggering spikes (one for each cycle) that drive a one-shot multivibrator. The multivibrator produces output pulses of uniform amplitude and duration. Only the frequency or density of pulses varies. A low-pass filter performs the pulse-counting function, producing an audio output that is determined solely and linearly by pulse count.

There is an additional performance advantage to this system. The multivibrator is either off (zero volts) or on (supply voltage). In either state, no noise is produced, since the system is sensitive to noise only at the instant of triggering. This results in an important reduction in overall noise. Furthermore, since there are no tuned circuits the pulse-count detector never needs alignment and is not affected by temperature or humidity.

Figure 3 shows the differential gain for a conventional ratio detector and for a pulse-count detector. Note that ratio-detector gain varies as the frequency deviates farther and farther away from the center, while the pulse-count detector gain remains linear over a very wide frequency range.

Distortion detection loop

With distortion caused by nonlinear detection virtually eliminated by the pulse-count detector, the one remaining possible source of distortion is the IF system of the FM tuner. In many FM tuners an indicator displaying center-tuning makes use of a balanced detector whose output voltage goes to zero when the converted signal is at the center of the detector's response. The drive from this circuit controls the deflection of the familiar zero-center tuning meter, or an AFC (*A*utomatic *F*requency *C*ontrol) system, if one is used. This system works on the assumption that the IF response is perfectly symmetrical and has the same center frequency as that of the detector driving the tuning meter. Unfortunately, this is not always the case.

The DDL (*D*istortion *D*etection *L*oop) system developed by Kenwood examines distortion and adjusts local oscillator frequency to place the converted IF signal precisely where it should be for minimum distortion. The block diagram of Fig. 4 shows that the local oscillator is frequency-modulated by an internally generated 95-kHz signal that contains 10% positive and negative deviation components.

To avoid interference with the selected incoming channel, the 95-kHz signal was chosen to be five times the 19-kHz pilot-signal frequency. It is mixed with the selected carrier signal in order to place frequency-modulated signals on the upper and lower skirts of the IF response curve. After FM detection, original test signals and any distortion (which appears as twice the 95-kHz signal) are extracted by a high-pass filter and applied to a synchronized detector where the original test signals and distortion components are compared. If an imbalance exists a DC error voltage is produced; this voltage is filtered and applied to the same varactor diode used to add the frequency-modulated injection signal to the local oscillator. This error voltage corrects the local oscillator's center frequency to balance the DDL phase detector. In this way the DDL system monitors the distortion by injecting test signals that accompany the selected channel through the IF system. It serves to balance the distortion and to place the selected channel at the precise mid-point of the IF passband.

To prevent interference with normal tuning, a logic-control circuit interrupts DDL control until manual tuning places a selected channel in the approximate center of the IF passband. Inputs to the control logic are a touch detector that is linked to the tuning knob, a noise detector that monitors IF output, and the output of the high-pass filter that delivers the recovered injection signals to the DDL phase detector. When the operator releases the tuning knob, the DDL system starts working, and a light is turned on to indicate that tuning for minimum distortion has occurred.

Sample-and-hold decoding

In the conventional stereo FM decoding process, the (L−R) and −(L−R) audio information is recovered from the positive and negative excursions of the 38-kHz composite-signal envelope. In such switching systems the (L−R) and −(L−R) information is recovered in the form of averaged 38-kHz components. In the course of filtering the ripple components of the 38-kHz signal to reclaim the original modulation some sacrifice in stereo separation normally occurs.

In a newly developed sample-and-hold technique, the 38-kHz signal envelope is examined in short bursts at a rate that is determined by the 38-kHz signal produced by a phase-locked-loop (PLL) system. The recovered levels, in terms of modulation envelope voltage, are stored in a capacitor that is effectively disconnected from the sampling switch after the sampling burst has passed. This voltage value is retained by the capacitor until the next sampling burst arrives. The capacitor then charges or discharges to the new envelope voltage value. As a result the envelope is traced in the form of horizontal voltage steps, as shown in Fig. 5. This represents a more accurate reproduction of the modulation envelope voltage. The resultant ripple component is lower and little filtering is required.

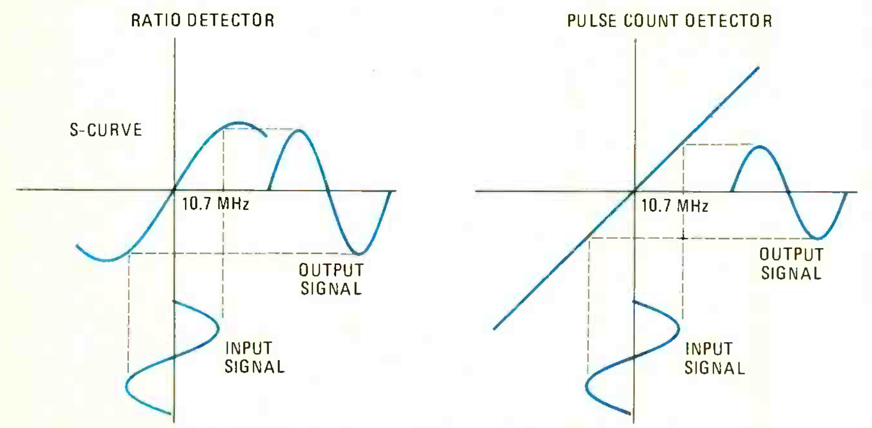
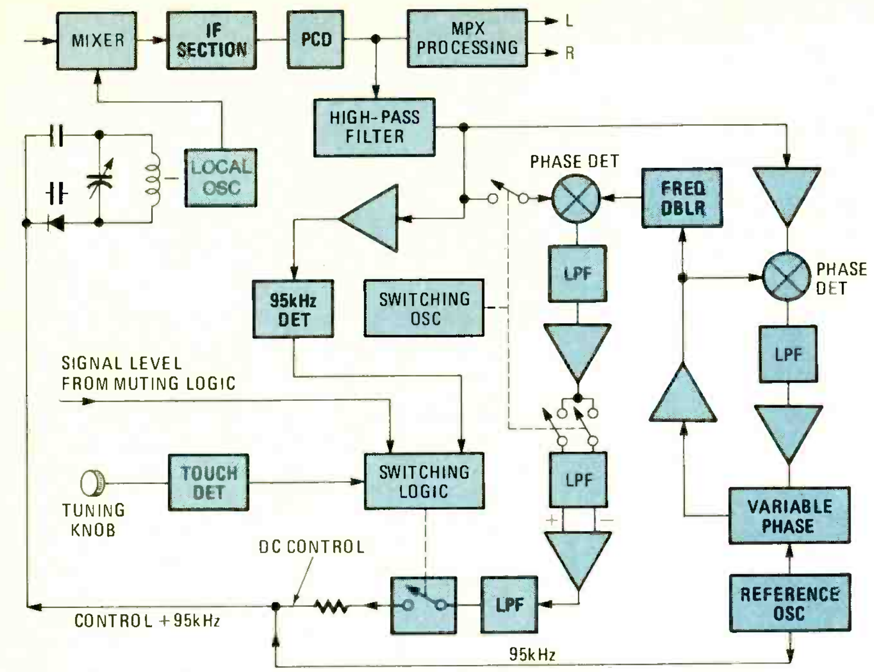
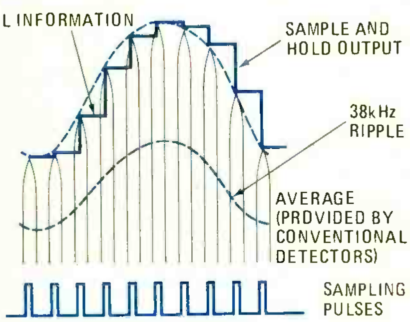


FIG. 3—TRANSFER CHARACTERISTICS for the conventional ratio detector and for the new pulse count detector.



BLOCK DIAGRAM OF DISTORTION-DETECTION LOOP (DDL)

FIG. 4—DISTORTION DETECTION LOOP senses the distortion level at the output of the detector and adjusts the local oscillator frequency for minimum distortion.



SAMPLE-AND-HOLD DETECTOR FOLLOWS 38kHz ENVELOPE PEAKS AND REQUIRES LESS FILTERING.

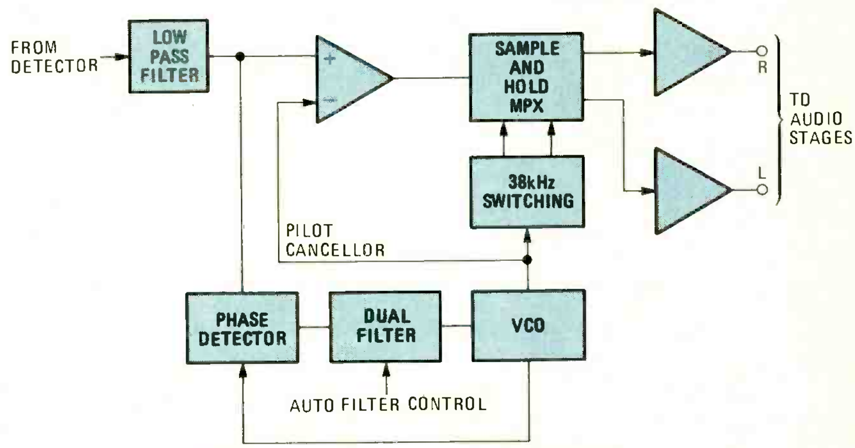
FIG. 5—SAMPLE-AND-HOLD stereo decoding circuit output follows the 38-kHz envelope and requires less filtering than conventional techniques.

Two-speed phase-locked loop

Another form of distortion can be introduced into stereo decoding circuits that use a phase-locked loop circuit to regenerate the 19-kHz and 38-kHz carrier signals during decoding. Ideally, the regenerated 38-kHz subcarrier signal should be immune to noise-induced frequency jitter. To reduce such frequency jitter, some designers narrow the bandwidth of the phase-locked loop, 19-kHz capture range. This approach makes it more difficult for the PLL circuit to lock onto the incoming pilot-carrier signal. Opening the bandwidth to allow fast and reliable capture of the pilot signal, on the other hand, increases the possibility of pilot jitter; this normally peaks at around 200 Hz to produce high-order audible intermodulation. In the Kenwood stereo decoder (shown in the block diagram of Fig. 6) a dual time-constant filter is used in the PLL circuitry: a wide filter for acquisition; followed by a narrow filter, which is inserted after lockup (of the pilot signal) to keep tight and jitter-free control of the regenerated pilot signal.

Figure 6 also demonstrates the way in which this PLL circuit eliminates any residual 19-kHz signals from the recovered audio outputs. Removal of this high-frequency signal is important because the presence of 19-kHz components in the output signals can produce beat frequencies during tape recordings (the 19-kHz harmonics can beat with the tape deck's bias oscillator); and can also cause improper tracking of built-in Dolby or other types of noise-reduction circuits. The conventional way of removing the 19-kHz pilot signal from the audio output signals is by using a simple low-pass filter. For the filter to be effective at 19 kHz, however, it must also rolloff response at lower audio frequencies, beginning at around 10 kHz or 12 kHz. The decoding system shown in Fig. 6 does not use such simple filters. Instead, a sample of the regenerated 19-kHz signal from the two-speed phase-locked loop is applied to a subtractor circuit in the decoder input section. Here, the original pilot signal and the regenerated 19-kHz pilot signal are 180 degrees out-of-phase. By adjusting the out-of-phase 19-kHz signal so that it is equal in amplitude to the incoming 19-kHz signal (part of the overall detected composite stereo signal), the two 19-kHz components cancel each other out without affecting audio frequency response.

Manufacturers of high-fidelity FM equipment such as Kenwood and others seem to be able to develop more and more improved circuits to provide audibly better FM reception in the home. Unfortunately, only a few FM broadcast stations are able to transmit clean enough signals to allow state-of-the-art hi-fi FM tuners and receivers to perform optimally. The truth is that the performance of most FM receivers today is limited by the antiquated transmission equipment used by a majority of FM stations, not to mention the scratched recordings, worn styluses, and hum-and-noise in studio consoles and cables that many stations continue to transmit. **R-E**

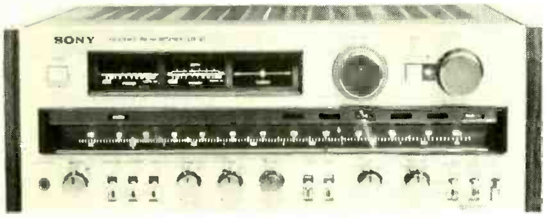


19kHz PHASE-LOCKED-LOOP

FIG. 6—BLOCK DIAGRAM of the Kenwood stereo decoder designed to eliminate pilot jitter. Two filters, one narrowband and the other wideband, provide a jitter-free regenerated pilot signal.

R.E.A.L. SOUND

Radio-Electronics Audio Lab Tests



1

SONY STR-V7 AM/FM Receiver

LEONARD FELDMAN
CONTRIBUTING HI-FI EDITOR

SONY CORPORATION HAS DEVELOPED ITS MOST powerful stereo receiver to date, the *model STR-V7* (see Fig. 1). This receiver's control layout has been carried over from earlier Sony models. The tuning knob and master volume control are conveniently placed in the upper right-hand side of the panel, and the POWER on/off pushbutton is located at the upper left-hand side. In between these controls are placed three meters—the center meter acts as either a signal-strength meter (when a pushbutton adjacent to the tuning knob is depressed) or, used with the meter on the left, as one of a pair of power-output meters directly calibrated in watts across an 8-ohm load. The third meter, next to the volume control, serves as a center-of-channel tuning indicator in the FM listening mode.

The FM dial scale is linearly calibrated with markings at every 200 kHz, while below it is a nominally calibrated AM scale. Above these scales are a series of indicator lights that denote program source as well as stereo FM reception. The remaining controls and switches are located along the bottom section of the panel. Adjacent to the usual headphone output jack at the extreme left is a SPEAKER selector switch. Next to this control are three toggle switches for the low-cut and high-cut filters and for bypassing the BASS and TREBLE controls. Next come a rotary BALANCE control, LOUDNESS and MODE (stereo/mono) switches, TAPE switch and FUNCTION selector switch. The TAPE mode switch permits you to monitor either of two connected tape decks as well as to copy tape from one deck to another. The FUNCTION switch has two phono settings: for magnetic cartridges, or, alternatively, for moving-coil cartridges. Three additional toggle switches on the lower right-hand side of the panel are used for varying FM-IF selectivity (both normal and narrow bandwidths), for FM muting and for activating the built-in Dolby FM decoding circuitry.

The upper left of the rear panel contains antenna terminals for 300-ohm or 75-ohm coaxial FM transmission lines and for connecting to an external AM antenna. A useful addition is an antenna lead-in clamp that retains the antenna line and protects it from strain. Nearby are a built-in ferrite-bar AM antenna, pivotable in two planes, and a chassis ground terminal. Near the two pairs of phono inputs is a two-position slide switch that selects either MM (*M*oving *M*agnet) or MC (*M*oving *C*oil) cartridge operation. The tape-input and tape-output jacks are located in the lower left of the rear panel. On the right-hand side are located two sets of spring-loaded, color-coded speaker-connection terminals, while just below are two AC receptacles (one switched and one unswitched). No external access to fuses is provided. A view of the rear panel is shown in Fig. 2.

2

The owner's manual contains virtually no information regarding the circuit design and no schematic diagram is provided. From a quick examination of the internal construction of the unit and an analysis of the block diagram (which *is* provided), we learned that the FM front-end uses a four-section tuning capacitor, and has separate filter systems for the normal and narrow bandwidth IF settings of the front-panel selectivity switch. The multiplex decoder comprises a phase-locked-loop circuit followed by low-pass filters to eliminate subcarrier products at the output. The AM circuit uses a single IC and a two-gang tuning capacitor. The Dolby FM decoding circuitry is also incorporated in a single IC. Power-output circuits are protected by electronic and mechanical-relay circuitry. The latter also serves to delay turn-on for a few seconds to prevent thumps and other noises from reaching the loudspeakers. Figure 3 is a diagram that shows how this receiver can be hooked up to associated components.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
Usable Sensitivity: 9.3 dBf (1.6 μV) **50-dB Quieting:** mono, 14.2 dBf (2.8 μV); stereo, 37.3 dBf (40 μV). **S/N Ratio:** mono, 75 dB; stereo, 70 dB. **Frequency Response:** 30 Hz to 15 kHz, ±0 dB. **Selectivity:** normal, 50 dB; narrow: 80 dB. **Capture Ratio:** 1.0 dB. **AM Suppression:** 60 dB. **Image Rejection:** 80 dB. **IF Rejection:** 100 dB. **Spurious Rejection:** 100 dB. **Muting Threshold:** 5 μV (19.2 dBf). **Distortion, Mono:** normal, 0.08% at 100 Hz and 1 kHz, 0.1% at 10 kHz; narrow, 0.2% at 100 Hz, 1 kHz and 10 kHz. **Distortion, Stereo:** normal, 0.15% at 100 Hz and 1 kHz, 0.3% at 10 kHz; narrow, 0.4% at 100 Hz and 1 kHz, 0.6% at 10 kHz. **Stereo Separation:** normal, 40 dB at 100 Hz, 48 dB at 1 kHz, 43 dB at 10 kHz; narrow, 35 dB at 100 Hz, 40 dB at 1 kHz, 37 dB at 10 kHz.

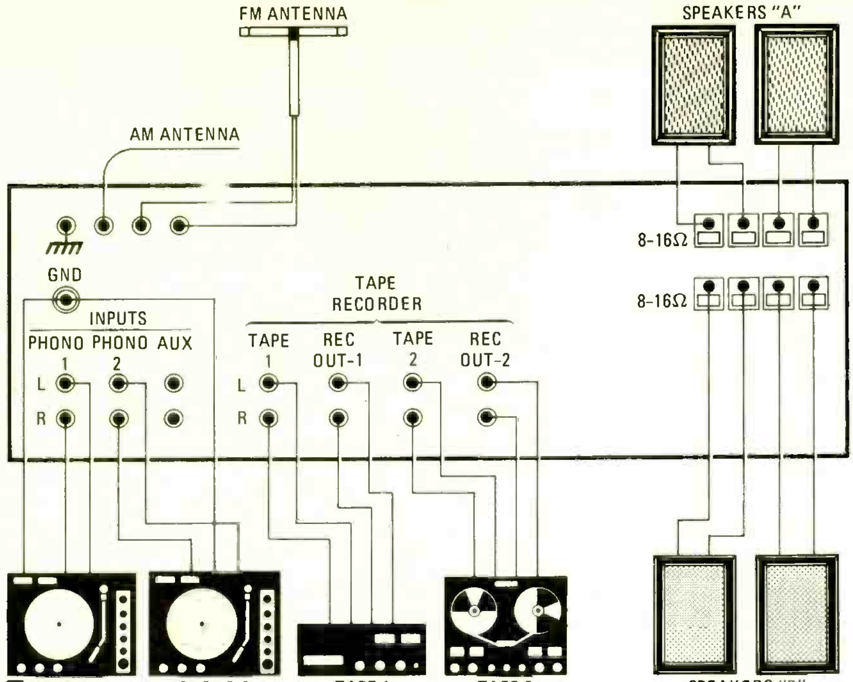
AM TUNER SECTION:
Usable Sensitivity: 100 μV (external antenna). **S/N Ratio:** 50 dB. **Harmonic Distortion:** 0.5%. **Selectivity:** 40 dB. **Image and IF Rejection:** 40 dB.

AMPLIFIER SECTION:
Power Output: 150 watts-per-channel, 8 ohms, 20 Hz to 20 kHz. **Rated THD:** 0.07%. **IM Distortion:** 0.07%. **Input Sensitivity:** phono, 2.5 mV and 0.25 mV; high level, 150 mV. **S/N Ratio** (Phono, A-Weighted): 80 dB and 65 dB (moving coil); high level, 100 dB. **Frequency Response:** phono, RIAA, ±0.5 dB; high level, 5 Hz to 50 kHz, +0, −2 dB. **Tone Control Ranges:** ±10 dB at 100 Hz and 10 kHz. **Filter Cut-Off Frequencies:** 50 Hz and 9 kHz, 6 dB-per-octave.

GENERAL SPECIFICATIONS:
Dimensions: 20½ W × 7½ H × 17¾ inches D. **Net Weight:** 48 lbs., 6 oz. **Power Requirements:** 120 volts, 60 Hz, 250 watts. **Suggested Retail Price:** $820.

FM measurements

Table 1 contains the measurements made for the FM tuner section of the *model STR-V7*. While usable sensitivity was poorer than claimed, the more important 50-dB quieting specification proved to be better than claimed, with readings of 2.3 μV (12.4 dBf) in mono and 38 μV (36.8 dBf) in stereo as opposed to the 2.8 μV and 40 μV claimed by Sony. On the other hand, the signal-to-noise ratio at strong signal levels failed to reach the manufacturer's specified levels. Even more surprising (and



3

disappointing) were the relatively small differences observed between distortion readings measured in the normal and narrow bandwidth modes. And, whereas we normally expect THD readings to be poorer in stereo than they are in mono, the opposite was true with this receiver. There is no easy way to determine whether this is the result of two types of distortion "tending to cancel each other out" or not. Stereo separation, while certainly adequate for all listening purposes, also fell short of published claims, both for the normal and narrow IF bandwidth settings; and, again, the differences were relatively small when shifting from one selectivity setting to the other.

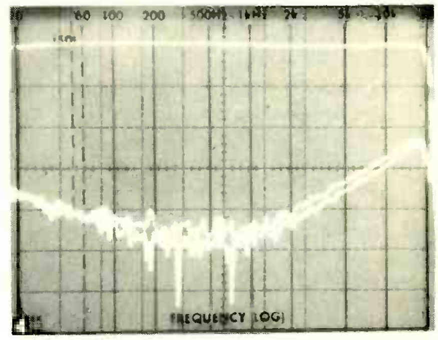
Muting threshold and stereo-switching threshold (and, hence, usable stereo sensitivity) were all set a bit too high—at around 12 μV (26.8 dBf). Sony specifications call for a 5-μV threshold. The frequency response of the FM section was excellent, with deviations of no more than 0.5 dB from 30 Hz to 15,000 Hz, as shown in the top trace in Fig. 4. The lower trace in Fig. 4 shows the separation (or, more properly, the crosstalk) in stereo FM. Two scope sweeps were taken: one for the normal IF mode, the other for the narrow mode; and results agree fairly well with the static point-by-point measurements discussed above and shown in Table 1.

Figure 5 shows the built-in Dolby FM decoder action. At higher modulation levels (see the upper trace), frequency response is virtually flat, while at progressively lower modulation levels, the appropriate treble attenuation is introduced automatically by the Dolby circuitry.

Figure 6 shows only the frequency-response curve of the AM section. In this respect, the *model STR-V7* is neither better nor worse than most competitive units. You should not expect anything resembling hi-fi performance from this minimal AM section.

Amplifier measurements

Table 2 shows the results of measurements made on the amplifier/preamplifier control section. While the power-amplifier section delivered considerably more than its rated 150 watts-per-channel at mid-frequencies (and somewhat more than its rated power at high frequency), it was barely able to deliver its rated power at 20 Hz. Dynamic headroom



measured a moderate 1 dB. The manufacturer's specifications for S/N ratio and input sensitivity are reported by Sony in a manner that does not yet reflect the new IHF Measurement Standards for Audio Amplifiers. Therefore, you should not attempt to compare the input sensitivity values and signal-to-noise

TABLE 1
R.E.A.L. SOUND PRODUCT TEST REPORT

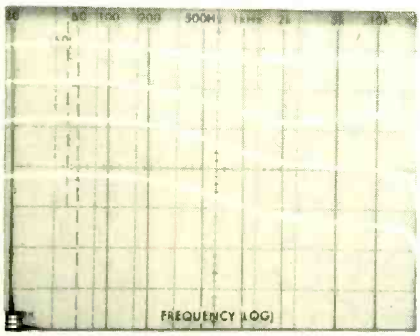
Manufacturer: **Sony Corporation** Model: **STR-V7**

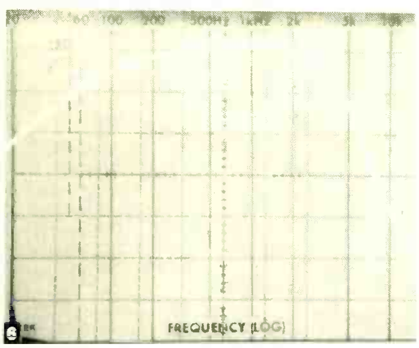
FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	1.9 (10.8)	**Good**
Sensitivity, stereo (μV) (dBf)	12.0 (26.8)	**Fair**
50-dB quieting signal, mono (μV) (dBf)	2.3 (12.4)	**Excellent**
50-dB quieting signal, stereo (μV)	38 (36.8)	**Fair**
Maximum S/N ratio, mono (dB)	70	**Good**
Maximum S/N ratio, stereo (dB)	68	**Average**
Capture ratio (dB)	1.2	**Very good**
AM suppression (dB)	60	**Excellent**
Image rejection (dB)	83	**Very good**
IF rejection (dB)	100+	**Superb**
Spurious rejection (dB)	100+	**Superb**
Alternate channel selectivity (dB)	80/48 (narrow)	**Very good**
FIDELITY AND DISTORTION MEASUREMENTS	**Narrow/broadband**	
Frequency response, 50 Hz to 15 kHz (±dB)	0.5	**Excellent**
Harmonic distortion, 1 kHz, mono (%)	0.22/0.2	**Fair**
Harmonic distortion, 1 kHz, stereo (%)	0.08/0.085	**Excellent**
Harmonic distortion, 100 Hz, mono (%)	0.3/0.28	**Fair**
Harmonic distortion, 100 Hz, stereo (%)	0.14/0.10	**Good**
Harmonic distortion, 6 kHz, mono (%)	0.16/0.25	**Good**
Harmonic distortion, 6 kHz, stereo (%)	0.20/0.25	**Very good**
Distortion at 50-dB quieting, mono (%)	1.0/1.0	**Fair**
Distortion at 50-dB quieting, stereo (%)	0.3/0.3	**Good**
STEREO PERFORMANCE MEASUREMENTS	**Narrow/broadband**	
Stereo threshold (μV) (dBf)	12.0 (26.8)	**Fair**
Separation, 1 kHz (dB)	45/45	**Very good**
Separation, 100 Hz (dB)	42/41	**Very good**
Separation, 10 kHz (dB)	25/27	**Fair**
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	12.0 (26.8)	**Fair**
Dial calibration accuracy (±kHz at MHz)	75 at 108	**Very good**
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		**Excellent**
Ease of tuning		**Excellent**
Accuracy of meters or other tuning aids		**Very good**
Usefulness of other controls		**Very good**
Construction and internal layout		**Excellent**
Ease of servicing		**Very good**
Evaluation of extra features, if any		**Very good**
OVERALL FM PERFORMANCE RATING		**Good**

values indicated in Table 2 with those shown by the manufacturer. The measured values should be judged on their own merits and compared with those obtained for other products that have been measured using the new IHF Standards. The RIAA equalization was as nearly perfect as we have ever measured, and phono overload was a much-more-than-adequate 230 mV (Sony's specification list makes no claims for this important parameter).

