Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE APRIL 1979/$1.25

Dynamic Audio Filter Removes Hiss & Noise
"Morse-A-Word" Alphanumeric Converter, Pt. II
Buying Guide to Computer Input/Output Boards

Build a "True RMS" Voltmeter

0 04 14024 14278
Popular Electronics

Tested In This Issue

Denon DP-2500 Manual Turntable
Kenwood KT-917 FM Tuner
Realistic SCT-30 Cassette Deck

How to buy a personal computer.

Suddenly everyone is talking about personal computers. Are you ready for one? The best way to find out is to read Apple Computer's "Consumer Guide to Personal Computing." It will answer your unanswered questions and show you how useful and how much fun personal computers can be. And it will help you choose a computer that meets your personal needs.

Who uses personal computers.

Thousands of people have already discovered the Apple computer—businessmen, students, hobbyists. They're using their Apples for financial management, complex problem solving—and just plain fun. You can use your Apple to analyze the stock market, manage your personal finances, control your home environment, and to invent an unlimited number of sound and action video games. That's just the beginning.

What to look for.

Once you've unlocked the power of the personal computer, you'll be using your Apple in ways you never dreamed of. That's when the capabilities of the computer you buy will really count. You don't want to be limited by the availability of pre-programmed cartridges. You'll want a computer, like Apple, that you can also program yourself. You don't want to settle for a black and white display. You'll want a computer, like Apple, that can turn any color tv into a dazzling array of color graphics.* The more you learn about computers, the more your imagination will demand. So you'll want a computer that can grow with you as your skill and experience with computers grows. Apple's the one.

How to get one.

The quickest way is to get a free copy of the Consumer Guide to Personal Computing. Get yours by calling 800/538-9696. Or by writing us. Then visit your local Apple dealer. We'll give you his name and address when you call.

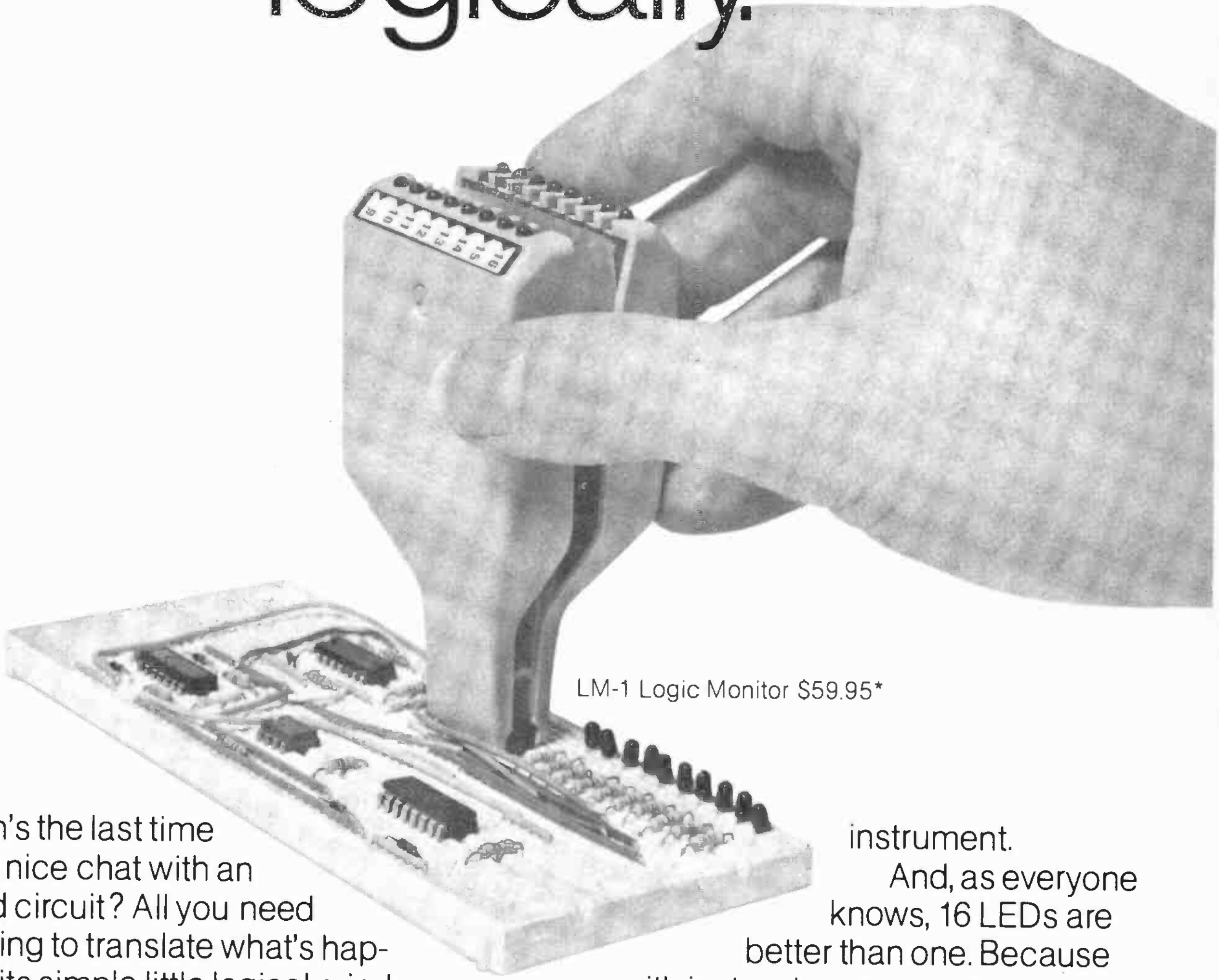
*Apple II plugs into any standard TV using an inexpensive modulator (not included).

apple computer T.M.

In California, call 800/662-9238.

CIRCLE NO. 26 ON FREE INFORMATION CARD

How to be 16 places at once, logically.



LM-1 Logic Monitor $59.95*

When's the last time you had a nice chat with an integrated circuit? All you need is something to translate what's happening in its simple little logical mind. Something like our popular Logic Monitors.

Clip one onto an IC—any DIP up to 16 pins—and the 16 LEDs atop our Logic Monitor flash to the rhythm of the state of each pin. You have, in effect, 16 tiny logic probes in one pocket-size circuit-powered instrument.

And, as everyone knows, 16 LEDs are better than one. Because with just a glance, you can see inputs affecting outputs, a whole IC at a time.

Psychologists call the principle *Gestalt* (in short, the whole is greater than the sum of its parts). You'll call it smart, a timesaver. We just think it's logical.

CSC for yourself!

Corporate Headquarters:
70 Fulton Terr., Box 1942, New Haven, CT 06509
351 California St., San Francisco, CA 94104
(415) 421-8872, TWX 910-372-7992
Canada: Len Finkler Ltd., Ontario

CONTINENTAL SPECIALTIES CORPORATION

CSC

800-243-6077

CIRCLE NO. 12 ON FREE INFORMATION CARD

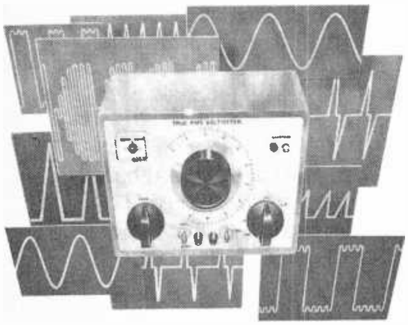
EUROPE, AFRICA, MIDEAST: CSC UK LTD.
Shire Hill Industrial Estate Units 1 and 2
Saffron Walden, Essex CB 11 3AQ
Telephone Number: SAFFRON WALDEN 21682
TLX 817477

*Manufacturer's suggested U.S. resale. Prices, specifications subject to change without notice.

APRIL 1979
VOLUME 15, NUMBER 4

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE



About the cover:

The "True RMS" Voltmeter featured here will at last enable readers to measure "effective" voltages of odd-shaped waveforms without spending considerable monies.

Cover Art by George Kelvin

Feature Articles

Construction Articles

Columns

Julian Hirsch Audio Reports

Departments

JOSEPH E. MESICS
Publisher

ARTHUR P. SALSBERG
Editorial Director

LESLIE SOLOMON
Technical Director

JOHN J. McVEIGH
Technicl Editor

JOHN R. RIGGS
Managing Editor

HAROLD A. RODGERS
Senior Editor

ALEXANDER W. BURAWA
Features Editor

EDWARD I. BUXBAUM
Art Director

ANDRE DUZANT
Technical Illustrator

CARMEN VELAZQUEZ
Production Editor

RUTH POLSKY
Editorial Assistant

Contributing Editors
Hal Chamberlin, Lou Garner, Glenn Hauser
Julian Hirsch, Ralph Hodges, Forrest Mims

JEFF NEWMAN
Assistant to the Editor

LINDA BLUM
Advertising Service Manager

MARIE MAESTRI
Executive Assistant

EDGAR W. HOPPER
Publishing Director

Popular Electronics®

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212-725-3500
Joseph E Mesics (725-3568)
John J Corton (725-3578)
Bonnie B. Kaiser (725-3580)

Midwestern Office
Suite 1400, 180 N. Michigan Ave.,
Chicago, IL 60601 (312-346-2600)
Midwest Representative: Buzz Vincent

Western Office
9025 Wilshire Boulevard, Beverly Hills, CA 90211
213-273-8050; BRadshaw 2-1161

Western Representative, Norm Schindler
Suite 205, 20121 Ventura Blvd.,
Woodland Hills, CA 91364 (213-999-1414)

Japan: James Yagi, Oji Palace Aoyama;
6-25, Minami Aoyama, 6 Chome, Minato-Ku,
Tokyo, 407-1930/6821, 582-2851

POPULAR ELECTRONICS, April 1979, Volume 15, Number 4 Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S. and Possessions, $13.00; Canada, $16.00; all other countries, $18.00 (cash orders only, payable in U.S. currency). Second Class postage paid at New York, NY and at additional mailing offices Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.

POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature.

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

Forms 3579 and all subscription correspondence: POPULAR ELECTRONICS, Circulation Dept., P O Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue

Editorial

1979½

The Consumer Electronics Show in Las Vegas this past January revealed what we can expect to be sold in stores during the first half or two thirds of '79. In most cases, products will remain the same as '78 year-end models, judging from what we saw at this giant trade convention. There were exceptions, though, as follows.

At the Jockey Club Hotel, away from the Convention Center mainstream, about 100 smaller audio companies were gathered in hotel suites to display their products. With late and limited publicity as to the existence of this added location, and owing to abominable elevator service, it was a challenge to cover it. But the effort was worthwhile, for here is where one can generally find the design innovator/entrepreneur person and, consequently, learn how a product really works. At one such meeting, I previewed a preamp with an audio hologram function, plus a 200 W/ch "Magnetic Field" power amp housed in a 6¾"-cube chassis, weighing about 12 lb., and tentatively priced at 75¢ per channel-watt. (We'll have a full test report on the prototype Carver Corp. preamp next month.)

At the main show, spread out over some 459,300 sq. ft., personal computer exhibits were clearly in evidence, Ohio Scientific, Apple, APF, and Commodore PET, among them. Bally introduced a new computer language called "Graffix" for expanded functions, while Mattel (yes, the "toy company") debuted its "Intellivision" system. The latter is a programmable game component which is expanded to a "computer" with a mating 64-key keyboard component. Uses prerecorded tapes.

Microprocessors were used for more dedicated applications, of course. For example, Coleco Industries (another "toy company") introduced its ZODIAC™ astrology computer; Comus, its hand-held "C-6 Diet Computer" for computing proper caloric needs according to input information on weight, height, type of exercise, etc. And then we saw—and tried out—Craig's portable M100 Language Translator. It converts English to another language automatically, with the foreign language reading out on a blue Digitron display. Memory capsules ($25 each) include Spanish, French, Italian, German and Japanese at this time, each with a vocabulary of about 1,500 words. Talking computerized chess games from Boris and Fidelity Electronics astounded many attendees, and for you Contract Bridge and/or Backgammon enthusiasts, there were computer-opponent games exhibited. Texas Instruments' programmable TI 58 and 59 solid-state software libraries impressed me, too.

The car stereo rage was certainly carried over into the CES, with numerous models shown. With one, you can now *feel* the sound as well as hear it owing to a "Bodysonic" amp that makes a seat cushion pulsate as music is played. It's from Pioneer Electronics of America. And from Fosgate is a four-channel 4 x 50W car amp that uses the Tate system.

We listened to a digital audio disc system developed by Matsushita Electric (sounded great!); marketing plans are incomplete, however. And also liked one of the least expensive items at the show, a Discwasher "Hi-Fi Seer" audio illuminator; a small, $7 flashlight-mirror system with on-off switch that lights up those dark recesses in a hi-fi cabinet.

In the communications field, Nevcom's cordless CM-100 communications microphone, with a three-meter range, worked beautifully. JS&A is marketing it. And writing about cordless, a handful of cordless telephone handsets were exhibited at the show. One of them, Pathcom's "EZ Phone," startled me when an incoming call caused it to ring while in the jacket pocket of the person I was talking to. It operates at 1.6 to 1.8 MHz and 49.8 to 49.9 MHz under Part 15 of the FCC Rules (no license required). About $170.

Among other interesting products revealed at the show were: "FlexSwitch," a thin, pressure-sensitive membrane that's designed to interface with logic circuitry. A prototype designer's kit costs $10 (Sheldahl, Electrical Products Div., Northfield, MN 55057.) Another was a portable synthesizer from England, the Tylophone 350-S, that simulates sounds of more than 20 different instruments when sliding a stylus across a 3½-octave keyboard.

With about 811 exhibitors in all, space doesn't permit me to mention all the newly introduced products. But as you can see, 1979½ will be an interesting part-year.

Art Salsberg

Here it is at last... THE FIRST FLOPPY DISK BASED COMPUTER FOR UNDER $1000

The C1P MF
$995

- Complete mini-floppy computer system
- 10K ROM and 12K RAM
- Instant program and data retrieval

The Challenger 1P Mini-disk system features Ohio Scientific's ultra-fast BASIC-in-ROM, full graphics display capability and a large library of instant loading personal applications software on mini-floppies including programs for entertainment, education, personal finance, small business and now *home control!*

The C1P MF configuration is very powerful. However, to meet your growth needs it can be directly expanded to 32K static RAM and a second floppy by simply plugging these options in. It also suports a printer, modem, real time clock and AC remote interface as well as the OS-65D V3.0 development oriented operating system.

Or Start with the C1P CASSETTE BASED Computer for just $349.

The cassette based Challenger 1P offers the same great features of the mini-disk system including a large software library except it has 4K RAM and conservative program retrieval time. Once familiar with personal computers, you'll be anxious to expand your system to the more powerful C1P MF.

You can move up to mini-disk performance at any time by adding more memory and the disk drive. Contact your local Ohio Scientific dealer or the factory today.

*Both systems require a video monitor, modified TV or RF converter and home television for operation. Ohio Scientific offers the AC-3 combination 12" black and white TV/monitor for use with either system at $115.00 retail.

All prices, suggested retail.

OHIO SCIENTIFIC

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

CIRCLE NO. 44 ON FREE INFORMATION CARD

Letters

AUTOMATIC KEYER FOR HAMS

After reading "Control Your Model Railroad With Audio Tape" (November 1978), I thought of another very practical use for the project. It can be used as a keyer for prerecorded Amateur Radio messages with a ham rig equipped with full break-in capability. The keyer could be used to send a CQ message with perhaps a 20- or 30-second delay before the message is repeated. The conversion is simple: connect a keyer in place of *S3* and forget *S4* altogether and use the contacts of *K1* to key the transmitter. —*Brian Torr, Monte Rio, CA.*

DISCO MIXER SPECIFICATIONS

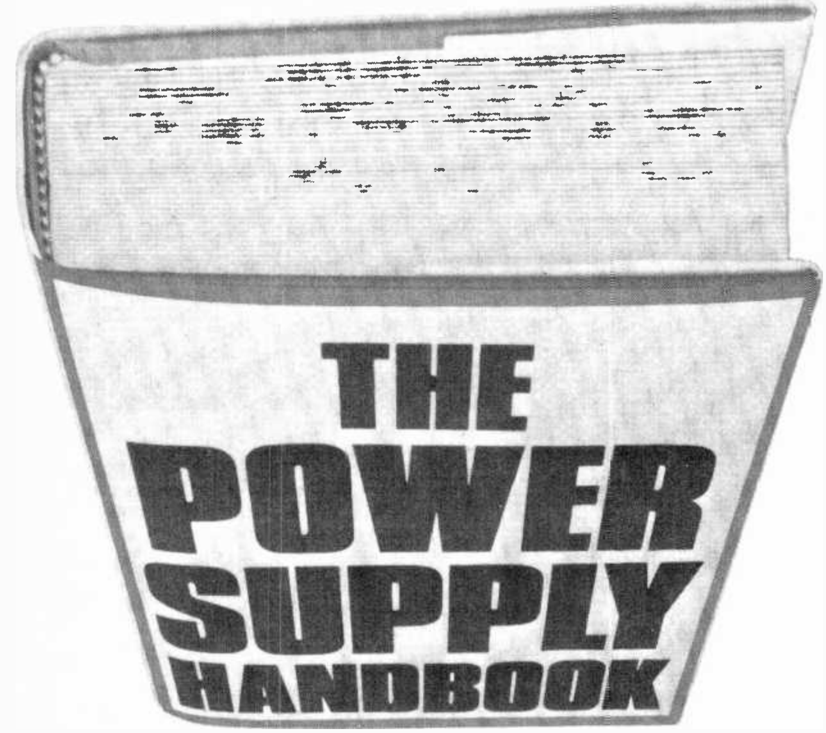
For those who are interested, here are the frequency-response and distortion specifications for my "Disco Preamp/Mixer" (September 1978). Phono Section: input impedance, 47,000 ohms and 100 picofarads; input overload 60 millivolts at 1 kHz; playback equalization, IEC ± 0.5 dB; input sensitivity, 4 mV at 1 kHz (for 500 mV output); S/N referred to 5 mV, 87 dB (IHF "A" weighting); THD + N, 0.1% (1 kHz at rated output); IM (SMPTE), 0.09%. High Level: input impedance, 50,000 ohms; frequency response, PA only, −0.4 dB at 20 Hz, 0 dB at 100 kHz, DM, −1 dB at 20 Hz, 0 dB at 100 kHz; IM (SMPTE), PA & DM, 0.003%; THD + N: (at 8 V rms) 20 Hz—0.012%, 2 kHz—0.0018%, 10kHz—0.0035%, 20 kHz—0.0052%; output clipping, 9 V rms; output noise, 92 dB below 500 mV (IHF "A" weighting) (117 dB below clipping).—*John R. Roberts.*

CIRCUIT CHANGE REQUEST

"Build a Digital Darkroom Timer" (August 1978) is really a lifesaver, but I have a request to make regarding its design. Would it be possible to change the circuitry so that the desired exposure time can be entered into the timer via a keypad?—*Freddie T. Reitz, Waupun, WI.*

We often receive letters in which readers ask us to detail how to make modifications to our published projects. Our response to such requests must be that we do not have the requested information and any attempt to provide this information requires researching that would jeopardize our deadlines.—Ed.

ELECTRONICS BOOK CLUB invites you to take a copy of "THE POWER SUPPLY HANDBOOK" (list $12.95)



absolutely
FREE!

...with a Trial Membership in the Book Club that saves you 25% to 75% on a wide selection of electronics books

The Power Supply Handbook

A broad, rich, and varied collection of ready-to-build power sources for electronics technicians, hams, engineers, and hobbyists!

This is THE complete power supply book...the all-in-one Answerbook with ALL the data you need to build, design, test, and customize virtually any power supply system you want—from AC-to-DC converters to linear amplifier filament transformers, from simple dual-voltage systems to hefty 3000V DC powerhouses, from low-voltage units to precision 10,000V DC references, from sine wave inverters to failsafe superchargers! It contains 420 pages of solid how-to info, stripped clean of irrelevancies, packed with practical instructions on how to create just the unit you need for that special application. You get a brief course in power supply theory, some basic schooling in testing, a thorough guide to power supply design, and section after section of pretested power supply circuits you can build and modify. Projects like 13V mobile systems, 12V 20A brute supplies, voltage sextuplers for SSB, 115V 60 Hz sine wave inverters, regulated nicad chargers, precision 10,000V DC references, adjustable low-voltage regulated supplies, 117V AC to 24V DC converters, and lots of special-purpose AC supplies. And precisely because this manual is so comprehensive, you'll be able to build PS systems that are as good as any you can buy, systems that meet your specifications.

Probably the most remarkable thing about this volume is the sheer variety and quality of the projects it offers...each one is reliable, pretested, easy to build, and you can construct most of them from inexpensive salvaged or surplus parts. It would have to be a very unusual PS indeed not to be covered in this manual, for here you'll find everything from simple get-the-job-done units to highly refined adjustable supplies. Step-by-step instructions tell you how to put together voltage doublers for MOS LSI, super low-voltage supplies, 78MG voltage regulators, 13V supplies for mobile equipment, 110V 600 Hz inverters, polarity changers, 12V to 300V converters, solid-state car alternator/regulators, silver-zinc cell battery chargers, zero to 30V lab supplies, simple four-voltage bench supplies, and many more. The projects come with all the data you need to insure flawless no-hitch construction—concise analyses of special circuits, easy-to-follow directions, detailed schematic diagrams, complete parts lists, and special discussions of construction safety precautions.

The scope of this handbook is broad—broad enough to include construction info on tested circuits that'll help you make the most of any power supply you put together—circuits that'll allow you to interface, modify, and test your own PS designs. The authors show you how to construct voltage splitters, IC protection circuits, smoke testers, two-terminal current limiters, voltage limit sensors, active voltage dividers, microfarad multipliers, capacitor rejuvenator-leakage testers, and many, many others. 420 pps., 292 illus. Hardbound. List $12.95.

ELECTRONICS BOOK CLUB, Blue Ridge Summit, Pa. 17214

May we send you this practical time-and-money-saving book absolutely FREE as part of an unusual offer of a Trial Membership in Electronics Book Club.

Like all Club offerings, this is a quality hardbound volume, especially designed to help you increase your know-how, earning power, and enjoyment of electronics. Whatever your interest in electronics, you'll find Electronics Book Club offers practical, quality books that you can put to immediate use and benefit.

This extraordinary offer is intended to prove to you through your own experience, that these very real advantages can be yours...that it is possible to keep up with the literature published in your areas of interest, and to save substantially while so doing. As part of your Trial Membership, you need purchase as few as four books during the coming 12 months. You would probably buy at least this many anyway, without the substantial savings offered through Club Membership.

To start your Membership on these attractive terms, simply fill out and mail the coupon today. You will receive "The Power Supply Handbook" absolutely FREE. If you're not delighted, return the book within 10 days and your Trial Membership will be cancelled without any obligation whatsoever.

Facts About Club Membership

- "The Power Supply Handbook" lists for $12.95. It is yours absolutely FREE with your Trial Membership.
- You will receive the Club News, describing the current Selection, Alternates, and other books, every 4 weeks (13x a year).
- If you want the Selection, do nothing, it will be sent to you automatically. If you do not wish to receive the Selection, or if you want to order one of the many Alternates offered, you simply give instructions on the reply form (and in the envelope) provided, and return it to us by the date specified. This date allows you at least 10 days in which to return the form. If, because of late mail delivery, you do not have 10 days to make a decision and so receive an unwanted Selection, you may return it at Club expense.
- To complete your Trial Membership, you need buy only four additional monthly Selections or Alternates during the next 12 months. You may cancel your Membership anytime after you purchase these four books.
- All books—including the Introductory Offer—are fully returnable after 10 days if you're not completely satisfied.
- All books are offered at low Member prices, plus a small postage and handling charge.
- **Continuing Bonus:** If you continue after this Trial Membership, you will earn a Dividend Certificate for every book you purchase. Three Certificates plus payment of the nominal sum of $1.99 will entitle you to a valuable Book Dividend of your choice which you may choose from a list provided Members.

ELECTRONICS BOOK CLUB
Blue Ridge Summit, Pa. 17214

Please open my Trial Membership in ELECTRONICS BOOK CLUB and send my copy of "THE POWER SUPPLY HANDBOOK" ABSOLUTELY FREE! If not delighted, I may return the book within 10 days and have my Trial Membership cancelled. I agree to purchase at least four books during the next 12 months, after which I may cancel my Membership at any time.

Name ____________________ Phone __________

Address ______________________________

City ______________________________

State ____________________ Zip __________

(Valid for new Members only.) PE-49

CIRCLE NO. 18 ON FREE INFORMATION CARD

Automatic Transmission

Who else wants to save time, trouble and aggravation? At $99, Rapidial™ is America's lowest priced, best selling automatic dialer.

Forty-nine out of 50 executives surveyed said they found it an absolute necessity – even though they bought it for convenience or on a lark. And most prefer it to having their secretaries or switchboard operators place their calls.

Rapidial will help make your day. Every day. Imagine dialing a number by touching a button. And, then, having the number you are calling ring in a second. (Tell somebody you will call right back, and his phone will ring the instant he hangs up!)

Works with any phone — One line or 10. Even turns a rotary into a Touch Tone®.

F.C.C. approved, manufactured in the U.S. and guaranteed for one full year, Rapidial comes with a plug-in wall jack adapter (4-prong or modular combination) for phones with one or two lines. For permanently installed office phones with up to six lines we have an inexpensive, two-screw "sandwich connector". And for phones with up to 10 lines the phone company will install an RJ35X connection (for a one time charge of about $30).

Rapidial works on any line of any multiple line phone. It also works with rotary phones. In fact, you can use the Rapidial keyboard to place all your calls with Touch Tone speed and ease.

It's Hands-Free

Rotary or Touch Tone, using the Rapidial keyboard regularly has added advantages. First, it's hands free telephoning. With a built-in type speaker system. You lift the receiver only when you hear someone answer. Second, if the line processed is busy, Rapidial shuts itself off automatically, remembering the number so you can redial at the touch of a button—as often as necessary.

There is no call you can't make. What's more, every call—local, long distance, inter-office, even over seas, is easier and faster. With Rapidial you can store as few or as many as 10 digits (area code and number) in memory. If you have to dial "9" or "1" or both, need the operator, want to access a WATTS line or a PABX system, just touch the extra buttons you need plus the button with the number you're calling.

Bonus Features

About the size of a hand-held calculator, Rapidial sits neatly on your desk next to your telephone. Always ready with no off/on switch to worry about. The numbers in memory are identified on the panel on top. The lower section is the Touch Tone keyboard pad. An LED DISPLAY lets you check any number in memory. The PAUSE CONTROL sets the machine to wait for a dial tone. There's an AUTOMATIC CANCEL button if you change your mind or hit the wrong number. And the BATTERY BACKUP protects the memory in a power failure.

® Touch Tone is a mark of A. T. & T. Co.

Five Different Uses

For peak operation and maximum efficiency at the lowest cost, Rapidial stores 20 numbers in memory—eliminating wrong numbers and having to stop to look them up. Numbers entered in seconds and changed—any time—by Rapidialing the new number.

Basically it allows you to place frequently made calls yourself in an instant. In far less time, actually, than it would take you to tell your secretary to do it for you. With immediate access to emergency numbers.

Interestingly, our survey unearthed some rather surprising and highly enterprising additional uses.

For example, most executives store *both* their most frequently called numbers, family, friends, clients or customers, service organizations and suppliers...and those important but less frequently called numbers that almost always have to be looked up.

Others use Rapidial mostly for inter-office calls. Since remembering extensions is almost impossible. And it's kind of inconsiderate to have a man get on the phone with your secretary first all the time.

The Memo Caller—or daily telephone organizer—is one of the more intriguing uses we discovered. These men (or their secretaries) program each day's calls. Crossing off the ones that are completed (adding new ones as necessary). A glance assures you no one's been left out, no call back has been forgotten. And a touch of the button gets you the next man on your list.

Finally, many report leaving the bottom bank of storage cells blank. Reserving them for the flow of calls that always accompanies a special deal or negotiation.

CIRCLE NO. 16 ON FREE INFORMATION CARD

$20 Less Than Retail...$50 Less Than The Closest Competitor's.

A repetory—or automatic dialer—from the phone company with 15 numbers costs $105 to install and $9 a month plus tax to lease—forever. For $130 you can get a 16 number dialer—with no keyboard of its own so it's only good for those numbers stored in memory. For $149.95 you can get a 20 number unit—but it's primarily for the home since a special telephone company installation for any multiple line phone is needed and it's not recommended at all for phones with more than three lines.

Rapidial will sell in stores for $119.95. But is being introduced by mail for $20 less. Why? To get as many as possible in use now by the kind of people Douglas Dunhill reaches by advertising in America's most influential publication.

So, you can have the easiest to use, most efficient and versatile unit on the market today for less than anybody else. And without risking one cent!

30 Day Trial

If your Rapidial isn't the executive necessity we described, the home convenience you hoped for, just return it in 30 days for a full refund. And we'll thank you for trying.

The price, including backup batteries and adapter for your wall jack, is just **$99.00** plus $2.50 shipping and handling. The Amphenol connection for multiple line office phones is only $19.95 extra. The adapter for the RJ35X is $19.95. (For the RJ35X connection itself, for phones with six or 10 lines, call your telephone business office.)

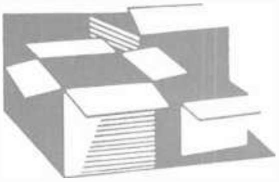
Deduct 10% from the price of the Rapidial on orders for ten or more. Call toll free to charge to your national credit card or send your check to Douglas Dunhill. (Illinois residents add sales tax.) You'll find it a far cry from standard transmission.

CALL 800-621-5554

Illinois residents call 800-972-5858

Douglas Dunhill
INC. AFFORDABLE QUALITY

Dept. 74-2339
Ten Douglas Dunhill Drive, Oak Forest, IL 60452



New Products

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

Sanyo Biamplified Auto Sound

The Sanyo Model FT-1490A is a car in-dash AM/FM/cassette system with biamplification. Its tuner has a dual-gate MOSFET front end, PLL multiplex decoder,

1-μV FM sensitivity (mono), and 30-to-16,000-Hz response; Dolby noise reduction for FM and tape; loudness contour control; selectable standard/biamplification mode; and tape transport with full auto-reverse and auto-repeat, self-draw tape compartment, and locking fast-forward and rewind. Biamplification provides separate amplifiers for bass (rated 12 watts/channel) and treble (2 watts/channel). $199.95.

CIRCLE NO. 86 ON FREE INFORMATION CARD

Antenna Inc. Low-Profile CB Antennas

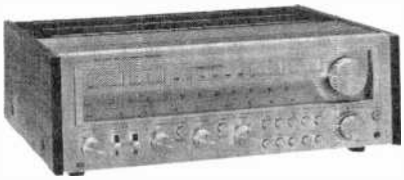
The Persuader™ is a new line of CB antennas from Antenna Inc. It features a pre-tuned hand-wound loading coil located right in the mounting cup instead of the usual nontunable and low-power printed-circuit assembly generally used in low-profile antennas. This design is reported to

require fewer mechanical and electrical connections and fewer resistive contacts between loading coil and cable terminations. Persuaders are tested at 500 watts of power and rated at 1000 watts continuous. Magnetic mounts are tested at 55 mph. The active radiator element is a 60" (1.5-m) long tapered stainless steel whip. Mounted on the center of a car roof, SWR is claimed to be 1.5:1 or less across all 40 CB channels. A choice of magnetic or trunk-lip mount is available, and mounts come in silver, bronze, black, blue, red, white, and clear. $34.98.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Realistic High-Power Receiver

The Realistic Model STA-2100 is said to be the most powerful AM/FM stereo receiver ever offered by Radio Shack. It is rated at 120 W/channel minimum rms at 8 ohms from 20 to 20,000 Hz with no more than 0.1% THD. Special features include separate bass, treble, and midrange tone controls, with selectable crossover points on bass and treble; switchable 25- and 75-μs deemphasis for FM Dolby reception; a multiplex filter, AM signal strength and FM center-channel meters; and dual power meters. Both DIN and phono-type input



and output jacks are provided for use with two tape decks. (One can record from one source while listening to another.) Specifications: 15 to 25,000 Hz ± 2 dB at 10 watts frequency response; 0.05% IM distortion at 70 watts; 70-dB phono, 75-dB AUX S/N; 1.6-μV (10.1-dBf) FM sensitivity; 75 dB alternate-channel separation; 52 dB at 1000 Hz FM stereo separation; 0.1% stereo, 0.05% mono FM THD. $599.95

CIRCLE NO. 88 ON FREE INFORMATION CARD

Mura Wireless Microphone

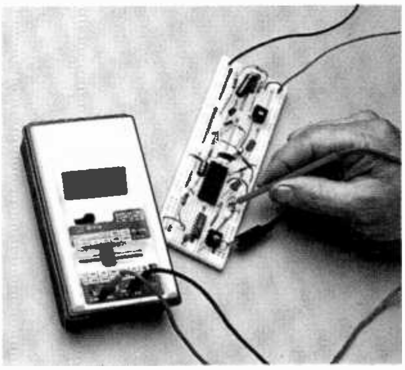
The Mura Model WMS-49 is a high-power wireless microphone system that contains a matched transmitter and receiver, both of

which are crystal controlled. The system operates in the 49-MHz walkie-talkie band where 100-mW output power is permitted without an FCC license. The microphone's electret element has a rated 30-to-18,000-Hz (no reference given) frequency range. The receiver has a standard phono plug output for connection to a PA or other microphone input and a VU meter to monitor the audio output signal level of the transmitter. A single 9-volt battery is required in the transmitter and the receiver. $69.95.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Hickok Hand-Held DMM Features LCD Display

The 3½-digit pocket-size Model LX-303 DMM from Hickok Electrical Instrument Co. features a liquid-crystal display for long battery life. Numeric display of the pa-

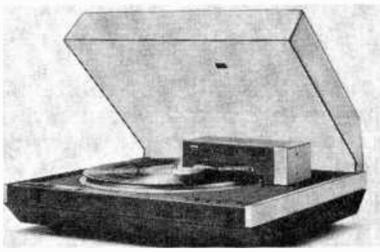


rameter being measured is backed up by automatic polarity and overrange indication. The instrument can measure from 0.1 mV to 1000 V (±0.5% of reading ±0.5% full-scale) on dc; from 0.1 V to 600 V (±1% of reading ±0.5% f.s.) on ac; 0.01 nA to 200 mA (±1% of reading ±0.5% f.s.) on dc; and 0.1 ohm to 20 megohms (±0.5% of reading ±0.5% f.s.). Protection is provided to 1000 volts on all dc ranges except the 200-mV range, where it is to 500 V; to 600 V on all ac ranges; and to 120 V on all resistance ranges. $74.95.

CIRCLE NO 91 ON FREE INFORMATION CARD

ReVox Direct-Drive Turntable with Tangential Tracking

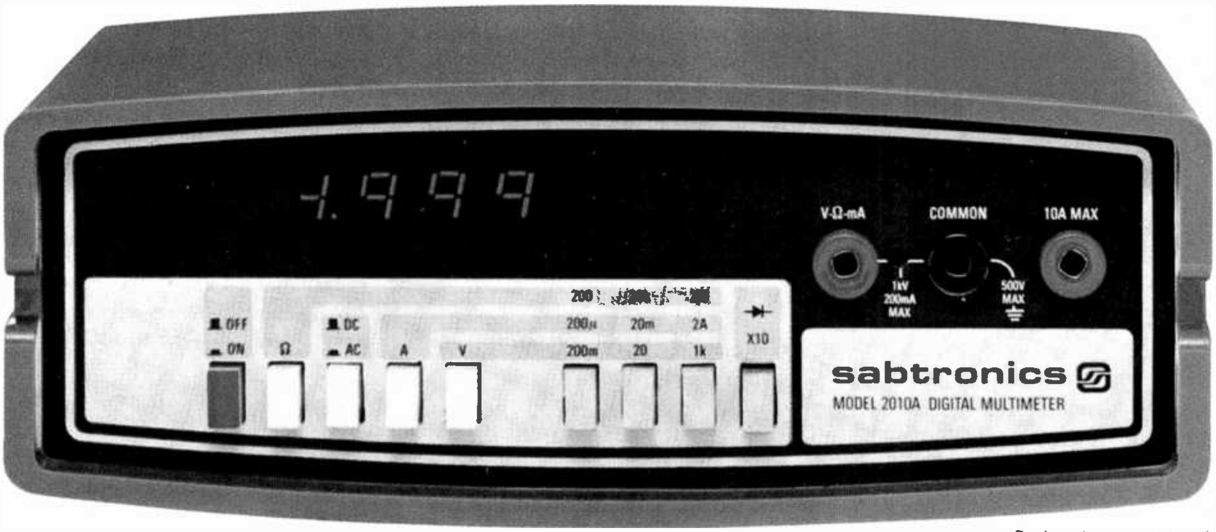
The B790 turntable from ReVox has no tonearm in the usual sense, but is equipped instead with an optoelectronic servo mechanism to position the cartridge.



ALL NEW AND ADVANCED DMM

by Sabtronics

for only $89.50



Designed and made in U.S.A.

The new and advanced Sabtronics Model 2010A is absolutely amazing . . . it gives you more performance, features and accuracy at a price no other Digital Multimeter can approach. It is versatile and rugged, for bench and portable use, with laboratory standard accuracy.

Greater Long-Term Accuracy

State-of-the-Art design features include a laser-trimmed decade resistor network and an ultra-stable band-gap reference element to insure long-term accuracy. Basic DCV and Ohms accuracy is 0.1% ±1 Digit, guaranteed for one year. With 31 ranges and 6 functions you can measure AC and DC volts from 100 μV to 1000V; AC and DC current from 0.1μA to 10 A; resistance from 0.1Ω to 20 MΩ.

Unique X10 Multiplier Switch

This exclusive feature of the Model 2010A gives you a convenient means of selecting the next higher decade range. The Hi-Lo Power Ohms capability gives you three High-ohm ranges that supply enough voltage to turn on a silicon junction for diode or transistor testing. Measure in-circuit component resistance with three Low-ohm ranges.

Touch and Hold Capability

The optional touch and hold probe allows you to make measurements in hard-to-reach places without taking your eyes off the probe tip. A button on the probe retains the display reading after the probe tip is removed from the test point.

Other Important Features

This quality instrument includes an ACV Frequency Response of 40 Hz to 40 kHz, automatic polarity, automatic zero, automatic decimal point, overrange indication, and overload protection on all functions and ranges. The bright LED display gives readings to ±1999 and is easy to read in dim light or bright light.

Reliability and Performance at Low Cost

The Model 2010A is factory tested, calibrated and is supplied complete with test leads, probes and detailed operating manual. A full compliment of optional accessories is available to increase the versatility of your 2010A DMM. Because you buy factory direct, you get this high-quality, full performance instrument at an incredibly low price of only $89.50.

Brief Specifications

DC Volts: 100μV to 1000V in 5 ranges
AC Volts: 100μV to 1000V in 5 ranges
DC Current: 0.1μA to 10 A in 6 ranges
AC Current: 0.1μA to 10 A in 6 ranges
Resistance: 0.1Ω to 20 MΩ in 6 ranges
Diode Test Current: 0.1μA, 10μA, 1mA
ACV Frequency Response: 40Hz to 40kHz
Input Impedance: 10 MΩ on ACV and DCV
Overload Protection: 1200 VDC or RMS on all voltage ranges except 250 VDC or RMS on 100mV and 1 V AC ranges. Fuse protected on ohms and mA ranges.
Power Requirement: 4.5 to 6.5 VDC (4 "C" cells) optional NiCd batteries or AC adapter/charger
Display: 0.36" (9.2mm) Digits reading to ±1999
Size: 8"W x 6.5"D x 3"H (203 x 165 x 76 mm)
Weight: 1.5 lbs. (0.68kg.) excl. battery

(Batteries not included)

Orders Yours Today

Call us with your Mastercharge or Visa order or use the convenient order form to take advantage of this special introductory offer.

Making Performance Affordable

sabtronics

13426 Floyd Circle M/S 24 · Dallas, Texas 75243
Telephone 214/783-0994

To: Sabtronics International, Inc., 13426 Floyd Circle M/S 24, Dallas, TX 75243

PLEASE SEND ME THE FOLLOWING:

______	Model 2010A Digital Multimeter(s)	@$89.50	$ ______
______	AC Adapter/Charger(s)	@$ 7 50	$ ______
______	Nickel-Cadmium Battery sets	@$17.00	$ ______
______	Touch-and Hold Probes	@$18.00	$ ______
	For delivery in Texas, add Sales Tax		$ ______
	Shipping, Handling and Insurance per unit $4.00*		$ ______

☐ Check enclosed ☐ Money Order, or bill my ☐ Master Charge ☐ Visa **TOTAL $** ______

Account No. ______ Expiry Date ______

Name ______

Street ______

City ______ State ______ Zip ______

*Continental U.S. only. AK, HI & PR, $5.00. Canada: $6.50. Foreign: $19.00 Airmail.

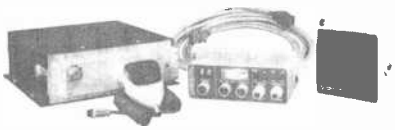
PE-4

The platter is turned by a direct-drive servo motor with quartz-crystal speed control at 33⅓ or 45 rpm with speed adjustments of ±7% and a four-digit, seven-segment LED speed readout. The cartridge is carried by a mounting plate of aluminum 4 cm long and weighing a little over a gram. The arm/cartridge assembly is mounted on an overhead carrier mechanism that moves the cartridge tangentially across the face of the record on steel rails. Lateral movement is controlled by a sensing system using an LED light source that advances the cartridge at the groove rate. The company claims that this arrangement eliminates tracking error and noncompliance due to the effective moving mass of a tonearm. The system is supplied with an Ortofon M20E moving-coil cartridge and a brush that automatically cleans the sylus between records. $799.

CIRCLE NO 92 ON FREE INFORMATION CARD

CPI CB AM/SSB Mobile

The Model CP-2500 mobile AM/SSB CB radio system from Communications Power, Inc., (CPI) combines the security of a trunk-mounted transceiver module with the



convenience of a dashboard control console. The system's control unit includes a numeric channel display; upper/lower-sideband and AM selector; volume, PA provision, r-f gain, microphone gain, clarifier, and squelch controls. The receiver features a separate, switchable automatic noise limiter and blanker; a logarithmic speech compressor; and front-panel signal strength, transmitter power and modulation meter. An 18' (5.5.-m) cable is provided for interconnecting the control and transceiver units.

CIRCLE NO 93 ON FREE INFORMATION CARD

Hazeltine Video Computer Terminal

Hazeltine Corp. has introduced a new low-priced B&W video terminal for data entry

and data inquiry in a microcomputer system. It features separate numeric keys. The new Model 1410 economy computer terminal is based on the company's 1400 and 1500 video terminals. It operates with a standard EIA RS-232 interface with eight transmission rates (selectable onboard) up to 9600 baud to accommodate all 128 ASCII character codes. A cooling fan is not required and electronic components are mounted on a single printed-circuit board.

CIRCLE NO 94 ON FREE INFORMATION CARD

Nikko Compact Preamplifier

Nikko has added the ultrathin (2 3/32"H) Beta III PET preamplifier to its professional series of audio components. It uses newly designed FETs throughout its signal circuitry for fast and accurate signal reaction, high S/N characteristics, and extremely

low distortion. Its specifications include: within ±0.2 dB for the 30-to-15,000-Hz RIAA phono frequency response (10 to 50,000 Hz ±0.5 dB tuner and AUX); less than 0.004% THD phono at 3 volts tape out (0.005% THD tuner and AUX at 2 volts preamp out); 2 mV phono (110 mV all other) input sensitivity; selectable 22k/47k/100k phono (47k all other) input impedance; 81 dB phono (at 2 mV input), 100 dB tuner and AUX S/N; ±10-dB bass and treble tone-control range; 350-mV maximum phono input; 1-volt output 1 and 2 and 100-mV tape 1 and 2 output level; 100 ohms output 1 and 2, 2200 ohms tape 1 and 2 output impedance; 19"W × 13"D × 2 3/32"H (48.3 × 33 × 5.3 cm); 13 lb (5.9 kg). $399.

CIRCLE NO 95 ON FREE INFORMATION CARD

Electra Scanner Includes AM Aircraft Band

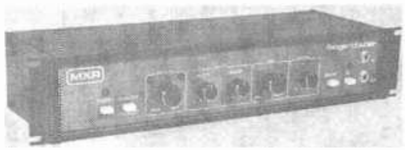
Electra Company's "Bearcat 220" is claimed to be the world's first scanning receiver to offer both standard FM Public

Service Band (five vhf-uhf) and AM Aircraft Band reception in a single unit. The crystal-less ac/dc receiver employs pushbutton frequency entry. Frequencies being monitored appear in a lighted numeric display. Up to 20 frequencies can be in any sequence or mix of bands. A priority function alerts the user when a call is received on the priority frequency programmed into the channel-1 location. Channels can be activated in banks of 10, permitting a single button to call up a group of 10 channels. Also, three search operations are provided to locate active frequencies. Other features include selective scan delay, scan speed selection, ac and dc operation, direct access to a programmed channel, and automatic and manual squelch.

CIRCLE NO 96 ON FREE INFORMATION CARD

MXR Flanger/Doubler

The MXR Flanger/Doubler produces a wide variety of time-delay effects and is instantly switchable between modes. Time delay is 0.25 to 5 ms in the flanging and 17.5 to 70 ms in the doubling modes. Featured are manual control over the delay time; mix control (between dry and un-

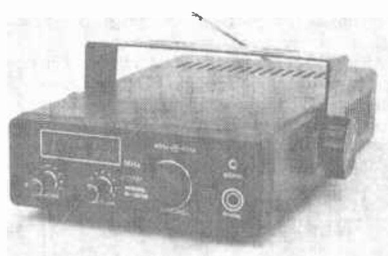


delayed signals); sweep controls for width and speed; and regeneration control for added intensity. Many varieties of flanging, hard reverberation, and numerous types of doubling, which include subtle chorus effects, can be produced. The device is rack-mountable and features instrument level inputs and outputs as well as line level inputs and outputs. Voltage-control terminals provide a means for externally controlling the delay and for ganging two units for stereo operation. $425.

CIRCLE NO 97 ON FREE INFORMATION CARD

Nihon Nav/Com Receiver

Nihon's COMNI R-1010 is a low-priced version of professional navigation/com-



(Continued on page 12)

munication vhf AM air-band receivers. Frequency control is by a PLL frequency synthesizer that tunes across the entire 108-to-135.975-MHz band in 25-kHz steps. Tuning is accomplished with concentric kHz and MHz channel-selector knobs. A five-digit LED numeric display provides frequency readout. Other features include a squelch control and a front-panel headphone jack.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Epicure "Trilogy" Speaker System

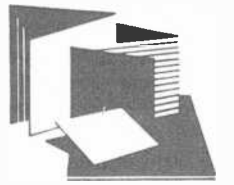
With its first three-way speaker system, the Model 3.0 "Trilogy", Epicure joins the growing number of manufacturers with enclosures that avoid the conventional box shape. The Trilogy's truncated-pyramid design is claimed to reduce time delay and other sources of distortion, while increasing power-handling capacity. Its rounded cabinet edges are said to eliminate diffraction effects. The Trilogy's 10" woofer crosses over to its separately baffled 6" midrange at 400 Hz; midrange crosses over to a 1" air-spring tweeter at 2600 Hz. Frequency response is rated at 32-20,000 Hz ±3 dB on-axis; response drops 3 dB at 15 kHz 90° off axis, and at 10 kHz 180° off axis. Nominal impedance is 4 ohms. Power requirements are 30 watts rms (15 dBW) minimum, 500 W (27 dBW) peak maximum, 100 W (20 dBW) average. Height is 41⅜", and the system slopes from 16¼" square at the bottom to 8½" square at the top. $575 each.

CIRCLE NO. 99 ON FREE INFORMATION CARD

TRS-80 Microcomputer Serial I/O

Electronic Systems has introduced a new accessory for the Radio Shack Model TRS-80 microcomputer—an RS-232 compatible serial I/O that can be used with or without the expansion bus. On-board switching is provided for 110, 150, 300, 600, 1200, and 2400 baud rates; odd, even, and no parity; five to eight data bits; and one or two stop bits. It is available wired and tested as part number 8010C for $79.95 or in kit form as part number 8010A for $59.95. The etched and drilled printed circuit board is available separately as part number 8010 for $19.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD



New Literature

HEATHKIT 1979 WINTER CATALOG

A 96-page catalog describes the latest electronic kits available from Heath Co. Areas of interest include color TV, hi-fi components, amateur radio, test instruments, digital clocks, personal computer systems, and other products for home improvement and family entertainment. New products include a rack-mounted FM/AM stereo tuner, a dc-to-35-MHz dual-trace delayed-sweep oscilloscope, a portable rechargeable fluorescent light, a solid-state heat/cool setback unit for home energy saving, a precision r-f generator, etc. Address: Dept. 470-170, Heath Co., Benton Harbor, MI 49022.

TRS-80 MICROCOMPUTER REFERENCE HANDBOOK

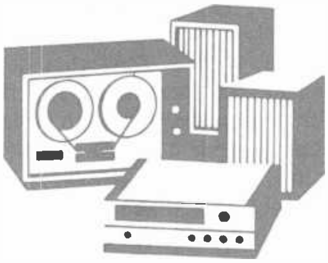
Radio Shack has published a 108-page book for technically oriented persons with a good working knowledge of digital logic circuits and interest in the TRS-80 microcomputer. It includes technical information and schematic diagrams for both Level-I and Level-II TRS-80 systems. Topics include theory of operation, adjustments and troubleshooting, the outside world (connections to external devices), parts list, etc. The Handbook is available for $9.95 from participating Radio Shack stores and dealers.

CHERRY KEYBOARD CATALOG

The 32-page Cherry KBC-78 Keyboard Catalog includes custom designed keyboards, a keyboard designer's worksheet, solid-state or gold crosspoint contact keyboards, a complete line of standard keyboards, keyboard switches and molded keycaps. The catalog features diagrams, photos and specifications. Address: Cherry Electrical Products Corporation, P.O. Box 718, Waukegan, IL 60085.

INTRA-FAB EQUIPMENT CABINETS

An eight-page catalog from Intra-Fab describes its line of integrated cabinets specially suited to the needs of the computer hobbyist. Selection information is provided on the construction, assembly, color and sizes of enclosures including Mod-U-Box desktop cabinets, Mod-U-Line and Timberline equipment cabinets, and Mod-U-Rack modular electronic card rack system. Address: Intra-Fab, 660 Lenfest Rd., San Jose, CA 95133.



Stereo Scene

By Ralph Hodges

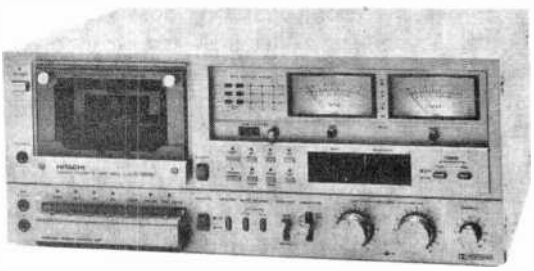
THE AUTOMATION OF TAPE

AS RECENTLY as the 1960s, before cassettes were a factor in the serious recordist's life, there was Scotch 111 and then there were other tapes. Scotch 111 was a hoary old product, with a history that descended linearly from the infancy of tape recording in the U.S. Ampex then was trying to get this nation's very first tape recorders into reliable operation.

Not even the 3M Company, 111's creator and manufacturer, would argue that it was an *outstandingly* good tape. There were certainly products available affording much greater potential performance when it was finally discontinued some years ago. But for a long period it reigned as *the* standard tape—presumably because it was fairly consistent and widely available, and because it was the direct evolutionary heir to the first U.S. ventures into magnetic recording. Tape recorders worldwide were adjusted to suit its characteristics, and when you were in doubt as to what tape to use for a particular application, you could almost always fall back on old 111 with a reasonable expectation of getting the job done adequately.

As much as anything else, it was the cassette era that brought an end to Type 111 and its ilk. No longer was there the option of using a higher tape speed or a wider track width to get through the more demanding recording jobs. The format didn't allow such flexibility. And so it was the tape itself that had to improve, and it did—by leaps and bounds. But this progress was exacted at a certain price. Tapes necessarily drifted away from the electromagnetic characteristics of 111, at first gradually and then dramatically. In short order, cassette tape bore only a passing resemblance to its open-reel relatives in terms of recording parameters, and then open-reel tapes began their own drive toward higher performance, bringing the relatively uncomplicated world of Scotch 111 to an end.

JVC Model KD-A8 Cassette Deck



Hitachi Model D-5500 Cassette Deck

The Problematic Present. When a tape is improved in any significant way—even if the change is something so ostensibly physical as a smoother coating surface, with the magnetic particles themselves left unchanged—it behaves differently with real-world tape machines as an electromagnetic entity. Generally it requires (or at least would benefit from) a different level of recording-bias current, followed by the obligatory touch-up of the record equalization. These are adjustments that require good instruments and a certain amount of technical expertise to accomplish. And they are time-consuming. Buy a handful of tapes from your local retailer, just to find out which brand suits you best, and you may find that all of them require somewhat different bias and equalization, even if they are of the same generic type. Optimizing your machine for each one so that you can evaluate noise levels and other important performance criteria will prove to be a project of considerable proportions.

Then, when you have found your preferred tape and begin to buy it regularly, you will sooner or later come up against a conundrum that isn't talked about much: batch variations. Tape manufacturer X's production run for June is not likely to be identical to the product he offered in March. Very serious recordists buy in quantity from a single batch and resign themselves to readjusting their machines when their supply runs out and a new batch must be investigated.

Of course, all of this completely overlooks the plight of the man on the street who cannot readjust his machine. He can only hope that the bias and EQ switches on the deck have enough flexibility to approximate the requirements of the tape. At the same time, he is going to be lured by ever-emerging new tapes claiming unprecedented levels of performance, but completely undefined as far as his machine is concerned. Its available bias and EQ characteristics may suit these tapes or they may not. He can only experiment and hope for the best, or stick to the older product he's always used—not exactly a formula for progress.

The situation can only become more confused. Tape manufacturers routinely trade off one performance characteristic for another they consider more desirable. It's a bit of a gamble, because if they stray too far from the mean characteristics exhibited by the majority of tapes of that generic type they risk missing the market. But at the same time it's a chance to further the technology, and perhaps to open a new market.

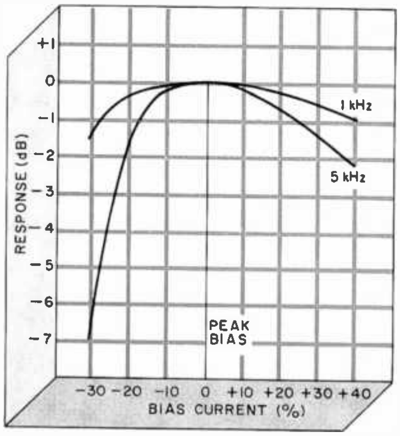
Self-adjusting Decks. In short, tape-type accommodation is a dilemma that's been crying for a solution for years. And here it comes, or a good part of it, at least. Following closely on the heels of a few innovative cassette decks incorporating two-tone oscillators that enable you to achieve reasonably flat frequency response with virtually any tape (better than nothing, surely), has come a small wave of machines that contain (usually) 4-bit microprocessors that undertake to set bias and equalization automatically through a pre-programmed test sequence. Last month I made reference to the Technics RS-1800, the first open-reel extravaganza (with a price to match, no doubt) that boasts this feature. But the man on the street is more likely to respond to the new cassette decks that will perform the same trick, best exemplified so far by the Hitachi D-5500 and the JVC KD-A8.

