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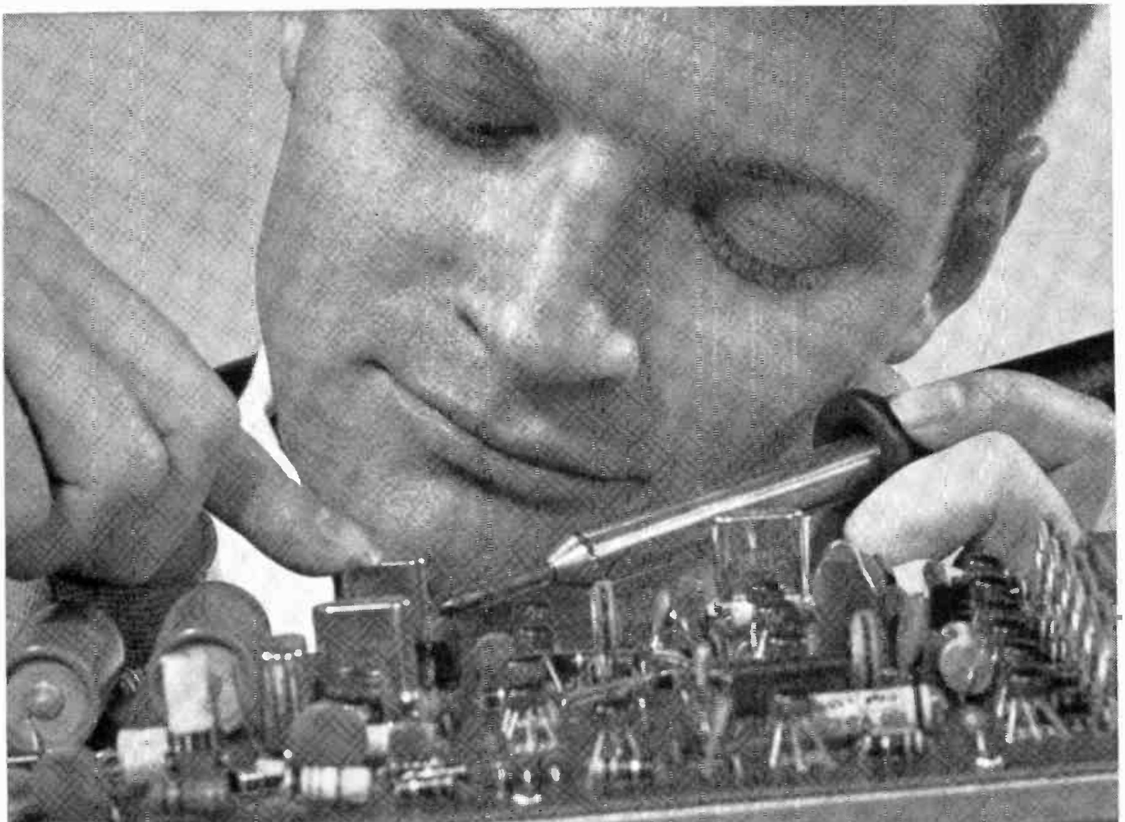

VOLUME 2 NUMBER 6 DECEMBER 1972

# Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

INCLUDING **Electronics World**

## FEATURE ARTICLES



## CONSTRUCTION STORIES




ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
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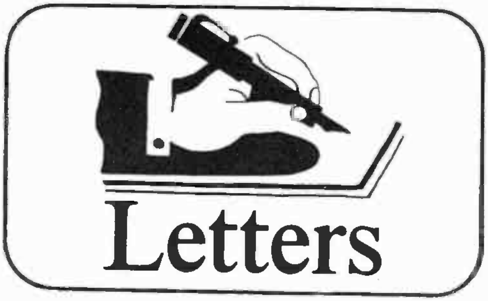


# Letters

## CIRCUIT BOARDS USING TAPE

Regarding the article "Constructing PC Boards" (September 1972), it is not necessary to go to photoresist boards and mess around with negatives. I have made up literally hundreds of experimental boards using Scotch tape directly on unsensitized boards. Adhesive tape in widths from 1/32" up is available from electronics supply houses.

Intricate designs (transistor terminals, integrated circuits) can be made using regular scotch tape and carving out the design using the point of a pen knife. This procedure may not be convenient if you are making dozens of similar boards, but what experimenter does?

Besides, unsensitized boards are a whole lot cheaper!

H. N. Campbell
Moravia, N.Y.

## ONE FOR ECOLOGY

The article "Constructing PC Boards" was very interesting and informative. However, the method suggested to dispose of the etchant is not a very good one. There are enough people pouring chemical waste into our water supplies without your openly encouraging such pollution.

B. Dakin, WA1GIR
Burlington, Vermont

*Bravo! And thanks for the admonishment. The etchant is an acid and should be treated with respect. Once it is used, however, it is partially neutralized. And you will note that we said to put it down the drain with a lot of running water (to protect not only the ecology but the drain pipes). Further neutralization and dilution would reduce the danger of contamination.*

## IDENTIFICATION IS GOOD

I have just read your article "Automatic Identification of Transmitters" ("Communications Scene," August 1972); and, for what it's worth, I'd like to give my full support to the FCC proposal.

Of course the loudest squawk will probably be heard from the CB'ers, since their total neglect of the law has made them feel that they are something special. Unfortunately, those few CB'ers who try to observe the law are dwarfed by those who have only a personal interest. I have often been criticized for refusing to "soup up" a CB rig or to "hike up" the antenna for a class D radio.

The only question I have is: How will the serious amateur or the licensed experimenter who builds his own transmitter be affected? I'm sure that, if this problem can be overcome, there will be wide acceptance of the proposal.

GEORGE ECHOHAWK
Sand Springs, Okla.

## BACK ISSUES FOR SALE

I have a considerable collection of POPULAR ELECTRONICS and ELECTRONICS WORLD magazines that I have to get rid of because I am moving. I have a complete set of PE (77 issues) from May 1966 through Sept. 1972 and an incomplete set (64 out of 69) of EW from April 1966 through Dec. 1971. Make an offer for either or both sets. Include estimate for shipping or pay shipping charges collect.

WILLIAM H. RAUCKMANN
1314 Osgood Road
Colorado Springs, CO 80915

## METAL DETECTOR PRICES

We enjoyed your article "Treasure Detectors for Land Use" (September 1972) but would like to point out an error in price for the White's Electronics Model 66T. The price given in the table is for a basic model which does not include the loops indicated. The 7½" and 10½" loops are part of a deluxe group package that lists for $359 retail.

R. C. RITTENHOUSE
The Jerry Martin Co.
Gurnee, Ill.

## SIMPLIFIED LIGHT MINDER

I like the "Light Minder" (September 1972) but I think it can be simplified by leaving out three of the four parts. The diodes can be done away with by connecting the Sonalert from the tail-light line (which is on whenever parking lights or head lights are on) and the oil pressure switch. This system has been used in my VW for three years.

J. D. YOUNG, WA8KNE
San Diego, Calif.

## ATWATER KENT MANUAL FOR SALE

I have a technician's repair manual that covers all of Atwater Kent's radio models. It includes schematics, parts lists, price lists, and instructions. The date of the manual is June 1931.

CHARLES E. BAKER
2520 Victor Place
Everett, Wash.

*Anyone interested? Please write directly to Charles.*

# Stereo Scene

By J. Gordon Holt

# A Galaxy of Gadgetry

SOME years ago, a cartoon in one of the photography magazines depicted an amateur photographer leaving his home burdened down by tripods, flash attachments, floodlights, exposure meters, filter cases, auxiliary lenses, and a shoulder bag that was presumably full of smaller items. He was looking over his shoulder at his wife, who was running after him, holding something aloft, and yelling "Wait a minute, you forgot your camera."

Of all hobbyists, photographers probably have the best-known reputation for being gadget-crazy, but there are two other groups that are equally deserving of the reputation: car buffs and audiophiles. And while the audiophile may sneer at the transistorized ignition system and dash-mounted tachometer in the car buff's vehicle, the car buff might be equally disparaging about the little brush that wipes an audiophile's discs clean while they're playing, or the multi-knobbed control center that allows him to rearrange the sound to suit his taste.

A gadget is, almost by definition, something that you acquire after the main object of your hobby (camera, car or hi-fi system) has satisfied you that it does what it should do. Most gadgets, then, are intended to make it do *more* than it should, or do it better. Gadgetry is thus rather a badge of sophistication—evidence for all the world to see that you have graduated from the level of a mere owner of something to an advanced user or appreciator. This is not to say that gadgetry buyers buy their gadgets to achieve status, or even that they are aware that status is involved. In fact, most of us buy gadgets because: (1) they promise to do something we want done and do it better or more easily than anything we already own; (2) because they (the gadgets) *look* as if they will enhance performance; and (3) because it's fun to spend money on your hobby. While you can't buy a new camera or car or hi-fi system every week, you *can* buy gadgets that often if you care to.

According to our definition, anything that is not absolutely necessary in order for a reproducing system to make sound can be considered a gadget, and the range of gadgets runs the price gamut from little plastic clips that prevent tape from unwinding from a reel, through stylus gauges and test records and head demagnetizers, up to multi-channel mike mixers, noise-reduction devices, and four-channel decoders with built-in logic sensing and enhancing.

It should be noted that small, inexpensive audio accessories are rarely listed in the directories of audio equipment that appear on newsstands every year, probably because there are just too many to list. The best sources of information about what's available are those big, fat catalogs issued by the large mail-order electronics supply houses like Allied/Radio Shack and Lafayette Radio, and the catalogs available from the firms that supply much of their gadgetry, like Robins Industries, Audiotex, and Notronics. Robins and Audiotex run the gamut, while Nortronics is exclusively in the tape-equipment field. In more specific areas, such as microphone or headphone accessories, the manufacturers of the devices also make available a wide selection of gadgets for use with them, and catalogs are available directly from the factories. For

example, Shure and Electro-Voice make almost as many mike accessories as mikes, while Koss produces many headphone accessories as well as their long line of phones. A collection of these catalogs, plus the big ones from the mail-order houses, is a veritable goldmine of gadgetry. Such as. . . .

### GADGETS FOR TAPES

We have already mentioned **reel clips,** which fasten to the edge of a tape reel to prevent the tape from unwinding when it is subjected to shaking, as in transit through the mail. These work, but only with a full reel of tape. With a partially full reel (or even a full one, for that matter), the same objective can be accomplished by folding the end of the tape over the reel flange and fastening it with a bit of Scotch mending tape.

Gummed-paper **title labels** for identifying recorded reels are available from hi-fi gadget suppliers, but equally suitable labels can be bought at much lower cost from stationery stores. The same goes for those bright red "china-marking" pencils that are sold for marking the cutting points on a tape that you're editing. They're cheaper when they aren't sold specifically for editing tape. And they can also be used for putting temporary identifying information on plastic or metal reels; the writing is removed from the reels with an alcohol-soaked rag.

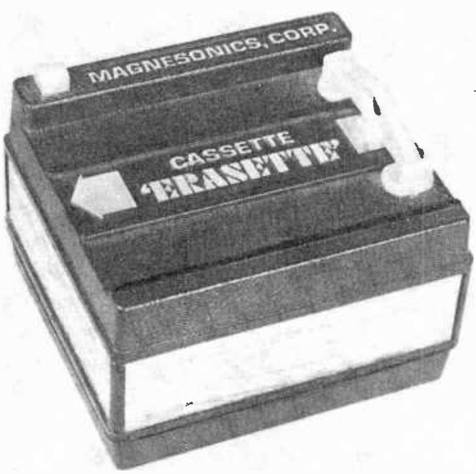
**Tape splicers** come in all shapes and sizes, and are one of the few things in the hi-fi field about which it can be said that you get exactly what you pay for. The cheapest ones will do a slightly better job than you can do with scissors and your bare hands; the most expensive ones—bars of cast aluminum several inches long with a slightly undercut channel along them to hold the tape—make the quietest, strongest splices, and will allow you to assemble bits of tape a fraction of an inch long into a smooth perfectly strong splice if the need for this should ever arise. The semi-automatic splicers are less flexible than the professional-type editing blocks, but require less manual dexterity and less skill to use. If your recorder is a 4-track type, though, try to get a splicer that trims a minimal amount from the width of the tape, for the left-channel tracks extend to the edges of the tape, and excessive trimming here will cause a momentary loss of left-channel signal level.

Cassette editors are available, but are best used only for repairing broken tapes. Cassette splices are likely to be conspicuously audible. Cartridge tapes can be edited on an open-reel editor, but since it is almost impossible to get the tape back into the cartridge, my suggestion here is to forget it.

Editing pencils, which allow you to erase small segments of tape, are of limited value, as the same thing can usually be accomplished more effectively by editing with a splicer.

**Bulk erasers,** for cleaning off old recordings without unwinding the tape, are also variable in their efficacy. Some don't erase completely, so try your prospective purchase with an *old* recorded tape. Recordings tend to "harden" with age, becoming more difficult to erase, so a bulk eraser that will clean off a recording several years old will cope with practically anything. The exception here is in the cassette field, where some of the new high-potency oxides are even harder to erase than a "hardened" ferrous-oxide tape. Before buying a cassette eraser try it with chromium-dioxide tape.

Hand-held erasers, if of sufficient potency, are usable on open-reel, cassette, or cartridge tapes, but don't try degaussing recorder heads with them, as they may weaken the magnets in the recording-level meters.




**Magnesonics, Corp. cassette eraser.**

Induction-type **telephone pickups,** for recording phone conversations without making a direct line tap, vary widely in their performance and their sensitivity. Many will hum loudly with most tape recorders, while some have too much output to feed a microphone input and too little to feed a high-level line input. Your best bet here is to try

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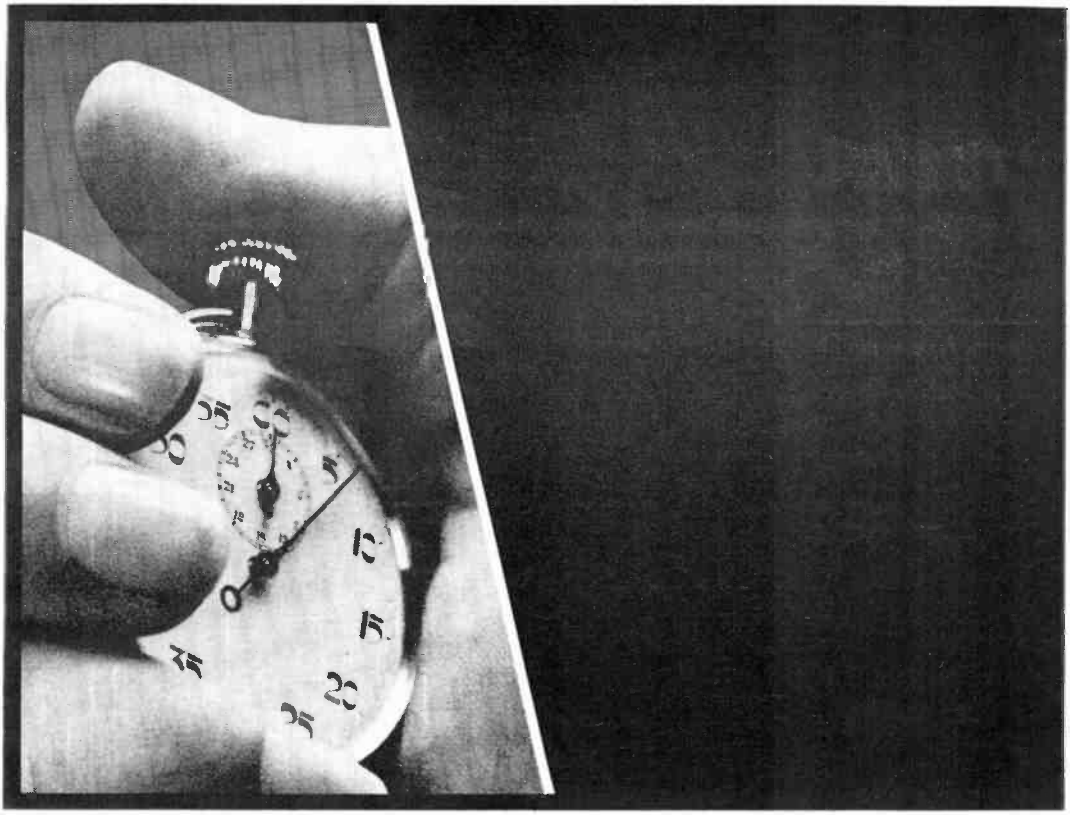
the one you're thinking of buying, using a telephone in the store, or buy with the understanding that you can return it for credit or a refund if it doesn't work with your recorder. And remember: without a court order, it is a federal offense to record a phone conversation without informing both parties that a recording is being made.