Tone controls operated fairly normally, with the pivot frequency of both the BASS and TREBLE control set at around 1 kHz, as shown in Fig. 7. (Note: In this and all other scope photos, one vertical division on the scope face equals 10-dB difference in amplitude.) Figure 8 is a scope photo of the high-cut and low-cut filter action. The high-cut filter has little audible effect upon hiss and scratch, while the low-cut filter, although it does help reduce turntable rumble, also considerably affects the lower bass frequencies in music programming. Both filter circuits use only a minimal 6 dB-per-octave roll-off slope. Figure 9 depicts the loudness-control circuit at various master volume-control settings (approximately 10-dB apart), in which both treble and bass frequencies are boosted as volume control settings are reduced. The treble accentuation has been kept at moderate levels compared with the bass boost.





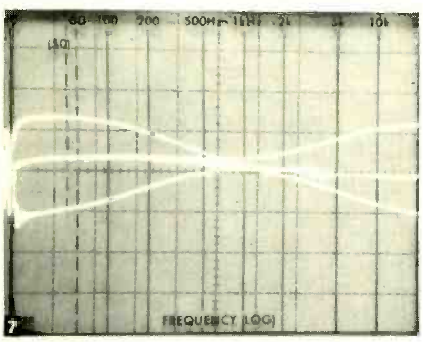


TABLE 2

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	164.7	**Excellent**
RMS power/channel, 8-ohms, 20 Hz (watts)	150.0	**Fair**
RMS power/channel, 8-ohms, 20 kHz (watts)	155.0	**Good**
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	**N/A**
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	**N/A**
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	**N/A**
Frequency limits for rated output (Hz-kHz)	20–20	**Fair**
Dynamic headroom (dB)	1.0	**Good**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.058	**Very good**
Intermodulation distortion, rated output (%)	0.17	**Good**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.055	**Very good**
Intermodulation distortion at 1-watt output (%)	0.04	**Very good**
DAMPING FACTOR AT 8 OHMS, 50 Hz	45	**Very good**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± dB)	0.1	**Superb**
Maximum input before overload (mV)	230	**Excellent**
Hum/noise, A-weighted, referenced to 1-watt or 0.5-volt output, for 5-mV input (dB)	71	**Good**
HIGH-LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± dB)	3.3–40	**Excellent**
Hum/noise A-wt'd, re: 0.5 or 1W out, 0.5V in (dB)	71	**Very good**
Residual noise, A-wt'd, minimum volume, re: 1w out (dB)	81	**Very good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 7	**Good**
Action of secondary tone controls		**N/A**
Action of high- and low-cut filters	See Fig. 8	**Fair/Good**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2, re: 1w or 0.5v out (mV)	0.16/0.02	
Input sensitivity, high level, re: 1w or 0.5v out (mV)	9.8	
Output level, tape outputs, at rated output (mV)	9.8	
Output level, headphone jack, at rated output (mV or mW)	700 mV	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Excellent**
Adequacy of input facilities		**Excellent**
Front panel layout		**Superb**
Action of controls and switches		**Very good**
Design and construction		**Excellent**
Ease of servicing		**Good**
OVERALL AMPLIFIER PERFORMANCE RATING		**Good**

TABLE 3

R.E.A.L. SOUND PRODUCT TEST REPORT

Manufacturer: **Sony Corporation** Model: **STR—V7**

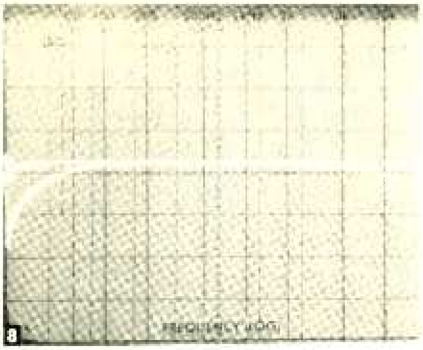
OVERALL PRODUCT ANALYSIS

Retail price	**$820**
Price category	**High**
Price/performance ratio	**Fair**
Styling and appearance	**Excellent**
Sound quality	**Good**
Mechanical performance	**Excellent**

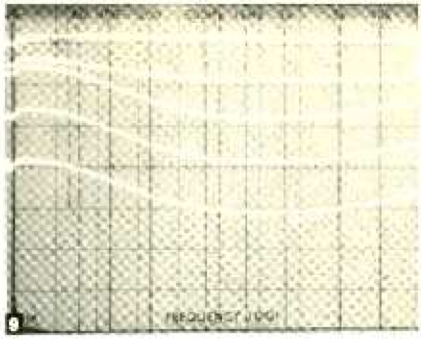
Comments: Sony's top-powered receiver for 1979 left us with mixed emotions. On the one hand, the control and front-panel layout was excellent. Controls functioned smoothly and accurately, and although such top-of-the-line features as a subsonic filter and a mid-range tone control were missing, there were ample input and output facilities including built-in Dolby decoding for Dolby FM broadcasts (a feature which is worth about $100.00).

What was disappointing was the tuner performance and, to a lesser degree, some of the measurements made on the amplifier section. Even after Sony went to the trouble of incorporating selectable IF bandwidth for the FM tuner, we found very little difference in distortion and separation capability between the two selectivity settings even though the readings themselves approached published specifications. The FM reception was not poor; it was, in fact, quite good, but no better than we have heard from receivers costing far less.

Table 2 shows that the amplifier just barely equaled its power-output specifications at the frequency extremes. We expect a certain degree of conservatism and reserve power in receivers selling for more than $800. This is not to criticize the sound the receiver produces when driving even low-efficiency speakers. Nor can we overlook the incorporation of a built-in "head amp" or pre-preamplifier, which will appeal to audiophiles who prefer moving-coil cartridges. It seems that the rising value of the Japanese yen (and the sinking U.S. dollar) is at last causing Japanese hi-fi manufacturers to drive up the prices of their products to levels that no longer yield the superb price/performance ratios of a year or two ago.



8



9

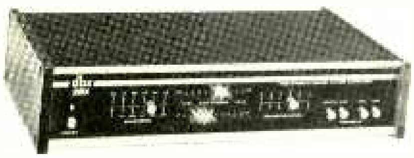
Summary

Table 3 contains our overall product evaluation as well as summary comments regarding this Sony receiver. The *model STR-V7* is, in many ways, an excellent instrument insofar as human engineering is concerned. Its controls are well placed and smooth operating. If it cost perhaps two hundred dollars less (or even one hundred dollars less) we might be more enthusiastic about its performance. As it is, we do feel that the *model STR-V7* is priced too high for what it does. We do recognize that prices of all Japanese products have been skyrocketing owing to the drastic shifts in currency exchange rates; but, in most cases, technology has kept pace with rising costs and tends to offset them. We now seem to be reaching the point where costs are rising more rapidly than advances in circuitry are able to keep them down.

In summary, we believe that only the more innovative manufacturers are going to succeed in this changing audio market, and, the new Sony *model STR-V7* receiver, while certainly adequate in every sense, lacks the features and state of the art performance one would expect from a receiver in such a high price bracket.

R-E

Radio-Electronics Audio Lab Tests



1

CIRCLE 107 ON FREE INFORMATION CARD

dbx, Inc. Model 2BX Dynamic Expander

JUST ABOUT EVERY HIGH-FIDELITY PROGRAM source we listen to suffers from a lack of dynamic range. Tape recordings and even the very best discs cannot contain the wide range of audio levels that exists in a live musical performance. Such a dynamic range may well reach 80 dB or 90 dB—from the softest passages to the loudest—in any given performance. And since most of what we hear on FM radio originates from tapes or discs, the same holds true for that program source.

One way of combatting this problem is to add a dynamic expander to your stereo component system. An expander "senses" the sound level of program material and, in simple terms, makes the "louds" louder and the "softs" softer. In the past, expanders suffered from an effect described as "pumping and breathing." In other words, you could hear the expansion process taking place, as an effect in itself, over and above the actual improvement in dynamic range afforded to the reproduced sound of the musical program.

dbx, Inc. (71 Chapel Street, Newton, MA 02195) specializes in expanders and noise-reduction devices. The company's new two-band expander, the *model 2BX*, is shown in Fig. 1. The unit is intended for connection to a stereo component system via either the tape-input/tape-output jacks on a receiver or integrated amplifier, or by being interposed between a separate preamplifier/amplifier in separate-component systems.

The front panel of the *model 2BX*, which is finished in black and silver, has a POWER on/off switch and an indicator light on the left-hand side. A slide-control knob labelled EXPANSION to the right adjusts the degree of linear expansion—from 1.0 (no expansion) to 1.5 (50% expansion, in which every 2-dB change for input signals results in a 3-dB change at the output).

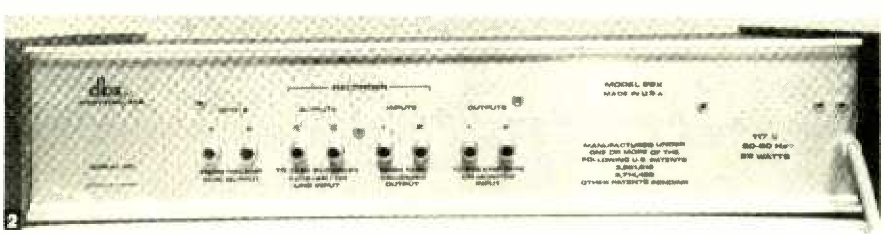
The most important innovation of this expander is its use of two separate frequency bands. Low frequencies are handled by one expansion circuit, while high frequencies are controlled by another circuit. (We'll discuss the importance of this feature later on in this article.) Two rows of LED's (five amber LED's and five red LED's per bank) indicate what is happening within each frequency band. The illumination of the amber lights in either row indicates that the signal frequencies are being *downward* expanded (i.e., low-level signals are lowered even more), while the illumination of the red LED's means that instantaneous signals are being expanded upward (loud signals are being made still louder).

The TRANSITION LEVEL control to the right of the rows of LED's determines the threshold or transition point between upward or downward expansion, and can be varied over a wide range to take care of a variety of program levels and types of music. Next to this control, two pushbuttons let you compare source and taped results, and two others let you select whether you want the expansion to occur *after* the tape outputs on the rear panel or ahead of them (for pre-expansion prior to taping).

The rear panel is shown in Fig. 2.

Part of the reason why less-sophisticated expanders tend to breathe or pump audibly is due to their attack-and-release times. While a rapid attack-and-release time may be good for

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND
RATES
DBX, INC. 2BX DYNAMIC EXPANDER
EXCELLENT



2

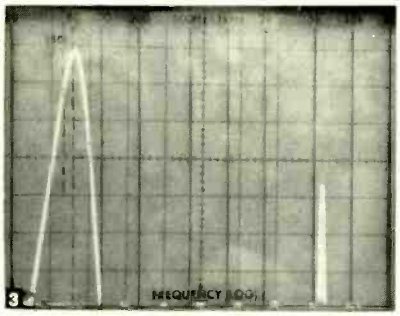
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

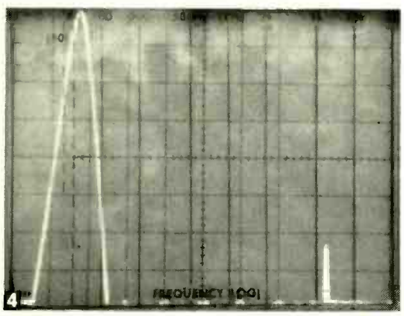
Expansion Ratio: 1.0 to 1.5, linear, in dB. **Transition Level Range:** 30 mV to 3.0 volts. **Frequency Response (at 1.0:1.0 Expansion):** 20 Hz to 20 kHz, ±0.5 dB. **Harmonic Distortion (at 1.0:1.0 Expansion):** 0.2% (20 Hz to 20 kHz). **IM Distortion (at 1.0:1.0 Expansion):** 0.15%. **Input Impedance:** 50,000 ohms. **Maximum Output Level:** 6.0 volts. **Power Requirements:** 117 volts, 50 to 60 Hz, 20 watts. **Dimensions:** 17¾ W × 3¾ H × 10½ inches D. Weight: 8 lbs., 5 oz. **Suggested Retail Price:** $450.

some types of music, different attack-and-release times may be desirable with other types of music. The *model 2BX*'s attack-and-release times actually follow the rate of change of the program envelope. In addition, attack-and-release times are scaled differently in each pair of frequency bands to provide an expansion characteristic that best suits the music.

As for the division of program material into two frequency bands, consider what would happen if in a given instant, a bass drum beat, or a series of beats, were to be sensed by a single-band expander. The level-detection circuits would momentarily increase the gain of the system, and, if other instruments or a vocalist's signal were also present, the entire program level would be expanded, resulting in an unnatural sort of heaving or breathing. By separating the lower frequencies from the mid- and high frequencies, the *model 2BX* does not allow the bass tones to influence vocals or mid-range instruments.

To demonstrate how the expander is able to handle different frequencies differently, we fed in a mixture of 60 Hz and 7 kHz (readily available from our IM Distortion Analyzer).





With our spectrum analyzer set to its higher sensitivity mode (2 dB of amplitude per-vertical-division), we first examined the output with the expansion control set for 1.0 (no expansion). Figure 3 shows the response from 20 Hz to 20 kHz. Note that the 60-Hz component at the output is some 7-dB greater than the 7-kHz contribution to the overall signal.

Next, the threshold control was set so that the 60-Hz signal caused the first "upward-expansion" LED to light up. Since the high-frequency component was considerably lower in amplitude, amber lights in the high-frequency row of LED's lit up, indicating downward expansion. We advanced the expansion control to 1.5 (that is, to maximum expansion) and examined the output signal again, as shown in the scope photo of Fig. 4. Note that the low-frequency component has been expanded by some 2 dB (one vertical division). By contrast, the high-frequency component was actually *downward*-expanded by more than 3 dB. Thus, the difference in levels between the two signal components is now around 12 dB. No single-band expander could have achieved these results.

Lab measurements

The few lab measurements we made on the *model 2BX* are summarized in Table 1. It is clear that the distortion produced by the device is so low as to be inaudible, even when the maximum expansion is used. Frequency response is uniform over more than the audio spectrum, and therefore does not affect the tonality of reproduced program material.

The overall product analysis is shown in Table 2, along with our summary comments.

The *model 2BX* is easy to install and use. It covers an adequate adjustment range, and we believe any expansion beyond 1.5:1 range would tend to make any reproduced music sound unnatural or artificial. A side benefit that should not be overlooked is the unit's ability to serve as a noise-reducing device. Since, with a properly adjusted threshold it provides both downward as well as upward expansion, residual noise levels (such as tape hiss or record-surface noise) that the detection circuits perceive as "low-level" signals are expanded downward and become less audible.

The *model 2BX* is a carefully engineered device that will appeal to serious music lovers who recognize the dynamic-range limitations of present-day program sources. Even though such devices may one day become obsolete, until that happens, the *model 2BX* provides the best alternative. **R-E**

TABLE 1
R.E.A.L. SOUND PRODUCT TEST REPORT

Manufacturer: **dbx, Inc.** Model: **2BX**

EXPANDER PERFORMANCE MEASUREMENTS

SPECIFICATIONS	R-E Measurement	R-E Evaluation
Expansion ratio range (%)	0 to 50	**Excellent**
Transition level range (volts)	0.015–3.0	**Excellent**
Frequency response at 1:1 expansion (Hz-kHz, ±dB)	20–35, 0.5	**Excellent**
THD at 1:1 expansion (%)		
at 20 Hz	0.022	**Excellent**
at 1 kHz	0.02	**Very good**
at 20 kHz	0.02	**Excellent**
THD at maximum expansion (%)		
at 20 Hz	0.1	**Very good**
at 1 kHz	0.037	**Excellent**
at 20 kHz	0.045	**Excellent**
IM distortion, 1:1 expansion (%)	0.02	**Excellent**
IM distortion, maximum expansion (%)	0.18	**Good**
Maximum output level (volts)	7.0	**Very good**
SUBJECTIVE EVALUATIONS		
Attack time		**Excellent**
Decay time		**Very good**
Noise-reduction effect		**Very good**
Effectiveness of controls		**Excellent**
Ease of installation		**Very good**
Ease of use		**Excellent**
Additional features		**Very good**
OVERALL EFFECTIVENESS OF EXPANDER		**Excellent**

TABLE 2
OVERALL PRODUCT ANALYSIS

Retail price	**$450**
Price category	**Medium/high**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Very good**

Comments: The *model 2BX* expander goes a long way towards overcoming the chief objection many serious audiophiles have had against "add-on" dynamic expanders. It produces very little "breathing and pumping"—a rise and fall of the background noise level as the gain of variable-voltage-controlled amplifiers changes. Much of the improvement comes from the two-band design of the unit, and from its carefully programmed attack-and-delay times. The only expander that goes one step beyond this expander is dbx's *model 3BX*, which sells for $200 more and divides the music frequency spectrum into *three* separate bands.

The effectiveness of the *model 2BX* will vary depending upon the type of music being reproduced. Obviously, not all program sources have been subjected to the same degree of compression and peak-limiting. It is important, therefore, to experiment with the *model 2BX* and to use its few front-panel controls to select the best overall effect for each type of musical program source. With FM radio programs, it was hardly ever necessary to alter the threshold setting once the unit was set up since FM modulation levels tend to remain fairly constant. With phonograph records, however, the average groove modulation can vary over a wide range from one disc to another, which is especially true in direct-to-disc records. The unit's secondary benefit—noise reduction—is clearly evident with all program material, but its chief virtue lies in its ability to restore missing dynamic range from just about any music program source. Once you experience the sound of music played through an expander such as this one, you may find not using it may make music sound extremely bland and unexciting.

HOBBY CORNER

How to modify an alarm clock for multiple alarms and long-term alarms.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN A PREVIOUS ARTICLE WE DISCUSSED how to build a "slow" digital clock to measure weeks, months or years. I hope you have had an opportunity to build the recommended oscillator and experiment with your own slow clock. Now it is time (!) to add some refinements to it with a few additional simple circuits. Each of the circuits described here can be added to *either* a slow *or* a regular clock.

Multiple alarm

A serious shortcoming of any alarm clock—slow or regular—is that it can be set to go off at one time only. Suppose, for example, you set your slow clock to go off at 10 am on the 18th of next month to remind you to have the car inspected. How then can you be reminded of your wife's birthday two weeks earlier and of your dental checkup three weeks later?

You *could* build several clocks, but a better solution would be to add more alarms to the one clock. Then, you could set each alarm for a different time. What you need is a way to build changeable *interfaces* between the clock IC output and an audio oscillator or LED's.

First, let's examine carefully the way a 7-segment readout creates the digits. The segments are designated by the letters shown in Fig. 1. Segments *b* and *c* are on to display a "1"; segments *a, b, g, e* and *d* display a "2" and so on. If you wrote all these letters and numbers down and studied the list, you would discover that there are certain short combinations that identify each digit exclusively.

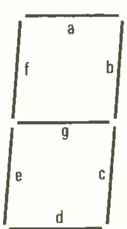


FIG. 1

For example, segments *a* and *f* are off (lo, 0) simultaneously *only* when digit 1 is being displayed. Segment *d* is on (hi, 1) while segment *f* is lo only when digit 3 is displayed. Such a short definitive pattern exists for each digit, and some digits even have more than one pattern. One useful set of patterns is shown in Table 1; and the alarm circuits we'll describe are based on this set. Note that the hi and lo (1 and 0) states are for a clock using common cathode displays; just reverse these for common anode displays.

TABLE 1

Digit	Segments on/hi/1	Segments off/lo/0
0	f	g
1		a,f
2		c,f
3	d	f
4	f	a,d
5		b,e
6		a,b
7	a	f,g
8	b,e,f,g	
9	a,f	d,e

With the segment information shown in Table 1, you're halfway to building the circuit. All you need now are a few gates and an audio or visual indicator.

Let's build a circuit to remind yourself when the clock shows 7 hours and 20 minutes, whatever date or time that stands for. (You can use the same principles to set an alarm for any "time.")

The circuit in Fig. 2 lights the LED only when the hours digit is "7" and the 10's-of-minutes digit is "2." Trace out the action of the gates to see how it accomplishes this. Of course, other gate combinations will produce the same result. Just use what is most convenient for you.

In Fig. 2, the 1's and 0's indicated in parentheses show the state of each line at 7:20. The LED requires no limiting resistor when it is used with CMOS gates unless the +V-supply is higher than 14 volts or so. The inset shows how to connect an LED that you want to light when the line goes high.

The input lines are connected to the digit drive pins of the clock IC. The top input line goes to segment *a* of the *hours* output, etc. If you have to use a segment connection on more than one alarm circuit, don't worry—you can add any practical number with no change in operation.

On a 12-hour clock you can use the AM/PM pin as a gate input to distinguish between 7:20 and 19:20, for example. On a 24-hour clock, you can use segments *b* and *g* as shown in Table 2.

TABLE 2

10's Hrs. Digit	Segments hi	Segments lo
Blank		b
1	c	
2	g	

Depending upon your clock's digital-drive circuit, you may find that the IC pin does not go high or low enough to switch the gate inputs. This may happen when there are current-limiting resistors between the pins and the digits. If you find this happens, simply replace the resistors with values up to 2K. The decrease in

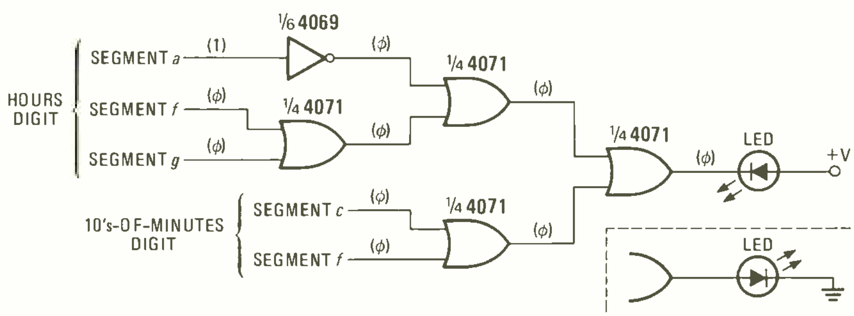


FIG. 2

digit brightness will be very little, but the changed load will allow the pin voltage to swing more.

I used LED's as alarm outputs on my clock. The LED's are arranged on a small panel next to labels on which is marked what each alarm is set for. You may want to use audible indicators with or without LED's to show which alarm is sounding off. A suitable audio oscillator can be made in many ways: by using transistors, unijunctions, 555's, etc. (See previous "Hobby Corners" and other articles if you need an oscillator circuit suitable for use as an alarm.)

Of course, you will have to change gate and clock IC connections whenever you wish to set an alarm for another "time." One approach is to use a bank of switches. Another method is to use a small section of solderless breadboard for cross-patching connections. Because changing alarm connections are made so seldom on a slow clock, I just tack-solder the connections as I need them.

A normal, real-time clock can be made into a multiple-alarm unit using the circuits described above for a slow clock. However, the inconvenience of resetting the alarms makes this of questionable value. With a normal clock, a more practical approach would be to use gates to pick off, say, 30-minute "ticks" that would drive counters, with the appropriate outputs being selectable through a switch or patch-cords.

Long-term alarm

Suppose you want to leave your digital clock *un*modified so that it displays the time, yet also provides a reminder for next week or next year. This problem is relatively simple to solve using a few "external" components.

For example, suppose you want an alarm set at exactly 3 pm 43 days from now. First, if the clock has a built-in alarm circuit, disconnect the alarm from the clock IC output; then set the alarm for 3 pm.

Next, use the IC alarm pin to drive one or more counters. Finally, connect the counter output(s) to enable the original alarm circuit (or some other indicator) after 43 pulses (produced by 43 24-hour periods) have elapsed.

There is a wide variety of CMOS counters to choose from. There are standard counters, programmable counters, and even counters that can count up to 16,384 (for instance, the 4020 IC)! For proper functioning, you may have to invert the output of the IC alarm pin, depending upon your use of a positive-edge or negative-edge triggering counter, otherwise, the alarm may be 12 hours fast or slow when triggered on next month.

Note that you can use this same alarm technique with a slow clock (described last month) to count times of any desired length. **R-E**

communications corner

Are the new computerized CB's really computerized?

HERB FREIDMAN, COMMUNICATIONS EDITOR

AS EXPECTED, THE FIRST "COMPUTERIZED" CB transceivers—those incorporating a microprocessor—are the higher-priced, high-performance models. A natural question, however, is: "Does computerization improve communications?" (After all, communications is what CB is all about.)

The answer, unfortunately, is *no*. Computerization has essentially no effect on communications, at least not at the present time. At best, it is simply an operating aid or convenience. And, depending on your particular application, computerized CB can be a decided convenience or inconvenience.