Bias is the tricky consideration in this whole business, in large part because the optimum bias level for a tape is controversial. Depending on your criteria, you could adopt a bias level that: (1) maximizes output of the tape at some reference frequency (usually 1000 Hz); (2) minimizes third-harmonic distortion from the tape (for a test frequency of your choice, but often one in the vicinity of 1000 Hz); (3) minimizes modulation noise; (4) minimizes intermodulation distortion in any of a number of two-tone tests; or (5) satisfies any of a number of "ideal" criteria for the relative usable output levels from the tape at low and high frequencies.

Designers of self-adjusting tape decks have decided against incorporating distortion analyzers, the complexity and expense being a bit too much for today's market. Instead, they all aim for maximum output level (MOL) at some specific frequency. Full details are not available in every case, but the Hitachi machine can serve as an example of the approach.

Hitachi chose to set bias for a MOL at 1000 Hz. However, the output vs. bias curve at that frequency exhibits a rather broad peak (see Fig. 1), and the resolution of the microprocessor was deemed inadequate to strike a really definitive bias point. At 5000 Hz the MOL peak is considerably sharper, and

Fig. 1. The more sharply defined optimum bias point at 5 kHz makes that frequency a more suitable choice for bias adjustment.



at the same time output-level variations from the tape (resulting from drop-outs, variations in tape-to-head contact, etc.) are not likely to confuse the adjustment process.

In a study of various representative tapes, Hitachi determined that the bias level giving peak output at 1000 Hz is roughly 33 percent higher than that which gives a 5000-Hz MOL for "normal" ferric-oxide tapes, roughly 25 percent higher for CrO_2 tapes, and 11 percent higher for ferrichrome tapes. With that statistical information, Hitachi was able to create a system that adjusted for MOL at 1000 Hz while actually testing the tape at 5000 Hz. A tape-type switch must still be used to make sure that the right correction factors are introduced.

The JVC machine will take on almost any tape without the need to throw a switch to identify its generic type. On the other hand, the JVC machine presumably doesn't offer the finer degree of resolution possible when the microprocessor is re-

"ON THE SIDE"? MOVE UP WHERE THE ACTION IS.

If you've been looking forward to moving up to where the CB action really is, now's your chance . . . with the fabulous Cobra 2000GTL base station.

Because the 2000GTL has everything CB-ers in general and sidebanders in particular—have ever dreamed about. It's the only base station with built-in 6-digit frequency counter, that lets you check both your transmitted and received signals with laboratory precision. The counter becomes an LED digital clock at the push of a button, and will, if you choose, turn on the radio automatically. Dual back-lit meters measure percent modulation, SWR, signal strength and RF power. "DynaMike Plus" permits full talk power even when you're not close to the mike.

Other important features include voice lock with coarse/fine tuning and headphone and auxiliary audio output jacks.

But it's in noise reduction where the 2000GTL really stands out above the crowd. In addition to switchable noise blanking and automatic noise limiting, the 2000GTL's receiver circuitry is designed to achieve sharp reduction of intermodulation and cross-modulation rejection. In addition, the SSB receiver employs a 6-pole, narrow-band crystal-lattice filter that provides excellent adjacent-channel rejection and noise reduction. (In SSB transmit mode, this same filter assures maximum carrier suppression.) The AM receiver is dual conversion, using crystal and ceramic filters. All this is topped off with separate IF strips for AM and SSB. The bottom line is quiet performance that must be experienced to be believed.

To assure highest quality sound, the 2000GTL has a separate speaker in its own enclosure. A second speaker may be added as a remote unit if you wish.

Best of all, now's the time to get everything the current state of the art makes possible—at a price the serious CB-er can afford. You may never get another chance like this to move up where the action is.

Cobra®

Punches through loud and clear.

Cobra Communications Products
DYNASCAN CORPORATION
6460 W. Cortland St., Chicago, Illinois 60635

National Sideband Convention, July 13-15, Chicago, IL
For information, write to PO Box 1691, Bridgeview, IL 60450

CIRCLE NO. 9 ON FREE INFORMATION CARD

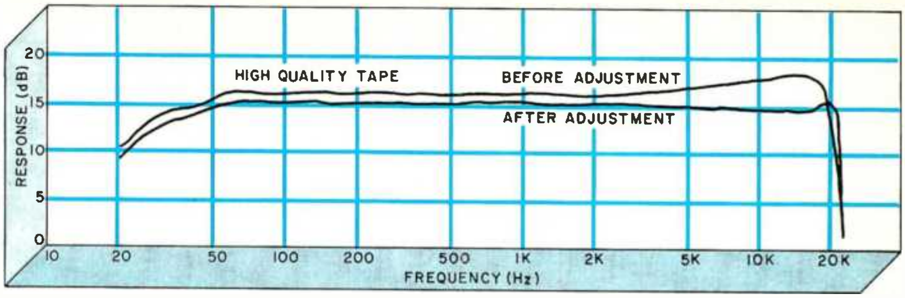


Fig. 2. A high-quality tape exhibits an almost perfectly flat frequency response after adjustment.

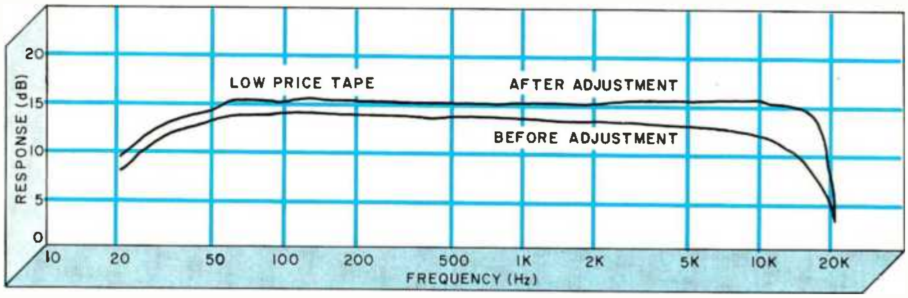


Fig. 3. A low-price tape shows obvious deficiencies in performance, but is much improved in any case after the adjustment sequence.

quired to "search" only a comparatively narrow range of bias-level options.

The "Search." A hunt through various stepped levels of bias is how these machines accomplish their jobs. In at least one case, the bias descends in steps and then ascends; the final level chosen is the average of the MOL's determined by the descending and ascending sequences. The Hitachi deck is a three-head machine and is thus able to present data immediately to the microprocessor. The JVC has two heads and must rewind the tape (which it does automatically as part of the test sequence) before it can play the recorded test signals and "read out" to the control circuits.

A similar hunt takes place during the subsequent automatic adjustment of recording equalization, but EQ is handled with varying degrees of sophistication. The Hitachi system appears to be the most complex, with shelving frequency-response characteristics below 10,000 Hz and peaking characteristics centered at 14,000 Hz. The JVC and Technics systems appear to provide comparatively simple filters with hinge points located somewhere in the midfrequencies. Whether the intricate mechanism that Hitachi has devised will be worth its weight in tape is a question that can be answered only after some serious experimentation with it.

For the cassette decks in this group, it is also necessary—or at least convenient—to provide some means of normalizing a tape's input/output characteristics (sensitivity, in other words), so that the level-dependent noise-reduction systems they have built in will function properly without further fussing by the user. Such facilities have been provided in the JVC and Hitachi decks, and they promise to be a real boon to those who have become disenchanted with noise reduction while being unable to get at the calibration controls that would make it work right. Dolby Laboratories, to name one manufacturer, does not encourage its licensees to provide accessible calibration controls, though some licensees make such provisions. But this policy leaves the user at the mercy of whatever tape he happens to be using—and at the mercy of the person who performed the initial calibration at the factory. (As independent tests have shown, the cassette-deck industry does not always distinguish itself by providing the best Dolby tracking imaginable.)

The Specs. The control circuits in these self-adjusting machines, being digital, cannot offer continuously variable settings. Their search proceeds in discrete steps as governed by their memories. The Hitachi machine provides 96 steps for bias level, obtained through a 4-bit converter and a 3-bit floating-point system. The EQ and sensitivity adjustment functions have 16 steps, each of 0.5 dB. The JVC machine has 32 steps for bias, 15 for sensitivity, and 7 for equalization. These differences are reflected to a certain degree in the specifications for the two machines. With a good tape, the Hitachi is said to maintain a frequency-response tolerance of ±0.5 dB over much of the audio frequency range. JVC's deck is typically ±1 dB according to the same criterion. Harmonic-distortion ratings are difficult to compare because of differences in testing.

Suffice it to say that both machines are rated in the range of 1 percent total harmonic distortion for recording levels below those that would cause tape saturation. Figure 2 shows Hitachi's curves for a high-quality tape before and after adjustments for sensitivity and frequency response have been made. Figure 3 presents the same data for an inexpensive tape. (It should be pointed out that there is a substantial price difference between the Hitachi and JVC machines. Final Hitachi pricing has not been announced, but a figure of $1000+ is anticipated. You'll find JVC's KD-A8 considerably easier on the pocketbook.)

I look forward to a flood of these self-adjusting tape decks within the coming year or so. The technology is here in an affordable format, and the wonders it can perform (refer to Figures 2 and 3 again) have to be just irresistable to someone who takes his tape recording seriously.

When the trend is fully established, there will be no more tape jungle for the consumer to flounder through. He will be able to buy an armload of different manufacturers' cassettes, take them home, and in the course of a civilized, low-pressure evening decide for himself what his brand is going to be, without the worry that a noncompatible machine is making a good tape look bad. By the same token, tape manufacturers will be able to concentrate their full efforts on making a genuinely better tape. It will not be just a *somewhat* better tape that has been compromised a little because it must match the performance and adjustment profile of the tape decks already in the hands of potential customers. ◇

FISHER INTRODUCES THE WORLD'S FIRST CASSETTE DECK WITH WIRELESS REMOTE EDITING.

Tape recording will never be the same.

In Fisher's 41 years of audio leadership, we've introduced many important high fidelity "firsts." But we honestly think the new CR4025 tape deck is one of our most exciting and practical innovations.

Remote electronic editing is as important an advance in tape recording as the cassette.

Now for the first time, you *can really enjoy* creating your own personal music library from FM broadcasts or record albums. The editing is done electronically while recording. A great leap forward from the old way of recording... without jumping up and down every 3 minutes to edit.

Fisher's wireless remote electronic editor makes tape recording a pleasure. The CR4025 tape deck has a built-in wireless receiver that operates the deck's solenoid-actuated Pause mechanism. The remote control transmitter operates the Pause control instantly from up to 20 feet away. Relax, listen, and capture the selections you want to keep at the push of a button.

Zap! You eliminate any commercial or announcer's voice from your off-the-air FM broadcast recording . . . or skip any unwanted track on an album you're taping from.

Of course, this fantastic convenience wouldn't be worth much if you had to sacrifice performance. Fortunately, you don't — the CR4025 has the excellent frequency response and extremely low wow & flutter that you expect from Fisher, plus Dolby noise reduction for clean, noise-free recordings.

The Fisher CR4025 is priced at $270* and is available at selected audio stores or the audio department of your favorite department store.

New guide to buying high fidelity equipment. Send $2 for Fisher Handbook, with name and address to Fisher Corp., Dept. H, 21314 Lassen St. Chatsworth, Calif. 91311.

*Manufacturer's suggested retail value. Actual selling price is at the sole discretion of the individual Fisher dealer.

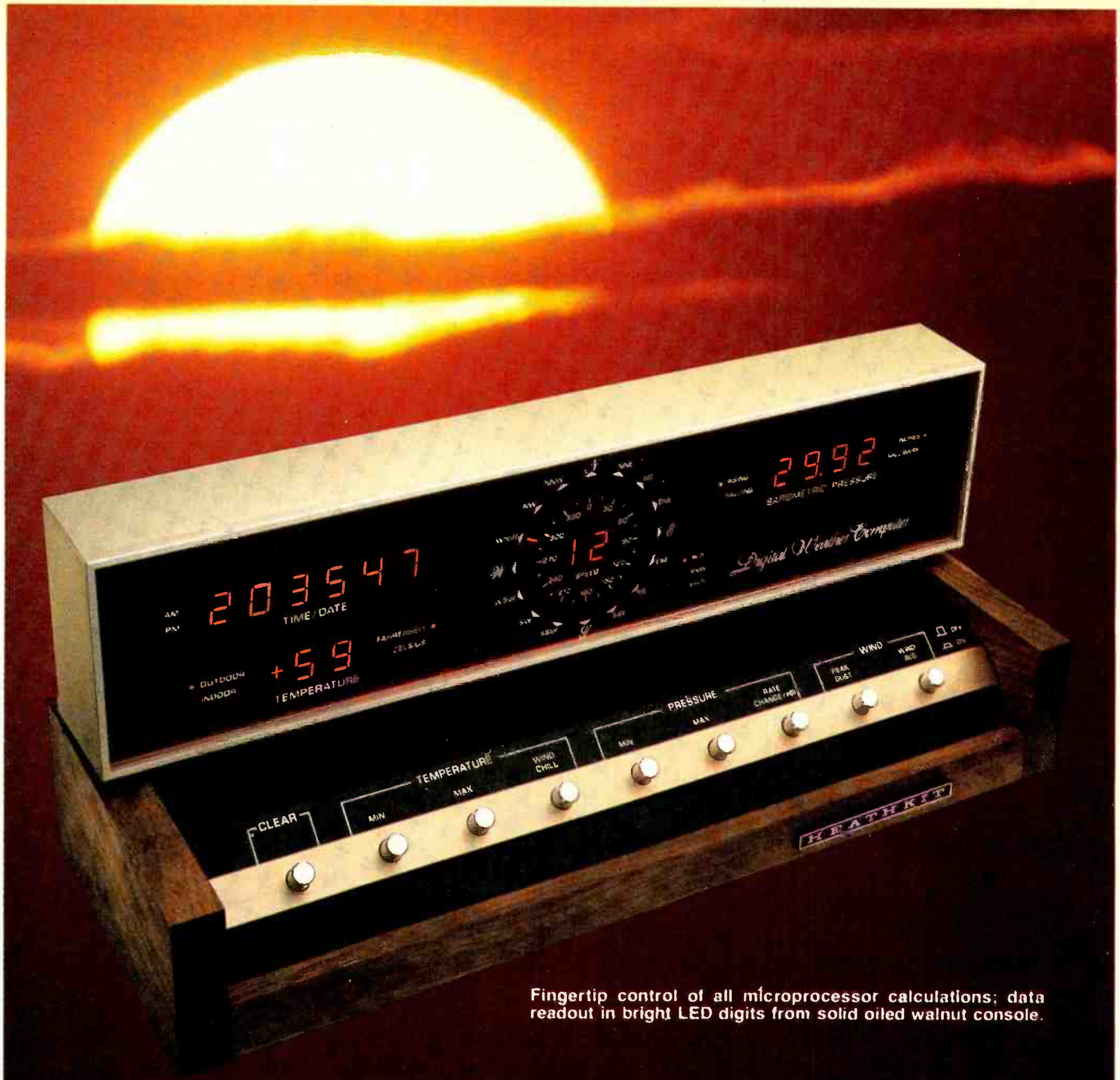
FISHER

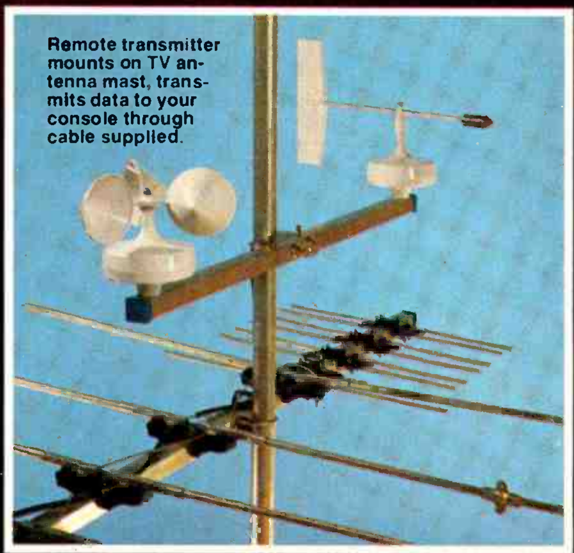
The first name in high fidelity.

CR4025

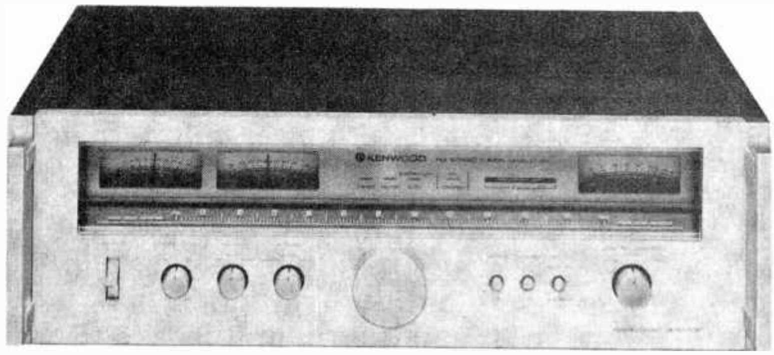
Dolby is registered trademark of Dolby Laboratories.

CIRCLE NO. 19 ON FREE INFORMATION CARD


2 0 3 5 4 7
TIME/DATE
+5 9
TEMPERATURE
1 2
SPEED
2 9.9 2
BAROMETRIC PRESSURE
Digital Weather Computer
CLEAR
TEMPERATURE
MIN
MAX
WIND CHILL
PRESSURE
MIN
MAX
RATE CHANGE/HR
WIND
PEAK GUST
WIND AVG
HEATHKIT



Julian Hirsch Audio Reports



The Kenwood Model KT–917 FM super tuner nulls tuning distortion automatically

distortion detection loop and pulse-counting demodulator are featured

HIRSCH-HOUCK LABS REPORT

THE Model KT-917 FM tuner from Kenwood uses unusual and innovative circuits to minimize or eliminate most of the conditions that normally lead to distortion in FM reception. The tuner also features three degrees of i-f selectivity and a multiple tuned circuit front end that gives outstanding interference rejection.

Kenwood has determined that the distortion levels in many FM tuners are unnecessarily high because the user has no means of accurately tuning for minimum distortion. Afc merely corrects for gross tuning errors, and even crystal-controlled synthesized tuning systems cannot guarantee that the pass-bands of the i-f and detector sections are accurately aligned with each other. Kenwood's solution, therefore, was to design a "Distortion Detection Loop" (DDL) system that automatically nulls out tuning distortion. The DDL is used in combination with a highly linear pulse-counting type of FM detector.

The tuner measures 18¼"D × 18⅛"W × 6⅜" H (46.4 × 46 × 16.2 cm) and weighs 33.1 lb (15 kg). Suggested retail price is $1000.

General Description. The tuner has a standard slide-rule tuning dial behind a window that also covers the large and easy-to-interpret meters. Two of these are conventional zero-center tuning and signal-strength meters. A third is a combination meter that can be switched to indicate either deviation or multipath distortion. The signal-strength meter is calibrated directly in 10-dB steps from 0 to 90 dBf. The deviation meter registers peak frequency deviations from zero to 120% of the rated 75-kHz maximum.

Four lights above the dial scale come on separately to indicate when muting is in operation, a stereo signal has been tuned, the tuner has been set for AUTO mono/stereo reception, and the Distortion Detection Loop is in operation. Tuning of the Model KT-917 is performed in the same manner as with any conventional tuner, tuning until the zero-center meter is in the center of its scale. The difference here is that a couple of seconds after the tuning knob is released, the DDL system automatically completes the tuning for minimum distortion. Then the DDL indicator comes on.

surface acoustic filters provide superior selectivity

The tuner's muting threshold can be set at either 20 or 40 dBf, or the muting system can be disabled altogether. A horizontal row of lighted green dots above the dial scale increases in length as the tuner's i-f bandwidth control is switched from narrow to normal to wide.

A "quieting control" permits the user to select the tuner's operating mode. In AUTO, either a mono or a stereo broadcast will be heard correctly. With the control set to the STEREO position, the tuner unmutes only for stereo signals. (In this position, if the signal strength drops low enough to make noise a problem, a multiplex filter automatically blends the left and right channels at the high frequencies to reduce the noise with no appreciable degradation of the stereo image and with no loss in high-frequency response.) All signals received, whether mono or stereo, are delivered to the amplifier in the mono format when the switch is set to MONO.

Pushbutton switches are provided for switching between deviation and multipath distortion display on the dual-purpose meter; dimming the panel lights; and connecting either of two antenna systems to the tuner. The normal A and B antenna connectors are 75-ohm coaxial jacks. The B antenna connector is paralleled by binding posts for a 75-ohm antenna and a 300-ohm antenna. The purpose of the dual antenna inputs is to simplify the orientation of antennas for minimum multipath distortion. By placing the two antennas at suitable angles to each other, one has a choice of two receiving conditions for every station. If the antennas are oriented for minimum multipath distortion on one or more stations, it will often be possible to improve reception appreciably by selecting the appropriate antenna without the cost and inconvenience of a rotatable antenna system.

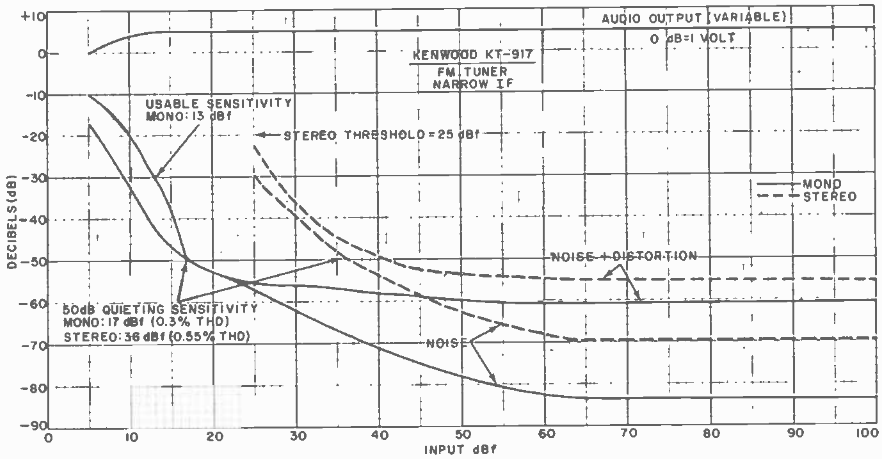
Vertical and horizontal outputs on the rear apron permit an accessory oscilloscope to be connected to the tuner for displaying multipath distortion. There are also separate pairs of fixed and variable-level audio output jacks; a slide switch for changing the deemphasis time constant from the normal 75 to 25 µs for use with an external Dolby adapter; and a single unswitched ac outlet on the rear apron.

The two MOSFET r-f amplifier stages in the tuner contain a total of *seven* tuned circuits. Two tuned circuits precede the first amplifier stage, two are between stages, and three couple the amplifier to a four-diode (Schottky) balanced mixer. Although it is complex and expensive, this approach gives the tuner a degree of immunity to overload and spurious-signal generation that is rarely, if ever, found in home-entertainment equipment. The local oscillator is followed by two buffer stages and other circuits. Both the oscillator and the second buffer stage are tuned, and the nine-section tuning capacitor is unique among the tuners we have seen.

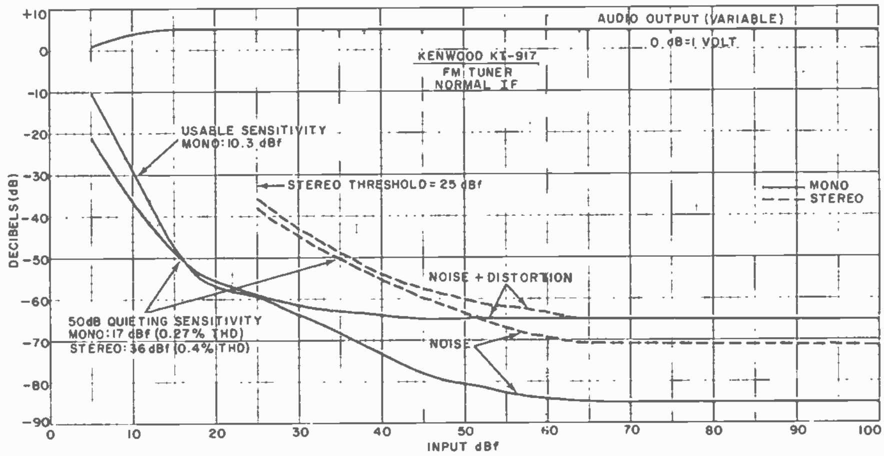
The 10.7-MHz output from the mixer is linearly amplified by a FET stage whose output is then processed for driving the signal-strength and multipath-distortion meters. The distortion meter responds to the amplitude modulation imposed on an FM signal during multipath distortion. The signal is passed through an accurate logarithmic converter before it is applied to the signal-strength meter.

row of green LEDs indicates selected i-f bandwidth

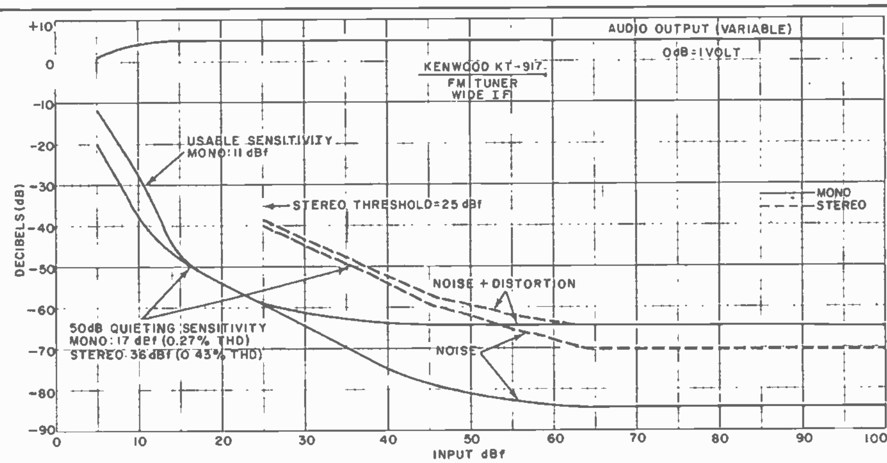
Following the linear i-f amplifier is a series of four surface acoustic filters (SAFs) that give the tuner its selectivity. (The SAFs operate by propagating acoustic waves across a ceramic substrate from an input transducer and receiving the waves in an output transducer that restores them to electrical form.) The SAF has excellent bandpass flatness, steep rejection skirts and good group delay characteristics, which are necessary for low distortion and good separation in stereo reception. Only one filter is used in the WIDE mode, two in NORMAL, and all four in NARROW. Filters coupled by amplifier stages are switched in and out by diodes that are operated by dc control signals.



Noise and sensitivity curves for narrow selectivity mode.



Noise and sensitivity curves for normal selectivity mode.



Noise and sensitivity curves for wide selectivity mode.

The 10.7-MHz i-f signal is converted to 1.96 MHz and amplified before going to the pulse-counting detector. Following detection, the signal is processed by a sample-and-hold stereo demodulator. The composite stereo signal is sampled at a 38-kHz rate, which is synchronized with the 19-kHz pilot signal, to convert it to left- and right-channel audio signals. Instead of the usual lowpass filter to remove 19- and 38-kHz components from the audio outputs (which can effect the flatness of a tuner's high-frequency response), the Model KT-917 has a pilot-canceller circuit in which the regenerated pilot carrier is used to cancel out the 19-kHz pilot signal in the detected output. This extends the tuner's flat audio response to beyond 15,000 Hz, while keeping 19-kHz leakage to low levels.

Laboratory Measurements. Be-

The Distortion-Detection Loop (DDL) in Kenwood's Model KT-917 tuner is a form of amplified afc, but with an important difference. Unlike a conventional afc, which tunes the local oscillator to produce a zero dc output from the detector, the DDL tunes for minimum second-harmonic distortion in the detected signal. This automatically compensates for any asymmetry in the i-f or detector, which is ignored in an ordinary afc system or in a manual-tuning system with the aid of a zero-center tuning meter setup.

Since there is no way to measure the second-harmonic distortion in a complex musical program, the Model KT-917 must supply its own test signal to operate the DDL. How this is done is illustrated in Fig. 1. As in any afc system, the dc local oscillator control voltage is present. This signal varies the local oscillator frequency through a Varactor diode and is combined with a locally generated 95-kHz signal that also frequency modulates the local oscillator. This is equivalent to having the FM station transmit a 95-kHz subcarrier at a low level of modulation.

At the output of the tuner's detector, the 95-kHz signal and any harmonics of it are separated from the stereo program by a high-pass filter. In a secondary control loop, the output of the 95-kHz oscillator is passed through an electronically controlled phase-shift network whose output is compared to the phase of the detected 95-kHz signal in Phase Detector #2. This process compensates for any phase shifts that occur in the modulation, amplification, and detection processes, so that the internal 95-kHz signal is exactly in-phase with the detected 95-kHz component.

The phase-corrected 95-kHz signal is passed through a frequency doubler. The resulting 190-kHz signal feeds one port of Phase Detector #1. The other port receives the filtered detector output, which consists of the 95-kHz signal and a small amount of second-harmonic distortion at 190 kHz. The phase of this distortion is a function of the direction of mistuning and its amplitude is proportional to the amount of the tuning error. Hence the output of Phase Detector #1 is proportional to any distortion created by a tuning error, although the second-harmonic distortion level is extremely low (about

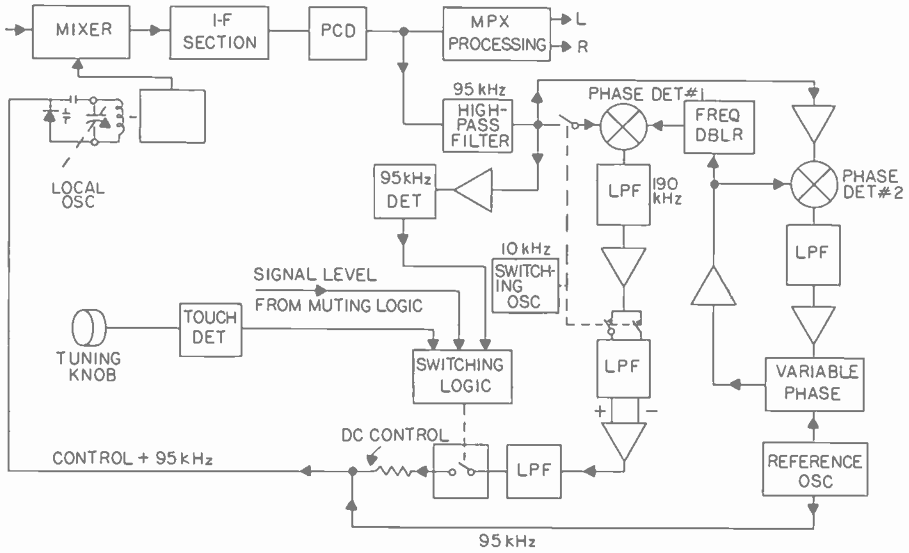


Fig. 1. Block diagram showing operation of the Distortion Dectection Loop (DDL)

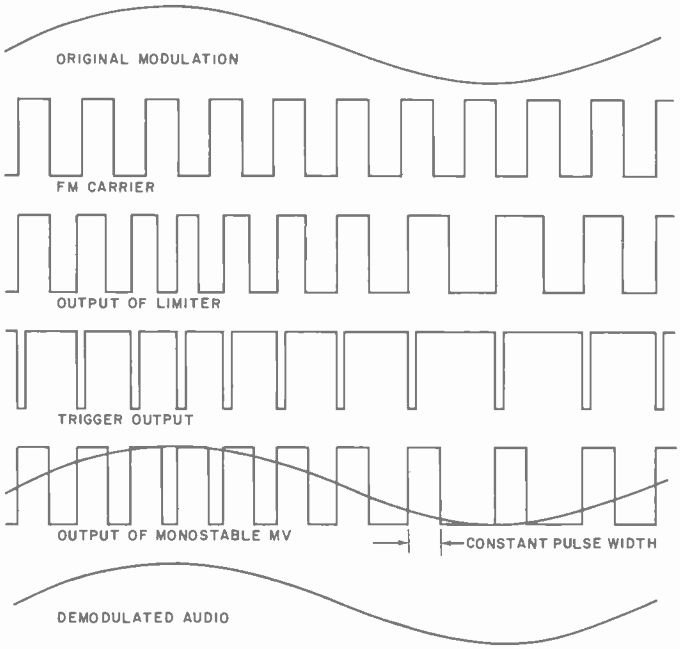


Fig. 2. Sequence of waveform changes in pulse-count demomulation.

100 dB below normal stereo program levels). A low-pass filter removes higher frequencies from the error signal, leaving a very small dc error voltage. Because of its extremely low level, it is necessary to use a switching (chopper) amplifier to amplify the dc error signal to useful levels without risking any drift that could introduce a tuning error. The phase detector and error amplifier are stabilized against drift by a 10,000-Hz switching signal that operates on the input and output signals to form an effectively direct-coupled high-gain amplifier with virtually no dc drift. After filtering to remove higher frequency components, this error signal is combined with the internally generated 95-kHz signal and sent on to the frequency control diode in the local oscillator.

A three-part logic system disables the DDL until a signal has been tuned in manually. The tuning knob functions as a touch detector. The detected 60-Hz hum is rectified and the resulting dc voltage goes to the DDL logic section. The logic also receives a dc level from the tuner's muting system and another from the detected 95-kHz signal. Unless a signal of sufficient strength and the necessary amount of 95-kHz modulation are present on it and the tuning knob is released, the DDL system is inhibited.

The pulse counting detector (PCD) is another novel circuit feature of the Model KT-917. Pulse counters are not new, having been used for decades for accurate linear FM demodulators in laboratory instruments and other critical applications. Until recently, they were too complex and expensive for use in consumer products, especially at the high i-fs employed in FM tuners. High speed ICs and transistors are now available at moderate cost, making the PCD practical for use in a high-quality FM tuner.

The principle of the PCD is very simple. The FM signal, at the intermediate frequency, is converted to a series of short pulses of constant width and amplitude, which occur at a frequency that is the same as that of the received signal. If the pulse train is clamped to a fixed (or zero) voltage level, its average value exactly follows the modulating waveform of the FM signal.

Figure 2 shows the sequence of waveform changes in the Model KT-917's PCD. The modulated FM signal after conversion to a lower i-f, is amplitude limited to form a square wave whose zero-axis crossings coincide with those of the input FM signal. Every time the limited waveform goes through the zero-voltage axis in a positive direction, a negative trigger pulse is generated by the trigger circuit. The trigger pulses drive a monostable multivibrator that produces pulses of uniform width and amplitude every time a trigger is received. Since the low and high levels of the pulse train are fixed, the average value of the multivibrator's output follows the waveform of the original modulation. It is only necessary to pass the pulse train through an integrator or low-pass filter to remove the carrier-frequency components and recover the audio.

The advantage of the PCD over a conventional tuned FM detector is illustrated in Fig. 3 (from data supplied by Kenwood). Since it depends on tuned circuits for its operation, the differential gain (the slope of the detector output voltage versus input frequency) changes slightly with frequency. The result is an output voltage that is not exactly proportional to the input frequency and distortion is created. The lower curve shows the almost constant differential gain of the PCD over a very wide frequency range. If the pulses are all identical, the output of the PCD is theoretically perfectly linear over a very wide frequency range.

Aside from its greater circuit complexity, the PCD also delivers an audio output voltage proportional to the deviation as a percentage of the operating frequency of the signal. At 10.7 MHz, a 75-kHz deviation is only 0.7% of the operating frequency, and the output is very low. By converting the 10.7 MHz i-f to 1.96 MHz, the same signal is now deviating 3.8% of the carrier frequency and the output is increased five-fold. This improves the S/N by about 15 dB, as compared to a PCD system operating at 10.7 MHz.

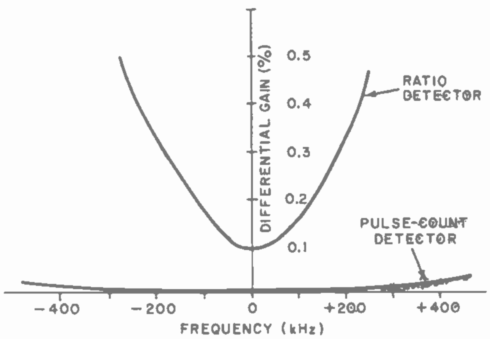


Fig. 3. Differential gain vs. frequency for ratio detector and pulse-count detector showing distortion performance.

cause many of the specifications of this tuner exceed those of good laboratory-grade signal generators, we did not expect to be able to fully confirm Kenwood's ratings. Specially designed or modified signal generators were used by Kenwood during the development of the tuner and to establish its performance ratings. Our tests were performed with a standard Sound Technology Model 1000A FM signal generator.

The measured sensitivity of the tuner was as rated. Measured distortion and noise were essentially those of our signal generator. Only by shutting off the modulation circuits in the generator (CW

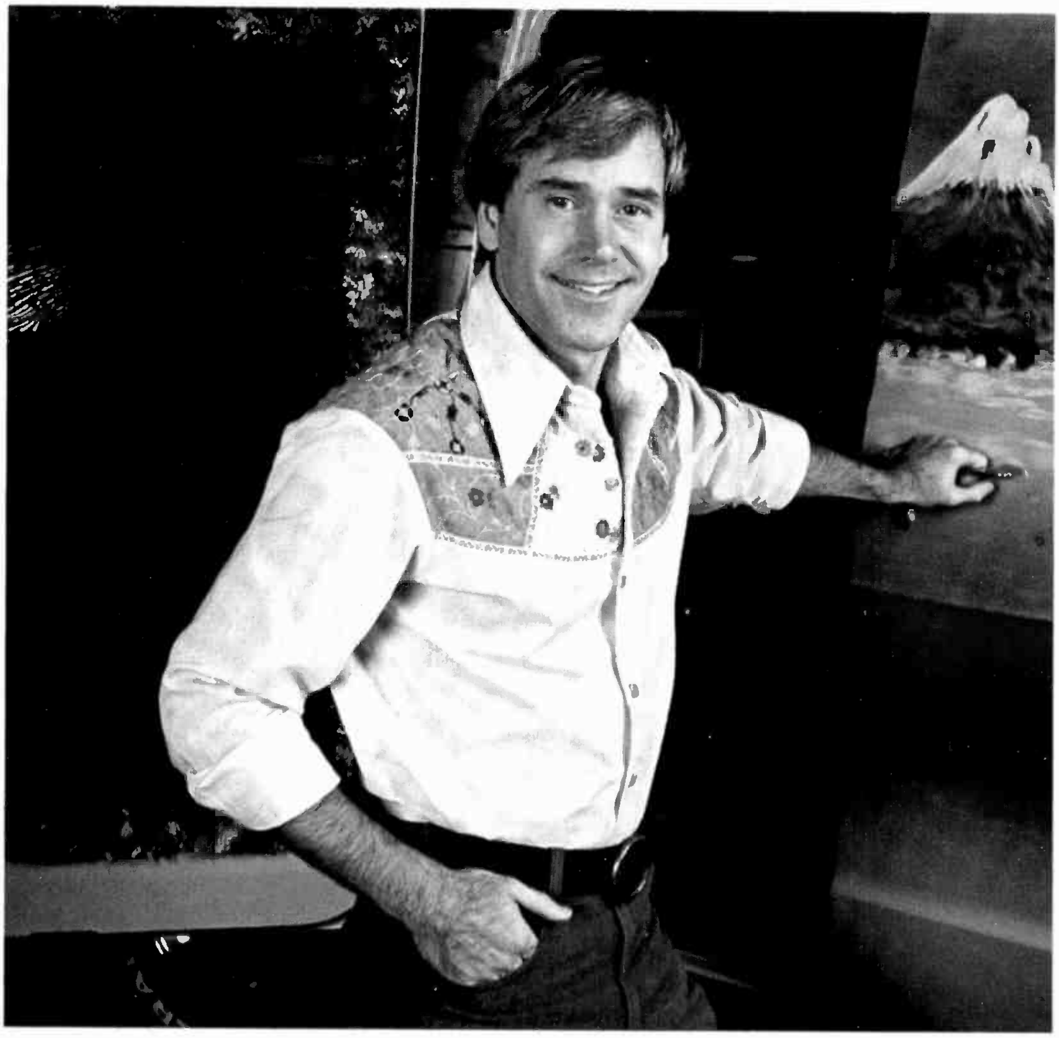
multipath meter is one of very few that is genuinely effective

mode) could we achieve the 84-dB mono S/N reading. Since the modulator was required for a stereo measurement, to supply the pilot-carrier signal, we were limited to approximately the 70-dB range of the generator. For our image-rejection measurement, we used a Boonton Model 202B signal generator, whose maximum output of 200,000 μV was not sufficient to produce a detectable signal at the image frequency, leaving us with an inconclusive but very impressive measurement of greater than 106 dB.

The only unexpected behavior we encountered when testing the tuner was the relationship of the DDL to stereo channel separation. The DDL worked perfectly and always produced minimum distortion, no matter how the tuning was set when the knob was released. However, when we first measured the stereo channel separation, with the tuning set "dead center," separation was 36 to 43 dB, which is perfectly adequate but somewhat short of Kenwood's claimed 50 to 60 dB. After confirming that the signal generator was correctly adjusted, we investigated further and discovered that releasing the tuning knob when the signal was barely tuned in, just at the point where the muting was overcome, gave much improved readings. We read typically 50 to 55 dB between 30 and 2000 Hz. With WIDE bandwidth, it exceeded 60 dB between 80 and 160 Hz and decreased smoothly to between 33 and 35 dB at 15,000 Hz. There was little difference in separation between IF BAND switch settings.

(Continued on page 28)

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.

Performance Specifications

Specification	Rating	Measured
Usable sensitivity		
(Mono)	10.8 dBf (1.9 μV)	10.8 dBf (NORMAL) 13 dBf (NARROW) 11 dBf (WIDE)
50-dB quieting sensitivity		
(Mono)	15.8 dBf (3.4 μV)	17 dBf
(Stereo)	37.2 dBf (40 μV)	36 dBf
S/N ratio		
(Mono)	90 dB	84 dB (unweighted—approx.
(Stereo)	84 dB	70 dB gen. residual)
Total harmonic distortion		
(Mono; 1000 Hz)	0.03% WIDE 0.06% NORMAL 0.15% NARROW	0.064% (approx. gen. residual) 0.064% 0.09%
(Stereo; 1000 Hz)	0.04% WIDE 0.09% NORMAL 0.12% NARROW	0.062% (approx. gen. residual) 0.062% 0.17%
CAPTURE RATIO	0.8 dB WIDE 1.4 dB NORMAL 1.7 dB NARROW	0.8 dB/0.73 dB (45/65 dBf) 0.8 dB/0.73 dB 2.1 dB/1.3 dB
Alternate channel selectivity	35 dB WIDE 60 dB NORMAL 60 dB NARROW	44 dB 44 dB 82 dB
Adjacent channel selectivity	N/A	6.3 dB (WIDE) 5.4 dB (NORMAL) 15.5 dB ((NARROW)
Stereo separation		
(1000 Hz)	60 dB WIDE 55 dB NORMAL 50 dB NARROW	51.0 dB 50.5 dB 54.5 dB
(50 to 10,000 Hz)	50 dB WIDE 45 dB NORMAL 40 dB NARROW	39.5 dB 38.0 dB 35.5 dB
(15,000 Hz)	40 dB WIDE 38 dB NORMAL 33 dB NARROW	33.0 dB 34.5 dB 34.0 dB
Frequency response	10-16,000 Hz +0.2/−0.5 dB	30-15,000 Hz +0.2/−0.3 dB
Spurious response ratio	125 dB	—
Image response ratio	125 dB	Greater than 106 dB
I-f response ratio	125 dB	—
AM suppression ratio	70 dB	70 dB (45 dBf) 73 dB (65 dBf)
Subcarrier product ratio	70 dB	66 dB
SCA rejection ratio	75 dB	—
Output level (1000 Hz, 100% mod)		
Fixed	0.75 V, 60 ohms	Confirmed
Variable	0-1.5 V, 60 ohms	0-1.86 V
Multipath output		
Vert.	0.01 V, 10,000 ohms	—
Horiz.	0.5 V, 3000 ohms	—

(Continued from page 23)

We were struck by the fact that the selectivity was approximately the same in both NORMAL and WIDE bandwidth modes. Our measurement of 44-dB alternate-channel selectivity would be considered marginal for most FM tuners if it were the only one available. However, we never experienced any interference problems using the tuner in New York City, where more than 50 stations can be received. In this area, which is subject to adjacent- and alternate-channel interference, the NARROW mode gave the tuner exceptional selectivity.

Dial calibrations were accurate to within 200 kHz and usually to within 100 kHz. The signal-strength meter indicated within 4 dB of the actual input signal level over its full range. The deviation meter's indications were about 15% greater than the actual deviation, which is of little importance for the meter's purpose. The multipath-distortion meter was one of the very few we have seen that is genuinely effective. Even a slight amount of multipath distortion produced an appreciable indication on the meter during modulation, and a signal without multipath did not cause any detectable pointer movement.

200,000 microwatts was not sufficient to produce detectable image signal

We were unable to use the scope outputs on the rear of the tuner as a multipath or tuning indicator. The reason for this was that the 0.01-volt vertical output was insufficient to produce a useful deflection on several scopes we tried.

User Comment. Since the tuner we tested was one of the first Model KT-917s to enter this country, we have no way of knowing if its unorthodox tuning for maximum stereo separation is inherent or a peculiarity of our test sample. Whatever the case, it is of minor importance, since broadcast stations are required to maintain only a minimum of 30 dB separation and virtually no phono cartridges or records are even that good. Needless to say, the tuner will never degrade the audible separation of the received program.

Operation of the DDL is very effective. With most tuners and receivers, normal tuning errors, even with great care, can easily degrade a 0.1% distortion condition to 0.3% and even 0.5%. As Kenwood points out, afc is no solution because its operation requires an error voltage that itself introduces a tuning error. The DDL, on the other hand, will give minimum second-harmonic distortion every time, with literally nothing the user can do to mistune the Model KT-917. (On weak signals of less than 25 to 40 dBf, the DDL may not lock on, in which case, the DDL indicator will not light. In any case, signals in this range will have their distortion masked by noise.)

can deliver last measure of performance possible

Basic operation of the tuner was superb! We usually preferred to set the muting threshold at 20 dBf, although one might find 40 dBf preferable in a very strong signal area to eliminate less powerful signals as the band is tuned. (The muting thresholds were very close to the indicated values, measuring 21 and 42 dBf.) The tuning mechanism operates with typical Kenwood smoothness, and the dial calibration was good enough to permit tuning to be set with the power off and, upon turning on the power, to hear the desired station perfectly tuned by the DDL system.

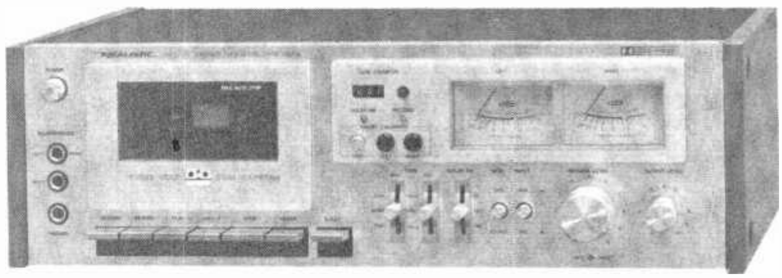
The signal-strength meter is highly informative because it displays the actual received signal levels in a form that can be related to the dBf ratings that appear in manufacturer ratings and our test reports. It is also useful in conjunction with the multipath meter for orienting a directional antenna. An antenna position that yields minimum deflection on the multipath meter and close to a maximum on the signal-strength meter is certainly the best for any given station. We never had occasion to use the deviation meter, which appeared to operate rapidly enough to give a useful indication of peak modulation levels. Although in a few less critical cases the tuner fell short of meeting its published specifications, there were at least as many of the far more important measurements that surpassed specs by wide margins.

In our opinion, only two i-f bandwidths would have been sufficient for any practical situation. With both the normal and the wide bandwidths giving virtually identical selectivity, distortion, and separation readings, one of the two was redundant. Our only other criticism is the unreasonably low output from the tuner's vertical scope terminals.

It would be difficult to show that a "super tuner" such as the Model KT-917 actually sounds better than a much less expensive and elaborate tuner on most typical broadcast material. After all, when *every* characteristic of the tuner is many times better than the corresponding property of the program material, one cannot expect sonic miracles.

The justification for a tuner like the Model KT-917 is that it overcomes the last vestige of human error in tuning and can be depended upon to deliver the last measure of performance possible on every station tuned in. As we see it, this is the rationale for the Model KT-917's existence, and it is a sufficiently convincing argument for those people who depend on FM sources for a substantial portion of their listening pleasure to make the considerable financial investment that this tuner represents.

CIRCLE NO. 101 ON FREE INFORMATION CARD



Three heads and variable bias adjustments are features of the Realistic SCT-30 stereo cassette deck

HIRSCH-HOUCK LABS REPORT

THE Realistic Model SCT-30 is currently Radio Shack's top-of-the-line cassette deck. This front-loading, three-head deck has separate Dolby noise-reduction systems for record and playback. Thus, programs can be monitored while recording with the same frequency response and noise level. The Dolby system can also be used to decode Dolbyized FM broadcasts with or without simultaneous recording.

The deck has separate bias and equalization switches for ferric-oxide, chromium-dioxide, and ferrichrome tapes. Other features include a dual-capstan tape drive; front-panel Dolby-level calibration control and test oscillator switch; vernier bias adjustment control for matching the requirements of different tape formulations; peak-responding meters; and adjustable "memory rings" that provide reference settings for the recording and playback level controls.

The cassette deck measures 18" W × 10" D × 5¾" H (45.7 × 25.4 × 14.6 cm) and weighs 16.5 lb (7.5 kg). It features walnut-veneer wood side plates and a satin-gold finished front panel. Suggested retail price is $399.95.

General Description. The Model SCT-30 resembles many other front-loading cassette decks, with its cassette loading well at the left of the front panel. Under the well is the customary bank of levers for operating the transport mechanism. A window in the cassette well door exposes almost the entire cassette to view during operation, and back lighting is provided.

separate record and playback Dolby for true tape monitoring

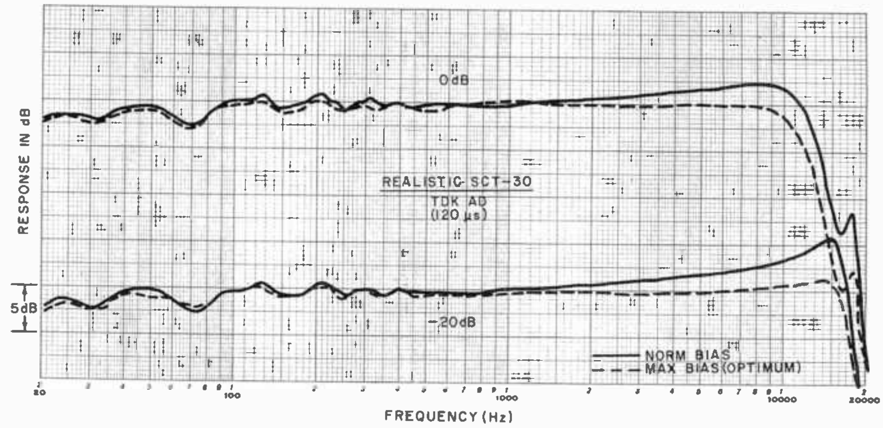
Bias and equalization for the various tape formulations can be set up with two lever switches. The BIAS switch has positions for CrO_2, ferric-oxide, and FeCr formulations. The EQ switch has corresponding legends for 70, 120, and 70 µs. (These time constants are for playback; recording equalization is also switched so that the 70-µs characteristics of the first and third positions of the EQ switch are not identical in their total effect.) A similar switch operates the Dolby system. Its third position is labelled FM, which is used to process audio from an FM station that Dolby-encodes its programs. In this mode, recording-level controls are disabled and the input level is controlled by two screwdriver controls (on the rear apron), using the test tones periodically transmitted by FM stations that use Dolby processing. The FM mode also converts the 75-µs deemphasis of the tuner's output to the 25-µs required by the Dolby noise-reduction system.

The two RECORD controls are concentric. A plastic ring that surrounds them can be set for conveniently returning to a predetermined gain setting. There is a slight detent at the ring's index mark. The OUTPUT (playback) level control also has a "memory ring."

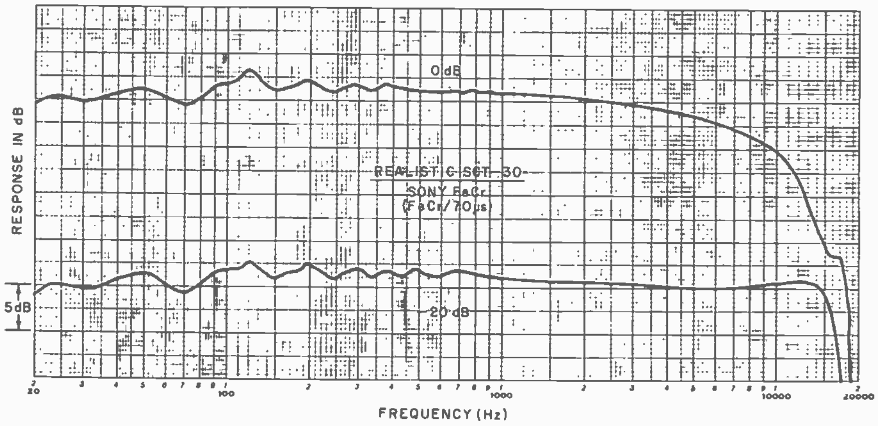
Laboratory Measurements. For our tests, we used the high-energy ferric-oxide Supertape Gold, TDK's AD and SA, Sony's FeCr, and Memorex's High Bias tapes. The overall record/playback frequency response with any of these tapes was well within the deck's published ratings. In fact, all the tapes performed very similarly to each other when the bias was adjusted according to instructions for each tape. The low-frequency "head ripples" in the response curve were rather low in amplitude, although they extended up to about 700 Hz. They did not reduce the low-frequency response, which was almost flat down to our measurement limit of 20 Hz.

The overall response was typically well within ±2 dB, referred to the 1000-Hz level, from 20 to 16,000 Hz with all of the tapes at a −20-dB recording level. The deck was slightly underbiased for TDK AD and Memorex High Bias tapes. However, with the bias adjustment set to its maximum limit, both tapes yielded very flat response curves.