There are several kinds of **noise-reduction devices** available, the best-known of which is of course the Dolby B, intended for home tape recording. Increasing numbers of recorders are now being made with built-in Dolby circuits, but several add-on Dolbys are available for use with existing recorders. These will be usable for de-Dolbying Dolby FM transmissions as they become the rule rather than the exception. All Dolby licensees must meet minimum-performance requirements set up by Dolby Labs, so the actual noise-reduction performance of all available Dolby units is about the same. Where the units differ is in accuracy of adjustment, which affects high-end response, and in the noise and distortion characteristics of the circuitry other than the Dolby parts. In addition, at least one available unit, the Advent 100A, has built-in provision for switching the Dolby playback sections directly in series with the main system preamp, so the Dolby can be used for deprocessing FM as well as any other incoming signal sources.

Dolby noise-reduction in playback is effective only with program material that was Dolby-processed during the recording phase. Most other noise-reduction systems can be used with any program material (except pre-Dolbyed material), but these devices do differ widely in their effectiveness and in the detrimental effects they have on the signal. Many add unacceptable amounts of distortion; many produce audible changes in frequency response or interruptions of low-level passages in the sound; and some add thumping or "swelling" modulations during wide-dynamic-range programs. So check out your prospective purchase with a recording having a wide range of dynamics on it. If it performs okay with that, it will be satisfactory with any kind of program material.

The advanced live-recording enthusiast almost invariably finds eventually that two mikes are not always enough to do a job properly, and starts investigating input mixers. These range from relatively inexpensive all the way up to astronomical prices



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Shure Brothers Inc.,
222 Hartrey Ave., Evanston, Ill. 60204.

SHURE

**CIRCLE NO. 36 ON READER SERVICE CARD**

(for professional consoles to feed dozens of mikes to 16 tape tracks); and, again, you get pretty much what you pay for. For under $100, you're likely to get some audible hum and hiss as well as rather high distortion. About $115 will buy you a semi-professional unit like the Shure M-688, with four inputs, panning provision in one input, and good performance; while $300 or more can buy a variety of compact professional mixers with six or more inputs. One model—the Gately Prokit SM-6—is available in kit form at a substantial cost saving, but it's hardly a job for a novice kit-builder to tackle.

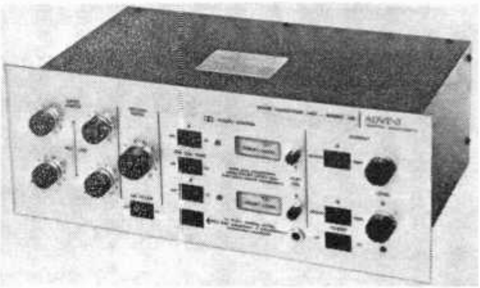
The Advent 100A Dolby unit has mixing provisions for two line-level inputs per channel, and many tape recorders offer mixing between mike and line inputs in each channel. With these, all that is necessary to get four mixable mike channels is to add the necessary preamplifiers. Advent has a high-performance, externally powered (15 to 20 volts dc) MPR-1 preamp, accepting a pair of professional-type balanced-line, low-impedance mikes, and the 100A has two outlets on it to power two of the preamps. Alternatively, the preamps can be battery powered or fed from a suitable dc takeoff from any associated component. Some inexpensive preamps that will do an adequate job have been sold by Lafayette; Fisher and others but these accept only high-impedance microphones. For using low-impedance mikes, which are necessary for live recording in concert halls, churches and so on, Shure, Electro-Voice and Beyer make available low-to-high-impedance matching transformers.

## RECORDER MAINTENANCE GADGETS

All of the available **head degaussers** are potent enough to do their job, but some may not be suitably shaped to reach your recorder's heads, so check this before buying. Special degaussers are available for use in cassette or cartridge machines, and at least one (from Ampex) combines cassette degaussing with a head-cleaning cycle.

The most worthwhile **alignment tapes** are those made for professional users and service technicians, and not only are these quite costly, they also require the use of suitable test equipment and a certain level of technical sophistication. Test tapes designed for "ear evaluation" of recorders are likely to give a recordist more unnecessary worry than enlightenment.

The best of the tape **head cleaners** is a cotton-tipped "Q-tip" swab saturated with a suitable solvent, and both are sold as hi-fi accessories. The cotton swabs are available at lower cost from drug stores, but I don't know of an alternate source of suitable solvent. (Carbon tetrachloride works fine, but inhaling the fumes causes liver damage, so that solvent is in disfavor these days.) Although overpriced, all of the head-cleaning solvents sold as such do a good job, if you can reach your recorder's heads with the cotton swabs. If you can't, which is often the case with cassette and cartridge machines, you can buy special cassettes and cartridges loaded with a slightly abrasive cleaning tape that will do almost as good a cleaning job on heads and guides as a Q-tip. The capstan and pinch wheel must sometimes still be cleaned with a solvent in order to keep wow and flutter within specs.



**Advent Dolby system for record/playback.**

Be careful with the solvents, though. The plastic trim on many tape recorders will readily dissolve in most head-cleaning fluids.

I don't recommend **silicone lubricants** for tape any more than for discs, and for the same reasons: they combine with dust to form an abrasive gunk, and they tend to foul the head surfaces, necessitating frequent cleaning. Most tapes are already suitably lubricated, and no more is required.

Tape stroboscopes are of value mainly to professional users and service technicians who are in a position to do something about a case of speed inaccuracy. For home recordists, periodic cleaning of the transport, plus an occasional pitch comparison (by ear) between the beginning and the end of a commercially recorded tape,will serve to ensure that constant speed is being maintained. To determine speed *accuracy*, compare the pitch of a pre-recorded tape with its equivalent disc release (making sure the disc is actually running at 33⅓ rpm). ◈

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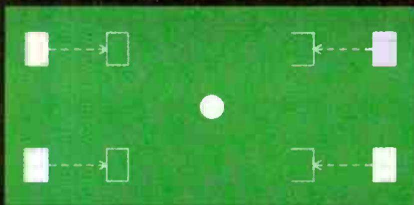

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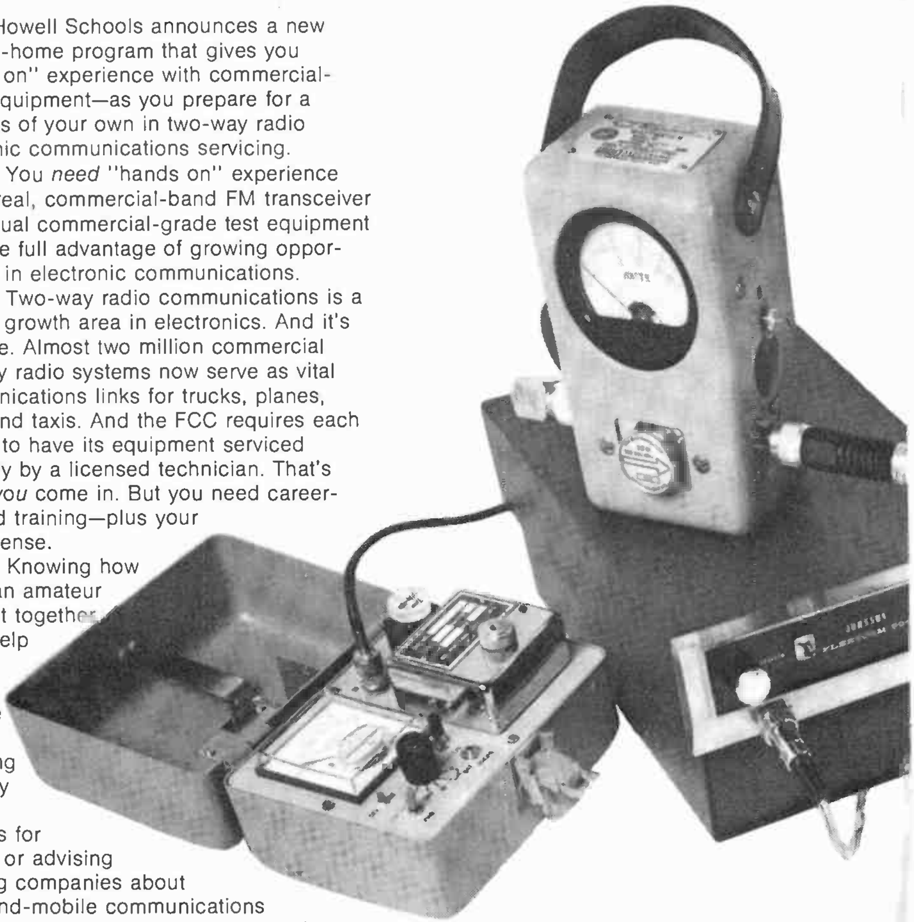

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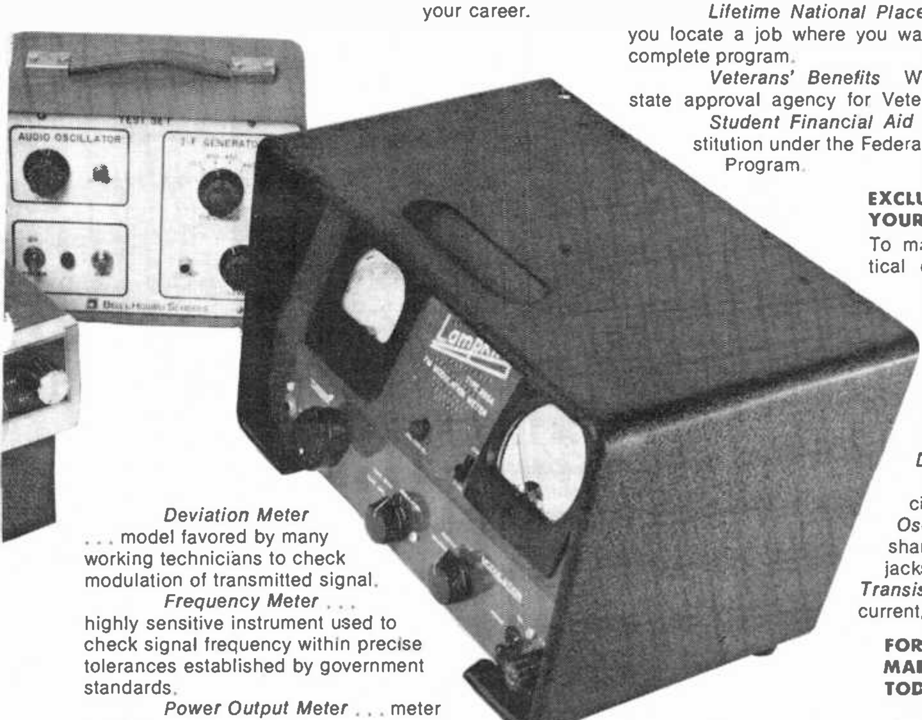


*Deviation Meter* . . . model favored by many working technicians to check modulation of transmitted signal.

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# News Highlights

### New Television Disc System

A new Video Long Play (VLP) television disc system was unveiled recently by Philips of the Netherlands. The VLP system plays color programs through an ordinary TV set via an ingenious "record-player" attachment. The record used resembles an ordinary audio disc and is pressed in the same manner. Instead of using a mechanical stylus to contact the grooves, the Philips system has a low-powered laser light source in an electro-optical pickup which plays the record without direct contact, thereby completely eliminating record wear. The VLP disc can provide color programs lasting up to 45 minutes on one side. The playback unit, slightly larger than an audio record turntable, will sell for about the same price as a color-TV set.

### Three-million Transistors for Auto Ignitions

Three-million power transistors have been ordered by Chrysler Corp. from RCA for use in electronic ignition systems for the 1973 Chrysler, Plymouth and Dodge cars. The order represents RCA's largest silicon transistor order from the auto industry to date. Chrysler will install the electronic ignition system as standard equipment in all its 1973 models. Each ignition system includes two transistors, one a hermetic high-voltage device and the other a plastic device to drive the high-voltage transistor. The system is an inductive pickup type that eliminates the traditional breaker points in the distributor. The system can fire spark plugs with a carbon buildup that would prevent firing with conventional ignition systems. Engine tune-ups should be necessary only about every 50,000 miles if the car burns low-lead gasoline. In contrast, an auto with a conventional ignition system should be tuned about every 12,000 miles.

### Laser Communication Experiment

Communication by laser beam from the fringes of space is the goal of a two-month long series of high altitude aircraft flights being conducted by NASA. The agency is testing an experimental communications system which includes a helium-neon laser transceiver in the aircraft and an argon laser acquisition and tracking station on the ground. The tests are being carried out through the use of a WB-57 aircraft operating at 65,000 ft, above 95 percent of the Earth's atmosphere. Most of the equipment has been developed by Gilfillan, a division of ITT, and Chrysler Corp. Space Division.

### Advanced Paint-by-Numbers Kit Uses Laser and Computer

Unlike the usual paint-by-numbers kit in which the pattern originates with the kit manufacturer, this new kit includes an enlarged (16 × 20 in.) number-coded pattern custom-made from a color photo submitted by the purchaser. Just about any color print or transparency, preferably a portrait shot, is submitted beforehand; from this picture, the numbered pattern is produced. These "Pesonal Paintings" are produced by a system consisting of precision camera, laser, scanner, optical card reader and computers. The submitted portrait is first re-photographed, where color correction occurs. A scanner then analyzes each point to determine the colors. This information is passed along to a computer, which stores and analyzes the findings to determine which of 100 colors and how much of each will be needed to complete the painting. Between 35 and 48 different colors are included with each painting. The computer simultaneously directs a laser beam over a sheet of photographic paper. As the laser moves, it sketches out an enlargement of what the scanner sees. Paint numbers and color guidelines are also printed by the laser. Cost of each kit is $19.95. The automated electro-optical system was designed by Itek Corp. for Craft Master.