The microprocessors—generally shown in schematics as a *box outline* with many connections protruding from each side—are basically user-programmable channel-selection (switching) circuits much as you might find in late-model VHF scanners before they also were computerized. At the touch of a button, the transceiver tunes through all 40 channels,

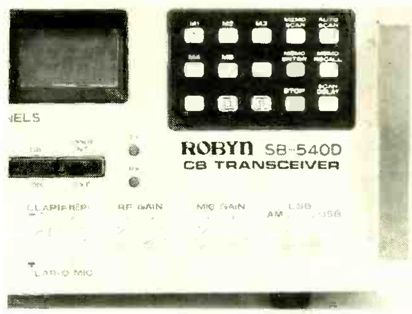


FIG. 1

stopping on busy or clear channels. The touch of another button lets you step through the channels one at a time; or by pressing a combination of pushbuttons, you can direct-access a particular channel. All this can be done (and has been done) with individual IC's; we don't really need the large-scale integration of a microprocessor. Although the use of a single IC does increase reliability.

The real difference between a computerized CB and a scanning CB is in the *memory*. The microprocessor permits you to program a specific group of channels to be scanned in a specific order. As a general rule, most CB microprocessors contain from 5 to 10 channel memories. Some manufacturers chose to make one of the memories Channel 9, which actually means you have less user-selected channel memory. The advantage is that you can receive the emergency-only channel at the push of a button.

The microprocessor also features keyboard entry, whereby a keypad similar to those used on *Touch-Tone* telephones provides the means to select channels, program memories and to choose the various functions.

Most of the "computerized" transceivers use each keypad switch for two purposes, as if the designer couldn't stand to see a switch with a *single* numeral or function printed above or below. As you might expect, this produces complexity beyond what is generally needed, which tend to confuse the consumer.

One of the few manufacturers who opted to go "the other way" (i.e., using

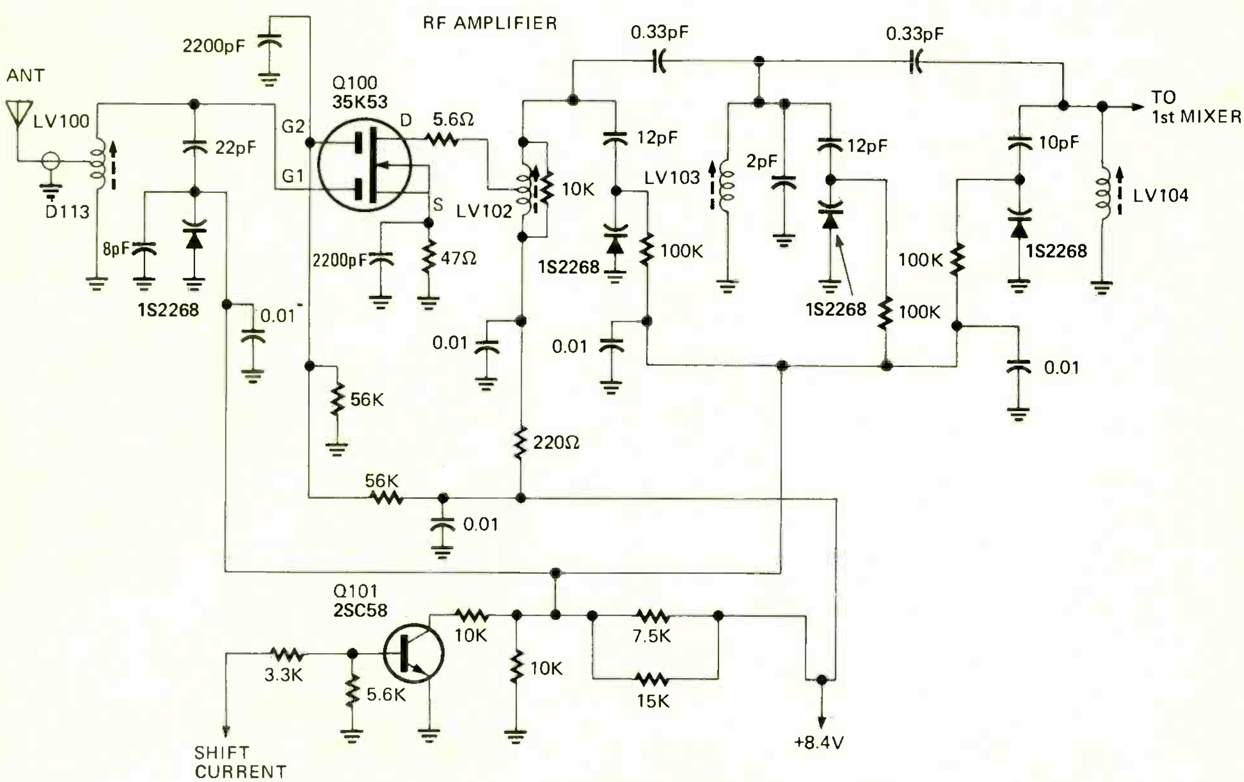


FIG. 2

the microprocessor for what many would consider the most important functions) is Robyn, whose uncluttered keypad from the *model SB-540D* AM/SSB Base Station is shown in Fig. 1. In this unit pushbuttons M1–M5 handle the memories, which can be programmed in any sequence at any time. You can scan only the memory channels by pressing the MEMO SCAN switch, or you can directly tune to a memory by first pressing the MEMO RECALL switch that also permits you to reprogram any memory at any time. The SCAN DELAY switch *holds* the channel while it is in the scan mode so the tuning doesn't skip to the next memory or channel during the pause between transmissions. If there is no activity on the channel, the scan delay releases and the scanning resumes.

The Robyn keypad is presently the easiest to use and understand. It is almost self-explanatory, something that cannot necessarily be claimed of keypads of other computerized CB's.

But regardless of the complexity and sophistication of a microprocessor-controlled CB, the transceiver remains essentially the same in terms of reception and transmission as those of other CB's: Computerization has no effect on sensitivity, selectivity, RF output or modulation. Essentially, the microprocessor simply provides memory and scanning on a single IC, rather than on several. And if the microprocessor is simply a substitute for several IC's previously used in VHF receivers, and if it has no effect on communications specifications, do we in fact truly have computerized CB transceivers? Does computerization of only operating conveniences justify the term "computerized"? We'd like to hear your opinion—pro or con—so just drop us a short note. (Address all correspondence to: Communications Corner, Radio-Electronics, 200 Park Avenue South, New York, NY 10003.—Editor)

Look Ma, no tuning capacitor!

If you ever had the need for relatively widely spaced VHF coverage (approximately 150 MHz–170 MHz) you know that you can generally peak the tuned circuits—such as the receiver's front end—for maximum performance to the low, middle or high side while experiencing reduced performance somewhere within the unit's frequency range. Generally, scanners are peaked for the center of the frequency band and you take whatever performance you can get at the frequency extremes.

While "letting the ends take care of themselves" is fine for hobbyist and semi-professional receivers, things should not take care of themselves if a life might depend on optimum performance. For instance, commercial VHF radios, such as those used on all kinds of ocean-going craft, optimize performance on *all* frequencies; it's handled very easily now that the phase-locked-loop (PLL) digital-frequency synthesizer is almost universal in all multifrequency receivers. In fact, because the PLL digital synthesizer is so convenient and competitively priced, it's used in many hobby/professional scanners such as those manufactured by Regency, Electra and Radio Shack; and even a hobbyist can enjoy optimum sensitivity from one end of the frequency band to the other.

While the tuning of the synthesizer is electrical, it doesn't require variable tuning capacitors or even trimmers. And it's the lack of a tuning capacitor that makes it all possible.

The Fig. 2 schematic shows how this can be accomplished. The circuit shown represents the front end of a commercial ship-to-shore VHF radio. The four diodes with the parallel-line capacitor symbol at the cathode end are *varactors*—diodes whose anode/cathode capacitance can be precisely controlled by an applied DC voltage. The varactor capacitance represents only a small part of the total capacitance needed to tune each resonant circuit using adjustable coils LV100–LV104. A fixed capacitor in series with each varactor, in addition to stray capacitance, establishes the minimum circuit capacitance for the L–C network. Note that the DC supply for each varactor originates at a common source—the collector circuit of transistor Q101.

When the user sets the frequency selector(s) of the VHF radio, a *shift* current is applied to the base of Q101, which, in turn, changes the transistor's collector-emitter current that flows through R110–R111. This causes a variation in the voltage available at the junction of R110–R111 that is the "control" voltage for the varactors. The varactors' capacitance changes simultaneously, tuning each L–C network to the operating frequency.

While commercial radios apply a fixed-shift voltage so that the receiver tunes to one specific frequency, the same idea is used in the digitally controlled scanning monitors. As the scanning frequency sweeps within the chosen limits, the PLL circuits also provide a sawtooth (or sweeping) waveform (increasing or decreasing the DC voltage) to the front-end varactors, thereby tuning the front end precisely to the frequencies being tuned. When the radio is in the manual mode, the PLL circuit applies a fixed voltage to the varactor diodes, tuning the front end to whatever frequency you selected (or "punched in").

Essentially, the digital-frequency synthesizer allows you to tune precisely to the operating frequency, rather than settle for a broadband adjustment. It is one of the important differences between a broad-tuned crystal-controlled VHF monitor and continuously tuned digitally controlled VHF scanner. **R-E**

computer corner

8085 *A look at the 8085 and how it compares to the 8080.*

P. RONY, C. TITUS, D. LARSEN, J. TITUS*

PAST COLUMNS HAVE LOOKED AT SOME applications of the 8085 central processing unit and some of IC's that are among the 8085 family. Now let's take a closer look at the 8085 and how it compares with the 8080.

One of the 8085's main features is that it is software-compatible with the 8080 machine codes. Thus, a 303 code is a jump (JMP) instruction in both systems. (The 8085 has two additional instructions to be discussed later.) Basic 8080 systems generally include a clock generator and a status latch circuit for external control. These functions are now provided for within the 8085. A simple R–C network or a crystal can be used directly with the 8085 to generate the necessary clock pulses. Many of the control signals required by external devices are now generated in the 8085 IC, further reducing the amount of external logic required.

There is a price to pay for this, though. The 8085 uses one set of eight lines to transmit both data and address information. In some systems, it may be necessary to latch the address bits (A7–A0) so that they are readily available for use. An Address Latch Enable signal (ALE) is output by the 8085 to control such a latch circuit. This type of bus multiplexing was also done in the 8008, the first general-purpose 8-bit microprocessor IC.

The 8085 provides the high-address bits (A15–A8) on eight output pins. These signals have no other purpose and they are not multiplexed. They are equivalent to the A15–A8 lines in an 8080-based computer. Some other 8085 input and output signals such as interrupt (INTR), interrupt acknowledge ($\overline{\text{INTA}}$), RESET, HOLD, hold-acknowledge (HLDA), and READY operate as they do in 8080 systems. Two new 8085 outputs include CLOCK OUT, a TTL-compatible clock signal of one-half the system clock frequency, and RESET OUT, which can be used to reset other system components. The RESET OUT signal is derived from the reset input to the 8085.

*This article is reprinted courtesy American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Both Dr. C. Titus and Mr. J. Titus are with Tychon, Inc.

Three control signals manage the flow of data to and from memories and the CPU, as well as to and from I/O devices and the CPU. These signals are: IO/$\overline{\text{M}}$, $\overline{\text{RD}}$ and $\overline{\text{WR}}$. The IO/$\overline{\text{M}}$ signal is used to indicate what type of device the 8085 is attempting to communicate with: logic 1 = I/O devices and logic 0 = memories. The $\overline{\text{RD}}$ and $\overline{\text{WR}}$ signals coordinate the reading or writing of data, respectively. These three signals are used directly by the 8085-compatible memory and by I/O devices such as the 8155 and 8355. In other systems, you may have to use these signals to generate the $\overline{\text{MR}}$, $\overline{\text{MW}}$, $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ signals that were discussed previously. Figure 1 shows the gating.

In almost all 8080-based systems, interrupts are implemented with an interrupt instruction port and restart instructions. The 8085 has four new interrupts that have been implemented. (See Table 1.) The overall priority of these interrupts from the highest to the lowest is as follows: TRAP, RST 7.5, RST 6.5, RST 5.5 and INT. The INT input is the usual 8080-like interrupt input. These interrupts have their vector addresses placed within the address space 000 000 to 000 100. Some of these addresses are placed between the usual 8080 vector addresses, leaving only four bytes of storage space between interrupt vector addresses. These new interrupts act in the same manner as the normal 8080-like interrupts, which means you still need a stack.

The 8085 also has a single input pin and a single output pin on the IC itself that can be controlled directly by software. Of course, the 256 addressable I/O port capability is still maintained. The two single I/O connections can be used for a single sense input and a single control output. Additionally, they could be used for serial I/O to a terminal or a teletypewriter, with the actual serialization being done by software.

Two new, single-byte instructions allow you to manage the new interrupts and the two I/O lines, SID and SOD, (*S*erial *I*nput *D*ata and *S*erial *O*utput *D*ata). These instructions are: Set Interrupt Mask (SIM = 060) and Read Interrupt Mask (RIM = 040). The A-register is used as the source or the destination of the data bytes for each operation. **R-E**

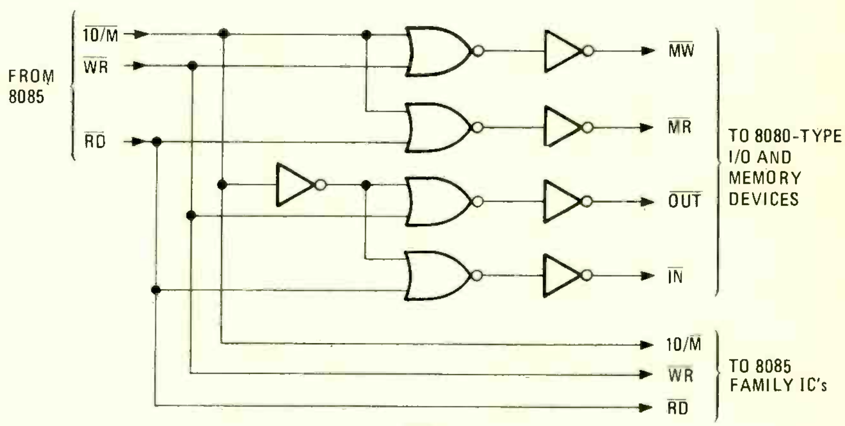


FIG. 1

TABLE 1—INTERNAL 8085 INTERRUPTS

Name	Restart Address	Characteristics
TRAP	000 044	Highest priority of all interrupts; nonmaskable, always "on"; both edge- and level-sensitive.
RST 5.5	000 054	Maskable, logic-1 sensitive
RST 6.5	000 064	Maskable, logic-1 sensitive
RST 7.5	000 074	Maskable, positive-edge sensitive

service clinic

If the symptom is a horizontal bar, suspect the filter capacitors.

JACK DARR, SERVICE EDITOR

EVERY ONCE IN A WHILE, AN OLD FAMILiar problem crops up again. Back in the "old days," we used to run into one particular symptom at quite frequent intervals. This symptom was the horizontal bar on the TV screen. It usually measured from ¼-inch to ¾-inch high, and crawled slowly up the screen. The bar could be lighter or darker than the picture, and it showed up mainly in less-expensive black-and-white TV sets.

The cause of this symptom was a voltage pulse getting into the *video* stages, where it caused partial blanking (a dark bar) or an increase in brightness (a light bar). Since there was only a single bar, this was obviously a 60-Hz line phenomenon. Many of the DC power supplies were full-wave supplies; so ripple would create two bars. In that case, where does the single bar come from?

It comes from the high-current pulse that is drawn by the *vertical-output* stage, once for each field. If this voltage isn't filtered out and gets into the video amplifiers, it causes the bar to appear. The bar crawls up the screen because of the very small difference between the vertical frequency of the picture and the local 60-Hz line ripple.

The major cause of this problem in the older sets was poor DC power supply filtering; that is, defective filter capacitors or poorly designed filter circuits. In some old TV sets, I have had to add as much as 100 μF of capacitance in order to get rid of the bar. Now, the same symptom is showing up in late-model solid-state TV sets. The "Service Clinic" mailbag has received quite a few questions on this problem.

The basic cause is still apparently that voltage pulse from the vertical-output stage getting into the video stages, which happens because the pulse isn't being filtered out. There is one *new* cause, but the reason is the same (more on this later).

Here, the scope is the best tool to use for a quick test. You don't have to scope the video-stage signals because you know that pulse is there just from looking at the screen. Scope the DC supply to the vertical-output stage and look for the voltage pulse. If it appears there, check the large filter capacitor that *should* be there. You can also go back to the filter output of the DC power supply and look at the ripple waveform. The amplitude of this waveform should be very low—typically, only 1.2 volt or so maximum. It should be stationary and usually looks like a sawtooth. If too much vertical signal is managing to get back into this, the waveform will slowly writhe and bend. Here again, this is due to the small phase difference between the 60-Hz frequency and the vertical frequency.

This usually means that one or more of the filter capacitors is not working properly. High power factor is a common cause; this reduces the filtering efficiency of the capacitor. One odd reaction occurs in these cases. If the defective capacitor does have high power factor, you can bridge it with a good one but it won't help! To make sure, unhook the original capacitor and put in a new one that's just as large or larger.

Now, here's the new wrinkle. In newer sets, particularly those with modules or separate circuit-board assemblies, the crawling bar can be caused by a very small difference in *ground potential* between the grounds on a board and the main chassis ground on the motherboard. In some sets, you can clear this up by adding a heavy jumper between board ground and the chassis, or by moving the ground-return point of a big capacitor from the board to the chassis. Check the service notes and modifications on the set; you may find this procedure is recommended.

Always examine all grounds very carefully. If they look suspicious, resolder them. I can vouch for this from recent bitter experience! My own antique *model CTC-15* had exhibited an assortment of weird symptoms. I wasted quite a bit of time changing tubes, cleaning socket contacts, etc. One day, in desperation, I drew my trusty solder gun and resoldered all seven ground points on the color board. This cleaned up all the symptoms! So, if all else fails, try soldering grounds—you never can tell!

As I said before and repeat for emphasis, this pulse always appears in the video signal. All you have to do is find out the cause and repair it. Changing filter capacitors is the answer in most cases; and fixing bad ground connections should take care of what's left! When replacing a capacitor, make sure that the replacement has an equal or higher voltage rating. **R-E**

service questions

DOUBLE TROUBLE

Thanks for your letter concerning the problems I had in a General Electric chassis H-3. You confirmed my idea that the trouble was in the AGC. Checking out the AGC circuit completely, I found a 7-ohm short to ground on the AGC control itself. I took it off, took it apart and found . . . nothing! I put back after cleaning and it worked!

Now there was a picture, but it was weak and full of color blobs. This problem was due to a break in the +280-volt supply line, where focus resistor R554 goes to the +280-volt line. Apparently when the chassis was moved around, this resistor had been pushed over or moved enough to break the printed-circuit conductor to which it was soldered. Everything works fine now, and thanks for holding my hand!—W. McL., Phoenix, AZ.

Glad to have been of some help!

HALF A RASTER, BLOWN DIODES

There are several problems in this Magnavox model T982. The scan board was a mess where D207, D208 and D209 are, and the three little chokes marked on the board had been replaced with small resistors, which were also burned up. I replaced the diodes with 2.5-amp diodes, and the resistors with 0.5-ohm types. When I turned the set on, only the top half of the raster showed with picture, color and sound all OK. Then I lost all the vertical sweep, and everything got hot.

Diode D208 had opened up again. I killed the −12.7-volt supply and checked capacitor C204 on the −12.7-volt supply; it was OK. Do you have any ideas?—M.D., APG, MD.

A few. First, do not use stock diodes as substitutes for D207–D209. These diodes are fed from the flyback, and you *must* use fast-recovery diodes. The half-raster problem is due to one of the transistors in the vertical-output stage (a complementary-symmetry circuit) being open or having lost the DC supply. One transistor is fed from the +16-volt line, the other transistor from the −12-volt line, and both these supplies come from the same area. Check for a possible shorted capacitor.

(Feedback: "Capacitor C203 was blown! That really helped!")

VOLTAGE OVERLOAD

Please send help. This Zenith 25EC58 has a raster but no video. Resistor R355 is open. Replacing R355 blows the horizontal-output transistor and resistor R354 smokes. One side of diode CR221 reads +50 volts, the other side reads +250 volts. What's wrong!—A. C., Puerto Nuevo, PR.

From the symptoms you describe, there's a short or an overload somewhere in the boost voltages, especially in the +240-volt supply that flows through R355. Check both boost diodes, CR221 and CR219. Make sure to use fast-recovery-type diodes for replacements in this and any other set using flyback-derived DC power supplies.

(Feedback: "Diode CR221 was very leaky. I replaced it, and changed CR219 just for luck. The set now works OK. Thanks a lot!") **R-E**

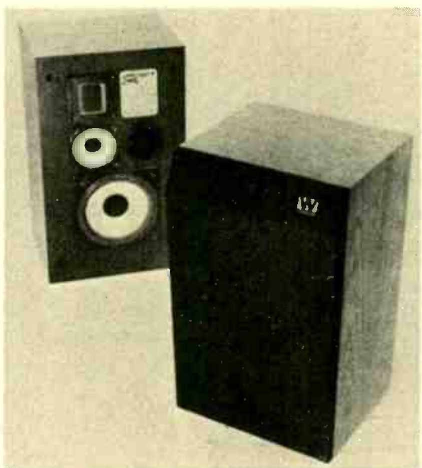
CIRCLE 9 ON FREE INFORMATION CARD

CIRCLE 19 ON FREE INFORMATION CARD

stereo products

More information on stereo products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

HI-FI SPEAKER SYSTEM, the *Wharfedale model Teesdale,* features an 8-inch woofer, a 4-inch mid-range cone and an isodynamic tweeter. Both the mid-range and tweeter were designed using laser beam holography techniques. The unit pro-



CIRCLE 131 ON FREE INFORMATION CARD

vides a frequency response from 40 Hz to 26 kHz ±3 dB, and an 87-dB sound-pressure level for 1 watt at 1 meter. The *Teesdale* comes in walnut veneer, measures $23 \times 13\frac{1}{2} \times 11$-inches, weighs 31 lb., and has a suggested retail price of $270.—**Rank Hi-Fi, Inc.,** 20 Bushes Lane, Elmwood Park, NJ 07407.

AM/FM STEREO RECEIVER, *Realistic model STA-2100,* provides 120 watts-per-channel into 8 ohms from 20 Hz to 20 kHz, with no more than 0.1% THD. Its features include bass, mid-range and treble controls; 25- and 75-μs de-emphasis; multiplex filter; dual tape monitors and dubbing;

CIRCLE 132 ON FREE INFORMATION CARD

DIN and phono tape-in/tape-out jacks; phono sensitivity switch; and high-cut and low-cut filters. The *model STA-2100* also includes built-in noise-reduction protection, plus AM signal-strength and FM center-channel meters and power meters.

The FM front end contains a MOSFET amplifier, ceramic filters and PLL circuitry. Specifications include: For the amplifier: Frequency response, 15 Hz—25 kHz ±2 dB at 10 watts; IM distortion, 0.05% at 70 watts; S/N ratio, 70 dB (phono); 75 dB (aux). For the FM section: IHF sensitivity, 1.6 μV (10.1 dBf); capture ratio, 1.5 dB; alternate channel rejection, 75 dB; stereo separation, 52 dB at 1 kHz; THD, 0.1%, stereo, 0.05% mono. The *model STA-2100* measures $6\frac{7}{8} \times 20\frac{1}{2} \times 16\frac{7}{8}$ inches, and sells for $599.95.—**Radio Shack,** 1400 One Tandy Center, Fort Worth, TX 76102.

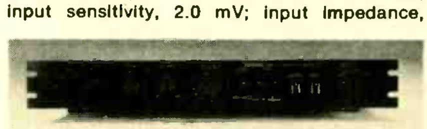
DIRECT-CONTROL TURNTABLES, *Project 7 models AF977* and *AF967,* are belt driven and use a phase-locked loop to control turntable speed. Selectable speeds are $33\frac{1}{3}$ RPM and 45 RPM. Speed variation is specified to be within ±0.002%. The *model AF977* (shown) is an automatic single-play turntable with digital speed readout, and the *model AF967* is a semi-automat-

CIRCLE 133 ON FREE INFORMATION CARD

ic unit. Wow-and-flutter in both turntables is 0.02% WRMS. Suggested retail prices: *model AF977,* $399; *model AF967,* $349.—**Philips High Fidelity Labs, Ltd.,** Box 2208, Fort Wayne, IN 46801.

FM TUNER PREAMPLIFIER, *model Beta III,* uses FET's in all its stages to provide low noise and low distortion. The first stage of the equalization amplifier section uses a single-cascade dual-FET input stage and the last stage uses a 3-parallel, regulated current load source follower. The tone-control amplifier uses attenuators in the I/O stages for lowest S/N ratio.

Specifications include: For phonos 1 and 2: frequency response, 30 Hz—15 kHz ±0.2 dB; input sensitivity, 2.0 mV; input impedance,



CIRCLE 134 ON FREE INFORMATION CARD

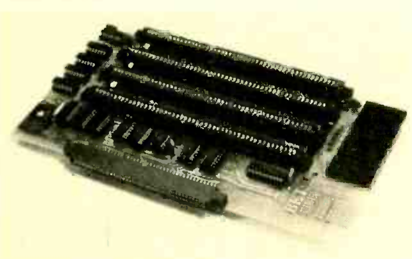
22,000, 47,000 and 100,000 ohms; S/N ratio, 81 dB (at input reference level of 2 mV); and THD, less than 0.004%. The unit is rack-mountable and comes with matte black front panel. The *model Beta III* measures $19 \times 2\frac{3}{32}$ H × 13 inches and weighs 13 lbs. $399.—**Nikko Audio,** 16270 Raymer St., Van Nuys, CA 91406. **R-E**

computer products

More information on computer products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

INTERFACE/MOTHERBOARD, *Betsi*, comes as a kit or assembled. Attaches to any PET computer to provide, on a single board, both interface and S-100 motherboard with four slots. Unit allows most S-100 compatible boards to be plug-compatible with PET. The board features a dynamic memory controller that allows use of *Expandoram* board for expansion to 32K of memory, plus sockets and address decoding for 8K of PROM (Intel 2716).