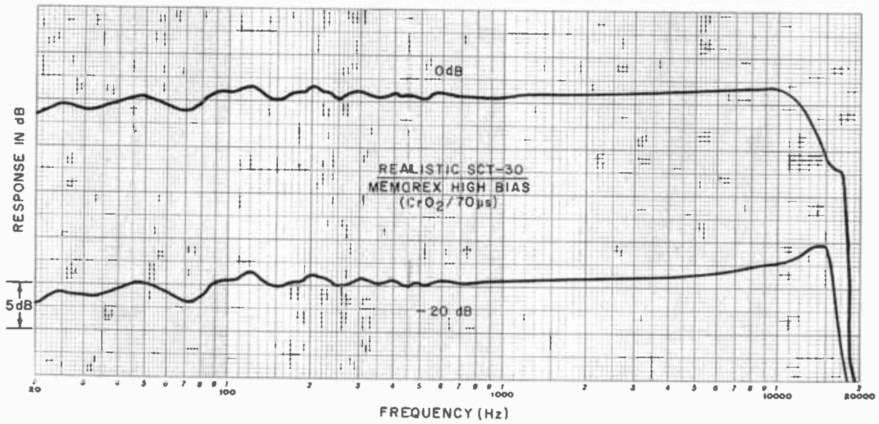
Much more impressive than the flatness of the −20-dB response curve was the performance at a 0-dB recording level. With most of the tapes, the response remained flat to about 8000 Hz and did not roll off rapidly until the frequency exceeded 10,000 Hz. (With TDK SA tape, using CrO_2 bias and equalization, the 0-dB response was flat to 10,000 Hz!) The 0- and −20-dB response curves intersected at 13,500 Hz with Realistic Supertape, but with all other tapes, the 0-dB response was always above the −20-dB curve so that intersection never occurred. This indicates unusual freedom from head and tape saturation—one of the benefits of a good three-head design, since the recording and playback heads can each be de-



Frequency responses at 0 and −20 dB for TDK AD at normal and maximum bias.



Frequency responses at 0 and −20 dB for Sony FeCr tape.



Frequency responses at 0 and −20 dB for Memorex High Bias tape.

signed for their separate tasks. We observed that the Sony FeCr tape revealed more evidence of high-frequency saturation than other tapes, with its 0-dB response rolling off smoothly above 2000 or 3000 Hz but never intersecting the −20-dB curve.

When we measured playback distortion as a function of recording level at 1000 Hz, we received a second surprise. Many cassette decks go into saturation just beyond their 0-dB meter calibrations and distortion rises rapidly before the meter's pointer goes off-scale. The Model SCT-30, however, had to be driven to about +10 dB with most tapes before third-harmonic tape distortion reached the reference 3% level. (With TDK AD tape and the bias set to maximum to flatten out its response, we had to go to +13 dB to reach 3% distortion!) At first, we wondered if the recorded levels were lower than usual, but the Dolby points on the meters were within 1 dB of the correct 200 nW/m flux level for a standard Dolby tape. This means that the Model SCT-30 has a headroom of 7 to 10 dB beyond the Dolby level before the distortion reaches 3%. Therefore, Dolby-encoded FM programs can be recorded with fully effective Dolby operation with no risk of tape saturation and the resulting loss of highs and increased distortion. This is very rare in cassette recorders, most of which cannot be recorded at levels greater than 3 or 4 dB above the Dolby level without excessive distortion.

On most recorders, if the FM Dolby signal levels are adjusted correctly for the Dolby system, with 50% modulation corresponding to a Dolby-level meter indication on the recorder, 100% modulated peaks will be at +6 dB and will almost certainly overload the recorder. The only alternative in most cases is to set the Dolby tone from the FM transmitter (50% modulation) several decibels below the meters' Dolby points, which can degrade frequency response and noise reduction but will not distort. These examples are based on recording the signal without decoding, a theoretically preferable approach. Often, the easiest solution is to decode the Dolby-encoded signal and record it in that form at correct levels. We also found that Dolby tracking of the recording and playback circuits of the Model SCT-30 deck was excellent. There was less than 1 dB change in any part of the response from 20 to 15,000 Hz at levels from −20 to −40 dB when the noise-reduction system was operating.

Playback distortion from a 0-dB recorded signal was very low, measuring 0.25% to 0.32% for most tapes and 0.63% with Sony FeCr tape. All of our measurements were below the deck's 0.9% rating. Playback frequency response was within ±1 dB from 40 to 12,000 Hz with the TDK AC-337 120-µs test tape and ±2 dB from 40 to 10,000 Hz with the Teac 116SP 70-µs test tape.

The unweighted S/N ratio was about 50 dB, referred to a 3% distortion level. With "A" weighting, readings improved to between 53.5 and 55.3 dB, depending on the tape. With CCIR/ARM weighting and the Dolby system switched in, S/N was about 64 dB with ferric-oxide tapes (Realistic Supertape and TDK AD) at normal bias settings. With bias adjusted for flattest response on TDK AD tape, the S/N improved to slightly greater than 66 dB, which is the same reading obtained with TDK SA tape and CrO_2 bias and equalization. The best S/N was measured with Sony FeCr tape, which was an excellent 68.5 dB. Noise increased by 9.2 dB through the microphone inputs at maximum gain.

An AUX input of 85 mV or a MIC input of 0.3 mV was required for a 0-dB reading on the deck's meters. The microphone input overloaded at a rather low 25-mV input. Maximum playback level from a 0-dB recorded signal was about 0.33 volt with ferric-oxide tapes and 0.4 volt with TDK SA and Sony FeCr tapes.

The CCIR or DIN weighted peak flutter with a TDK AC-317 test tape

playback distortion from 0-dB recorded signal was very low 0.25% to 0.32%

Performance Specifications

Specification	Rating	Measured
Frequency response (±3 dB)		
Supertape	30–15,000 Hz	20–16,000 Hz ±2 dB (ST)
CrO_2	30–16,000 Hz	20–15,500 Hz ±2 dB (SA)
FeCr	30–15,500 Hz	20–15,000 Hz ±2 dB (FeCr)
Overall S/N ratio	61 dB (CrO_2, Dolby CCIR weighted)	49 dB (ST), 48.3 dB (AD), 50 dB (SA), 49.5 (FeCr) (unweighted)
		53.5 dB (ST), 54 dB (AD), 54.7 dB (SA), 55.3 dB (FeCr) (A weighted)
		64 dB (ST), 64.3 dB (AD), 66.3 dB (SA), 68.5 dB (FeCr) (CCIR/ARM, with Dolby)
Distortion at 0 VU	Less than 0.9%	0.32% (ST) 0.28% (AD) 0.25% (SA) 0.63% (FeCr)
Crosstalk	Under −60 dB	−42 dB (TDK AC-352 tape)
Wow/flutter	Under 0.06% wrms	0.075% wrms (TDK AC-342) 0.09% wpk
Erase ratio	70 dB	Not measured
Output level	At least 0.55 V	0.33 to 0.40 V for 0 dB recorded signal
Output impedance	10,000 ohms (8 ohms, phones)	Not checked
Input impedance	AUX 100,000 ohms Mic. OK for 500 to 5000 ohms	Not checked
Record bias frequency	105 kHz	Not checked
Fast forward/rewind time	Under 125 s for C-60	96 s

was ±0.09%, and the JIS weighted rms flutter was 0.075%. In a combined record/playback measurement, readings were slightly higher. Speed was 0.5% fast. The deck required about 96 seconds to handle a C-60 cassette in both fast forward and rewind. This was faster than the rated time, but still rather slow. The 1000-Hz crosstalk from right to left channel with a TDK AC-352 test tape was −42 dB. The meters had a fast response, with about 15% to 20% overshoot on a 0.3-second tone burst, and a slow decay time that appeared to be on the order of a couple of seconds. Headphone volume was excellent, even with 200-ohm phones.

User Comment. When we compared the sound of interstation FM tuner hiss entering and leaving the recorder, we found the two to be close with all of the tapes we used. It was virtually perfect when the bias was carefully adjusted. In taping FM broadcast programs, we could never hear any difference between the incoming and outgoing signals when we used the monitor button on the recorder or amplifier. Recording levels are much less critical with this deck than with most we have used. We found it perfectly practical to record with the deck's meters regularly indicating in the range between 0 and +3 dB. With the meter pointers often pinned to their right indexes, there was no audible sign of compression, distortion, or loss of highs.

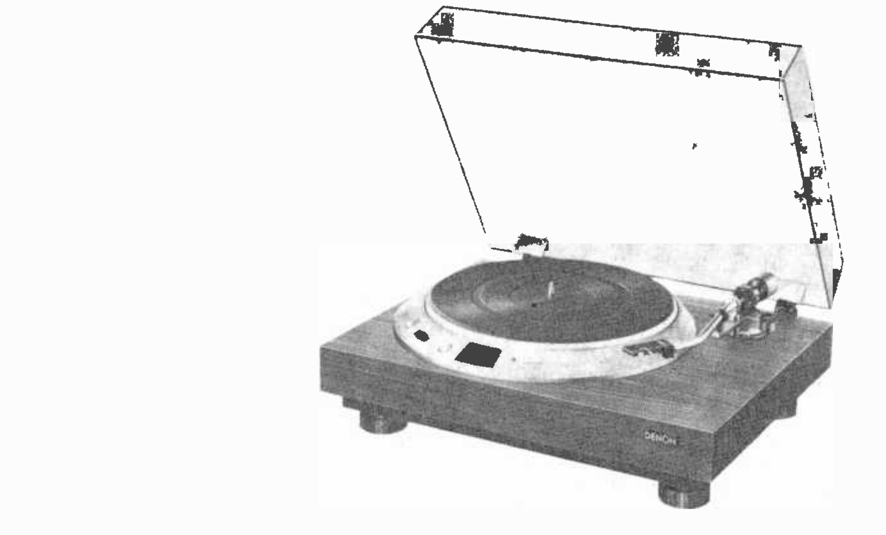
The Model SCT-30 lacks a few frills, such as memory rewind and microphone mixing, neither of which is likely to be missed by most cassette deck users. To compensate for this, the buyer gets one of the very few cassette decks, and possibly the only one at this deck's price, that can decode or record Dolby-encoded FM broadcasts without the risk of distortion and with fully effective Dolby operation. In its sound quality, this deck takes second place to none when recording from records and FM broadcasts. It is more limited for live recording purposes if one wishes truly high-quality results, of course, owing to the cassette medium and, perhaps, to the low-mike overload point.

Handling quality of the deck ranged from fair to good. When EJECT is pressed, the cassette well moves out in a smooth, cushioned manner. Levers such as FAST FORWARD disengage automatically moments after the end of a tape is reached—a neat feature. The action of the transport lever, though positive and smooth, does have a mechanical latch for locking purposes. Also, the levers are all the same size (except STOP) so, without illumination, one would be hard pressed to control the transport in a darkened room.

The foregoing does not detract from the overall fine value of this deck. Naturally, there are trade-offs to be made for the price. Raw performance is super. Variable bias adjustment; big, well-lighted meters; Dolby monitor; Dolby test-adjust facility; three tape heads; and the like more than make up for some noted shortcomings. And let's not forget the front-load facility, which is a pleasurable convenience, though transport start is delayed somewhat as heads are moved into position. In all, the new Realistic SCT-30 would be a fine addition to virtually any high-quality stereo component system when overall high performance is the overriding criterion.

CIRCLE NO. 102 ON FREE INFORMATION CARD

Denon DP–2500 record player offers direct drive with quartz control and dc braking



HIRSCH-HOUCK LABS REPORT

THE Model DP-2500 record player introduced by Denon offers a quartz-controlled direct-drive turntable and a high-quality tonearm. The single-play, manually operated player is mounted on a 40-mm thick wooden base.

The turntable features an ac motor with bidirectional servo control and dc braking to give it exceptionally fast start-up, speed-change, and shutdown times and very low flutter and rumble. A dynamically damped tonearm reduces the effect of low-frequency tonearm/cartridge resonance. It employs a lightweight rigid aluminum headshell with a four-pin plug-in design. The wood base is sandwiched with a viscous damping material to reduce resonances. The base is covered in a vinyl wood-grain (choice of blond ash or walnut) veneer and comes with a clear-plastic dust cover.

With the dust cover closed, the Model DP-2500 record player measures 19″ W × 16″ D × 7″ H (48.3 × 40.6 × 17.8 cm) and weighs 26.5 lb (12 kg). Suggested retail price, $525.

General Description. Like other Denon record players, the Model DP-2500 has its cast-aluminum platter almost entirely above the motorboard and surrounded by a bevelled ring. On the sloping surface of the ring are the turntable controls, including a pushbutton power switch and a green indicator light, a 33⅓- and 45-rpm speed selector switch, and a momentary-contact button for starting and stopping the turntable. Stroboscope markings under the platter are visible through a window in the control ring.

The ac servo motor that drives the platter is controlled by a quartz crystal oscillator whose operating frequency is about 1.3 MHz. The feedback signal from the platter to the control amplifier is derived from a magnetized band on the inside rim of the platter. On this band are recorded 1000 pulses. A pickup head that resembles the tape head used in a cassette deck senses the magnetic pulses as the platter rotates. The output signal frequency from this pickup at 33⅓ rpm is approximately 500 Hz. It is compared with a similar reference frequency derived from the crystal oscillator after frequency division. Any error between the two signals causes a correcting signal to be generated for the motor.

Denon claims that the 500-Hz speed-sensing frequency is approximately five times the frequency typical of most direct-drive turntables. This helps give the Model DP-2500 a speed stability and freedom from overshoot that surpass the performance of other direct-drive turntables.

The neon lamp that illuminates the stroboscope pattern is driven by a signal derived from the quartz oscillator. Hence, a single stroboscope pattern is used for both speeds. The pattern is stationary during momentary shifts in line-power frequency and phase, which can cause most stroboscope patterns to waver even when platter speed is constant.

The tonearm consists of an S-shaped aluminum tube that is balanced by a threaded counterweight on which the tracking-force scale is located. After the tonearm is balanced, the scale is set to zero and the entire weight is rotated to align the desired force calibration (0 to 2.5 grams in 0.1-gram increments) with a reference mark on the tonearm's tube. Antiskating force can be adjusted while a record is being played. The cueing lever for the tonearm is viscous damped. Tonearm height is adjustable to accommodate different cartridge dimensions, while remaining parallel to the turntable.

Laboratory Measurements. Although no stylus-positioning jig was supplied with the sample record player, the setup directions state that the stylus should be 50 mm from the mounting reference surface at the end of the tonearm for minimum tracking error. When the stylus was positioned as instructed, tracking error was very low, typically less than 0.25°/in. and a maximum of 0.4°/in. at a 2.5" (63.5-mm) radius.

Calibration of the tracking-force scale was exact after initial balancing of the tonearm according to instructions. The antiskating force had to be set slightly greater than the tracking force for best correction. In our tests, we used an antiskating force of 2 grams at a 1.5-gram tracking force. The cueing mechanism allowed the tonearm to drift considerably outward during descent. When the stylus finally contacted the record's surface, about 12 seconds was repeated.

Effective mass of the tonearm was about 20 grams. Capacitance of the tonearm and signal cables was 90 pF to ground in each channel and 1 pF between channels.

Turntable speed was more accurate than our ability to measure. The platter came up to speed in less than a second, which was about the same time it took for the platter speed to stabilize when switching from one speed to the other. Dc braking stopped the platter completely within two seconds after the OFF button was operated.

isolation was considerably greater than typical direct-drive player

Rumble was somewhat lower than we have observed on most direct-drive turntables, measuring −35 dB unweighted and −64 dB with ARLL weighting. Rumble energy was principally below 5 Hz. The unweighted peak or DIN flutter measured ±0.08% (0.075% wrms JIS). Flutter was mostly below 10Hz.

The extremely compliant base mounting feet had considerable lateral freedom of movement, making it difficult to measure the isolation from conducted vibration in our usual manner, with vibration applied directly to the feet through small transducers. We determined, however, that the isolation of the Denon mounting system was considerably better than that of the typical direct-drive record player. It was, in fact, comparable to that of many of the better belt-driven players.

User Comment. Although the Model DP-2500 is a no-frills record player, devoid of concessions to automatic play, it shares many of the qualities we have found in Denon's top-priced Model DP-6700 player. Specifically, it is unusually easy to set up. Also, when the tonearm is balanced and the cartridge is positioned according to instructions, tracking force is precisely correct and tracking error is at the theoretical minimum for this size tonearm.

The fast start and stop action of the turntable will be appreciated by anyone who has used an "automatic" turntable that requires one to wait usually 12 to 15 seconds for the tonearm to reach its playing position after turn-on or for completely shutting down after a record has been played. With the Model DP-2500, the start-up, speed-change, and shut-off operations are virtually instantaneous, smooth, and silent.

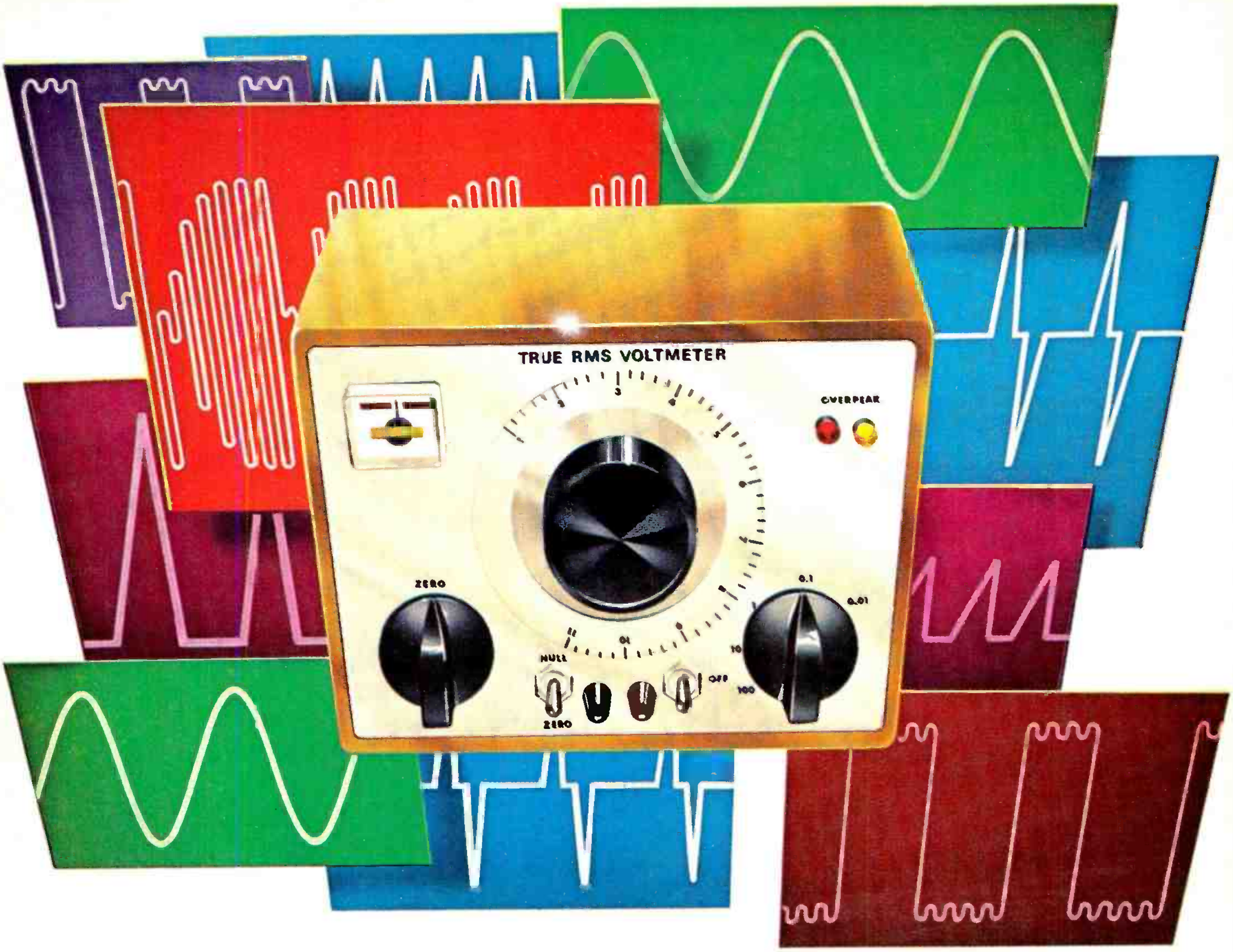
Since we use different test methods than those employed by Denon, we did not make an effort to compare specs. As evidenced by our standard measurements, the Model DP-2500 is indeed a top-rated performer.

The only thing we found not to our liking was the outward drift of the cueing system during descent of the tonearm. This was in marked contrast to the virtual perfection of every other aspect of the player's design and performance. Of course, the tonearm can be manually handled at all times, which is no great problem in view of its excellent finger lift and balance.

In all, Denon's DP-2500 is a solidly built record player of exceptional quality. It operates smoothly, rapidly, and virtually silently. It should also prove to be relatively free of the acoustic-feedback problems that plague many record-playing installations. And as an added fillip, its appearance has all the indications of top quality.

CIRCLE NO. 103 ON FREE INFORMATION CARD


HEWLETT PACKARD 37E
HEWLETT PACKARD 38E
HEWLETT PACKARD 31E
HEWLETT PACKARD 32E
HEWLETT PACKARD 33E



BUILD A TRUE RMS VOLTMETER

Measures effective ac voltage rather than the usual average values

BY DANIEL METZGER

EVENTUALLY, most serious electronics experimenters find a need to measure the power content of an odd-shaped waveform. This might occur in measuring the output of a class-C amplifier, audio, video or noise signals; power supply inverter waveforms; or just plain power supply ripple.

When the time comes, the experimenter will discover that a standard VOM or DVM simply won't provide true rms readings! An rms voltmeter is needed for this purpose. Unfortunately, this is a rather expensive instrument.

With the plans presented here, however, a true rms voltmeter can be built for only about $30. To fully understand how this is accomplished, let's first examine what rms means.

What Is RMS? Rms values allow the expression of the average power content of an ac waveform whose instantaneous power varies from zero (at the zero crossing) to some high value at the voltage peak. In practice, rms means "equivalent to dc." Mathematically, given a voltage and a resistance, power is calculated as $P = E^2/R$.

The "equivalent-to-dc" voltage for a continuously varying ac voltage must be calculated by squaring the voltage at each instant, averaging the infinte number of instantaneous values produced (taking the mean), and then extracting the square root. Hence, the term Root of the Mean of the Square (RMS).

For anything beyond a simple rectangular waveform, this rms technique involves calculus. For sine waves *only*, it produces $E_{RMS} = E_{PK(SINE)}/\sqrt{2} = 0.707E_{PK}$.

For periodic waveforms that cannot be mathematically expressed, the rms technique requires iterative computer analysis. For completely undefinable

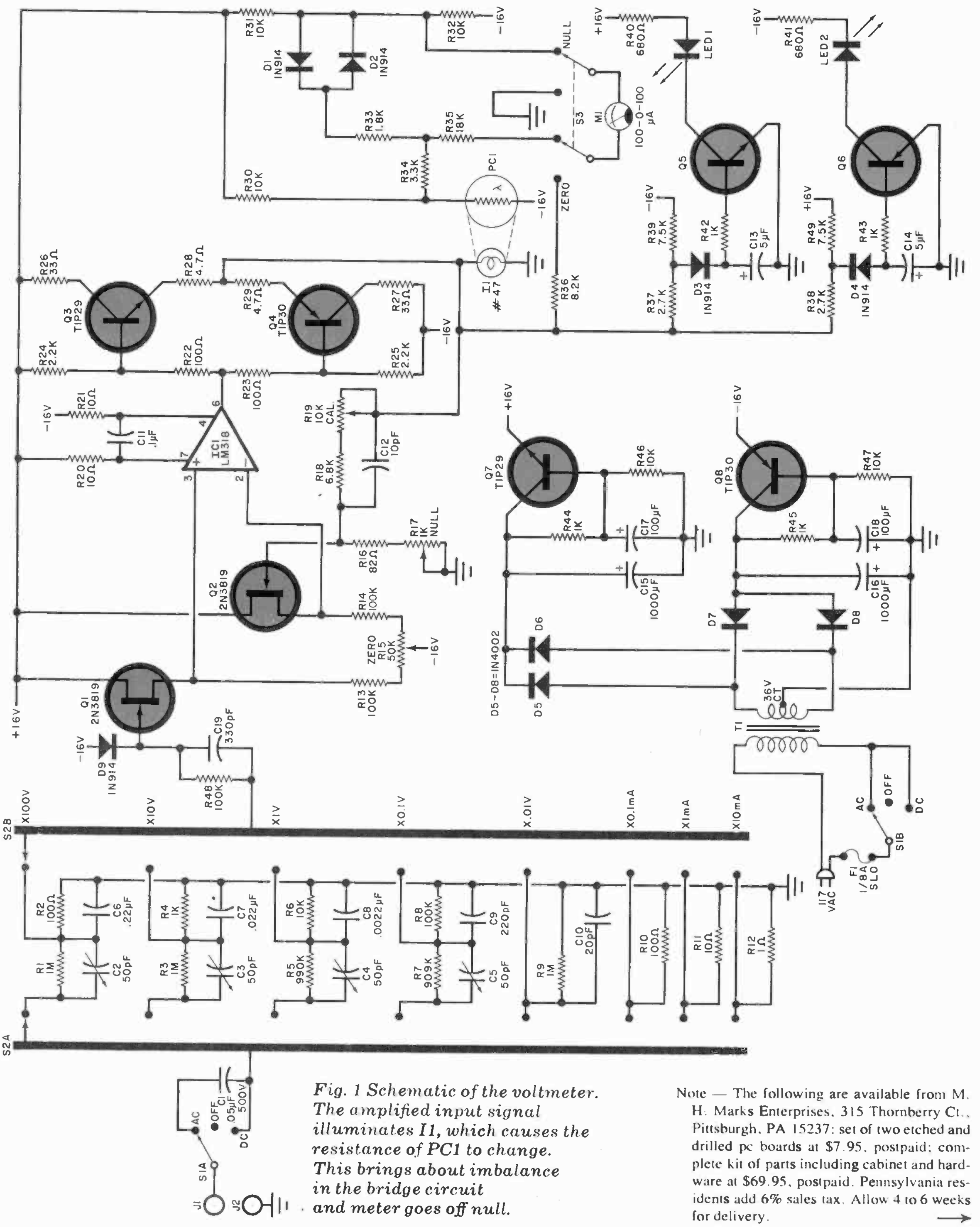


Fig. 1 Schematic of the voltmeter. The amplified input signal illuminates I1, which causes the resistance of PC1 to change. This brings about imbalance in the bridge circuit and meter goes off null.

Note — The following are available from M. H. Marks Enterprises, 315 Thornberry Ct., Pittsburgh, PA 15237: set of two etched and drilled pc boards at $7.95, postpaid; complete kit of parts including cabinet and hardware at $69.95, postpaid. Pennsylvania residents add 6% sales tax. Allow 4 to 6 weeks for delivery. →

PARTS LIST

C1 — 0.05-μF, 500 volt capacitor
C2 through C5 — 50-pF trimmer
C6 — 0.22-μF Mylar capacitor
C7 — 0.022-μF Mylar capacitor
C8 — 0.0022-μF capacitor
C9 — 220-pF capacitor
C10 — 20-pF capacitor
C11 — 0.1-μF capacitor
C12 — 10-pF capacitor
C13,C14 — 5-μF, 15-volt electrolytic
C15,C16 — 1000-μF, 35-volt electrolytic
C17,C18 — 100-μF, 25-volt electrolytic
C19 — 330-pF capacitor
D1 thru D4, D9 — 1N914
D5 thru D8 — 1N4002
F1 — 1/8-ampere slow-blow fuse
I1 — #47 pilot lamp
IC1 — LM318 op amp
J1,J2 — Five-way binding posts, one red (J1), one black (J2)
LED1,LED2 — Light emitting diode
M1 — 100-0-100-μA meter
PC1 — See text
Q1,Q2 — 2N3819,MPF102, or similar
Q3,Q7 — TIP29 or similar
Q4,Q8 — TIP30 or similar
Q5,Q6 — Any small-signal silicon transistor
R1,R3,R9 — 1-megohm, 1%, 1 watt resistor
R2,R10 — 100-ohm, 1% resistor
R4 — 1000-ohm, 1% resistor
R5 — 1-megohm, 1% resistor (try for 990k)
R6 — 10,000-ohm, 1% resistor
R7 — 909,000-ohm, 1% resistor (try for 900k)
R8 — 100,000-ohm, 1% resistor
R11 — 10-ohm, 1% resistor
R12 — 1-ohm, 1% resistor
R13,R14,R48 — 100,000-ohm resistor
R16 — 82-ohm resistor
R18 — 6800-ohm resistor
R20,R21 — 10-ohm resistor
R22,R23 — 100-ohm resistor
R24,R25 — 2200-ohm resistor
R26,R27 — 33-ohm, 1-watt resistor
R28,R29 — 4.7-ohm resistor
R30,R31,R32,R46,R47 — 10,000-ohm resistor
R33 — 1800-ohm resistor
R34 — 3300-ohm resistor
R35 — 18,000-ohm resistor
R36 — 8200-ohm, ½-watt resistor
R37,R38 — 2700-ohm 5% resistor
R39,R49 — 7500-ohm 5% resistor
R40,R41 — 680-ohm resistor
R42,R43,R44,R45 — 1000-ohm resistor
R15 — 50,000-ohm linear-taper potentiometer
R17 — 1000-ohm linear-taper potentiometer (see text)
R19 — 10,000-ohm, trimmer pot
S1 — Dpdt center-off toggle switch
S2 — 8-position, 2-pole rotary switch
S3 — Dpdt switch
T1 — 36-V CT, 0.1-A transformer (Stancor 8611 or similar)
Misc. — Suitable enclosure, dial plate and knob for R17, pointer knobs (2), press-on type, mounting hardware, etc.

waveforms such as noise, however, we have to go back to the rms voltmeter.

This may be a good place to observe that the time-honored VOM and most DVMs actually respond to *average* voltage (not rms) on their ac scales. The average value of one half-cycle of a sine wave is 0.637 of its peak value, or 0.901 of its rms value.

The meter scales are calibrated in rms, but this calibration is valid for sine waves only. VTVMs and FET meters generally respond to peak voltages on their ac ranges. Again, the meter scales are calibrated for rms readout on sine waves only. Consequently, a VOM or VTVM can display different and incorrect conclusions about a 25% duty cycle waveform, as illustrated in boxed section below right. Interestingly, most VOMs err in one direction on non-sine waves, while VTVMs err in the other.

The majority of true rms meters operate by electronically squaring and averaging the input signal, or by taking the log of the signal, doubling it, then taking the antilog. Building such a meter is best avoided because of its circuit complexity. The meter discussed here takes the direct approach of amplifying the input waveform and using its large signal to turn on a conventional incandescent lamp. The brilliance of the lamp is sensed by a photocell so that comparisons between ac and equivalent dc voltages can be made. In operation, the amplifier gain is adjusted until the lamp reaches a predetermined brightness, and the rms voltage is then read off a calibrated "gain" control.

Circuit Description. As shown in Fig. 1, resistors *R1* through *R9* provide voltage divisions by progressive factors of ten while maintaining a 1-megohm input resistance. Capacitors *C2* through *C10* provide identical division ratios at high frequencies while maintaining an input capacitance of 20 pF. Without these capacitors, the reactance of any stray wiring capacitance would completely swamp the resistive dividers above approximately 50 kHz, resulting in false division ratios. Resistors *R10* through *R12* are used in the measurement of current.

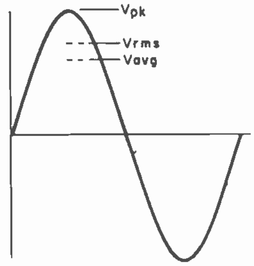
Source follower *Q1* provides an almost infinite input impedance for the amplifier, while FET *Q2* provides compensation for variations in *Q1* source voltage with temperature. Both *Q1* and *Q2* should be well matched—zero volts between their sources with the input grounded and control *R15* (ZERO) near the center of its rotation. Also, the transistor cases should be thermally bonded.

Op amp *IC1* has a gain between 10 and 100, depending on the setting of the CAL *(R19)* and NULL *(R17)* controls. Capacitor *C12* compensates for stray capacitance in the *R16-R17* leg, and is selected for good high-frequency response. Components *R20, R21* and *C11* are required to prevent high-frequency oscillation via power supply coupling. A complementery symmetry voltage follower (*Q3* and *Q4*) provides the high current required by lamp *I1*.

The sensitive surface of photoresistive cell *PC1* is butted to the lamp and secured in place with opaque heat-shrink tubing. The photocell forms one arm of a Wheatstone bridge, with *R30-R32* as the other arms. At one particular

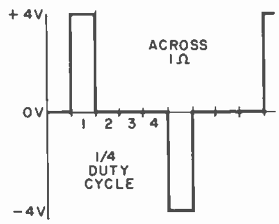
VTVM AND VOM ERRORS

For sine waves:



$V_{PK} = 1.414V_{RMS} = 1.569V_{AVG}$
$V_{RMS} = 0.707V_{PK} = 1.110V_{AVG}$
$V_{AVG} = 0.637V_{PK} = 0.901V_{RMS}$
VOMs read $1.110V_{AVG}$
VTVMs read $0.707V_{PK}$

For this rectangular wave:



$P_{INST} = E^2/R = 4^2/1 = 16$ W
$P_{AVG} = 16/4 = 4$ W
$E_{RMS} = \sqrt{PR} = \sqrt{4 \times 1} = 2.00$ V
VOM reads:
$1.110 \times V_{AVG} = 1.110 \times ¼ \times 4$
$= 1.11$ V or $2.00\ V_{RMS}$
VTVM reads:
$0.707 \times V_{PK} = 0.707 \times 4$
$= 2.83$ V or $2.00\ V_{RMS}$

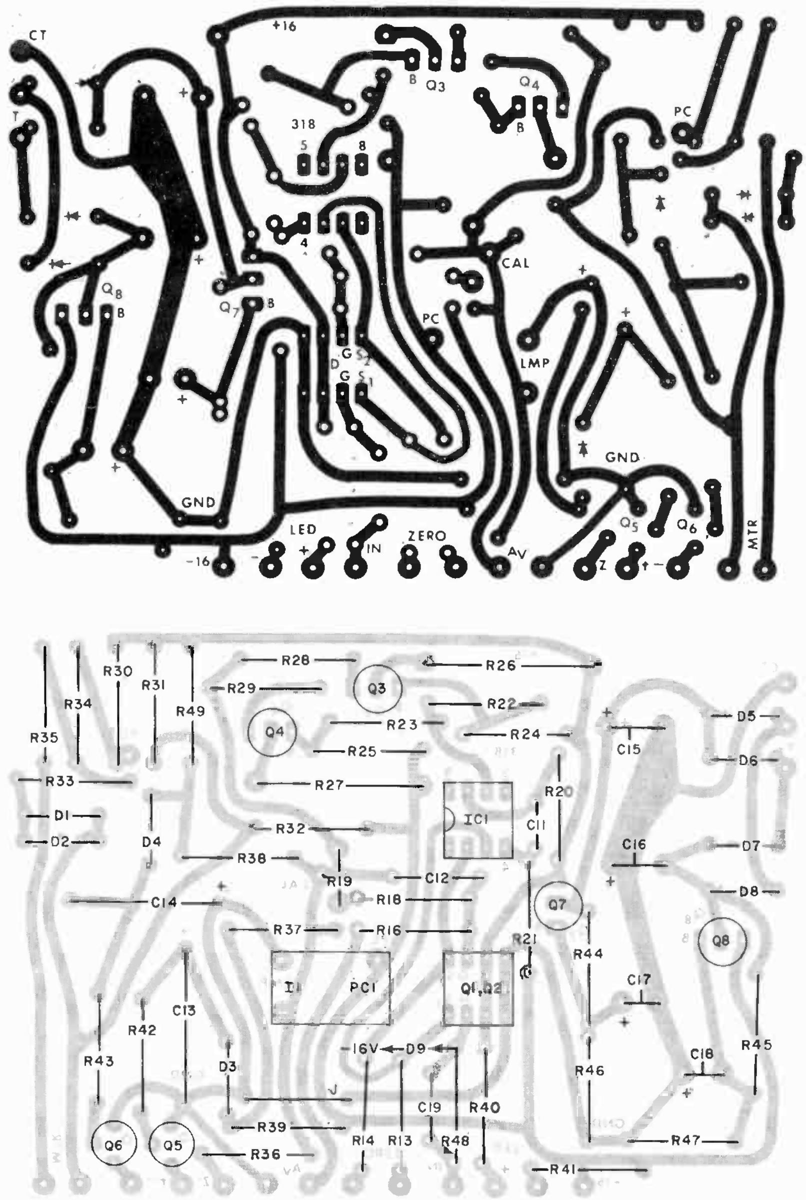


Fig. 2. Actual-size foil pattern for main pc board is at top, component installation immediately above.

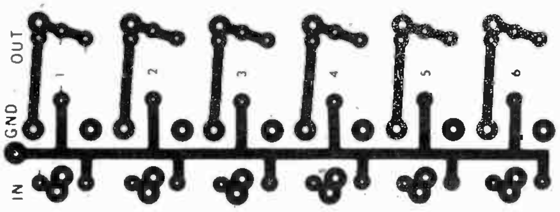


Fig. 3. Components for attenuator can be mounted on board similar to that at left. Only four sections are used in this case.

lamp intensity, the cell resistance will equal 10,000 ohms and meter *M1* will indicate zero. For unbalance currents of about 25μA, *D1* and *D2* will begin to conduct, shunting the meter with *R33*. This makes it easier to find the null by reducing the meter sensitivity for off-null settings. The meter can be switched to zero out dc voltage at the amplifier output when the input is grounded.

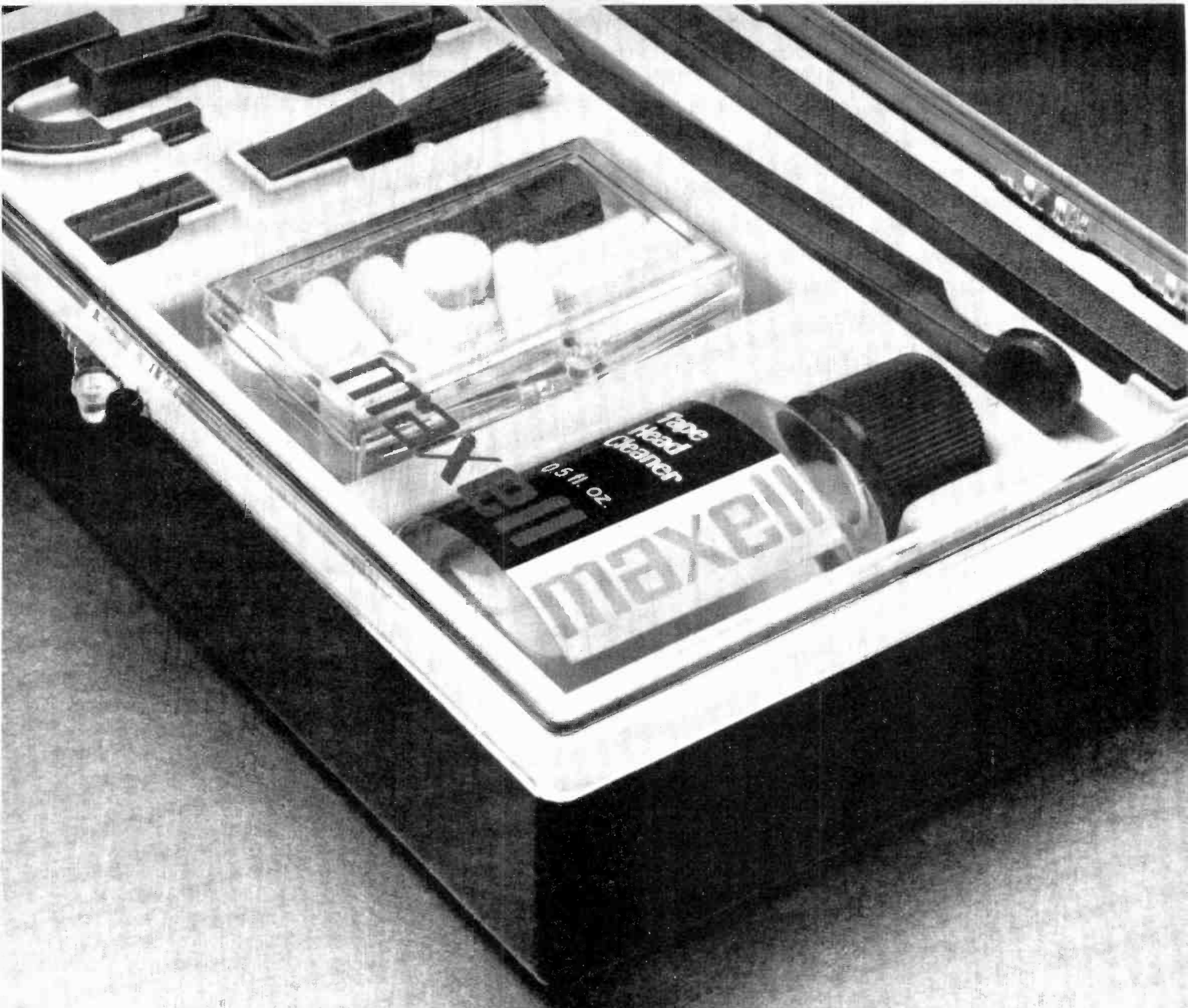
In the prototype, balance was achieved with 2 volts rms (or dc) across the lamp. For sharply peaked waveforms, it is possible that the peak voltage might exceed the approximately 10-volt limit of the amplifier resulting in distortion of the waveform. Diodes *D3* and *D4* detect such peaks slightly before the threshold of distortion, causing the front panel positive *(LED1)* or negative *(LED2)* overpeak indicators to glow.

The power supplies are well filtered by the emitter follower action of *Q7* and *Q8*. Regulation is not required because the differential amplifier and bridge circuits remain balanced in spite of power supply voltage variations.

Construction. Few of the components are critical and substitutions are possible. The NULL potentiometer *(R17)* should be of the highest quality since accuracy of the instrument depends on reading its angular position. Resistors *R1* through *R12* directly affect the accuracy and should be held to ±1%. For the voltage dividers, it is the resistance *ratio* that is important. Ceramic trimmer capacitors hold their values better than compression types and are recommended for *C2* through *C5*. Transistors *Q3* and *Q4* may dissipate as much as 2 watts and must have heat sinks.

Using an LM318 for *IC1* results in a 400-kHz bandwidth. A μA741 reduces the bandwidth to about 20 kHz. Any photoresistive cell having a resistance of 10,000 ohms when illuminated by a #47 lamp with 1.5 to 2.5 volts dc applied to it will work for PC1.

The bulk of the circuit can be assembled on a pc board using the foil pattern and component layout shown in Fig. 2. The front-end attenuator can be built up on a small pc board like that shown in Fig. 3. Fixed and trimmer capacitors are mounted on the foil side and the resistors on the other. This board supports the first four attenuator elements. (Two sections on this small board will be unoccupied.) Once the components are mounted on the board, the pc assembly can be wired to the appropriate lugs on *S2* with short lengths of hookup wire.



People who aren't using our new tape care kit should have their heads examined.

After every ten hours of recording or twenty hours of play back, you should spend a few minutes cleaning your tape heads.

Because in that period of time enough dust and residue accumulate on your tape heads to significantly affect the sound that comes out of your tape deck.

So at Maxell, we've developed a tape care kit to help you get the cleanest possible sound out of your recordings.

In addition to liquid head cleaner, it has special curved probes, swabs, a brush and a mirror to help you keep even areas you can't see spotless. All of which means you'll be getting maximum performance out of your machine. Year after year.

And if that doesn't sound like a good idea, maybe you need to have more than your tape heads examined.

maxell

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

CIRCLE NO. 38 ON FREE INFORMATION CARD

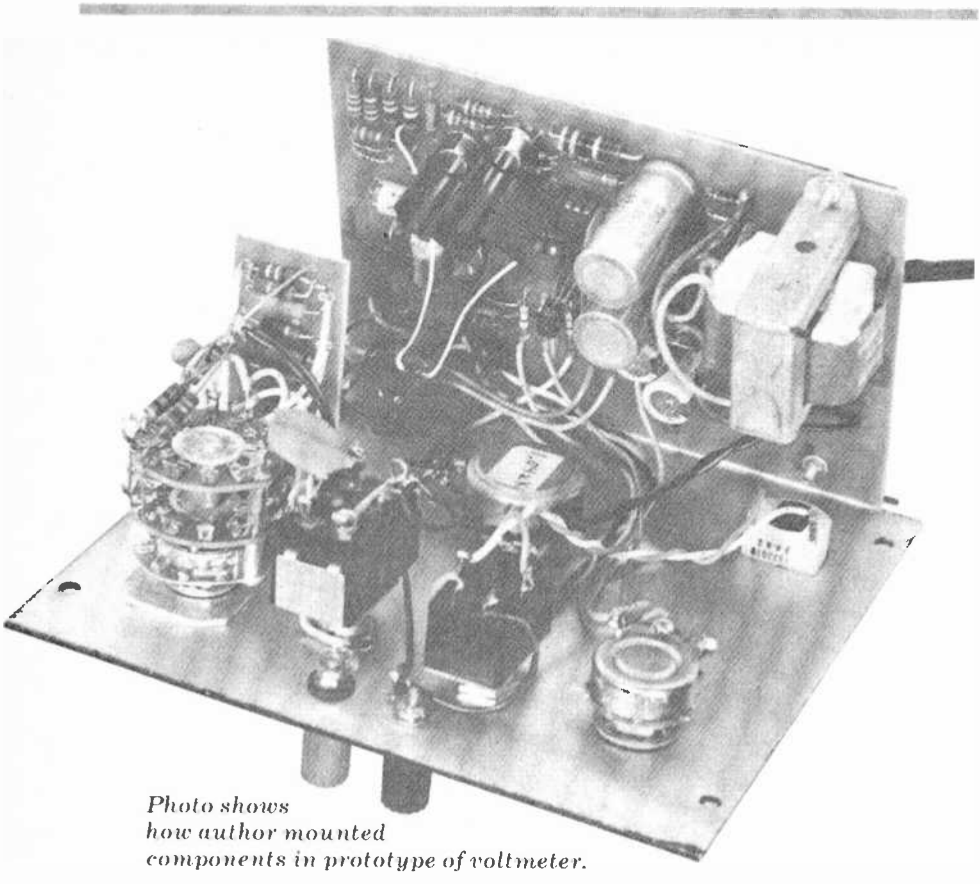


Photo shows how author mounted components in prototype of voltmeter.

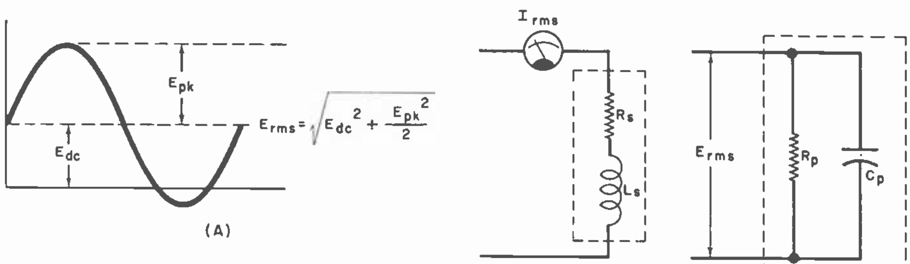


Fig. 4. Rms value of sine wave can be calculated as described in text using diagrams shown here.

The four remaining attenuator sections are resistors that can be mounted directly on *S2*.

As shown in the photograph, on the front panel are the meter, two overpeak LED's, *R17* (NULL), *R15* (ZERO), *S3* (NULL/ZERO), *S1* (AC, DC POWER ON-OFF), *S2* (RANGE) and input jacks *J1* and *J2*.

These components can be mounted as desired on the front panel, leaving enough room around *R17* to accommodate a calibrated dial plate. Press-on type can be used to identify controls.

Calibration. Set the NULL control *(R17)* to its minimum resistance. With *S3* at ZERO, connect *J1* to *J2* and adjust *R15* (ZERO) for no meter deflection (center zero).

Set *S2* to the ×1V position and *S3* to NULL. Apply an accurate 1-volt dc between *J1* and *J2* (positive to *J1*) and adjust the pc board mounted *R19* for a zero meter indication.

Mark the NULL dial plate with a 1, then apply 2, 3, etc., up to 11 volts dc, zeroing the meter with the NULL control and marking the dial as you go. If desired, you can apply a 60-Hz sine wave of known rms value to verify the "equivalent-to-dc" function.

The *S2* trimmer capacitors can be adjusted with the aid of an audio generator. Null the meter to read a 60-Hz sine wave someplace on the ×.1 range.

Without changing the generator output level, raise the frequency to 50 kHz and adjust *C5* for a null at the same spot on the dial. Repeat this for *C4*, *C3* and *C2* on their ranges. Alternately, the trimmer capacitors can be adjusted for the cleanest 10-kHz square-wave response with a scope probe across *I1*.

Use. Here are some guidelines for using the rms meter.

When there is an ac or combined ac and dc voltage across an unvarying (pure) resistance, the rms value of the voltage can be used to compute the average power in the resistance by the equation $P_{AVG} = E_{RMS}^2/R$.

Similarly, if the rms current through an unchanging resistance is known, then $P_{AVG} = I_{RMS}^2 R$.

Note that unlike many rms meters, the meter described in this article can indicate the rms value of a waveform having a dc component. This dc component cannot be simply added to the rms value of the ac component to obtain the rms value of the total waveform. For sine-wave ac components, the rms value can be calculated as illustrated in Fig. 4. For other waveforms, it's either calculus or the dc-coupled rms meter.

An rms measurement cannot be applied to the calculation of power where the load impedance is partly reactive. However, if the numerical value of the resistive part of the load can be determined, true power can be calculated as shown in Fig. B, since the reactive portion consumes no power.

The rms measurement is also not appropriate for calculating the average power delivered to devices having changing ohmic resistance. Examples of such devices are diodes, SCRs, switching transistors and the plate or collector of a class-C amplifier.

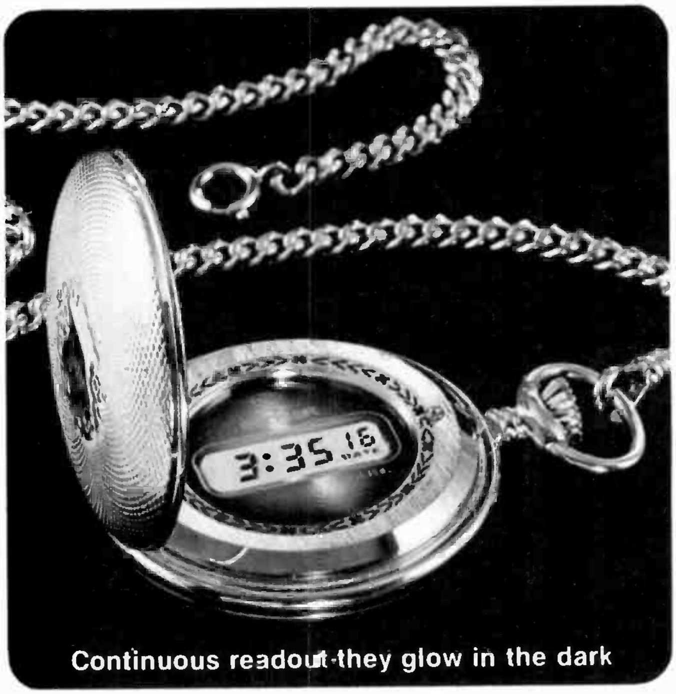
For such devices, measure the average voltage and current for the device and calculate: $P_{AVG} = I_{AVG}E_{AVG}$.

If current flows always in one direction, a VOM on the dc range can be used. If ac is involved, you must use a meter that measures the average absolute (without regard to sign) value of voltage and current.

A VOM or average-reading DVM on the ac range fills this function if the readings are multiplied by 0.901 to change the rms calibration to average calibration. Be wary of such meters on the ac ranges since many of them have upper frequency limits below 1 kHz. ◇

Breakthrough!

Five Year Watch Guarantee



Now! A new long-range guarantee on fashionable timepieces you will enjoy repair-free for years!

Sensor, the American-made watch, has developed an exciting new series of watches in both pocket and wrist style—guaranteed for 5 full years! You don't even have to replace the battery.

Of course, these superbly crafted watches will give you many, many years of accurate repair-free service. The 5 year guarantee covers **everything** except the wrist band or the chain and face protective cover of the pocket watch. Both watches feature the extended-life lithium battery which is included in the 5 year guarantee!

They glow in the dark

Both watches also feature TriLite™, a new space-age illuminating technique developed by Sensor. Two tiny glass tubes, lined with phosphor, injected with tritium, are sealed permanently by **laser beam** and mounted behind the digital display. Perpetual interaction between phosphor and tritium emits a constant glow. The soft green light becomes more pronounced as exterior light dims.

With TriLite, there's no battery drain. No button to push. TriLite is self-contained. Self-powered. And it illuminates the digital display for continuous readout, day and night, for years and years.

The 5 year **pocket watch** in 24-K 3 microns gold Swiss case is a traditionally respected design for today's popular vested suit. The large display of hours, minutes, seconds or date is at the same viewing angle as the famous "railroad watches" of yesterday. Elegant 3 microns gold Waldemar chain is also included.

The 5 year **wrist watch** display of hours, minutes, seconds or date protected by a mineral glass crystal (extremely hard) is set off by a bezel ring of 24-K 5 microns gold. The Swiss made case is plated with Perfectus, a nickel alloy with stainless steel characterstics. A handsome 2-tone bracelet of polished stainless steel and 2.5 microns 24-K gold specially treated for hardness and scratch resistancecompliments this outstanding water resistant watch.

Water Resistant

The water resistant capability of the 5 Year **wrist watch** means that it has been tested to three atmospheres of pressure—equal to a water depth of 80 feet! With complete confidence you can use and wear the 5 Year Wrist Watch in all types of normal water situations—from showers to swimming.

Both watches include Sensor's unique liquid crystal display design made in Dallas, Texas. Over one million watches using the Sensor display have been manufactured and shipped and it has been acclaimed the most reliable liquid crystal display ever developed.

Experience either or both of the 5 Year Watches for 10 days at our expense. You have to see and try these watches to appreciate their beauty and value. That's why we encourage you to enjoy them for 10 days free trial. If you do not agree that these are the most accurate and beautiful watches you've seen, simply return for courteous refund. $110.00 each, please add $2.50 per watch for shipping and insurance. Remember, both watches are guaranteed for 5 full years...including the lithium battery!