### Admiral to Introduce Cartrivision

The Admiral Corp. is introducing its Cartrivision video tape recorder color-TV console to the Chicago consumer market. A wide range of pre-recorded and blank tapes of various lengths for recording off the air and taking home movies will be available through Admiral dealers. The units will also be introduced to the Los Angeles and New York markets later. Suggested retail price for the combination Cartrivision 25-in. color TV with black and white camera and tripod is $1795.

### Television Via Optical Fiber

Seen recently was a TV set operating with both the audio and the video channels reaching the set through a single transparent optical fiber. What's more, the reception was as free of electronic noise as though a bulky, expensive coaxial cable had been used to carry the signals. Signals were beamed into the fiber by a modulated helium-neon laser. In another instance, different colored light beams from colored light bulbs were transmitted through a single fiber, then filtered out to activate a horn and a light bulb. The fiber used was made of DuPont's Crofon plastic material, which is far less expensive but not as thin as an optical fiber made from glass. Light guides of optical fibers may one day be used to interconnect data or signal communication links.

### How Many Objects in Orbit?

Here's a box score of orbiting satellites just past mid-year as reported by Goddard Space Flight Center, NORAD, and the Smithsonian Astrophysical Observatory. At the top of the list is the U.S. with 1947 objects in orbit. Next is the U.S.S.R. with a total of 801 objects. In third place is France with 44 objects. Next comes the U.K. with 7. In first place for the number of "decayed" objects (no longer in orbit) is the U.S.S.R., with 2177. This is followed by the U.S. with 1105 objects.

### Serious Shortage of Engineers Predicted

The nation faces a serious shortage of engineering manpower by the mid-1970's unless immediate steps are taken to reverse the downward trend in engineering school enrollment, according to Dean Andrew Schultz, Jr. of Cornell's College of Engineering. The dean also said he feels the White House is evidently unconvinced of the urgency of the situation. Failure to move rapidly, he said, will result in the irretrievable loss of engineering education capacity, since engineering schools, as the most expensive undergraduate educational units, are targets for economy-minded academic administrations.


# BUILD A 4-CHANNEL UNIVERSAL DECODER

Plays back CBS "SQ," Sansui and E-V matrixed 4-channel program material.

BY FRED NICHOLS / *Electro-Voice, Inc.*

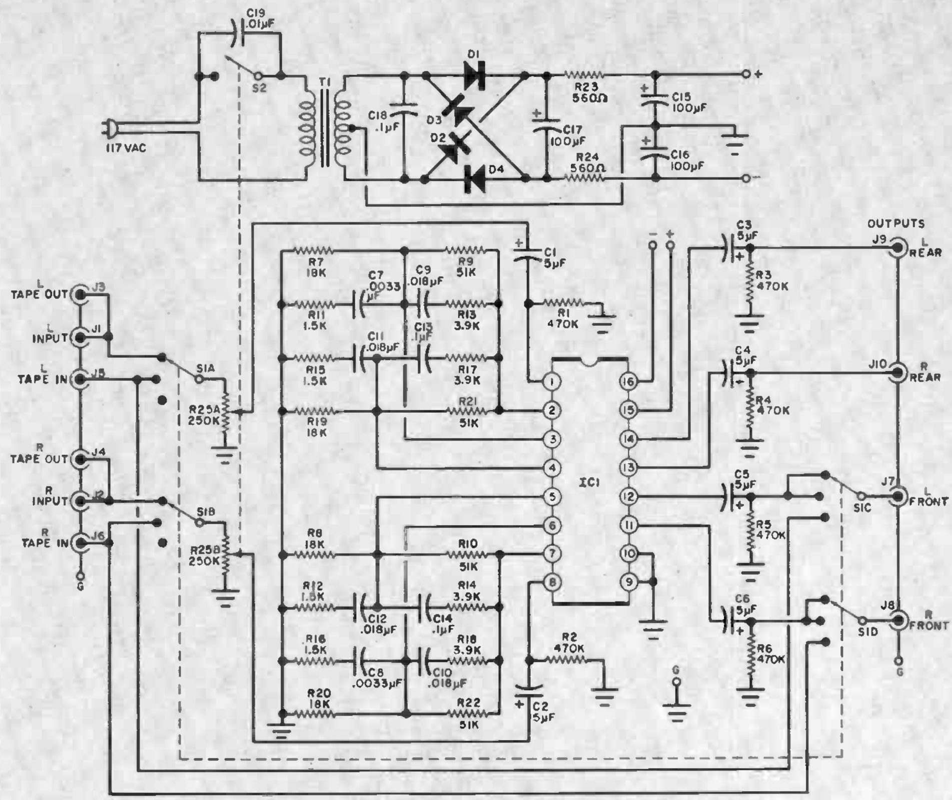
IN the two years or so since matrix four-channel systems were introduced, an impressive degree of sophistication has been obtained. Continuing development of the Electro-Voice "Stereo-4" system has resulted in a "universal" decoder which properly decodes all commercially available encoded material. The entire decoding circuitry has been reduced to an integrated circuit, which operates with various external phase-shift networks.

Because the integrated circuit involves simpler and more accurate circuitry than discrete components, a decoder built around this IC makes an ideal home construction project which offers performance equal to that of commercial units. Such a decoder is presented here for use as a separate unit or the decoder circuitry can be built into another piece of equipment, such as a back-channel stereo amplifier. The integrated circuit with close-tolerance phase-shift network components is available from Electro-Voice, as well as a more complete set of specialized parts, including an etched-circuit board. How the decoder board can be mounted in a professional-looking, commercially available enclosure is shown, although the unit can be housed in any manner the builder desires.

**Construction.** The entire decoder, including power supply, is built on a single printed-circuit board. See Figs. 1 & 2. Use of PC-mount controls greatly simplifies unit wiring. If the controls as shown are not needed, appropriate wire jumpers may be inserted in the board.

Mounting the power transformer, volume control, and selector switch first provides support, making it easy to perform the balance of the assembly. Be sure these parts are fully seated before you start soldering. Use a low-wattage iron and small-diameter rosin-core solder. "Tinning" the copper foil first will speed the component soldering job and reduce the amount of heat required. Special care is required when installing the integrated circuit and phase-shift components—which should be done after all other parts are mounted.

Observe the polarity of the electrolytic capacitors and the identifying notch of *IC1* when installing.




## PARTS LIST

*R1, R2, R3, R4, R5, R6—470,000 ohm, ½ W res.*
**R7, R8, R19, R20—18,000 ohm, ½ W res., 2%*
**R9, R10, R21, R22—51,000 ohm, ½ W res., 2%*
**R11, R12, R15, R16—1500 ohm, ½ W res., 2%*
**R13, R14, R17, R18—3900 ohm, ½ W res., 2%*
*R23, R24—560 ohm, ½ W res.*
*R25—250,000 ohm, dual-section audio-taper pot (with a.c. switch, S2)*
*C1, C2, C3, C4, C5, C6—5 µF, 25 V electrolytic capacitor*
**C7, C8—0.0033 µF, 25 V polystyrene capacitor, 2½%*
**C9, C10, C11, C12—0.018 µF, 25 V polystyrene capacitor, 2½%*
**C13, C14—0.1 µF, 25 V Mylar capacitor, 5%*
*C15, C16—100 µF, 16 V electrolytic capacitor*
*C17—100 µF, 50 V electrolytic capacitor*
*C18—0.1 µF, 100 V ceramic or Mylar capacitor*
*C19—0.01 µF, 150 V a.c.—1400 V d.c. ceramic capacitor*
*J1—J10—Phono jack*
*D1, D2, D3, D4—1 A, 100 PIV diode*
*S1—4 pole, 3-pos. selector switch*
*S2—"On-off" switch (on R25)*
*T1—Power transformer: 40 V center-tapped, 30 mA.*
*IC1—E-V 87743 decoder integrated circuit*
*Misc.—Chassis, line cord, grommet, mounting hardware, etc.*
**Indicates close-tolerance phase-shift components. Do not substitute.*
*Note: The following parts are available from Electro-Voice, Buchanan, Mich. 49107:*
*Complete set of phase-shift components marked * plus IC1 decoder chip. $16.00 ppd.*
*Etched and drilled PC board with all parts shown in schematic (except line cord and phono jacks) plus knobs and control hardware. $32.00 ppd. PC board is NOT available separately.*
*Michigan residents add 4% sales tax.*
*Enclosure shown on front cover is Ten-Tec Model JW-5; available from electronic parts distributors or Ten-Tec, Inc., Sevierville, Tenn. 37862.*

Fig. 1. Schematic diagram and parts list for the "Universal" decoder.

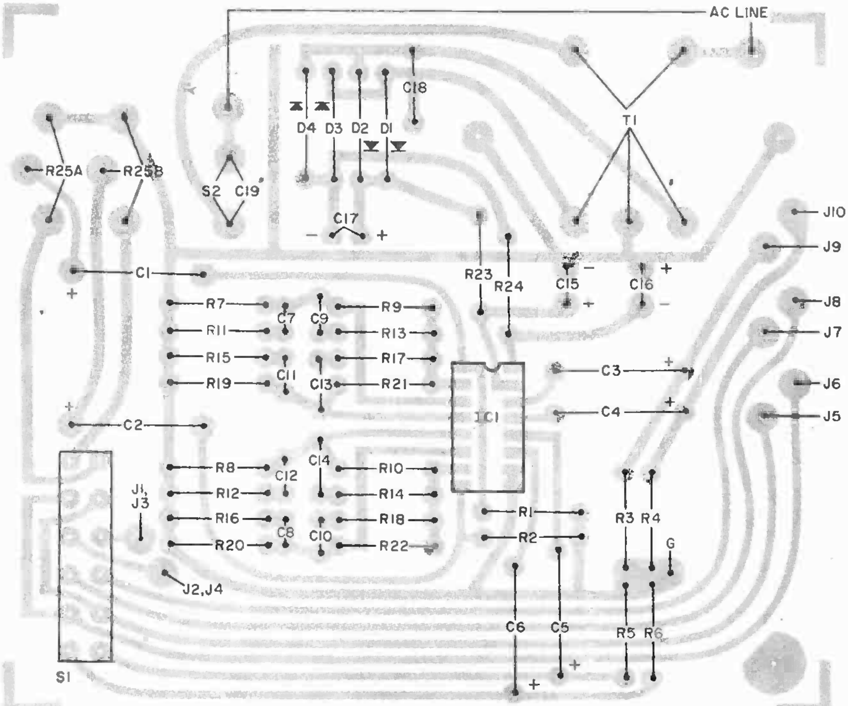
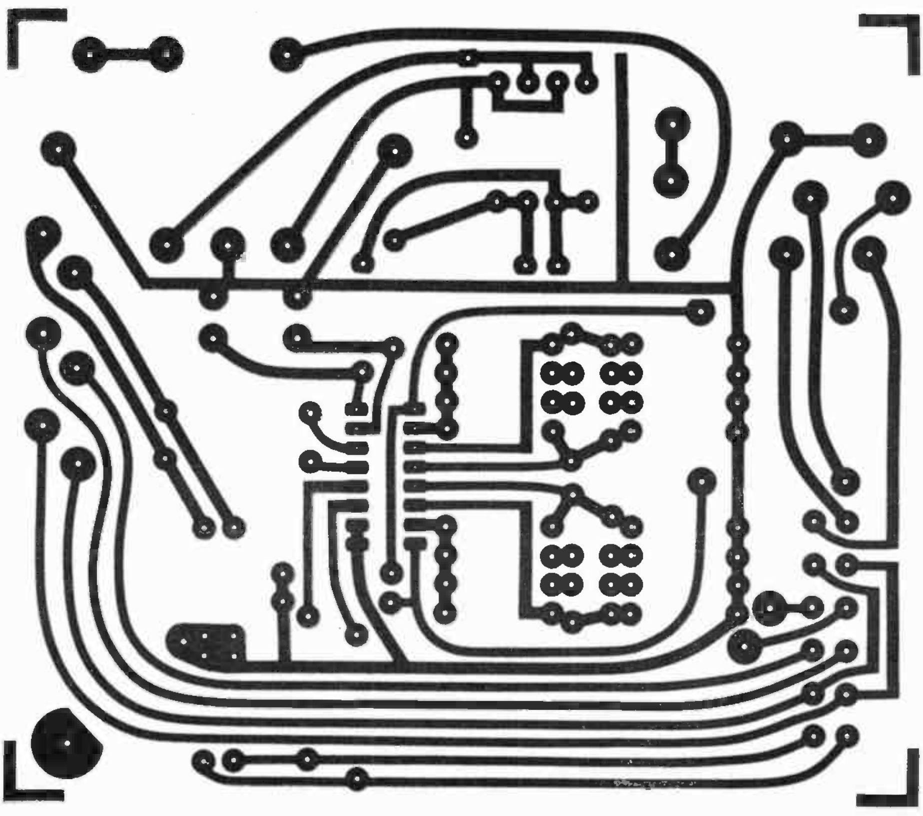
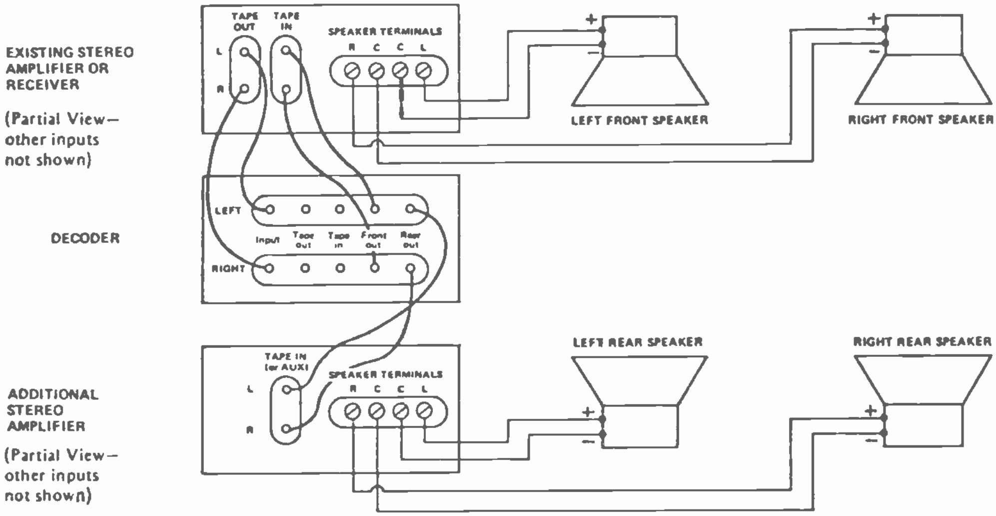



Fig. 2. Actual size PC board foil pattern is shown below; component layout above.