Kit includes single-sided board, owner's manual, plus all components and one 100-pin connector. Assembled, the *Betsi* comes with four 100-pin connectors and manual. Price: kit, $119; assembled, $165.—**Forethought Products,** P.O. Box 8066, Coburg, OR 97401.



CIRCLE 121 ON FREE INFORMATION CARD

LOGIC ANALYZER KIT, *model LTC-2*, contains three high-speed (10-ns) digital troubleshooting tools—the *model LP-3* logic probe, the *model DP-1* digital pulser and the *model DM-1* logic monitor. The *model LP-3* probe features 0.5-megohm input impedance, switch-selectable TTL/DTL and CMOS/HTL thresholds, LED indicators, built-in pulse stretcher and memory switch. The *model DP-1* provides single-pulse or 100-hz-pulse operation and a TTL/CMOS mode switch. The *model LM-1* monitor clips onto standard 14- or 16-pin DIP IC's; LED's show pin state. Accessories include probe tips, adapters, ground leads, operator's manuals and guides—all housed in rugged plastic case. Suggested retail price: $235.05.—**Continental Specialties Corp.,** 70 Fulton Terrace, New Haven, CT 06509.

CIRCLE 122 ON FREE INFORMATION CARD

DATA ACQUISITION/PROCESS CONTROL SYSTEM, *Real World Interface System* (available as kit or assembled) is designed for use with both mini- and microcomputers, with typical applications in environmental control, robotics and automated assembly-line testing. The system cabinet contains a power supply, card cage and motherboard for up to 12 plug-in modules, including A/D and D/A converters and a computer interface card. Plug-in modules contain from 8 to 32 I/O channels (the *Current Probe* has 4 I/O channels). Plug-in module price range: kits, $65—$125; assembled, $79.50—$150. Cabinet with power supply, motherboard and parallel CPU interface, $299 for the kit; $360, assembled.—**General Computer Technology,** 400 S. Lipan, Denver, CO 80223.

CIRCLE 123 ON FREE INFORMATION CARD

DISC SOFTWARE, *model SL80-10F* text editing system, *model SL80-11F* text processing system and *model SL80-12F* mnemonic assembler, are designed for the 8080 microcomputer and operate under the CP/M disc operating system. The text editor features block move and copy, tabs, overlays, append and restrictive column searches. The text processor provides over 50 commands covering pagination, margin/indent settings, spacing, titling, centering and justification. New instructions can be implemented with conditional commands, number registers, terminal prompts and a loop command. A separate data file can be read for information required by the text file. The mnemonic assembler supports standard pseudo op-codes, plus paging, titling, hex or octal listings, line numbers, etc. All programs include user's manual, source listing and an 8-inch disc. Prices: *model SL80-10F* editor, $40; *model SL80-11F* processor, $50; *model SL80-12F* assembler, $40.—**Technical Systems Consultants, Inc.,** P.O. Box 2574, West Lafayette, IN 47906.

CIRCLE 124 ON FREE INFORMATION CARD

communications products

More information on communications products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

MOBILE CB TRANSCEIVERS, the *McKinley, Thomas J.,* and *Andrew J.,* all provide a 4-watt AM power output (the *McKinley* has a 12-watt

CIRCLE 111 ON FREE INFORMATION CARD

SSB output) and −60 dB spurious rejection. Both the *Thomas J.* and *Andrew J.* transceivers have 100% modulation. The *McKinley* unit (shown) features standard controls plus a clarifier. The *Thomas J.* unit has standard controls, plus a Channel 9 priority switch and an SWR meter. The *Andrew J.* unit contains a combination transmit/receive light and variable RF gain control. Prices: the *McKinley*, $269.95; the *Thomas J.*, $159.95; the *Andrew J.*, $119.95.—**President Electronics, Inc.,** 16691 Hale Ave., Irvine, CA 92714.

MORSE CODE COPIER, *model DE-150,* is designed to operate with communications receivers and transceivers and features a built-in 100-Hz bandpass filter with 800-Hz center frequency. Other features include an 8-character 5 × 7 dot

CIRCLE 112 ON FREE INFORMATION CARD

matrix LED display and 50- to 60-word-per-minute copying capability. Comes with built-in 115-VAC power supply, patch cord and output monitor jack and measures 2 × 10 × 4 inches. Suggested retail price: $425.—**Dynamic Electronics, Inc.,** Box 896, Hartselle, AL 35640.

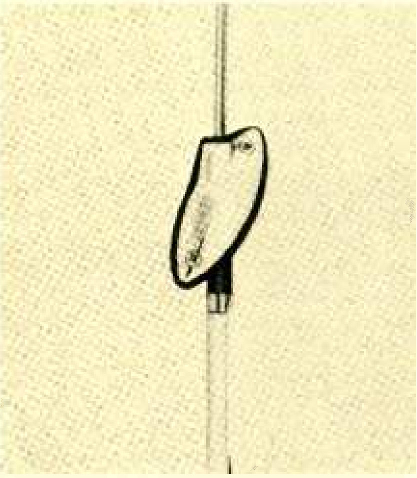
MARINE TRANSCEIVER, *model TI 2100,* is a fully synthesized solid-state VHF/FM unit with programmable scan feature that enables simulta-

CIRCLE 113 ON FREE INFORMATION CARD

neous channel monitoring. The unit also provides 55-channel transmit and 76-channel receive capabilities (includes 4 weather stations) and operates on all USA and international channels. Keyboard automatically selects simplex, duplex, 1-

watt or receive-only operation. Other features include high-visibility displays, squelch and remote control. Suggested retail price: $795.—**Texas Instruments, Inc.**, P.O. Box 226080, Dallas TX 75266.

AM/FM CUSTOM ANTENNAS, *models KL-16F, NL-15-B, PM-95H, PM-21D, PM-30, PM-58,* is a complete line of OEM-styled customized antennas for imported autos. The antennas are in-



CIRCLE 114 ON FREE INFORMATION CARD

tended for BMW, Datsun, Fiat, Mazda, Saab, Honda, Subaru, Toyota and VW. All models (*model PM-95H* designed for the Honda Accord is shown) feature stainless steel masts, shielded bodies and cables, and heavy chrome-plated hardware. Suggested retail price range: $5–$7.50.—**Harada Industry of America,** Dept. P, 145 E. Albertoni St., CA 90746. **R-E**

AC OUTLET CHECKER

continued from page 53

ance *only if the outlet box itself is grounded.*

What happens all too often is that the adapter gives the user a false sense of security and he tends to forget the safety precautions he once observed. Unwittingly, he has created a system that can potentially be even more dangerous than the original.

How then do you know when the system is safe? It's simple; just hook the adapter up as it will be used, then plug the Outlet Polarity Checker into it. If the adapter checks out OK, all is well and it can be used with confidence. If not, the best remedy is to rewire the outlet to the proper 3-wire configuration. Figure 2 shows the various combinations of lights.

The same method can be used to check that the neutral (white) wire in a 2-wire system is grounded. Connect the green lead of the adapter to a known ground and then test it. If it checks out OK, then the ground is grounded. If not, you will get a "no ground" indication.

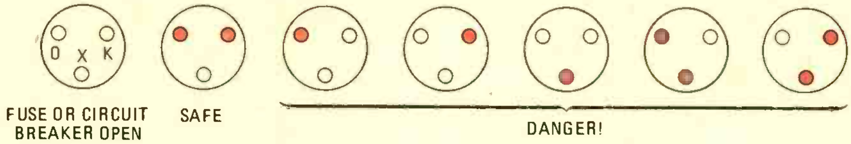


FIG. 2—HOW THE LIGHTS INDICATE different conditions. Indications are same as in Table 1.

The Outlet Polarity Checker is a one-evening project. In most cases it can be made entirely from junk-box parts. For DS1, DS2 and DS3 you can use neon lamp assemblies with built-in current-limiting resistors. It is recommended that DS1 ("O") and DS3 ("K") have amber or clear lenses, and that DS2 ("X") have a red lens. The plug and cable can be cut from any 3-wire polarized (grounding) cord. The completed checker is housed in a small *Bakelite* case. You can use transfer lettering to label the panel for a professional appearance. **R-E**

PRECISION DMM
continued from page 42

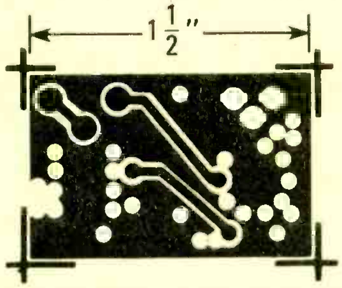


FIG. 8—TOP SIDE of the board for the true-RMS converter.

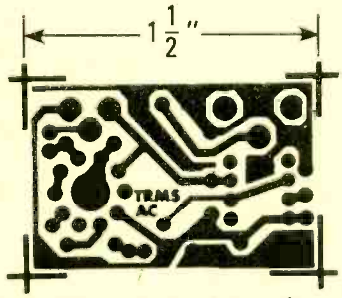


FIG. 9—PATTERN for the bottom side of the TRMS converter board.

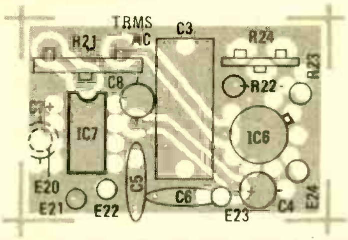


FIG. 10—HOW PARTS ARE POSITIONED on the TRMS converter board.

ment and check all solder connections for cold joints and possible bridges. Plug in the instrument, apply power and check for +5V, −5V and −8 volts at the output pins of the three voltage regulators.

If the correct supply voltages are obtained, then remove power from the instrument and install all remaining IC's in their sockets taking care to observe proper pin orientation.

Calibration

Table 2 shows the calibration sequence for the multimeter. The ADC voltage reference is calibrated by allowing the meter to read a known voltage between 1 and 2 volts and adjusting R9 until the known value is obtained. (Use the 2-volt range.) The known voltage can be from a voltage reference source or a standard cell, or a stable voltage calibrated by another digital voltmeter or a fresh mercury cell (1.35 volts). The temperature references must be calibrated by another voltmeter, measuring between the test point indicated in Table 2 and the −5-volt supply. Known resistors are supplied with the kit of parts (see parts list) to calibrate the resistance ranges.

There are two adjustments for the AC converter calibration. Trimmer R24 is
continued on page 80

PRECISION DMM
continued from page 79

TABLE 2—MULTIMETER CALIBRATION SEQUENCE

Step No.	Calibrate	Pot No.	Switches	Display
1	ADC Reference	R9	S5, S7	Known input voltage between 1 and 2 volts DC or 1.35 volts from a fresh mercury battery cell.
2	Celsius Reference	R36	S2	2.732 volts measured from arm of R36 to −5-volt supply using an external voltmeter.
3	Fahrenheit Reference	R33	S3	4.594 volts measured from arm of R33 to −5-volt supply using an external voltmeter.
4	Celsius Range	R29	S2	.0000° (ice water bath) 100.00° (boiling water)
5	Fahrenheit Range	R31	S3	Adjust R31 to equal Celsius range using conversion equation.*
6	2000-ohm Range	R15	S4, S7	Adjust to equal known resistance.
7	20,000-ohm Range	R14	S4, S8	Adjust to equal known resistance.
8	200,000-ohm Range	R13	S4, S9	Adjust to equal known resistance.
9	2-megohm Range	R12	S4, S11	Adjust to equal known resistance.
10	20-megohm Range	R10	S4, S11	Adjust to equal known resistance.
11	AC Offset	R24	S5, S6, S7	0.0000V with input shorted or with pins 2 and 4 of IC6 shorted.
12	AC Calibration	R25	S5, S6, S7	Adjust to equal known AC input voltage (RMS value, not peak).

* $°C = 5/9\,(°F-32)$
$°F = (9/5 \times °C)+32$

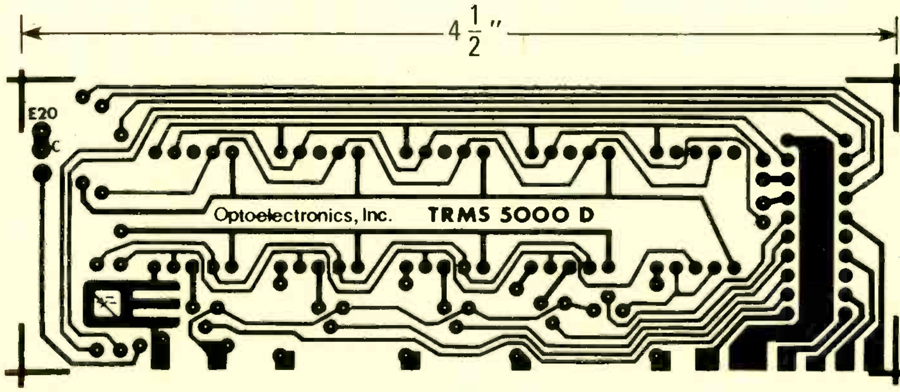


FIG. 11—FULL-SIZE PATTERN for the display board. All components are mounted on the front surface.

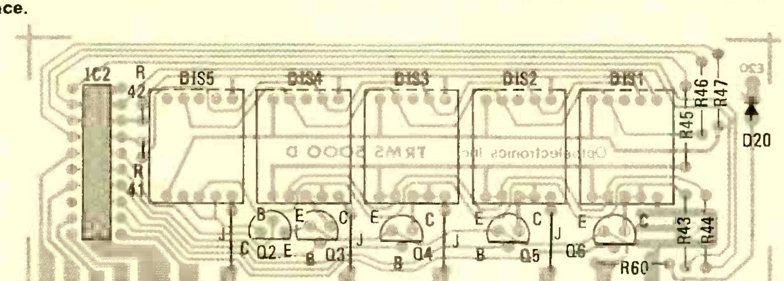


FIG. 12—DISPLAY BOARD parts placement. The IC is the display segment driver. The transistors are used in digit multiplexing.

the offset or zero trim, which is adjusted with the input shorted. There is a possibility of significant noise pickup due to the high input impedance of buffer IC7, so it may be necessary to short the input pin to IC6 by shorting pin 4 to pin 2 while adjusting the offset to zero. Trimmer R25 is used to fine adjust the AC calibration with a known RMS value AC voltage applied to the input. If a calibrated AC voltage is not available, the pot should be centered for accuracy. **R-E**

books

UNDERSTANDING DIGITAL ELECTRONICS, Texas Instruments Learning Center. Texas Instruments, Inc., Box 3640, M.S. 84, Dallas, TX 75285. 265 pp. 5¼ × 8¼ in. Softcover $3.95.

Finding out how digital electronics work by using a handheld calculator is the goal of this book, and a step-by-step approach explains circuits, from the most basic to the very sophisticated. Because it is really a self-teaching course, the book should be read chapter by chapter; self quizzes are provided at the end of each chapter (with the answers in the back of the book); and a glossary of special terms and a bibliography are also provided.

THE INCREDIBLE SECRET MONEY MACHINE, by Don Lancaster. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 159 pp. 5¼ × 8¼ in. Softcover $5.95.

This is not a "get-rich-quick" book, but rather a "cookbook" and guide on how to turn your own full-time small-scale computer, technical or craft business into a successful enterprise. Written in tongue-in-cheek yet down-to-earth style, the book contains helpful hints on how to reduce your taxes, not pay a utility bill, get totally free insurance, and many other necessary adjuncts to running a successful "secret money machine."

HOW TO BUILD YOUR OWN STEREO SPEAKERS: CONSTRUCTION, APPLICATIONS, CIRCUITS AND CHARACTERISTICS, by Christopher Robin. Reston Publishing Co., Div. of Prentice-Hall Co., Reston, VA 22090. 193 pp. 6¼ × 9¼ in. Hardcover $15.95.

The title of this book says it all—it is a "how-to" guide for hobbyists and professional engineers who want simple step-by-stop instructions on constructing a state-of-the-art speaker enclosure. The book also includes data on acoustics, planning and designing speaker crossover networks, and basic woodworking. Dimensional drawings and photographs accompany the text; and the back of the book contains several appendixes and a complete glossary of terms.

TAPED EDITING, by Joel Tall. Elpa Marketing Industries, Inc., Thorens & Atlantic Aves., New Hyde Park, NY 11040. 32 pp. 5½ × 8½ in. Softcover $2.

This little book explains in detail all the ins and outs of audio and video tape splicing. It also gives you helpful tape editing hints such as how to run the tape backward in order to recognize speech sounds. Other chapter topics deal with splicing and editing procedures, speech characteristics and how to work within the limits of hearing sensitivity.

BASIC FOR HOME COMPUTERS, by Bob Albrecht, LeRoy Finkel and Jerald R. Brown. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 336 pp. 6½ × 10 in. Softcover $5.95.

This book is a self-instruction course in the BASIC programming language for home computer applications; it does not require access to an actual computer. The version of BASIC used is *Microsoft* BASIC developed for the Altair MITS. Some of the topics covered are assigned statements, stored programs and branching; subscripted variables, double subscripts; string variables and functions; and subroutines. Each chapter contains a self-test section, and there is a final self-test in the back, together with appendixes containing lists of computing periodicals, BASIC functions and ASCII character codes.

S S I MICROCOMPUTER SOFTWARE GUIDE. S S I Publications, 4327 East Grove St., Phoenix, AZ 85040. 140 pp. 5½ × 8½ in. Softcover $7.95 (also available on mini-floppy disc).

This book is a must for anyone planning a microcomputer system for business, home or education applications. It consists of a listing of over 2200 software programs, alphabetically arranged from ASCII (codes, displays, etc.) to Zip Code (mail-code sorting & printing). The 236 classifications are drawn from discs, cassettes, books, paper tapes, listings, pamphlets and magazines; and the back of the book contains a list of 130 microcomputer software sources and addresses.

BUGBOOK VIII, 8080/8085 SOFTWARE DESIGN WITH 190 SOFTWARE SOLUTIONS, by Christopher A. Titus. E&L Instruments, Inc., 61 First St., Derby, CT 06418. 288 pp. 6 × 9 in. Softcover $9.

This detailed treatment of assembly language programming for 8080- and 8085-based computers contains many elementary and advanced instructions. It analyzes and discusses programming techniques for mathematical routines, number system conversions, command decoders, arrays and tables, interrupt programming, etc. Many complete and tested programs in standard mnemonics are included. **R-E**

market center

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). **$1.50 per word (no charge for zip code)** . . . minimum 15 words.

NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) **85¢ per word** . . . no minimum.

ONLY FIRST WORD AND NAME set in bold caps. Additional bold face (not available as all caps) at 10¢ per word. Payment must accompany all ads except those placed by accredited advertising agencies. 5% discount for 6 issues, 10% for 12 issues within one year, if paid in advance. All copy subject to publisher's approval. Advertisements using P.O. Box address will not be accepted until advertiser supplies publisher with permanent address and phone number. Copy to be in our hands on the 26th of the third month preceding the date of the issue (i.e., August issue closes May 26). When normal closing date falls on Saturday, Sunday, or a holiday, issue closes on preceding working day.

FOR SALE

FREE catalog (anglais). IC's, semi's. **CORONET ELECTRONICS,** 649A Notre Dame W., Montreal, Que., Canada, H3C 1H8. US inquiries.

RADIO & TV tubes 36¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, Calif. 92105

TEST equipment catalog listing used Tektronix, HP and GR equipment at bargain prices. Price $1.00 refundable with first order. **PTI,** Box 8699, White Bear Lake, MN 55110

NAME brand test equipment. Guaranteed discounts up to 50%. Free catalog. **SALEN ELECTRONICS,** Box 82-M, Skokie, IL 60077

PRINTED-circuit boards, reasonable. Also, artwork, prototypes, designs, fabrication and testing. **MICROCON INC.,** Box 43, Glenview, IL 60025

RCA, Zenith original TV parts. Dealer prices, fast service. Send part and model numbers. **L.I. ELECTRONICS,** 981 Sunrise Hwy., Bayshore, NY 11706, 516-666-7360

TEKTRONIX 5440 Opt. 1 60-MHz scope, 5A48, 5B42 $1750. Tektronix DM501 with temp. and probes, TM504 mainframe, 2 blank plug-ins, flexible extender cable $550. H-P 5326A systems counter $550. Wavetek 142 function generator $400. All excellent with manuals. Call **518-489-4946** after 6 P.M. Eastern Time.

VIDEO recorders, cameras, blank tapes, prerecorded movies at low discount prices. **MIDWEST VIDEO,** Box 3233, Dayton, OH 45431, 513-227-7609

NEW. Meter solid-state isolated relay. Control 5 millivolts 5 microamperes 1000 ohms DC. Lead circuit 3 amperes 125 VAC. Write today for facts. **EGYED ELECTRONICS,** Box 92, Huntingdon Valley, PA 19006

SENSITIVE converter 1.7-2.4 GHz $99.95 postpaid. Details for stamp. **GW ELECTRONICS,** POB 688, Greenwood, IN 46142

PARTS priced to sell—bought at bankruptcy. All new parts. Guaranteed satisfaction. Send two 15¢ stamps for list. **MARCRUM,** 513 Pontiac Ct., Madison, TN 37115 (615) 865-7078

SAM'S photofacts original folders numbers 1 to 568 order your needs, will confirm. **RINEHART,** 241 South West 2nd Street, Richmond, IN 47374

RECORDSAVER, poly-lined inner sleeves, ten cents each, postpaid, minimum 100. **DEO INC.,** Box 452J, Glenview, IL 60025

To run your own classified ad, put one word on each of the lines below and send this form along with your check for $1.50 per word (minimum 15 words) to:

Radio-Electronics, 200 Park Avenue South, N.Y., N.Y. 10003

ORDER FORM

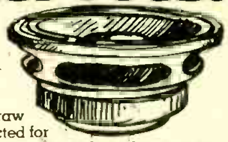
PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of $10.

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) ______
Special Category: $10

(PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

SpeakerGuts.



The absolute latest in advanced speaker technology. *Wave Aperature™ Drivers, the Patented Nestrovic Woofer System™*, raw speaker components selected for their excellence. Horns, crossovers, subwoofers, woofers, midranges, horn and dome tweeters. Over 30 in all. Build your own speaker system and we'll provide top quality speakers and design information. Send for FREE 48 page color catalog from the largest, most experienced speaker kit manufacturer in the world. *DON'T DELAY. Write today!*

Speakerlab®
Dept. 8-RE, 735 N. Northlake Way
Seattle, Washington 98103

PLANS & KITS

SCANNER users—build many useful accessories. Free kit catalog. **CAPRI ELECTRONICS,** Route 1R, Canon, GA 30520

PRINTED circuit boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. **DANOCINTHS INC.,** Box 261, Westland, MI 48185

FREE schematic. Touchlite electronic switch and dimmer. Send stamp: **TOUCHLITE,** Box 161, Plainville, NY 13137

ALUMINUM panels 19 × 6 × ⅛. Perfect for rack or custom installations. $6.50 each. RJP SALES, 2360 Rockymont, St. Louis, MO 63136

CONSTRUCTION plans for profitable business ideas. Catalog $1.00. **GARLING,** 438 N. Garfield Street, Lombard, IL 60148

ELECTRONICS "Gas" detector plans including IC amplifier. Detects carbon monoxide, propane, natural gas, smoke, etc. Ideal for Home, Vans, Autos, RV's, Boat Bilges or for controlling Vent Fans, Garage Door Openers, etc. $2.75. **JR INDUSTRIES,** 5834-B Swancreek, Toledo, OH 43614

NEW modern design specialties for hobbyists and kit builders never been on US market, featuring professional quality PC boards and components for outstanding performance at economy prices. Write for free catalog. **LORS ASSOCIATES,** Box 518, Berwyn, IL 60402

CHARGE! Build your own negative ion generator and save. Plans $5.00. **LUNATRIX,** P.O. 891, Yucaipa, CA 92399

GRAPHIC EQUALIZER

TWELVE bands/channel **$100 kit** still available: See May 1978 cover story. Complete instructions, reprint review $2.50. Free information. **SYMMETRIC SOUND SYSTEMS,** 1608 South Douglas, Loveland, CO 80537

EDUCATION & INSTRUCTION

TELEPHONE bugged? Don't be Watergated! Countermeasures brochure $1.00. **NEGEYE LABORATORIES,** Box 547-RE, Pennsboro, WV 26415

UNIVERSITY degrees by mail! Bachelors, Masters, Ph'D's . . . Free revealing details. **COUNSELING,** Box 317-RE8, Tustin, CA 92680

UNDERSTAND digital electronics. Programmed learning courses. Design of Digital Systems, 6 volumes, only $19.95. Digital Computer Logic, 4 volumes, $14.95. Both $29.95. Free details. **GFN INDUSTRIES,** Bldg. 7-20, 203 Loudon Road, Concord, NH 03301

FORTUNES made in **Real Estate**. Book tells secret guidelines. $3.00 plus 30¢ postage. **DEBLEN'S SPECIALTIES,** Dept. RE8, 2300 W. Pleasant Valley, Parma, OH 44134

EARN high school diploma, spare time. College-recognized. Credits given for previous courses, job experience. Low tuition. Exams repeated free. Individual counseling. State registered. **CAMBRIDGE ACADEMY,** Dept. RE-1, 409 E. Osceola, Stuart, FL 33494. Toll-free 1-800-327-8103.