Credit Card Orders Call Toll Free
800-323-2272
Illinois Residents Call:312-595-0461

Contemporary Marketing, Inc.
790 Maple Lane, Bensenville, Ill. 60106

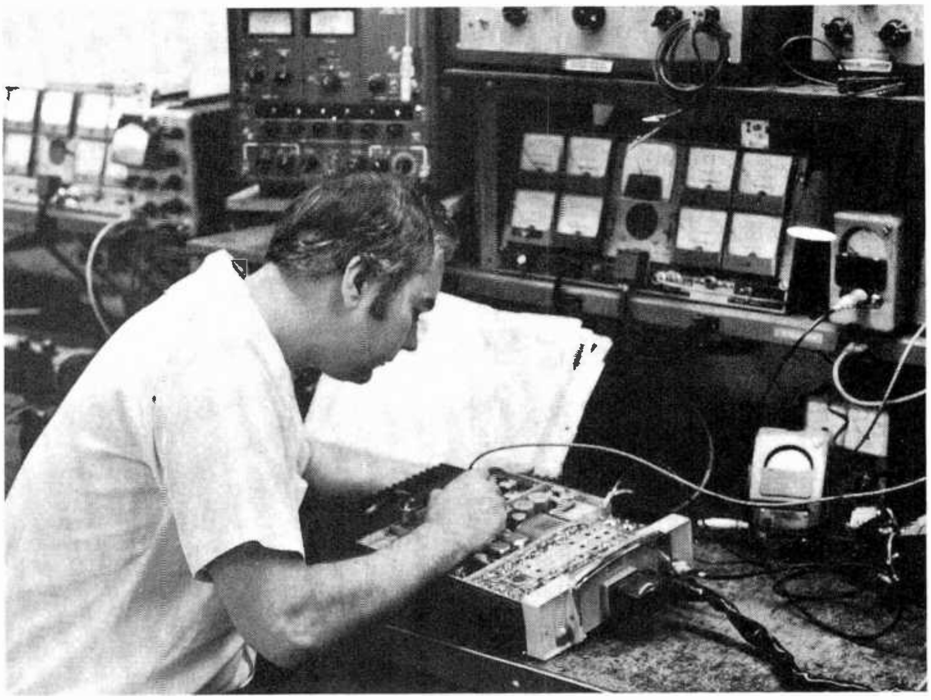
Please send me the following watch(es):
____The 5 Year **Pocket** Watch-$110.00 (Item 0621)
____The 5 Year **Wrist** Watch-$110.00 (Item 0622)
Add $2.50 per watch for shipping and insurance.
Illinois residents include 5% sales tax.
☐ Check or M.O. Enclosed
☐ Please Charge My Credit Card:
☐ American Express ☐ Mastercharge ☐ Visa
☐ Carte Blanche ☐ Diners Club
Card No. ____________ Exp. Date ________
Name ____________
Address ____________
City ____________
State ____________ Zip ____________
Signature ____________
PEMC-091 ©CMI 1979230R

Contemporary Marketing, Inc.
790 Maple Lane, Bensenville, Illinois 60106

CIRCLE NO. 11 ON FREE INFORMATION CARD

Microwave...AM & FM Radio...Radar...TV Broadcasting...Mobile Radio...
Marine Communications and Navigation...CB...Aircraft Electronics

The expanding world of communications means expanding opportunities for the qualified technician.



NRI Trains You at Home in Your Spare Time... Learn Installation, Maintenance, Repair

The communications explosion of the last few years is just the beginning of an incredible expansion as business, government and public services intensify their use of more versatile, cost-efficient systems. With this tremendous growth comes a continuous demand for qualified technicians...people trained to install, manitain, and repair modern electronic equipment.

You can start an exciting new career with NRI's Complete Communications Electronics Course. You learn at home...no travel or night school. You learn in your spare time ...no need to quit your present job. And you learn the right way...with NRI "bite-size" lessons and "power-on" training.

You Build Your Own 2-Meter Digitally Synthesized VHF Transceiver

NRI training is "hands-on" training. You get practical bench experience as you build and test this industrial quality two-way radio and power supply. You reinforce theory lessons as you induce and correct faults, study individual circuits and see how they interface with others.

You also build and keep a transistorized volt-ohm meter and digital CMOS frequency counter. NRI even gives you special training to get your Amateur License so you can go on the air with your completed unit.

FCC License or Full Refund

In all, you get 48 lessons, 9 special reference texts, and 10 training kits ...the training you need to start in a rewarding new career. And NRI includes special training for the required FCC radiotelephone license examination. You pass *or your tuition will be refunded in full.* This money-back agreement is valid for six months after completion of your course.

Free Catalog... No Salesman Will Call

NRI's free, 100-page full-color catalog shows all the equipment you get, describes each lesson and kit in detail, tells more about the many specialized fields we train you for...also includes facts on other opportunity areas like TV/Audio servicing and digital computer electronics. Mail the postage-paid card now and grow with the future.

If card has been removed, write to:

NRI McGraw-Hill

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

DESIGN OF TRANSMISSION-LINE TRANSFORMERS

How coreless transformers can be made from coaxial transmission line

BY ROY HARTKOPF

Although transmission-line transformers are widely used in front ends of television receivers, there is not much information available about what they are and how they work. It is often assumed that they are just another ordinary transformer that uses a fancy high-frequency ferrite to obtain the desired results. In reality, the only thing in common between transmission-line and conventional transformers is the name. Their operating principles are totally different. In this article, we will explore what a transmission-line transformer is and how it works. But first let us see how it differs from conventional transformers.

How It Differs. In a conventional transformer, an alternating current in the primary continuously changes the amount of flux in the core, which, in turn, sets up a voltage in the secondary. Disregarding losses, since the amount of flux cuts every turn of both the primary and the secondary, the voltage ratio is directly proportional to the ratio of the turns in the windings. Also, since the action of the conventional transformer depends on the flux generated in the core, the bandwidth and efficiency depend entirely on the core material.

Normal iron cores are useful at frequencies up to a few hundred hertz. Although there are ferrite cores used in the megahertz range, their permeability and efficiency drop off fairly rapidly with increasing frequency. Another factor that comes into play at high frequencies is that the capacitance between the turns of the windings also limits the usefulness of the conventional transformer at megahertz frequencies.

It is useful at this point to examine a few conventional transformers to compare them to the transmission-line transformer we are talking about here.

A simple step-up transformer with a center-tapped secondary is shown in Fig. 1A. Three things are obtained with such a transformer: a step up in voltage at its output, isolation between its primary and secondary, and a secondary that is symmetrical about its center tap. Here we are mainly concerned with the voltage ratio. Another parameter that should be mentioned because it is very important in transmission-line transformers is the impedance ratio.

Suppose that the primary of the transformer shown in Fig. 1A is rated 6 volts and 1 ampere (6 watts). Since we cannot obtain something for nothing, the output, even at 100% efficiency, can never be more than 6 watts. Hence, if the secondary potential is 12 volts, the secondary current can be no greater than 0.5 ampere.

By Ohm's Law, impedance is equal to the voltage divided by the current ($Z = E/I$), where E and I can be ac terms. Therefore, the impedance of the primary in our example is 6 volts/1 ampere, or 6 ohms, while the impedance of the secondary is 12 volts/0.5 ampere, or 24 ohms. Hence, even though the turns and voltage ratios are 1:2, the impedance ratio in our example is 1:4. (The impedance ratio is actually the *square* of the turns ratio.)

Another transformer that is very similar to that shown in Fig. 1A, except that the primary and part of the secondary are a common winding, is shown in Fig. 1B. This autotransformer does the same job as the previous transformer, except that there is no isolation between the primary and secondary windings.

Finally, in Fig. 1C is a very simple 1:1 isolation transformer. In this case, the impedance, turns and voltage ratios are all 1:1. The only purpose of such a transformer is to provide isolation between the primary and secondary windings.

Although the schematic symbols shown in Fig. 1B and Fig. 1C can be and often are used for transmission-line transformers, this is where the resemblance between the conventional and transmission-line transformers ends. The first and perhaps most striking difference between the two is that with the transmission-line transformer, the core material is relatively unimportant. Instead of limiting the high-frequency response, the only effect it has is to extend the low-frequency response.

As far as high-frequency response is concerned, the core just does not matter. It could be made out of hard candy and the transformer would still work. A second very important difference is concerned with the number of turns. With the transmission-line transformer, the number of turns has nothing to do with

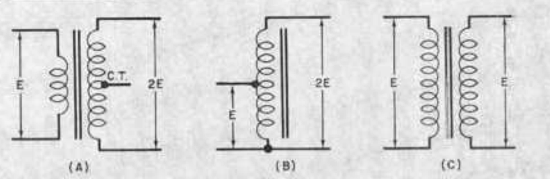


Fig. 1. Three basic transformers: (A) step-up; (B) autotransformer; (C) isolation.

the impedance. Finally, the pains taken to minimize capacitance in a conventional transformer are unnecessary in the transmission-line transformer. The transmission-line transformer uses the capacitance between its windings. In fact, this capacitance is often made as large as possible by twisting together the wires that make up the transmission-line transformer.

Technical Details. The transmission-line transformer is simply a length of transmission line. It is a pair of conductors that are either parallel to each other, twisted together, or arranged coaxially. Of importance is the spacing between the conductors, which must be constant throughout the line's length.

Each conductor in the transmission-line transformer has an inherent inductance. Also, between the wires of a conductor pair, there is an inherent capacitance. It is this combination of continuous inductance and capacitance that gives the transmission line its characteristic impedance. Any type of line can be used for a transmission-line transformer, but if a line is wound on a toroid, parallel or twisted lines are most often used because they are easy to handle and do not get pulled out of shape.

Examples of the characteristic impedances one can expect from various types of lines are as follows: No. 23 PVC-insulated hookup wire twisted at about one turn/inch yields about 150 ohms; 0.040" enamelled wire with about eight twists/inch yields about 25 ohms; and 0.040" enamelled wires wound side by side, with the turns kept as close together as possible, works out to between 50 and 70 ohms.

The essential condition for the proper operation of a transmission line is that the currents flowing in the two conductors be equal and opposite. Anything that causes an unbalanced current flow will prevent the line from operating properly. Suppose, for example, that a coaxial transmission line is very short and has one leg grounded at each end, as shown in Fig. 2. It is quite possible that there could be a ground current, I_g, flowing through the ground leg in addition to transmission-line current. There are, in fact, many ways in which a short transmission line can have unbalanced currents flowing through its conductors, all of which defeat the effect of the line.

Suppose the short transmission line shown in Fig. 2 were wound to form an inductor, as shown in Fig. 3A. (Its schematic representation is shown in Fig. 3B.) Even though one leg is still grounded at each end, the ground current will be impeded by inductive reactance. The transmission-line currents, however, would not be affected here because they are equal and opposite at every point along the line, thus neutralizing the inductive effect of the coil. The actual line length can be short as 1/50-wavelength so no significant phase shift takes place.

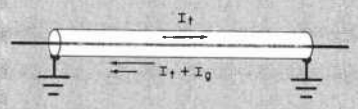


Fig. 2. Current flow in a short piece of coax line grounded at each end.

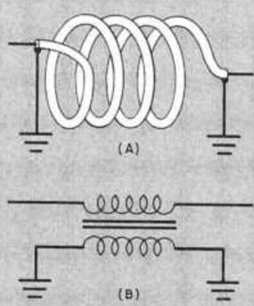


Fig. 3. Coax line wound to form an inductor (A) and its schematic (B).

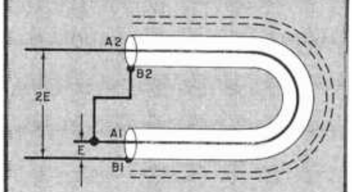


Fig. 4. The 4:1 balun is similar to autotransformer shown in Fig. 1B.

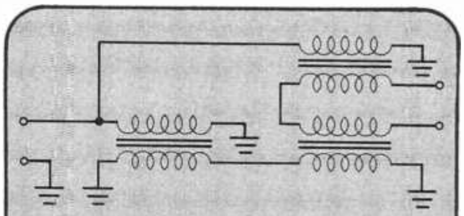


Fig. 5. A transmission-line transformer for interstage coupling with dc isolation.

If the transmission line were now wound on a ferrite rod or, better yet, a toroid core, it would be even more effective and would produce a higher degree of isolation. As the frequency increases, less inductance would be required to obtain the same isolation effect. Even if the core material is useless at very high frequencies, the isolating effect would still remain.

The autotransformer shown in Fig. 1B has a voltage ratio of 2:1 and an impedance ratio of 4:1. Exactly the same ratios can be obtained with a transmission-line transformer. The principle involved can be readily seen with a coaxial transmission line, as shown in Fig. 4. This is the well-known 4:1 balun (balanced-to-unbalanced) transmission-line transformer. The schematic symbol for the balun transformer would be the same as for the autotransformer of Fig. 1B.

In Fig. 4, ignoring losses, if a voltage is supplied between points A1 and B1, it will appear at points A2 and B2. With point B2 connected to point A1, twice the input voltage would appear across output points B1 and A2. This means that the output impedance would be four times the input impedance and the output would be symmetrical about the A1/B2 junction. In practice, the A1/B2 junction would be connected to the shield of the main coaxial transmission line and would generally be grounded.

There must be a very high impedance to out-of-balance currents between A1 and A2, isolating the two ends from each other. As a rule-of-thumb, this could be at least 50 times the characteristic impedance of the line—2500 ohms for a 50-ohm line. Winding the cable around a toroid is an effective way of getting the required impedance. A special case is the ¼-wave balun, where isolation is provided by the ¼-wave effect. However, this is effective only at one frequency, and cannot provide a broadband transformer.

Making a Transformer. Now that you know what a transmission-line transformer is and how it works, let us proceed to make a vhf power transformer using a core of audio-frequency material. Just about any type of toroid—ferrite or, better still, one made from flat strip iron rolled up in a coil, such as the type used in dc-to-dc converters—will do.

Wind two lengths of 0.040" enamelled wire onto the toroid. Keep the wires parallel to each other and make each turn touch the previous turn. Do not attempt to crowd too many turns on the toroid. The object is to wind only as many turns on the toroid in a single layer without having the conductors cross each other.

Bear in mind that many toroids have sharp edges and that even ferrite material is often conductive. If the edges cut into the insulation, the wire windings can be short-circuited. If the transformer does not operate as expected, short-circuiting will be the most probable cause since, practically speaking, there is nothing else that can really go wrong with the transformer. After winding your transformer, use an ohmmeter to test the insulation between each conductor and the core and between windings.

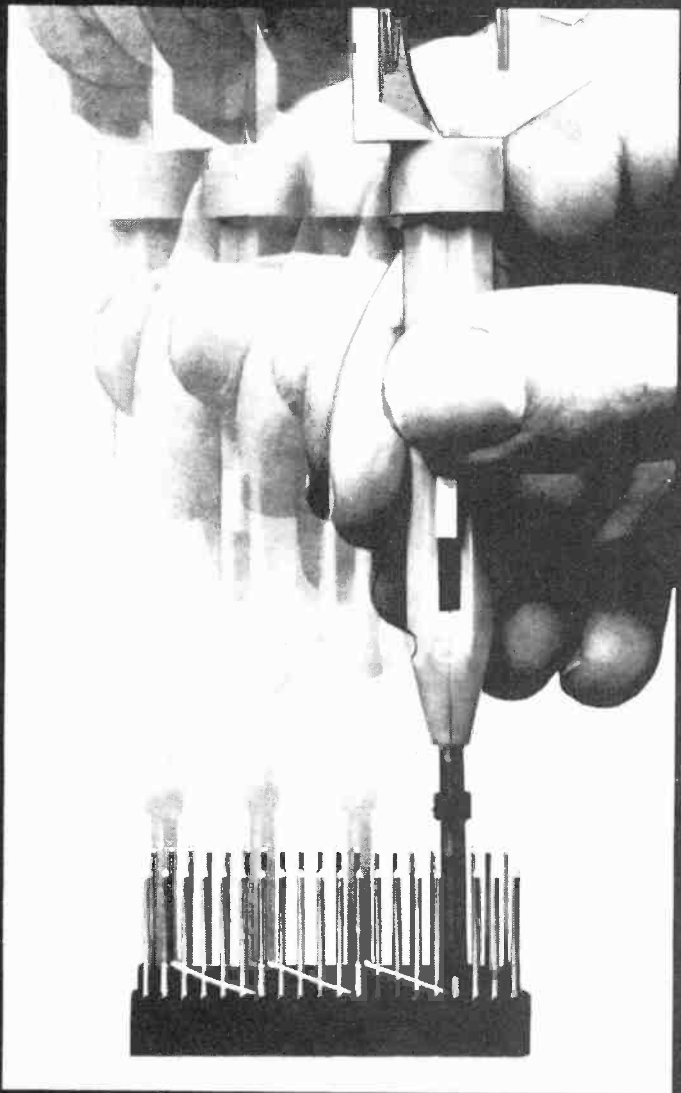
The basic transmission-line transformer just fabricated will yield a 1:1 impedance ratio and complete isolation so that it can be used as a balanced-to-unbalanced or, for that matter, any other type of configuration. If we need a 4:1 balun, it is necessary only to connect the ends of the conductors as shown in Fig. 4, without altering the winding.

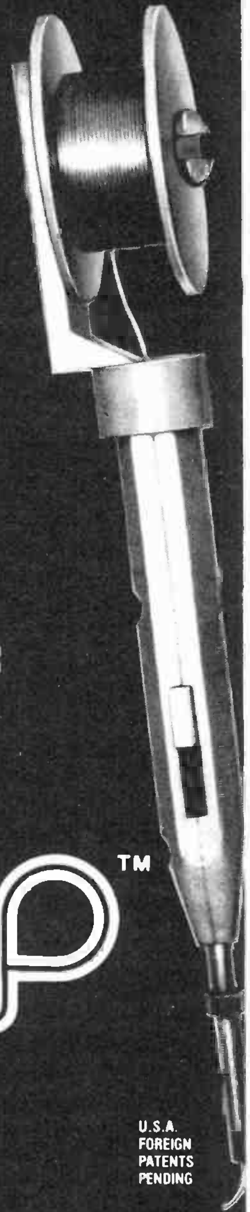
When necessary, as when using a transmission-line transformer for interstage coupling, dc isolation can be obtained by using three transformers, as shown in Fig. 5. Remember that the core is there only to prevent out-of-balance currents. Therefore, if the wire size is small enough and the toroid core is large enough, it is possible to wind all three transformer windings on the same core.

In Conclusion. There is one basic limitation concerning transmission-line transformers. This is that the ratios obtainable are limited to 1:1 and 2:1, and multiples of 2:1 if two or more transformers are used. Also, it can be difficult to obtain the required impedance, particularly with a twisted-pair line.

If you want to build a wideband amplifier and must match, say, a 12-ohm transistor to a 50-ohm output, or make a balanced modulator, or provide really good isolation in a noise bridge, or make a balun transformer for a high-power transmitter, the transmission-line transformer is the way to go. The transmission-line transformer offers a great opportunity for experimenting. ◇

NEW!





WHY CUT?
WHY STRIP?
WHY SLIT?

WHY NOT...

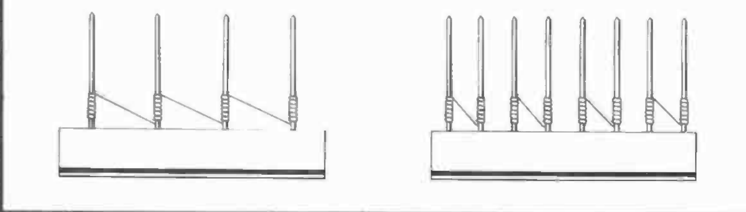
JUST WRAP™

U.S.A.
FOREIGN
PATENTS
PENDING

- AWG 30 Wire
- .025" Square Posts
- Daisy Chain or Point To Point
- No Stripping or Slitting Required
  ....JUST WRAP™....
- Built In Cut Off
- Easy Loading of Wire
- Available Wire Colors:
  Blue, White, Red & Yellow

$14.95*

	JUST WRAP TOOL WITH ONE 50 FT. ROLL OF WIRE	
COLOR	PART NO.	U.S. LIST PRICE
BLUE	JW-1-B	$14.95
WHITE	JW-1-W	14.95
YELLOW	JW-1-Y	14.95
RED	JW-1-R	14.95
	REPLACEMENT ROLL OF WIRE 50 FT.	
BLUE	R-JW-B	1.98
WHITE	R-JW-W	1.98
YELLOW	R-JW-Y	1.98
RED	R-JW-R	1.98



DAISY CHAIN　　POINT TO POINT

ok

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

*MINIMUM BILLING $25.00 / ADD SHIPPING CHARGE $2.00 / NEW YORK CITY / STATE RESIDENTS ADD APPLICABLE TAX.

CIRCLE NO. 45 ON FREE INFORMATION CARD

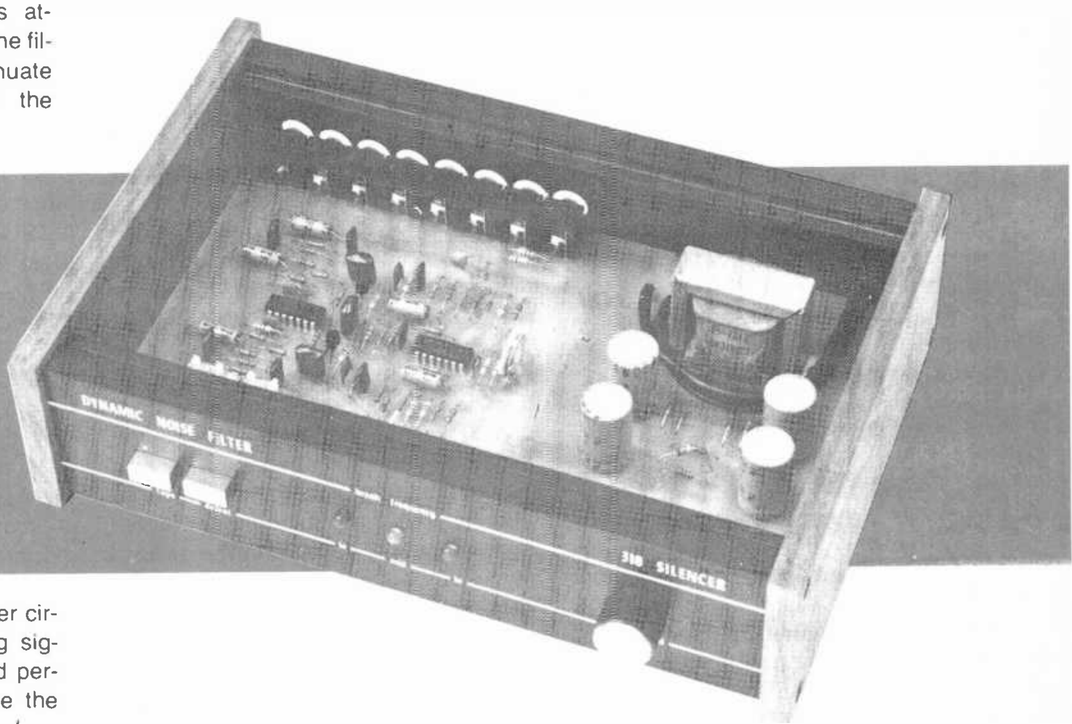
BY COLLEEN McNEICE AND ROGER COTA

Build a DYNAMIC AUDIO NOISE FILTER

Cleans up radio, tape and record signals from any stereo system

THE "SILENCER" dynamic noise filter described here can eliminate tape hiss, record-surface noise, and atmospheric radio noise. Consequently, it is an ideal add-on device for stereo hi-fi systems. Moreover, it does not require encoding and decoding.

The device is essentially a voltage-controlled low-pass filter whose cutoff or break frequency is continually changing to accommodate program material and shut out any detracting noise. It only filters when noise and hiss are audible, when program material is at a low level or absent. The phenomenon of masking is utilized. That is, high-level signals mask noise that would be objectionable if program material level were low. When such masking occurs, the whole signal is passed. When there is no masking by program material, however, the filter extends the bandwidth only as far as required by the music. Beyond this, the high-frequency noise is attenuated. The frequency at which the filter begins rolling off to attenuate high-frequency noise is called the "break frequency."



About The Circuit. The silencer circuit constantly analyzes incoming signals for amplitude, frequency, and persistence. These factors determine the bandwidth at any instant, as well as how quickly the variable low-pass filter changes. Attack and release times vary with the music, thus eliminating a "pump and wheeze" effect of noise modulation.

The device has a continuously variable threshold control, with front-panel LEDs calibrated to indicate "Low," "Mid," and "High" break frequencies. The filter's break frequencies vary between 1.5 and 20 kHz with a roll-off slope of 9 dB/octave (maximum). The Silencer is a single-ended stereo device, making it ideal for use with tapes, records, and tuners for playback and record purposes.

The unit connects either in the auxili-

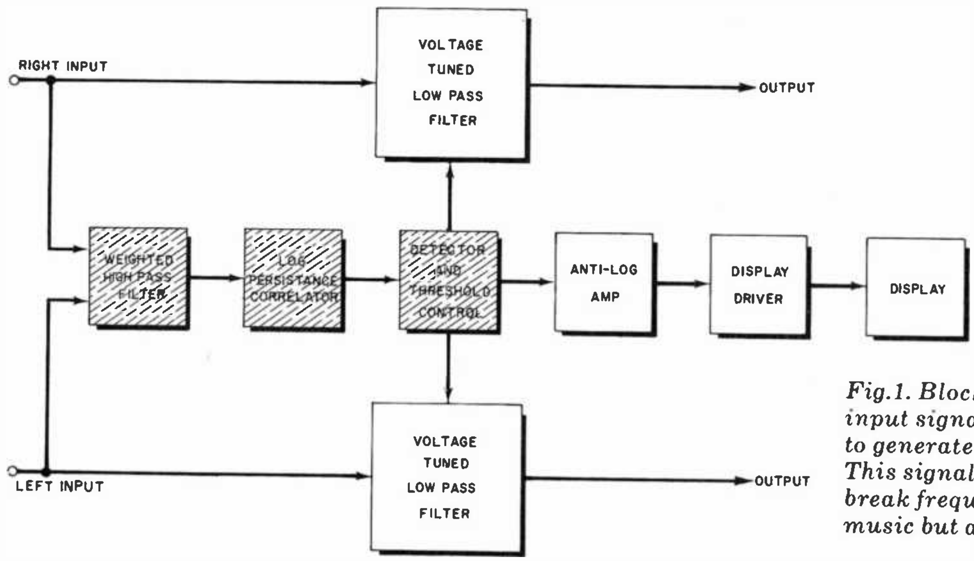


Fig.1. Block diagram shows how input signals are processed to generate a control signal. This signal governs filter's break frequencies to pass music but attenuate noise.

ary mode or in the tape loop of your audio amplifier. On the back panel are IN and OUT jacks for the tape loop; the front panel also has a TAPE monitor button, and a system DEFEAT.

The block diagram of Fig. 1 shows the functions of the dynamic noise filter. The voltage-controlled low-pass filter is composed of *IC1A* and *IC1B*, as shown in the schematic of Fig. 2. (The components to the left of the dashed line make up one stereo channel; only one is shown in the schematic for clarity.) The gain of op amp *IC1A* is approximately *R3/R5*. At low frequencies, the capacitive reactance of capacitors *C4* and *C5* is very high, making the output of *IC1B* look like a low impedance source. The gain of *IC1A* is then:

$$A = R3/R5 = 10{,}000 \text{ ohms}/1000 \text{ ohms} = 10$$

At higher frequencies, however, the impedance of *C4* and *C5* decreases; *IC1B* generates an output and bootstraps *R5*. This bootstrapping effect causes *R5* to look larger. Therefore, gain A becomes smaller and the filter attenuates the high-frequency energy.

To vary the breakpoint of the filter, FET *Q1* has the ability to shunt the signal at the non-inverting input of *IC1B* to ground. Figure 3A shows the filter with the FET open and the high frequencies attenuated, while 3B illustrates the filter's action with the FET shorting the signal to ground. The control signal applied at the gate of the FET allows the bandwidth of the low-pass filter to be self-adjusting for any frequency. This allows high-frequency signals and subtle harmonics of fundamental bass frequencies to be passed, while unmasked noise is attenuated.

The circuits represented by the shaded blocks of Fig. 1 are the dynamic analytical controls. They automatically judge the program material, adjust the bandwidth to accommodate it, and change the attack and release times to maximize the masking effect and minimize noise modulation. The control signal is applied to the gate of *Q1*. It's determined by the (1) spectral content, (2) amplitude, and (3) persistence of the incoming signal.

The spectral content is sensed by the high pass weighting filter, a network made up by *R8, R29, R30, R31, C6, C17*, and *IC2A*. This network is driven by the output of *IC1B*, which actually determines the quiescent operating point of the low-pass filter. Amplitude is determined by threshold control, *R27*, a 100K-ohm front-panel potentiometer. This pot sets the voltage divider for the positive input to *IC2A*, and the dc level for *IC2A*'s output. The dc output level determines the quiescent operating point of the FET. The dynamic operation of the FET is adjusted by the ac control signal, allowing it to follow the program material. The ac component of *IC2A*'s output is determined by sensing the signal's amplitude on the output of *IC1B*.

The persistence log amp is formed by *R33, D2*, and *C20*. It checks the correlation coefficient of the signal, and adjusts the attack and release time of the low-pass filter to minimize any noise modulation problems. Variable attack and release times allow for the most effective masking of the noise.

The anti-log amplifier *IC2B* also senses the control voltage output of *IC2A*. This signal is then rectified and filtered by *D4* and *C21*, and is then used to drive threshold comparators *IC2C* and *IC2D*. These amps drive the logic network of *D5, D6*, and *D7*, which drives the display. The 10K-ohm trimpot, *R37*, is used to calibrate the LEDs. The red LED indicates a break frequency of 1.5 kHz, the yellow, a break frequency between 1.5 and 10 kHz, and the green that the filter is opening up above 10 kHz.

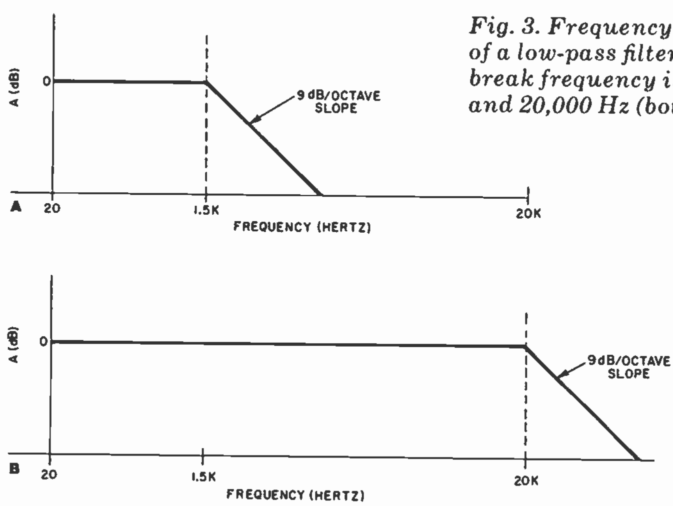


Fig. 3. Frequency response of a low-pass filter when its break frequency is 1500 Hz (top) and 20,000 Hz (bottom).

PARTS LIST

C1, C3, C9, C11, C21—1-μF 50-volt axial-lead electrolytic capacitors
C2, C10—680-pF disk ceramic capacitors
The following are 100-volt Mylar capacitors:
C4, C5, C12, C13—.022-μF
C6, C14, C17—.001-μF
C7, C15, C20—.1-μF
C8, C16—.01-μF
C18, C22, C23, C24—1000-μF 35-volt radial-lead electrolytic
D1—33-volt Zener diode
D2 through D7—1N914 signal diode
D8 through D11—1N4002 rectifier
F1—½-ampere fuse
IC1, IC2—μA4136 quad op amp (Fairchild)
J1-J8—RCA phono jacks
LED1—Red (Fairchild FLV 110 or equivalent)
LED2—Yellow (Fairchild FLV 410 or equivalent)
LED3—Green (Fairchild FLV 310 or equiv.)
Q1, Q2—Matched pair of 2N5458 JFETs.
The following are ¼-watt, 5% tolerance resistors:
R1, R13, R26—47,000 ohms
R2, R14, R35, R43, R44—4700 ohms
R3, R15, R33, R38—10,000 ohms
R4, R16—100 ohms
R5, R17—1000 ohms
R6, R18—39,000 ohms
R7, R19, R45, R46—2200 ohms
R8, R20, R29—15,000 ohms
R9, R21—11,000 ohms
R10, R22, R36, R39, R41—100,000 ohms
R11, R12, R23, R24, R34—1 megohm
R25—22,000 ohms
R28, R32—470,000 ohms
R30—680,000 ohms
R31—130,000 ohms
R40, R42—27,000 ohms
Other resistors and controls:
R27—100,000-ohm potentiometer with switch (CTS FR-GC-XM 450 or similar)
R37—10,000 ohm thumbwheel trimpot
R47, R48—10 ohms, ½ watt, 5% tolerance resistor
S1, S2—DPDT switches
S3—110-V, 2-A switch (part of R27)
T1—22-volt center-tapped, 50-mA transformer
Misc—Ac line cord, knob for threshold pot, buttons for switches, suitable enclosure, hardware, hookup wire, solder, etc.
Note—The following items are available from Logical Systems, 3314 "H" St., Vancouver, WA 98663 (Tel. 206-694-7905): Complete 318 Silencer kit, including 6063 extruded aluminum chassis and hand-finished black walnut end pieces, $129.00. Also available separately: Etched and drilled circuit board, $15.00; individually tested and matched 2N5458 FETs, $3.50. Washington state residents please add 5% sales tax.

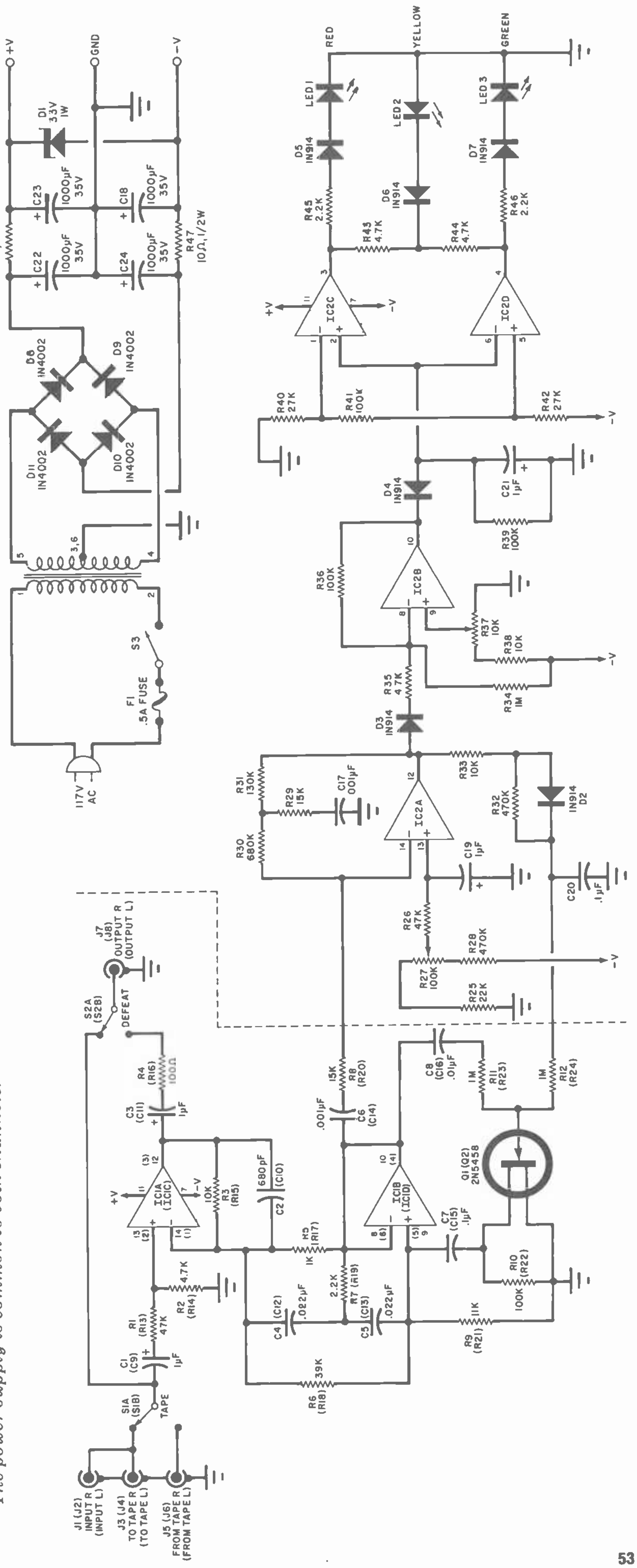
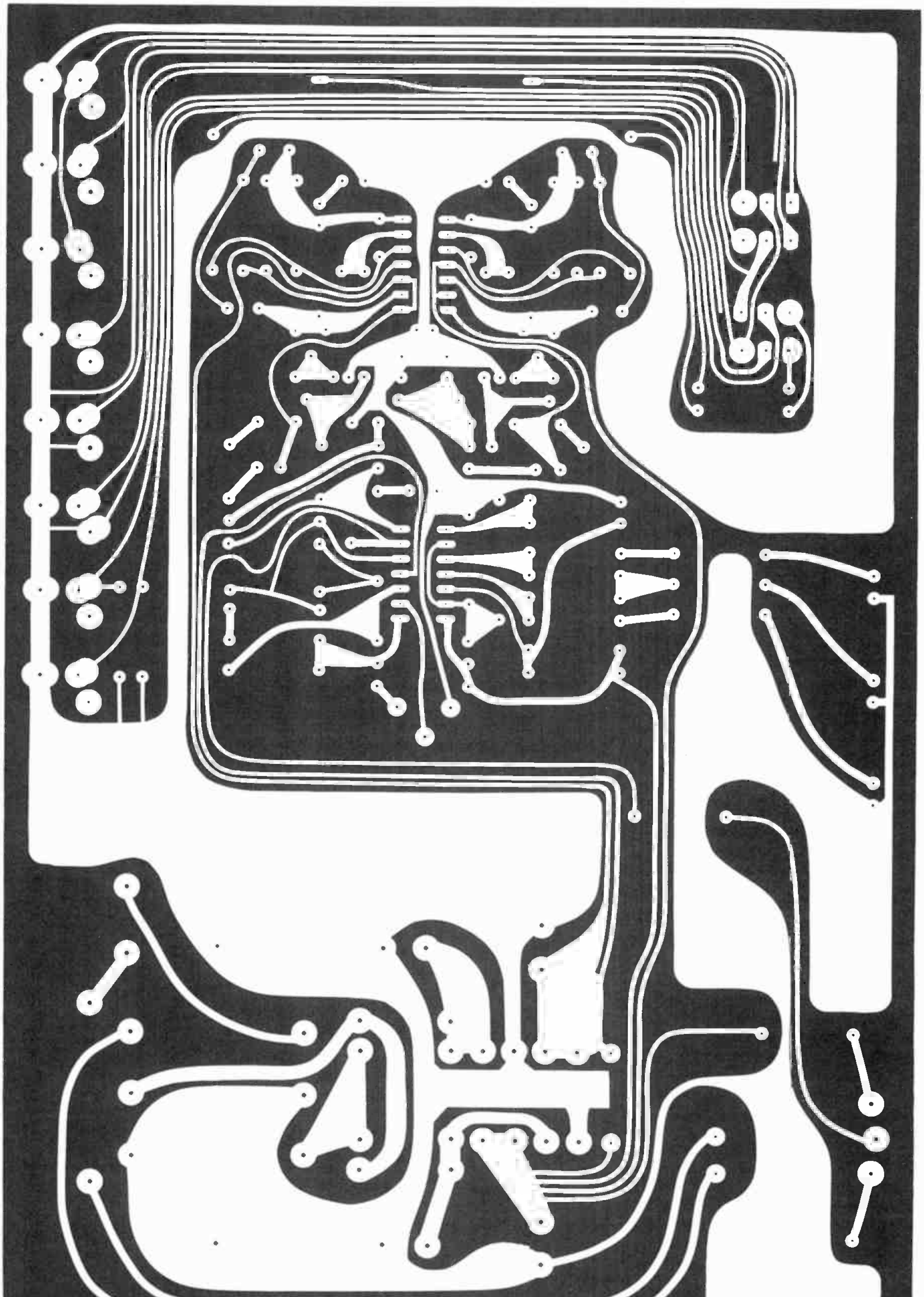
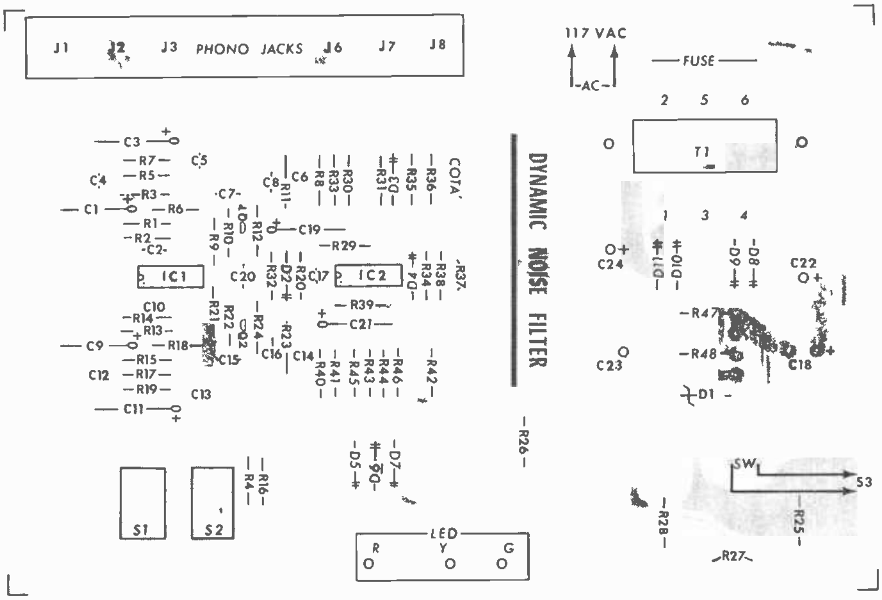


Fig. 2. Schematic diagram. Components of the left-channel filter are numbered in parentheses. The power supply is common to both channels.



A



B

Fig. 4. Actual-size etching and drilling guide for the "Silencer." Board is shown at (A); parts placement at (B).

OPERATING SPECIFICATIONS—"SILENCER"

Hiss Reduction:	15 dB at 10,000 Hz
Max. Filter Slope:	9 dB/octave
Frequency Response:	20 to 20,000 Hz ±0.5 dB
Minimum Bandwidth: (Filter Closed)	1500 Hz
Dynamic Range:	Output noise greater than 100 dB below max. output, 20 to 20,000 Hz
S/N Ratio:	Better than 85 dB below 2 V ac output 20 to 20,000 Hz
THD:	Less than 0.1%, at rated output, 20 to 20,000 Hz.
IM Distortion:	Less than 0.01% at rated output 60/7000 Hz mixed 4:1; typically less than 0.005%
Rated Output:	2 V ac into 10,000 ohms
Max. Output:	10 V ac into 10,000 ohms
Input Impedance:	47,000 ohms, single ended
Output Impedance:	100 ohms
Power requirements:	110/120 V, ac 50/60 Hz, 8 W

Note: All measurements made with filter bandwidth open maximum except where specified. (This is the worst-case condition.)

Construction. This unit is most easily constructed using a printed-circuit board. Complete etching and drilling guides are shown in Fig.4A, with the component guide shown in Fig. 4B. Proper orientation of parts is very important. Take careful note of how FETs *Q1* and *Q2* are mounted as well as op amps, diodes, and electrolytic capacitors. Also observe that the dynamic characteristics of the FETs must be matched. Moreover, when choosing op amps, it is important to make sure that the one chosen for the detection circuit, *IC2*, has an open-loop gain of at least 50 dB at 10 kHz. Op amps in the parts section were chosen for their excellent noise figures.

The unit is designed to fit into a custom aluminum extrusion, held by the eight screws in the wood ends. Any suitable enclosure will work, however. The circuit board itself measures 6" × 9". The RCA phone jacks, front-panel switches, and threshold pot are circuit-board mounted for ease of construction and minimum noise. LEDs may be circuit-board mounted or attached to your front panel and then wired. If you choose not to use the furnished printed-circuit guides, make sure that the power supply is as far away as possible from the rest of the circuit to eliminate stray hum.

Calibration. Calibration should be done before you fully enclose the unit. To calibrate, connect the noise filter into your amplifier's or receiver's auxiliary or tape input. Find a low-level noise source—an erased magnetic tape would be ideal. If you don't have tape facilities you may use the inside groove of an LP record. Increase the amplifier's gain so you can hear the noise very well.

Start with the Silencer's threshold pot turned fully counter-clockwise and slowly turn the control knob clockwise. You will hear the noise change character and become more objectionable. Return to the position where the noise-content change just begins (listen several times so you will be able to identify this point). With the threshold knob in this position, adjust *R37*, the thumbwheel trimpot, so that the red LED lights. You should adjust the pot so that it is at the point where only a slight adjustment will cause the yellow LED to light.

In conclusion, this easy-to-build noise-reduction system will be a helpful and versatile addition to any stereo hi-fi system, cleaning up signals from any source. ◇

"HOT" NEW BOOKS FOR MICRO-COMPUTER PROS!

The latest in micro-computer books that people waited in line to buy!
Now available by mail for the first time.

How to Buy & Use Minicomputers & Microcomputers
By W. Barden, Jr.
Explores the basics; covers hardware, software, peripheral devices, programming languages & techniques; use for fun or profit! 240 pgs. *#21351 . . . $9.95*

Microcomputer Primer
By M. Waite & M. Pardee
Explains it all: central processing unit, memory, input/output interfaces, programs. Discusses well-known models & shows how to program your own. 224 pgs. *#21404 . . . $7.95*

Basic Primer
By M. Waite & M. Pardee
Covers BASIC fundamentals, program control, organization, functions & variations. With a game program & data on numbering systems & ASCII character codes. 192 pgs. *#21586 . . . $8.95*

How to Program Microcomputers
By W. Barden, Jr.
Examines assembly-language programming of 8080, MC6800 & MCS6502 models. Explains concepts, operation & architecture. With precanned operations. 256 pgs. *#21459 . . . $8.95*

Fundamentals of Digital Computers (2nd Ed.)
By D. Spencer
Explains computers, programming, hardware, BASIC, FORTRAN & COBOL languages, advanced concepts & computer center operation. 320 pgs. *#21534 . . . $9.95.*

The 8080A Bugbook®: Microcomputer Interfacing and Programming
By Rony, Larsen & Titus
Emphasizes the computer as a controller. Covers principals & 4 basic tasks of computer interfacing. BUGBOOK® is a registered trademark of E&L Instruments, Inc., Derby, Conn. 06418. 416 pgs. *#21447 . . . $10.50*

DBUG: An 8080 Interpretive Debugger
By C. Titus & J. Titus
How to use DBUG (a software debugging package) to develop & test programs. With documented hexadecimal & octal listings. 112 pgs. *#21536 . . . $4.95*

Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing
By Rony, Larsen & Titus
Covers basic gates thru microcomputer interrupts, with hardware & software examples. Experiments re: breadboarding, circuits, etc. over 416 pgs. each. Book 1: *#21550 . . . $12.95.* Book 2: *#21551 . . . $10.95.* Both: *#21552 . . . $20.95*

NCR Data Communications Concepts
By NCR Corp.
Explores concepts, techniques & limitations of data communications: telephone-based & others. 208 pgs. *#21548 . . . $6.95*

NCR Data Processing Concepts Course
By NCR Corp.
Intro to data processing, computers & digital logic. Covers input/output devices, memories, control. 256 pgs. *#21547 . . . $7.95*

Understanding CMOS Integrated Circuits (2nd Ed.)
By R. Melen & H. Garland
Begins with basic digital ICs; covers semiconductor physics, CMOS fabrication technology & design, & advanced CMOS applications. 144 pgs. *#21598 . . . $5.95*

Transistor-Transistor Logic (2nd Ed.)
By G. Flynn
Discusses digital logic & different types of logic circuits used in the TTL functional class. With block diagrams, schematics, logic truth tables. 288 pgs. *#21572 . . . $6.95*

SAVE 10% when you order 3 or more!
Examine any book(s) at NO RISK for 15 Days!

315

Clip Out–Mail Today!

YES—Please send me the book(s) indicated below. If I'm not completely satisfied, I may return any or all within 15 days of receipt for full credit or refund. Add sales tax where applicable.

	☐ 21534	☐ 21552
☐ 21351	☐ 21447	☐ 21548
☐ 21404	☐ 21536	☐ 21547
☐ 21586	☐ 21550	☐ 21598
☐ 21459	☐ 21551	☐ 21572

☐ I have checked 3 or more titles and deducted my 10% savings.

Name ______________ (Please Print)

Address ______________

City ______________

State ______ Zip Code ______ Total: $______

☐ Check ☐ Money Order ☐ Master Charge
☐ Visa/BankAmericard

Exp. Date ______

Account No.: ______

Interbank No.: ______ (Master Charge only)

Signature: ______

Minimum credit card purchase: $10.00 ME52

MAIL TO:
Howard W. Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

Prices subject to change 6 months after issue date.

The MORSE-A-WORD

BY GEORGE STEBER

PART TWO: Construction, Alignment, and Use

Construction. The Morse-A-Word is most easily assembled using printed circuit techniques. Three pc boards are required—a main circuit board, display board, and a power supply board. The parts placement guide for the main circuit board appears in Fig. 5. Etching and drilling guides are shown in Fig. 6. Similarly, etching and drilling guides for the double-sided display board are shown in Fig. 7. This board's parts placement guide appears in Fig. 8. Finally, the etching and drilling and parts placement guides for the power supply board appear in Figs. 9 and 10.

When soldering components to circuit board foils, use a low-wattage, fine-tipped soldering pencil and fine solder. Be sure to employ the minimum amount of heat and solder consistent with good connections, and take care not to inadvertently create solder bridges between adjacent foils. The use of IC sockets or Molex Soldercons is recommended.

Assemble the main pc board first. Start by inserting and soldering the IC sockets and Molex Soldercons. Install the smallest components next, gradually working up to the larger items. For example, start with the ¼-watt resistors, then install the diodes, the small capacitors and finally the larger capacitors. Be sure to observe the polarities of diodes and tantalum and electrolytic capacitors, and the pin basing of transistors and ICs. The board furnished by the kit supplier has plated-through holes so you need only solder component leads on the bottom side of the board.

Neither the power supply, the display circuits, the sidetone speaker, jacks, CODE and DAH LEDs or the SPEED control are mounted on the main pc board. Insulated wire leads of suitable lengths should be soldered to appropriate points on the pc board now for connection to these components.

Wire the display board next, referring to the parts placement diagram of Fig. 8. Use Molex Soldercons to mount the dual IEE 1785R LED displays. Make sure the Soldercons are properly aligned before soldering them to the board. This will ensure a good fit for the displays. Resistors, capacitors and IC sockets or Soldercons for the driver ICs should be installed and soldered next. The resistors should be mounted in a vertical position. Notice that there are a number of jumper wires to be soldered to this board. These are used to interconnect the display board and the main circuit board and to support the display board. The jumpers should be made of heavy solid wire, about ½" (1.3 cm) long, and bent into "L" shapes so they extend parallel to the board and point downward.

Position the display board perpendicular to the main pc board. Insert the jumper wires connected to the display board through the appropriate holes on the main pc board and push down the display board until it just touches the main board. Check the alignment of the display board and then solder the jump-

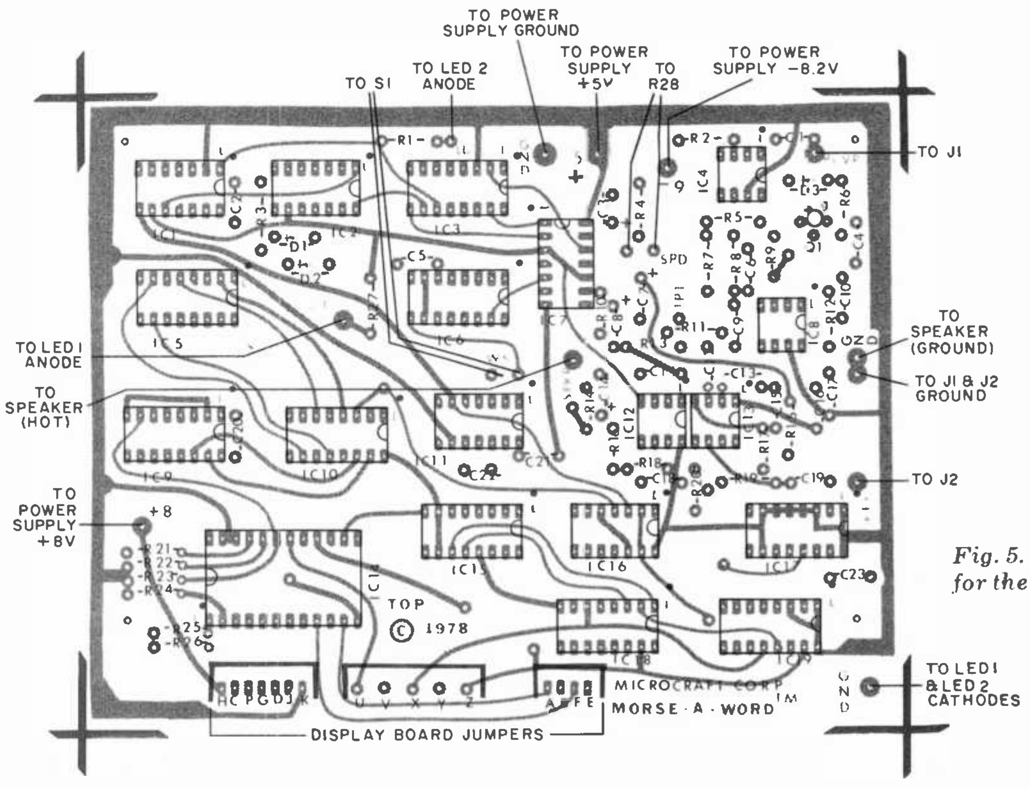
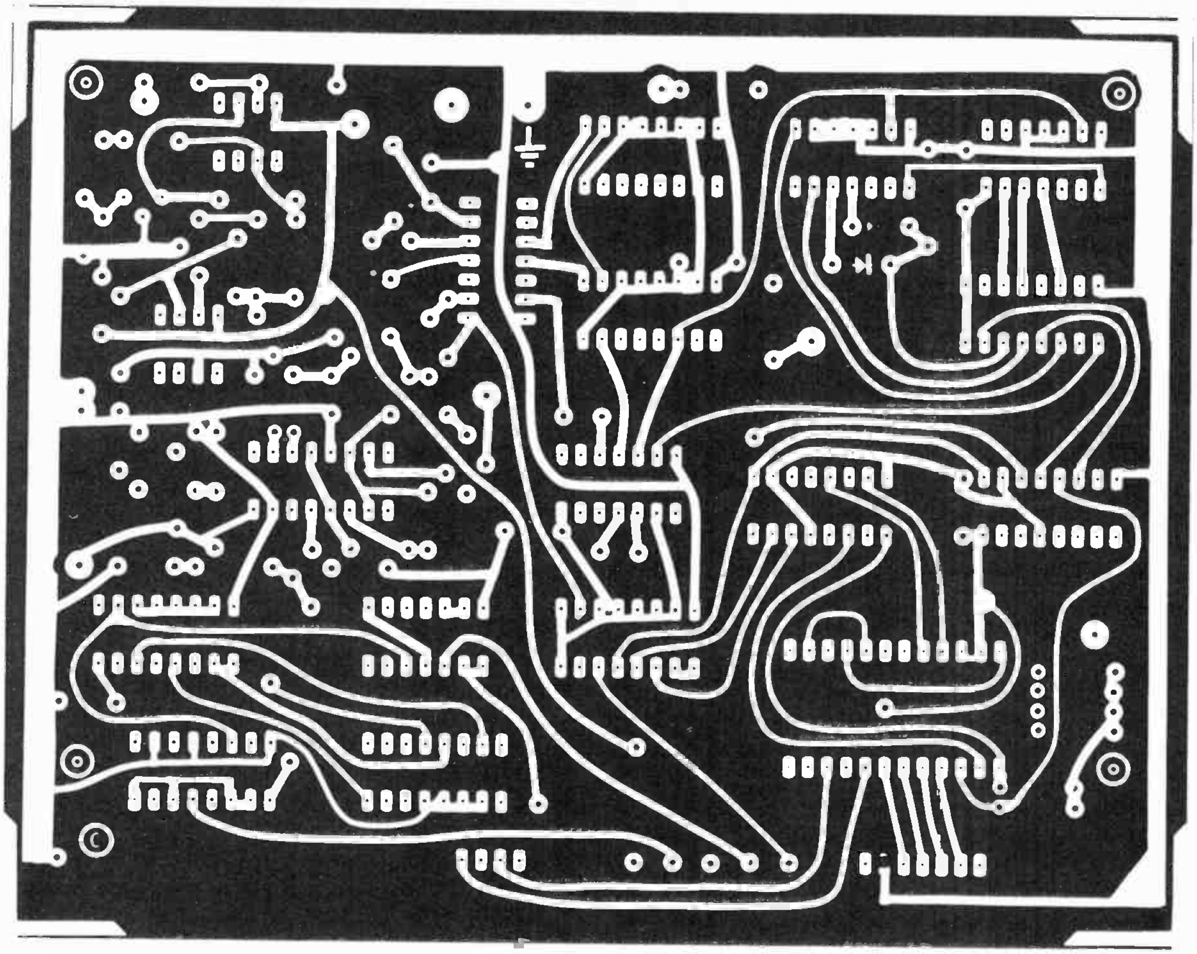


Fig. 5. Parts placement guide for the main circuit board.