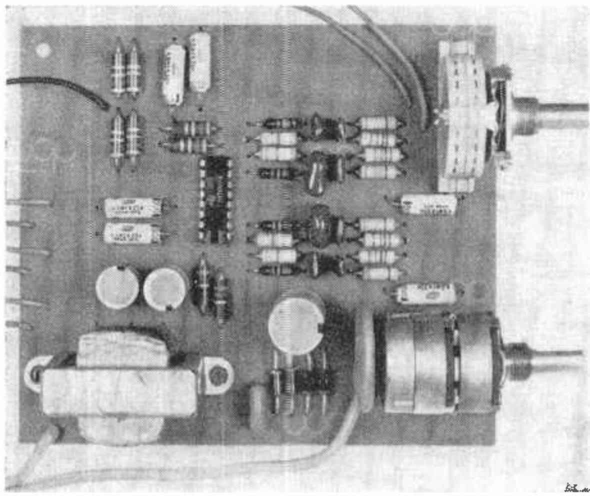



**Rear panel connections for both inputs and outputs.**

**Housing.** The assembled PC board may be mounted in any suitable enclosure, using ¼-inch standoffs. The board should be supported at the two transformer mounting holes, plus another hole provided at the back corner, by 4-40 hardware. The front of the board is secured by the two control shafts.

Ten phono jacks, providing inputs and outputs, should be mounted on the back of the chassis. Insulated jacks, or insulating washers, are recommended. The line cord should be knotted and then exit the back of the chassis through a grommet.

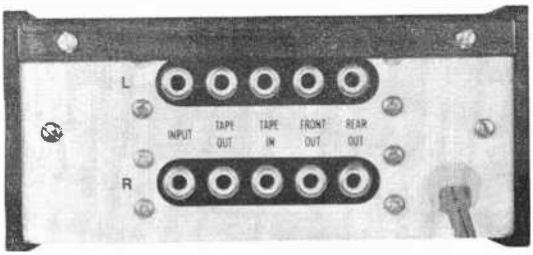
Control functions and the order in which the phono jacks should be installed are shown in the diagram and photos. Appropriate labels may be applied with a tape marker or press-on lettering.



**Top view of the decoder PC board.**

**Connections.** This decoder is designed to operate with signals in the 0.1 to 1-volt range. Maximum input is 4 volts rms. Normally a set of "tape-monitor" connections provides the proper signal source, plus a way to return the decoded front signals to the existing power amplifiers. The rear-channel signals may then be connected to an additional stereo power amplifier and a pair of rear speakers. Of course, the decoder may be connected between separate preamps and power amplifiers as well.

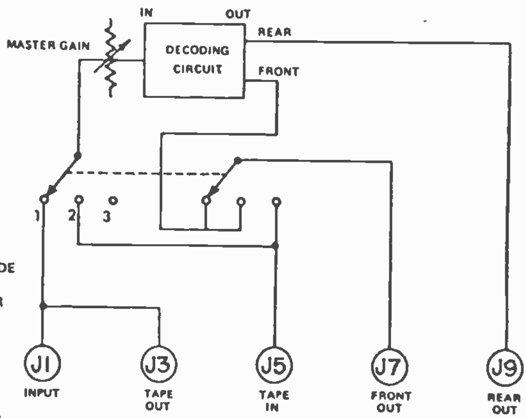
**Suggested jack layout on rear panel.**




**Operation.** As shown in the diagram of Fig. 3, the Selector switch allows a choice of decoding from the Source or Tape inputs, or playing the Tape inputs "straight-through." This latter position restores the tape-monitor function to the system.

Fig. 3. The block diagram of the decoder. Only the left channel is shown; but right channel is the same.

| SWITCH POSITION | FUNCTION |
|---|---|
| 1 | SOURCE DECODE |
| 2 | TAPE DECODE |
| 3 | TAPE MONITOR |




The Master volume control provides control of all four channels when decoding. To start, turn this control fully clockwise. Then advance the volume controls of the front and rear amplifiers to the loudest level you expect to use. The decoder's Master volume control may then be used to lower the level of all four channels for normal listening. ◈

## THE ELECTRO-VOICE EVX-44 DECODER

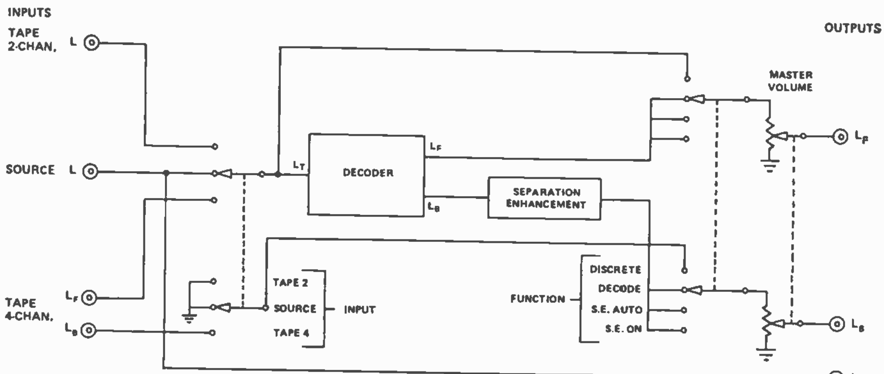
Our Cover Photo shows the original prototype for this particular 4-channel decoder. The circuit used is the simplest and obviously least expensive design for decoding 4-channel program material.

This design differs somewhat from the new Electro-Voice EVX-44 decoder, which is a more sophisticated unit. While it offers the same decoding circuits, the EVX-44 employs a 4-gang master volume control just ahead of the output jacks which can be incorporated by eliminating the input volume control, *R25*. Outputs *J7*, *J8*, *J9*, and *J10* would then go to the inputs of a 4-section, 50,000-ohm audio-taper pot. With this arrangement, the master volume control will affect output in all functions, including the tape monitor (tape 2).

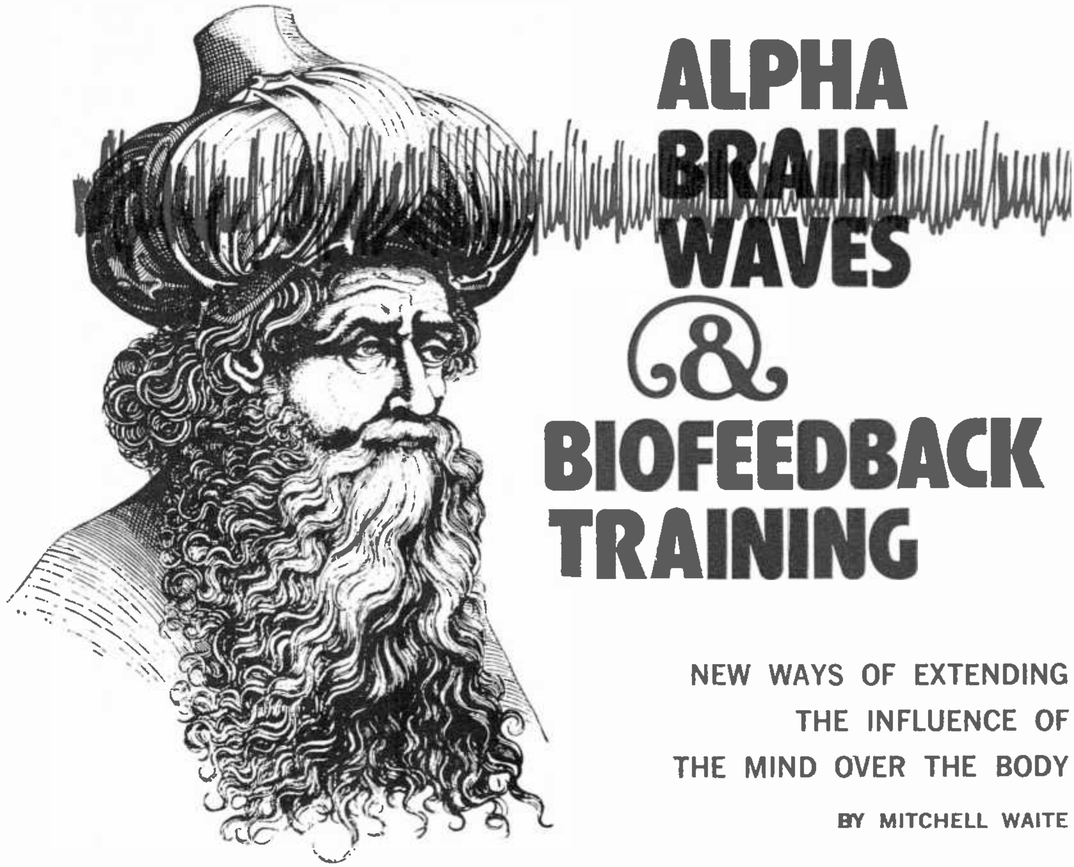
Input and function selection are separate switches in the EVX-44. This permits decoding or playing any input discretely. In addition, a 4-channel discrete tape input is provided.

The EVX-44 incorporates a Separation Enhancement circuit which follows the universal decoder and permits some personal control of playback effect. Incorporating four op amps, the circuitry senses the presence of a front-center soloist. Back separation is decreased and front-to-back isolation is increased to firmly localize the soloist in the front speakers. Separation Enhancement in the EVX-44 operates automatically and can be manually switched "off" or "on" as well. The EVX-44 retails for $99.95.

**Functional diagram of the Electro-Voice EVX-44 decoder.**




LEFT CHANNELS ONLY SHOWN FOR CLARITY
RIGHT CHANNELS IDENTICAL, WITH ALL CONTROLS GANGED TO THOSE SHOWN HERE.



# ALPHA BRAIN WAVES & BIOFEEDBACK TRAINING

## NEW WAYS OF EXTENDING THE INFLUENCE OF THE MIND OVER THE BODY

BY MITCHELL WAITE

HIGH in the Himalayas, the monks of Tibet have practiced a remarkable initiation ritual for thousands of years. On the coldest days of winter, candidates go to spend the night by frozen lakes clad only in their thin orange robes. Symbolic white robes are dipped into the icy water and draped around their naked bodies. The number of robes a candidate can melt in a single night symbolizes the level of his spiritual achievement.

Eastern mystical teachings have a formula that anyone can follow to achieve such spectacular body control: years devoted to meditation, complex visualizations, and sexual continence.

Characteristically, however, Western technology is encroaching on this formerly Eastern monopoly with electronic devices that demand neither sacrifice nor discomfort.

Elmer Green at the Menninger Foundation in Topeka, Kansas, has taught subjects to lower the temperature of their hands ten degrees by using a simple device which indicates body temperature increases by movement of a meter. Subjects were told to move the indicator up-scale and hold it there. Most subjects could, in a small amount of time, learn to influence the temperature of different parts of their bodies by using the information transmitted by the electronic measurement circuit.

Similar to the monks, his subjects were using their minds to generate heat energy at a particular area of their body. Ten degrees is a long way from melting frozen robes but scientists are finding that people can influence all kinds of body processes, hitherto believed beyond the range of conscious control.

**Closing the Loop.** Traditionally, Western medicine considered certain regulatory func-

**Editor's Note:** In response to many requests from readers for articles on alpha brain waves, we are presenting two stories. This month, we cover the general principles of biofeedback training as well as the various types of waveforms generated by the brain. Next month, we will have an alpha-wave monitor construction project for those who want to do some experimenting.

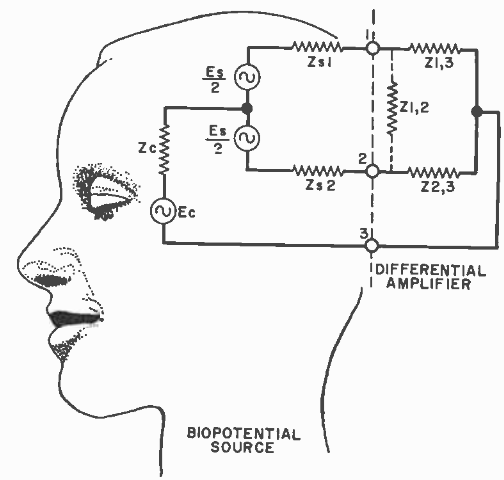
tions of the body such as skin temperature and heart rate as outside the domain of willful control. This assumption seems to have helped shape the self-concept most of us have of being at the mercy of our involuntary nervous system. The self-regulating nervous system is, of course, a necessity, for imagine the effort of controlling all the specialized muscles involved in breathing or digesting. We could, you might say, speed up our heart rate by physical exertion such as fast breathing, but this is not direct control of the autonomic nervous system.

Certain recent experiments have now caused scientists to take a new look at this old assumption. Some visceral organs, it was discovered, could be eventually controlled by the mind if special conditions were first set up. What was needed was a special signal or stimulus, such as sound or light, which would follow the activity of the body function to be controlled. By observing the "feedback" signal, people could actually interact with a particular body function through the monitor. The monitor or biofeedback mechanism serves in a sense as an interpreter between the mind and the so-called "automatic" mind.

The principle is similar to the way you learn to throw a ball. You feel your arm move, see where the ball went and correct your arm movement the next time. In a similar way, an electronic instrument can detect small internal changes in such processes as blood flow or brain-wave patterns of which you may not be consciously aware. By showing you these changes, the device can help you to recognize the cues and learn control. What is even better is that with practice, control can be developed so that the instrument is no longer needed.

**The Body Electronic.** To understand fully the range of the feedback principle, it is helpful to examine the source of the feedback signal.

Bio-potentials, tiny voltages present in all living organisms, are caused in man by the activity of nervous system sensors, muscles, or nerves. All bio-potentials originate at the cellular level, but the measurement of any one signal is related to a specific physiological subsystem. Thus, the electrocardiogram (EKG) is a recording of the electrical activity of the heart, the electroencephalogram (EEG) of the voltages in the brain, the electromyogram (EMG) of the activity of the muscles.




Z1,2=COMMON MODE INPUT IMPEDANCE
Ec=COMMON MODE SIGNAL GENERATOR
Zs1,Zs2=IMPEDANCE BETWEEN ELECTRODE AND BRAIN
$\frac{Zs1}{Zs2}$ CAN VARY FROM ONE TO OVER ONE HUNDRED

**Fig. 1. Schematic of brain shows how unbalancing of source impedances (Zs1 and Zs2) can affect the common mode rejection of differential circuit. Common mode generator includes all unwanted signals such as electrode potentials, power line interference, noise from extraneous body signals, etc. Unfortunately, these signals are not always common mode and show up at differential amplifier output, distorting the real brain-wave signal. Ignoring the loading effect of Z1,2, and if Z1,3 equals Z2,3, and both Zs1 and Zs2 are much less the Z1,3 and Z2,3, the CMR limit (greatest reduction to a common mode signal) is 20 times the log to base 10 of Z1,3 divided by the difference between Zs1 and Zs2. Thus, if Z1,3 is 100,000 ohms and electrode impedance ratio is 100, the CMR limit is 60 dB. Source and input impedance of circuit determine actual rejection. A circuit with these values produces 1 mV of common mode output noise for every 1 volt on the input.**

Detecting the brain-wave biopotentials is greatly complicated by the minute signal voltages, high level of external interference (noise and hum) and high impedance values of the body. For example, the magnitudes of the signals measured on the scalp typically vary from ten to a hundred millionths of a volt (10-100 microvolts) peak-to-peak. To top it off, in residential areas, stray 60-cycle fields from power lines surround the body. Such fields may reach values of 10 volts, or a million times stronger than the brain-wave signal! It is this interference problem which has been a stumbling block of experimentalists for so long.

Recent advances in semiconductor technology have allowed the construction of miniature feedback devices which overcome these basic problems. The large fields can be screened out by a differential amplifier, which rejects any extraneous voltage *common to two inputs* while boosting the small difference signal *between the two inputs*. (See Fig. 1.)