BUSINESS OPPORTUNITIES

MECHANICALLY inclined individuals desiring ownership of Small Electronics Manufacturing Business—without investment. Write: **BUSINESSES,** 92-R, Brighton 11th, Brooklyn, NY 11235

LEARN to repair PLL or crystal synthesis CB for profit, 30 PLL's covered. Send $12.95 for instruction book. **A.P. SYSTEMS,** PO Box 488, Milford, PA 18337, Dept. RE

WANTED

ELECTRONICS technician to repair musical electronic equipment (amplifiers, synthesizers, etc.). Salary commensurate with ability. Send resume to: **ACE MUSIC,** 13630 W. Dixie, N. Miami, FL 33161

RADIO and TV tubes 1938 to 1978 $1.00 ea. **PRELLER TV,** Augusta, AR 72006. (501) 347-2281.

CHRISTMAS IN AUGUST

DELTA'S FIRST-TIME-EVER SALE! We bring you Christmas Savings now so you can get more for your money than ever-before!

OUR ORIGINAL PRICES ½ OFF GOOD TILL SEP. 30

½ OFF!

TV Game Boards!

FANTASTIC TREASURE OF PARTS!!

Without Joysticks No. 6939R **$2.95**
With Joysticks. No. 6938R **5.95**

These TV game boards are a fantastic source of parts as you can see by the parts listed below. Included with ea. board is step-by-step instructions for the removal of all these parts.

C-MOS

4001—3 pcs.—Quad 2-Input NOR gate.
4008—1 pc —4 bit Full adder.
4011—3 pcs.—Quad 2-Input NAND gate.
4013—2 pcs.—Dual D Flip Flop.
4016—2 pcs.—Quad Analog switch/Quad Multiplexer.
4023—1 pc —Triple 3-Input NAND gate.
4071—1 pc —Quad 2-Input OR gate.
4511—1 pc —BCD-to-7 segment latch/decoder/driver.
4519—2 pcs—4-Bit AND/OR selector.
4520—1 pc —Dual Binary UP counter.
4528—1 pc —Dual Monostable Multivibrator.
3401—2 pcs.—Quad Operational Amplifier.
LM339—5 pcs—Quad Differential Comparators.
LM301A—1 pc—High-performance operational amplifiers.
NE555—2 pcs.—NPN high speed switching transistor.
2N3904—2 pcs.—timer.
2N3906—1 pc —PNP high speed switching transistor.

$25.00 WORTH OF ICS

Also included are two 10K joysticks (which we sell for $3.95), many capacitors, resistors, trimmers & diodes.

SWITCHCRAFT INC.

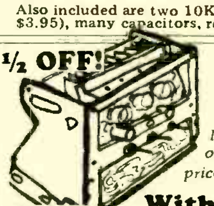
½ OFF! **$3.50** *Delta's original $6.95 ea.*

2 for $6.
No. 6408R

Push BUTTON Assemblies!

This is the top-of-the-line SWITCHCRAFT multi-gang switch. It has SIX push buttons. Button 1 is SPST, momentary switch; and releases any button that has been depressed. Switches 2 and 3 lock when depressed and release when switches 1—4—5 or 6 is depressed. Switches 4—5 & 6 are interlocked, depress any one of them releases the others. Switch 2 is SPST normally open. Switch 3 is SPDT & SPST normally open. Switch 4 is DPDT. Switch 5 is DPDT & 3 SPST normally open switches. Switch 6 is DPDT & SPST normally open. A fantastic feature of this switch is that any of the switch sections may be removed from its initial position and placed on another push button; and ganged so that more combinations are possible on any of the push buttons. This switch has the special SWITCHCRAFT LOCKOUT feature which prevents operation of more than one push button at a time. Switchcraft catalog price (in 1976) was $29.48. Delta's original price $6.95.

½ OFF!



BEAM-X Counters!

Delta's original price $13.95 **$6.95** 2 for $12

No. 5265R

With 3 Nixie Tubes!

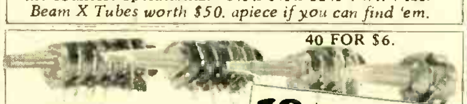
This counter was originally used by a large mfg of copying machines. Function: the number of copies desired was preset by dials & the machine then made this number of copies—displaying the count on the NIXIE tubes. When the preset number was reached, the counter stopped the machine. These counters were removed from the copiers & replaced by new models. Input: 115VAC and uses 24V logic. This unit contains 5 BEAM—X switching tubes, its own power supply, plus a 200 VDC & 6.3 VAC supply. It contains 3 Burroughs NIXIE tubes, type B5092A which currently sells for $17 each. We supply diagram of BEAM—X tubes, operating instructions and some application data. We are selling these counters at this low price because of the minor defects that some of these counters have. Unfortunately we do not have the time to test or make the minor repairs needed to make the counters operational. 6½ x 6½ x 11½". Wt. 7 lbs.
Beam X Tubes worth $50. apiece if you can find 'em.

½ OFF! Momentary Push Button Switches

Delta's original price $2.

$1 Each

This switch is the same physical shape as the one shown above, except this momentary switch has only TWO switches. Compact, low-silhouette design. Only 1¾" H. & 3 5/8" behind panel. Plunger on 5/8" centers. Features 2 momentary switches. The first is a momentary on-off switch. Second has 4 functions, the 1st is a momentary on-off, the 2nd is a SPDT, the 3rd & 4th section are DPDT momentary. The catalog price is $9 ea.
No. 6412R



40 FOR $6.

18 Assorted Pots **$3**

½ OFF! GANGED

No. 8902R

POT Bonanza

We have acquired the entire inventory (2 million pieces) of ganged pots from one of the largest makers of automobile radios in the country. There are 2-gang, 3-gang, 4-gang, 5-gang, and 6-gang pots; almost all also include line switch. These are made by C-T-S (American made). All the popular resistance values, tapers and many of the pots are tapped. Any one of these pots would cost you more than the whole package of 18 pieces.

WoW! Less Than 17¢ Each!

CopperClad PC Boards!

No. 5721R....9½x18", single-sided copper clad with phenolic board on reverse side; (With holes). Original Delta price $2. ea.	**$1.**
No. 5672R....12x18", single-sided, copper clad with approx. 1-oz. of copper. Reverse side 1/16" G-10 glass epoxy board. (With holes). Original Delta price $3 ea.	**1.50**
DOUBLE SIDED	
No. 5712R....12x18", double-sided copper clad, with approx. 1-oz. of copper each side, over 1/16" G-10 glass epoxy board (No holes). Original Delta price $5. ea.	**2.50**
No. 5711R....16x17", double-sided copper clad, with approx. 1-oz. of copper each side, over 1/16" G-10 glass epoxy. (No holes). Original Delta price $6. ea.	**$3.**

NEW MAIL-ORDER ADDRESS

DELTA ELECTRONICS
176 SECOND AVE.
WALTHAM, MASS.
02154
TEL. (617) 388-4705

When in our area, northeastern Mass. or southern N.H. visit our retail at 7 Oakland St., Amesbury, Mass.

HIGHLY PROFITABLE **ONE-MAN ELECTRONIC FACTORY**

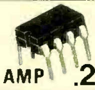
Investment unnecessary, knowledge not required, sales handled by professionals. Ideal home business. Write today for facts! **Postcard will do. Barta-RE-T, Box 248, Walnut Creek, CA 94597.**

BREATHE REFRESHING **"VITAMINS OF THE AIR"** with an amazing **NEGATIVE ION GENERATOR**
ROOM-PORTABLE-CAR UNITS, TESTERS AND ACCESSORIES
(Dealers Wanted)

$129.00 Or Send $1.00 for fascinating details to
GOLDEN ENTERPRISES, INC.
P.O. Box 1282-RE
Glendale, Arizona 85311

7400 TTL	
7400	.16
7404	.18
7408	.19
7410	.16
7412	.25
7413	.40
7416	.25
7420	.16
7425	.28
7426	.28
7427	.25
7430	.16
7437	.24
7438	.24
7440	.16
7445	.75
7451	.16
7454	.16
7474	.35
7475	.49
7483	.58
7485	.78
7486	.35
7489	1.80
7490	.43
7492	.42
7493	.42
7495	.65
74107	.35
74123	.49
74141	.78
74151	.58
74155	.75
74160	.86
74165	.86
74175	.75
74180	.75
74181	1.85
74195	.65
MISC TTL	
74S04	.35
74S05	.35
74S50	.35
74S153	1.95
74S181	2.75

P1103A
1024 X 1 Dynamic RAM
42¢

741PC

MINI-DIP OP AMP .29¢

S-100 16K BOARD
ASSEMBLED & TESTED

$279.00

NIXIE TUBE
BURROUGHS
$1.25

8038C
VCO Waveform Gen. w/sine
$2.75

2708
1024X8 EPRM
250ns
$8.50

LM300H
VOLTAGE REGULATOR
$1.00

7114A APPLE II™ PROM MODULE
PERMITS THE ADDITION OR REPLACEMENT OF APPLE FIRMWARE WITHOUT PHYSICAL REMOVAL OF THE APPLE ROMS.
◆NEW◆ $79.95 LESS PROMS

555 TIMER
in depth
28¢

82S115
QTYS LIMITED
512X8 PROM 60ns
$4.75

3HT1
3 AMP 100 VOLT
FULL WAVE BRIDGE
.50¢

LM305H
VOLTAGE REGULATOR
TO-99
75¢

7811A ARITHMETIC PROCESSOR
◆ BASED ON AMD'S AM9511
◆ ADD ★ SUBTACT ★ MULTIPLY ★ DIVIDE
TRIG ★ ROOTS ★ LOGS
$400.00

1702A
256 X 8 EPROM
$3.95

74S201
256 X 1 Static RAM
50 ns
$1.95

ULN2001
High-current Drivers. Darlingtons
75¢

2716
16K EPROM
$38.50

Calculator
CREDIT CARD SIZE
W/MEMORY
AUTOMATIC SHUT-OFF
$19.95

SOROC TERMINAL

IQ 120
$749.00

74LS240 74LS244 74LS245 74LS373 74LS374
IN STOCK
LIMIT 10 EACH
$2.45

MC1458P
Dual Op-Amp
24¢

2505K
512 X 1 DYNAMIC SHIFT REGISTER
95¢

LINEAR	
LM300H	.78
LM301N	.35
LM305H	.60
LM306H/N	1.50
LM307H/N	.35
LM308N	.95
LM309K	1.25
LM310N	1.10
LM311N	.85
LM320T5	1.25
LM320T12	1.25
LM320T15	1.25
LM322N	1.75
LM323K	5.75
LM340T5	1.25
LM340T12	1.25
LM340T15	1.25
LM556	.89
LM566	1.65
LM711N/H	.39
LM723N	.55
LM725H	1.75
LM733N	.95
LM741N/H	.35
LM747N	.78
LM749N	.85
LM3900	.46
78H05	6.95
SG4501	1.95
TRANSISTORS	
2N2222A	5/1.00
2N2907A	5/1.00
2N3055	.85
2N3904	6/1.00
2N3906	6/1.00
2N4401	6/1.00
2N4403	6/1.00
MJE2955	1.20
MJE3055	1.00
DIODES	
1N914	20/1.00
1N4003	15/1.00
1N4005	12/1.00
1N4007	10/1.00
1N4148	20/1.00

6301-1J
256 X 4 PROM
$1.65

20,000. VOLT RECTIFIER
25 ma
$1.65

CONCORD
COMPUTER COMPONENTS
1971 South State College-Anaheim, Calif. 92806
Visa- Master Charge
Check or M.O.
No COD
(714) 937-0641
Minimum Order-10.00
Add 1.00 for Frt.
Cal.Res. add 6%

78H05
5 AMP 5 VOLT REGULATOR IN TO-3 PKG
$4.95

8 AMP SCR
2N4442
200 V
.50

CIRCLE 31 ON FREE INFORMATION CARD

HOBBY WORLD

CALL TOLL FREE:
(800) 423-5387
CA, HI, AK: (213) 886-9200
Your No.1 Source for Computer Electronics

FINALLY! PANAVISE at a Discount


IC Sockets Penny-A-Pin
- Texas Instruments
- Solder tail
- Package quantities only

Order by Cat No. 1117 and pins

8 pin	20 for $1.60
14 pin	10 for $1.40
16 pin	10 for $1.60
18 pin	8 for $1.44
20 pin	8 for $1.60
22 pin	8 for $1.76
24 pin	3 for .72
28 pin	3 for .84
40 pin	2 for .80

Pay by check, COD, Visa, or Mastercharge. Order by phone or mail. Please include phone number and magazine issue you are ordering from. USA: add $2 for shipping/handling, $3 for air. Foreign: add $3 for surface, $6 for air. COD's also add $1. Guaranteed satisfaction for 120 days or your money back!

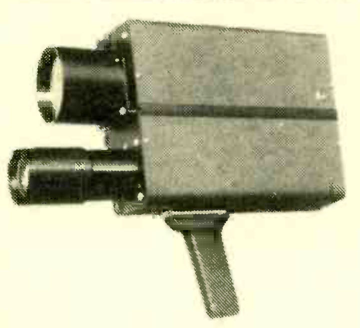
Send for FREE CATALOG Featuring
The best selection of computer accessories add-ons, factory fresh IC's, led's, semi's, software, PC aids, prototyping aids, books, test equipment, and more! Always updated! Dozens of new products every issue!

19355 Business Center Dr.
Northridge CA 91324 6R8

CIRCLE 26 ON FREE INFORMATION CARD


Electricity from the sun.
5 Volt panel ¼ amp $50 2.5 Volt panel ½ amp $40
GIANT 3½ inch cell, delivers 1 amp $8.50
Above cell with special motor & prop, runs in sun $10.25

LOGIC power supplies, unused, solid state construction.
5 Volt 4 amp $35 5 Volt 15 amp $45 5 Volt 25 amp $45
5 volt 35 amp $50 12 Volt 15 amp $40


Govt surplus walky talky, used cond.
47-55.4 mc range.
Ant. $5 each extra.
With data.
$25 ea 2 for $45
AN/PRC-6


SEE IN THE DARKNESS
IR viewer, portable, new with choice of one lens...close up, telephoto or gen. purpose.
Requires 6 volt DC btry.
$250
Shipping extra on all merchandise

Meshna Inc., PO Box 62, E. Lynn, Mass. 01904

CIRCLE 47 ON FREE INFORMATION CARD

DIGI-KEY CORPORATION

Quality Electronic Components

TOLL FREE 1-800-346-5144

MN., AK., HI. RESIDENTS 218-681-6674

DON'T FORGET OUR DISCOUNTS WHEN COMPARING PRICES

I.C.'S • RESISTORS • TRANSISTORS • CAPACITORS • DIODES • I.C. SOCKETS & PINS • SWITCHES • CLOCK MODULES • OPTOELECTRONICS • BREADBOADING & TESTING DEVICES • DRAFTING SUPPLIES • DATA BOOKS • HEAT SINKS • WIRE • TOOLS ... AND MORE ... WRITE FOR FREE CATALOG ....

I.C. Socket Prices Slashed

I.C. SOCKETS

- BOTH SOLDERTAB AND WIRE WRAP ARE TIN
- SOLDERTAB SOCKETS ARE LOW PROFILE
- WIRE WRAP SOCKETS ARE STANDARD PROFILE/LEVEL 3

Part No.	Description	1	10	100
8-ST	8 Pin Solder Tab	.08	.80	8.00
14-ST	14 Pin Solder Tab	.14	1.40	14.00
16-ST	16 Pin Solder Tab	.16	1.60	16.00
18-ST	18 Pin Solder Tab	.18	1.80	18.00
20-ST	20 Pin Solder Tab	.20	2.00	20.00
22-ST	22 Pin Solder Tab	.22	2.20	22.00
24-ST	24 Pin Solder Tab	.24	2.40	24.00
28-ST	28 Pin Solder Tab	.28	2.80	28.00
40-ST	40 Pin Solder Tab	.40	4.00	40.00
8-WW	8 Pin Wire Wrap	.24	2.30	20.50
14-WW	14 Pin Wire Wrap	.26	2.50	22.00
16-WW	16 Pin Wire Wrap	.30	2.85	25.50
18-WW	18 Pin Wire Wrap	.60	5.70	51.00
20-WW	20 Pin Wire Wrap	.70	6.65	59.50
22-WW	22 Pin Wire Wrap	.84	8.00	71.50
24-WW	24 Pin Wire Wrap	.96	9.10	81.50
28-WW	28 Pin Wire Wrap	1.12	10.00	95.20
40-WW	40 Pin Wire Wrap	1.36	12.50	115.00

MOLEX I.C. SOCKET PINS

.85/C	8.20/M	38.20/5M	275.00/50M

INTEGRATED CIRCUITS

7400 / 74LS00 / 74C00 series, CMOS 4000 series, linear (LM, CA, MC, UA, NE) and interface devices with prices. [illegible]

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab · Solder Eye · Wire Wrap

RELIABLE, COST-EFFICIENT CONTACT DESIGN

- 50 (Wire Wrap) to 75 (solder Tail) micro-inches gold inlay over a nickel diffusion barrier.
- Copper-nickel-tin CA 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

NOTE — Dimensions below are the pin center to center measurement followed by the distance separating the two pin rows.

H4 SERIES .100"x.200" EDGEBOARD CONNECTORS [illegible]

H4 SERIES .125"x.250" EDGEBOARD CONNECTORS [illegible]

H4 SERIES .156"x.200" EDGEBOARD CONNECTORS [illegible]

For polarizing keys order P/N CR1164-7 10/ea 7.50/C

SILICON TRANSISTORS

2N3904, 2N3906, 2N4124, 2N4126, 2N4401, 2N4403, 2N4410, 2N5087, 2N5089, 2N5210, 2N5457, 92PU01A, 92PU10, 92PU45A, 92PU51A, MJ2955, MJE172, MJE182, MJE3439, MJE344, MJE370, MJE371, MJE520, MJE521, MJE700, MJE703, MJE712, MJE722, MJE800, MJE803, MPF102, MPS2222A, MPS2369A, MPS2907A, MPS3392, MPS3393, MPS3394, MPS3395, MPS3563, MPS3565, MPS3638A, MPS3641, MPS3643, MPS5918, MPS6530, MPSA13, TIP112, TIP115, TIP120, TIP122, TIP125, TIP127, TIP132, TIP135, TIP29C, TIP30C, TIP31C, TIP32C, TIP61C, TIP62C — prices at 1/10/100/1000. [illegible]

½ WATT ZENER DIODES

1N5226B 3.3V – 1N5241B 11V; 1N5242B 12V – 1N5257B 33V [illegible]

SILICON DIODES

	1	10	100
1N4001		.80	7.00
1N4002		.80	7.00
1N4003		.80	7.20
1N4004		.80	7.90
1N4005		1.00	9.00
1N4006		1.00	9.00
1N4007		1.00	9.00
1N4148		.60	5.00

SLIDE SWITCHES

SPST 15 1.25/10 10.00/C
SPDT 19 1.70/10 13.00/C
DPDT 23 2.00/10 19.00/C

FREE CATALOG

Panasonic DISC CAPACITOR KIT

An Assortment of 18 Popular Values
310 DISC CAPACITORS ONLY $22.95

Price includes divided plastic box and bin guide for easy storage and quick access.

ELECTRONIC HARDWARE KIT

1600 PIECES OF STEEL/ZINC PLATED HARDWARE — ONLY $14.95

Price includes divided plastic box and bin guide for easy storage and quick access.

WIRE-WRAPPING WIRE PRE CUT — PRE STRIPPED

Wire for Wire Wrapping, AWG-30 (0.25 MM) KYNAR. Wire 100 Wires per package Stripped 1" Both Ends

30-AWG Blue/Yellow/White/Red Wire, 2"–8" Overall Length, $1.62 – $2.67 [illegible]

NEW! DIGI-CLOCK kit

ONLY $19.95

- Trouble-free Module!
- 270° Swivel Mount!
- Inlaid Walnut Chrome Trim Bezel!
- 12 VDC — Ideal for Car, Van or Boat!
- 3-5/8"x2-3/16" Tall x 2-1/8" Deep!
- Quick and Easy To Install!

Part No. 5001K

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 10 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 9.1 Megohm (360 total pcs.)	$9.90

½ WATT RESISTORS ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 10 megohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 9.1 Megohm (360 total pcs.)	$9.90

NEW! THE MA1023 by NATIONAL SEMICONDUCTOR THE "PROGRAMMABLE" CLOCK MODULE

MA1023

0.7" HIGH DIGITS — RED LED DISPLAY (Not shown actual size)

The MA1023 Clock Module offers a degree of flexibility not available in conventional clock modules. This has been accomplished by manufacturing into each MA1023 Module a set of options over which you, the user, has total control. In a very real sense, this control allows you to program the MA1023 to fit your specific application. It is the MA1023 user that determines whether his module will operate in a 12 or 24 hour mode. It is the user that selects his preference for a fixed or flashing colon. And, by the simple introduction of a potentiometer the user gains continuous control over the module display brightness. But probably the ultimate feature offered by the MA1023 Module is the unique back-up oscillator option that allows for continuous time keeping during power failures with a single 9 volt battery and an external 5M potentiometer. This means that when other clocks grind to a halt, the MA1023 runs on. And if an alarm is your delight, the MA1023 makes it easy. Simply connect the buzzer to the alarm circuit and you're ready to go. Finally, an alarm circuit that calls for no complex interviewing circuitry. The large 0.7" red led display, low power consumption, leading zero-blanking and many other excellent features are offered at this remarkably low cost. After reading through the features, we are confident that you will agree that there is no question that the MA1023 "Programmable" clock module is truly unique. And to enhance the MA1023 kit even more, Digi-Key is introducing a specially designed switching panel kit complete with standoffs and hardware for "sandwich mounting" with the MA1023 module. But if your preference or needs dictate remote mounting of the switching panel — no problem. You will still enjoy the straight forward one-to-one pin connection offered by the Digi-Key switching panel kit and MA1023 module. Furthermore, the printed circuit board that provides the basis for the switching panel incorporates circuitry that will speed and simplify completion of the project. In addition to the simplicity offered by the Digi-Key switching panel, the low profile, light touch, pushbutton switches utilized will add quality and professionalism to your finished product. Order your MA1023 "Programmable" clock module and specially designed Digi-Key switching panel today.

DIGI-KEY SWITCHING PANEL KIT MA1023P

(Shown assembled and sandwich mounted to MA1023 Clock Module)

Catalog No.	Description	COST
MA1023M	MA1023 Clock Module Only (Assembled and tested)	$9.95
MA1023P	Digi-Key Switching Panel Kit for MA1023 (includes P.C. Board, Switches, Wraposts, Standoffs, Hardware, Components)	6.95
MA1023T	Special Transformer for MA1023	2.95
MA1023B	Alarm Buzzer For MA1023	2.25
MA1023K	Includes MA1023M, P, T & B	19.95
MA1023C	Conventional switch set for applications where MA1023P is not used, includes one 501PB and six 502PB	2.95
MA1023R	Clock Module Conventional Switches Transformer	14.95

JMJ DIGITAL DISPLAY BEZEL

FOR MA1002, MA1010 AND MA1023 CLOCK MODULES **$4.95**

PATENTED CHROMAFILTER SCREEN, DIE CAST METAL FRAME MOUNTS IN PANELS UP TO 3/16" THICK, NO EXPOSED HARDWARE, SCRATCH RESISTANT AND EASILY CLEANED, ELIMINATES GLARE.

MOUNTING ADAPTERS AVAILABLE TO SIMPLIFY MOUNTING AND ASSURE PERFECT ALIGNMENT.

400 BEZEL WITH RED FILTER	4.95
420 MOUNTING ADAPTER FOR MA1001 & MA1002	.69
421 MOUNTING ADAPTER FOR MA1010	.69
422 UNIVERSAL PC BOARD MOUNTING ADAPTER	.69
423 MOUNTING ADAPTER FOR MA1023	.69
401 BEZEL AND ENCLOSURE FOR MA1003	5.95

OK — WSU-30 Regular Wrap $6.95 · WSU-30M Modified Wrap $7.95

STRIPS · WRAPS · UNWRAPS

PANASONIC TRIMMER POTENTIOMETERS

5/16" (8 mm) DIA. PRESET VARIABLE RESISTORS [illegible]

PLESSEY MINIBOX METALLIZED POLYESTER CAPACITORS

[illegible]

PANASONIC ELECTROLYTIC CAPACITORS

RADIAL LEADS / AXIAL LEADS — values .47/50V through 10,000/16V, prices at 1/10/100. [illegible]

PANASONIC POLYESTER CAPACITORS

100 VDC plus minus 10% TOLERANCE [illegible]

PANASONIC METALLIZED POLYESTER CAPACITORS

250 VDC plus minus 10% TOLERANCE [illegible]

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

[illegible]

PANASONIC DISC CAPACITORS

[illegible]

HARDWARE

2-56 1/4 SCREW	1.39/C
2-56 1/2 SCREW	1.39/C
4-40 1/4 SCREW	.99/C
4-40 1/2 SCREW	.99/C
6-32 1/4 SCREW	.99/C
6-32 1/2 SCREW	.99/C
8-32 3/8 SCREW	1.39/C
8-32 5/8 SCREW	1.39/C
2-56 HEX NUT	.75/C
4-40 HEX NUT	.75/C
6-32 HEX NUT	.75/C
8-32 HEX NUT	.75/C
NO. 2 LOCKWASHER	.85/C
NO. 4 LOCKWASHER	.55/C
NO. 6 LOCKWASHER	.55/C
NO. 8 LOCKWASHER	.55/C

ACE 200-K "18"

Digi-Key Stocks the Entire AP Line

8080A CHIP SET

ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102AN-4L ALL FOR — **$44.95**

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$ 9.95
8212	8-BIT I/O PORT	$ 3.25
8216	BI-DIRECTIONAL BUS DRIVER	$ 3.25
8224	CLOCK GENERATOR	$ 3.25
8228	SYSTEM CONTROLLER	$ 6.00
8251	COMMUNICATIONS INTERFACE	$10.50
8255	PERIPHERAL INTERFACE	$10.50
1702A	2K EPROM 1 USEC	$ 5.75
2708	8K EPROM 450 NSEC	$15.75
2102AN-4L	1K LOW POWER 450 NSEC RAM	$ 1.69
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MM 2 CLOCK 40 DIL	$24.95
2112	1024-Bit Static Ram (256x4) 16 Dip	2.90
93348	8-Bit Addressable Latch 16 Dip	1.90
93410N	256x1 Bipolar Static Ram 45 ns Access 16 Dip	1.95
946N	Quad 2-In NAND DTL Gate 14 Dip	.21

STRANDED HOOK UP WIRE

20 ga PVC 2.50/100' 10.00/500'
22 ga PVC 2.80/100' 11.25/500'
24 ga PVC 2.80/100' 11.25/500'

DIGI-KEY Means Toll Free Wats

DOUBLE DIGIT DISCOUNTS SAVE YOU EVEN MORE!