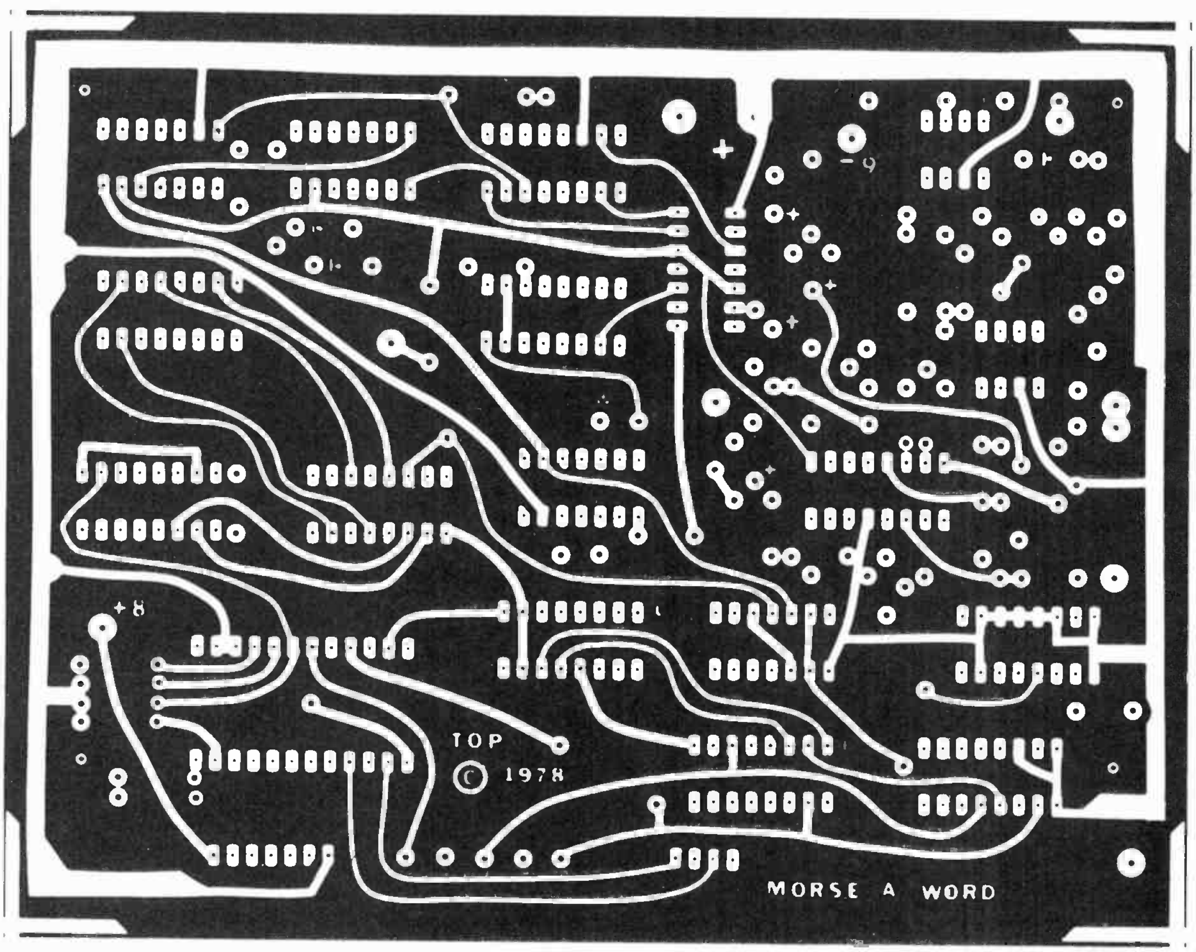
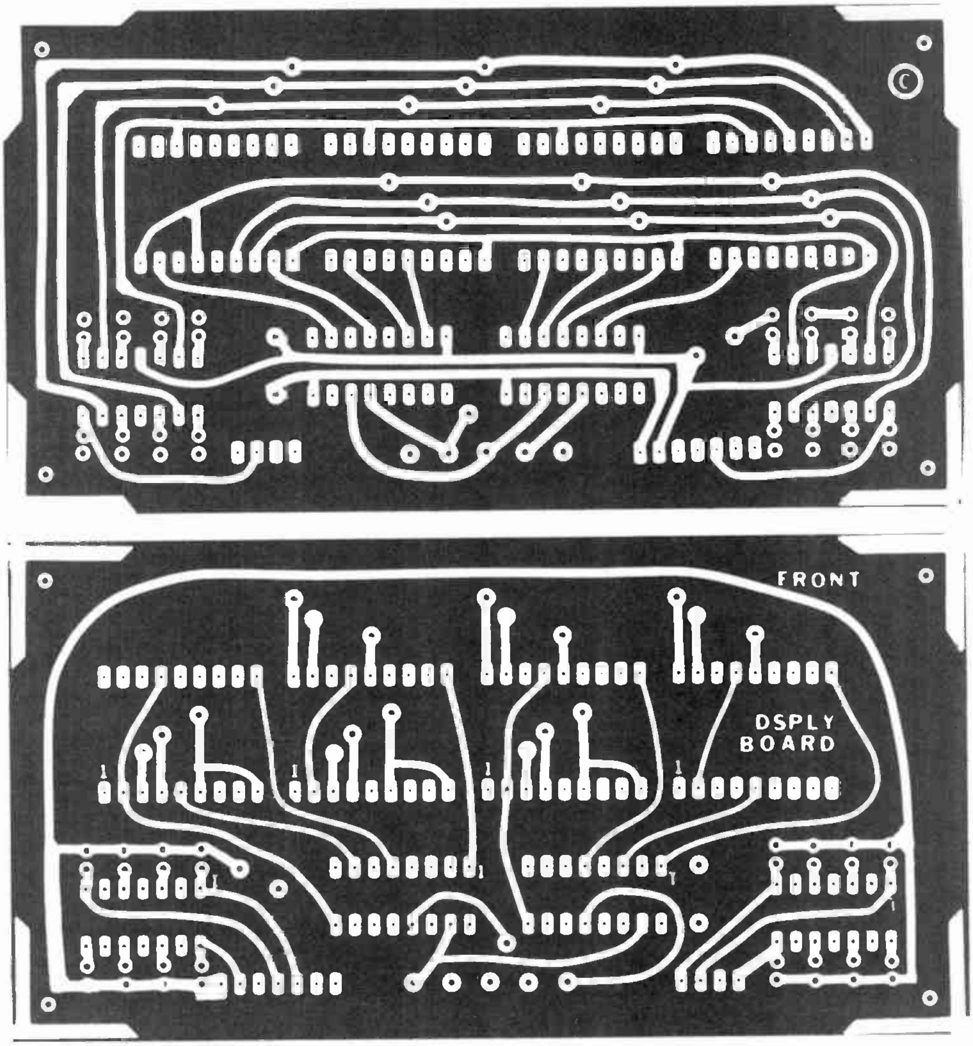


Fig. 6. Actual-size etching and drilling guides for the double-sided main printed circuit board.



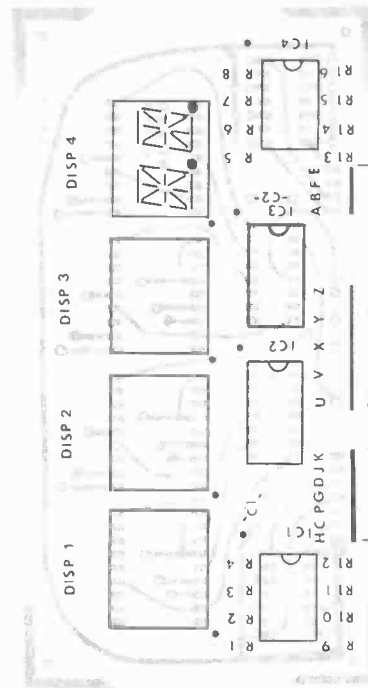


Fig. 8. Parts placement guide for front side of display board is above.

Fig. 7. Actual-size etching and drilling guides for the double-sided display board are at left.

ers to the foils on the bottom of the main pc board. Cut off excess jumper lengths.

For proper Morse decoding, the 1702A ROM must be programmed in accord with Table I. A construction article that appeared in the February 1978 issue of this magazine described a project that allows you to program your own blank ROMs. Some parts distributors will program the 1702A for you if the truth table accompanies your order. The kit supplier for the Morse-A-Word also offers a preprogrammed ROM.

Install the ICs and the dual-character IEE 1784R LED displays in their Soldercons. Make sure they are correctly oriented and take the usual precautions to avoid bending the leads or damaging the MOS ROM. It is not necessary to have a full eight-character display. Those builders with a tight budget, for example, can install only one dual-character IEE 1785R LED readout. However, a minimum of two readouts (four characters) is recommended. If fewer than four readouts are used, make sure they are right-justified (installed at the *DIS4*, *DIS4* and *DIS3*, etc.)

The remaining pc board, that for the power supply, should now be assembled. You will note that the board has space for extra components to be used in another project. These components

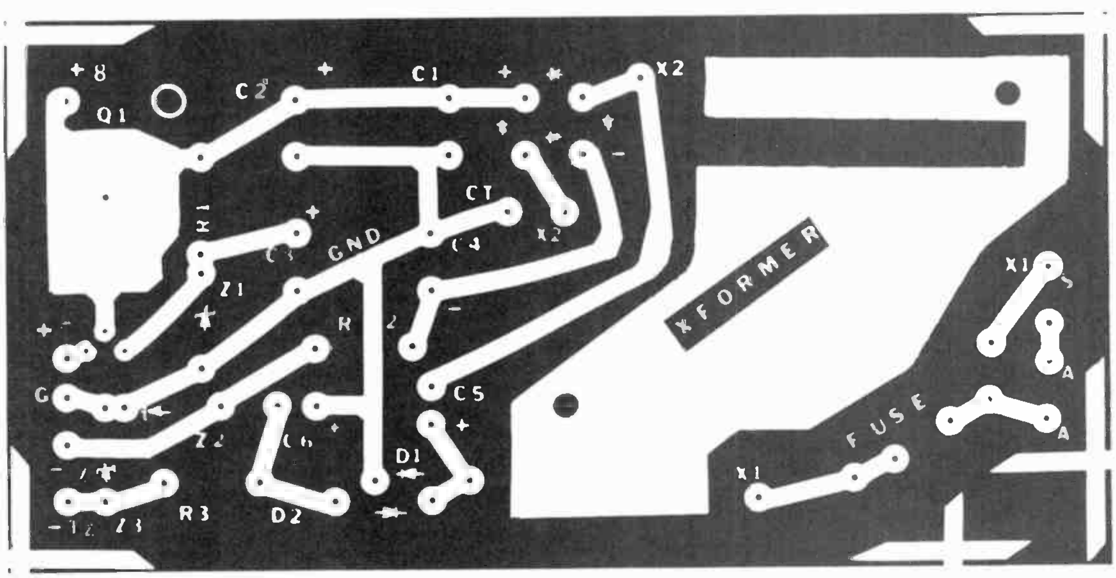


Fig. 9. Actual-size etching and drilling guide for the power supply board.

Professional or not, the Computer
the best books in the field. . .

PROGRAMMING LANGUAGES. By Allen B. Tucker, Jr. *439 pp., illus.* Gives you not only the *principles* of design but the *applications* of six major programming languages so you can decide—among the special features of each—what best suits your operations. Shows you the languages' strengths and weaknesses through demonstrations of their use in solving various representative "benchmark" problems. Also provides programs using a variety of computers so you can evaluate languages and their compilers on a basis of uniform and meaningful criteria.
654/158 Pub. Pr., $19.95 Club Pr., $14.95

THE "COMPULATOR" BOOK: Building Super Calculators and Minicomputer Hardware with Calculator Chips. By R. P. Haviland. *320 pp., illus.* Calculator chips are good for more than calculators—and here's the book to prove it. An imaginative, one-of-a-kind guide, it shows you how to use calculator chips in hundreds of innovative, practical ways, building bigger displays, designing better calculators, and creating exotic functions. Now experimenters can approach the full power of their own desktop minicomputers—multifunctioned, superbrained, and ready to do everything but get up and walk away!
783/578 Pub. Pr., $10.95 Club Pr., $9.30

INTERACTIVE COMPUTER GRAPHICS. By S. S. WALKER. *176 pp., illus.* Written to provide a simple yet comprehensive introduction for potential designers and developers of hardware and software, this book first introduces general concepts in terms of basic qualities of the human and physical capabilities of the machine.
767/661 Pub. Pr., $14.50 Club Pr., $12.30

BE SURE TO CONSIDER THESE IMPORTANT TITLES AS WELL—

MICROPROCESSOR/MICROPROGRAMMING HANDBOOK. By B. Ward
768/749 Pub. Pr., $9.95 Club Pr., $8.45

PROGRAMMING MICROPROCESSORS. By M. W. McMurran
770/913 Pub. Pr., $9.95 Club Pr., $8.45

SOFTWARE RELIABILITY Principles & Practices. By G. J. Myers
769/885 Pub. Pr., $19.95 Club Pr., $15.75

MATHEMATICAL ELEMENTS FOR COMPUTER GRAPHICS. By D. F. Rogers & J. A. Adams
535/272 Pub. Pr., $11.95 Club Pr., $9.25

57 PRACTICAL PROGRAMS & GAMES IN BASIC. By K. Tracton
784/957 Pub. Pr., $10.95 Club Pr., $9.30

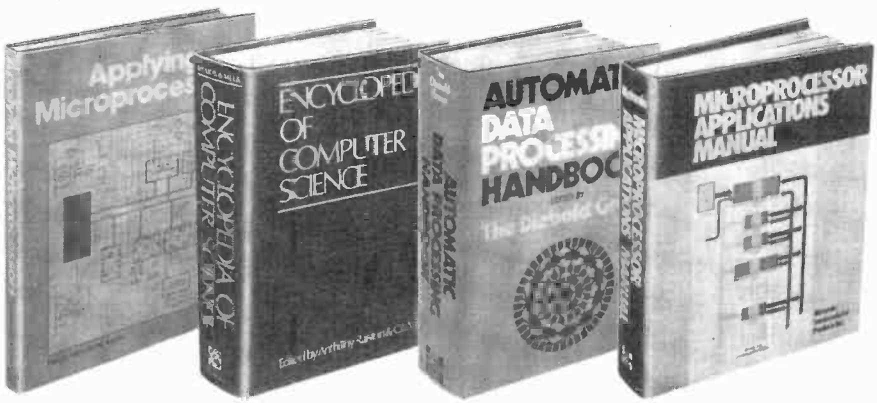
GETTING INVOLVED WITH YOUR OWN COMPUTER A Guide for Beginners. By L. Solomon & S. Veit
771/952 Pub. Pr., $9.95 Club Pr., $8.35

MICROPROCESSOR AND MICROCOMPUTER SYSTEMS. By G. V. Rao
783/659 Pub. Pr., $24.50 Club Pr., $19.50

MICROCOMPUTER-BASED DESIGN. By J. Peatman
491/380 Pub. Pr., $24.50 Club Pr., $17.50

DIGITAL COMPUTER DESIGN. By R. Kline
784/450 Pub. Pr., $19.50 Club Pr., $15.75

INTRODUCTION TO PROGRAMMING: Programming Logic and Flowcharting. By G. A. Silver & J. B. Silver
574/456 Pub. Pr., $9.60 Club Pr., $7.95



This title counts for two premium books

ENCYCLOPEDIA OF COMPUTER SCIENCE. Edited by Anthony Ralston and C. L. Meek, *1,500 pp., 60 illus., 100 charts, 7 x 10 format. This first and only in-depth coverage of the entire field of computer science in a single volume* is utterly comprehensive and completely up to date. An invaluable reference work for specialists, nonspecialists, educators, students, general readers, and librarians, it provides answers to any computer science discipline question in minutes. In addition to covering every aspect of the discipline in five broad areas, each is broken down into some 500 articles, most of them containing bibliographic information to make intensive study of any one subject easier.
769/01X Pub. Pr., $60.00 Club Pr., $39.95

ERROR-DETECTING CODES, SELF-CHECKING CIRCUITS, AND APPLICATIONS. By JOHN WAKERLY. *321 pp., with figures and tables.* Offers you the newest, most profitable uses of error-detecting codes in the design of *logic circuits that check themselves.* Combining a comprehensive treatment of the best codes for checking hardware errors in computers with the latest research results, this book is the first detailed study of self-checking circuits using the codes and their applications in computer design.
784/574 Pub. Pr., $18.95 Club Pr., $15.50

FORTRAN: A Structured, Disciplined Style. By GORDON B. DAVIS *and* THOMAS R. HOFFMANN. *372 pp., illus., 8½ x 11 format.* Why another FORTRAN book? First, the 1977 changes in the American National Standard (ANS) FORTRAN made many existing texts obsolete. Second, recent developments in programming style and discipline made most existing works inappropriate.
159/017 Pub. Pr., $11.50 Club Pr., $9.25

PROGRAMMING FOR MINICOMPUTERS. By J. C. CLULEY. *288 pp., illus.* For practicing engineers, scientists, and students who must know the latest details and techniques of assembly level programming—particularly in the context of on-line operations—here is a book which covers the whole spectrum from the encoding of data and instructions to the specific performance of systems software.
785/49X Pub. Pr., $17.50 Club Pr., $13.50

MICROPROCESSOR PROGRAMMING For Computer Hobbyists. By Neil Graham. *282 pp., with figures, tables, and samples.* If you are a personal computer enthusiast or technician, this book will prove to be one of the most valuable and interesting investments you can make. It contains full details on programming—from the very basics to the state-of-the-art capabilities—and yet it is written so simply, and progresses in such a direct and logical manner, that any reader, no matter how inexperienced, can easily follow it.
783/56X Pub. Pr., $12.95 Club Pr., $10.95

ELECTRONICS DICTIONARY. Edited by JOHN MARKUS. *4th Ed., 768 pp., 1,173 illus.* The indispensable, easy-to-use standard authority on the meaning of 17,090 terms that make up the language of today's electronics is now available in a revised, updated edition. With the vocabulary becoming more challenging and more complex every year, this latest edition is a real necessity for everyone in the electronics community—engineers, technicians, technical writers, students, and scientific and technical libraries.
404/313 Pub. Pr., $24.50 Club Pr., $19.50

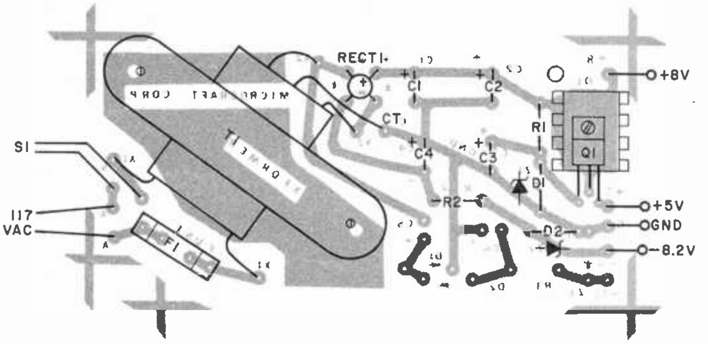


Fig. 10. Component placement for the power supply board shown above.

are not required in the Morse-A-Word and the pc locations for them should be ignored. When you have completed assembly of the board, apply line power to it and verify that the desired voltages are being produced. If the voltages are correct, remove line power and interconnect the supply and main pc boards with suitable lengths of color-coded hookup wire. Then mount the boards in the project enclosure and connect the free ends of the hookup wires already soldered to the main pc board to speaker, jacks, etc. A cutout for the displays must be made on the front panel of the enclosure. This can best be done with a nibbling tool. For those who prefer a prepunched enclosure, one is available from the kit supplier. Display contrast and project appearance will be enhanced by installing a bezel and red filter in the cutout.

Apply power to the project. Several or all of the dual-character displays should start to glow. If they don't, disconnect power and go back and thoroughly check for loose wires, cold solder joints, solder bridges, or incorrect wiring.

Alignment. The center frequency of the bandpass filter and the tone decoder's peak response frequency must be the same if the Morse-A-Word is to function properly. Any frequency between 800 and 2600 Hz is suitable, but the higher frequencies will produce a better circuit response. On the other hand, the higher frequencies tend to be more difficult to tune on a highly selective communications receiver. As a compromise, 1200 Hz was selected as the center frequency of the band-pass filter and the tone decoder.

To align the project, apply a 0.5-volt rms, 1200-Hz signal to the receiver input jack. Connect an ac voltmeter or oscilloscope to the output of the bandpass filter (*TP1*) and adjust trimmer potentiometer *R9* for maximum output. Next, adjust *R20* until a tone is heard in the speaker and the CODE LED lights. Reduce the input signal to as low a level as possible and repeat the procedure. If a 1200-Hz signal is not available and you have a cassette tape recorder, a cassette tape available from the kit supplier has the necessary tone recorded on it. The tape also includes recordings of sample Morse code messages and selections which can be used for code practice.

The only other adjustment is the setting of trimmer potentiometer *R14*, which determines the loudness of the speaker output. A low volume setting is

TABLE I
TRUTH TABLE FOR 1702A PROM IC14

Character	Input								Output							
	A7	A6	A5	A4	A3	A2	A1	A0	D8	D7	D6	D5	D4	D3	D2	D1
A	0	1	1	0	1	0	1	1	1	1	0	0	1	0	0	1
	0	0	1	0	1	0	1	1	0	1	0	0	1	0	0	1
B	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0
	0	0	1	1	1	1	0	0	1	1	0	1	1	0	0	1
C	0	1	1	1	0	1	0	0	1	1	0	0	0	0	0	1
	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0
D	0	1	1	1	1	0	0	1	1	0	0	1	0	0	0	0
	0	0	1	1	1	0	0	1	1	1	0	1	0	0	0	1
E	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1
	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0
F	0	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1
	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
G	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1
	0	0	1	1	0	0	0	1	1	0	0	0	1	0	0	1
H	0	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1
	0	0	1	1	1	1	1	0	0	1	0	0	1	0	0	1
I	0	1	1	1	1	0	1	1	1	0	0	1	0	0	0	0
	0	0	1	1	1	0	1	1	1	0	0	1	0	0	0	0
J	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1
	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1
K	0	1	1	0	1	0	0	1	0	1	0	0	1	0	0	1
	0	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0
L	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	1
	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0
M	0	1	1	0	0	0	1	1	0	1	1	0	0	0	0	1
	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0	1
N	0	1	1	1	0	0	1	1	0	1	1	0	0	0	0	1
	0	0	1	1	0	0	1	1	0	1	0	0	0	1	0	1
O	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	1
	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	1
P	0	1	1	1	0	0	1	0	1	1	0	0	1	0	0	1
	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	0
Q	0	1	1	0	1	0	0	0	1	1	0	0	0	0	0	1
	0	0	1	0	1	0	0	0	1	1	0	0	0	1	0	1
R	0	1	1	1	0	1	0	1	1	1	0	0	1	0	0	1
	0	0	1	1	0	1	0	1	0	1	0	0	1	1	0	0
S	0	1	1	1	1	1	0	1	1	0	1	0	0	0	0	1
	0	0	1	1	1	1	0	1	1	1	0	0	0	1	0	0
T	0	1	1	0	0	1	1	1	1	0	0	1	0	0	0	0
	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0
U	0	1	1	0	1	1	0	1	0	1	0	0	0	0	0	1
	0	0	1	0	1	1	0	1	1	1	0	0	0	0	0	1

recommended to avoid confusion when listening to both the receiver and the Morse-A-Word simultaneously.

Use. The Morse-A-Word is easy to operate. The setting of the front-panel SPEED control (*R28*) is the only adjustment that must be made, and only a rough setting is required. Keep in mind that the Morse-A-Word has a sensitive input stage, so don't set the receiver audio gain control higher than is necessary. When the receiver is tuned to the center of the filter passband (1200 Hz), you should hear audio from the project's internal speaker and the code LED should flicker in time with the incoming code. The passband is only about 120 Hz wide, so some care is required when tuning in a signal.

With the signal properly tuned in, adjust the SPEED control so the DAH LED glows only when dahs are sent, and not dits. The alphanumeric readout LED will now display the incoming characters. If word spaces are desired, make sure the WORD SPACE switch is closed. Only a few amateur stations actually send word spaces, so don't expect perfectly spaced copy unless you are tuned to a

V	0	1	1	0	1	1	1	0	0	1	0	0	0	1	0	1
	0	0	1	0	1	1	1	0	0	0	1	0	0	0	0	0
W	0	1	1	0	0	1	0	1	0	1	0	0	0	1	0	1
	0	0	1	0	0	1	0	1	0	1	0	0	0	1	0	1
X	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0
	0	0	1	0	1	1	0	0	0	0	1	0	0	1	0	0
Y	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0
	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Z	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	0
	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	1
	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1
1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
2	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1
	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0
3	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0
	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	1
4	0	1	0	0	1	1	1	1	0	1	0	0	1	0	0	0
	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	1
5	0	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0
	0	0	0	1	1	1	1	1	1	0	0	0	1	0	0	1
6	0	1	0	1	1	1	1	0	1	1	0	0	1	0	0	1
	0	0	0	1	1	1	1	0	1	0	0	0	1	0	0	1
7	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0
	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1
8	0	1	0	1	1	0	0	0	1	1	0	0	1	0	0	1
	0	0	0	1	1	0	0	0	1	1	0	0	1	0	0	1
9	0	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0
	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	1
.	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0
,	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
?	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0
	0	0	0	1	1	0	0	1	0	1	0	1	1	0	0	0
/	0	1	0	1	0	1	1	0	0	0	0	0	0	1	0	0
	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0
–	0	1	0	0	1	1	1	0	0	0	0	0	1	0	0	0
	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0
Space	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0
$\overline{AR}$	0	1	0	1	0	1	0	1	1	1	0	1	1	0	0	1
	0	0	0	1	0	1	0	1	0	1	0	1	1	1	0	0
$\overline{SK}$	0	1	0	0	1	0	1	1	1	1	0	1	1	0	0	0
	0	0	0	0	1	0	1	1	1	0	1	1	0	1	0	0
$\overline{KN}$	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	1
$\overline{AS}$	0	1	0	1	1	1	0	1	1	0	1	1	0	1	0	0
	0	0	0	1	1	1	0	1	1	0	1	1	0	1	0	0

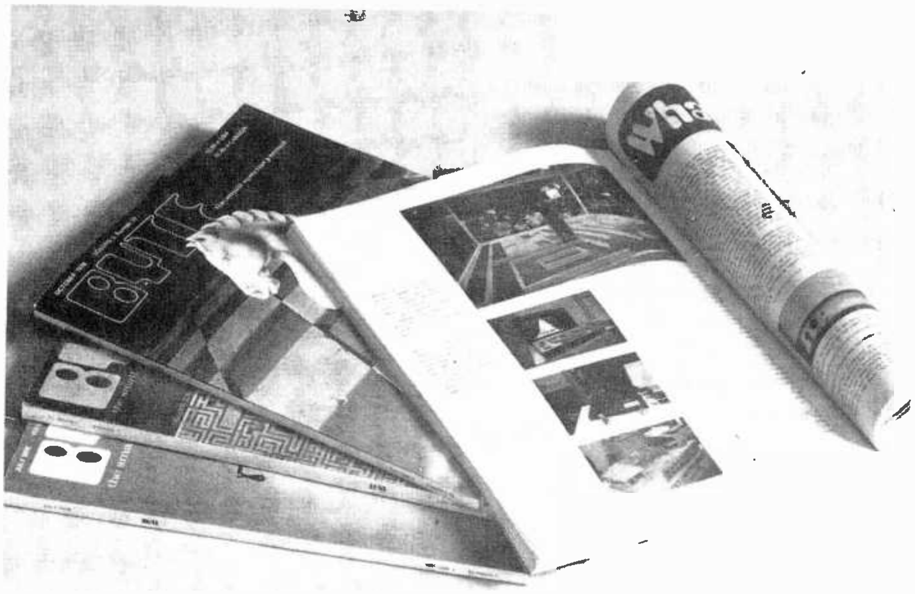


TABLE II
SOME COMMERCIAL CW STATIONS

Station	Frequency (MHz)	Traffic
NSS	8.090	Weather Bulletins
WSL	8.516	Commercial Press
WAX	8.527	Messages
WCC	8.587	Messages
WCC	8.590	Messages
NBA	8.617	Telegrams
NAM	12.134	Weather Bulletins
NMN	12.720	High Speed CW
NAWS	12.725	Weather Bulletins
WCC	12.926	Messages
WSL	13.026	Messages
NAWS	15.921	Messages
WCC	16.935	Messages

station such as W1AW which sends machine-perfect code. Invalid Morse characters will be displayed as blanks.

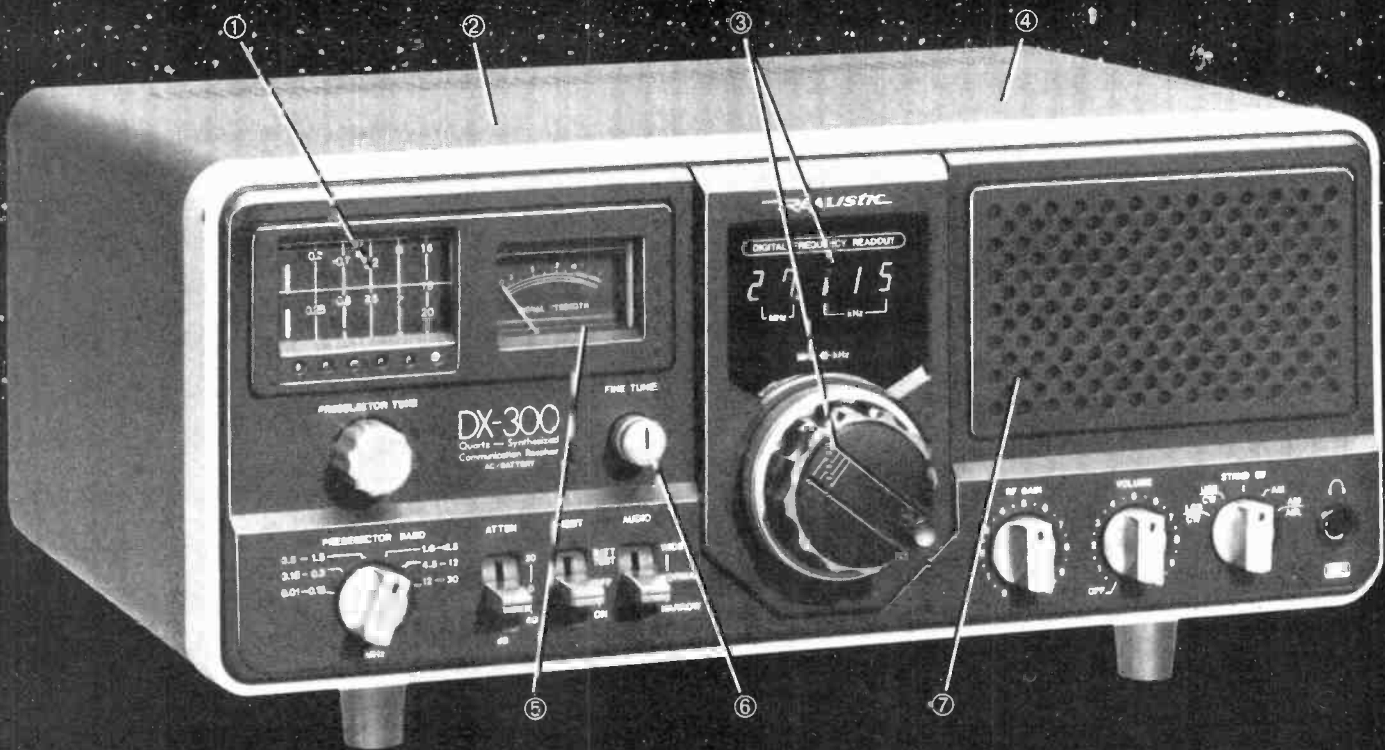
For code practice sessions, connect your telegraph key to the KEY jack and adjust the SPEED control for the approximate sending speed. You can calibrate your SPEED control using the formula: Speed (WPM) = $0.15f$. That is, the code speed in words per minute equals fifteen hundredths of the clock frequency as set by the SPEED control.

An excellent source of code material is amateur station W1AW, operated by the American Radio Relay League. The station transmits several code practice sessions each day, as well as ham news bulletins, propagation forecasts and OSCAR bulletins, all in Morse code, on 3.58, 7.08, 14.08, 21.08 and 28.08 MHz, as well as vhf frequencies. For a complete W1AW operating schedule, send an SASE to ARRL, 225 Main St., Newington, CT 06111.

Commercial CW stations that transmit ship-maritime, press, and weather messages are also valuable sources of code practice. Table II is a list of eight shortwave stations that you'll want to tune in if you have a general-coverage receiver. Whether you plan to confine your listening to the ham bands or branch out into the other shortwave frequencies, remember that a good antenna and a sensitive, stable communications receiver play key roles in good CW reception.

One final note—international radio regulations prohibit the disclosure to others of *any* information gleaned from press or commercial transmissions. Accordingly, it is illegal to pass information so obtained (except that learned from amateur radio or broadcast transmissions) to a third party. ◇

NOW! An Affordable Digital LED Readout Receiver that Brings You Exciting Global News, Action and Entertainment, from 10 kHz to 30 MHz Continuous, in 30 Bands!



REALISTIC®
DX-300

Tune in the world with the Realistic® DX-300, the general coverage receiver that gives you features never offered at this low price. Enjoy English as well as foreign-language shortwave broadcasts from world capitals and every corner of the globe. Pick up aviation weather and marine SSB. Get WWV time signals and the Voice of America. Hear CB and worldwide Amateur radio conversations and listen to standard AM stations from all across the USA. Accuracy, resetability and ease of tuning are incredible. Just set the dial to the exact frequency of the station you want —105 international SW stations are listed in the owner's manual alone. For finest reception from any station, the DX-300 has a 3-step RF attenuator audio bandwidth and RF gain controls, and two antenna inputs. And what versatility: terminals for remote receiver muting, tape recording, screw-on whip antenna for portable use, built-in oscillator and key jack for code practice. U.L. listed, of course. Step up to great listening at a great price. Only 379.95* buys you the world!

① Six-range preselector, with LED indicators, boosts RF signals and matches the DX-300 to your antenna.

② Three-way power: operates on AC, 8 optional "C" batteries, or external 12VDC. Automatic AC/battery switching, too.

③ Quartz-synthesized accuracy and a big 5-digit frequency readout replace mechanical dials with all-electronic precision—you can dial directly to any station and re-tune to it easily. No more searching for stations.

④ Dual-gate MOSFET front end, synthesized drift-cancelling triple-conversion mixer system, and 6-element ceramic filter for super sensitivity and freedom from adjacent-channel interference.

⑤ Relative signal strength and battery condition meter. Illuminated for easy reading.

⑥ Product detector and fine-tuning control for outstanding reception of code and SSB.

⑦ Audio power IC, 1.5 watts output, and a large speaker for high-intelligibility sound.

DISCOVER REALISTIC: SOLD ONLY AT

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7000 LOCATIONS IN NINE COUNTRIES

*Retail price may vary at individual stores and dealers

Microcomputer I/O Board Buying Directory

Make & Model	Price[1] (S)	Power required (mA)[2] +8V	+16V	−16V	RAM capacity min.	max.	Expansion kit size and price	Speed (ns)	Type	Min. addr. block size	Features[2] BS	BB	WS	WP	Remarks
S-100															
Advanced Computer Prods.															
LOGOS 1	126 (k)				8K	8K	none	450				X		X	Hardware protect in
	150 (w)														256-byte to 8K incre-
LOGOS 1Z	150 (k)				8K	8K	none	250				X		X	ments, switchable
	200 (w)														from top of board.
Base 2															
8KS-B	125 (k)	X			8K	8K	none	500	stat.	4K	X	X	X		
	150 (w)														
8KS-Z	145 (k)	X			8K	8K	none	250	stat.	4K	X	X	X		250-ns version.
	170 (k)														
16S-B	285 (k)	X			16K	16K	none	500	stat.	4K	X	X	X		
	310 (w)														
16KS-Z	325 (k)	X			16K	16K	none	250	stat.	4K	X	X	X		250-ns version.
	350 (w)														
Central Data															
16K RAM	289 (w)	300	150	20	16K	32K	16K/$200	450	dyn.	16K					
32K RAM	475 (w)	00	150	20	32K	32K	none	450	dyn.	16K					
CGRS Microtech															
16K RAM	450 (k)				16K	16K	none		stat.						
	490 (w)														
Chrislin															
CI-S100	390				16K	64K	none	300	dyn.						
	650				32K			300	dyn.						
	825				48K			300	dyn.						
	995				64K	64K	none	300	dyn.						
Computerware, Inc.															
8K Static	146 (w)				8K	8K	none	450	stat.				X		Phantom disable.
	186 (w)				8K	8K	none	250	stat.						Phantom disable.
	350 (w)														
Cromemco															
4KZ	195 (k)	800			4K	4K	none	450	stat.		X		X		Wait states only
	295 (w)														@ 4 MHz on non-se-
16KZ	495 (k)	800	599	19	16K	16K	none	200	stat.		X				quential address.
	795 (w)														
Digital Micro Systems															
DM16K (w.8K)	35 (b)	2A			8K	16K	8K	350	stat.	4K	X			X	Alph-Micro DMA
	275 (k)														compatible; also
DM16K	35 (B)	2A			16K	16K	none	350	stat.	4K	X			X	available as
	465 (k)														kit less RAM,
	495 (w)														$95.
Dynabyte															
MD161	399 (w)	8A		.5A	16K	16K	none	459	dyn.	8K					Transparent refresh
															DMA compatible.
MS1645	525 (w)	1.6A			16K	16K	none	300	stat.	4K	X				
MS1625	555 (w)	1.8A			16K	16K	none	250	stat.	4K	X				
MS3245	925 (w)	3.1A			32K	32K	none	300	stat.	4K	X				
MS3225	995 (w)	3.8A			32K	32K	none	250	stat.	4K	X				
Electricom															
4020	287 (w)				2K	2Kx9	$10	250			X				On-board battery, charg-
															er and power-state
															monitor; wire-wrap
															ribbon-cable or S-100
															connection.

can you be bribed?

You get a $35.21 bribe when you try only 10 DAK ML90 high energy cassettes for only $2.19 each!

Hats off to Maxell. Their UDXL cassette established a new standard of quality for all cassettes.

The new DAK ML90 starts another new technology. A technology of extreme reliability and protection from Hi frequency losses.

Later we are going to offer you a valuable bribe, if you will test these cassettes, risk free; so read on!

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

I'm sure this is one experience we all dread, and is one of the main reasons to buy name branded guaranteed tape you can trust.

Enter DAK. We manufacture over one million units of cassette tape each month, and many of our cassettes are used for high speed duplication, which causes more cassettes to fail than any other use.

When we first started, DAK's cassettes failed, just like many others. So we installed over $20,000 worth of high speed duplication equipment at our factory and set out to design the perfect cassette.

FAILURE

Failure after failure. We substituted, remade, tested and retested the over 20 parts of our cassette, and checked everyone elses cassettes. Finally after over 6 years we positively linked cassette failure or the prevention of failure to the slip sheets, or liners in the cassette.

We were not alone. Scotch, TDK, and several others must have been doing the same research because they have also been coming out with special improved slip sheets.

MOLYSULFIDE

A new chemical named molysulfide, that reduces friction within the cassette several times better than graphite gave us success.

We developed polyester slip sheets with raised spring loaded ridges coated with a unique formulation of molysulfide and graphite.

The tape ran more smoothly than ever before within the cassette. The new formulation is also much tougher than the graphite formulation, so it is extremely resistant to wear.

Static electricity within the cassette was drastically reduced by the low friction, and easily bled off, so its tendency to erase very high frequencies was drastically reduced. A very important consideration for often played tapes.

The molysulfide formulation gives both superior electrical and mechanical performance, thus it has formed the basis for the birth of the new DAK ML cassette.

MAXELL IS BETTER

Yes honestly, if you own a $1000 cassette deck like a Nakamici, the frequency response of Maxell UDXL is superior to DAK and you just might be able to hear the difference.

DAK ML has a frequency response that is flat from 40cps to 14,500cps ±3db. Virtually all cassette recorders priced under $600 are flat from 40cps to about 12,000cps, so we have over 2000cps to spare, and you'll probably never know the difference.

No apology We feel that we have equalled or exceeded the mechanical reliability of virtually all cassettes and offer one of the best frequency responses in the industry. Maxell UDXL is truly the Rolls Royce of the industry, and DAK is the 100% US made Cadillac or Corvette!

Price DAK manufactures the tape we sell, you avoid paying distributor and retailer mark ups. While Maxell UDXL 90s may sell for $3.50 to $4.50 each, DAK ML90s sell factory direct to you for only $2.19 each.

YOU WIN

You are paying less for the 10 90 minute cassettes than you would pay for the bribes we are offering if you went to a Radio Shack Store.

Yours Free

CHECK THE VALUE OF THE BRIBES AT RADIO SHACK

Think of it, 10 six foot hook up cords with RCA plugs at each end. Whether you use the cords now, or when you buy new equipment, those of us who are tape recorder nuts, never seem to have enough. Radio Shack sells six foot cords for $1.89 each.

You will find dozens of uses for this deluxe battery eliminator AC adaptor around your home or office. 4 voltages, 3, 4.5, 6 and 9 volts. 4 plugs will fit virtually any calculator, radio, or battery operated recorder we have seen. You'll save a lot of money on batteries. Radio Shack sells a similar 4 voltage adaptor for $9.95.

The deluxe 12oz can of spray head cleaner will clean your tape heads for years to come. The handy snorkel included, can reach just about any tape head, even 8trk heads. Radio Shack does not sell a large 12oz can, but 12oz from them costs $6.36.

The Radio Shack prices are not list prices, but the actual prices you would pay when you walk in the door.

Yours Free

WE WIN TOO

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and 4500 repeat customers from this advertisement. We are betting you will buy our cassettes again, and we are putting our money where our mouth is!

TRY DAK ML90 FREE

We want you to try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, simply return the tapes and bribes to DAK for a full refund.

To order your 10 DAK ML90 minute high energy cassettes and receive your $35.21 bribe with your credit card, simply call toll free 800, 423-2636, (in Calif. call 213-984-1559) or send your check for $21.90 plus $3 for postage and handling for each group of 10 cassettes and bribes to DAK. (Calif. residents add 6% sales tax).

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette fc reach additional 10 you buy and of course you get all 3 bribes with each group of 10 tapes.

DAK INDUSTRIES INCORPORATED

Call TOLL-FREE ....(800) 423-2636
In California Call ....(213) 984-1559
10845 Vanowen St., North Hollywood, CA 91605

CIRCLE NO. 60 ON FREE INFORMATION CARD

Make & Model	Price[1] ($)	Power required (mA)[2] +8V	+16V	−16V	RAM capacity min.	max.	Expansion kit size and price	Speed (ns)	Type	Min. addr. block size	Features[2] BS	BB	WS	WP	Remarks
Electronic Control Technology															
16K RAM	350 (k)	1.5A			16K	16K	none	450	stat.	16K		X			Spare IC spaces
	399 (w)														for user circuit.
16K RAM 4MHz	415 (k)				16K	16K	none	250	stat.	16K		X			Spare IC spaces
	475 (w)														for user circuits.
Electronic Systems															
300	23 (b)				1K			250	stat.				X		Bare-board version
	160 (k)														includes
	200 (w)														regulator.
Fire Bird Sales															
16KRB	323 (w)				16K	16K	none	260	dyn.	16K	X				
Franklin Electric															
8KSr	249 (k)	1.2A			8K	8K	none	400	stat.	2K	X	X		X	LED indicators for
	295 (W)														power OK, board
8KSh	289 (k)	1.7A			8K	8K	none	250	stat.	2K	X	X		X	select, write-pro-
	330 (w)														tect; DIP addr. SW.
Godbout															
Econoram II	135 (k)	1.5A			8K	8K	none		stat.	4K			X	X	Software write pro-
	155 (W)														tect w. vector.
Econoram IV	279 (k)	2A			16K	16K	none		stat.	16K				X	Write-protect for
	314 (w)														4K blocks.
Econoram V	279 (k)	2A			16K	16K	none		stat.	16K				X	Manual high-8K/low-
	314 (w)														8K deselect.
Econoram VII	445 (k)	2A			24K	24K	none		stat.	2, 4K,	X			X	Can deselect either
	485 (w)									2, 8K					4K/8K pair.
GRE Data Products															
232-8	179 (W)	1.2			8K			400	stat..	8K					Provisions for MWRT
															and Phantom
232-16	319 (W)				16K			400	stat.	16K	X				disable.
IMSAI															
RAM 4A-4	139 (k)	800			4K	4K	none	500	stat.	4K		X			
	189 (w)														
RAM 16	449 (k)	500	150	10	16K	16K	none	500	dyn.	4K*	X				*4K block missing
	499 (w)														with memory-map option.
RAM III-32	895 (w)	360	250	10	32K	32K	none	500	dyn.	4K*	X				As above.
RAM III-64	1695 (w)	360	250	10	64K	64K	none	500	dyn.	4K*	X				As above.
Industrial Micro systs.															
C00232	135				8K	8K		low	stat.						
C00232-HS	150				8K	8K		hi	stat.						
C00282	304				16K	16K		low	stat.						
C00282-HS	343				16K	16K		hi	stat.						
C00360	625				32K	32K		low	stat.						
C00360-HS	689				32K	32K		hi	stat.						
Ithaca Audio															
8KSR	25 (b)	1.4A			1K	8K			stat.	4K	X	X	X	X	Software protect/unprotect.
	160 (w)	1.4A			8K	8K		450	stat.	4K	X	X	X	X	
	199 (w)	1.4A			8K	8K		250	stat.	4K	X	X	X	X	
16KDR	35 (b)	1.4A			16K	64K			dyn.						
Jade Computer															
JG8K	25 (b)	2.5A			8K			450	stat.	8K	X		X		Adapter ($13) avail-
	126 (k)														able for use with
	150 (w)														Motorola D-2 6800
	140 (k)	2.5A			8K			350	stat.	8K	X		X		Eval. Kit.
	160 (w)														
	170 (k)	2.5A			8K			250	stat.	8K	X		X		
	190 (w)														
Micro Data Systems															
MD-697 (8K)	179 (k)	1.5A			8K	32K	8K/$129	450	stat.	16K	X				250-ns option avail.
	199 (w)														
MD-697 (16K)	308 (k)	1.5A			16K	32K	8K/$129	450	stat.	16K	X				250-ns optional.
	348 (w)														
MD-697 (24K)	437 (k)	1.5A			24K	32K	8K/$129	450	stat.	16K	X				250-ns optional.
	497 (w)														

Make & Model	Price[1] ($)	Power required (mA)[2]			RAM capacity		Expansion kit size and price	Speed (ns)	Type	Min. addr. block size	Features[3]				Remarks
		+8V	+16V	−16V	min.	max.					BS	BB	WS	WP	
MD-697 (32K)	539 (k) 599 (w)	1.5A			32K	32K	none	450	stat.	16K	X				250-ns optional.
National Multiplex															
8K	190 (w)				8K	8K			stat.						
North Star															
RAM-16	399 (k) 459 (w)	600	400	100	16K	16K	none	250	dyn.	8K					Parity option, $39 (k), $59 (w).
Noval															
32K RAM	650				32K	32K		2MHz	dyn.	8K					Hardware disable for any 8K block.
Pacific Digital															
8KRS (450)	150 (w)	2A			8K	8K	none	450	stat.	4K		X			
8KRS (250)	190 (w)	2A			8K	8K	none	250	stat.	4K		X			
Parasitic															
Econoram III	188 (w)	350	155		8K	8K	none	250	dyn.	4K					"Invisible refresh".
Piiceon															
SupeRam 2	1150 (w)	X	X	X	48K	64K	16K/$220	2-MHz	dyn.	16K	X				DMA-compatible; uses digital delay lines; software or hardware bank select.
Polymorphic															
8K RAM	300 (k)	2.6*						500ns				X			*Standby power, 1.5A @ 2.2V; phantom disable.
Processor Tech.															
4KRA	125 (k) 150 (w)	1A			4K	4K	none	460	stat.						
8KRA	225 (k) 250 (w)	1.9A			8K	8K	none	400	stat.						
16KRA	429 (w)	800	150	20	16K	32K	none	400	dyn.	4K					
32KRA	750 (w)	800	150	20	32K	32K	none		dyn.						
Quay															
080 SMB	235 (w)				8K	8K	none	450	stat.			X	X		Memory protect in 4K blocks.
Seattle Computer															
24-101	375 (w)	1.8A			16K	16K	none	494	stat.	4K					
	425 (w)	1.8A			16K	16K	none	294	stat.	4K					
SCP-16K	425 (w)	1.9A			16K	16K	none	471	stat.	4K	X				Parallel addressing capability.
	475 (w)	1.9A			16K	16K	none	271	stat.	4K	X				
Solid State Music															
MB4	91 (k)	1.1A			4K	4K	none	2 MHz	stat.	4K		X	X		Memory protect in 4K blocks.
MB-6A	165 (k)	2.0A			8K	8K	none	2 MHz	stat.	8K		X	X	X	Memory protect to 256-byte blocks; phantom provisions.
	175 (k)	2.0A			8K	8K	none	4 MHz	stat.	8K		X	X	X	
MB-7	449 (k)	550	80	25	16K	16K	none	2-3 MHz	stat.	16K				X	4K memory protect; phantom provision.
MR-9 PROM/RAM	80 (k)	X			0	4K			stat.				X		Can intermix RAM and PROM in 256-byte increments; jump on reset or on power-up.
Space Byte															
16K	599 (w)	1.6A			16K	16K	—	450/250	stat.	4K	X		X		Phantom disable and write protect for each 4K; DMA-compatible.
Thinker Toys															
EconoRam III	159 (k) 149 (w)	240	80	20	8K	8K	none	471	dyn.	4K					With Synchrofresh.
SuperRam	299 (k) 334 (w)	2A			16K	16K	none	450	stat.	4K			X		

YOU ASKED FOR IT YOU GOT IT DSI QUIK-KIT®

50 HZ TO 550 MHZ COUNTER KIT

95% ASSEMBLED 100% TESTED

Performance You Can Count On

FREQUENCY COUNTER APPLICATION:

- Ham Radio — Two Way Radio — CB
- Audio Amplifier & Receiver Repair
- Computer Maintenance & Construction
- A Must for TV & PLL Repair

$99.95
MODEL 3550K

includes built-in Pre-Amp & Prescaler

DSI OFFERS THE BEST OF TWO WORLDS . . .

An unprecedented DSI VALUE . . . in a high quality, LSI Design, 50 HZ to 550 MHZ frequency counter kit. And, because it's a DSI innovation, you know it obsoletes all competitive makes, both in price & performance.

With 95% of the assembly completed by DSI, you are only one hour away from solving all of those difficult bench problems, from adjusting 60 HZ clock-time bases to setting the frequency of a 468 MHZ Mobile Radio.

FACT: Every 3550 QUIK-KIT® PC board is factory assembled and tested before shipment. **FACT:** The problems of bad LED's, IC's, and Capacitors are a thing of the past. **FACT:** No manufacturer except DSI offers a 550MHZ frequency counter with. . . 8 digits, .5 in. LED's, TCXO, 1HZ resolution and a one year warranty on parts for under $100.00. **FACT:** We do not know how long we can hold this low, low price. **GO WITH THE LEADER . . . BUY A DSI FREQUENCY COUNTER KIT TODAY. SAVE TIME & MONEY AND BE ASSURED IT WILL WORK THE FIRST TIME.**

DSI — GUARANTEED SPECIFICATIONS

Time Base TCXO 1PPM 65° to 85° F
Freq. Range 50HZ to 550MHZ incl. two SO239 inputs
Resolution 1HZ to 55MHZ, 10HZ to 550MHZ
Gate Time 1 sec & 1/10 sec with Auto Decimal Point
Display 8 digits, ½ inch LED with Leading Zero Blanking
Sensitivity 25MV @ 25MHZ, 150MHZ, 250MHZ; 75MV @ 450MHZ
Power Batt., 12VDC @ 300Ma, 110VAC (with AC-9)

3550K Kit	**$99.95**
T-101 Ant.	**3.95**
AC-9 AC Adp.	**7.95**
Shipping, Handling, Ins.	**10.00**
3550W Wired	**149.95**
T-101 (incl.)	**NC**
AC-9 (incl.)	**NC**
Shipping (incl.)	**NC**

AMERICAN EXPRESS · master charge · VISA

CALL TODAY TOLL FREE: (800—854-2049) **Cal. Res. CALL** (800—542-6253) **TO ORDER OR RECEIVE MORE INFORMATION ON DSI'S FULL PRODUCT LINE OF FREQUENCY COUNTERS RANGING FROM** 10HZ TO 1.3GHZ

TERMS: MC - VISA - AE - Check - M.O. - COD in U.S. Funds. Orders outside of USA & Canada, please add $20.00 additional to cover air shipment. California residents add 6% Sales Tax.

DSI INSTRUMENTS, INC.
7924 Ronson Road, Dept. G, San Diego, CA 92111

CIRCLE NO. 15 ON FREE INFORMATION CARD

Make & Model	Price[1] (S)	Power required (mA)[2] +8V	+16V	−16V	RAM capacity min.	max.	Expansion kit size and price	Speed (ns)	Type	Min. addr. block size	Features[3] BS	BB	WS	WP	Remarks
Trace Electronics															
1600	499 (w)	1.7A			4K	32K	16K/$256	450	stat.		X				DMA-compatible; phantom provision; "Megextend" can address to 1M bytese with 4-bit output port.
	599 (w)	1.7A			4K	32K	16K/$356	250	stat.		X				
3200	749 (w)	3.3A			32K	32K	none	450	stat.		X				
	849 (w)	3.3A			32K	32K	none	250	stat.		X				
Vector Graphic															
8KF	245 (w)	1.8A			8K	8K	none	250	stat.	8K		X		X	Phantom disable.
16K	485 (w)	1.8A			16K	16K	none	300	stat.	X					Phantom disable.
Wameco															
MEM-1	30 (b) 250 (k) 295 (w)				1K	8K		450	stat.	8K			X		
MEM-2	30 (b) 665 (k) 695 (w)				4K	16K		450	stat.	8K	X		X		
Xitan															
Z-16	489 (w)	205	105		16K				stat.	4K	X			X	Write protects each 4K.
D-16	489 (w)				16K				dyn.	4K	X				
D-32	869 (w)				32K				dyn.	4K	X				
K-32	799 (w)	190	250	*	32K	32K	none	4MHz	dyn.*	32K	X				*−5V @ 15 mA; transparent refresh, 4K block deselection (switched).
K-48	1099 (w)	190	250	*	48K	48K	none	4MHz	dyn.*	48K	X				*As above, but 8K deselect.
K-64	1299 (w)	190	250	X	64K	64K	none	4MHz	dyn*	64K	X				*As above.
K-128	2599	190	250	X	128K	128K	none	4MHz	dyn.*	128K	X				*As above, 16K deselect.