Because of the typically high impedance levels of the head (1,000 to 10,000 ohms) the differential amplifier cannot load the signal source and therefore requires a very high input impedance, typically 0.1 to 100 million ohms. The amplifier also must not, while amplifying, contribute any spurious signals to the original biopotential. All these factors add up to a high-gain, low-noise, high-input-impedance differential amplifier commonly referred to in electronics as an instrumentation amplifier. Medical equipment reflects this high quality with typical prices for a multi-channel EEG amplifier and recorder of $1000 to $10,000. Less expensive devices sacrifice the unnecessary electronics involved in medical equipment while retaining just enough information for feedback recognition.

The second step in a biofeedback system is utilization of the amplified biopotential signal. Optimally, a second signal source which falls into the range of one of the five senses is varied (modulated) by the amplified biopotential signal. For example, a tone which is easily sensed by the ears is made to vary in volume by the amplified biopotentials of the brain. The user of the feedback device makes a mental effort to alter the intensity of the sound. (See Fig. 2.)

This last step, altering the sound, completes the biofeedback loop. With routine practice a user develops control over the sound pattern and thus is actually altering an organ's functioning. It is still however, a subtle effect, difficult to describe to other people, and some never completely master it.

Although biofeedback training has similarities to conditioning, it does not offer an explicit reward for the correct response. The only reward is what comes from eventual mastering of the process.

**Clinical Research.** Currently, biofeedback research is being carried on by over 150 different laboratories. A Biofeedback Society has been formed which brings together experimental research and integrates it with current psychological knowledge. The mainstream of activity covers five basic areas of body control: (1) muscle tension (EMG), (2) blood flow and blood pressure, (3) heart rate (EKG), (4) body temperature, and (5) brain waves (EEG).

For example, psychologists at the University of Colorado Medical Center in Denver have employed feedback therapy to cure patients who have suffered from muscle tension headaches for an average of nine years.

Patients lie down in a comfortable position with small surface electrodes taped to their foreheads. They then listen to a tone from a pair of headphones. As the muscle contraction of the forehead increases (increased muscle tension) the pitch of the tone goes higher. The people are told to try to lower the tone. Within twenty minutes the tone drops and they have halved the original muscle tension!

What are these people doing that they hadn't already tried? Most found that any direct effort to relax resulted in a higher pitch tone (increased muscle tension). Only by "letting go" could they relax the forehead muscles. It appears that by not concentrating on the headache, other processes of the brain come into play, processes that are unfamiliar and difficult to explain.

At the Menninger Foundation in Topeka, Kansas, researchers have helped patients to stop their migraine headaches by monitoring the blood flow as it went up the main artery to the face. They trained these people to reduce the arterial swelling by reducing the blood flow through it. Rather than trying directly to stop the headache, they learned, through biofeedback, to steer around it much as a pilot does when he is flying blind.

But even more incredible is the new information coming from heart rate control research. At the University of Wisconsin in Madison, subjects were taught to "drive" their own hearts much like the driving skill booths at penny arcades. Subjects would watch a light which moved left or right as the time between heartbeats changed. Trained subjects could eventually keep the light in the middle and thus keep the time between heartbeats a constant 10%. This didn't mean necessarily that they were directing the autonomic nervous system. As mentioned earlier, the heart can be influenced by the breathing process. However, this was later ruled out when subjects showed they could learn to control breathing and heart rate independently.

At the Gerontology Research Center in Baltimore, Dr. Bernard T. Engel and his colleagues have trained eight persons to control potentially lethal irregularities in heart rhythm. The subjects were trained to slow their heartbeats by concentrating intensely when a red light appeared and to speed up the heart rate in the presence of a green light. Ultimately, they learned to maintain a safe mid-pace indicated by a steady yellow light. Eventually, three of the patients acquired the ability to stabilize their rhythms at the first sign of an oncoming attach of arrhythmia with their own feedback cues.

**Map of Consciousness.** Perhaps the most exciting aspect of biofeedback is its contribution to mapping altered states of consciousness.

Dr. Joe Kamiya at the Langley Porter Neuropsychiatric Institute in San Francisco has spent a decade studying the effect of *alpha* brain-wave training. He was particularly interested in whether normal subjects could discriminate alpha from non-alpha. Dr. Kamiya used a feedback program which produced a score every time the person indicated verbally which state he was in; alpha or non-alpha. After two weeks of training, 70 percent of the subjects could differentiate alpha and non-alpha. What was the alpha experience of Dr. Kamiya's subjects?

The replies were mostly diverse and inarticulate. This is almost to be expected—the English language has few words to describe different conscious states. Alpha has been described as "a range of mildly pleasurable reveries and body feelings often called relaxed awareness."

As for the other brain-wave states, each frequency band has associated with it certain behavior traits. (See Table.) The theta band (3.5 to 7.5 Hz) occurs during uncertainty, day dreaming, and problem solving. Worry, anger, fear, and tension are characteristic of the beta band, 13 to 28 Hz. Between theta and beta lie the alpha rhythms. These frequencies, 7.5 to 13 Hz, have drawn special attention since they are most often produced during states of meditation and relaxation.

Alpha is difficult to describe. It is a nonthinking and non-emotional condition; a detachment from the usual reality. There is an opening of awareness and an enhanced ability to be still. Researchers call it a mode of de-automization, a reduction in the cortical activity of the brain.

This partly explains why alpha-wave feedback is being so widely discussed. It is because the alpha wave and its positive mental character can be turned on and sustained by using a biofeedback device.

**TYPICAL BRAIN-WAVE DETAILS**

| Name of Brain Wave | Magnitude ($V \times 10^{-6}$) | Frequency (Hz) | Associated Mental State* | Percent Produced Per Day |
|---|---|---|---|---|
| Alpha | 10 to 100 | 7.5 to 13 | Tranquility, relaxation, heightened awareness. | 10 |
| Theta | 50 to 200 | 3.5 to 7.5 | Uncertainty, problem solving, future planning, switching thoughts, day dreaming. | 25 |
| Delta | 10 to 50 | 0.2 to 3.5 | Deep sleep, trance state, non-REM type of sleep. | 10 |
| Beta | 10 to 50 | 13 to 28 | Worry, anger, fear, attention, tension, hunger, surprise. | 35 |
| ? | 0.01 to 0.1 | Vhf to Uhf | ** | ? |

*These descriptors are from a Clyde Mood Adjective checklist following one 60-minute feedback session with the eyes open.
**This last band is a recent Russian discovery. It could be revolutionary in the brain-wave field. In terms of just information content, these signals could contain over a billion times more data than the slower brain waves produce.

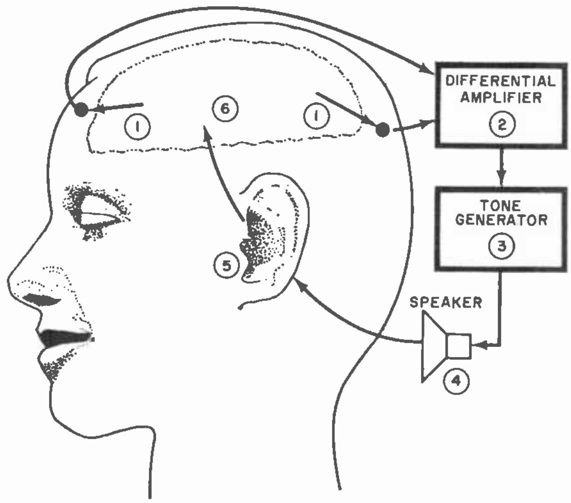



**Fig. 2. Brain-wave signals originating in the brain (1) pass through cerebral fluids and reach the surface electrodes. Electrode cream is used on electrodes to help lower resistance to the scalp. From electrodes, the signals flow into the special differential amplifier where interference is reduced and signal level is raised. The amplified signal is used to control (turn on and off) a tone (3) which drives a speaker (4). Sounds leaving the speaker are following the brain-wave signal (the brain-wave frequency is well below the threshold of human hearing) so a sound is perceived each time the brain-wave signal reaches a peak. These peaks occur at a smooth stacatto rate which the hearing integrates as the alpha wave if it is a 10-Hz rate or the theta wave if it is 4 Hz. Signals from speaker return to the ear (5) and then back to brain (6).**

Kamiya and researchers like him seem to feel that this is one way of reducing tension and increasing awareness by dealing with it in an internal and self-motivated way. It may be possible, says Kamiya, to use the descriptors of biopotential signals (frequency, magnitude, direction, origin) to discover how to reproduce altered states of awareness.

Already various groups are following brain-wave biofeedback research and presenting it to the public in more palatable form. Some of the interest is in providing verbal instruction and exercises in producing the desired brain-wave states. There is some skepticism voiced that these different groups have over-inflated claims and they are using mass suggestion. However, no one has tested the brain waves of these people or how they control them so it is still to be proved. The brain waves of people with ESP powers have been studied and they show a definite abundance of the alpha wave just prior to the ESP experience.

Some companies are producing brain-wave monitors which allow anyone to safely experiment in feedback training. The Xerox Corporation is exploring the feasibility of brain-wave training in helping employees relax and get their strength back after hard business meetings.

Besides mapping consciousness, brain-wave research is giving science more insight into different philosophies and their objective biophysical correlations.

The classical experiments that started this exploration were set up to record the brain waves of both students and masters of Yoga and Zen. Kasamatsu and Hirai in 1966 found a highly positive correlation between the EEG pattern and the number of years of Zen meditation. They reported as the years of study of Zen increased: (1) the brain-wave rhythm which was predominately alpha lowered in frequency toward theta by up to three hertz; (2) the percentage of alpha in the occipital areas (back of the head) decreased while alpha activity in the frontal (front of the head) increased; (3) there was an increase in average brain-wave amplitude; (4) there was alpha activity with the eyes open (something that is particularly rare in most people's EEG's); and (5) when an external stimulus (such as a loud click) was delivered, the alpha activity of the Zen student was blocked for constant 2-to-3-second periods. Normal subjects, that is those with non-Eastern type philosophies, block alpha but the blocking interval decreases as the external stimulus occurs more often.

When Anand, et al., studied the brain waves of Yoga masters, they found "increased alpha activity (magnitude and percent occurance) and absolutely *no* blocking on an external stimulus"!

How can the difference in alpha blocking between the Zen, Yoga, and non-meditator be explained? In the case of the normal subjects (non-meditators) the more the stimulus occurs, the less interference there is in alpha production. The subject adapts to the stimulus and eventually does not hear it. On the other hand, the Yoga student (no alpha blocking) apparently is totally screening out stimuli from the outside world while the Zen meditator (constant alpha blocking interval) is reacting to every stimuli in an equal manner.

For psychology and philosophy, these results help to organize a division between subjective reporting of conscious states according to a particular world view and their measureable physiological correlates. The follower of Buddhism (who uses Yoga as an exercise) believes the sensory world to be illusory and attempts to withdraw from it. The practicer of Zen, however, believes the world is not illusion and tries to remain awake and fully sensitive to it. From the point of view of the average subjects, the world is simply related to him in a self-centered manner. He explores the stimulus with a "What's in it for me" attitude and, if satisfied it offers nothing, stops paying attention to it.

**Biofeedback in the Future.** Interpreting brain-wave patterns is helping scientists understand the general activity level of moods, feelings and mental attitudes. To understand the actual mechanisms of thinking and reasoning a closer look at the brain is needed. However the countless chemical reactions of the brain occur at such high speeds and low magnitudes that direct observation reveals little.

Nevertheless, Derek Fender, professor of biology and applied science, and his graduate assistant Robert Kavanagh, have found some beginning answers to how the brain works. They have constructed a machine which records brain waves from many areas of the scalp and sends them into a specially programmed computer. From there the brain waves are analyzed and displayed on a cathode ray tube. The result is a picture of the brain waves—a contour map of the peaks and troughs of electrical activity as "seen" through the top of the subject's head.

Each picture is photographed and used to make a movie. Two movies have been made, each a minute long, representing the brain-wave activity in a quarter of a second —but slowed down 250 times.

By studying various subjects, Fender and Kavanagh have discovered a simultaneous sound and light-flash stimulus causes activity in three distinct locations of the brain. One area analyzes visual images, the second sound patterns, and the third seems to decide if the sound and light come from the same place. They have discovered these locations by increasing the number of electrode positions to 49 and plotting the locus of the neuron emissions with the powerful computer program. The computer gives an accurate reading of exact positions of the brain-wave sources rather than just the frequency and magnitude. By studying these brain-wave movies, scientists are bridging the gap between single neuron firing and the functioning of groups of neurons working together.

During this project Fender discovered that the best subjects for his brain-wave studies were waitresses. Most people either produced fast surface level beta waves or just went to sleep. Waitresses however were just right. They were quick-minded so they didn't fall asleep and industrious enough to concentrate on the light-flash stimulus. And they weren't too nosy about what was going on or too preoccupied with some other problem.

As computers become more powerful with faster and larger memories, Fender's programs might reveal creative brain-wave patterns and possibly provide a means of utilizing biofeedback to stimulate these types of thinking.

As biofeedback techniques become more effective, we might begin to see their use in therapeutic techniques. Ancient teachings have constantly pointed to using the mind to prevent disease and eliminate infection. We may one day see doctors prescribing biofeedback methods instead of pills. ◈

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# What's in a Color-TV Signal ?

## More than you might think—information for the viewer, the broadcaster, the phone company, and the program originator.

BY FOREST H. BELT

IF ELECTRONICS is your specialty, you probably think that you know all about the makeup of a television signal. But do you really? If you grew up with black-and-white TV, you might not know that stations change their horizontal and vertical scan frequencies when they switch to color programs. Engineers and technicians outside the broadcast field often can't identify the white lines that are sometimes seen at the top of the picture (slightly over the edge of the top black bar). Hardly anyone ever sees the little network cue-flag that tells a station operator that he can drop away from the network for a local commercial or station identification.

You may be surprised to learn just how much information rides on an ordinary color-TV signal. There's more than just video, sync, and chroma—and every month, someone seems to find something new to add.

Assuming that you know how a monochrome signal is put together, let's take a look at what happens when color enters the picture.

**Switching to Color.** The conventional monochrome transmitter sync generator undergoes some changes in the switch to color. The main timekeeper, or "clock", now comes from a 3.579545-MHz oscillator (chroma phase reference), which, besides acting as the color reference for chroma coding (later decoding at the receiver), also changes the horizontal sync frequency from 15,750 Hz to 15,734.264 Hz, and the vertical frequency from the conventional 60 Hz to 59.94 Hz. This slight frequency change is a result of complex harmonic relationships that enable the interleaving of the chroma signal with the black-and-white (brightness) signal to make color-TV compatible with monochrome.

The color camera separates the red, blue, and green components of the scene being viewed and feeds these, along with the brightness signal (now called "Y"), into a matrix that develops two signals called "I" and "Q." (These stand for in-phase and quadrature—90°—phase, respectively.) In the actual operation, the chroma phase reference signal is passed through a 57° phase shifter and applied to the I modulator along with the I chroma information. The same signal is also passed through a 90° phase shifter and applied with the Q chroma to the Q modulator. The construction of the I and Q chroma signals is a matter of vector addition, too complex to go into in this brief article.