HANDLING CHARGES

$ 0.00-$9.99	Add $2.00
$ 10.00-$25.00	Add $0.75
$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
$100.00 & Up	No Charge

VOLUME DISCOUNT & HANDLING CHARGE

All items except those with catalog numbers ending with the suffix -ND may be combined for discount. First total all discountable items and apply the volume discount. Then add to this sub-total the nondiscountable items. Add the handling charge. We pay shipping and insurance to addresses in the U.S.A. and Canada when check accompanies order.

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%

Orders Accepted by Phone or Mail
MasterCharge • VISA • COD • Check • Money Order
P.O. Box 677, Thief River Falls, Minn. 56701 (218) 681-6674

DIGI-KEY CORPORATION

Quality Electronic Components

P.O. Box 677 Thief River Falls, MN 56701 (218) 681-6674

CIRCLE 29 ON FREE INFORMATION CARD

7400 TTL

Part	Price	Part	Price	Part	Price
SN7400N	.16	SN7470N	.29	SN74160N	.89
SN7401N	.18	SN7472N	.29	SN74161N	.89
SN7402N	.18	SN7473N	.35	SN74162N	1.95
SN7403N	.18	SN7474N	.35	SN74163N	.89
SN7404N	.18	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.59	SN74172N	6.00
SN7410N	.18	SN7485N	.79	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	.89
SN7412N	.25	SN7489N	1.75	SN74175N	.79
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.25	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	.89	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.25	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.49	SN74194N	.89
SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.49	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74S200	4.95
SN7444N	.75	SN74143N	2.95	SN74251N	1.79
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	.89	SN74365N	.69
SN7451N	.20	SN74151N	.59	SN74366N	.69
SN7453N	.20	SN74152N	.59	SN74367N	.69
SN7454N	.20	SN74153N	.59	SN74368N	.69
SN7459A	.25	SN74154N	.99	SN74390N	1.95
SN7460N	.20	SN74155N	.79	SN74393N	1.95
		SN74156N	.79		
		SN74157N	.65		

C/MOS

Part	Price	Part	Price	Part	Price
CD4000	.23	CD4028	.89	CD4070	.55
CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4076	1.39
CD4007	.25	CD4040	1.19	CD4081	.23
CD4009	.49	CD4041	1.25	CD4082	.23
CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.23	CD4043	.89	CD4098	2.49
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.39	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
CD4015	1.19	CD4048	1.35	MC14419	4.95
CD4016	.49	CD4049	.49	MC14433	19.95
CD4017	1.19	CD4050	.49	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	14.50
CD4020	1.19	CD4056	2.95	MC14583	3.50
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

Part	Price	Part	Price	Part	Price
74C00	.39	74C85	2.49	74C163	2.49
74C02	.39	74C90	1.95	74C164	2.49
74C04	.39	74C93	1.95	74C173	2.60
74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
74C20	.39	74C154	3.00	74C922	5.95
74C30	.39	74C157	2.15	74C923	6.25
74C42	1.95	74C160	2.49	74C925	8.95
74C48	2.49	74C161	2.49	74C926	8.95
74C73	.89			80C95	1.50
74C74	.89			80C97	1.50

LINEAR

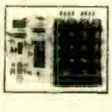
Part	Price	Part	Price	Part	Price
78MG	1.75	LM340K-18	1.35	LM710N	.79
LM106H	.99	LM340K-24	1.35	LM711N	.39
LM300H	.80	LM340T-5	1.25	LM723N/H	.55
LM301CN/H	.35	LM340T-6	1.25	LM733N	1.00
LM302H	.75	LM340T-8	1.25	LM739N	1.19
LM304H	1.00	LM340T-12	1.25	LM741CN/H	.35
LM305H	.60	LM340T-15	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-18	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-24	1.25	LM748N/H	.39
LM309H	1.10	LM358N	1.00	LM1310N	2.95
LM309K	1.25	LM370N	1.95	LM1458CN/H	.59
LM310CN	1.15	LM373N	3.25	MC1488N	1.39
LM311N/H	.90	LM377N	4.00	MC1489N	1.39
LM312H	1.95	LM380N	1.25	LM1496N	.95
LM317K	6.50	LM380CN	.99	LM1556V	1.75
LM318CN/H	1.50	LM381N	1.79	MC1741SCP	3.00
LM319N	1.30	LM382N	1.79	LM2111N	1.95
LM320K-5	1.35	NE501N	8.00	LM2901N	2.95
LM320K-5.2	1.35	NE510A	6.00	LM3053N	1.50
LM320K-12	1.35	NE529A	4.95	LM3065N	1.49
LM320K-15	1.35	NE531H/V	3.95	LM3900N(3401)	.49
LM320K-18	1.35	NE536T	6.00	LM3905N	.89
LM320K-24	1.35	NE540L	6.00	LM3909N	1.25
LM320T-5	1.25	NE544N	4.95	MC5558V	.59
LM320T-5.2	1.25	NE550N	1.30	8038B	4.95
LM320T-8	1.25	NE555V	.39	LM75450N	.49
LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE561B	5.00	75453CN	.39
LM320T-24	1.25	NE562B	5.00	75454CN	.39
LM323K-5	5.95	NE565N/H	1.25	75491CN	.79
LM324N	1.80	NE566CN	1.75	75492CN	.89
LM339N	.99	NE567V/H	.99	75493N	.89
LM340K-5	1.35	NE570N	4.95	75494CN	.89
LM340K-6	1.35	LM703CN/H	.69	RC4136	1.25
LM340K-8	1.35	LM709N/H	.29	RC4151	2.85
LM340K-12	1.35			RC4194	5.95
LM340K-15	1.35			RC4195	4.49

74LS00TTL

Part	Price	Part	Price	Part	Price
74LS00	.29	74LS47	.89	74LS138	.89
74LS01	.29	74LS51	.29	74LS139	.89
74LS02	.29	74LS54	.29	74LS151	.89
74LS03	.29	74LS55	.29	74LS155	.89
74LS04	.35	74LS73	.45	74LS157	.89
74LS05	.35	74LS74	.45	74LS160	1.15
74LS08	.29	74LS75	.59	74LS161	1.15
74LS09	.35	74LS76	.45	74LS162	1.15
74LS10	.29	74LS78	.49	74LS163	1.15
74LS11	.75	74LS83	.89	74LS164	1.25
74LS13	.59	74LS85	1.25	74LS175	.99
74LS14	1.25	74LS86	.45	74LS181	2.49
74LS15	.35	74LS90	.59	74LS190	1.15
74LS20	.29	74LS92	.75	74LS191	1.15
74LS21	.35	74LS93	.75	74LS192	1.15
74LS22	.35	74LS95	.99	74LS193	1.15
74LS26	.35	74LS96	1.15	74LS194	1.15
74LS27	.35	74LS107	.45	74LS195	1.15
74LS28	.35	74LS109	.45	74LS253	.99
74LS30	.29	74LS112	.45	74LS257	.89
74LS32	.35	74LS123	1.25	74LS258	1.75
74LS37	.45	74LS125	.89	74LS260	.69
74LS40	.35	74LS132	.99	74LS279	.75
74LS42	.89	74LS136	.49	74LS367	.75
				74LS368	.75
				74LS670	2.49

EXCITING NEW KITS

NEW JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for micro-processor use
- 3 User Define keys with one being bi-stable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

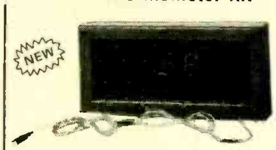
FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... $59.95

Digital Thermometer Kit

NEW



- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter Incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... $39.95

DISCRETE LEDS

Part	Color	Price	Part	Color	Price
.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	.190" dia.		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
			XC111Y	yellow	4/$1
			XC111C	clear	4/$1

INFRA-RED LED 1/4"x1/4"x1/16" flat 5/$1

TIMEX T1001 LIQUID CRYSTAL DISPLAY CLASS II

FIELD EFFECT

4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

Part	Price	Part	Price
CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

Part	Price
MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

Part	Price
MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

Part	Price
MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	.38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 PCS	1.75
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance (if desired)

Spec Sheets — 25¢
1979 Catalog Available — Send 41¢ stamp

FREE A 1979 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU AUGUST

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialler	$14.95
AY-5-9200	Repertory Dialler	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.95

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5MHz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator (Same as MCT 2 or 4N25)
2/99¢

SN 76477 SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc.) **7.95/set**

EXAR

Part	Price	Part	Price	Part	Price
XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV 1 AMP		12/1.00
				1N4003	200 PIV 1 AMP		12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV 1 AMP		12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV 1 AMP		10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV 1 AMP		10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV 1 AMP		10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	.28
1N5232	5.6	500m	.28	1N4735	6.2	1w	.28
1N5234	6.2	500m	.28	1N4736	6.8	1w	.28
1N5235	6.8	500m	.28	1N4738	8.2	1w	.28
1N5236	7.5	500m	.28	1N4742	12	1w	.28
1N5242	12	500m	.28	1N4744	15	1w	.28
1N5245	15	500m	.28	1N1183	50 PIV 35 AMP		1.60
1N456	25	40m	6/1.00	1N1184	100 PIV 35 AMP		1.70
1N458	150	7m	6/1.00	1N1185	150 PIV 35 AMP		1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV 35 AMP		1.80
1N4001	50 PIV 1 AMP		12/1.00	1N1188	400 PIV 35 AMP		3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

Part	Price	Part	Price	Part	Price
C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	15/25V	.63	.50	.40
1.0/35V	.28	.23	.17				

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-99	100-	Radial Lead	1-9	10-99	100-
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CIRCLE 4 ON FREE INFORMATION CARD

Transistor Checker

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2". "C" cell battery not included.

NEW

Trans-Check $29.95 ea.

Custom Cables & Jumpers

NEW  NEW

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS

25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95

4-Digit Clock Kit

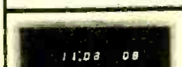
- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3¼ x 1¾ x 1¼

JE730 $14.95

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
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 $29.95

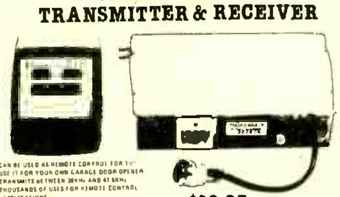


- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 38KHz AND 41.8KHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 1.5V BATTERY
- SCHEMATIC INCLUDED

$19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

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	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 15 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES

Proto Board 203

A total ready to use power breadboard Prototest device with a built-in regulated, short proof power supply. Just plug in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24 14 pin DIP capacity. Attractive two tone quality case. All metal construction. 9¾"L x 6½"W x 2¾"H 5 lbs.

PB 203 $75.00

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95

Proto Board 203A

All the features of the PB-203 plus additional power supply flexibility, provides 1%-Regulated 5VDC supply (same specifications as PB 203). Regulated separate +15VDC and −15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise of + and −15V supplies 10mV at 0.25A.

PB 203A $124.95

Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

THE SINCLAIR PDM35

DC Volts (4 ranges)
Range 1mV to 1000V.
Accuracy of reading 1.0%± 1 count.
Note: 10MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range 1V to 500 V
Accuracy of reading 1.0%± 2 counts.
DC Current (6 ranges)
Range 1 nA to 200 mA
Accuracy of reading 1.0%±1 count.
Note: Max. resolution 0.1 nA
Resistance (5 ranges)
Range: 1Ω to 20 MΩ
Accuracy of reading. 1.5%± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power Supply: 9 V battery or Sinclair AC adapter (Battery not incl.)
Sockets: Standard 4mm for resilient plugs.

Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet.

PDM35: Digital Multimeter (completely assembled) . . . $59.95
PDM-AC: 117V AC Adapter . . . 6.95
PDM-DP: Deluxe padded carrying case . . . 6.95

CSC 100 MHz 8-Digit Counter

CONTINENTAL SPECIALTIES CORPORATION

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

REGULATED POWER SUPPLY NEW

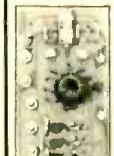
JE200 5V-1 AMP POWER SUPPLY

- Uses LM309K
- Heat sink provided
- PC Board construction
- Provides a solid 1 amp @ 5 volts
- Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- Includes components, hardware & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD

— Adapts to JE200 — ±5V, ±9V and ±12V



- DC/DC converter w/ +5V input
- Toroidal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x9/16"h

JE205 $12.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance (if desired)

Spec Sheets — 25¢
1979 Catalog Available — Send 41¢ stamp

FREE A 1979 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU AUGUST

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark. High = 025 space, 2225 mark.
Receive Sensitivity	−46 dbm accoustically coupled
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VDM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K $75.00

COMPUTER CASSETTES

- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.95 ea

CAS-6 $14.95 (Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

Wide Band B/W or Color System

- ★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.

MOD II is pretuned to Channel 33 (UHF).

- ★ Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

Function Generator Kit

- Provides 3 basic waveforms: sine, triangle & square wave
- Frequency range from 1 Hz to 100K Hz
- Output amplitude from 0-volts to over 6 volts (peak to peak)
- Uses a 12V supply or a ±6V split supply
- incl. chip, P.C. board, components and instructions.

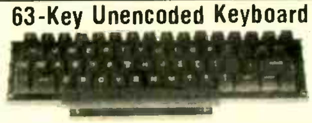
JE2206B $19.95

IDEAL FOR TRS 80 — CASSETTE CONTROLLER

"Plug/Jack interface to any computer system requiring remote control of cassette functions"
The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

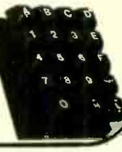
#CC-100 $29.50

63-Key Unencoded Keyboard



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK $29.95/each

Hexadecimal Unencoded Keypad



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. $10.95/each

CIRCLE 15 ON FREE INFORMATION CARD

ADVANCED COMPUTER PRODUCTS

NEW CATALOG AVAILABLE NOW!

THE FIRST TO OFFER PRIME PRODUCTS TO THE HOBBYIST AT FAIR PRICES NOW LOWERS PRICES EVEN FURTHER!

1. Proven Quality Factory tested products only, no re-tests or fallouts. Guaranteed money back. We stand behind our products.

1979 CATALOG NOW AVAILABLE.

Send $1.00 for your copy of the most complete catalog of computer products. A must for the serious computer user.

STATIC RAM BOARDS

Now, just more than 1½¢ per bit!

S-100 32K (uses 2114)
ASSEMBLED / Kit
450ns. 599.00 / 450ns. 539.95
250ns. 699.95 / 250ns. 599.95
Bare Board 49.95
Bare Board w/all parts less mem. 99.95

S-100 16K (uses 2114) KIT (exp. to 32K)
ASSEMBLED / 450ns. 279.00
450ns. 325.00 / 250ns. 299.00
250ns. 375.00
Bare Board 49.95

LOGOS I 8K
ASSEMBLED
450 ns. 169.95 KIT 450ns. 125.95
250ns. 189.95 250ns. 149.95
Bare PC Board w/Data $21.95
Now over 1 year successful field experience
"Special Offer" Buy (4) 8K 450ns. Kits $117.00

FLOPPY DISK DRIVES

1. VISTA V-80 MINIDISK FOR TRS-80
   - ★ 23% More Storage Capacity - 40 Tracks
   - ★ Faster Drive - Up to 8 Times Faster
   - 2 Drive Cable Add $29.95
   - 4 Drive Cable Add $39.95
   - 395.00
2. VISTA V-200 MINI-FLOPPY SYSTEM
   - ★ 204K Byte Capacity ★ w/CPM, Basic "E"
   - ★ One Single Sided, Double Density Drive
   - ★ One Double Density Controller w/Case & P.S.
   - V-200 699.00
   - **Add to your EXIDY, HORIZON, etc.**
3. VISTA V-1000 FLOPPY DISK SYSTEM
   - ★ (2) Shugart 800-R 8" Floppy Disks
   - ★ Controller Card, Cable, Case & P.S.
   - ★ CPM & Basic "E", Instructions & Manual
   - V-1000 1699.00
4. MPI B51-5¼" 40 tracks 279.00
5. Shugart SA400-5¼", 35 tracks 295.00
6. Siemens/GSI FDD100-8 8" 375.00
7. Shugart 800/801R 8" 495.00
8. PERSCI Model 277 Dual 1195.00

EXPANDORAM MEMORY KITS

★ Bank Selectable ★ Uses 4115 or 4116 200 ns.
★ Write Protect ★ Power 8VDC, ±16VDC
★ Phantom ★ Lowest Cost/Bit

Expando 32 Kit (4115)		Expando 64 Kit (4116)	
8K	$179.00	16K	$248.95
16K	$229.00	32K	$369.00
24K	$299.00	48K	$469.00
32K	$349.00	64K	$565.00

IMS STATIC RAM BOARDS

$699.00

★ Memory Mapping ★ Low Power
★ Phantom ★ Assembled & tested
Recommended by Alphamicrosystems

	250 ns.	450 ns.
8K Static	$209.00	$189.00
16K Static	$449.00	$399.00
32K Static	$799.00	$699.00

ANADEX PRINTER

Model DP-8000 compact, impact, parallel or serial. Sprocket feed, 80 cols, 84 lines/min., bi-directional. New only $895.00

VERBATIM™ DISKETTES

LOW PRICE TOP QUALITY DISKETTES

★ 5¼" Minidiskettes ★
Softsector, 10 Sector, 16 Sector
$4.25 Each, 10/39.95
★ 8" Standard Floppy Disks ★
Soft Sector, Hard Sector
$4.50 Each, 10/41.95
*Add 4.95 for 10 Pack In Deluxe Disk Holder

6800

MOTOROLA EXORCISER COMPATIBLE

9600 MPU Module w/6802 CPU $495.00
9601 16 Slot Mother Board 175.00
9602 Card Cage (19" Retma Rack Mount) ... 75.00
9603 8 Slot Mother Board 100.00
9604 Switchmode System Power Supply 250.00
9610 Utility Prototyping Board 36.00
9616 Quad 8K Eprom Module .... ***
9620 16 Channel Parallel I/O Module 295.00
9622 Serial/Parallel I/O Combo .... ***
9626 8K Static RAM Module 295.00
9627 16K Static 450ns 495.00
9630 Card Extender 68.00
9640 Multiple Programmable Timer (24 Timers) 395.00
9650 8 Channel Duplex Serial I/O 395.00
96103 32/32 I/O Module 275.00
96702 32 Point Reed Relay Module 350.00

6800 BARE BOARDS

9620-0	$45.00	9603-0	27.00
9626-0	45.00	9600	55.00
9650-0	45.00	96103	55.00
9601-0	50.00	96702	55.00

Also AMI EVK System in Stock

APPLE/EXIDY/EXPANDO TRS 80 16K-UPGRADE KIT

★ 16K with Jumpers & Instructions for either Level I or Level II $89.95
★ 16K for Apple II Upgrade $89.95
Special: TRS80 Schematic .... $ 4.95
Expansion Interface Schematic .... $ 4.95

TRS 80 TO S-100 PET TO S-100 ADAPTER

Allows Pet/TRS 80 to be interfaced to popular S-100 Bus.
Pet to S-100 Kit $189.95
Assembled $269.95
TRS 80 to S-100 HUH 8100 Kit $275.00
Assembled $355.00

KEYBOARD ASCII ENCODED

One time purchase of NEW Surplus keyboards. From the Singer Corporation. The keyboard features 128 ASCII characters in a 63 key format. MOS encoder circuitry "N" key rollover, lighted shift lock, control, escape and repeat functions. Ltd Qty **63 KEY $59.95**

UV "Eprom" Eraser

Model UVs-11E $64.95
Holds 4 Eprom's at a time. Backed by 45 years experience.
Model S-52T... $219.95
Professional Industrial Model

TARBELL FLOPPY INTERFACE

★ Z80/8080 S100 Compatible ★ Uses CPM
Assembled for Shugart ... **SALE $229.00**
Assembled Other Drives $269.95
Kit $179.95
Bare Board .... $36.95 (Doc Add $10.00)
Note: For CPM Add 70.00 Documentation Add $20.00
Vista Double Density 5¼" Controller Assem. $299.00
SD Versa Floppy Kit $159.95
SD Versa Floppy Assembled $189.95
Tarbel Cassette I/O Kit $115.00
Sale ★ 1771-01 Floppy Chip $27.95

BYTE USER 8K EPROM BOARD

★ Power on Jump ★ Reset Jump
Assembled & Tested $94.95
Byteuser Kit $64.95
Bare PC Board $21.95
Special Offer: Buy 4 kits only $59.95 each
MR-8 8K w/1K Ram $99.50
MR-16 16K w/1K Ram $99.50
EPM-1 4K 1702 .... $59.95
EPM-2 2708 or 2716 Eprom $69.95

Z-80/Z-80A/8080 CPU BOARD

★ On board 2708 ★ 2708 included (450ns.)
★ Power on jump ★ completely socketed
Assembled and tested $185.00
Kit $129.95
Bare PC Board .... $ 34.95
★ For 4MHz Speed Add $15.00
8080A Kit .... $ 99.95
8080A Assembled $149.95

S-100 MOTHERBOARD SPECIAL

8 slot expandable w/9 conn.
reg $69.95 .... NOW $52.95

TARBELL FLOPPY CONTROLLER

Card assembled and tested for use with Shugart Drives $ SALE PRICE only $229.00

ACOUSTIC MODEM

NOVATION CAT™
0-300 Baud
Bell 103
Answer, Originate $198.00

ACOUSTIC COUPLER SPECIAL

AJ MODEL A30
SPECIAL PURCHASE
OF SURPLUS UNITS
AVAILABILITY LIMITED $29.95

DATA BOOKS • COMPUTER BOOKS

1978 IC Master	49.95	Intel MCS 80 Manual	7.95
NSC TTL Data	3.95	Intel MCS 40 Manual	4.95
NSC Linear	4.95	AMD 8080A Manual	5.95
NSC Linear App Notes II	3.95	AMD Schottky Databook	4.95
NSC CMOS	3.95	AMI MOS/LSI Data	3.95
NSC Memory	3.95	GI MOS/LSI Data	4.95
Intel Databook	4.95	Harris Analog Databook	4.95
Intel MCS 85 Manual	7.50	TI Linear Control Data	3.95

SALE • OSBORNE BOOKS • SALE

	Reg.	Sale
Intro to Micros Vol. 0	8.50	7.75
Intro to Micros Vol. I	8.50	7.75
8080A Programming	8.50	7.75
6800 Programming	8.50	7.75
Z80 Programming	8.50	7.75
Vol. II Some Real Microprocessors w/Binder	30.00	27.50
Vol. III Some Real Support Devices w/Binder	20.00	18.50
Intro to Micros Vol. III	20.00	18.50

SALE • DILITHIUM COMPUTER BOOKS • SALE

	Reg.	Sale
Understanding Computers	8.95	7.95
8080Microcomputer Experiments	13.95	11.95
Beginning BASIC	9.95	8.95
Beginners Glossary & Guide	6.95	5.95
Peanut Butter & Jelly Guide to Computers	7.95	6.95
8080 Machine Language Programming	7.95	6.95
Home Computers Vol. I Hardware	7.95	6.95
Home Computers Vol. II Software	13.95	11.95
Starship Simulator	7.95	6.95

MICROPROCESSORS

Z-80	$16.95
Z-80A	18.95
F-8 (3850)	16.95
2650	18.95
CD1802	19.95
8080A	9.95
8080A-4MHz	11.95
SALE 8085	19.95
8008-1	14.95
2901	16.95
2901A	24.95
TMS 9900JL	49.95
CP1600	39.95
6502	11.50
6502A	19.95
IM6100	29.95
6800	16.95
6802P	24.95
8035	17.50
8755	49.95
8748	69.95

SUPPORT DEVICES

AM9511 Arith Processor	$195.00
AM 9511-1 300 ns	245.00
AM9517 DMA Controller	21.95
AM9519 Universal Interrupt	24.95
3881 (Z80 PIO)	10.45
3881-4 (4MHz)	14.95
3882 (Z-80 CTC)	10.45
3882-4 (4MHz)	14.95
8205 74S138 Decoder	2.95
8212 8 bit I/O	2.50
8214 Priority Int	4.95
8216 Bus Driver	2.50
8224 Clock Gen	2.95
8224-4 (4MHz)	9.75
8226 Bus Driver	3.95
8T26 Bus Driver	2.39
8228 Sys Control	5.95
8238 Sys Cont	6.25
8251 Prog I/O	6.95
8253 Int Timer	19.50
8255 Prog I/O	6.50
8257 Prog DMA	19.50
8259 Prog Int	19.50
8275 CRT Controller	74.95
8279 Prog Keyboard	19.95
6810-1 128 x 8 RAM	4.75
6820 PIA	6.50
6821 PIA	6.50
6828 Priority Int	11.00
6834-1 512 x 8 Eprom	12.95
6850 ACIA	7.20
6852 Serial Adapter	9.95
6845 HD46505 CRT Contr	39.95
6860 Modem	9.95
6862 Modulator	11.95
6871A 1.0MHz OSC	25.95
6875	8.25
6880 Bus Driver	2.39
MC6B488	19.95
1821 SCD 1K RAM	25.00
1822 SCD 256 x 4 RAM	16.95
1824 CD 32 x 8 RAM	9.95
1852 CD 8 bit I/O	10.95
1854 Uart	10.95
1856 CD I/O	8.95
1857 CD I/O	8.95
6520 PIA	7.50
6522 Mult	9.25
6530-002	15.50
6530-003	15.50
6530-004	15.50
6530-005	15.50
3851 F8 Prog. Store	14.95
3853 F8 Memory I/O	14.95