Notes:
[1] (b)=bare board; (k)=kit; (w)=wired.
[2] In amperes where indicated by "A."
[3] BS=bank-select or memory-mapping option; BB=battery backup; WS=wait-states; WP=write-protect.
*See "Remarks" column.

Make & Model	Price[1] (S)	Power required (mA)[2] +8V	+12V	−12V	RAM capacity min.	max.	Expansion kit size, and price	Speed (ns)	Type	Min. addr. block size	Features[2] BS	BB	WS	WP	Remarks
SS-50															
Digital Service & Design															
DSD 2114-16K	27 (b)	9.5A			1K	16K		450	stat.	8K	X				
Gimix															
16KWR	495 (w)	1.6A			16K	16K	none	450	stat.	4K	X			X	Software-controllable addressing, disable/enable, write-protect, register-select.
Midwest Scientific															
RAM-68	225 (k)* 335 (w)*	X			8K					8K		X			*Sockets, $35.
Smoke Signal															
M-16A	379 (w)	1.6A			16K	16K	none	250	stat.	16K					DMA-compatible.
Southwest Tech Products															
MP-M	65 (k)	750			2K	4K	2K/$35	500	stat.						
MP-8M	250 (k)	1A			8K	8K	none	500	stat.						
MP-16	400 (w)	X	X		16K	32K	16K/$250	500	dyn.						

Make & Model	Price[1] ($)	Power required (mA)[2] +5V	−5V	±12V	RAM capacity min.	max.	Expansion kit size, and price	Speed (ns)	Type	Min. addr. block size	Features[2] BS	BB	WS	WP	Remarks
SBC MULTIBUS															
Chrislin															
CI-8080	390				16K			300	dyn.*						*On-board refresh.
	650				32K			300	dyn.*						
	825				48K			300	dyn.*						
	995				64K			300	dyn.*						
Datacube															
RM-117	1200 (w)	X			16K	1M	use CM118	350	stat.	8K	X		X		Dual-port memory system allows 2 SBC buses to share common memory w. Intel 8086.
CM-118	1250 (w)	X			32K	32K		350	stat.	32K					Usable as stand-alone 32K RAM w. 8K PROM, or as slave memory.
Electronic Solutions															
RAM-4	295 (w)	1.2A			4K	4K	none	400	stat.	4K					
RAM-4L	312 (w)	1.2A			4K	4K	none	400	stat.	4K		X			With battery back-up.
RAM-8	395 (w)	2A			8K	8K	none	400	stat.	8K					
RAM-8L	428 (w)	2A			8K	8K	none	400	stat.	8K		X			With battery back-up.
National Semiconductor															
BLC-016	784 (w)	1.5A	10	700	16K	16K	none	435	dyn.	16K			X		No wait states with BLC 80/204 CPU.
BLC-032	1292 (w)	3.0A	47	11	32K	32K	none	430	dyn.	16K	X	X	X		
BLC-048	1767 (w)	3.0A	47	11	48K	48K	none	430	dyn.	16K	X	X	X		
BLC-064	2090 (w)	3.0A	47	11	64K	64K	none	430	dyn.	16K	X	X	X		
Xycon															
Xycon 16	684 (w)				16K	32K		250	stat.	8K	X	X			
Xycon 32	1024 (w)				32K	32K		250	stat.	8K	X	X			

Experimenter's Corner

By Forrest M. Mims

THE ANALOG SAMPLE/HOLD CIRCUIT

MICROPROCESSOR enthusiasts are constantly seeking simple ways to interface small controllers and computers with the outside world of analog signals. One well-known analog circuit with many interfacing applications is the op-amp sample/hold (or sample and hold) circuit.

A sample/hold circuit stores in a capacitor the instantaneous voltage present at its input. The stored voltage, which can represent anything from the intensity of light illuminating a photocell to an audio signal, can be converted into digital form by an analog-to-digital converter for processing by a microprocessor. What's more, a sample/hold stage can be used in many different analog applications.

Simple Sample/Hold Circuit. Figure 1 schematically shows a very simple but functioning sample/hold circuit. The key component of the circuit is capacitator *C1*. When switch *S1* is momentarily toggled to its SAMPLE position, the capacitor charges to the voltage present at the input. The charge on the capacitor is monitored by *IC1*, an op amp with a very high input impedance, which should be an NE536 or similar amplifier with a FET input stage. When switch *S1* is released, it returns to its center (off) HOLD position and disconnects *C1* from the input of the circuit. Because the op amp's input impedance is very high, the charge stored in the capacitor is effectively trapped and the voltage across *C1* remains almost constant for an appreciable amount of time.

The op amp is connected as a voltage follower with unity gain. This arrangement permits the charge on the capacitor to be measured by a standard multimeter without significantly altering the amount of stored charge. Connecting a conventional, low-input-impedance voltmeter across the capacitor would, of course, quickly drain the capacitor of its charge. After the magnitude of the voltage sample has been determined, the switch can be momentarily placed in its RESET position to remove the charge from the capacitor and prepare the circuit for a new sample.

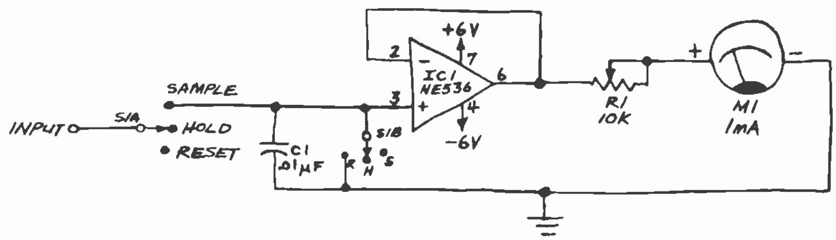


Fig. 1. Schematic of a demonstration sample/hold circuit.

It's easy to operate the circuit in Figure 1. Use a 1.5-volt cell to supply the input voltage. With the sample switch closed, adjust calibration potentiometer *R1* until the meter reads 0.15 mA, which corresponds to a voltage of 1.5 volts.

You can omit the milliammeter and potentiometer if you prefer to connect a voltmeter directly to the output of the op amp. Because the op amp is connected as a unity-gain voltage follower, the voltage at its output will be identical to that at its input. This does not mean that the op amp is superfluous. To the contrary, it provides the very high input impedance that permits the voltage stored across *C1* to be monitored without significant loss.

After you have sampled the input voltage, allow the switch to return to its HOLD position and monitor the meter reading. If *C1* is a high-quality, low-loss polystrene or Mylar unit, the sampled voltage will remain constant for a substantial period of time. Lower-quality capacitors including some ceramic discs will lose their stored charge at a much faster rate, as will be evidenced by a noticeable downward movement of the meter needle.

To increase the circuit's useful storage time, a capacitor larger than the one specified in Figure 1 can be used. But it will require a longer sample interval to charge up to the full input voltage, especially if the sample generator has a significant internal impedance.

Incidentally, if you don't have an NE536 or similar FET-input op amp on hand, you can use a standard 741 for demonstration purposes. You'll have to increase the capacitance of *C1* to 1µF or more, because the stored voltage will

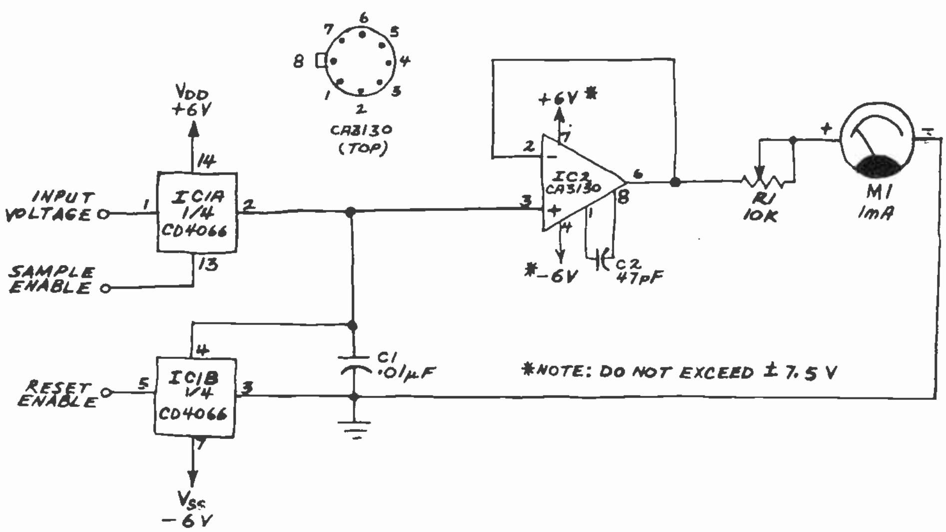


Fig. 2. Digitally controlled sample/hold circuit using CMOS chips. To sample: make sample enable high. To reset: make reset enable high.

be lost much more rapidly than if a FET-input op amp is used, due to the 741's much lower input impedance.

Adding Digital Control. The circuit we have just described is fine for demonstration purposes, but the circuit shown in Fig. 2 is more practical because the sample/hold process is controlled by logic levels instead of mechanical switches. As you can see by comparing the two circuits, the ganged sample/hold/reset switches have been replaced by two of the analog switches in a CD4066 quad analog switch. Furthermore, the NE536 has been replaced by a CA3130 MOSFET-input op amp, but the circuit will work with the 536 as a pin-for-pin replacement without *C2*.

The analog switch is a newcomer to this column. Like the three-state gate described in the March 1978 issue, the analog switch has an ENABLE input and ports that allow a signal to enter and leave. The analog switch, however, can transmit or block both digital logic levels *and* analog (variable) voltages. Like a conventional mechanical switch, an analog switch can pass a signal in either direction. Figure 3 shows the equivalent circuit of the analog switch.

The CA3130 op amp is also a newcomer to this column. I'll have more to say about both it and the CD4066 in future columns. Meanwhile, suffice it to say that the CD4066 is one of a family of CMOS analog switches having many fascinating applications. The switches in the CD4066 are *off* when their ENABLE inputs are *low* and *on* when their ENABLE inputs are *high*. The "off" resistance is around 10^{11} ohms, and the "on" resistance is typically 80 ohms.

To sample a voltage with the circuit shown in Fig. 2, the SAMPLE ENABLE input, which is normally kept low, is allowed to go high. The sampled signal level is then stored by *C1* until the RESET ENABLE input, which also is normally kept low, goes high. This allows *C1* to discharge to ground through *IC1B*.

If the RESET ENABLE input is again made low, *C1* will immediately store the voltage present at the input if the SAMPLE ENABLE input is still high. Of course, if the SAMPLE ENABLE input is low, *C1* will not receive the new sample until the SAMPLE ENABLE input is high. (Ordinarily, both ENABLE lines should *not* be allowed to go high simultaneously. Otherwise, the signal source output will be connected to ground via a low-impedance path.)

As you can see, there are several operating possibilities for the circuit, each of which can be readily selected by a two-bit logic signal. The factors governing the calibration of the output meter and the selection of *C1* are identical to those that apply to the previous circuit.

Applications. The most straightforward application for the sample/hold circuit of Fig. 2 is an analog memory circuit capable of storing a transduced temperature, light intensity, or pressure, or any other analog signal for later processing.

The circuit can also be used as a timer. Replace meter *M1* and *R1* with a LED and 330-ohm series resistor. The LED will glow until the voltage across *C1* drops below the LED's turn-on threshold. Increase the capacitance of *C1* for longer time delays. Increasing the magnitude of the sampled voltage up to a maximum of V_{DD} will also give longer delays.

You can create unusual sound effects by connecting the output of the circuit to a voltage-controlled oscillator such as the 566 function generator or unijunction transistor relaxation oscillator. For a siren effect, connect a high resistance (e.g. 1 megohm) between pin 4 of *IC1B* and *C1*. When the RESET ENABLE input is activated, the output voltage will slowly decrease, causing the VCO to generate a siren-like sound. The upward wail of the siren is obtained by connecting a second high-value resistor between pin 1 of *IC1A* and the INPUT VOLTAGE source.

No doubt you will find other applications for both circuits with which we've been experimenting this month. I plan to cover some of those that I have found in a future column. ◇

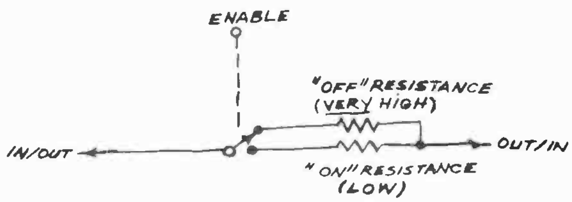
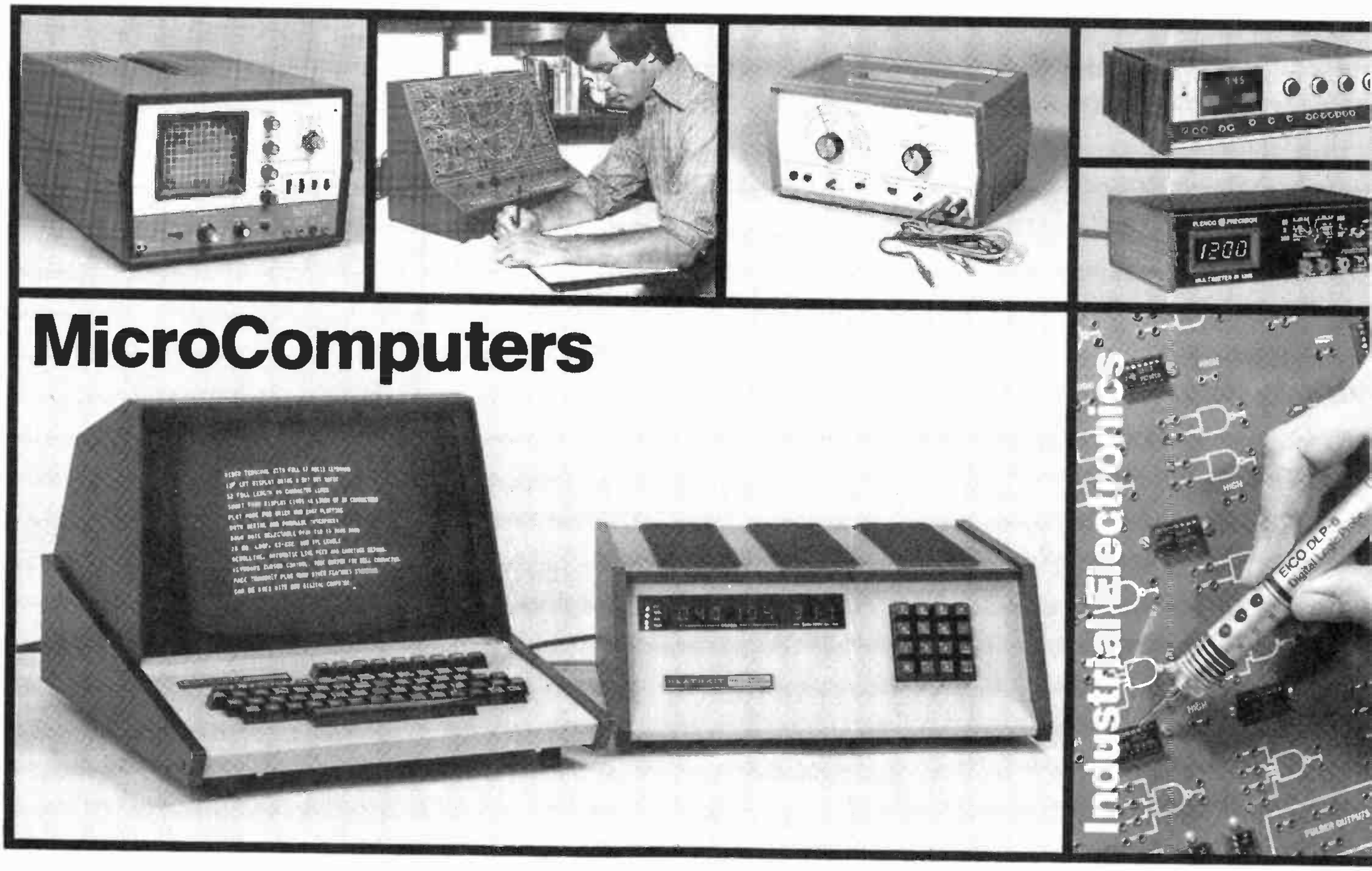


Fig. 3. Equivalent circuit of a basic analog switch.

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. 205-049
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.

English Broadcasts Audible in No. America

by Glenn Hauser

TIME[1] EST/CDT	TIME UTC/GMT	STATION	QUAL.[2]	FREQUENCIES, kHz[3]
4:00-4:15 a.m.	0900-0915	BBC	A	11955, 9640, 9510, 7150, 6195
4:00-4:15 a.m.	0900-0915	R. Japan[4]	B	9505
4:00-5:00 a.m.	0800-1000	R. Australia	C	9670, 9540
4:00-6:00 a.m.	0900-1100	R. Oman	D	11890
5:00-5:05 a.m.	1000-1005	UN Radio	A	9565, 5955 (Sat.)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12035, 10040, 9840
5:00-sunrise	1000-	R. Australia	B	5995
5:00-6:00 a.m.	1000-1100	AFRTS	A	6030
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9655
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:56 a.m.	1100-1156	R. RSA	C	21535, 25790
6:00-7:35 a.m.	1100-1235	TWR-Bonaire	A	11815 (Sat, Sun-1220)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	11535, 9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	11775, 6195, 5990
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	B	11835, 9770
6:00-9:00 a.m.	1100-1400	AFRTS	A	15430, 15330, 11805, 9700
6:00-9:00 a.m.	1100-1400	VOA	A	11715, 9730, 9565, 6185, 5955
6:00-10:00 a.m.	1100-1500	R. Moscow	B	15150, 11770
6:30-6:45 a.m.	1130-1145	R.R.I. Yogyakarta	C	5046
6:30-9:00 a.m.	1130-1400	CBC Northern Service	B	9625, 6065 (not all Eng.) (from May, 1030-)
7:00-7:15 a.m.	1200-1215	Vatican R.	B	21485
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	Israel Radio	C	26095, 21495, 17685, 15540, 15415, 11655
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	9600, 9540, 6025, 5975
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17765, 15410
7:00-7:45 a.m.	1200-1245	R. Berlin International	C	21540, 15320, 15125
7:00-7:55 a.m.	1200-1255	R. Peking	C	9820, 6995
7:00-11:00 a.m.	1200-1600	HCJB, Ecuador	A	15115, 11745
7:15-7:30 a.m.	1215-1230	V. of Greece	B	17830, 15345, 11730
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	D	12070, 6383 (not Sun)
7:30-7:55 a.m.	1230-1255	Austrian R.	C	21530 (frequent changes)
7:30-8:00 a.m.	1230-1300	R. Bangladesh	D	21670, 15375 (both vary)
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21700
7:30-8:20 a.m. (Sat)	1230-1320	TWR-Bonaire	A	15255
7:30-9:20 a.m. (Sun)	1230-1420	"	"	"
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Finland	C	15400
8:00-10:50 a.m.	1300-1550	R. RSA	B	25790, 21535, 17780, 15220
8:00-11:00 a.m.	1300-1600	HCJB, Ecuador	B	17890
8:15-8:45 a.m.	1315-1345	Swiss R. International	C	21570, 21545-SSB, 21520, 15350, 17790
8:30-9:30 a.m.	1330-1430	R. Finland	C	15400 (Sun. only)
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	21710, 17705, 15400 (from 1430), 15070
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	17840, 21730 (Sun only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4120
9:00-9:30 a.m.	1400-1430	R. Afghanistan	D	4775
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	9600, 9540, 6025, 5975
9:00-9:45 a.m.	1400-1445	R. Berlin International	B	21540, 15125
9:00-10:00 a.m.	1400-1500	VOA	A	11715, 9565
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	11789
9:00-11:00 a.m.	1400-1600	AFRTS	A	15425, 15330, 11805, 9700
9:00 a.m.-7:00 p.m.	1400-2400	CBC Northern Service	B-C	11720, 9625 (not all Eng.)
9:30-10:00 a.m.	1430-1500	R. Finland	B	15400
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (also French; when in session)
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9615 (frequent changes)
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 11775 (Sat, Sun)
10:00-12:00 a.m.	1500-1700	R. Moscow	B	11770, 9795
10:15-10:30 a.m.	1515-1530	V. of Greece	B	17830, 15345, 11730 (last two, not Tues.)
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570
10:30-11:15 a.m.	1530-1615	NSB, Tokyo	C	9595, 6055
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	12035, 10040, 9840
10:45-11:00 a.m.	1545-1600	R. Canada International	A	17820, 15325 (Mon-Fri only)

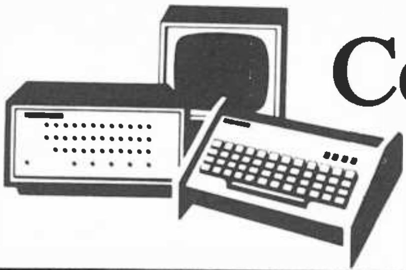
11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21590, 17640, 15512
11:00-11:30 a.m.	1600-1630	R. Korea	C	9720, 9640, 7150
11:00-11:30 a.m.	1600-1630	R. Norway	B	21655, 17755, 15345 (Sun only)
11:00-12:00 a.m.	1600-1700	VOA	A	26040, 21485, 17870, 17710
11:00 a.m.-12:09 p.m.	1600-1709	BBC	B	17830, 11775, (Sat, Sun-1745)
11:00 a.m.-1:00 p.m.	1600-1800	AFRTS-Washington	A	15430, 15330, 11805, 9700
-11:30 a.m.	-1630	R. Singapore	C	11940 (fade-in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	17820, 15325
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:15 p.m.	1700-1715	Vatican R.	B	17900
12:00-1:00 p.m.	1700-1800	HCJB, Ecuador	B	21480, 17865, 15380
12:00-1:00 p.m.	1700-1800	VOA	A	26040, 21590, 21485,
				17870, 17710
12:00-2:00 p.m.	1700-1900	R. Moscow	B	9795
12:05-12:55 p.m.	1705-1755	R. France International	B	21620, 21580, 17860, 17850, 17795,
				17735, 15425, 15360, 15300, 15210
				(from April, 1605-1655)
12:10-12:55 p.m.	1710-1755	BRT, Belgium	C	17735 (1610-1655 from May)
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 12095 (11820 from 1800)
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	B	17820, 15260
1:00-1:30 p.m.	1800-1830	R. Norway	C	17755 (Sun only)
1:00-1:30 p.m.	1800-1830	R. Korea	C	9720
1:00-2:00 p.m.	1800-1900	R. Australia	C	11800
1:00-2:30 p.m.	1800-1930	V. of Nigeria	C	15120, 11770
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	12085
1:00-4:30 p.m.	1800-2130	AFRTS-Washington	A	17765, 15430, 15330, 11805, 11790
1:00-5:00 p.m.	1800-2200	VOA	A	26040, 21590, 21485, 17870, 17785,
				17710, 15445
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	15305
1:15-2:00 p.m.	1815-1900	V. of Revolution, Guinea	C	15310 (varies) (Sun only)
1:15-2:15 p.m.	1815-1915	R. Bangladash	D	15285, 11765 (both vary)
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 19505-SSB, 15410 (Fri)
1:45-2:45 p.m.	1845-1945	Sri Lanka Br. Corp.	C	17850, 15115, 11870
1:45-3:00 p.m.	1845-2000	R. Ivory Coast	C	11920
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	C	15105
2:00-2:30 p.m.	1900-1930	R. Canada International	A	17875, 15325, 11905
			B	17820, 15260
2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	11770 or 11820 or 11805
				(frequent changes)
2:00-3:00 p.m.	1900-2000	B.S.K. Saudi Arabia	C	11855
2:00-3:30 p.m.	1900-2030	HCJB, Ecuador	B	21480, 17865, 15295
2:00-5:00 p.m.	1900-2200	R. Moscow	B	9795, 9490
3:00-3:15 p.m.	2000-2015	R. Japan	B	15105
3:00-3:30 p.m.	2000-2030	V. of Iran	C	9022 (frequent time changes)
3:00-3:30 p.m.	2000-2030	R. Algeria	C	9510
3:00-3:30 p.m.	2000-2030	R. Korea	C	11860
3:00-3:30 p.m.	2000-2030	R. Canada International	A	17875, 17820, 11855
3:00-3:30 p.m.	2000-2030	Israel R.	C	11655, 9815
3:00-4:15 p.m.	2000-2115	BBC	A	17830, 15260, 6175
3:10-4:50 p.m.	2010-2150	R. Habana Cuba	A	17855
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21640, 17810, 11740, 11730
3:30-4:30 p.m.	2030-2130	V. of Vietnam	C	15012, 10040
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 9770
4:00-4:15 p.m.	2100-2115	R. Japan	B	15105
4:00-4:50 p.m.	2100-2150	R. RSA	B	21535, 17780, 15155
4:15-5:00 p.m.	2115-2200	BBC	A	15260, 6175
4:15 p.m.-1:30 a.m.	2115-0630	R. New Zealand	C	17770
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17875, 17820, 15325, 15150, 11945
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	C	15280
4:30-5:00 p.m.	2130-2200	R. Sofia	B	11850, 11750
4:30-5:30 p.m.	2130-2230	R. Baghdad	C	9745
4:30-6:00 p.m.	2130-2300	V. of Turkey	C	11955, 9515, 7170, 6185
4:30-7:00 p.m.	2130-2400	AFRTS-Washington	A	21650, 17765, 15430, 15330, 11790
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15345
5:00-5:15 p.m.	2200-2215	R. Yugoslavia	C	9620
5:00-5:15 p.m.	2200-2215	R. Japan	B	17755
5:00-5:30 p.m.	2200-2230	R. Nacional, Venezuela	B	15400 (irregular)
5:00-5:30 p.m.	2200-2230	R. Norway	C	15175, 11860 (Sun only)
5:00-5:45 p.m.	2200-2245	BBC	A	15260, 11910, 9590, 6195, 6175,
				5975
5:00-6:00 p.m.	2200-2300	R. Canada International	A	15325, 11860
5:30-6:00 p.m.	2230-2300	Israel R.	A	15485, 11655, 11620, 9815
5:45-6:00 p.m.	2245-2300	BBC	A	15260, 11910, 9590, 9410, 7325,
				6195, 6175, 5975
5:45-6:00 p.m.	2245-2300	UN Radio	A	15225, 11920 (Fri)
6:00-6:30 p.m.	2300-2330	BBC	A	15260, 11910, 9590, 9580, 9410,
				7325, 6195, 6175, 5975
6:00-6:30 p.m.	2300-2330	R. Japan	B	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	C	11705, 9695
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	7400, 7360, 7215
6:00-6:50 p.m.	2300-2350	Rdif. Argentina	C	11710 (Mon-Fri)
6:00-7:00 p.m.	2300-2400	VOA	A	26895, 25990, 21610,
				21460, 17895, 17820
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	11535, 9977

6:00-8:00 p.m.	2300-0100	CBC Southern Service	A	5960 (Mon.-Fri.) (2200-2400 from May)
6:00-9:00 p.m.	2300-0200	R. Moscow	B	17720, 15455, 15180, 15140, 12050, 11850, 9760, 9710, 9685, 9665, 9530, 9505, 9490
6:30-7:00 p.m.	2330-2400	R. Finland	C	11800, 9565
6:30-7:30 p.m.	2330-2430	BBC	A	15260, 11910, 9590, 9580, 7325, 6175, 6120, 5975
6:45-7:45 p.m.	2345-2445	R. Japan	B	17825, 15270
7:00-7:15 p.m.	0000-0015	R. Japan	B	17755
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	R. Norway	C	11870, 9645 (Mon only)
7:00-7:55 p.m.	0000-0055	R. Peking	B	17680, 15520, 15060
7:00-8:00 p.m.	0000-0100	VOA	A	25990, 21460, 17895, 17820, 15205, 11740, 9640, 6130
7:00-8:00 p.m.	0000-0100	R. Sofia	B	9705
7:00-8:00 p.m.	0000-0100	AFRTS-Washington	A	21650, 17765, 15330, 11790, 6030
7:00-9:00 p.m.	0000-0200	Spanish Foreign R.	B	11880, 9630
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090
7:00 p.m.-1:06 a.m.	0000-0606	CBC Northern Service	B	9625, 6195 (not all Eng.) (from May,-0506)
7:15-7:30 p.m.	0015-0030	V. of Greece	B	11730, 9760, 9515
7:15-8:00 p.m.	0015-0100	BRT, Belgium	C	6080
7:30-7:50 p.m.	0030-0050	SODRE, Uruguay	C	11885, 9515 (time varies)
7:30-8:00 p.m.	0030-0100	R. Sweden	C	11905
7:30-8:00 p.m.	0030-0100	R. Prague	C	9630, 6055
7:30-8:00 p.m.	0030-0100	R. Kiev	B	17870, 15180, 12000, 7150, 6020, 5980
7:30-9:00 p.m.	0030-0200	HCJB, Ecuador	A	15115
7:30-10:30 p.m.	0030-0330	BBC	A	15260, 11750, 9580, 9410, 7325, 6175, 6120, 5975
7:30-12:00 p.m.	0030-0500	HCJB, Ecuador	B	11915, 9745
7:50-8:35 p.m.	0050-0135	TWR-Bonaire	B	11925
8:00-8:15 p.m	0100-0115	R. Japan	B	17755
8:00-8:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	11810, 9575
8:00-8:30 p.m.	0100-0130	R. Canada International	A	17865, 5960
8:00-8:30 p.m.	0100-0130	V. of Chile	B	11890, 11765
8:00-8:45 p.m.	0100-0145	R. Berlin International	C	11805, 9730
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 9630, 9540, 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	17680, 15600, 15520, 15060, 12055
8:00-9:00 p.m.	0100-0200	VOA	A	15205, 11740, 9640, 6130
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15425, 15345
8:00-10:00 p.m.	0100-0300	WYFR, Family Radio	A	5985
8:00-10:30 p.m.	0100-0330	R. Habana Cuba	A	11930
8:00-10:30 p.m.	0100-0330	R. Australia	B	17795, 21740
8:00-11:00 p.m.	0100-0400	AFRTS-Washington	A	21650, 17765, 15330, 17790, 6030
8:30-8:50 p.m.	0130-0150	V. of Germany	A	11865, 9605, 9565, 9545, 6100, 6085, 6075, 6040
8:30-8:55 p.m.	0130-0155	Austrian Radio	C	9770, 6155
8:30-8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
8:30-9:25 p.m.	0130-0225	R. Bucharest	C	11940, 11840, 9690, 9570, 6155, 5990
8:30-9:30 p.m.	0130-0230	R. Japan	B	21640, 17825, 17725, 15195
8:45-9:15 p.m.	0145-0215	Swiss R. International	B	11780-SSB, 11715, 9725, 9660, 6135
9:00-9:15 p.m.	0200-0215	R. Japan	B	15105
9:00-9:30 p.m.	0200-0230	R. Canada International	A	9535, 5960
9:00-9:30 p.m.	0200-0230	R. Norway	B	9645, 9550, 6180 (Mon only)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6000 (not Mon)
9:00-9:30 p.m.	0200-0230	R. Warsaw	C	15120, 11815, 9525, 6135, 6095
9:00-9:50 p.m.	0200-0250	R. RSA	B	11900, 9610, 9585, 5980
9:00-9:55 p.m.	0200-0255	R. Peking	B	17680, 15600, 15060, 12055
9:00-10:00 p.m.	0200-0300	R. Moscow	B	17720, 15455, 15180, 15140, 12050, 12010, 11860, 9710, 9665, 9530, 9490
9:00-10:30 p.m.	0200-0330	R. Cairo	B	12050, 9475
9:15-9:30 p.m.	0215-0230	V. of Greece	B	11730, 9760, 9515
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17830
9:30-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
9:30-10:00 p.m.	0230-0300	R. Lebanon	C	11785 (frequent changes)
9:30-10:00 p.m.	0230-0300	R. Sweden	C	11705, 9695
9:30-10:00 p.m.	0230-0300	V. of Chile	B	17800, 11890, 11765
9:30-10:15 p.m.	0230-0315	R. Berlin International	C	11805, 9730
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
9:50-11:00 p.m.	0250-0400	TIFC, Costa Rica	B	5055
10:00-10:15 p.m.	0300-0315	R. Japan	B	15105
10:00-10:15 p.m.	0300-0315	Austrian Radio	C	9770, 6155 (Sun only)
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11845, 9605, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11935, 6025 (Mon -0320)
10:00-10:30 p.m.	0300-0330	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6000
10:00-10:30 p.m.	0300-0330	R. Warsaw	C	15120, 11815, 9525, 6135, 6095
10:00-10:30 p.m.	0300-0330	R. Kiev	B	11860, 9780, 9580, 7400, 7245, 6020, 5980
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9630, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17532, 15300, 15060, 12080, 12055, 11685

10:00-11:00 p.m.	0300-0400	RAE, Argentina	C	9690 (Tue-Sat)
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	11935
10:00-11:00 p.m.	0300-0400	UBC, Uganda	B	15325
10:00-11:00 p.m.	0300-0400	R. Moscow	B	12010, 11860, 9710, 9530, 9490, 7205
10:00-11:26 p.m.	0300-0426	R. RSA	B	11900, 9585, 7270, 5980, 4990
10:00 p.m.-12:15 a.m.	0300-0515	R. New Zealand	C	15280
10:00 p.m.-1:00 a.m.	0300-0600	V. of the Voyageur	C	6220
10:00 p.m.-2:00 a.m.	0300-0700	VOA	A	9670, 5995
10:25-10:30 p.m.	0325-0330	V. of Armenia	B	15180, 12000, 5735 (Sun., Wed, Thu, Sat)
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 6155
10:30-11:00 p.m.	0330-0400	R. Australia	B	17795
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11970, 11890, 11840
10:30-11:45 p.m.	0330-0445	BBC	A	9410, 6175, 6120 (to 0430), 5975
10:30-11:50 p.m.	0330-0450	R. Habana Cuba	A	11930, 11725
10:30-12:00 p.m.	0330-0500	R. Tanzania	D	15435
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760
10:30 p.m.-12:30 a.m.	0330-0530	R. Moscow	B	17870, 15455, 15140, 12050, 12010, 9780, 9505
11:00-11:15 p.m.	0400-0415	R. Japan	B	15105
11:00-11:15 p.m.	0400-0415	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6040 (Wed & Sat)
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	11940, 11840, 9690, 9570, 6155, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	B	9550, 6180, (Mon only)
11:00-11:55 p.m.	0400-0455	R. Peking	B	17532, 15300, 15060, 12055, 11685
11:00-12:00 p.m.	0400-0500	R. Australia	B	17795, 15320
11:00 p.m.-2:00 a.m.	0400-0700	AFRTS-Washington	A	17765, 11805, 11790, 6030
11:30-11:55 p.m.	0430-0455	Austrian R.	C	5945
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	9725, 6045
11:30-12:00 p.m.	0430-0500	R. Sofia	B	9530
11:45 p.m.12:45 a.m.	0445-0545	BBC	A	9510, 6175, 5975 (11860 from 0500)
12:00-12:15 a.m.	0500-0515	Israel R.	B	15105, 11655, 11620
12:00-12:15 a.m.	0500-0515	R. Japan	B	9505
12:00-12:30 a.m.	0500-0530	R. Portugal	B	11935, 6025 (Mon -0520)
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17890, 17870, 17725, 15240
12:00-2:00 a.m.	0500-0700	HCJB, Ecuador	B	6095, 9560, 11915
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	11880, 9630
12:22-12:30 a.m.	0522-0530	UN Radio	A	9540, 6055 (Sat)
12:30-12:50 a.m.	0530-0550	V. of Germany	A	11785, 9545, 6185, 6100, 5960
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6165
12:30-2:30 a.m.	0530-0730	R. Moscow	B	15140, 12050, 12010, 9780, 9505, 7170
12:30-7:05 a.m.	0530-1205	R. New Zealand	C	6105
12:45-1:00 a.m.	0545-0600	UN Radio	A	9540, 6135 (Sat)
12:45-2:30 a.m.	0545-0730	BBC	B	11955, 11860, 9640, 9510, 7150, 6175
12:55-3:35 a.m.	0555-0835	V. of Nigeria	B	15120, 11770, 7255
1:00-1:15 a.m.	0600-0615	R. Japan	B	9505
1:00-1:30 a.m.	0600-0630	R. Norway	B	9645 (Mon only)
1:00-2:00 a.m.	0600-0700	RAE, Argentina	C	11755, 9690, 6120 (Tue-Sat only)
1:00-2:00 a.m.	0600-0700	R. RSA	C	17780, 15220
1:00-4:15 a.m.	0600-0915	R. Australia	B	15320
1:15-1:30 a.m.	0615-0630	R. Canada International	B	11845, 11825, 9655, 9635 6140, 6045 (Mon-Fri)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Korea	C	9640
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:40-3:15 a.m.	0640-0815	R. New Zealand	C	11945
1:45-2:00 a.m.	0645-0700	R. Canada International	B	11845, 11825, 9655, 9635, 6140, 6045 (Mon-Fri)
2:00-2:15 a.m.	0700-0715	R. Japan	B	9505
2:00-4:00 a.m.	0700-0900	R. Australia	B	11740, 9570
2:00-7:00 a.m.	0700-1200	AFRTS-Washington	A	9700, 9685, 6155, 6095, 6030
2:07-2:15 a.m.	0707-0715	UN Radio	A	9540, 6135 (Sat)
2:30-2:45 a.m.	0730-0745	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	11955, 9640, 9510, 7150
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715

Explanatory Notes.

1. Times in first column are EST (or CDT from April. 29). For AST/EDT, add 1 hour. CST/MDT, subtract 1 hour. MST/PDT, subtract 2 hours. PST, subtract 3 hours. Days of week are in GMT.
2. Quality. A—strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" at 1807, 1900 to Europe, Sunday; 0100, 0300, on Monday and 1900 Wednesday to Africa on R. Canada International for late changes.
4. R.—Radio; V.—Voice



Computer Bits

By Leslie Solomon

LANGUAGE TRANSLATION

MOST OF us remember the various times that Capt. Kirk, in "Star Trek," used a "universal language translator" to communicate with alien lifeforms. Well, such a vocal input/output system has not yet come along, but we are getting closer.

Within a period of three weeks, we had the opportunity to try out two "language translators"—the LK-3000 from Lexicon Corp. (8355 Executive Center Drive, Miami, FL 33166) and the M-100 from Craig Corp. (921 West Artesia Blvd, Compton, CA 90220). The translators are similar in operation though there are minor differences.

Both systems resemble pocket-size calculators and have alphanumeric keypads, and 16-digit multi-segment displays. The Lexicon uses LED's while the Craig uses fluorescent readouts.

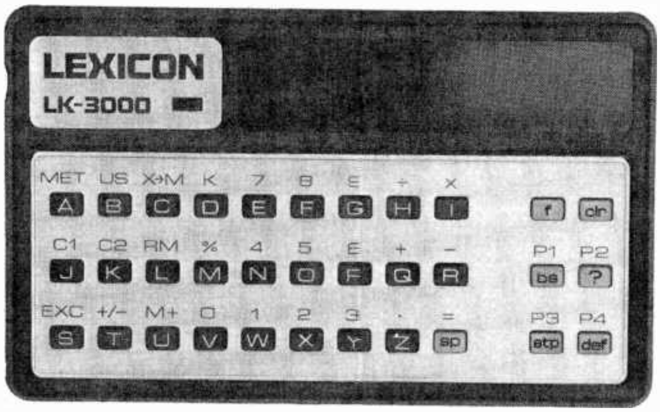
These machines have English as their "base." In operation, an English word is entered on the keyboard, a switch is depressed and both the English and its equivalent in the other language appear in the display. It is also possible to enter the foreign language word and have the display give the English equivalent. Both are provided with about 1500 commonly used words (similar to those little travel books tourists carry), and both also contain 50 or so of the most frequently used phrases. Foreign languages include French, Spanish, Italian, Portugese, etc., with Japanese, Russian and others coming soon. If an expression is longer than the display, the words will scroll left to allow the message to pass along.

Both machines are provided with plug-in modules that are used to change languages, and are in the $225 category. They also provide simple calculator operations and can provide a "menu" of the data within their ROM's.

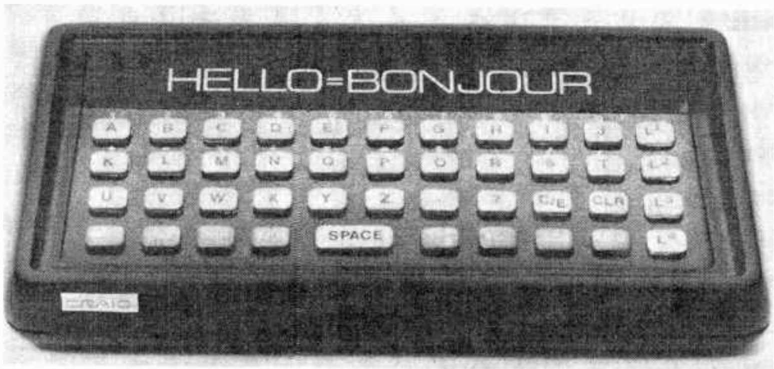
Electronically, both are basic computers in that they contain a processor, some RAM and have their language in ROM. The processor has the usual support circuitry and includes the 16 character display. The M-100, for example, uses a 3870 CPU, features 16K bits of internal ROM (carrying housekeeping and English), and can support 32K or 64K of plug-in ROM carrying the other language and data.

Everything is done in software (actually firmware) and both use proprietary programs. In both cases, the plug-in ROM will be sold over the counter. (Craig is asking $25 per language.)

Engineers for both companies refused to speculate on vocal input/output attachments for their devices, so we still have something to look forward to be-



The Lexicon LK-3000 language translator uses LED readouts.



The Craig Model M-100 translator uses a 3870 CPU.

fore we can join Kirk in his galactic conversations.

Atari Steps In. After several years of being one of the leaders in making arcade and home video games, Atari Inc. is now offering a pair of personal computers. One is the Atari-400 (approximately $500) using a 6502 CPU, 8K of RAM and 8K of ROM (expandable to 16K). The keyboard is a 57-key Monopanel with fingertip touch-contact points rather than mechanical keys. The system has upper and lower case, graphics and screen editing functions. Up to 40 characters on 24 lines can be displayed on a conventional TV. Up to 16 colors and 8 luminance levels are provided.

A built-in r-f modulator, set to either channel 2 or 3, conforms to the FCC Type-1 specifications. R-f radiation is kept down by using an extruded metal shield to cover the complete system (under a plastic cover). BASIC is provided. A special I/O connector allows interfacing to the several peripherals Atari intends to provide. Special input jacks, located under the keyboard on the front, allow use of game-playing controllers.

(Continued on page 88)

The Atari-400 personal computer uses a 6502 CPU, 8K of RM and 8K of ROM. Keyboard is a 56-key Monopanel with touch-control points.

(Continued from page 87)

The cassette player used with the system has no volume or tone controls, but does have a tape counter and pushbutton controls. It is also operated by the computer. Digital data is on one track, while audio is carried on the other. Data transmission is 300/600 baud, software controlled. Atari supplies a complete line of software, including many games.

The second system, the Atari-800 (approximately $1000), has all the electronic features of the 400 and comes with 8K of RAM plug-in expandable to 48K. It too comes with BASIC in ROM. This system can drive up to 4 disks and a printer. Soon to be available are an acoustic modem, a direct telephone adapter, an ac controller, a light pen, voice synthesizer and recognition, and a music synthesizer. Atari also supports this system with a full line of software (interchangable with the 400). Languages include BASIC and DISK BASIC, with other languages under consideration. They also hope to have an assembler, disassembler and text editor.

Each of the plug-in modules (RAM and operating system) is protected by a plastic enclosure. Details of the 44-pin bus were not available.

The keyboard features 57 full-stroke mechanical keys and four separate function keys. It too has a built-in modulator. Besides its built-in speaker, the 800 also provides TV sound.

The 40-column printer uses dot matrix and standard paper rolls and ribbons. It handles 40 characters per second and one line per second. It contains its own processor. The 800 can handle up to four disks simultaneously. The disk system uses standard 5½" diskettes with 92K per side and also contains its own processor. The various peripherals are "daisy chain" coupled to the single output connector.

TRS-80 S100 Adapter. The 8100, an S100 bus adapter motherboard, plugs into the TRS-80 via a ribbon cable. The 8100 also features 6 slots and card guides, and a second TRS-80 connector allows other TRS-80 devices to be connected at the same time. The new motherboard has optional on-board circuitry and sockets for 16K of dynamic RAM, I/O interfaces for serial and parallel I/O both RS232 and 20-mA loop and an 8-bit parallel I/O port. The basic unit, including the S100 bus interface, one edge connector/card guide set, and manual is $185 per kit and $245 assembled. Five connectors/card guides are $45 as a kit, $75 assembled. The RAM support option (less RAM's) is $45 kit and $75 assembled, while the I/O option is $85 kit, $115 assembled. HUH Electronics, 1429 Maple St., San Mateo, CA 94402 (Tel: 415-573-7359).

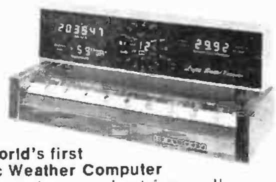
Apple Robot. If you have an Apple II, the addition of ROBOT 1, will enable you to control a battery-powered car merely by speaking the words "forward," "reverse," "stop," "left," "right," and "straight". The ROBOT 1 plugs into an Apple slot, and the accompanying program is run. The speech system uses the Heuristics Model 20A Speechlab. The radio link is effective to about 300 feet. The system comes with car, radio-link controller, Apple II peripheral card, preprogrammed demonstration tape and instruction manual. Heuristics, Inc., 900 San Antonio Rd, Los Altos, CA 94022 (Tel: 415-948-2542).

New Computer Clubs. An 1802 user group is now in operation in Finland. Contact: J. E. Nystrom, Ulvilantie 2 C 27, SF-00350 Helsinki 35, Finland.

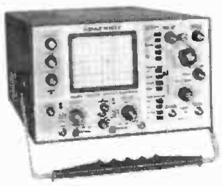
A new Canadian club has also been reported. Contact: West Coast Computer Society, POB 4476, Vancouver, B.C., Canada V6B 3Z8. ◇

There's only one way to have the newest and most unique top-value electronic products...choose and build from the nearly 400 fascinating kits you'll find in this new

FREE HEATHKIT® CATALOG!



See the world's first Electronic Weather Computer It indicates, stores and retrieves all temperature, pressure and wind data ...even computes wind chill factors for home, farm or office.

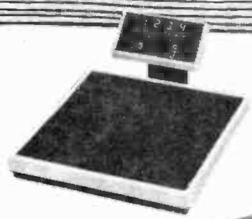


See the very finest, most advanced oscilloscope Heath has ever developed. Compare this DC-35 MHz Dual Trace, Delayed Sweep Scope with others costing hundreds of dollars more.

See the new GC-1415 deluxe Digital Car Clock with trip timer and stopwatch. Useful and practical for car, van or truck.

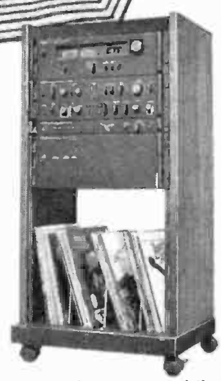
The R/C'ers dream — Heath's Pack 17 8-channel open gimbal R/C transmitter with instant plug-in frequencies ...at big kit savings!

A super coin-shooter! Heath's 'Cointrack' Metal Locator with adjustable discrimination and pushbutton tuning.



See the first and the best electronic digital bathroom scale with a strain-gauge transducer like the most expensive laboratory scales.

See the world's first and finest fully computerized and programmable color TV that lets you program an entire evening's viewing.



See Heath's newest and finest 'rack-mount' series of audio components — professional performance for discriminating audiophiles and music lovers who want the best.

Plus hundreds of top-performing, value-priced electronic kit products for home, hobby or business. See the most powerful personal computer systems you can buy with complete software and peripherals. See the Heathkit Continuing Education Self-Learning Programs in Basic and Advanced Electronics, Automotive Electrical, Test Instruments and Novice and General Amateur Radio Licenses—the most efficient and economical way to stay on top of our electronics world!
FILL-IN COUPON AND SEND TODAY.

If coupon is missing, write Heath Co., Dept. 010-520, Benton Harbor MI 49022.

Every Heathkit product is backed by world-famous technical service and counsel — plus sales and service facilities at 54 Heathkit Electronic Centers* coast-to-coast (*units of Schlumberger Products Corporation). See the white pages of your phone directory for the center nearest you.

SEND FOR YOUR FREE COPY TODAY!

HEATH
Schlumberger

Heath Company, Dept. 010-520
Benton Harbor, Michigan 49022

FREE CATALOG

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

Name ______

Address ______

City ______ State ______

CL-689 Zip ______

CIRCLE NO. 27 ON FREE INFORMATION CARD

Soft ware Sources

BASIC Business Software. Five application packages for small business are now available in BASIC listings or as Micropolis disks. Each system uses only two files of its own, a master file and a transaction file. Each may be used as a stand-alone program or as part of an integrated multi-function system. MICROLEDGER is a dual-entry bookkeeping system matching revenues and expenses, with journal, trial-balance, posting, audit-trail, P&L-statement and balance-sheet functons. MICROPAY is an accounts-payable system reporting cash requirements and payables by vendor and by date or dates. MICROREC is the accounts-receivable counterpart, which can print invoices, and report aged trial balances or receivables by date or customer. MICROPERS is a payroll/personnel-management system which can produce paychecks, W-2 forms, and reports. MICROINV carries out inventory-control functions, including analysis and order-quantity suggestions. Programs are available for Micropolis or Cromemco 16K BASIC. Packages with listings are $120 per program; Micropolis II disks, available to package buyers only, are $10 each. CompuMax Associates, 505 Hamilton Ave., Palo Alto, CA 94301.

North Star Applications Software. Three diskettes of programs (one each financial, mathematical analysis and statistical) from the Osborne book "Some Common BASIC Programs" two game diskettes, one diskette each of backorder, retail sales-report and mailing-list programs using disk data files, and a Northstar DOS for Centronics printers are now available from Arizona and Dallas Byte Shops, or from MicroAge. $35 per diskette. MicroAge Mail Order, 803 N. Scottsdale Rd., Tempe, AZ 85281.

CP/M Users' Group Programs. For a $4 annual membership charge, CP/M users can have access to hundreds of programs for $8 per diskette, with an average of about 17 programs per disk, or 50 cents per program. Program disks available include utility, game, instructional, general ledger, math, monitors, and such languages as BASIC-E, PILOT, ALGOL-M, STOIC, and CASUAL. CP/M Users' Group, 164 West 83rd St., New York, NY 10024.

SC/MP Cross-Assembler for 8080. Systems capable of running the ASM80 macroassembler for 8080 can now be used to develop programs for the National Semiconductor SC/MP (INS8060). The cross-assembler program, MDSMAC, consists of a set of macros loaded into the host system assembler's macro tables. Paper tape, $5.00. National Computer Users Group, National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051.

8080 Development Software and Aids. Tychon, whose principals edit the popular 8080 Bugbooks, also offers two progams and two versions of a programming aid for 8080 users. The TED editor and TAS assembler accept both octal and hex values and yield octal or hex program listings from either input. The package has its own relocator, character string search, and occupies less than 5K. The standard version, with relocator, addressed at 00, is $35 for a paper tape and manual; it's also available custon. assembled to any address for $50. Hex or octal listings are $30 each. DBUG: An 8080 Interpretive Debugger allows programs to be entered, changed, and single-stepped, and displays registers at breakpoints. It resides in 1K. DBUG tapes are $10, and documentation is $4.95. DBUG listing book from Howard Sams (order # 21536), 4300 W. 62, Indianapolis, IN 46268; other items from Tychon, Box 242, Blacksburg, VA 24060.

PROJECT OF THE MONTH

BY FORREST M. MIMS

EXPERIMENTAL SOLID-STATE OSCILLOSCOPE

In the October 1978 Experimenter's Corner I made a brief reference to an experimental solid-state oscilloscope that employs, as a display screen, the 160-element LED array that appeared as the last Project of the Month. Many readers have written requesting additional information, so here it is!

Figure A is the schematic diagram of the experimental scope. In operation, a signal applied to the noninverting input of the 741 op amp is amplified and routed to a flash A/D converter made up of LM339 quad comparators and a 74147 priority encoder. A detailed description of this A/D converter was given in the September and October 1978 Experimenter's Corner columns.

The digital output of the 74147 is a 4-bit BCD nibble. This nibble, after being decoded by a 74145 1-of-10 decoder, activates one of the ten horizontal rows of LEDs. One of the sixteen vertical columns of LEDs is activated simultaneously by a horizontal scanning circuit consisting of a 555 timer, 74193 4-bit counter and 74154 1-of-16 decoder. The 555 serves as a time base whose sweep frequency is controlled by a 1-megohm potentiometer. The 74193 and 74154 form a 0-to-15 sequence generator that sweeps the sixteen columns of LEDs one at a time.

Because only one row and one column of LEDs are activated at any time, only one LED in the array glows at any single instant. When the sweep rate is faster than 20 or 30 complete scans per second, the individual LEDs merge into a broken line that provides a rough pictorial representation of the positive half of the waveform appearing at the input of the 741 op amp.

Three of the gates in a 7400 quad NAND gate add a simple but very useful trigger feature. When pin 14 of the 74193 is grounded by placing the MODE switch in its FREE RUNNING position, the sweep circuit scans the LED columns continuously. A careful adjustment of the time base potentiometer will freeze the waveform being displayed. Any drift, however slight, in the incoming waveform will require a readjustment of the time base. Otherwise, the waveform being displayed will move across the screen from left to right or right to left, as it did before the potentiometer was adjusted.

When the MODE switch is placed in its TRIGGERED position, pin 14 of the 74193 is reset (or cleared) to 0000 when an input signal is not present. An input signal with enough amplitude to activate the lowest-order LM339 comparator causes pin 6 of the 7400 to go from high to low. This allows the 74193 to make a complete scan of the display columns.