The outputs of the two modulators are added, along with the Y signal, so that the chroma is interleaved with the Y to make it invisible on a monochrome receiver. To enable a color set to decode and display the chroma information, a small piece of the original chroma phase reference signal is required at the receiver to establish a local phase reference so that the colors come out right. At the transmitter, a special gating circuit, called logically a burst gate, extracts eight cycles of this oscillator frequency and inserts them on the "back porch" of each horizontal sync pulse. Special circuits within the receiver extract this reference burst and use it to phase lock a crystal-controlled 3.579545-MHz oscillator within the receiver with the original phase of the transmitter. The local reference is used in a decoding matrix, in conjunction with the video signal, to regenerate the red, blue, and green color components for further processing for display on the color CRT.

**Test Signals.** Because transmission facilities—both microwave and coaxial cable—

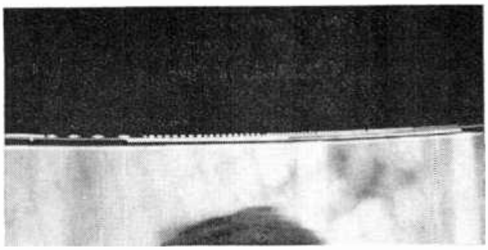


**Fig. 1. Adjust vertical hold to see VITS at top of picture on receiver.**

are not perfect and because color-TV chroma information is both phase and amplitude sensitive, some means must be found to check the transmission medium continuously without interfering with the viewers' pleasure. (A few degrees of phase shift causes color to change, while a change in amplitude causes a gentle pastel to go to a saturated color.) This takes the form of a test signal of known amplitude and phase that is transmitted from the point of video origin, with tests at various points down the line to show what, if anything, has changed.

The most useful test signal accompanies the color signal all the time. The FCC long ago approved the insertion of a test signal in the last 12-$\mu$s of line 17, and anywhere on lines 18, 19, and 20; and this can be done in both fields. If you don't know what these lines are, remember that when the scanning beam reaches the bottom of the picture, a vertical pulse resets the beam to the top of the picture, so that the vertical sweep can begin again. Each of these scans is called a "field" and when both are interlaced, this is called a "frame". All during the vertical interval (retrace), a continuous series of horizontal pulses is transmitted to keep the set's horizontal oscillator in step during the vertical blanking interval. There is a "dark" spread of 18 horizontal lines in each field during the vertical retrace; and, in a normally operating set, these are above the visible picture masked by the CRT enclosure, so that they are not normally visible.

A network transmission committee (NTC) formed of network and phone-company engineers, agreed on a more-or-less standard test signal that would fit on lines 18 and 19 of both fields. Appropriately, they named it Vertical Interval Test Signal or "VITS".

At home or on a picture monitor, the VITS is visible only if the raster doesn't fill the top of the screen. Or, you can roll down the blanking bar (with the vertical hold control) and see the video patterns caused by VITS (see Fig. 1).

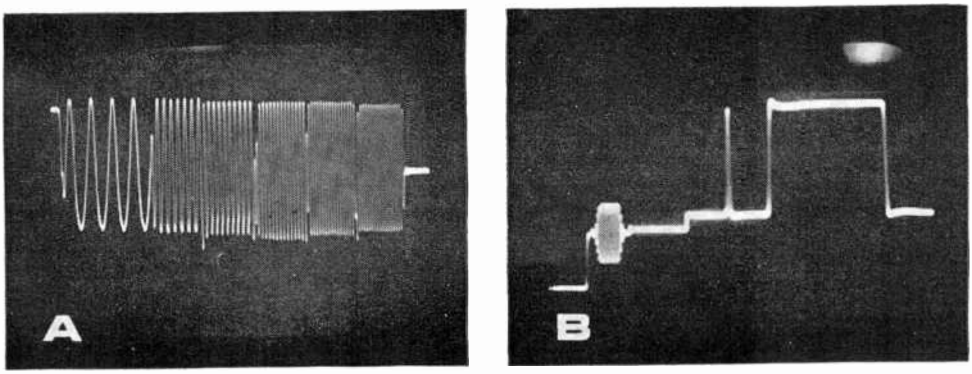
The VITS appears only when network color is on, unless your local station uses a VITS generator of its own to check its studio transmitter link. TV stations are beginning to operate by remote control and you may soon see more locally generated VITS.

In a station, you watch the VITS on a line-selective A-scope, a triggered oscilloscope made especially for monitoring television waveforms a line at a time. Delay circuits let you pick which line you want to inspect and in which field.

The first item in the test signal, on line 18 of field 1 (top line of Fig. 1), is a flag—a single bar of brightness. Its leading edge rises abruptly from zero to maximum white. That's followed by a signal called *multiburst*. It comprises six bursts of r-f energy, one each at 0.5, 1.5, 2.0, 3.0, 3.6, and 4.2 MHz.

The position of the multiburst flag denotes where the VITS originates. If the bar of brightness precedes the 0.5-MHz burst, as

**Fig. 2. Two lines of VITS as seen on a special A-scope. Multiburst is at left and sine-squared and window bar are at right.**



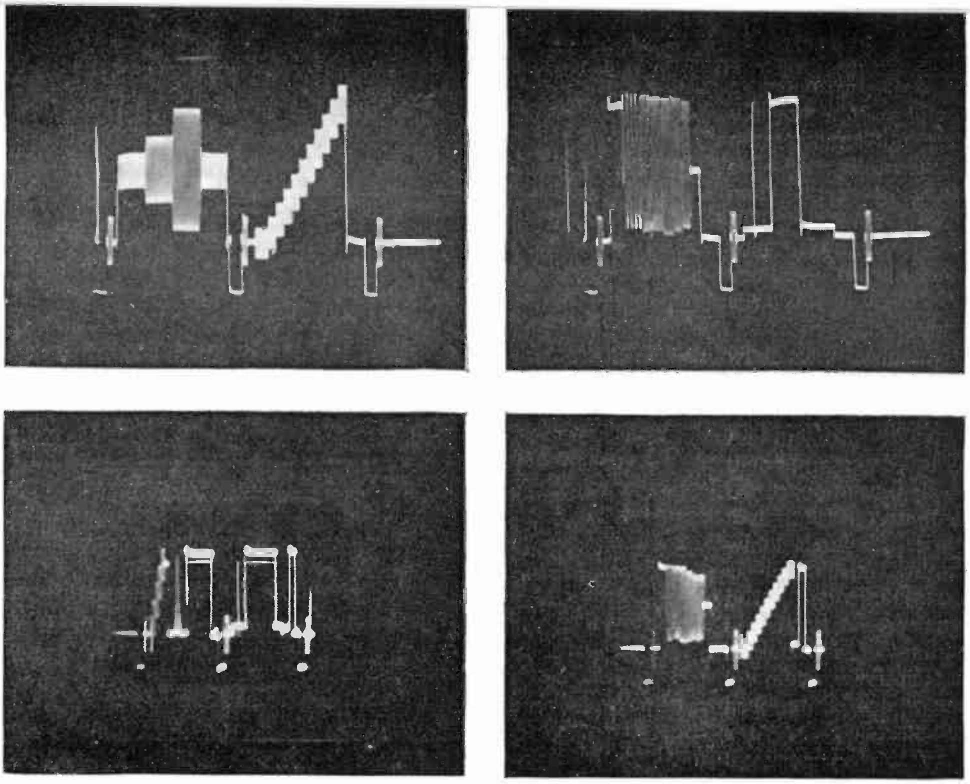


**Fig. 3. At top is NBC VITS used during some tests; field 1 at left, field 2 at right. ABC used the version of VITS shown in bottom row; field 1 at left, field 2 at right.**

in the photo, the VITS comes from New York; between the 0.5 and 1.5 bursts, Hollywood; and between 1.5 and 2.0, Chicago. For all three networks, most VITS originates in New York.

Take another look at Fig. 1. The flag is the long white bar at the left end of the top line. The first group of four "bumps" is the 0.5-MHz burst. Next is the 1.5-MHz burst; if you can distinguish its bumps, the bandwidth of the receiver or monitor exceeds 1.5 MHz.

The next grouping is the 2.0-MHz burst, and so on. You can distinguish bumps all the way out to the fifth group (printing permitting). That means response goes up to 3.6 MHz. The little bumps in the sixth burst run together so the response doesn't extend quite to 4.2 MHz.

You can get a look at one multiburst spread out on an A-scope in Fig. 2A. The flag is off-screen to the left. The important thing is the amplitude of each multiburst. If higher-frequency bursts are shorter, response is poor in the transmission chain. If taller, highs may be overpeaked. Either condition degrades color reproduction.

Following the multiburst is a program-black reference bar at 7.5 IRE units amplitude. The A-scope lets you check comparative levels. Then comes a program-white reference bar at 100 IRE units.

First along line 19 is a *sine-squared* pulse. It is extremely sharp, of 0.125-$\mu$s duration (at half-amplitude). You evaluate it with the A-scope (Fig. 2B). If you spread the pulse out to $\times 25$, over-shoot indicates the signal has picked up phase delay somewhere along the way.

The wide bar is a *window* signal. It checks sync compression or expansion, video streaking, and ringing. The window is followed by a return to 10 IRE units, then to zero, and finally program-black and program-white reference levels.

Line 19 of field 2 has what is known as a *modulated stairstep* signal. It is a series of eleven bursts of 3.579545-MHz energy, each 20 IRE units in peak-to-peak amplitude. The first burst rides at zero level, extending 10 above and 10 below. Each successive burst rides 10 IRE units higher.

Without the 3.58-MHz modulation, the signal would be a simple 10-step black-and-white gray scale and would show video linearity. The modulation lets you test differential gain and differential phase.

**Everything Has Changed.** In recent months networks have been altering their

VITS to suit themselves. Some are redesigned in cooperation with the telephone company (the Long Lines Dept. of AT&T, which handles network transmission). Often however, even affiliate-station engineers don't know what a new version is for. Such confusion irks station personnel since they can't depend on the VITS—which cancels out its usefulness.

Fig. 3 (top) shows what the VITS looked like at one NBC affiliate for a few days a while back. Line 18 of field 1 carries the unfamiliar pattern at the top left. It consists of four 13-$\mu$s bursts of 3.579545-MHz signal. Checked with a vectorscope, all four were found to be 90° away from burst reference. The purpose of this signal was not explained to either AT&T or the network's station engineers. Line 19 of the same field carries a modulated stairstep.

Field 2 is at top right in Fig. 3. The standard multiburst is all that is on line 18. Line 19 has only the sine-squared and window pulses. On other days, NBC had been sending a more standard VITS.

At an ABC affiliate, recently, the VITS was as shown at bottom left in Fig. 3. Field 1 has a five-step modulated stair on line 18, a special modulated pulse called a 10T (more about it shortly), and a window; on line 19 are sine-squared pulse, window, and white reference. Field 2 (Fig. 3, bottom right), has multiburst on line 18 and modulated stairstep and white reference on line 19.

About that time CBS was also sending a VITS variation. Field 1, Fig. 4 (top left), was standard, but not field 2 (top right). On line 18 was a five-step modulated stair, a sine-squared pulse, that special modulated pulse, and a long-duration window. On line 19 were a standard modulated stairstep and white reference bar.

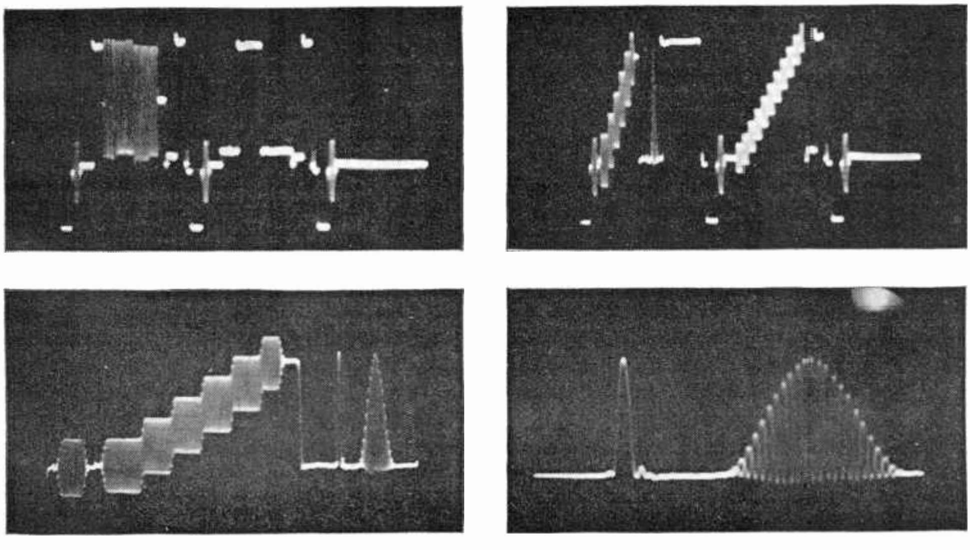
That field-2 line 18 in the CBS test signal is worth spreading out for a closer look. Switch on the 5× multiplier of the A-scope (Fig. 4, bottom left). The first burst is color sync on the back porch of the horizontal pulse. Then comes a burst of 3.58 MHz at zero, and five more at 20, 40, 60, 90, and 100 IRE units.

The next patterns on line 18 are gaining popularity. The narrow one is called a *2T bar*. The wider one is a *20T display*, modulated by 3.579545-MHz signal. Their purpose is quick measurement of envelope delay at both low and high video and chroma frequencies. (ABC alters the 20T phase to show VITS origin; New York is 347° or blue. Chicago is 103° or red, Washington is 241° or green.)

The CBS version is actually a 2T and 14T display. It is shown spread out 25× in Fig. 4 (bottom right). The things to watch are overshoot and symmetry of the 2T pulse and the baseline of the 14T. The latter is wavy in the photo, instead of straight. The distortion reveals delay in some portion of the chroma signal.

A more informative VITS is a continuing

**Fig. 4. CBS version of VITS with field 1 at top left, field 2 at right. The first line of field 2 is expanded at lower left, and lower right is expanded 2T and 14T.**



goal of network, station, and telephone-company engineers. But it may be time for a new Network Transmission Committee to recap who's doing what. The "standard" VITS no longer is.

**Making Sure of Color.** An experiment last year added still another signal to the vertical interval. It was a chroma reference signal and was called Vertical Interval Reference (VIR). Since lines 18 and 19 were already full, the VIR went on line 20.

The VIR was worked out by a Broadcast Television Systems (BTS) committee of the EIA. The purpose is to give network, telephone company, and station engineers a way to check and adjust chroma phase and amplitude. Eventually, transmitter and repeater equipment could have circuitry to sample the VIR and automatically compensate for any chroma discrepancy. Receivers, too, might be so equipped.

The VIR signal is diagrammed in Fig. 5. Program-black reference is at 7.5 IRE units. Luminance (brightness, Y, or video) reference is at 50 IRE units, a reference against which the chroma amplitude must compare.