DYNAMIC RAMS

416/4116 16K (16 Pin)				12.45
Set of 8 416's				89.00
4115 8K (16 Pin)				6.95
4050 4K x 1 (18 Pin)				4.25
4060 4K x 1 (22 Pin)				4.95
4096 4K x 1 (16 Pin)				3.95
2104 4K x 1 (16 Pin)				4.75
4027 4K x 1 (16 Pin)				4.95
5261	1.95	1103		1.25
5262	1.95	4008L		4.95
5270	4.95	6605		7.95
5280	4.95	6604		4.95
5290	12.45	6002		1.50

PROMS

2708	9.95
2708-6	7.50
1702A	3.95
1702A-6	3.50
2716-5V	59.95
2716 5V 12V	40.00
2758 5V	29.95
5203AQ	11.95
5204AQ	9.95
6834-1	12.95
IM 5610	2.95
SALE 8223 32 x 8	2.95
82S115 512 x 8 (TS)	16.95
82S123 32 x 8	2.50
82S126 256 x 4	3.50
82S129 256 x 4 (TS)	3.50
82S130 512 x 4 (OC)	6.50
NSC DM7578 32 x 8	2.95

CHARACTER GEN

2513-001 (5V) Upper	9.50
2513-005 (5V) Lower	10.95
2513-ADM3 (5V) Lower	14.95
MCM6571	10.75
MCM6571A	10.75
MCM6574	14.50
MCM6575	14.50

UARTS/USRTS

TR1602B (5V, 12V)	3.95
AY51013 (5V 12V)	4.95
AY51014A/1612 (5-14V)	6.95
AY51015A/1863 (5V)	6.95
TMS 6011 (5V 12V)	5.50
IM6402	7.95
IM6403	8.95
2350 USRT	9.95
1671B Astros	24.95
SALE TR1472B	9.95

BAUD RATE GEN

MC14411	11.95
4702	14.95
WD1941	9.95

KEYBOARD ENCODERS

AY5-2376	13.75
AY5-3600	13.75
HD0165	9.95
74C922	9.95
74C923	9.95

A/D CONVERTERS

8700 8 bit Binary	13.50
8701 10 bit Binary	22.00
8703 8 bit TS	13.50
9400 Volt to Freq. Conv	7.25
8750 3-1/2 Digit BCD	13.95
1408L6 6 bit	3.95
1408L8 8 bit	5.95
DACOl A/D	5.95

STATIC RAM HEADQUARTERS

	1-24	25-99	100
21L02 450ns	1.30	1.25	1.15
21L02 250ns	1.59	1.55	1.45
2102	1.25	1.15	1.10
2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
2101-1	2.90	2.70	2.55
2114L-250ns	12.95	10.95	9.95
2114L-300ns	8.95	7.95	6.45
2114L-450ns.	7.50	6.75	4.75
4044/4041 300ns	9.95	8.75	7.95
4044/4041 450ns.	7.50	6.75	4.75
EMM4200A		9.75 8.75	7.95
EMM4402	7.95	7.25	6.25
EMM4804	12.50	11.50	9.95
5101C-E	7.95	7.95	7.25
uPd410 (4200)	10.95	10.25	9.25
AMD9140 41	10.95	10.25	9.25
AMD9130 31	12.95	11.95	10.25
FSC 460 4K16K CCD Only $18.95 Each			
1101	1.95	1.75	1.25
P2125 93425 (45 ns)	7.95	7.35	7.25
6508 1K x 1 CMOS	7.95	7.95	7.25
6518 1K x 1 CMOS	7.95	7.95	7.25
74S189 64 bit Ram	3.95	3.25	2.50
8155 I/O w/Ram 21.95			
2147 Low Power 4K Static 14.95 ea			

CHARGE COUPLED DEVICES

16K CCD First time offered Fairchild 460 CCD 16K Memory (now you can experiment with CCD technology at a reasonable price. 17 page Application note supplied with each order. Quantity limited)
$18.95 each (reg. 43.00)

CRYSTALS

Microprocessor Timebases TV Game

Frequency	Price	Frequency	Price
1.0MHz	$5.85	6.0MHz	$4.95
1.8432	4.95	6.144	4.95
2.0MHz	5.85	6.5536	4.95
2.01MHz	2.95	10.0MHz	4.95
2.097152MHz	5.85	13.0MHz	4.95
2.4576MHz	5.85	14.31818	4.95
3.5-9545MHz	1.50	18.0MHz	4.95
4.0MHz	4.95	18.432MHz	5.95
4.194304MHz	5.95	20.0MHz	4.95
4.91520MHz	5.95	22.1184MHz	5.95
5.0MHz	4.95	27.0MHz	5.95
5.0688	4.95	36.0MHz	5.95
5.7143MHz	5.95	48.0MHz	5.95
		100KC	12.95

DISPLAYS/OPTO/LED'S

★ 7 SEGMENT ★ CALC ★ CLOCKS ★

DL 704 (CC) DL 707 (CA) .300" Red	.99
FND 357 (CC) .357" Red	.99
FND 500/503 (CC) .500" Red	.99
FND 507/510 (CA) .500" Red	.99
FND 800/803 (CC) .800" Red	1.75
FND 807/810 (CA) .800" Red	1.75
XAN 3062 .500" Green	1.15
HP5082-7731 (CA) .300" Red	.99
9 Digit Bubble Mini Calc Display	.99
9 Digit Panaplex Display .400"	.99
9 Digit Fluorescent .300"	.99
MA1003 12V Auto Clock Module	18.95
Bezel for MA1003 w/Red Filter	4.95
MA1002A LED 12 hr. Clock Module	10.95

★ HEX DISPLAYS ★ ENCODED DISPLAYS ★

HP 5082-7340 Red Hexidecimal	15.95
HP 5082-7300 Red Numeric	14.95
TIL 306 Numeric w/Logic	8.95
TIL 308 Numeric w/Logic	8.95
TIL 309 Numeric w/Logic	8.95
TIL 311 Hexadecimal	12.95
MAN 2A .320" Red Alpha-Numeric	5.95
MAN 10A .270" Red Alpha-Numeric	8.95

★ LED's ★ OPTOISOLATERS ★

LEDS Red, Yellow, Green .185	5/1.00
MCT 2 Photo XSTR HFE 250, 30V	.99
4N25 Photo XSTR HFE 250, 30V	1.29
4N33 Photo Darlington	1.75
FPT 110B Photo XSTR Flat Lense	SALE 4/1.00

ATTENTION KIM USERS

KIMSAI-expansion to S-100 125.00 Kit/	165.00
KIMSI to KIM Connector	5.75/pair
KIM 1 6502 Single Board Computer	179.00
KIM 1 Power Supply	59.95
KIM Memory Plus - (consists of 8K Ram, 8K2718 Eprom, Programmer, I/O etc.)	245.00

KIM SOFTWARE

• Please package (cassette) 12 games	16.95
• Help Editor package (cassette)	16.95
• Help Mailing List pkg. (cassette)	16.95
• Help Info Retrival pkg. (cassette)	16.95
• Microchess (cassette)	16.95
• Microad Assembly/Disassem/Editor	27.95
• Microad Source Listing (cassette)	27.95
• Tiny Basic for KIM (paper tape)	10.95

COMPUTER SPECIALS

WOW!

	LIST	SALE
HiPlot Plotter	1085.00	899.00
HiPlot Digitizer	795.00	735.00
Exidy w/32K	1395.00	1195.00
Apple II w/16K	1195.00	1045.00
Compucolor II w/16K	1695.00	1595.00
TEI PT208 (1 avail.)	4995.00	3995.00
Cromemco Sys III	5990.00	5395.00
Commodore Pet	795.00	765.00
Soroc IQ/120	995.00	895.00
ADM3A Assem.	895.00	829.00
Teletype 43	1349.00	1150.00
Centronics P-1	495.00	395.00
Centronics S-1	595.00	525.00

MONTHLY IC SPECIALS

LF13508 JFET Anlog Multi 8 bit	8.95
ICM7208 Seven Decade Counter	17.95
ICM7207 Oscillator Controller	6.95
ICM7045 Precision Sto/Watch Timer	22.95
ICL7107 3½ Digit A/D (LED)	14.95
ICL8211 Voltage Reference	1.95
LM390 Battery OP Audio Amp	3/1.00
LM1830 Fluid Detector	3/1.00
LM1850 Ground Fault IC	3/1.00
LM1800 Phase Lock Loop FM Stereo	3/1.00
LM1820 AM Radio	3/1.00
DS3625 Dual Mos Sense Amp	2.50

1408L8	4/19.95	10147 ECL Ram	9.95
1488/1489	2/1.99	NE561	5.00
22 Pin S/T Socket	10/1.00	LF356HBiFet	3/1.99
8223 Prom	2.95	MCM14505	8.95
6331-1 Prom	1.95	74S89	3/1.99
MK5014 Calc	2/1.99	74107N	6/1.99
74141N	3/1.99	75452N	8/1.99
LM2917	2.25	741N-14	10/1.99
8T26/8T28	2.39	555CN	5/1.99
95H90	9.95	556CN	3/1.99

ATTENTION APPLE II USERS

Apple II w/16K	$1045.00
16K Upgrade Kit	89.95
Floppy Disk II w/interface	595.00
Floppy Disk II	495.00
Firmware Card	180.00

SOCKETS

8 Pin W W	.32	8 Pin S T	.17
14 Pin W W	.37	14 Pin S T	.20
16 Pin W W	.38	16 Pin S T	.22
18 Pin W W	.60	18 Pin S T	.31
20 Pin W W	.90	20 Pin S T	.34
22 Pin W W	.83	22 Pin S T	.35
24 Pin W W	.85	24 Pin S T	.41
28 Pin W W	1.15	28 Pin S T	.49
40 Pin W W	1.49	40 Pin S T	.69

TEXTOOL ZERO INSERTION FORCE SOCKETS

16 Pin $ 5.50 24 Pin $7.50
40 Pin $10.25

CONNECTORS

DB25P (RS232)	3.25
DB25S Female	3.75
Hood	1.25
Set w/Hood Sale	$6.50
22/44 W/W S/T KIM	2.95
43/86 W/W S/T MOT	6.50
50/100 S-100 Connector w/w	4.25
50/100 S-100 Connector s/t	3.25

CTS DIPSWITCHES

CTS206-4	$1.75	CTS206-8	$1.95
CTS206-5	$1.75	CTS206-9	$1.95
CTS206-6	$1.75	CTS206-10	$1.95
CTS206-7	$1.75		

LIVERMORE BASIC

ON 65K ROM
THAT'S RIGHT ON ROM!!
OUR PRICE only $95.00

NAKED PC BOARD SALE

Z-80 CPU (Ithaca)	$34.95
8080A CPU	34.95
8K Static RAM (Logos)	21.95
16K Static RAM (2114)	29.95
32K Static RAM (2114)	49.95
Floppy I/O (Tarbell)	39.95
Cassette I/O (Tarbell)	29.95
8K Eprom (2708)	21.95
1702 Eprom Board	30.00
2708/2716 Eprom (Ithaca)	34.95
2708/2716 Eprom (WMC)	30.00
Realtime Clock	34.95
ACP Proto Bd (3M Conn)	27.95
Vector 8800 Proto	19.95
Vector 8803 11 slot MB	29.95
ACP Extender w/Conn	15.95
Video Interface (SSM)	27.95
Parallel Interface (SSM)	27.95
13 Slot MotherBoard (WMC)	32.95
9 Slot MotherBoard (WMC)	29.95
8 Slot Mother (expandable)	34.95

WAVEFORM GENERATORS

8038 Function Gen	3.95
MC4024 VCO	2.45
LM566 VCO	1.75
XR2206 Function Generator	5.25

FLOPPY DISK I/O

1771-01 8" & Minifloppy	27.95
uPd372 Nec Floppy	49.95
1781 Dual Floppy	39.95
1791 Dual Floppy	44.95

TV INTERFACES

Pixie-Verter	8.50
TV-1 Video Interface	8.95
Microverter	35.00
M&R Modulator	35.00

ATTENTION PET USERS

BETSI-pet expansion to S100 .... 105.00 Kit/160.00
PET Connector Kit. Includes (4) Connectors for memory expansion, IEEE 488 I/O, cassette I/O and parallel user port. 7.95/set

Video Buffer (converts to Std. Video)	28.95
Petunia (Music Board)	29.95
Combo (Video & Petunia)	49.95
Beeper (signals tape load)	24.95

ATTN TRS 80 USERS

20/40 Pin Memory Exp. Conn	$7.95
16K Memory Add-on w/Inst	89.95
Vista V80 Minifloppy	395.00
40 Track DOS Patch on Disk	10.95
4 Drive Cable for V80	39.95
Centronics 779 w/tractor	1179.00
Centronics 701 Bidirect	1579.00
ANADEX DP8000	995.00
Micro-P (same as Quick Printer)	395.00
Cable to plug in Expansion I/O	39.00
Power Strip (6 outlets)	17.95
Surge Suppressor/Filter	23.95
Microsoft Fortran on Disk	325.00
Electric Pencil on Cassette	99.00
Electric Pencil on Disk	150.00
CP/M for TRS on Disk	150.00
Library 100 (cassettes)	49.95
Micro Chess (cassette)	19.95

TV CHIPS

AY38550-1 6 Games Color w 8515	58.95
AY38500-1 6 Games B/W	4.95
AY38515 Color Converter	2.95
AY38603-1 Roadrace Game	8.95
AY38605-1 Warfare Game	9.50
AY38606-1 Wipeout Game	9.50
AY38607-1 Shooting Gallery	8.95
AY38610-1 10 Games Color w 8615	9.50
AY38615 Color Converter	3.95
AY38910 Gimini Cricket Sound Generator	12.95
SN76477 TI Sound Generator	3.95
MM5320/21 TV Synch Gen	9.95
MM5369 Prescaler	3.95
LM1889 RF Modulator	3.95
MM57100 NSC Color TV Game	6.95
MM57104 Clock Gen	3.75
RF Modulator w Audio	8.95

All Shipments 1CM or UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Mastercharge Bank americard/COD accepted w/25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Same day shipment. Add 35 cents for Data.

Retail pricing may vary from Mail Order Pricing. All pricing subject to change without notice.

P. O. BOX 17329 Irvine, California 92713 Phone (714) 558-8813
TWX: 910-595-1565

Retail Store Open Mon. – Sat. Located at 1310 "B" E. Edinger, Santa Ana, CA 92705

FREQUENCY COUNTER KIT

Outstanding Performance

Incredible Price $89^{95}

CT-50

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. **Order your today!**

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadir	15.95

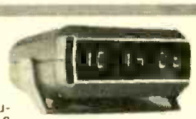
CAR CLOCK

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock



12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDS, high accuracy (1 min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
DM-1 dimmer adapter	2.50

PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens, typically 20 mv at 150 mHz. Specify ÷ 10 or ÷ 100 ratio.

PS-1B, 600 mHz prescaler	$59.95
PS-1BK, 600 mHz prescaler kit	49.95

OP-AMP SPECIAL

741 mini dip	12/$2.00
BI-FET, mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all. 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches.

Complete kit, less case (not available)
DC-9 $34.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain: 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 kit	$12.95
FM-3 wired and tested	16.95

CLOCK KITS

our Best Seller your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).

Clock kit, 12/24 hour, DC-5	$22.95
Clock with 10 min. ID timer, 12/24 hour, DC-10	27.95
Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

Hard to find PARTS

LINEAR ICs	
301	$ .35
324	1.50
380	1.25
380-8	.75
555	.45
556	.85
566	1.15
567	1.25
1458	.50
3900	.50
CMOS ICs	
4011	.20
4013	.35
4046	1.85
4049	.40
4518	1.25
5369	1.75
TRANSISTORS	
2N3904 type	10/1.00
2N3906 type	10/1.00
NPN 30W Pwr	3/1.00
PNP 30W Pwr	3/1.00
2N3055	.60
UJT 2N2646 type	3/2.00
FET MPF102 type	3/2.00
UHF 2N5179 type	3/2.00
MRF-238 RF	11.95
SOCKETS	
8 pin	10/2.00
14 pin	10/2.00
16 pin	10/2.00
24 pin	4/2.00
28 pin	4/2.00
40 pin	3/2.00

REGULATORS	
78MG	$1.25
723	.50
309K	.85
7805	.85
78L05	.25
7905	1.25
7812	.85
7912	1.25
7815	.85
TTL ICs	
74S00	.35
7447	.65
7475	.50
7490	.50
74196TI	1.35
SPECIAL ICs	
11C90	13.50
10116	1.25
4511	2.00
5314	2.95
5375AB	2.95
7001	6.50
4059 + N	9.00
7208	17.95
LEDs	
Jumbo red	8/1.00
Jumbo green	6/1.00
Jumbo yellow	6/1.00
Mini red	8/1.00
Micro red	8/1.00
BiPolar	.75
FERRITE BEADS	
With info, specs	15/1.00
6 hole balun	5/1.00

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit $2.95 FM-2 kit $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.

Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.

Complete kit, BL-1 $2.95

VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!

Complete kit, VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.

Complete kit, TD-1 $5.95

WHISPER LIGHT KIT

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.

Complete kit, WL-1 $6.95

SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.

Complete kit, BN-9 $5.95

POWER SUPPLY KIT

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and + 5V at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.

Complete kit, PS-3LT $6.95

SIREN KIT

Produces upward and downward wail characteristic of a police siren. 5W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.

Complete kit, SM-3 $2.95

ramsey electronics
BOX 4072, ROCHESTER, N.Y. 14610

PHONE ORDERS CALL (716) 271-6487

TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order, $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

CIRCLE 40 ON FREE INFORMATION CARD

HICKOK TEST INSTRUMENTS
HICKOK
New Digital Mini-Multimeter
Lowest Price
MODEL LX303
• Big 1/2" high LCD display
• Use indoors or out
• 200 hour 9V battery life
• Auto zero, Polarity, Overrange Indication
• 100 mV DC F.S. sensitivity
• 19 ranges and functions
Oscilloscopes
30 MHz Dual Trace
MODEL 532
Reg. $995.00
Our Price $845.75 incl. probes
15 MHz Dual Trace
MODEL 517
Reg $695.00
Our Price $590.00 incl. probes
15 MHz Triggered Sweep
MODEL 515
Reg $495.00
Our Price $425.75 incl. probes
Call TOLL FREE
(800) 645-9518
In N.Y. State call (516) 752-0050
"We Will Beat Any Advertised Price"
Before you buy, check our prices...
FORDHAM
RADIO SUPPLY CO., INC.
855R Conklin St.
Farmingdale, N.Y. 11735
YOUR ONE STOP DISCOUNT CENTER
Master Charge, Bank Americard, Visa, C.O.D.'s accepted.
ADD $3.00 TO COVER SHIPPING, HANDLING & INSURANCE. N.Y. Res. add approp. sales tax.
FREE
Send for new 1979 catalog of over 3,000 items ... 164 pages of test equipment, CB tools, tubes, components and electronic supplies.

Sinclair PDM35 digital MultiMeter
• 3½ digit resolution
• Sharp, bright LED display
• Automatic polarity selection
• All purpose versatility
Reg. $59.95 $52.95
SENCORE
TV-VTR-MATV and Video Analyzer
Model VA48
$875.00 Reg. $975.00
CSC CONTINENTAL SPECIALTIES
100 MHz 8-Digit Counter $119.00
Model MAX-100
PS500 500MHZ Prescaler $52.95
B&K PRECISION 3½-Digit Portable DMM
Model 2800 $85
Model 2810 $110.50
Ungar Heat Gun
Reg. $65.00
$46.50
B&K PRECISION Digital Capacitance Meter
Reg. $130.00
$110.50 Model 820
CODE-A-PHONE Telephone Answering Devices
$249.95 Model 1500
Wiremote Command Model 1400 $199.95
BSR Changer Accessories
$29.95
WAHL NEW ISO-TIP "Quick Charge"
$27.95
MODEL 7800
6" x 9" 3-Way Speaker
20 oz. ceramic magnet
$14.95
Weller Xcelite
Service Master Tool Kit
Model 99SM
$42.95
Attache Style Tool Cases
MODEL TC-100/ST
$269.95
Roll Kit
$15.95
Logic Monitor CSC
Model LM-1 $52.95 complete
NLS 15 MHz Mini Oscilloscope
Model MS 15
Reg. $318.00
$269.95
NOW AVAILABLE
Dual Trace Version
Model MS 215 Reg. $435.00 $369.95
platt Attach Tool Case with 2 Removable Pallets
Model 600T Reg. $89.00 $65.00
HICKOK Function Generator
$169.15
B&K PRECISION 15MHz 3" Dual Portable Trace Scope
Model 1432P
Reg. $780.00
$663. with probes
CSC Logic Probe
Model LP-1
$40.00 complete
LEADER Instruments Corp
20 MHz. Dual Trace
Model LBO-508
Reg. $769.95
$654.50 with accessories
B&K PRECISION SUPER SPECIAL
Model 1827
30MHz Portable Frequency Counter
Reg. $120.00
$59.95
In-Dash AM/FM 8 Track Stereo
C-777
$52.50
AM/FM Cassette Stereo
CAS 888
$57.50
B&K PRECISION Substitution Box $51
Model 2910
Weller Controlled Output Soldering Station
$45.00
Reg. $75.00
Model WTCP-N
FREE 1979 Catalog
SENCORE POCKET CRICKET TRANSISTOR/FET TESTER
Reg. $125.00 $99.95
TF 40
Magnifier LAMP
Model MG 10A
$49.50
700 Series
Auto Stereo 40 Watt Power Booster
POW-40 Reg. $39.95 $24.95
VOM Multimeters
20K ohm/v $19.95
1K ohm/v $9.95
"We Will Beat Any Advertised Price"
Call TOLL FREE
(800) 645-9518
For N.Y. State call (516) 752-0050
FORDHAM
855R Conklin St Farmingdale, N.Y. 11735

AUGUST 1979

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!

- proximity triggered
- voltage triggered
- mechanically triggered

3-WAY PROTECTION!

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm.

SPECIAL $19.95

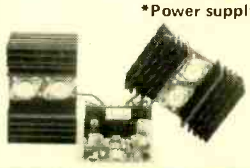
ALL UNITS FACTORY ASSEMBLED AND TESTED—NOT A KIT!

100 W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

*Output power : 100W RMS into 8-ohm
125W RMS into 4-ohm
*Frequency response: 10Hz - 100 KHz
*T.H.D.: less than 0.008%
*S/N ratio: better than 80dB
*Input sensitivity: IV max.
*Power supply: ±40V @ 5amp



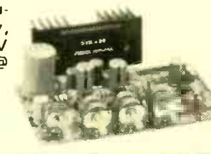
TA-1000 KIT
$51.95

Power transformer
$15.00 each

LOW TIM DC STEREO PRE-AMP KIT TA-10-20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz — 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency response. Independent I.C. regulated power supplies to eliminate power fluctuation! Specifications: *T.H.D. less than .005% *T.I.M. less than .005% *Frequency response: DC to 100KHz ±0.5dB *RIAA deviation: ±0.2dB *S/N ratio: better than 70dB *Sensitivity: Phono 2MV 47K/Aux. 100MV 100K *Output level: 1.3V *Max output: 15V *Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz *Power supply: ±24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A



ONLY $44.50

X'FORMER
$4.50

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name!

Features:

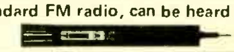
- 24 hour alarm
- Chronograph counts up to 12 hrs., 59 mins 59.9 sec.
- Precision of chrono up to 1/10 sec indicated by 10 moving arrows!!
- Lap time (with chrono running uninterrupted)
- Time displays by LCD for hour, min, sec, day, date of the week and AM/PM.
- Calendar gives out date-day
- Dual time zone for any two cities of the world at your own choice.
- With light switch to allow you to see the time in the dark!

$65.50

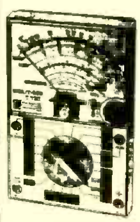
ONE YEAR FULL WARRANTY!

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphonep powered by an AA size battery. Transmits in the range of 88—108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good. **$16.50**



sanwa



— COMPACT —
— LIGHTWEIGHT —
— ULTRA-SLIM —
BATTERY CHECKER
— LED TESTER —

T-55D (w/o temp probe)
$44.50

T-55THD (temp probe)
$66.50

SPECIFICATIONS:

Ranges

DC Voltage:	150mV, 500mV, 1.5V, 5V, 15V, 50V, 250V, 1kV (All 20kΩ/V) 25kV *Using HV probe)
DC Current:	50μA, 2.5mA, 25mA, 250mA (500mV drop)
AC Voltage:	15V, 150V, 500V (9kΩ/V)
AC Current:	6mA, 6A (2V and 55mV drop)
Resistance:	10kΩ 100kΩ 1MΩ 5MΩ (max celbtn) 100Ω 1kΩ 10kΩ 50kΩ (mid scale)
Load Current:	30mA 3mA 300mA
Load Voltage:	3V 3V 3V
Decibels:	-10 to +55dB
Batt Check:	0.9 to 1.5V (10Ω load)
LED Check:	(Available)
Temperature:	-50 to +100°C and 0° to +200°C (Probe not supplied with T-55D)

Accuracy

DC Voltage:	±2.5% f.s.d.
DC Current:	±2.5% f.s.d.
Batt Check:	±2.5% f.s.d.
AC Voltage/Power on 1.5V range:	±5% f.s.d.
AC Voltage/Power above 15V range:	±3.5% f.s.d.
AC Current:	±5% f.s.d.
Resistance/Temperature:	±3% of arc

Dimensions:
146 x 97 x 28 mm thick
Weight: 240g
Instrument supplied with BAtteries 1.5V (UM-3 or R6)x2
Fuse & Spare: 500mA 250V
Temperature Probe (T-55THD only)

NEW MARK III
9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose red). The power range is very large, from -30dB to +5dB. The Mark III indicator is applicable to 1 watt — 200 watts amplifier operating voltage is 3V — 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

HICKOK LX303 DIGITAL LCD MULTIMETER

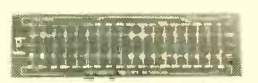
- 3½ digits display
- 200 hours 9V battery life
- Auto zero; polarity; overrange indication
- 100MV DC F.S. sensitivity
- 19 ranges and functions
- D.C. volt: 0.1 MV to 1000 V
- A.C. volt: 0.1 V to 600 V
- Resistance: 0.1Ω to 20 MΩ
- D.C. current: 0.01ΩA to 100 MA

CALL FOR OUR DISCOUNTED PRICE

MARK IV 18 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (18 per channel) to indicate the sound level output of your amplifier from -36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 36 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



MARK IV KIT $31.50

60W + 60W STEREO AMPLIFIER

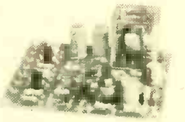
COMPLETED UNIT—NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit

Assembled $49.50 ea.
Power transformer $ 8.50 ea.