If the input signal is still present when the scan is completed, another scan is immediately begun. Otherwise, the scope waits for the signal to recur before initiating a new scan. The result is that in the triggered mode the scope automatically locks onto a recurrent waveform, and displays it with its rising portion originating in the first column of LEDs. A LED connected to the trigger gate network indicates when trig-

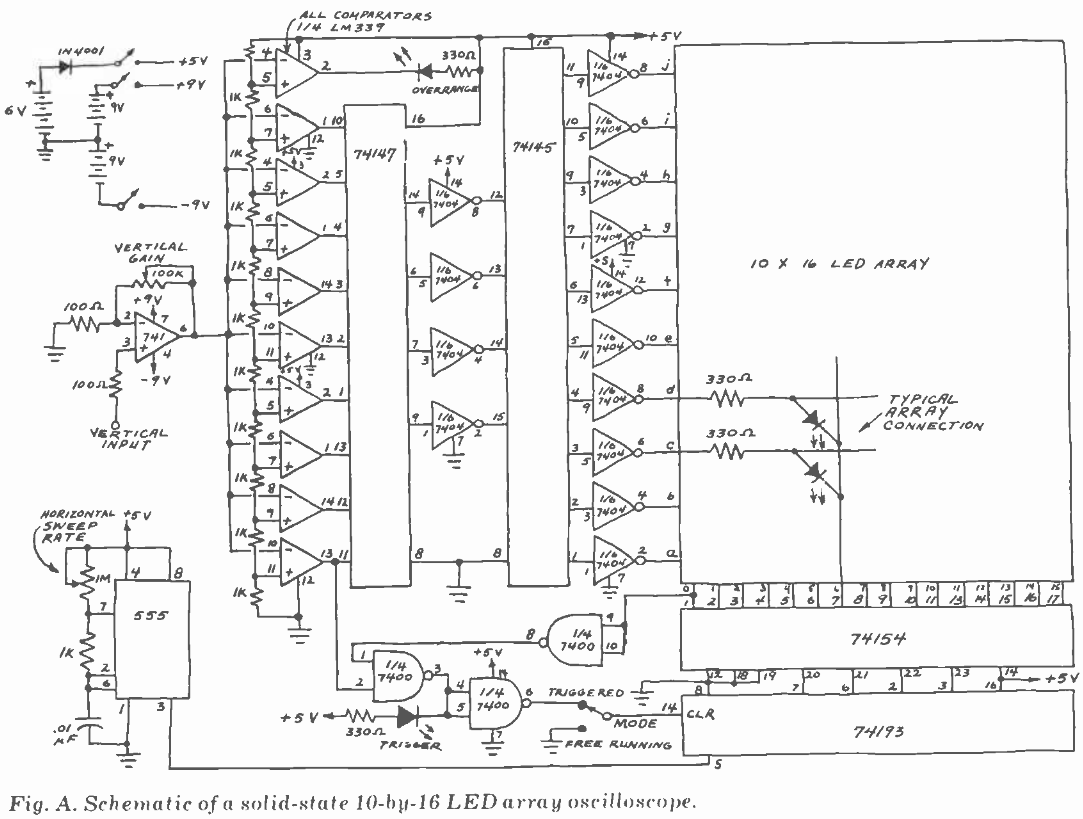


Fig. A. Schematic of a solid-state 10-by-16 LED array oscilloscope.

gering is occurring, which might not be known if the gain is set so high as to prevent observation of the waveform.

When the scope is in the triggered mode, the waveform being displayed can be expanded or compressed by changing the horizontal sweep rate. Similarly, the height of the waveform can be increased or decreased by adjusting the VERTICAL GAIN potentiometer. An overrange LED connected to the output of the highest-order LM339 comparator indicates when the gain is too high and the top of the waveform is therefore off the screen.

Although it is considerably easier to assemble the drive circuit than the LED display board described last month, care must be exercised when building it because wiring errors can be very difficult to find. I assembled the prototype driver circuit on the same kind of board used for the display (Radio Shack 276-152 or similar) using wrapped-wire, point-to-point construction. Figure B shows how the major components were arranged on the top side of the board. Note the miniature phone jack that serves as the vertical input for the scope. This jack should be installed from the front side of the board.

After the components on the board are connected together, connections to the display board, the time base potentiometer, the vertical gain potentiometer and the power supply are provided by soldering wrapping wire to the appropriate copper fingers on the board.

Last month, the bus locations I used on the display board were given. The bus locations used for the remainder of the scope circuit are as follows:

Oscilloscope Circuit	*S-44 Socket*
+5 volts	1
Ground	2
Overrange LED Cathode	3
Vertical Gain Control	M
Vertical Gain Control	N
Horizontal Sweep Control	S
Horizontal Sweep Control	T
Mode Switch:	
Pin 6 7400	U
Ground	V
Pin 14 74193	W
Trigger LED Cathode	X
-9 volts	Y
-9 volts	Z

Don't feel compelled to use these bus locations. All of them can be changed so long as they don't interfere with the display bus. It's a good idea to reserve the *1*, *2*, *Y* and *Z* locations for the power supply since these are closest to the two copper strips that traverse the perimeter of the circuit boards. You can use a small file to separate these into four separate strips.

After the scope circuit has been completed, saw off the upper portion of a second circuit board and install a power switch (3PST), trigger mode switch (SPDT), trigger LED and vertical gain and horizontal sweep rate potentiometer. Figure C shows the layout I used to make the prototype. This board becomes the control panel for the scope. Its components should be connected to the appropriate copper fingers in accordance with the bus given above or the one you select.

You'll need to make a card rack or mother board to hold the three boards that comprise the oscilloscope. If you can afford a commercial mother board, great. If not, do what I did and attach three 44-connector sockets with wire-wrap terminals to a couple of wood or plastic rails. Mount the sockets an inch apart from each other. Next,

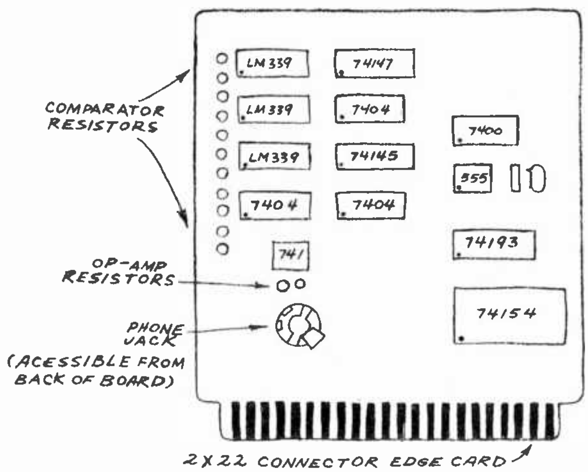


Fig. B. Layout of the major components of the experimental oscilloscope on a 2 x 22 connector edge board.

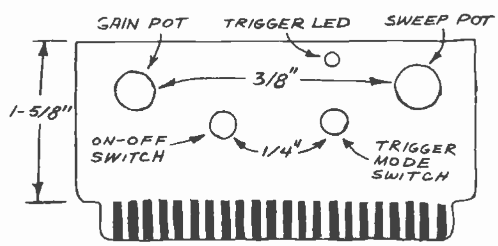


Fig. C. Prototype layout for the control board for the LED oscilloscope.

connect all the common connectors with wrapping wire. Then insert the scope card in the rearmost socket (ICs facing forward), display card in the center socket and control card in the foremost socket.

The prototype scope is powered by two 9-volt batteries and a 6-volt battery made from four AA alkaline cells in a plastic holder. The batteries are connected to the scope with three battery connector clips.

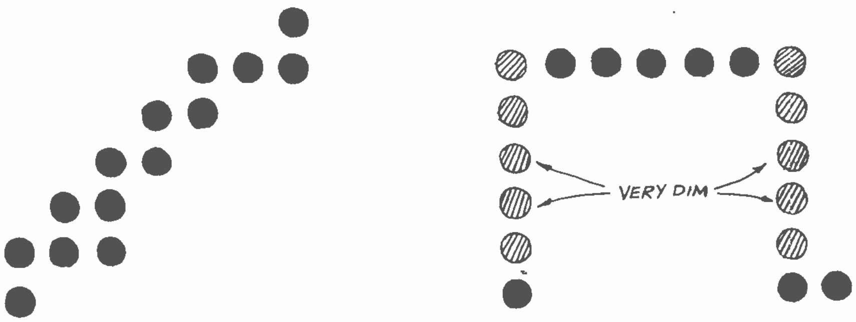
Before applying power to the circuit, be sure to take the time necessary to retrace all the wiring to make sure you've made no errors. The most common problem in a project using wrapped wiring is overlooked connections, particularly those to the power supply pins of the ICs.

Make a probe for the scope from a length of flexible shielded cable, a miniature phone plug, a test clip and an alligator clip. For initial tests, use a ramp or triangle wave having an amplitude of up to a few volts and a frequency of a few hundred hertz. Be sure to perform the tests in a darkened room, at least initially, since the LED array will not be as brightly illuminated as a conventional CRT screen.

If the scope fails to respond, make sure that power is being applied properly. Then try changing the gain and time base settings as well as the trigger mode. If the scope still does not work, you will have to troubleshoot the circuit. Hint: Proceed one step at a time. For example, troubleshoot the sweep circuit by beginning at the 555 (is it pulsing?). Then move to the 74193 (is it counting?), etc.

Once you have the scope working, you'll be able to display a variety of waveforms after a little practice. Spikes, triangles and ramps are the waveforms best reproduced. Sine waves are slightly distorted by the low resolution of the screen, and the rising and falling portions of square waves are usually very faint. Often several LEDs in a vertical column will appear to be on as shown in Figure D, but it's usually possible to resolve the general waveform being displayed.

Although the resolution of this experimental scope is poor and the design of the vertical section leaves much to be desired, it does demonstrate that a flat-screen, compact oscilloscope can be built. If you build the scope you'll want to spend some time calibrating the vertical and horizontal sections with the help of a voltmeter and frequency generator or a conventional oscilloscope. You might also want to modify or try to improve the design if you're experimentally inclined. The A/D converter of the vertical section, for example, can be greatly simplified by using a single-chip A/D converter. The sensitivity of the vertical comparator string can be varied by replacing the 1-megohm resistor at the top of the voltage divider with either a fixed resistor having a different value or, better yet, a 1-megohm potentiometer. Similarly, a wide range of sweep rates can be obtained by replacing the single timing capacitor with a group of fixed capacitors of various values, one of which would be selected by a rotary switch. ◇



(A) TYPICAL RAMP AS DISPLAYED ON 160-ELEMENT LED SCREEN

(B) TYPICAL SQUARE WAVE

Fig. D. Portions of two waveforms as displayed on 160-element LED display.

Active Electronic Sales Corp.

Features..........

BRAND NEW!

JUST RELEASED
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**

CMOS I.C.'S

CD4000BE	17	CD4042BE	.59	CD4515BE	$1.95
CD4001BE	17	CD4043BE	.57	CD4516BE	.69
CD4002BE	.17	CD4044BE	.55	CD4518BE	.79
CD4006BE	.87	CD4046BE	.99	CD4519BE	.47
CD4007BE	17	CD4049BE	.33	CD4520BE	.69
CD4008BE	.75	CD4050BE	.33	CD4522BE	99
CD4009BE	.39	CD4051BE	.54	CD4526BE	.99
CD4010BE	.39	CD4052BE	.54	CD4527BE	$1.09
CD4011BE	17	CD4053BE	.54	CD4528BE	69
CD4012BE	17	CD4060BE	.99	CD4531BE	74
CD4013BE	32	CD4066BE	.44	CD4532BE	$1.19
CD4014BE	73	CD4068BE	.21	CD4539BE	.99
CD4015BE	.69	CD4069BE	.21	CD4543BE	$1 39
CD4016BE	.35	CD4070BE	.29	CD4555BE	.65
CD4017BE	.62	CD4071BE	.21	CD4556BE	65
CD4018BE	.69	CD4072BE	21	CD4581BE	$2.25
CD4019BE	.39	CD4073BE	21	CD4582BE	.79
CD4020BE	.69	CD4075BE	.21	CD4584BE	.60
CD4021BE	.69	CD4076BE	.79	CD4585BE	.90
CD4022BE	.69	CD4077BE	.25	40014PC	.59
CD4023BE	17	CD4078BE	21	40085PC	$1.09
CD4024BE	49	CD4081BE	.21	40097PC	.60
CD4025BE	.17	CD4082BE	.21	40098PC	.60
CD4026BE	$1.39	CD4085BE	.69	40160PC	.89
CD4027BE	.39	CD4086BE	.69	40161PC	.99
CD4028BE	.57	CD4093BE	.40	40162PC	.89
CD4029BE	.74	CD4104BE	$2.25	40163PC	.99
CD4030BE	.35	CD4502BE	.85	40174PC	.89
CD4033BE	$1.45	CD4508BE	$2.25	40175PC	.89
CD4034BE	$2.25	CD4510BE	.88	40192PC	$1.19
CD4035BE	.64	CD4511BE	.99	40193PC	$1 19
CD4040BE	.74	CD4512BE	.59	40194PC	$1.10
CD4041BE	.74	CD4514BE	$1.95	40195PC	$1.10

LINEAR I.C.'S

LM324N	.49	Quad Op Amp
LM339N	.49	Quad Comparator
LM555N-8	.29	Timer
LM556N-14	.59	Dual Timer
LM723CN	.34	Voltage Regulator
LM723CH	.39	Voltage Regulator
LM741CH	.37	Op Amp
LM741CN-8	.24	Op Amp
LM1458N-8	.39	Dual Op Amp

VOLTAGE REGULATORS

PART NO.	UNIT PRICE	DESCRIPTION
LM323K	~~$5.50~~ $4.95	3 Amp 5 Volt Regulator
78H05KC	$5.75	5 Amp 5 Volt Positive Regulator TO3
7800UC Series TO-220 /LM340T	.79	Positive Voltage Regulators (Plastic) 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
78MOOHC Series TO-5 / LM340H	$1.50	Positive Voltage Regulator 1/2 Amp 5, 6, 8, 12, 15, 18, 24 Volts
7800KC Series TO-3 / LM340K	$1.60	Positive Voltage Regulator 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
78LOOAWC Series TO-92	.29	Positive Voltage Regulator 100 MA 2.6, 5, 6.2, 8.2, 12, 15 Volts
7900UC Series TO-220 / LM320T	$1.10	Negative Voltage Regulator 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
79M00HC Series TO-5 / LM320H	$1.50	Negative Voltage Regulator 1/2 Amp 5, 6, 8, 12, 15, 20, 24 Volts
7900KC Series TO-3 / LM320K	$1.95	Negative Voltage Regulator 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
78MGT2C	$1.25	Dual In Line Adjustable 4 Terminal Positive Voltage Regulator
78GUI TO-220	$1.45	1 Amp Adjustable Positive Voltage Regulator
78S4OPC	$2.50	Switching Regulator

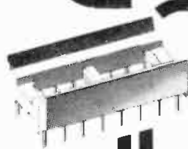
All new major manufacturer production material offered.
Largest variety of device types available anywhere.

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		



GENERAL INSTRUMENT

1 Amp Rectifiers (Epoxy)

Part No.		Price
1N4001	50V	.029
1N4002	100V	.039
1N4002	200V	.045
1N4004	400V	.049
1N4005	600V	.055
1N4006	800V	.065
1N4007	1000V	.07

1.5 Amp Single Phase Silicon Bridge Rectifiers

Part No.		Price
W06M	600V	.34
W08M	800V	.39

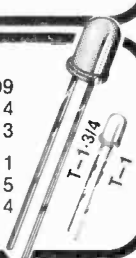
SWITCHING DIODES

Part No.	Price
1N914 (100V 4NS)	.027
1N4148 (100V 4NS)	.027

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

MAJOR MANUFACTURER



MICROPROCESSOR CHIPS

CPU's

Part No.	Price
8080A	~~5.95~~ 5.50
6800	~~8.95~~ 7.95

INTERFACE SUPPORT CIRCUITS

Part No.	Price	Part No.	Price
8212	1.98	8255	5.95
8214	~~4.95~~ 3.95	8257	9.95
8216	1.98	8259	14.95
8224	2.75		
8226	1.98	6810	~~3.95~~ 3.50
8228	4.75	6820	~~4.95~~ 3.95
8238	4.75	6821	~~4.95~~ 3.95
8251	~~5.95~~ 4.95	6850	~~5.95~~ 4.95
8253	14.95	6852	~~5.95~~ 4.95

MOS Static RAM's

Part No.	Price
2102LFPC 1K 350NS (Low Power)	$1.19
2102-1PC 1K 450NS	$.99
2114 4K (1K x 4) 300NS	$7.50
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
416-3 200NS	$9.95
416-5 300NS	$7.95

UART's

Part No.	Price
AY5-1013A	$4.95
AY3-1015	$5.95

1K CMOS RAM

Part No.	Price
5101 450NS (Low Power)	$4.95
5101 800NS	$3.95

Zilog

Z80-CPU	~~14.95~~ $13.60	Z80-CTC	$10.90
Z80A-CPU	~~24.95~~ $16.20	Z80A-CTC	$13.10
Z80-PIO	~~7.95~~ $10.90	Z80-DMA	~~46.00~~ $32.20
Z80A-PIO	~~11.95~~ $13.10	Z80-SIO/0	~~59.00~~ $45.00
		Z80A-SIO/0	~~68.00~~ $50.00
		Z80-SIO/1	~~59.00~~ $45.00
		Z80A-SIO/1	~~68.00~~ $50.00

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 3 LOCATIONS

5651 FERRIER ST.
MONTREAL, QUEBEC
H4P 2K5
Tel:(514)735-6425

4800 DUFFERIN ST.
DOWNSVIEW, ONTARIO
M3H 5S9
Tel:(416)661-1115

BAXTER CENTRE
1050 BAXTER ROAD
OTTAWA, ONTARIO
K2C 3P2
Tel:(613)820-9471

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.

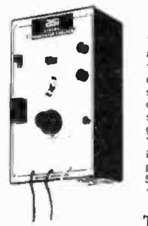
CHARGEX VISA

master charge

CIRCLE NO. 2 ON FREE INFORMATION CARD

CIRCLE NO. 22 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.

Trans-Check $29.95 ea.

Custom Cables & Jumpers

NEW! NEW!

DB 25 Series Cables

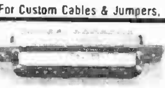
Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

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

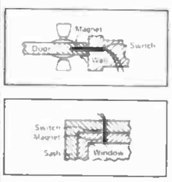
Solar Cells 2x2cm

- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 $1.95 ea. or 3/$5.00

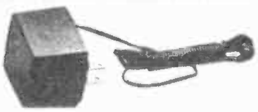
Magnetically Activated Switch



The 9250-0002 is a single pole normally closed switch. When the magnet is engaged, the circuit is open. This switch is only suitable for use in non-magnetic doors and windows.

#9250-0002 2/$1.00

AC Wall Transformer



Ideal for use with clocks, power supplies or any other type of AC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95

REMOTE CONTROL TRANSMITTER & RECEIVER

- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 38MHz AND 41.5MHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 9V BATTERY
- SCHEMATIC INCLUDED

$19.95

INSTRUMENT/CLOCK CASE

This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

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
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)	1.95

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 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
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
TMS2516 (2716)	16K*	EPROM(Intel 2716)	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 BOARDS

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

Proto Board 203A

All the features of the PB 203 plus additional power supply flexibility provides 1A Regulated 5VDC supply (same specifications as PB 203). Regulated separate +15VDC and -15VDC 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-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

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

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage - 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4 x 4.4 x 2

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

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

New CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, Input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-IPC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

$10.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 Catalog Available—Send 41¢ stamp

NEW 1979 Catalog

Jameco ELECTRONICS

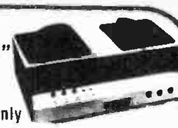
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME
(415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070

ADVERTISED PRICES GOOD THRU APRIL

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 VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

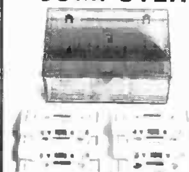
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) for only $139.95

COMPUTER CASSETTES



- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED
- 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II

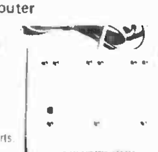
UHF Channel 33 TV Interface Unit Kit

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

RS-232 CONTROL CENTER

Plug in your modem, computer prom programmer, terminal, printer, etc. and selectively control data flow.



- Same Contour as Pennywhistle 103
- Totally self-contained
- Includes 2 master ports and 3 slave ports

PART NO.
RS-232CC $89.95 kit only

CASSETTE CONTROLLER

Ideal for use with the TRS 80 and others.
"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

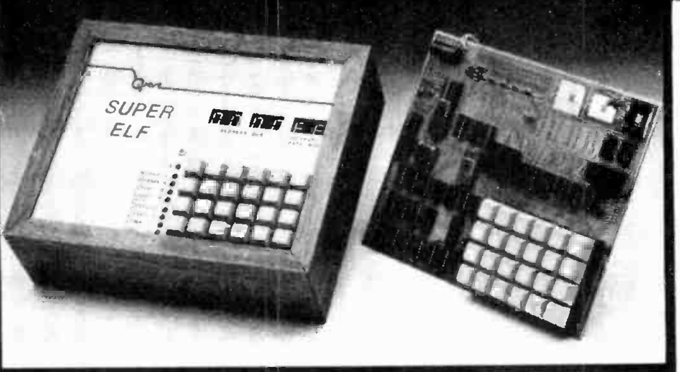
Hexadecimal Unencoded Keypad

19-key pad Includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. $10.95/each

P.O. Box 4430C Santa Clara, CA 95054
For will call only: (408) 988-1640
2322 Walsh Ave.

Quest ELECTRONICS

ELECTRONICS Market Place



Same day shipment. First line parts only Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

7400TTL	
7400N	17
7402N	17
7404N	19
7409N	23
7410N	17
7414N	63
7420N	17
7422N	1 39
7430N	20
7442N	50
7445N	69
7447N	60
7448N	69
7450N	17
7474N	29
7475N	.49
7485N	88
7489N	2 00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
74150N	95
74151N	69
74154N	1.00
74157N	.69
74161N	87
74162N	87
74163N	87
74174N	.96
74175N	.90
74190N	1 15
74192N	87
74193N	85
74221N	1 55
74298N	1 65
74365N	66
74366N	66
74367N	66
74LS00 TTL	
74LS00N	25
74LS02N	25
74LS04N	.25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	.25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	35
74LS75N	47
74LS90N	51
74LS93N	.51
74LS95N	1 89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	.91
74LS163N	91
74LS174N	.95
74LS190N	1.06
74LS221N	1.95
74LS258N	.67
74LS367N	.89
LINEAR	
CA3045	90
CA3046	.67
CA3081	1.80
CA3082	1.90
CA3089	2.95
LM301AN/AH	35
LM305H	[illegible]
LM307N	35
LM308N	.89
LM309H	1.15
LM309K	95
LM311H/N	.90
LM317T/K	2.92
LM318	1.35
LM320K-5	1.25
LM323K-5	6 95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.50
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1 25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1 25
LM340T-18	1 25
LM340T-24	1.25
LM343H	4.50
LM350	7 50

LM370	1 15
LM377	3 00
LM379	5 00
LM380N	1 00
LM381	1.60
LM382	1.60
LM703H	.40
LM709H	28
LM723H/N	50
LM733N	67
LM741CH	35
LM741N	25
LM747H/N	.62
LM748N	35
LM1303N	82
LM1304	1 10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	47
LM1800	1.75
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	1.50
LM3900N	60
LM3905	1.75
LM3909N	.61
MC1458V	.50
NE540L	2.89
NE550N	65
NE555V	.43
NE556A	.79
NE565A	1.00
NE566V	1 50
NE567V	1 20
NE570B	5 00
NE571B	5.00
78L05	.60
78L08	60
79L05	70
78M05	.85
75108	1.75
75491CN	50
75492CN	55
75494CN	89
A to D CONVERTER	
8038B	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25
CMOS	
CD34001 Fair	50
CD4000	16
CD4001	.21
CD4002	21
CD4006	1 10
CD4007	.21
CD4008	21
CD4009	39
CD4010	39
CD4011	.21
CD4012	21
CD4013	36
CD4014	86
CD4015	.86
CD4016	.36
CD4017	94
CD4018	94
CD4019	21
CD4020	1 02
CD4021	1 02
CD4022	86
CD4023	21
CD4024	75
CD4025	21
CD4026	1.51
CD4027	36
CD4028	79
CD4029	1 02
CD4030	21
CD4035	1.02
CD4040	1 02
CD4042	.71
CD4043	63
CD4044	63
CD4046	1 67
CD4049	36
CD4050	36
CD4051	1 13
CD4060	1 42
CD4066	.71
CD4068	40
CD4069	40
CD4070	40
CD4071	21
CD4072	21
CD4073	.21
CD4075	.21
CD4076	1.75
CD4078	.40
CD4081	.21
CD4082	.21
CD4116	.47
CD4490	5 50
CD4507	1.00
CD4508	4.25
CD4510	1.02
CD4511	.94
CD4515	2.52
CD4516	1.10
CD4518	1 02
CD4520	1.02
CD4527	1 51
CD4528	79

CD4553	3.50
CD4566	2.25
CD4583	4 50
CD4585	1 10
CD40192	3 00
74C00	.28
74C04	.33
74C10	.28
74C14	2 10
74C20	28
74C30	28
74C48	1 95
74C74	75
74C76	1 40
74C90	1.15
74C93	1.40
74C154	3 00
74C160	1.44
74C175	1.35
74C192	1 65
74C221	2.00
74C905	3 00
74C906	75
74C914	1 95
74C922	5 50
74C923	5.50
74C925	6.95
74C926	6 95
74C927	6 95
INTERFACE	
8095	.65
8096	.65
8097	.65
8098	65
8T09	1 25
8T10	4.50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3.50
8T25	3 20
8T26	1.69
8T28	2.75
8T97	1 69
8T98	1 69
MOS/MEMORY RAM	
2101-1	3 95
2102-1	95
2102AL-4	1 60
21F02	1 25
2104A-4	4 95
2107B	4.95
2111-1	3 75
2112-2	3.95
2114	8.50
4116	12.95
2513B	6.30
21L02-1	1 29
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4.00
PD411D-4	5 00
P5101L	13.95
4200A	9.95
82S25	2.90
91L02A	1 50
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	9 95
9368	3.50
410D	10 00
416	16.00
CLOCKS	
MM5309	3 00
MM5311	3.60
MM5312	4.80
MM5313	3 60
MM5314	3 90
MM5315	4.00
MM5316	5.00
MM5318	3 60
MM5369	2.10
MM5841	14.45
MM5865	7 95
CT7001	5 80
CT7002	8 95
CT7010	8.95
CT7015	7.25
MM5375AA/N	3 90
MM5375AB/N	4 90
7205	16 50
7207	7 50
7208	15.95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50
MICROPROCESSOR	
6800	17 50
6802	24 95
8080A with data	8 95
8085	27 00
Z80A	19.75
8212	2.90
8214	8 00
8216	2.90
8224	2.90
8228	5 35
8251	8 50
8253	10.00
8255	9.25
8257	19 50
8259	19 50
CDP1802CD	19.95

CDP1802D	25 00
CDP1861	12 95
6820	9.95
6850	12.95
6502	12.50

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	18	24	35
16	20	28	42
18	.27	36	58
20	29	40	.57

3 level wire wrap gold
14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	25	24	86
16	33	28	1 00
18	.57	40	1 23

UART/FIFO	
AY5-1013	5.50
AY5-1014	7.50
3341	6.95
PROM	
1702A	3 95
N82S23	2.95
N82S123	3 50
N82S126	3 75
N82S129	3 75
N82S131	3.75
N82S136	8.75
N82S137	8 75
2708	10 50
DM8577	2.90
8223	2.90
2716T1	29.50
2716 Intel	48 00
CRYSTALS	
1 MHz	4.50
2 MHz	4.50
4 MHz	4 25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3 90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1 20
2.0100 MHz	1 95
2.097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5.0688 MHz	4 50
5.185 MHz	4 50
5 7143 MHz	4.50
6 5536 MHz	4 50
14.31818 MHz	4.25
18 432 MHz	4 50
22.1184 MHz	4.50
CONNECTORS	
44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5 25
KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	13.50
74C922	5.50
74C923	5.50
HD0165-5	6.95

IC Test Clips

	1	10
Red	55	47
Black	55	.47

Keyer 8043	14.50
comp w/spec./sock	
TRANSISTORS	
2N1893	40
2N2222A	18
2N2369	30
2N2904A	20
2N2907A	.25
2N3053	40
2N3638	25
2N3643	25
2N3904	18
2N3906	18
2N3055	69
2N4400	25
2N4401	75
2N4402	20
TIP31	60
TIP33A	1 00
D Connectors RS232	
25 Pin Subminiatures	
DB25P	2.95
DB25S	3 95
Cover	1.50
RS232 Complete Set	6.50
DE9P	1 50
DE9S	1.95
DA15P	2 10
DA15S	3.10

CLOCK MODULES Complete alarm clocks ready to hook up with transformer and switches. Very compact with .50" and .84 digits

MA1002A, C or E .50	8.95
102P3 Transformer	2.25
MA1010A, C or E .84	11.95
102P2 Transformer	2.25
Special transformer and six switches when purchased w/module	2.95
MA1003 car module .3 green fluor. display	15.95

RESISTORS ¼ watt 5%
10 per type .03 — 1000 per type .012
25 per type .025 — 350 piece pack
100 per type .015 — 5 per type 6 75

KEYBOARDS	
56 key ASCII keyboard kit	$67.50
Fully assembled	77 50
53 key ASCII keyboard kit	60.00
Fully assembled 70.00 Enclosure	14 95
LEDS	
Red T018	15
Green, Yellow T018	20
Jumbo Red	20
Green, Orange, Yellow Jumbo	25
Cliplite LED Mounting Clips	8/$1 25
(specify red, amber, green, yellow, clear)	

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr. $128.95

OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

DIGITAL THERMOMETER $48.50
Batt. oper. General purpose or medical 32–230 F. Disposable probe cover ±.2 accuracy. Comp. Assy. in compact case. Switches from F to C.

COMPUTER BOARD KITS	
8K RAM Board Kit	$135 00
4K EPROM Kit	114.95
I/O Board Kit	44.50
Extender Board w/connector	12 50
16K EPROM board kit w/o PROMS	74 50
North Star Floppy Disk Kit	$665.00
Additional Drive Kit	415 00
SPECIAL PRODUCTS	
MM5865 Stopwatch Timer	9.00
PC board	7.50
Switches Mom. Pushbutton	.27
3 pos. slide	25
Encoder HD0165-5	6.95
3 Digit Universal Counter Board Kit Operates 5-18 Volt DC to 5 MHz typ. 125 LED display	10.50
Voice actuated switch	.50
Paratronics 100A Logic Analyzer Kit	$224.00
Model 10 Trigger Expander Kit	$229.00
Model 150 Bus Grabber Kit	$369.00
Sinclair 3½ Digit Multimeter	$59.95
Clock Calendar Kit	$23.95
TRANSFORMERS	
6V 300 ma	3.25
12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3 50
24V CT 400 ma	3.95
10V 1 2 amp wall plug	4.85
12V 6 amp	12 95

DISPLAY LEDS

MAN1	CA	.270	2.90
MAN3	CC	125	39
MAN72/74	CA/CA	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1 95
FND359	CC	357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
3 digit Bubble			60
4 digit bubble			.80
DG8 Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			60
7520 Clairex photocells			39
TIL311 Hex			9.50

COMPUTER GRADE CAPS

1600	mfd	200V	4.50
2000	mfd	45V	2.50
3200		50V	2.50
5500		25V	2 50
5800		40V	3 00
6100		40V	3 00
6100		50V	3.00
7700		50V	2 50
8000		55V	2.50
9400		65V	3.00
10000		20V	2.50
12000		30V	3.50
35000		25V	5.00
55000		25V	5.00
82000		15V	6.00
60000		10V	8.00

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Tiny Basic, ASCII Keyboards, video character generation, etc.**

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest address and data bus displays before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on nine LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select and single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 90 page instruction manual.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested. **Questdata**, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM $38.00. Super Elf owners, 30% off. **Object code listing with manual $5.00. Object list, manual and paper tape $10.00. Original ELF Kit Board $14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A **1K Super ROM Monitor $19.95** is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up.

Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board and Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector** set with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board**.

The **Power Supply Kit** for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $5.00. Case $10.00. Add $1.50 for shipping.

Auto Clock Kit $15.95

DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

RCA Cosmac VIP Kit $229.00

Video computer with games and graphics. Fully assem. and test. $249.00

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays. Red only. $21.95 Case $11.75**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

Digital Temperature Meter Kit

Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Very accurate. **$39.95**
Beautiful woodgrain case w/bezel **$11.75**

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K Assembler $85.00. 8K Basic Interpreter $100.00. Power supply assembled in case $60.00.

Multi-voltage Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $34.95. Woodgrain case $10.00.

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

2.5 MHz Frequency Counter Kit

Complete kit less case $37.50

30 MHz Frequency Counter Kit

Complete kit less case $47.75
Prescaler kit to 350 MHz $19.95

79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. Foreign $5.00. 1978 IC Master closeout $19.50.

Stopwatch Kit $26.95

Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

Hickok 3½ Digit LCD Multimeter

Batt/AC oper. 0.1mv–1000v. 5 ranges. 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. $74.95.

S-100 Computer Boards

8K Static RAM Kit	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	$89.00
Video Interface Kit	$139.00
Motherboard $39. Extender Board	$8.99

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax. BankAmericard and Master Charge accepted. Shipping charges will be added on charge cards.

FREE: Send for your copy of our NEW 1979 QUEST CATALOG. Include 28¢ stamp.

CIRCLE NO. 50 ON FREE INFORMATION CARD

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.20	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.20	ww	.40
	18-pin	pcb	.25	ww	.95
	20-pin	pcb	.35	ww	.95
	22-pin	pcb	.35	ww	.95
	24-pin	pcb	.35	ww	.95
	28-pin	pcb	.45	ww	1.25
	40-pin	pcb	.50	ww	1.25
	Molex pins	.01	To-3 Sockets		.25
	2 Amp Bridge		100-prv		.95
	25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.			
	2N2222	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic Unmarked)	.10
	2N3904	NPN (Plastic Unmarked)	.10
	2N3054	NPN	.45
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.15
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.35		9601	.20
	9316	1.10		9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

QTY.			QTY.		
	8T13	1.50		2107B-4	4.95
	8T23	1.50		2114	9.50
	8T24	2.00		2513	6.25
	8T97	1.00		2708	10.50
	74S188	3.00		2716 D.S.	34.00
	1488	1.25		2716 (5v)	59.00
	1489	1.25		2758 (5v)	23.95
	1702A	4.50		3242	10.50
	AM 9050	4.00		4116	11.50
				6800	13.95
	MM 5314	3.00		6850	7.95
	MM 5316	3.50		8080	7.50
	MM 5387	3.50		8212	2.75
	MM 5369	2.95		8214	4.95
	TR 1602B	3.95		8216	3.50
	UPD 414	4.95		8224	3.25
	Z 80 A	22.50		8228	6.00
	Z 80	17.50		8251	7.50
	Z 80 PIO	10.50		8253	18.50
	2102	1.45		8255	8.50
	2102L	1.75		TMS 4044	9.95

C MOS

QTY.		
	4000	.15
	4001	.15
	4002	.20
	4004	3.95
	4006	.95
	4007	.20
	4008	.75
	4009	.35
	4010	.35
	4011	.20
	4012	.20
	4013	.40
	4014	.75
	4015	.75
	4016	.35
	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
	4026	1.95
	4027	.35
	4028	.75
	4029	1.15
	4030	.30
	4033	1.50
	4034	2.45
	4035	.75
	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
	4046	1.25
	4048	.95
	4049	.45
	4050	.45
	4052	.75
	4053	.75
	4066	.55
	4069/74C04	.35
	4071	.25
	4081	.30
	4082	.30
	4507	.95
	4511	.95
	4512	1.10
	4515	2.95
	4519	.85
	4522	1.10
	4526	.95
	4528	1.10
	4529	.95
	MC 14409	14.50
	MC 14419	4.85
	74C151	1.50

LINEARS, REGULATORS, etc.

QTY.			QTY.			QTY.		
	MCT2	.95		LM323K	5.95		LM380 (8-14 Pin)	1
	8038	3.95		LM324	1.25		LM709 (8-14 Pin)	
	LM201	.75		LM339	.75		LM711	
	LM301	.45		7805 (340T5)	.95		LM723	
	LM308	.65		LM340T12	.95		LM725	2
	LM309H	.65		LM340T15	.95		LM739	1
	LM309K (340K-5)	1.50		LM340T18	.95		LM741 (8-14)	
	LM310	.85		LM340T24	.95		LM747	1
	LM311D	.75		LM340K12	1.25		LM1307	1
	LM318	1.75		LM340K15	1.25		LM1458	
	LM320H6	.79		LM340K18	1.25		LM3900	
	LM320H15	.79		LM340K24	1.25		LM75451	
	LM320H24	.79		LM373	2.95		NE555	
	7905 (LM320K5)	1.65		LM377	3.95		NE556	
	LM320K12	1.65		78L05	.75		NE565	
	LM320K24	1.65		78L12	.75		NE566	1
	LM320T5	1.65		78L15	.75		NE567	
	LM320T12	1.65		78M05	.75			
	LM320T15	1.65						

– TTL –

QTY.			QTY.			QTY.			QTY.		
	7400	.10		7482	.75		74221	1.00		74LS02	
	7401	.15		7483	.75		74367	.95		74LS04	
	7402	.15		7485	.55		75108A	.35		74LS05	
	7403	.15		7486	.25		75491	.50		74LS08	
	7404	.10		7489	1.05		75492	.50		74LS09	
	7405	.25		7490	.45		74H00	.15		74LS10	
	7406	.25		7491	.70		74H01	.20		74LS11	
	7407	.55		7492	.45		74H04	.20		74LS20	
	7408	.15		7493	.35		74H05	.20		74LS21	
	7409	.15		7494	.75		74H08	.35		74LS22	
	7410	.15		7495	.60		74H10	.35		74LS32	
	7411	.25		7496	.80		74H11	.25		74LS37	
	7412	.25		74100	1.15		74H15	.45		74LS38	
	7413	.25		74107	.25		74H20	.25		74LS40	
	7414	.75		74121	.35		74H21	.25		74LS42	
	7416	.25		74122	.55		74H22	.40		74LS51	
	7417	.40		74123	.35		74H30	.20		74LS74	
	7420	.15		74125	.45		74H40	.25		74LS76	
	7426	.25		74126	.35		74H50	.25		74LS86	
	7427	.25		74132	.75		74H51	.25		74LS90	
	7430	.15		74141	.90		74H52	.15		74LS93	
	7432	.20		74150	.85		74H53	.25		74LS107	
	7437	.20		74151	.65		74H55	.20		74LS123	1
	7438	.20		74153	.75		74H72	.35		74LS151	
	7440	.20		74154	.95		74H74	.35		74LS153	
	7441	1.15		74156	.70		74H101	.75		74LS157	
	7442	.45		74157	.65		74H103	.55		74LS160	
	7443	.45		74161	.55		74H106	.95		74LS164	1
	7444	.45		74163	.85		74L00	.25		74LS193	1
	7445	.65		74164	.60		74L02	.20		74LS195	
	7446	.70		74165	1.10		74L03	.25		74LS244	1
	7447	.70		74166	1.25		74L04	.30		74LS367	
	7448	.50		74175	.80		74L10	.20		74LS368	
	7450	.25		74176	.85		74L20	.35		74S00	
	7451	.25		74180	.55		74L30	.45		74S02	
	7453	.20		74181	2.25		74L47	1.95		74S03	
	7454	.25		74182	.75		74L51	.45		74S04	
	7460	.40		74190	1.25		74L55	.65		74S05	
	7470	.45		74191	1.25		74L72	.45		74S08	
	7472	.40		74192	.75		74L73	.40		74S10	
	7473	.25		74193	.85		74L74	.45		74S11	
	7474	.30		74194	.95		74L75	.85		74S20	
	7475	.35		74195	.95		74L93	.55		74S40	
	7476	.40		74196	.95		74L123	.85		74S50	
	7480	.55		74197	.95		74LS00	.30		74S51	
	7481	.75		74198	1.45		74LS01	.30		74S64	
										74S74	
										74S112	
										74S114	
										74S133	
										74S140	
										74S151	
										74S153	
										74S157	
										74S158	
										74S194	1.
										74S257 (8123)	1.
										8131	2.

INTEGRATED CIRCUITS UNLIMITED

7889 Clairemont Mesa Blvd., San Diego, California 92111
24 Hour Toll Free Phone 1-800-854-2211
(714) 278-4394 California Residents 1-800-542-6239
CABLE ADDRESS ICUSD

CUSTOMER NAME ______________________

STREET ADDRESS ______________________

CITY ______________ STATE ______________ ZIP ______________

PHONE ______________ CHARGE CARD # AE Visa BA MC ______________ EXP. DATE ______

C.O.D. _____ WILL CALL _____ UPS _____ POST _____ NET 10th OF THE MONTH _____ PO # ______________

ALL ORDERS SHIPPED PREPAID – NO MINIMUM – COD ORDERS ACCEPTED – ALL ORDERS SHIPPED SAME DAY
OPEN ACCOUNTS INVITED – California Residents add 6% Sales Tax. PRICES SUBJECT TO CHANGE WITHOUT NOTICE.
We accept American Express / Visa / BankAmericard / Master Charge

SPECIAL DISCOUN

Total Order	Ded
$35-$99	10
$100-$300	15
$301-$1000	20

CIRCLE NO. 32 ON FREE INFORMATION CARD

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Electronic Design Corp., Victrola amplifier model 80-12C. Need source for information. W. Wyatt Miller, 305 W. Diamond Ave., Gaithersburg, MD 20760.

Hallicrafters Sky Buddy receiver and **RCA** R-65/APN-9 receiver indicator. Schematics. Ted K. Wright, 3929 Woodlane, Ft. Worth, TX 76117.

Knight Kit model C22 CB transceiver. Schematic and operating instructions. William Pence, 800 Old Stage Rd., Cave Junction, OR 97523.

National Union Oscillograph Co., type B3-5 oscilloscope. Instruction manual. Bruce W. Miller, Box 21963, Seattle, WA 98111.

Devry Technical Institute combination oscilloscope VTVM from 1959 home study courses. Assembly manual and schematic. D. Moore, Box 83, Main St., Aylesford, N.S. Canada, BOP 1C0.

Sansui model 1000A tuner amplifier. Operating manual and schematic. Paul Shelton, 9004 E. 29th Pl., Tulsa, OK 74129.

RCA CB 2608A, serial #02. Schematic and tube list. F. C. Bergquist, 105 Ellis St., Leesville, LA 71446.

Stromburg Carlson radio model 642A. Schematic and owners manual. James Olin, 720 E. Harbor Dr. S, St. Petersburg, FL 33705.

Precision model 120-volt-ohm meter. Schematic. Alex R. Minelli, 718 Michigan St., Hibbing, MN 55746.

Heathkit model HWA-202-2 tone burst encoder module for HWA-202 two-meter transceiver. Manual or kit. Gary Resta, 20C Tindal Lane, Niagara Falls, NY 14304.

Bradford model WTG-59816 tape recorder. Schematic and any other information. Earl Stephenson, 1956 Minnesota Ave., Columbus, OH 43211.

Lafayette HA 350 receiver. Schematic and instruction manual. Bud Benson, 976 E. Lawson St., St. Paul, MN 55106.

Lafayette KT-320 receiver. Schematic and operating manual. L. T. Switzer, 654 Georgia, Marysville, MI 48040.

Singer model HE8121 television. Schematic, diagrams and operating manual. Charles Peklenk, 12939 Tosca, Houston, TX 77024.

Sonic guitar amplifier. Schematic. Roger Gran, 225 S. 7th St., La Crosse, WI 54601.

Jackson Electric Instrument Co., model TVG-1 TV signal and sweep generator. Schematic and operating instructions. Don Schultheis, 3746 Garfield Ave., Pennsauken, NJ 08105.

Atwater Kent model 60C radio receiver. Schematic, service manual. David G. Ford, 906 Iola, Victoria, TX 77901.

Sprague Teleohmike capacitor analyzer model TO-4 and **Heathkit** model AV-3 audio VTVM. Service manuals, calibration data and schematics. E. J. Prado, Box 75591, Los Angeles, CA 90005.

Lafayette model 99-50775 power supply. Schematic needed. David Edlund, 2923 N. Stevens, Tacoma, WA 98405.

RCA model WR-39C TV calibrator. Operation manual. Bob Brandel, Rose Hulman Institute of Technology, Box 927, 5500 Wabash, Terre Haute, IN 47803.

Fairchild channel F system II video game. Schematic. S. T. Stickle, 651 E. Travis Blvd #14, Fairfield, CA 94533.

Radio City Products model 664 VTVM. Schematic and manual needed. H. T. Finch, 6158 Winton, Dallas, TX 75214.

Hammarlund HQ-110A. Operating manual needed. Paul Migliore, N2AKO, 710 Cookman Ave., Asbury Park, NJ 07712.

RCA model MI-11940 tape drive unit. Need service manual or any other information. James J. Julian, 850 Broad St., Teaneck, NJ 07666.

Howard Communications model 460 receiver and **Hallicrafter** model S53A receiver. Manuals and schematics needed. S. Selowentchich, 135 Colfax Ave., Clifton, NJ 07013.

Central Electronics, model 20-A multiphase exciter. Schematic and manual. A. McGinnis, WA2DTQ, 55 Patton St., Iselin, NJ 08830.

Hammarlund model HQ200 receiver. Operation manual, schematic and parts list. William A. Unrath, 134 Grove St., Ramsey, NJ 07446.

Hewlett Packard model 400A vacuum tube voltmeter. Need manual and schematic. J. O. Dickinson, 1408 Monmouth Ct. W., Richmond, VA 23233.

Dumont type 208-B oscilloscope. Schematic and operations manual. C. E. McLellan, Box 575, Clarkson, NY 14430.

AN/USM-32 single trace oscilloscope. Schematics, parts list and service manual. Wayne Murningham, 2700 Eaton Rapids Rd., Lot 228, Lansing, MI 48910.

Precision Apparatus Co, Inc. oscillograph series ES-500. Need schematic and parts list. Sgt. M. E. Rudd, P.S.C., Box 944, MacDill A.F.B., FL 33608.

American Trading Corp., model 8P vhf/uhf monitor receiver. Schematic and manual. A. L. Oliveira, 94 Potomska St., New Bedford, MA 02740.

Concertone series 90 reel recorder. Operation and shop manual. **Dumont** model 304-HR oscilloscope. Need operation manual. Kent Waterman, 3833 20th St., San Francisco, CA 94114.

Philco model 39-85 radio. Schematic and parts list. Tim Floyd, 3113 N. Norfolk St., Indianapolis, IN 46224.

Mallory model 12V multivibrator. Need several for GE radios. Chuck O'Connor, Box 264, Santa Clara, CA 95052.

E.C.I. Courier 50 FM transceiver. Schematic, parts list and operating manual. W. Person, 135 Roe St., Staten Island, NY 10310.

Zenith model G500 6-band transoceanic receiver chassis 5G40. Need schematic and any other information. D. J. Kluth, 503 E. Skillman Ave., St. Paul, MN 55117.

Dumont oscillograph type 304H. Need instructions, service manual and graticule. Richard W. Schramke, RD 5, Box 164, Tyrone, PA 16686.

Code-A-Phone model 700 telephone answering machine. Schematic and service manual. W. C. Hoar, 1273 N.W. 9th St., Homestead, FL 33030.

Solo Symphonic model 1113 record player. Schematic and parts list. Robert A. Yetman, Rt. 1, Box 200R, Doniphan, MO 63935.

Scott model 222C stereo amplifier. Schematic and repair manual. E. C. Ozag, 823 N. Marion, Oak Park, IL 60302.

U. S. Navy model R-4A/ARR-2 aircraft communications receiver. Jason Spitzer, 437 Carrillo St., Santa Rosa, CA 95401.

Concord model F-140 stereo cassette recorder. Parts list and schematic. Roy P. Swauger, 104 Valley Drive, Bridgeport, WV 26330.

Dumont model 304H oscilloscope and model 264A voltage calibrator. Need operations manual, schematic or any other information. John R. Stephenson, 6057 Pernecia St., Jacksonville, FL 32210.

Hallicrafters model S38 receiver. Need operating instructions and manual. C. E. McLellan, Box 575, Clarkson, NY 14430.

Heathkit model V-7A VTVM. Schematics and operating instructions. **Knight** model KG-680 capacitor checker. Scott Silva, Box 2394, Orcutt, CA 93454.

Supro model S6698 guitar amplifier. Schematic and parts list. W. D. Chupp, 806 "F" Lane, Elkhart, IN 46514.

Concertone model 302-D stereo 4 track tape deck. Need schematic, parts list and repair manual. Bill Szarek, 6515 Spring Rose, San Antonio, TX 78249.

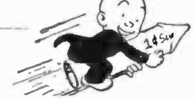
IT'S NEW! IT'S EXCITING! POLY PAKS GIANT

"ONE PENNY GETS YOU TWO"*

1¢ SALE

*Buy any item on this page and choose 2nd item for only one penny!

* of the same cat. no.