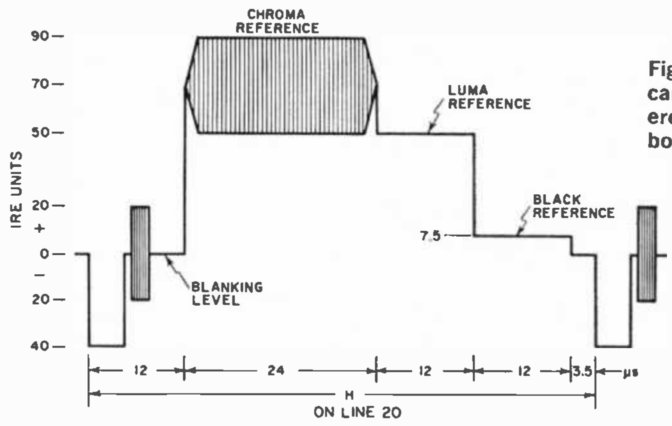



**Fig. 5. Latest EIA test signal is called VIR (vertical interval reference) and is usually on line 20, both fields. It is being tested.**

Chroma is in a bar 40 IRE units high, 20 units above and below an amplitude center of 70 IRE units.

The VIR experiment went on several months. The signal was on line 20 of field 1 part of the time and on line 20 of both fields the rest of the time. All three networks tried out the VIR.

There is still controversy over whether VIR is needed or not. Aims of VIR could be as well served by VITS, say some station people, if equal care were taken with phase and amplitude and the test signal were processed differently in repeaters. The 2T/20T display may be one step in that direction. Meanwhile, if you occasionally spot something on line 20, someone is still trying the VIR signal or some revision of it.

**There's More.** But that's still not all that a color transmitter sends you. The FCC last year approved transmitting coded signals on the first and last 10 $\mu s$ of lines 21, 22, 23, 260, 261, and 262. But no such transmission can exceed 1 second.

So, some commercials are now coded with bars or dots in all four corners. Monitoring services can determine from this digital information when particular commercials are aired. You won't see the dots or bars very long—less than a second. You might catch them on an underscanned monitor. Not many A-scopes display lines beyond 20.

Networks often use a small cue-flag to show when a station can drop away to its own commercials or station identification. The cue-flag is a small white square superimposed in the upper right corner of the active raster. It flashes for about a second. You won't see it unless the raster is underscanned or the picture tube is one of the new square types. (The ends of film reels usually have a round spot or circle in a similar position.)

If you thought the color signal was just monochrome with a little paint added, a rethink is in order. It is sound, video, sync, chroma, tests, references, digital ID's, and, by the time you're reading this, who knows what else. ◈

# RECEIVERS FOR THE SHORTWAVE LISTENER

BY JULIAN D. HIRSCH
*Hirsch-Houck Laboratories*

# PART 2

## TABLE MODEL AND PORTABLE RECEIVERS

LAST month in Part 1 of this article, we discussed the features and test results of a number of communication-type SWL receivers. In Part 2, our discussion is limited to portable receivers and one table-type receiver for shortwave listening.

### TABLE & PORTABLE RECEIVERS

**Midland 13-910.**

Externally, this receiver is similar to many of the small radios used in bedrooms and children's rooms for ordinary AM and FM listening. However, unlike the latter which, at most, cover the AM and FM broadcast bands, the Midland receiver has no fewer than seven tuning ranges. The usual AM and FM broadcast bands are supplemented by a 30-45-MHz (police), 108-135-MHz (air-to-ground), and 145-175-MHz (mobile radio, police, and weather) bands.

The SWL's needs are met only partially, by two bands covering 1.6-4.0 MHz and 4-12 MHz. Concentric with the main tuning control is a smaller fine tuning knob for use on the two high-frequency bands. Its measured range was about 20 kHz at 4 MHz and 90 kHz at 12 MHz. There is also a switchable afc for FM reception. A small tuning meter is operative on all ranges.

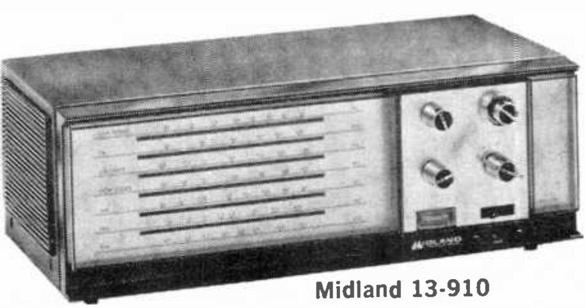
The measured sensitivity of the receiver was 9-11 $\mu$V on the AM broadcast band and 2.2-3.8 $\mu$V on the two SW bands. The vhf sensitivity was not measured, but rough checks showed it to be 30-100 $\mu$V on the various ranges.

The i-f bandwidth (selectivity) was 8 kHz at −6 dB, 23 kHz at −20 dB, 54 kHz at −40 dB, and 125 kHz at −60 dB. Image rejection was negligible at 12 MHz and approximately 30 dB in the lower half of the tuning range.

The dial calibration points were widely spaced (4-MHz intervals on FM and 1-2-MHz intervals on the SW bands), making tuning in a station on a known frequency a matter of luck and skill. However, the accuracy of the dial calibration points was generally good, within 1-2 percent of the indicated frequency. On the FM band, the error was typically 300 to 500 kHz, giving little chance of selecting a desired station in a well-populated area except by trial-and-error methods.

This receiver can serve the beginner and young SWL as an introduction to this fascinating hobby. The stronger SW transmissions can be received well, although the absence of the bands above 12 MHz tends to limit the receiver's usefulness to late afternoon and evening hours, and its selectivity is put to a severe test at those times. We also noticed a tendency to overload and produce spurious responses from any moderately strong signal.

The retail price of the Midland 13-910 receiver is $104.95.


Midland 13-910

**Heath GR-78.**

This one could be described either as a communication-type or a portable receiver. We have elected to classify it with the portables because it is battery powered. The receiver is a very compact, lightweight unit, much smaller and pounds lighter than any other receiver in this survey.

This is a general-coverage receiver, tuning 550 kHz to 30 MHz in five bands and the LF band from 200 to 400 kHz. Externally, it resembles other general-coverage receivers. A slide-rule dial is flanked by a small drum dial with bandspread calibrations for the 10-80-meter ham bands and a signal strength meter with arbitrary calibrations from 1 to 5. Adjacent to the main tuning and band-spread tuning control knobs are the band switch and concentric r-f and a-f controls. Between these are anl, avc/mvc, AM/CW-SSB, 500-kHz crystal-controlled marker signal, receive/standby, and light switches. The light switch is spring loaded; pressing it illuminates the dials and meter.

A single-conversion superhet, the GR-78 has a 455-kHz i-f on the lower five bands. On the highest band, it is a double-conversion receiver with a 4034-kHz first i-f. Selectivity is accomplished with ceramic filters in the 455-kHz i-f. There are also separate AM and product detectors.

The power supply design of the GR-78 is unique—and baffling unless one reads the manual carefully. Its internal batteries are rechargeable nickel-cadmium cells which power the receiver whether or not it is connected to an external power source. The internal batteries are trickle charged by the external source, but only when the receiver is turned *off*. In other words, if the GR-78 is plugged into the ac line when used and unplugged when not in use, the batteries will run down after about 8 hours of operation. The charging rate is based on the receiver being left plugged in at all times and used no more than 8 hours out of a 24-hour period.

No preselector tuning control is provided. Hence, sensitivity varies widely from one end to the other of each tuning range. We measured values of 1.4-6.0 $\mu$V at most frequencies, reducing to 14 $\mu$V at 200 kHz. The i-f bandwidth was 8 kHz at −6 dB, 14 kHz at −20 dB, 22 kHz at −40 dB, and 38 kHz at −60 dB. Image rejection was fair (35.5 dB) at 7 MHz, but the use of double conversion on the high band resulted in a much better than average figure of 37.5 dB at 30 MHz. The S meter had a roughly logarithmic characteristic with 11 $\mu$V producing a reading of S-1 and 700 $\mu$V being required for a full-scale reading of 5 (at 11 MHz).

The major weakness of the GR-78 was its tuning and dial calibration. The small dials are crowded and the tuning was critical. The calibration of the main dial was very good, within 1 percent, but the bandspread dial calibration errors were large. The stability and tuning "feel," in general, were

**Heath GR-78**

not adequate for SSB reception. (Switching on the dial illumination often completely detuned high-frequency SSB signals.)

On the other hand, the receiver did a perfectly satisfactory job of pulling in SW stations, and its size and weight could be significant advantages for portable or vacation use. We question the advisability of the ham band calibrations on the band-spread dial which imply that the receiver could be used for this service. But the SW band calibrations can be of value to many users.

The Heath GR-78 receiver retails for $129.95 in kit form.

**Sony CRF-160.**

This is a 13-band portable receiver. On its lower frequency ranges (150-400 kHz, 530-1605 kHz, and 1.6-4.5 MHz), the CRF-160 is a conventional superhet receiver. Band selection is via pushbutton. Three slide-rule scales are clearly marked, although their calibration intervals are widely spaced at 500 kHz on the highest of the three bands.

Pushing a button marked SW3-SW10 converts the unit to a double-conversion receiver with nine band-spread ranges covering the SW bands at 60, 49, 41, 31, 25, 19, 16, 13, and 11 meters. A large knob set into the right side of the case is used to change bands and display only the selected frequency scale in a window above the main tuning dial.

Although no schematic or technical information was supplied, the performance of the receiver strongly suggested the use of a crystal-controlled oscillator for the first conversion and a stable, fairly linear tunable oscillator covering 600 kHz for the second conversion. Since each SW band covers only 600 kHz, the CRF-160 tunes even less critically on the SW bands than on the broadcast band. A small knob shifts the 100-kHz dial calibration intervals to align with the numbers on the dial scale. Since the receiver has no built-in calibrating signal, one must depend on CHU (7335 kHz) or WWV (10 or 15 MHz) for this purpose. However, we found that setting the calibration lines to center on the dial numerals was sufficiently accurate.

An r-f gain control turns on the bfo when rotated clockwise. Concentric with this control is a ring that tunes the bfo frequency for proper reception of USB or LSB signals. A tone control and a selectivity button that narrows the i-f bandwidth on the AM bands are provided.

A pushbutton selects the FM band which is tuned by a separate knob, dial pointer, and scale. Switchable afc is provided, but it is not necessary since the receiver is quite stable and easy to tune. A spring-loaded switch illuminates the dial and tuning meter when it is depressed. A miniature headphone jack is on the front panel, and a 6″ × 3″ oval speaker is at the top of the panel.

Our measurements of the CRF-160 showed sensitivity varying from 1.6 to 6.0 $\mu$V on the SW bands, 6-7 $\mu$V on the broadcast band, and 6-9 $\mu$V on the longwave bands. The normal selectivity was 7 kHz at −6 dB, 10 kHz at −20 dB, 27 kHz at −40 dB, and 37 kHz at −60 dB. In the sharp selectivity position, these figures were reduced by about one-third. The i-f's were not specified, but a search with a signal generator for image responses indicated a first i-f of about 2.2 MHz. At 7 MHz, image rejection was 35 dB; 26 MHz, it was 0 dB. A number of spurious responses were

**Sony CRF-160**

found at other frequencies, but they were too low in level to present any problems.

The frequency calibration of the bandspread dial scales was excellent, with typical errors between 1 kHz and 20 kHz, even without previous calibration against a known frequency. While this unit is not the equal of those communication receivers having a 1-kHz or better readout capability, it is far more accurate than any of the general-coverage models. Tuning the CRF-160 was easy and non-critical in spite of some backlash in the tuning mechanism. Hard blows on the receiver produced no more than a faint microphonic quaver on CW and SSB signals. In this respect, the CRF-160 resembled the better communication receivers.

The FM dial calibrations were at 2-MHz intervals, with errors of 250-500 kHz at the marked points, making it impractical to identify a station from the dial reading alone. Performance was good with respect to sensitivity, selectivity, tuning ease, and sound quality.

The Sony CRF-160 receiver is retail priced at $249.50.

### Zenith D7000Y

This receiver is an 11-band portable which has a number of conveniences for the camper and boating enthusiast as well as the SWL and general public. The D7000Y covers the standard AM broadcast band, a low-frequency band from 150 kHz to 400 kHz, the FM broadcast band, and the vhf services band from 161 MHz to 164 MHz. For the SWL, there are two general-coverage bands from 1.6 MHz to 3.5 MHz and 3.5 MHz to 9 MHz, and five bandspread ranges covering the 31-, 25-, 19-, 16-, and 13-meter bands. The bandspread tuning ranges average about 1 MHz wide, giving a tuning rate comparable to that on the AM broadcast band.

This is a single-conversion receiver with a 455-kHz i-f for AM reception. Three separate "front ends" are used for the LW/AM/SW, FM broadcast, and vhf bands. A single tuning knob and a large band switch knob are features, the latter rotating the dial scale drum so that only the scale in use is visible.

There are separate r-f and a-f gain (the former turns on agc), tone, and combined bfo switch/pitch controls for CW and SSB reception. Although a conventional diode detector is employed, the bfo signal is injected into the i-f amplifier at a sufficient level for satisfactory SSB reception.

The tuning meter can be used to monitor battery condition by moving a 3-position switch to the right. Moving the switch to the left turns on the dial and meter illumination as well as a retractable chart light on the front panel. Two other switches control FM afc and AM bandwidth.

A world time map is displayed on the inside top cover of the cabinet. A movable index allows the time in any part of the world to be determined at a glance. Also in the cover is a removable book which contains operating instructions, lists of standard time and frequency transmissions, and information on specialized transmissions and the frequencies and locations of SW and FM broadcast stations. Inside the front cover is a rotatable compass scale which can provide directional bearings on a station by observing the null on the tuning meter. A comprehensive instruction manual gives suggestions on using the receiver for direction finding while boating.

The receiver's sensitivity varied by 2.5-4.0 $\mu$V on the SW and AM broadcast bands. At the low-frequency end of each general-coverage band, sensitivity was a poor 16-25 $\mu$V, and was 5.5-10 $\mu$V on the low-frequency band.

With normal bandwidth, selectivity was 7 kHz at −6 dB, 15 kHz at −20 dB, 24 kHz at −40 dB, and 32 kHz at −60 dB. The sharp setting reduced these figures by about one-third. Image rejection was 28.5 dB at 7 MHz and 6 dB at 22 MHz. The frequency calibration was quite good on all bands; the maximum error was about 50 kHz, and typically 10-30 kHz. The FM calibration was also very good, within 100 kHz, although the dial was calibrated at only 2-MHz intervals.

The general-coverage dial scales were quite crowded, but tuning was fairly easy. On the band-spread ranges, the receiver tuned very easily. Although CW and SSB signals could be received, there was considerable hand capacitance which detuned signals when the panel or cabinet was touched. Mechanical stability was fairly good.

The receiver overloaded quite easily on very strong signals, and many spurious responses could be detected with inputs as low as 1000 $\mu$V (although most SW signals are well below this level). In-band images were also evident in the 13-, 16-, and 19-meter bands with the same station appearing twice. Although the receiver gives the impression of being "hot," due to its busy-sounding bands, much of this is the result of spurious and image responses.

Zenith D7000Y

The performance and listening quality on AM and FM broadcasts were good. The overall behavior of the receiver on SW reception was also good.

The Zenith D7000Y receiver sells for $279.95.

### Panasonic RF-5000A

An 11-band portable, the Panasonic RF-5000A was the largest, heaviest, and most expensive of those we tested. A general-coverage, single-conversion unit, it tunes a 160-400-kHz low-frequency band, continuously from 530-kHz to 30 MHz in nine bands, and the FM broadcast band. This receiver appears to have been designed to meet the needs of both our and the Japanese markets since the FM range is 76-108 MHz.