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or overload to protect your amplifier as well as your speakers. A must for OCL circuits.

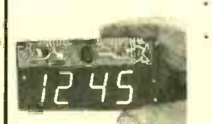


KIT FORM
$8.75 EA.

JUMBO 1" LED ALARM CLOCK MODULE

Assembled — not a kit!

Features:
- 1" 4 digits red LED display
- 12 hours real time format
- 24 hours alarm audio output (just add speaker)
- Power failure indicator
- Count down timer 59 mins.
- 12-16V AC 50/60 Hz input
- 10 min. snooze control



Red Display
$8.50 each

Green Display
$10.50 each

Transformer $1.75

FM WIRELESS MIC KIT

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condensor microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft.! With an LED indicator to signal the unit is on.

KIT FORM $7.95

30W 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V D.C. as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz.

$32.50 PER KIT

POWER TRANSFORMER $6.50 EACH

For faster service

USE ZIP CODE

on all mail

Active Electronic Sales Corp.

EPROM'S

Special of the Month

1702A-6 ~~$6.95~~ $4.45
256 x 8 1.5 uS

2708 $9.95
1K x 8 450 NS

MOS Static RAM's

Part No.	Price
2101 (1K 22 PIN)	~~$2.45~~ $2.39
2102LFPC (1K 350NS (Low Power))	~~$1.19~~ $1.14
2102-1PC (1K 450NS)	~~$.99~~ 0.94
2114 (4K (1K x 4) 300NS)	~~$6.99~~ $6.75
2114 (4K (1K x 4) 450NS)	$6.50

MOS Dynamic RAM's

Part No.	Price
4K 4027 (4K (4K x 1) 300NS 16 PIN)	$2.95
16K 416-3 (16K(16Kx1) 200NS 16PIN)	$9.95
16K 416-5 (16K(16Kx1) 300NS 16PIN)	$7.95

UART's

Part No.	Price
AY5-1013A	~~$4.50~~ $4.25
AY3-1015	~~$5.50~~ $5.25

1K CMOS RAM

Part No.	Price
5101 (450NS (Low Power))	~~$4.95~~ $4.50

MICROCOMPUTER BOARDS

SYM-1 MICROCOMPUTER BOARD

- Hardware compatibility with KIM-1
- Standard interfaces include audio cassette with remote control both 8 bytes second (KIM) and 185 bytes second (SYM-1) cassette formats TTY and RS232 system expansion bus TV KB expansion board interface four I O buffers and an oscilloscope single line display
- Single +5V power requirements

SYM-1 $329.00

NEC MICROCOMPUTER TK-80A

- The TK 80A is a complete microcomputer on a board based on the industry standard 8080A. The board has both 1K RAM and 1K Electrically Erasable PROM expandable to 4K x 8 and 8K x 8 respectively on board. It also features 300 or 1200 baud cassette interface (the Kansas City type) and three 8 Bit Programmable I O Ports (24 lines). Keypad with 25 real keys (not a glorified calculator keypad) and 8 big bright 1/2 digits for display are also included

TK-80A $299.00

Rockwell International AIM65

AIM 65 features on-board thermal printer and alphanumeric display and a terminal-style keyboard. It has an addressing capability up to 65K bytes and comes with a user dedicated 1K RAM. Two installed 4K ROMs hold a powerful Advanced Interface Monitor program and three spare sockets are included to expand on-board ROM or PROM up to 20K bytes. An application Connector provides for attaching a TTY and one or two audio cassette recorders and gives external access to the user-dedicated general purpose I O lines. Also included as standard are a comprehensive AIM 65 User's Manual, a handy pocket reference card, an R6500 Hardware Manual, an R6500 Programming Manual and and an AIM 65 schematic. AIM 65 is packaged on two compact modules. The circuit module is 12 inches wide and 10 inches long, the keyboard module is 12 inches wide and 4 inches long. They are conected by a detachable cable

AIM65 $375.00

MULTIBUS MEMORY

LARGE SCALE MULTIBUS MEMORY
MEMORY ONLY

SIZE (BYTES)	MUPRO PRODUCT NUMBER	INTEL® EQUIV PART NUMBER	PRICE
16K	MBC-016/8	SBC-016	$ 715
32K	MBC-032/8	SBC-032	1125
48K	MBC-048/8	SBC-048	1475
64K	MBC-064/8	SBC-064	1795
32K	MBC-032/16	SBC-032	1125
64K	MBC-064/16	SBC-064	1795

MICROPROCESSOR CHIPS

CPU's

Part No.	Price
8080A	5.50
8085	12.95
6800	7.95

INTERFACE SUPPORT CIRCUITS

Part No.	Price	Part No.	Price
8212	1.98	8255	4.95
8214	3.95	8257	10.95
8216	1.98	8259	14.95
8224	2.75		
8226	1.98	6810	3.95
8228	3.98 ~~4.75~~	6820	3.95
8238	3.98 ~~4.75~~	6821	3.95
8251	5.50	6850	4.95
8253	14.95	6852	4.95

Zilog

Part	Price
Z80-CPU	$13.60
Z80A-CPU	$16.20
Z80 PIO	$10.90
Z80A-PIO	$13.10
Z80-CTC	$10.90
Z80A-CTC	$13.10
Z80-DMA	$32.20
Z80-SIO/0	$45.00
Z80A-SIO/0	$50.00
Z80-SIO/1	$45.00
Z80A-SIO/1	$50.00
Z80-SIO/2	$45.00
Z80A-SIO/2	$50.00

Features..........

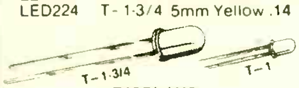
BRAND NEW!
1979 IC MASTER
2500 pages

Complete integrated circuit data selector. Master guide to the latest I.C.'s including microprocessors and consumer circuits.

Free Quarterly Updates **$39.95**

L.E.D. LAMPS

LED209	T-1 3mm Red	.09
LED211	T-1 3mm Green	.14
LED212	T-1 3mm Yellow	.13
LED220	T-1-3/4 5mm Red	.11
LED222	T-1-3/4 5mm Green	.15
LED224	T-1-3/4 5mm Yellow	.14



DISPLAYS

FND357	375	Common Cathode	~~$1.15~~	$1.09
FND500	500	Common Cathode	~~$1.20~~	$1.09
FND507	500	Common Anode	~~$1.20~~	$1.09
FND567	500	Common Anode	~~$1.40~~	$1.29
DL747	630	Common Anode	~~$2.75~~	$[illegible].49
DL704	300	Common Cathode	~~$1.50~~	$1.29
DL707	300	Common Anode	~~$1.50~~	$1.29

ISOLATORS

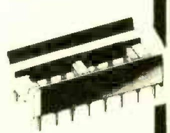
TIL112	Opto Isolator 1500V	~~$0.58~~	$0.49
MCT6	Dual Opto Isolator 1500V	~~$1.39~~	$1.29

Texas Instruments Low Profile Sockets

Finest Quality Socket available in the world. Nobody can match Texas Instruments quality — a unique combination of I.C. technology and multi-metal expertise.

Over one million pieces in stock.

Contacts	Price	Contacts	Price
8 PIN	.08	22 PIN	.22
14 PIN	.12	24 PIN	.24
16 PIN	.14	28 PIN	.28
18 PIN	.18	40 PIN	.40
20 PIN	.20		



LINEAR I.C.'S

LM324N	.49	Quad Op Amp
LM339N	.49	Quad Comparator
LM555N-8	.29	Timer
LM556N-14	.59	Dual Timer
LM723CN	.36	Voltage Regulator
LM723CH	.39	Voltage Regulator
LM741CH	.37	Op Amp
LM741CN-8	.24	Op Amp
LM1458N-8	.49	Dual Op Amp
RC4558N-8	.45	Dual Op Amp

Active Electronic Sales Corp.

P.O. BOX 1035 FRAMINGHAM, MASSACHUSETTS 01701

Over-the-counter sales,
12 Mercer Rd., Natick, Mass 01760
Behind Zayres on Rte. 9
Telephone Orders & Enquiries (617) 879-0077

IN CANADA

5651 FERRIER ST.
MONTREAL, QUEBEC
H4P 2K5
Tel: (514) 735-6425

4800 DUFFERIN ST.
DOWNSVIEW, ONTARIO
M3H 5S9
Tel: (416) 661-1115

MINIMUM ORDER $10.00 • ADD $2.00 TO COVER POSTAGE & HANDLING

Foreign customers please remit payment on an international bank draft or international postal money order in American dollars.

BAXTER CENTRE
1050 BAXTER ROAD
OTTAWA, ONTARIO
K2C 3P2
Tel: (613) 820-9471

3070 KINGSWAY
VANCOUVER, B.C.
V5R 5J7
Tel: (604) 438-3321

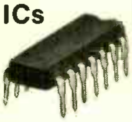
CHARGEX VISA · master charge

CIRCLE 17 ON FREE INFORMATION CARD

Radio Shack: No. 1 Parts Place
Low Prices and New Items Everyday!

Top-quality devices, fully functional, carefully inspected. Guaranteed to meet all specifications, both electrically and mechanically. All are made by well-known American manufacturers, and all have to pass manufacturer's quality control procedures. These are not rejects, not fallouts, not seconds. In fact, there are none better on the market! Always count on Radio Shack for the finest quality electronic parts!

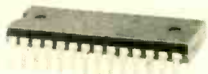
TTL and CMOS Logic ICs



Full-Spec Devices Direct from Motorola and National Semiconductor

Type	Cat. No.	ONLY
7400	276-1801	49¢
7402	276-1811	49¢
7404	276-1802	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7473	276-1803	49¢
7474	276-1818	59¢
7475	276-1806	89¢
7476	276-1813	59¢
7490	276-1808	89¢
7492	276-1819	89¢
74154	276-1834	1.39
74192	276-1831	1.19
74193	276-1820	1.19
4001	276-2401	69¢
4011	276-2411	69¢
4012	276-2412	79¢
4013	276-2413	99¢
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	69¢
4027	276-2427	99¢
4028	276-2428	1.29
4046	276-2446	1.69
4049	276-2449	79¢
4050	276-2450	79¢
4051	276-2451	1.49
4066	276-2466	1.39
4070	276-2470	79¢
4511	276-2447	1.69
4518	276-2490	1.49
4543	276-2491	1.99

SN-76477 Sound/Music Synthesizer IC



2.99 Featured in Oct. Popular Electronics

Creates almost any type of sound — music to "gunshots!" Built-in audio amp. Includes 2 VCO's, LF osc., noise gen., filter, 2 mixers, envelope modulator, logic circuit. 28-pin DIP. With data/applications circuits. 276-1765 .... 2.99

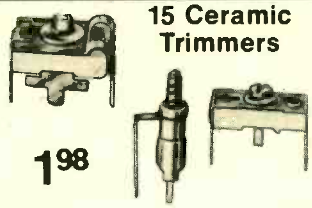
Mercury Tilt Switch

- *Hermetically Sealed*
- *Perfect for Alarm Circuits*

89¢ **Actual Size!**

Subminiature position-detecting switch for use in projects or special applications. Switch is normally closed when upright, opens when tilted more than 45°. Rated 100mA at 24VDC. 275-025 .... 89¢

15 Ceramic Trimmers



1.98

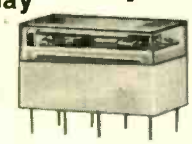
Assorted low-loss RF trimmer capacitors. May include both compression and piston types rated up to 500VDC with maximum capacity values of 3 to 100 pF. 272-805 .... Pkg. of 15/1.98

Top-Quality IC and PCB Accessories

- A **PC Board.** Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹/₁₆". 276-151 .... 2.99
- B **PC Board.** Mounts single 14 or 16-pin IC or socket. 276-024 .... Pkg. of 2/99¢
- C **16-Pin IC Test Clip.** 276-1951 .... Sale 2.89
- D **16-Pin DIP Header.** With snap-on cover. 276-1980 .... 1.29
- E **8-Position DIP Switch.** 275-1301 .... 1.99
  4-Position DIP Switch. (Not shown.) 275-1304 .... 1.49
- F **Vertical 16-pin Socket.** For LED displays. 276-1986 .... 1.49
- G **16-Pin DIP Jumper Cable.** 18" long. 276-1976 .... 3.99

DPDT Dual Inline Relay

4.49



Fits Std. 14-Pin IC Socket

Subminiature relay is designed for use with TTL or CMOS circuitry. Contacts rated 1A at 125VAC. Coil requires 5VDC. Coil resistance, 50 ohms. 275-215 .... 4.49

Handheld 6-Digit Frequency Counter

Reg. 99.95 **49.95**

- **Lead Zero Blanking**
- **100 Hz Up to 45 MHz**
- **kHz and MHz Decimals**

Accuracy is 3 ppm at 25°C or less than 30 Hz at 10 MHz. Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. 3x4½". With mini-rod antenna, leads, case, instructions. Requires 9V battery. 22-351 ... Sale 49.95

AC Adapter. U.L. listed. 65-731 ...... 4.95

Digital IC Logic Probe

24.95

Multi-Logic Family Compatibility from 5-15VDC

Detects one-shot low repetition rate, narrow pulses scopes miss. Combines level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1", Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high-frequency signals (up to 1.5 MHz). With cables. 22-300 .... 24.95

MC14553 3-Digit BCD Counter IC

For Low-Cost Digital Readout

CMOS chip replaces over 8 separate IC's in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP. 276-2498 .... 3.49

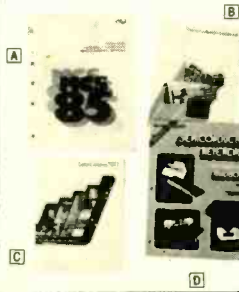
Custom Printed Circuit Board Kit

Everything you need for making high-quality custom PC boards. 276-1576 .... 7.95

Extra Resist Pen. 276-1530 .... 1.29

Extra Etching Solution. 276-1535 .... 2.19

Computer Data Manuals & Semiconductor Handbook



- A **Intel 8080/8085 Programming Manual.** Handy reference for programming with Intel's assembly language. 62-1377 .... 3.95
- B **Intel Memory Design Handbook.** Explains use of Intel's memory components and support circuits in systems. 62-1378 .... 3.95
- C **Intel Data Catalog.** 928 pages of specifications on most of Intel's standard microcomputer-related products. 62-1379 .... 4.95
- D **Semiconductor Reference and Application Handbook.** Complete specs and applications for popular IC transistors, diodes. 276-4002 .... Sale 99¢

RAM Memory ICs

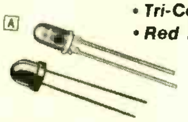
Under 450 nS Access Time

2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 8 and save! 276-2501 .... 2.49 Ea. or 8/14.95

2114L 1024 x 4 Array. NMOS static RAM. 18-pin DIP. 276-2504 .... New Low Price 10.99

NEW LEDs

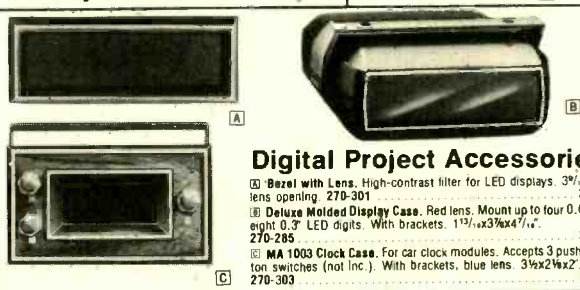
- *Tri-Color*
- *Red Flasher*



A Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage: 2.2VDC. Max. current: 25mA. T1-¾ case style. 276-035 .... 1.39

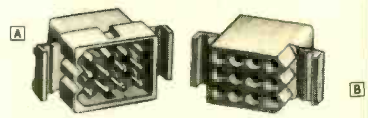
B Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC. 276-036 .... 1.29

Digital Project Accessories



- A **Bezel with Lens.** High-contrast filter for LED displays. 3⁹/₁₆x1" lens opening. 270-301 .... 3.95
- B **Deluxe Molded Display Case.** Red lens. Mount up to four 0.6" or eight 0.3" LED digits. With brackets. 1¹³/₁₆x3⅞x4⁷/₁₆". 270-285 .... 3.95
- C **MA 1003 Clock Case.** For car clock modules. Accepts 3 pushbutton switches (not Inc.). With brackets, blue lens. 3½x2⅛x2". 270-303 .... 5.95

Molded Connectors



Rated 8A @ 250V. Standard .093" pin diameter.

Fig	Pins	Type	Cat. No.	Each	Fig.	Pins	Type	Cat. No.	Each
A	4	Male	274-224	99¢	B	4	Female	274-234	99¢
A	6	Male	274-226	1.19	B	6	Female	274-236	1.19
A	9	Male	274-229	1.39	B	9	Female	274-239	1.39
A	12	Male	274-232	1.49	B	12	Female	274-242	1.49

2-Pin Male & Female. (Not shown) 274-222 .... Pair 89¢

WHY WAIT FOR MAIL ORDER DELIVERY? IN STOCK NOW AT OUR STORE NEAR YOU!

Prices may vary at individual stores and dealers

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7000 LOCATIONS IN NINE COUNTRIES

CIRCLE 65 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
—	AMC Sales	94
52	A P Products, Inc.	32
10	Aaron-Gavin Instruments	16
17	Active Electronics	99
63	Advance Electronics	7, 71
2	Advanced Computer Products	91
37	All Electronics	92
62	Amelect, Inc.	80
30	American Antenna	Cov. 4
46	Ampower	100
57	B & K Precision Dynascan Co.	75
32	Babylon Electronics	102
—	Karel Barta	84
51	Beckman Instruments	2
—	Bullet Electronics	94
—	Burdex Security Co.	82
64	C F R Associates	100
—	Chaney Electronics	94
—	Cherry Electronics	79
—	C I E—Cleveland Institute of Electronics	18-21
—	Command Productions	82
31	Concord—Computer Components	86
12	Continental Specialties	Cov. 2
13	The Cooper Group—Electronics Div.	17
—	Dage Scientific	94
8	Delta Electronics	84
29	Digi-Key	87
—	Digital Research Corporation	92
—	Electronic Development Lab	100
41	Electronic Supermarket	98
53	Enterprise Development	76
—	Fair Radio Sales	82
49	Fordham Radio Supply	95
33 & 34	Formula International	96 & 97
—	Fuji-Svea	83
—	G C Electronics	22
60	GFN Industries	35
35	Godbout Electronics	98
—	Golden Enterprises	84
54	Gould, Inc.—Instruments Div.	26
36	Grantham College of Engineering	77
100	Heath	13, 25
48	Hickok Electrical Instruments	65
26	Hobby World	86
—	Information Unlimited	100
58	International Crystal Mfg. Co.	73
4 & 5	Jameco Electronics	88-89
7	Jim-Pak	15
—	Lakeside Industries	100
47	Meshna	86
—	Millco Industries	82
42	MTI—Mobile Training Institute	73
—	National Radio Institute (NRI) Div. of McGraw-Hill	8-11
—	National Technical Schools	28-31
43, 44	Netronics	33, 77
24, 25	O.K. Machine & Tool	27, 34
3	Ohio Scientific	1
16	Optoelectronics	Cov. 3
19	P A I A	74
23	PTS Electronics	77
38	Panavise	76
15	Poly Paks	90
39	Pomona Electronics	36
18	Quest	85
11	Quimtronix	94
65	Radio Shack	101
40	Ramsey Electronics	93
27	Rye Industries	26
—	Sabtronics	14
56	Schober Organ	69
—	Sheldahl	16
59	Shure Brothers	67
61	Solarex	33
6	Solid State Sales	98
55	Southwest Technical Products	78
—	Spacecoast Research	94
—	Speakerlab, Inc.	84
9	Tab Books—Electronic Book Club	74
45	Tek-El Corp.	92
20	Tri-Star	100
21	Tuner Service	23
—	V.I.Z. Mfg.	81
28	Wersi Electronics	78
14	Zemco	12

Independent News Company, Inc. is pleased to announce a Retail Display Plan available to all retailers interested in earning a display allowance on Radio-Electronics magazine and who purchase the magazines from suppliers other than Independent News Co., Inc., or the publisher.

To obtain details and a copy of the formal contract please write to **Director, Retail Sales Division, Independent News Co., Inc., 75 Rockefeller Plaza, New York, N.Y. 10019.** Under the display plan in consideration of your acceptance and fulfillment of the terms of formal contract to be sent to you upon your request you will receive a display allowance of 10% of the cover price per copy sold by you. This plan will become effective with all issues of Radio-Electronics delivered to you subsequent to the date your written acceptance of the formal Independent News Co., Inc. Retail Agreement is received and accepted by our Company.

MOVING?

Don't miss a single copy of **Radio-Electronics.** Give us:

Six weeks' notice

Your old address and zip code

Your new address and zip code

ATTACH LABEL HERE

name (please print)

address

city state zip code

Mail to: Radio-Electronics, SUBSCRIPTION DEPT., P.O. BOX 2520, BOULDER, COLO. 80322

ALL NEW Real-State-of-the-Art

TWO NEW AC●DC●BATTERY PORTABLE COUNTERS

OPTO-8000.1A 10Hz to 600 MHz — FREQUENCY COUNTER

- Precision TCXO time base 0.1 PPM Stability 17-40°C
- Super Sensitivity with preamps in both HI-Z & 50 Ohm inputs <10mV to 50MHz, 25 mV @ 150 MHz <50mV to 600MHz
- Auto Decimal Point ● Aluminum Case ● Socketed IC's
- Three position attenuator: X1, X10, X100 (avoids false counting)

#OPTO-8000.1A	Factory Assembled	$329.95
#OPTO-8000.1AK	Kit Form	$279.95
#NI-CAD-80	NI-CAD Battery Pack	$ 19.95

OPTO-7000 10 Hz to 600 MHz MINIATURE COUNTER

- XTAL (TCXO) Time Base ±.08PPM/°C
- Aluminum Case ● HI-Z & 50 Ohm inputs
- 1 Sec. & 1/10 Sec. Gate times ● Auto Dec. Pt.
- Built-in Prescaler and Preamps Standard

#OPTO-7000	Factory Assembled - 1 Year-Guar	$139.95
#OPTO-7000K	Kit Form	99.95
#AC-70	AC Power Pack	4.95
#NI-CAD-70	NI-CAD Battery Pack	19.95
#TCXO-70	Precision TCXO Time Base <0.1PPM, 17-40°C	79.95

ACCESSORIES

PROBES:

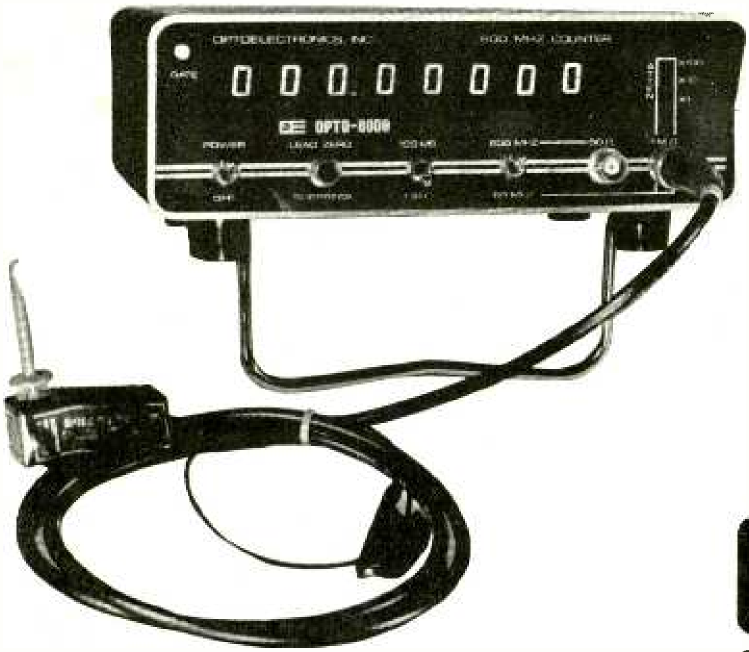
#P-100	50 Ohm, 1X	$13.95
#P-101	Lo-Pass	16.95
#P-102	H1-Z, 2X	16.95

 # AP- 8015 UHF Counter Preamp 20 MHz to 600 MHz 15-50 DB Gain (Not Shown) .. $49.95/Kit $39.95

#D-450 Antenna
Rubber Duck RF Pick-up 450 MHz ... $12.50

#D-146 Same as above
146.5MHz ... $12.50

#RA-BNC Right-Angle BNC Adapter for above Antenna ... 2.95



master charge
BANKAMERICARD

ORDER FACTORY DIRECT — PHONE OR MAIL

TERMS: Orders to U.S. and Canada, add 5% to maximum of $10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: $1.00. Personal checks must clear before merchandise is shipped.

OPTOELECTRONICS, INC.
5821 NE 14 Avenue
Ft. Lauderdale, FL 33334
Phones: (305) 771-2050 771-2051

Phone orders accepted