A PENNY MORE GETS YOU TWO

☐ 8-SKINNY TRIM POTS, PRECISION, asst. styles, values 50% yield (#3389)	1.29	12 for 1.30
☐ 60pc-PRECUT, PRETINNED WIRE, various lengths and colors (#1971)	1.29	120 for 1.30
☐ 60-MINI RESISTORS, for PC appl., vert, 1/8W, color coded (#2235)	1.29	120 for 1.30
☐ 8-TRANSISTOR RADIO EARPHONES, 8 ohms imped (#2946)	1.29	16 for 1.30
☐ 10-5K POTS, audio taper, plastic snap-in mounting (#5124)	1.29	20 for 1.30
☐ 10-1&2 MEG DUAL POTS, audio taper, "snap-in" mnt (#5125)	1.29	20 for 1.30
☐ 50-1 AMP ZENERS, wide asst. of values, untested (#1964)	1.29	100 for 1.30
☐ 12-SCR'S & TRIACS, 10 AMP, asst. values, untested (#2087)	1.29	24 for 1.30
☐ 3-QUADRACS, 10 AMP, 100% prime, 50-100-200 V, TO-220 (#5048)	1.29	6 for 1.30
☐ 20-MINI RECTIFIERS, 1½ AMPS, 25V, epoxy, axial (#5374)	1.29	40 for 1.30
☐ 10 1N4007 1000V MINI RECTIFIER, epoxy case, axial leads (#2383)	1.29	20 for 1.30
☐ 75-MOLEX CONNECTOR Type M1938-4, makes 14 to 40 pin sockets (#1609)	1.29	150 for 1.30
☐ 50 IF TRANSFORMERS, asst sizes (#35A9)	1.29	100 for 1.30
☐ 10-T.V. CHEATER CORD JACKS, (#5519)	1.29	20 for 1.30
☐ 10-1 AMP 200V MINI RECTIFIER, IN4003, epoxy, axial (#2379)	1.29	20 for 1.30
☐ 4-1.5V SILVER OXIDE WATCH BATTERIES, (#5063)	1.29	8 for 1.30
☐ 3-LCD WATCH READOUTS, 3½" digits, 7 seg, dim 1½ x 1" (#5066)	1.29	6 for 1.30
☐ 20-IC DICE CHIP, complete circuitry, asst. sizes (#5065)	1.29	40 for 1.30
☐ 2-100KHz MARKER CRYSTALS, specify 104.067, 104.092, or 114.00 KHz (#3896)	1.29	4 for 1.30
☐ 12-1.5V LAMP AND SOCKET SET, 200ma, T2 style (#3956)	1.29	24 for 1.30
☐ 10-RCA PHONO JACKS, chassis mount, teflon base (#5119)	1.29	20 for 1.30
☐ 10-COAXIAL PIN HEAD LEDS, RED (#5617)	1.29	20 for 1.30
☐ 4-5 DIGIT 7—SEGMENT READOUTS, in flat pak case (#5616)	1.29	8 for 1.30
☐ 4-¼" BLOCK TRIM POTS, 5K (#2536)	1.29	8 for 1.30
☐ 1 "FOTO-FET" N CHANNEL, Crystalonics, J-Sealed Effect Transistors. (#1169)	1.29	2 for 1.30
☐ 1-VOLTAGE REGULATOR, TO202 case, 12V 600MA (#1900)	1.29	2 for 1.30
☐ 1-3 DIGITS ON A DIP, LED, red, DL-33 (#1887)	1.29	2 for 1.30
☐ 3-MM5262 2K DYNAMIC RAM, specify type (#3459)	1.29	6 for 1.30
☐ 10-2N711 HIGH SPEED SWITCHING TRANSISTORS, TO18, npn (#3374)	1.29	20 for 1.30
☐ 2-15W HI POWER TRANSISTORS, 220V, npn, TO66 (#2797)	1.29	4 for 1.30
☐ 3-24 PIN IC SOCKETS (#2168)	1.29	6 for 1.30
☐ 1-MM5312 DIGITAL CLOCK CHIP, 100% (#1525)	1.29	2 for 1.30
☐ 2-MM5725 4 FUNCTION CALCULATOR CHIP, 100% (#2036)	1.29	4 for 1.30
☐ 1-MM5202 ERASABLE PROM, 100% (#3459)	1.29	2 for 1.30
☐ 3-10 AMP 25V BRIDGE RECT, comb style (#2447)	1.29	6 for 1.30
☐ 10-2N3565 RF TRANSISTORS, TO106, 2N5133 (#3372)	1.29	20 for 1.30
☐ 6-LINEAR SWITCHING TRANSISTORS, 2N2905, pnp, TO5 (#3375)	1.29	12 for 1.30
☐ 50-2 AMP CYLINDRICAL RECT, up to 1K, u-test (#4006)	1.29	100 for 1.30
☐ 6-OPEN-FACE READOUTS, LED, red, some segs missing mostly duals (#3952)	1.29	12 for 1.30
☐ 10-2N2222 (or equiv.), TO-18 metal case (#1992)	1.29	20 for 1.30
☐ 10-DATA ENTRY SWITCHES, SPST, 1 amp, norm open 125V (#5321)	1.29	20 for 1.30
☐ 8-TRANSISTOR RADIO EARPHONES, 8 ohms imped (#2946)	1.29	16 for 1.30
☐ 15 FLUORESCENT OVERFLOW READOUT TUBES, w/leads (#3288)	1.29	30 for 1.30
☐ 10-2N3704 TO92 TRANSISTORS (#3490)	1.29	20 for 1.30
☐ 1-2N5001 80V TRANSISTORS STUD (#2800)	1.28	2 for 1.30
☐ 3 MICROPROCESSOR/SUPPORT CHIPS, asst. MM5780-90 series, 24-28 pin (#5639A)	1.29	6 for 1.30
☐ 6 CLOCK/CALCULATOR CHIPS, asst. MM5378, 75, 5737 etc. (#5638A)	1.29	12 for 1.30
☐ 25 DTL FAIRCHILD IC's, gates and flip flops, Dip, 100% (#3709)	1.29	50 for 1.30
☐ 1-24 VOLT 50 MIL. TRANSFORMER, 115 V input, open frame, 1" x 1" x 3/4" (#5631)	1.29	2 for 1.30
☐ 10-2N3704 TRANSISTORS, silicon, TO-92 case, hfe-300, 100% (#5625)	1.29	20 for 1.30
☐ 10-2N3705 TRANSISTORS, silicon, TO-92 case, hfe-150, 100% (#5626)	1.29	20 for 1.30
☐ 10 D33021 TRANSISTORS, low power, silicon, hfe-60, TO-92 (#5627)	1.29	20 for 1.30
☐ 1 ALLEN BRADLEY POT, 10K, 2-1 4 watts, type-J, 2" x ¼" shaft (#1748)	1.29	2 for 1.30
☐ 50 ASST. RED LEDS, 20% or better, various styles and types (#5624)	1.29	100 for 1.30
☐ 10 G.E. POWER TAB TRANSISTORS, D40N1, N2, some N5, TO-220 (#5629)	1.29	20 for 1.30
☐ 2-¼" BLOCK TRIM POTS, 200K (#2535)	1.29	4 for 1.30
☐ 1-12VDC 5MIL REED RELAY, spst, N.O, 2200 ohms, 7/8" x 5/16" x 5/16" (#5515)	1.29	2 for 1.30
☐ 50 TEMP. COEFFICIENT VOLTAGE REF. DIODES, asst. volt, +50% (#5647)	1.29	100 for 1.30
☐ 8 OLM-380 IC's, 2 watts, dip, 50%+ yield, U-test (#1975)	1.29	20 for 1.30
☐ 50 RED BLOCK DISC CAPS, assorted values, 50% material (#1698)	1.29	100 for 1.30
☐ 50 SHOCKLEY DIODES, most popular switching diode, hobby & untested (#1072A)	1.29	100 for 1.30
☐ 6 OPTO-COUPLER, 1500V isolation, hobby material, U-test (#2629A)	1.29	12 for 1.30
☐ 4 CHERRY MICRO SWITCH, 125 VAC, 15A, N.C. type E-13, screw terminals (#5525)	1.29	8 for 1.30
☐ 5 SPST PUSHBUTTON MOMENTARIES, rt. angle, pc mt, on-on' (#5635)	1.29	10 for 1.30
☐ 25 TTL's, with 7400's, U-test, dips (#2415A)	1.29	50 for 1.30

☐ 30 RADIO AND TV KNOBS, asst styles, sizes (#B217)	1.29	60 for 1.30
☐ 60 TUBULAR CAPACITORS, asst volts and sizes (#B219)	1.29	120 for 1.30
☐ 55 LOW NOISE RESISTORS ¼, ½W, HiFi, etc (#220)	1.29	110 for 1.30
☐ 50 POWER RESISTORS, 3,5,7 w, axial, pop sizes (#B228)	1.29	100 for 1.30
☐ $25 SURPRISE, all kinds of parts in a pak (#B294)	1.29	2 for 1.30
☐ 12 PANEL SWITCHES, rotary, slide, toggle, etc (#B295)	1.29	24 for 1.30
☐ 60 COILS AND CHOKES, rf, parasitic, if, etc (#B297)	1.29	120 for 1.30
☐ 60 TERMINAL STRIPS, up to 4 solder lugs (#B334)	1.29	120 for 1.30
☐ 60 PRECISION RESISTORS, ½W, 1%, axial (#B363)	1.29	120 for 1.30
☐ 50 MICA CAPACITORS, asst values (#B373)	1.29	100 for 1.30
☐ 10 SETS RCA PLUGS AND JACKS, phono (#B402)	1.29	20 for 1.30
☐ 60 DISC CAPACITORS, asst values long leads (#B437)	1.29	120 for 1.30
☐ 20 TRANSISTOR ELECTRO'S, asst up and ax (#B453)	1.29	40 for 1.30
☐ 75 HALF WATTERS, resistors, color coded, asst (#B454)	1.29	150 for 1.30
☐ 35 SILVER MICAS, red backs, axial, asst. (#B455)	1.29	70 for 1.30
☐ 6-50 AMP RECT, asst volts up to 25, stud (#L717)	1.29	12 for 1.30
☐ 100 GERMANIUM DIODES, axial leads, u test (#L642)	1.29	200 for 1.30
☐ 100 STABISTORS, Regulator, sensing and computer. Axial, excellent yield (#3140)	1.29	200 for 1.30
☐ 100 PRINTED CIRCUIT ½ WATT RESISTORS, asst (#U1060)	1.29	200 for 1.30
☐ 12 TRANSISTOR SOCKETS, asst npn and pnp types (#U651)	1.29	24 for 1.30
☐ 50-3 AMP SILICON RECTIFIERS, axial, asst V (#U865)	1.29	100 for 1.30
☐ 50 POLYSTYRENE CAPS, plastic coated, prec. (#U1052)	1.29	100 for 1.30
☐ 10 NE-2 bulbs, for 110vac projects, hobby, etc (#U1222)	1.29	20 for 1.30
☐ 10 PROXIMITY REED SWITCHES. (#U1258)	1.29	20 for 1.30
☐ 6 2N915 UHF TO-18 TRANSISTORS (#U1423)	1.29	12 for 1.30
☐ 30 MOLEX CONNECTORS, nylon, asst. sizes (#5642)	1.29	60 for 1.30
☐ 50-MINI BLOCK CAPACITORS, Erie, red square discs. Asst. values. (#1698)	1.29	100 for 1.30
☐ 6-CALCULATOR AC ADAPTOR JACK, standard threads 3 terminals. (#2316)	1.29	12 for 1.30
☐ 50 ONE AMP ZENER DIODES, asst, axial, u test (#U1964)	1.29	100 for 1.30
☐ 5-PA-263 THREE WATT PC BOARDS, for amps (#U2013)	1.29	10 for 1.30
☐ 5 MINI MOTORS, 1½ Vdc, for many hobby proj (#U2551)	1.29	10 for 1.30
☐ 50 IN4000 RECTIFIERS, asst to 800V, u test (#U2594)	1.29	100 for 1.30
☐ 15 PRINTED CIRCUIT BOARDS, asst sizes, hobby (#U2010)	1.29	30 for 1.30
☐ 2 MERCURY SWITCHES, silent touch, SPST (#U2823)	1.29	4 for 1.30
☐ 6 ITS A SNAP, 9 VDC BAT-clip, red n black lead (#U2852)	1.29	12 for 1.30
☐ 8 1400 VOLT "RED BALL" RECTIFIERS, axial 1 AMP (#U2590)	1.29	16 for 1.30
☐ 20 1N4148 SWITCHING DIODES, 4 nsec. axial (#U3000)	1.29	40 for 1.30
☐ 3-10 AMP QUADRACS, w/trigger diode up 600V (#U3620)	1.29	6 for 1.30
☐ 5 MICRO SWITCHES, push, asst types (#U3011)	1.29	10 for 1.30
☐ 40 SQUARE DISC STYLE CHOKES, color coded (#U3203)	1.29	80 for 1.30
☐ 30 TRANSISTORS TO92 2N4400 series, u test (#U3291)	1.29	60 for 1.30
☐ 6-TRANSISTORS TRANSFORMERS, audio, inter, etc mini (#U3295)	1.29	12 for 1.30
☐ 15 PRINTED CKT TRIMMER POTS, asst values, etc (#U3346)	1.29	30 for 1.30
☐ 20 ft CABLE, 1 cond shielded, 1-24, for phono (#U3653)	1.29	40 ft 1.30
☐ 10-PNP 30 WATT TO-3 TRANSISTORS, hobby (#U3772)	1.29	20 for 1.30
☐ 50 TUBE SOCKETS, 4,5,6,7 pin tubes, asst (#U3839)	1.29	100 for 1.30
☐ 1-10 AMP POWER TAB QUADRAC, 200 PRV, TO220, 2/trigger (#1590)	1.29	2 for 1.30
☐ 10-BULLET RECTIFIERS, 1.5 amp, 200V, axial (#84)	1.29	20 for 1.30
☐ 6-READOUTS, MAN 3, common cath, LED, the claw, RED (#3338)	1.29	12 for 1.30
☐ 8-LEDS, asst. sizes and shapes, red, green, yellow, amber (#3869)	1.29	16 for 1.30
☐ PHOTO FLASH ELECTRO. CAP, 600 MF 360 V (#3897)	1.29	2 for 1.30
☐ 2-CIRCUIT BREAKERS, glass sealed, axial, rated 1 amp (#3905)	1.29	4 for 1.30
☐ MICRO MINI TOGGLE, SPST, 2 pos, on-off, 125V 3 amps (#3936)	1.29	2 for 1.30
☐ 5-CB CRYSTALS, orig. used w/synthesizer, asst. freq, HC-18/U holder (#5051)	1.29	10 for 1.30
☐ 4-PUSH BUTTON, SPST, PANEL, N.C. 125V 1 A (#5289)	1.29	8 for 1.30
☐ 10-INSTRUMENT KNOBS, asst. styles and colors, ¼" shaft (#5121)	1.29	20 for 1.30
☐ 4-TAPE HEADS, Hifi types (#5182)	1.29	8 for 1.30
☐ 5-TANTALUM ELECTROS, TEARDROP style, 2.2uf 25V (#5205)	1.29	10 for 1.30
☐ 2-INLINE FUSE HOLDERS, complete w/5 amp fuse (#5213)	1.29	4 for 1.30
☐ 30-4" CABLE TIES, non-slip white plastic (#5217)	1.29	60 for 1.30
☐ 30pc-HEAT SHRINK, asst. sizes, 50% shrinkage (#5248)	1.29	60 for 1.30
☐ 20-TOROIDS, some with coils (#5431)	1.29	40 for 1.30
☐ 10-15V ZENERS, 400mw, axial, glass case (#5404)	1.29	20 for 1.30
☐ 2-ALUMINUM HEAT SINKS, for TO-220 (#5338)	1.29	4 for 1.30
☐ 2-5.1V, 5%, 10W, STUD ZENER, DO-4 case (#5287)	1.29	4 for 1.30

1,000,000 TTL IC "A PENNY MORE GETS YOU TWO" SALE

It's our special penny IC JAMBOREE for our valued customers everywhere!

Order by Cat. No. 92CU1981 & Type No.

Type	SALE	2 FOR
☐ SN7401	$.18	$.19
☐ SN7402	.18	.19
☐ SN7403	.18	.19
☐ SN7405	.21	.22
☐ SN7406	.29	.30
☐ SN7407	.29	.30
☐ SN7409	.21	.22
☐ SN7410	.18	.19
☐ SN7411	.25	.26
☐ SN7413	.40	.41
☐ SN7416	.25	.26
☐ SN7420	.19	.20
☐ SN7423	.29	.30
☐ SN7426	.29	.30
☐ SN7427	.29	.30
☐ SN7437	.25	.26
☐ SN7438	.25	.26
☐ SN7440	.19	.20
☐ SN7443	.69	.70

Type	SALE	2 FOR
☐ SN7444	.59	.60
☐ SN7450	.20	.21
☐ SN7451	.20	.21
☐ SN7453	.20	.21
☐ SN7454	.21	.22
☐ SN7455	.19	.20
☐ SN7460	.21	.22
☐ SN7464	.19	.20
☐ SN7465	.19	.20
☐ SN7470	.30	.31
☐ SN7491	.59	.60
☐ SN7494	.69	.70
☐ SN7495	.69	.70
☐ SN7496	.65	.66
☐ SN7498	.19	.20
☐ SN74107	.33	.34
☐ SN74109	.49	.50
☐ SN74114	.25	.26
☐ SN74121	.35	.36
☐ SN74123	.59	.60

Type	SALE	2 for
☐ SN7472	.30	.31
☐ SN7474	.35	.36
☐ SN7480	.50	.51
☐ SN7482	.69	.70
☐ SN7483	.69	.70
☐ SN7485	.89	.90
☐ SN7488	.79	.80
☐ SN74180	.69	.70
☐ SN74182	.79	.80
☐ SN74192	.85	.86
☐ SN74193	.89	.90
☐ SN74194	.89	.90
☐ SN74195	.69	.70
☐ SN74197	.89	.90
☐ SN74199	1.49	1.50
☐ SN74200	4.95	4.96
☐ SN74284	3.95	3.96
☐ SN74285	3.95	3.96
☐ SN74298	1.49	1.50

"OOOOPS" POP OPS STARRING A PENNY MORE GETS YOU TWO

Order by Type No.

Type	SALE	2 FOR
☐ LM300N	.49	.50
☐ LM300H	.49	.50
☐ LM301V	.25	.26
☐ LM301H	.25	.26
☐ LM308V	.29	.30
☐ LM308H	.59	.60
☐ LM318V	.99	1.00
☐ LM320-6V	.99	1.00
☐ LM322N	.79	.80
☐ LM322H	.59	.60
☐ LM340K-18V	.99	1.00
☐ LM340K-24V	.99	1.00
☐ LM340T-6V	.99	1.00
☐ LM340T-12V	.99	1.00
☐ LM340T-18V	.99	1.00
☐ LM350N	.79	.80
☐ LM377N	1.49	1.50
☐ LM380N	.89	.90
☐ NE531H	1.49	1.50
☐ NE532H	.25	.26
☐ NE556N	1.25	1.26
☐ NE558H	.29	.30
☐ NE561N	1.99	2.00
☐ NE565N	.89	.90

Type	SALE	2 FOR
☐ NE565H	.79	.80
☐ LM703H	.39	.40
☐ LM704H	.19	.20
☐ LM709H	.19	.20
☐ LM710N	.29	.30
☐ LM711N	.39	.40
☐ LM733N	.59	.60
☐ LM741H	.19	.20
☐ LM741N	.39	.40
☐ LM1304N	.99	1.00
☐ LM1310N	.99	1.00
☐ MC1312N	2.49	2.50
☐ LM1414V	.49	.50
☐ LM1800N	.79	.80
☐ LM3028H	.69	.70
☐ LM4250H	1.99	2.00
☐ 75451	.29	.30
☐ 75453	.29	.30
☐ 75491	.49	.50
☐ 75492	.49	.50
☐ 75494	.69	.70
☐ PA263	.77	.78
☐ DM8864	.99	1.00

25 AMP BRIDGE RECTIFIERS

Order No. 2273 & voltage

PIV	2 FOR	SALE
☐ 25	1.26	1.25
☐ 50	1.96	1.95
☐ 100	2.26	2.25
☐ 200	2.96	2.95
☐ 400	3.51	3.50
☐ 600	4.26	4.25
☐ 800	4.96	4.95

LASER DIODES

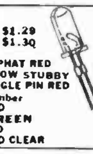
5 to 9 watts,

$8.88

2 for $8.89

No. 3508

LEDS!



YOUR CHOICE 6 for $1.29
1¢ SALE 12 for $1.30

Order by Cat. No.

☐ # 1788	MICRO TOPHAT RED
☐ # 1942	MED YELLOW STUBBY
☐ # 1802	MICRO SINGLE PIN RED
☐ # 2793	JUMBO Amber
☐ # 2135	JUMBO RED
☐ # 2138	JUMBO GREEN
☐ # 2137	MICRO RED
☐ # 2790	JUMBO RED CLEAR

RIBBON CABLE AT THIN PRICES

Cond		Sale	2 for	
☐ 10	10 ft	$1.98	20 ft	$1.99
☐ 14*	8 ft	1.98	16 ft	1.99
☐ 20	5 ft	1.98	10 ft	1.99
☐ 25	4 ft	1.98	8 ft	1.99
☐ 26	4 ft	1.98	8 ft	1.99
☐ 34	3 ft	1.98	6 ft	1.99
☐ 36	3 ft	1.98	6 ft	1.99
☐ 40	2 ft	1.98	4 ft	1.99
☐ 50	2 ft	1.98	4 ft	1.99
☐ 60	1 ft	1.98	2 ft	1.99

- *Ultra flat!*
- *28 AWG*

Order by Cat. No. 3939 and conductors.

*color coded.

10 AMP - POWER TABS!

1730 - SCR'S
1448 - TRIACS
1590 - QUADRACS

PRV	Sale	2 for
50	$ .69	$ .70
100	.88	.89
200	1.19	1.20
400V	1.39	1.40

1-10 WATT STEREO

AMPLIFIERS!

PA, hi-fi, mobile, 12V (#5324)
8.88 2 for 8.89

HOW TO ORDER

When ordering, always use catalog number, type no., the name of the magazine you are ordering from and the month

FREE! FREE! Buy $20.00 Worth Choose Any Two $1.29 Items Free

1N4000 Epoxy Rectifiers

Cat. No.	Type	Volts	Sale		1¢ SALE!	
2377	1N4001	50	10 for	$ .75	20 for	$ .76
2378	1N4002	100	10 for	.85	20 for	.86
2379	1N4003	200	10 for	.95	20 for	.96
2380	1N4004	400	10 for	1.19	20 for	1.20
2381	1N4005	600	10 for	1.39	20 for	1.40
2382	1N4006	800	10 for	1.49	20 for	1.50
2383	1N4007	1000	10 for	1.59	20 for	1.60

LED WATCH GUTS

$1.95 2 for $1.96

Factory "lay-arounds." Do they work? Who knows! A micro digital technicians bonanza. The complete guts are there. With black case and leatherette band. 5 functions: HOURS, MINUTES, SECONDS, MONTH, & DATE. Sorry, no specs.
Cat. No. 5267 Wt 4 oz.

POLY PAKS®

COD's MAY BE PHONED!

P.O. BOX 942-E4
SO. LYNNFIELD, MA
01940

Terms: Add Postage Rated: Net 30
Phone: (617) 245-3828
Retail: 16-18 Del Carmine St. Wakefield, MA
MINIMUM ORDER: $8

CIRCLE NO. 49 ON FREE INFORMATION CARD

CIRCLE NO. 14 ON FREE INFORMATION CARD

CIRCLE NO. 3 ON FREE INFORMATION CARD

Electronics Classified

REGULAR CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services, $2.50 per word. Minimum order $37.50. **EXPAND-AD® CLASSIFIED RATE:** $3.75 per word. Minimum order $56.25. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance. **PERSONAL RATE:** For individuals with a personal item to buy or sell, $1.50 per word. No minimum! **DISPLAY CLASSIFIED:** 1" by 1 column (2-1/4" wide), $300. 2" by 1 column, $600.00. 3" by 1 column, $900.00. Advertiser to supply film positives. For frequency rates, please inquire. **GENERAL INFORMATION:** Ad copy must be typewritten or clearly printed. Payment must accompany copy except when ads are to be billed on credit cards — American Express, Diners Club, Master Charge, VISA (supply expiration date) — or when ads are placed by accredited advertising agencies. First word in all ads set in caps. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Advertisements will not be published which advertise or promote the use of devices for the surreptitious interception of communications. Ads are not acknowledged. They will appear in first issue to go to press after closing date. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Classified Advertising, **POPULAR ELECTRONICS,** One Park Avenue, New York, N.Y. 10016. For inquiries, contact Linda Lemberg at (212) 725-3924.

FOR SALE

FREE! Bargain Catalog—I.C.'s, LED's, readouts, fiber optics, calculators parts & kits, semiconductors, parts. Poly Paks, Box 942PE, Lynnfield, Mass. 01940.

GOVERNMENT and industrial surplus receivers, transmitters, snooperscopes, electronic parts. Picture Catalog 25 cents. Meshna, Nahant, Mass. 01908.

LOWEST Prices Electronic Parts. Confidential Catalog Free. KNAPP, 4750 96th St N., St. Petersburg, FL 33708.

ELECTRONIC PARTS, semiconductors, kits. FREE FLYER. Large catalog $1.00 deposit. BIGELOW ELECTRONICS, Bluffton, Ohio 45817.

RADIO—T.V. Tubes—36 cents each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction plans — Complete, including drawings, schematics, parts list with prices and sources . . . Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch Tone Dial — Quadraphonic Adapter — Transistorized Ignition — Burglar Alarm — Sound Meter . . . over 60 items. Send 50 cents coin (no stamps) for complete catalog. Technical Writers Group, Box 5994, University Station, Raleigh, N.C. 27650.

SOUND SYNTHESIZER KITS—Surf $14.95, Wind $14.95, Wind Chimes $19.95, Musical Accessories, many more. Catalog free. PAIA Electronics, Box J14359, Oklahoma City, OK 73114.

HEAR POLICE / FIRE Dispatchers! Catalog shows exclusive directories of "confidential" channels, scanners. Send postage stamp. Communications, Box 56-PE, Commack, N.Y. 11725.

UNSCRAMBLERS: Fits any scanner or monitor, easily adjusts to all scrambled frequencies. Only 4" square $29.95, fully guaranteed. Dealer inquiries welcomed. PDQ Electronics, Box 841, North Little Rock, Arkansas 72115.

TELETYPE EQUIPMENT for sale for beginners and experienced computer enthusiast. Teletype machines, parts, supplies. Catalogue $1.00 to: ATLANTIC SALES, 3730 Nautilus Ave., Brooklyn, NY 11224. Tel: (212) 372-0349.

WHOLESALE C.B., Scanners, Antennas, Catalog 25 cents. Crystals: Special cut, $4.95. Monitor $3.95. Send make, model, frequency. G. Enterprises, Box 461P, Clearfield, UT 84015.

BUILD AND SAVE TELEPHONES, TELEVISION, DETECTIVE, BROADCAST Electronics. We sell construction plans with an Engineering Service. Speakerphones, Answering Machines, Carphones, Phonevision, Dialers, Color TV Converters, VTR, Games, $25 TV Camera, Electron Microscope, Special Effects Generator, Time Base Corrector, Chroma Key. Engineering Courses in Telephone, Integrated Circuits, Detective Electronics. PLUS MUCH MORE. NEW Super Hobby Catalog PLUS year's subscription to Electronic News Letter, $1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

NAME BRAND Test Equipment. Up to 50% discount. Free catalog. Salen Electronics, Box 82, Skokie, Illinois 60076.

SURPLUS COMPONENTS, Communication and test equipment. Illustrated catalog 25 cents. E. French, P.O. Box 249, Aurora, Illinois 60505.

WEATHER MAP RECORDERS: Copy Satellite Photographs, National-Local Weather Maps. Learn How! $1.00. Atlantic Sales, 3730 Nautilus Ave., Brooklyn, N.Y. 11224. Tel: (212) 372-0349.

NAME BRAND TEST EQUIPMENT at discount prices. 72 page catalogue free. Write: Dept. PE, North American Electronics, 1468 West 25th Street, Cleveland, OH 44113.

UNSCRAMBLERS FOR any scanner. Several models available. Free literature. Capri Electronics, 8753T Windom, St. Louis, MO 63114.

UNSCRAMBLER KIT. Tunes all scramble frequencies, may be built-in most scanners, 2-3/4 x 2-1/4 X 1/2. $19.95. Factory built Code-Breaker, $29.95. Free Catalog: KRYSTAL KITS, Box 445, Bentonville, Ark. 72712. (501) 273-5340.

FREE

THE GREAT ELECTRONIC THINGS & IDEAS BOOK!

HUNDREDS OF UNUSUAL PARTS, GADGETS & IDEA ITEMS, UNAVAILABLE IN STORES OR CATALOGS ANYWHERE! Bargain prices on everything! New items in every issue! Rush postcard for your copy!

ETCO ELECTRONICS Dept. 035, North Country Shopping Ctr., Plattsburgh, N.Y. 12901.

B&K Test Equipment. Free catalog. Free Shipping. Dinosaur discounts. Spacetron-AS, 948 Prospect, Elmhurst, IL 60126.

SURPLUS ELECTRONICS

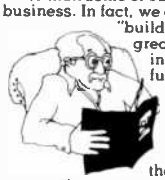
ATTENTION HOBBYISTS — SEND FOR YOUR FREE CATALOG

Great buys in tape drives, keyboards, power supplies, and transformers. We also have heat sinks, steel cabinets, I/O terminals, video displays, printers, and equipment cases. And of course components, fans, wire, and cable. Write now to

Worldwide Electronics 130 Northeastern Blvd. Nashua, N.H. 03060

BUILD THE ARTISAN ELECTRONIC ORGAN . . . The 20th century successor to the classic pipe organ. Kits feature modular construction, with logic controlled stops and RAM Pre-Set Memory System. Be an ar-ti-san. Write for our free brochure. AOK Manufacturing, Inc., Box 445, Kenmore, WA 98028.

WRITE US AND WE'LL SEND YOU THE BEST CATALOG YOU EVER READ!



No kidding. Speakerlab's catalog took longer to write than some of our competitors have been in business. In fact, we created an industry by "building great kits so you can afford great speakers." Our catalog is an invaluable manual of speaker function and design. And, it will introduce you to the finest speaker kits made anywhere...with the strongest money-back guarantee. Find out for yourself...FREE. FREE, that is. Write now. Right now.

Speakerlab® Dept. C-PE, 735 N. Northlake Way Seattle, WA 98103

THE BEST CB ANTENNA

SEND FOR FREE PAL FULL LINE CATALOG AND DECAL

PAL Antenna Corp.

2614 EAST ADAMS · PHOENIX, ARIZONA 85034

POLICE/FIRE SCANNERS, crystals, antennas, CBs, Radar Detectors. HPR, Box 19224, Denver, CO 80219.

CB RADIOS, VHF-UHF Scanners, Crystal, Antennas, Radar Detectors. Wholesale. Southland, Box 3591, Baytown, TX 77520.

BARGAINS GALORE! Buy-sell-trade classifieds in "Electronics Trader" only 10¢ word! Send $2.00 for next four issues. Electronics Trader, Darwin, CA 93522.

TRANSISTORS FOR C-B Repair, IC's and diodes TV audio repairs 2SC756A — $2.40, 2SC1306 — $2.95, 2SC1307 — $3.85, PLLOZAG — $7.50, AN239 — $5.50, STK439 — $8.95. Many more. FREE Catalog and transistor. B&D Enterprises, Box 32, Mt. Jewett, PA 16740.

CIRCUIT BOARD from production-ready artwork. Free details. QUANTITY discounts. CM CIRCUITS, 22 Maple Ave., Lackawanna, NY 14218.

UNSCRAMBLE CODED MESSAGES from Police, Fire and Medical Channels. Same day service. Satisfaction guaranteed. Don Nobles Electronics, Inc., Rt. 7, Box 265B, Hot Springs, Arkansas 71901. (501) 623-6027.

MONTHLY PICTURE FLYER. Quality Surplus Electronic parts. Low Prices. Star-Tronics, Box 683, McMinnville, OR 97128.

PRINTED CIRCUIT supplies, chemicals, tools, artwork, plating solutions. Major credit cards. Catalog $1.00, refundable. CIRCOLEX, Box 198, Marcy, NY 13403.

RECONDITIONED TEST EQUIPMENT $1.00 for catalog. WALTER'S TEST EQUIPMENT, 2697 Nickel, San Pablo, CA 94806. (415) 758-1050.

ELECTRONIC PARTS, Tubes, Semiconductors, Phonograph Needles. FREE CATALOG. Rey Enterprises, Box 1539, Hialeah, FL 33011.

CHEMICALS, Lab Supplies. Lowest prices, fastest service anywhere. Listing 25¢. Westech Corp., Box 593, Logan, Utah 84321.

LOW, LOW Component Prices! Ask for free flyer. Write: EEP, 11 Revere Place, Tappan, NY 10983.

NEGATIVE ION GENERATORS AND ACCESSORIES. (Kits). Fascinating details—$1.00. Golden Enterprises, Box 1282-PE, Glendale, Arizona 85311.

Super Powerful Wireless Mic

10 times more powerful than other mics. Transmits up to ½ mile to any FM radio. Easy to assemble kit. 15V battery (not incl.) Call (305) 725-1000 or send $18.95 + $1.00 shipping to USI Corp., P.O. Box PE-2052, Melbourne, FL 32901. COD's accept. For catalog of transmitters, voice scramblers and other specialty items, enclose $2.00 to USI Corp.

$18.95 Qty Disc Avail

RENT, LEASE, SELL TVS! Guaranteed complete system $15.00. Perrys' Rental Systems, Box 1407, Santa Maria, CA 93456.

CANADIAN — SURPLUS ELECTRONIC PARTS. Free flyers & samples. Special: Tantalum 47uf 20VDC, 10 for $1.00. G. Paquette, 2264 Gagnon Rd., Blainville, Que., Canada. U.S. Inquiries.

ELECTRONIC components/hardware grabbag, $20 value for $3. G.F. Mumenthaler Ind., P.O. Box 853, Bonita, CA 92002.

VIDEO TAPE L-500 Beta, $14.00 each, 20 for $240.00. Good buys on other types. 408-224-0606.

ADJUSTABLE FREQUENCY OSCILLATOR CIRCUIT drives 180mH to 16v. Assembled-tested. $5.50 guaranteed. K3 Electronics, Box 100, Athens, NY 12015.

OPTO ELECTRONIC DEVICES, laser diodes, LED's, fiber optics for experimenter and electronic enthusiast. For free information, write: Eastern Electronics, P.O. Box 2204, Clifton, NJ 07015.

VIDEO CASSETTES — Large Selection — Pre-recorded, all ratings, for VHS & BETA. Also blank cassettes, L-500 @ $14.00, L-750 @ $19.00, VK-250 @ $19.00, in lots of 10 or more. We accept MC and VISA. Send for free catalog. Parker Electronics, 123P Dutchess Turnpike, Poughkeepsie, NY 12603.

BUYERS SPECIALS — Bearcat 250 $279.00, Bearcat 111 High Band with all crystals $115.00, 12 Volt 4 Amp Regulated Power Supply $14.50, Cobra Modulated Mic. $8.95. Many more closeouts and specials. Send $2.00 for complete list. R & L ELECTRONICS, 2923 20th St., Rockford, Ill. 61109.

SATELLITE TV
GET 50 CHANNELS!
It's all true! No matter where you live receive movies, sports, pay television, sports from around the world! 24-hour programming! Crystal clear reception! For complete information, sources and design information, send $7.95.
SPACECOAST RESEARCH
Dept. D, P.O. Box 442, Altamonte Springs, FL 32701

PRINTED CIRCUIT BOARDS, your artwork. 45¢ sq. in. single sided, 60¢ sq. in. double sided. Mail your order now, or send for free details. Digitronics, P.O. Box 2494, Toledo, OH 43606.

SCANNERS, VIDEO RECORDERS, C.B.'s. All brands discounted. Bearcat 250, $279.95. S.A.S.E. (large) speeds prices. McDonald Electronics, Box 1385(W), Rohnert Park, CA 94928. (707) 544-4388.

ELECTRONIC SURVEILLANCE (Bugs/Taps) COUNTERMEASURES. Technical articles. List $1.00. Ross, 18114 Kitchenhouse, Germantown, MD 20767.

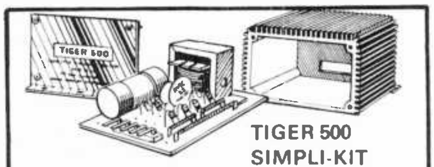
VIDEO TAPE VHS VK250, 10 for $169.50. Beta L-500's, 10 for $119.50. We ship anywhere. Video Hotline, (408) 224-0606. MC/VISA.

COSMAC ELF II OWNERS: display any register or memory location on TV. Fantastic debugging aid. Manual $6.00. Cassette & manual $16.00. K. Meyer, 20412 Mauer, St. Clair Shores, MI 48080.

PLANS AND KITS

AMAZING ELECTRONIC PRODUCTS
LASERS SUPER POWERED, RIFLE, PISTOL, POCKET · SEE IN DARK · PYRO TECHNICAL · DE-BUGGING · UNCRAMBLERS · GIANT TESLA · STUNWAND · TV DISRUPTER · ENERGY PRODUCING, SCIENTIFIC DETECTION, ELECTRIFYING, CHEMICAL, ULTRASONIC, CB, AERO, AUTO AND MECH DEVICES, HUNDREDS MORE · ALL NEW PLUS INFO UNLTD PARTS SERVICE
INFORMATION unlimited
CATALOG $1 Dept. E8, Box 716, Amherst, NH 03031

FREE KIT Catalog contains Test and Experimenter's Equipment. Dage Scientific Instruments, Box 1054P, Livermore, CA 94550.



TIGER 500 SIMPLI-KIT
FOR THE DO-IT-YOURSELFER
NOW! a high quality CD ELECTRONIC IGNITION SYSTEM in kit form.
Contains all components and solder to build complete Solid-State Electronic CD Ignition System for your car. Assembly requires less than 3 hours.
- Increases MPG 15%
- Increases horsepower 15%
- Plugs and Points last 50,000 miles
- Eliminates 4 or 5 tune-ups
- Instant starting, any weather
- Dual system switch

Fits only 12 volt neg. ground...
Only $26.95 postpaid
Tri-Star Corporation
P.O. Box 1727 Grand Junction, Colorado 81501

TV-OSCILLOSCOPE CONVERTER externally adapts TV into audio frequency oscilloscope. Info. $1.00, Plans $7.50, with P.C. $15.00, TV-1 VHF modulator $12.00, kit $60.00. Evolutionics, Box 855-F, San Rafael, CA 94902.

CB/HAM ACCESSORIES, kits, parts, construction plans — catalog. Omnipolarized antenna, 300 MHz counter, Modulation booster. Plans $3.00 each, $7.50 all. PANAXIS, Box 130-A4, Paradise, CA 95969.

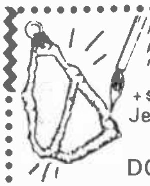
BUILD YOUR OWN SYMPHONY OF SOUND!
It's fun and easy—takes just minutes a day! Complete kits for organs, pianos, strings, rhythms, amplifiers, synthesizers. Also factory assembled. 104-page catalog $2.00
WERSI
Wersi Electronics, Inc.
Dept. ZD, 1720 Hempstead Road
Lancaster, PA 17601

FREQUENCY COUNTERS 50 MHZ $59.95, 500 MHZ $79.95. Flashing LED's $1.00. Digital clocks $12.95. Lectronix, Box 42, Madison Heights, Michigan 48071.

PRINTED CIRCUIT Boards from sketch or artwork. Kit projects. Free details. DANOCINTHS Inc., Box 261, Westland, MI 48185.

PROTECT electrical devices from unauthorized use. New patented circuit is cheap, easy to build, uses no power. Plans/instructions direct from inventor. $3.50. SEQSWITCH-PE, Box 1084, San Mateo, CA 94403.

TAPE — SLIDE Synchronizer, multiprojector, lap-dissolve plans, $5.50. Audiovisual group, $8.50. Millers, 1896 Maywood, S.Euclid, OH 44121.



$15.00
+ $1.00 postage and handling
Jewelers — Hobbyists
For Fun or $$$
DO IT YOURSELF

Instructions included. Must be electroplated.
NOW!!! You can build and plate 14Kt, 18Kt heavy abstract edges on any stone and create jewelry, plate baby shoes, baseballs, leaves, flowers, acorns, etc. Information and instruction sheets only $1.00.
GOLD EDGE
7117 3rd Ave./Box P/Dept. GM
Scottsdale, AZ 85251/(602) 994-5752

WELDING-BURNING LASER—$9.00. Five Laser Plans—$8.00. Laser Light Show—$19.00. "Wild Ideas" Catalog—$2.00. Solaser, "PE79", Box 1015, Claremont, CA 91711.

DOLBY ADD-ON ENCODES/DECODES RECORDINGS, FM. Quality components, complete kit. Calibration tapes. Comprehensive test report. PE-A INTEGREX, Box 747, Havertown, PA. 19083.

ELECTRONIC KITS under $5, includes wireless mics., electronic sirens, alarms, etc. Brochure. Electrokit, 5 Redwood, Milford, Mass. 01757.

GIANT TV PROJECTION. Shows like $1000's projector. Lens kit $14.95. Plans $1.00. Projeco, 829 Flatbush, Brooklyn, NY 11226.

GIANT SCREEN TV. Same components as $2000-$4000 sets. Plans, 3 element lens, and washable screen $329. Plans only $5 (deductible from order). Video Projection, P.O. Box 158, Lake Zurich, IL 60047.

TOP QUALITY IMPORTED KITS, IC's, foreign transistors. Free catalog. International Electronics, Box 567, Williamsville, NY 14221.

TELEPHONES & PARTS

TELEPHONES UNLIMITED, Equipment Supplies. All types, Regular, Keyed, Modular, Catalog 50 cents. Box 1147E, San Diego, California 92112.

OMAK PHONE CENTER. All types of telephones — keyed, modular and decorator. Catalog $1.00 (refundable). Box 38, Beardstown, IL 62618. (217) 323-3963.

ALARMS

QUALITY BURGLAR-FIRE ALARM EQUIPMENT at discount prices. Free Catalog! Steffens, Box 624K, Cranford, N.J. 07016.

Burglar · Fire · Smoke Alarm Catalog
- Billions of dollars lost annually due to lack of protective warning alarms.

FREE CATALOG Shows you how to protect your home, business and person. Wholesale prices. Do-it-yourself. Free engineering service.

Burdex Security Co.
Box 82802 PE-049 Lincoln, Ne. 68501

PROFESSIONAL ALARM SYSTEMS and supplies at wholesale prices. FREE CATALOG. CAPCO, Box 5980-CPE4, Incline Village, Nevada 89450.

VEHICLE STOLEN — CAN BE LOCATED. "Information" Protect automobile, boat, trailer, airplane, home, office. Fowler Alarms, Box 64466-PE1, Los Angeles, CA 90064.

MUSICAL INSTRUMENTS

UP TO 60% DISCOUNT. Name brand instruments catalog. Freeport Music, 114 G. Mahan St., W. Babylon, N.Y. 11704.

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218. For Fast Service call Toll Free 800-221-0906.

CUSTOM CASSETTE RECORDERS. 4 track, half-speed. Cassettes last four times as long! Also Time Compression: listen double speed without pitch change. Free catalog. SFB PRODUCTS, Box, E-385, Wayne, PA 19087.

WANTED

GOLD, Silver, Platinum, Mercury, Tantalum wanted. Highest prices paid by refinery. Ores assayed. Free circular. Mercury Terminal, Norwood, MA 02062.

WANTED! CB DEALERS AND DISTRIBUTORS
PAL Antenna Corp.
2614 EAST ADAMS · PHOENIX, ARIZONA 85034

MARANTZ RC4 Remote Control for 4-channel receiver. Postage paid. 64 Parklands Rd, Chichester, Sussex, U.K.

TUBES

RADIO & T.V. Tubes—36 cents each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

TUBES: "Oldies", Latest. Supplies, components, schematics. Catalog Free (stamp appreciated). Steinmetz, 7519-PE Maplewood, Hammond, Ind. 46324.

TUBES-RECEIVING, Industrial and Semiconductors Factory Boxed. Free price sheet including TV, Radio and audio parts list. Transleteronic, Inc., 1365 39th St., Brooklyn, New York 11218. Telephone: (212) 633-2800. Toll free: 800-221-5802.

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

GOVERNMENT SURPLUS

MANUALS for Govt Surplus radios, test sets, scopes. List 50 cents (coin). Books, 7218 Roanne Drive, Washington, D.C. 20021.

JEEPS—$59.30! — CARS—$33.50! — 200,000 ITEMS! — GOVERNMENT SURPLUS — Most COMPREHENSIVE DIRECTORY AVAILABLE tells how, where to buy — YOUR AREA — $2.00 — MONEYBACK GUARANTEE — Government Information Services, Department GE-60, Box 99249, San Francisco, California 94109 (433 California).

GOVERNMENT SURPLUS. Buy in your Area. How, where. Send $2.00. Surplus, 30177-PE Headquarters Building, Washington, D.C. 20014.

"GOVERNMENT SURPLUS DIRECTORY." Buy 250,000 items (including Jeeps) . . . low as 2¢ on dollar! Most complete information available — $2.00. Surplus Disposal, Box 19107-HD, Washington, DC 20036.

INSTRUCTION

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, Ph.D's. Free revealing details. Counseling, Box 317-PE04, Tustin, California 92680.

LEARN WHILE ASLEEP! HYPNOTIZE! Astonishing details, strange catalog free! Autosuggestion, Box 24-ZD, Olympia, Washington 98507.

INTENSIVE 5 week course for Broadcast Engineers. FCC First Class license. Student rooms at the school. Radio Engineering Inc., 61 N. Pineapple Ave., Sarasota, FL 33577.

1979 "TESTS - ANSWERS" for FCC First Class License. Plus - "Self Study Ability Test." Proven! $9.95 Unconditional Moneyback Guarantee. Command Productions, Box 26348-P, San Francisco, CA 94126.

MATHEMATICS. ELECTRONICS. Advanced mathematics. Engineering mathematics. Digital Technology. Free catalog. IHSI, Box 1189, Panama City, FL 32401.

PASS FCC EXAMINATIONS — 1st - 2nd - 3rd -Radar. Proven method by Victor Veley, noted author-teacher. Part I, Workbook consisting of hundreds of problems with complete solutions. Part II, Question and Answer Manual has hundreds of practice questions. Complete course — Both Manuals, $14.95 postpaid. Oeffinger Publishing, Box 1240, Garden Grove, Calif. 92642.

RADIO BROADCASTING: Become DJ, engineer. Start your own station — investment/experience unnecessary! Receive free equipment, records. Free details. Broadcasting, Box 130-A4, Paradise, CA 95969.

ASSEMBLING HEATHKIT VTVM? Plentiful detail photos, audiocassette instruction increase your success, satisfaction. Only $9.75, postpaid. Specify IM5218 or IM5228. The Instruction Company, P.O. Box 2646, Stanford, CA 94305.

MICROCOMPUTERS

RADIO SHACK Authorized Sales Center Special 10% savings on catalog prices including TRS-80. Free delivery on orders over $75.00. 1117 Conway, Mission, TX 78572.

MICROCOMPUTER OWNERS. Thousand programs loaned free. Try before buy. SASE for listing. TREND IV, Box 7433, Hollywood, FL 33021.

FOR INVENTORS

PATENT AND DEVELOP Your invention. Registered Patent Agent and Licensed Professional Engineer. Send for FREE PATENT INFORMATION every inventor should have. Richard L. Miller, P.E., 3612 Woolworth Building, New York, NY 10007. (212) 267-5252.

HAVE YOU AN INVENTION? We evaluate, develop, improve and market meritorious inventions and ideas. For free brochure write, call: Inventors Guild, P.O. Box 411, Fort Washington, PA 19034. (215) 233-5252.

BUSINESS OPPORTUNITIES

I MADE $40,000.00 Year by Mailorder! Helped others make money! Torrey, Box 318-NN, Ypsilanti, Michigan 48197.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

NEW LUXURY Car Without Cost. Free Details! Codex-ZZ, Box 6073, Toledo, Ohio 43614.

MECHANICALLY INCLINED individuals desiring ownership of Small Electronics Manufacturing Business — without investment. Write: BUSINESSES, 92-K2 Brighton 11th, Brooklyn, New York 11235.

MILLIONS in Mail!!! Free Secrets. Transworld-17, Box 6226, Toledo, OH 43614.

GET RICH!!! Secret law erases debts. Free report exposes millionaire'$$ secrets. blueprints, No. EE4, 453 W. 256, NYC 10471.

MECHANICALLY INCLINED INDIVIDUALS
—WANTED—

Assemble electronic devices in your home. Get started in spare time. Experience, Knowledge or Investment Not Necessary. Expect big profits: $300 - $600/Wk. Possible. Write for free literature telling how.

ELECTRONIC DEVELOPMENT LAB
BOX 1560PE, Pinellas Park, FL 33565

BORROW $25,000 "OVERNIGHT." Any purpose. Keep indefinitely! Free Report! Success Research, Box 29263 GC, Indianapolis, Indiana 46229.

$1200.00 MONTHLY Correcting Pupils' Lessons!!! Start Immediately. Free Report. Send self-addressed stamped envelope. Home, Box 98201-SJXM, San Diego, CA 92109.

BEAT THE RACES! Free Booklet! "Unlimited Lifetime Income From Thoroughbreds - Harness". Elias, Box 47BB, Brooklyn, NY 11219.

WHAT'S BEHIND OVER 1,000 opportunity offers. Free details. Allied American, 5217C Sydney, Port Orange, FL 32019.

HOW TO MAKE $100 weekly/kitchen table! Free brochure. Brooks, Box 68-ZD, Quenemo, KS 66528.

BE YOUR OWN BOSS. Your own metalizing business FREE. We supply all equipment and know how. Free details. Write: Mason, Room MC-376-ID, 1512 Jarvis, Chicago, IL 60626.

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence, illustrated brochure free. Hermes-Verlag, Box 110660/Z, D-1000 Berlin 11, Germany.

EMPLOYMENT OPPORTUNITIES

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240E, Northport, New York 11768.

RADIO-TV JOBS . . . Stations hiring nationwide! Free details: "Job Leads", 1680-PG Vine, Hollywood, CA 90028.

ELECTRONIC TECHNICIANS: Government job listing & Instructions, $10.00. World Air Data, Dept.-E, Box 5706, Derwood, MD 20855.

EMPLOYMENT INFORMATION CENTER: Information for all 50 states and Canada. Send $1.00 for details. J. Fraser, Dept. C, 208 S. 4th, De Soto, MO 63020.

DO-IT-YOURSELF

MODULAR TELEPHONES now available. Sets and components, compatible with Western Electric concept. Catalog 50 cents. Box 1147W, San Diego, California 92112.

AUDIO/ANALOG/SYNTHESIS. Plans, parts, kits, etc. for the most exciting sound projects ever. Get on our mailing list, send 25¢ to: CFR Associates Inc., Newton, N.H. 03858.

COMPLETE LINE Security Systems for home, Business. Send self addressed, stamped envelope. Darbar, Box 1147E, San Diego, CA 92112.

UNBELIEVABLE: 850 page Tool and Supply Catalog for Tradesmen, Craftsmen, Hobby or Recreational Endeavors, 60,000 items. $5.00 refundable. McKilligan, PE479, Johnson City, NY 13790.

REAL ESTATE

BIG . . . FREE . . . SUMMER CATALOG! Over 2,600 top values coast to coast!! UNITED FARM AGENCY, 612-EP, West 47th, Kansas City, MO 64112.

RUBBER STAMPS

RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog. Jackson's, E-100, Brownsville Rd., Mt. Vernon, Ill. 62864.

BOOKS AND MAGAZINES

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. MEGIDDO Mission, Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

POPULAR ELECTRONICS INDEXES For 1977 now available. Prepared in cooperation with the Editors of "P/E," this index contains hundreds of references to product tests, construction projects, circuit tips and theory and is an essential companion to your magazine collection. 1977 Edition, $1.50 per copy. All editions from 1972 onward still available at the same price. Add $.25 per order for postage and handling. $.50 per copy, foreign orders. INDEX, 6195 Deer Path, Manassas, Va. 22110.

FANTASTIC! TV facts booklet as seen on NBC T.V. $1.00, guaranteed. DVS, Box 912E, Smithtown, NY 11787.

HOBBIES

333 WORLD STAMPS 10¢

Genuine AMERICANA postage stamps collection from Seychelles, Grenadine, Malagasy-many more.
PLUS hundreds of others of interest.
$12.00 CATALOG VALUE
Other fine stamps enclosed for your inspection. FRASEK Co., Inc. Dept. PE-49 White Plains N.Y. 10601

MOTION PICTURE FILMS

WELCOME SPRING WITH MUSIC! Frolic & fun with "Thoroughly Modern Millie" (Julie Andrews) 17:44 S-8 Color/Snd, $49.95 (save $6.). Shirley MacLaine stars in "Sweet Charity", wistful memorable musical, 17:00, $48.95. Jesus Christ Superstar 17:18 S-8 color/snd, spectacular, innovative, shot in Israel, $46.95. Big name westerns: Rory Calhoun "Flaming Guns"; Glen Ford "Cowboy"; John Wayne "The Cowboy & the Girl"; James Stewart "Frontier Fun" — S-8 B/W Silent 200' action films, ltd quant., $9.95 ea PPD. "The Big Surf" spec. 200' S8 Eastman color — ride the waves with Hawaii's best; only $16.95 ea PPD. News Headlines in the '70's, last chance for collectors. '71 News Parade (Nixon, Kissinger, Open Door to China); '73 News (Watergate & energy crisis); '74 News (Nixon resigns, Ford pres., Cyprus Battle, Peron dies); '75 Spectacular, 38th anniv. news — $8.95 ea + 35¢ ship. Ltd Quan. Added features — Movies Great Headlines — Hindenburg, Pearl Harbor, Tacoma Bridge collapse. Famous fights, S8 B/W Snd 200' action reels (1) Marciano-Louis & Moore-Jackson + 2 bouts. (2) Ali-Williams & Johnson-Ketchel (1909); Zale-Graziano + Ross-Armstrong; $18.95 ea PPD (save $3. film). Universal 64-pg catalog $1.20 (foreign $2.). Columbia, Sportlite, Universal, Ring Classics order forms 35¢ ea with flyers. SPORTLITE FILMS, Elect-4/79, Box 24-500, Speedway, IN 46224.

HYPNOTISM

FREE Hypnotism. Self-Hypnosis. Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

MISCELLANEOUS

MPG INCREASED! Bypass Pollution Devices easily. REVERSIBLY!! Free details — Posco GEE4, 453 W. 256, NYC 10471.

COLOR TRANSPARENCIES without photography or artistry. Easy 2step process! Enables PC board etching direct from magazine layouts, in minutes . . . Kit $3.95. "Holographics", P.O. Box 323, Yellowsprings, OH 45387.

CB RADIO OPERATORS — Send your name, handle and license number. We will inscribe this information attesting to your status as a CB operator on a handsome scroll, suitable for framing. Send information printed or typed together with check or money order for $4.95 to: Larry Bergman, P.O. Box 281, Cedarhurst, NY 11516.

STOP WASTING MONEY, start saving, lowest prices guaranteed: LCD Chrono Alarm Watch $55, TI-30 Calculator $14, Wahl 150-Tip $12. MOST EVERYTHING . . . Details $1. S.A.S.E. to Creatik, Box 926, Tulsa, OK 74101.

1979 STEREO DIRECTORY & BUYING GUIDE

All the latest information on stereo and quadraphonic systems and components for your home. A complete guide to more than 2500 products in all —with complete specifications, descriptions and prices. PLUS bonus feature articles. A must for anyone concerned with good sound.

Order from STEREO DIRECTORY, Dept. 01053, P.O. Box 278, Pratt Station, Brooklyn, New York 11205. Enclose $3.00* ($2.50 plus 50¢ for postage and handling).
*Residents of CA, CO, DC, FL, IL, MI, MO, NY STATE, and VT add applicable sales tax.

Popular Electronics

ADVERTISERS INDEX

READER SERVICE NO. — ADVERTISER — PAGE NO.

For faster service USE ZIP CODE on all mail

How to listen to Moscow, Russia... Moscow, Idaho and your good buddy, Max Moscow.*

RF-2900

Introducing all-band readout in Command Series™ RF-2900 and RF-4900.


RF-4900

Tune in. Sit back. And travel the world with Panasonic's short wave radios—the Command Series. Set your itinerary by simply setting the dial. Get the news from Britain on the BBC. Be in Peking when they announce the new pecking order. Or visit old friends in the old country. Any old country. Even the good ol' U.S.A.

A fluorescent all-band readout in the RF-2900 (shown above) and the deluxe RF-4900 makes it easy to find thousands of overseas and domestic short wave transmissions as well as AM, FM and CB. The Panasonic fluorescent digital display is accurate to within 1 kHz. That's accuracy!

And if you want to hear more, both models give you more. Like SSB (single sideband) amateur radio. All 40 CB channels. Even Morse communications. And, of course, there's AM and FM.

And like our deluxe short wave receiver, the RF-2900 has an RF-Gain Control to enhance weak, distant stations or to prevent overload distortion from overstrong stations.

The Command Series from Panasonic. You can travel the world without ever leaving home.

*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

Panasonic®
just slightly ahead of our time

CIRCLE NO. 56 ON FREE INFORMATION CARD

LX303

ALL THE MOST WANTED FEATURES AT A MOST WANTED PRICE...

$74.95

- BIG ½" 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

Removable cover stores test lead set furnished as part of the unit.

Available accessories include AC adapter, padded vinyl carrying case, 40KV DC probe, 10 amp DC shunt.

X10 DCV probe adapter available for protecting input up to 10KV.

HICKOK

Here is the handfull of accuracy you've been waiting for. Handsomely encased. Compact. Efficient. Only 8 ounces. Hickok's exciting, new LX 303, 3½ digit Mini-Multimeter with high quality components, one year guarantee and rugged Cycolac® case offers features previously found only in expensive units. . .at a price under $75.00! So why wait any longer? The amazing LX 303 is here, NOW! Another American made test equipment breakthrough from Hickok, The Value Innovator. Order today!

See your local Hickok distributor or order below

SPECIFICATIONS:

DC VOLTS (5 RANGES): 0.1 mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10MΩ; Max. input 1kV except 500V on 200mV range.
AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (−2dB max. at 5kHz); Max. input: 600V.
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC al ranges.
DC CURRENT (6 RANGES): .01nA to 100mA Accuracy: ±1.0% rdg ±0.5% f.s.
DIMENSIONS AND WEIGHT: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; **POWER:** 9V battery (not included) or Hickok AC adapter; **READ RATE:** 3/sec.

ANCRONA

Send Check or Money Order to P. O. Box 2208P Culver City, Calif. 90230. California residents add 6% sales tax. Add $3.00 to cover postage and handling. Master Charge and Visa welcomed. Please include your charge card number, Interbank number and expiration date.

CALIFORNIA ANCRONA
11080 Jefferson Blvd., Culver City, CA 90230
(213) 390-3595
1300 E. Edinger Ave., Santa Ana, CA 92705
(714) 547-8425
1054 E. El Camino Real, Sunnyvale, CA 94087
(408) 243-4121

PHONE ORDERS: 213-641-4064

PLEASE SEND ME

Hickok LX303 Digital Multimeters	@ 74.95 ea.
RC-3 AC Adapter, 115VAC (220VAC avail.)	@ 7.50 ea.
CC-3 Deluxe Carrying Case	@ 7.50 ea.
VP-10 X10 DCV Probe Adapter	@ 14.95 ea.
CS-1 10 ADC Current Shunt	@ 14.95 ea.
VP-40 40 KV DC Probe	@ 35.00 ea.

Name ______________________________

Address ______________________________

City ______________ State ______ Zip ______

ARIZONA ANCRONA	GEORGIA ANCRONA	OREGON ANCRONA	TEXAS ANCRONA	CANADA, B.C. ANCRONA
4518 E. Broadway	3330 Piedmont Rd. N.E.	1125 N.E. 82nd Ave.	2649 Richmond Ave.	5656 Fraser St.
Tucson, AZ 85711	Atlanta, GA 30305	Portland, OR 97220	Houston, TX 77098	Vancouver, B.C. V5W 2V4
(602) 881-2348	(404) 231-7100	(503) 254-5541	(713) 529-3489	(604) 324-0707

CIRCLE NO. 57 ON FREE INFORMATION CARD

Introducing Electroscan. A quiet CB radio!

We finally built a CB so complete, there's only one popular feature it doesn't have.

Radio Hash. You know, the irritating noise you hear every time your squelch is wide open.

Because Motorola's exclusive VariCom® noise elimination system combines RF and IF gain to selectively reduce noise on the channels. It trims away radio hash for cleaner operation, especially when the squelch is wide open and you're listening really hard.

The Electroscan's microprocessor also has the convenient programmable memory which allows you to set, in the sequence you desire, any 10 channels you enjoy listening to everyday.

The Electroscan also offers a scanner which lets you search quickly for either an available, open channel to continue your conversation...or the nearest occupied channel to locate other CB'ers.

Besides these features, Electroscan also offers the Extender® noise blanker and fully variable noise limiter. Plus variable control/dynamic gain microphone that adjusts mic gain over a 20 db range to make your voice sound better.

So stop in today at a Motorola® Dealer and take a look at the Electroscan, the first CB that virtually eliminates radio hash.

MOTOROLA
CB

To find the dealer nearest you, write: Market Relations Manager, Motorola, Inc., Automotive Products Division, 1299 East Algonquin Road, Schaumburg, Illinois 60196.

CIRCLE NO. 59 ON FREE INFORMATION CARD