A large rectangular dial has all ranges clearly marked. Pushing a button below the dial illuminates the scales and lights an arrow on the dial next to the band in use. A row of pushbuttons are on top of the receiver. These select the bands (simultaneously turning on power) and separately turn off power. Four smaller buttons are for wide/narrow AM bandwidth, FM afc, anl, and bfo. Turning on the bfo disables the agc. A small thumbwheel is used to control r-f gain. The large tuning knob is mechanically clutched to move the FM dial pointer only when the FM button is depressed. At all other times, only the large AM/SW dial pointer moves. The tuning meter is used to keep tabs on battery condition. Two small knobs control volume and fine tuning (an electrical vernier which is active on only the AM and SW bands), and a pair of small concentric knobs control separate bass and treble tone characteristics.

On top of the receiver are two telescoping antennas for FM reception. A rectangular metal loop swings up from the rear to form an SW antenna for frequencies above 4.5 MHz. Two built-in ferrite rod antennas are used for the lower frequencies. Two speakers—a circular and a larger oval—are operated in parallel.

When the front cover is swung down to operate the receiver, a world time conversion dial is visible next to a pocket containing a collection of hints in several languages on SWL'ing. The open cover extends well in front of the receiver to form a desk surface, but it can be removed if desired.

Sensitivity varied by 2.2-5.0 $\mu$V at all frequencies above 4.5 MHz. It dropped from 5.2 to 35 $\mu$V between 4.5 and 1.6 MHz and varied 11-45 $\mu$V across the two lower frequency bands. The wide i-f bandwidth was 10 kHz at −6 dB, 16 kHz at −20 dB, 30 kHz at −40 dB, and 52 kHz at −60 dB. With the narrow setting, the corresponding figures were 3, 12, 19, and 35 kHz. Image rejection was 26.5 dB at 7 MHz and 14.5 dB at 30 MHz.

The dial calibration was good, with the error typically less than 25 kHz and never more than 50 kHz, except at 30 MHz where it was off by 130 kHz. The FM calibration was in error typically by 500 kHz or more; combined with the calibration intervals 4 MHz apart, this made tuning a particular station largely a matter of guesswork.

**Panasonic RF-5000A**

In tuning the RF-5000A, we were immediately aware of its excellent audio quality and high undistorted output, both far superior to any of the other receivers in the group. The mechanical stability was very good even with hard tapping on the case. We were also surprised to find that the anl worked very well—much better, in fact, than on most of the other receivers having this feature. The FM quality was on a par with the audio performance of the receiver, and the AM quality was at least as good as that of most hi-fi receivers.

The Panasonic RF-5000A receiver retails for $299.95.

**Conclusion.** A careful study of the features in this group of receivers and our test data will reveal that there is no "ideal" receiver for the SWL. Of course, your listening habits should be given the highest priority when shopping for a receiver. The portables, in general, offer the greatest overall utility. Their performance is more than adequate for a great many SWL's. From a practical standpoint, we found little difference between the portables with respect to their effectiveness.

As our tests reveal, a low-cost communication-type receiver is not necessarily better than—or even as good as—a good general-purpose portable. However, low cost is an undeniable plus, especially when the user is a youthful newcomer to SWL'ing.

The best SW performance is definitely offered by the more expensive double-conversion communication-type receivers such as the Allied SX-190, Drake SW-4A, and Heath SB-313. Although their list prices are comparable to those of good portables, the elimination of such features as FM and AM broadcast band reception and battery operation has permitted the enhancement of their basic receiving performances. They are unequivocally fine receivers, their high prices easily justified if tuning accuracy by the serious listener is a must for SW DX.

Bear in mind that the specific figures we obtained for receiver performance may not agree with the manufacturers' published data. This does not mean that either of us is incorrect but simply that test conditions differed somewhat. Since our data were obtained on all receivers under identical conditions, we consider them to be valid as a basis for making comparisons. ◈

# RADIO EMERGENCY CALL BOXES

## OPERATE WITHOUT BATTERIES OR CONNECTING WIRES

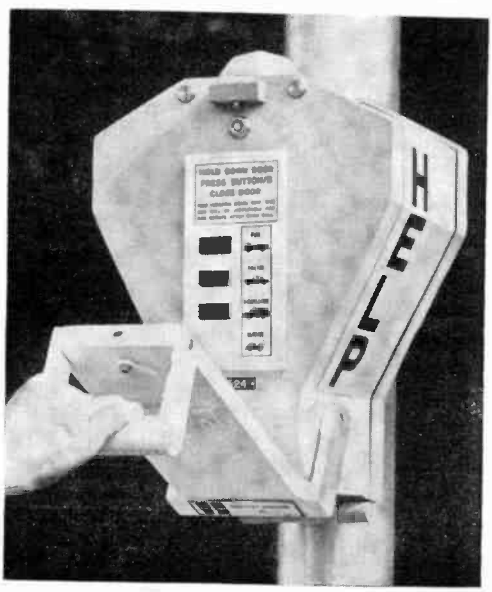
A UNIQUE call-box system for use in summoning emergency assistance on highways and city streets is shown below. Designed to operate without batteries or interconnecting cables, the emergency call box can be easily installed and requires little maintenance over long periods.

In a typical highway use, the boxes are placed about every half mile on both sides of the road. When faced with an emergency or distress situation, the motorist merely walks or drives to the nearest box, opens a door lever, and presses one or more of four buttons marked "Fire," "Police," "Ambulance," and "Service." A coded distress call is received at either a master console located at a central dispatch station or a small console at a substation. Aid can then be dispatched immediately.

Using solid-state circuitry, the boxes derive their power from a patented electromechanical power module, which is activated when the door lever is opened. The electrical charge thus produced is retained temporarily to power the compact, integral FM transmitter. This means no batteries to run down and no dependence on regular electric power, which can fail just when motorists may particularly need help.

Because the solid-state tranmitter circuits are supplied with power only when the door is opened and the emergency buttons are depressed, there is no chance that they can be electronically operated by a false signal. Thus, a box will never pick up a spurious signal such as might be produced by a passing vehicle with a mobile radio transmitter. The call boxes are manufactured by ADT. ◈

**When motorist in need of help pulls down front door handle on the roadside call box, power is automatically turned on. Then when he presses one of the buttons, a signal is transmitted to the central station, right, and the proper aid is sent to him.**



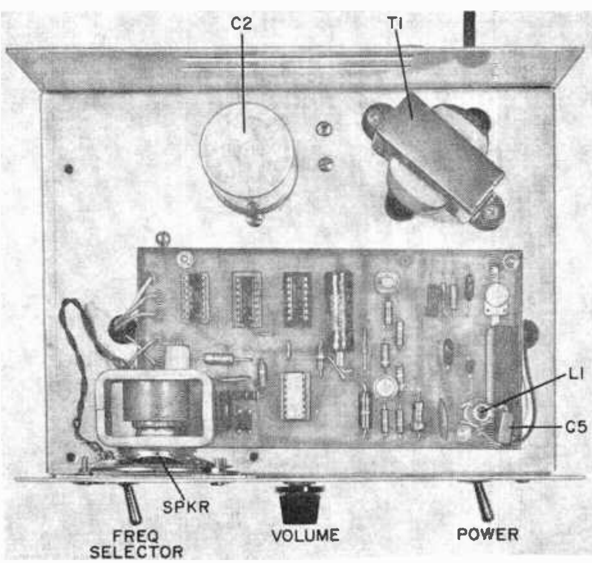

# Build a Crystal-Controlled Musical Instrument Tuner

## AN ACCURATE SOURCE OF 440 HZ, A ABOVE MIDDLE C

BY HANK OLSON

MANY orchestras use the oboe as the instrument to which all of the others are tuned just before a performance. The oboe has been previously tuned to an accurate source of 440 Hz (A above middle C). Although there are many ways of generating the 440 Hz, the most accurate is an electronic system using a crystal-controlled oscillator. In this way, the pitch can be established within 1/10th of a hertz, which is far better than most other tune-up systems. In addition, the 440-Hz tone can be easily divided by two to obtain 220 Hz, which can be used to tune a bassoon.

**Capacitor C5 is mounted on L1. Power supply components are under T1 and C2.**




Since 440-Hz crystals are hard to find, a crystal with a higher frequency and a suitable countdown circuit can be used. Such a circuit is shown in Fig. 1. The oscillator (*Q1*) operates at approximately 901 kHz. This frequency is used because there is usually available a surplus-type crystal (FT241) that will fill the bill. However, before starting this project, it is advisable to check on the availability of the crystal.

The oscillator operates in the 32-pF parallel-resonance mode and is quite stable. Between the crystal oscillator and the first digital divider (*IC2*), are two isolation stages (*Q2* and *Q3*) that drive a Schmitt trigger (*IC1*) to produce a clean toggle waveform.

The digital countdown circuit (*IC2* through *IC4*) needs no adjustment and is inherently stable. Total division is $2^{11}$ or 2048 which brings the crystal frequency down to within 1/10th of a hertz of 440 Hz. The oscillator frequency can be adjusted slightly by *C1* to make the final frequency even closer to 440Hz. If a sharper or flatter A note is required, FT241 crystals are available every 1.042 kHz, making each step represent a change of about ½ Hz in output frequency.

**Construction.** Although almost any type of construction can be used, an etched circuit board makes the work easier (see Fig.

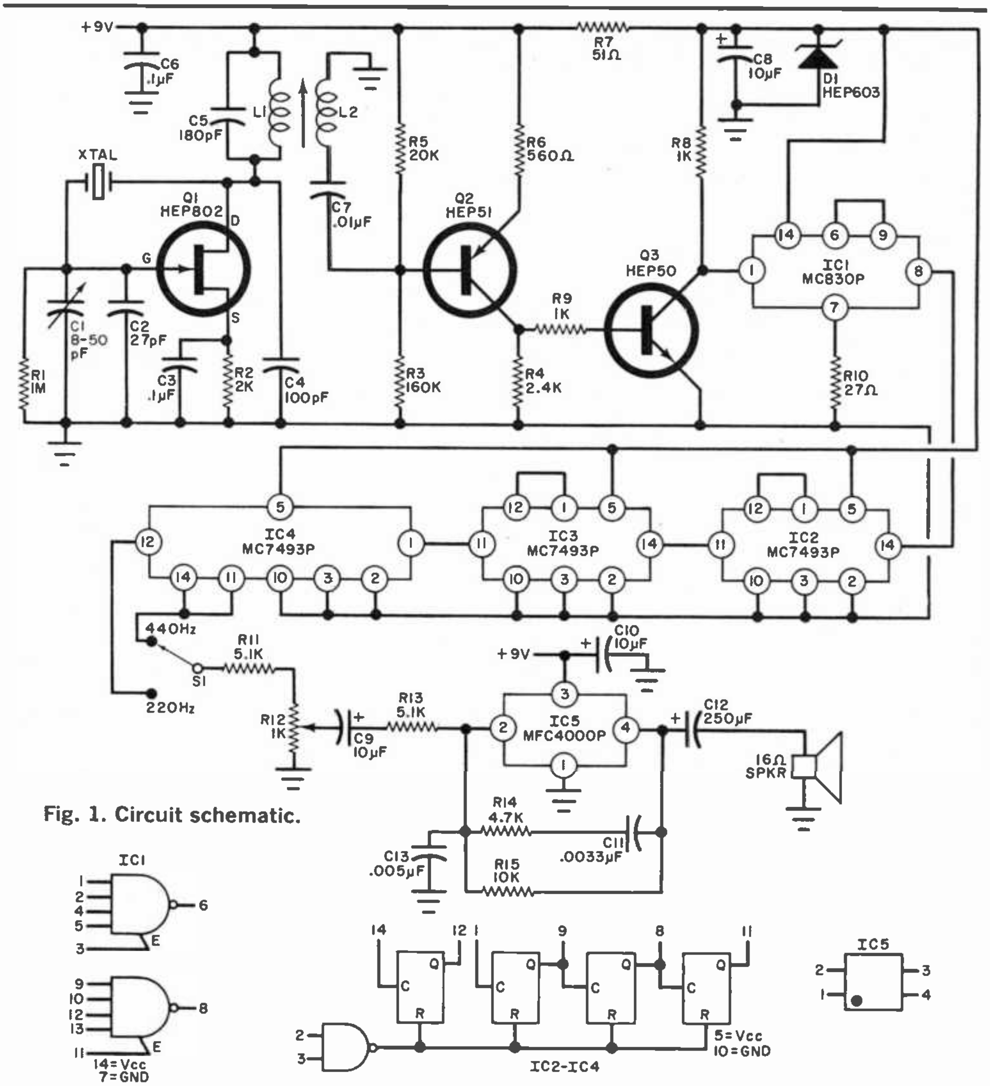



Fig. 1. Circuit schematic.

## PARTS LIST

*C1—8-50-pF ceramic trimmer capacitor*
*C2—27-pF silver-mica capacitor*
*C3,C6—0.1-µF, 50-volt Mylar capacitor*
*C4—100-pF silver-mica capacitor*
*C5—180-pF silver-mica capacitor*
*C7—0.01-µF, 50-volt Mylar capacitor*
*C8-C10—10-µF, 12-volt electrolytic capacitor*
*C11—0.0033-µF, 50-volt Mylar capacitor*
*C12—250-µF, 15-volt electrolytic capacitor*
*C13—0.005-µF, 100-volt Mylar capacitor*
*D1—5.6-volt, 1-watt zener diode (1N4734A, HEP603)*
*IC1—Dual 4-input gate (µL930, MC830P, SN15830N, CD2300E/830, HEPC1030P)*
*IC2-IC4—4-bit binary counter (SN7493N, MC7493P, or similar)*
*IC5—Audio amplifier (MFC4000P HEPC6003)*
*L1—120-243-µH (CTC X2060-8)*
*L2—10 turns #24 wire wound over L1*
*Q1—FET (HEP802, MPF102, or similar)*
*Q2—Transistor (HEP51, 2N3638, 2N5142)*
*Q3—Transistor (HEP50, 2N3646, 2N708)*
*R1—1-megohm, ½-watt resistor*
*R2—2000-ohm, ½-watt resistor*
*R3—160,000-ohm, ½-watt resistor*
*R4—2400-ohm, ½-watt resistor*
*R5—20,000-ohm, ½-watt resistor*
*R6—560-ohm, ½-watt resistor*
*R7—51-ohm, ½-watt resistor*
*R8,R9—1000-ohm, ½-watt resistor*
*R10—27-ohm, ½-watt resistor*
*R11,R13—5100-ohm, ½-watt resistor*
*R12-1000-ohm potentiometer with switch*
*R14—4700-ohm, ½-watt resistor*
*R15—10,000-ohm, ½-watt resistor*
*S1—Spdt switch*
*SPKR—16-ohm speaker*
*XTAL—901.042-kHz FT241 crystal (available from JAN Crystals, 2400 Crystal Dr., Ft. Myers, FL 33901)*
*Misc.—Suitable chassis, knob, line cord, rubber feet, mounting hardware, etc.*
*Note—An etched and drilled PC board is available from Eico, 283 Malta St., Brooklyn, NY 11207 for $3.00.*

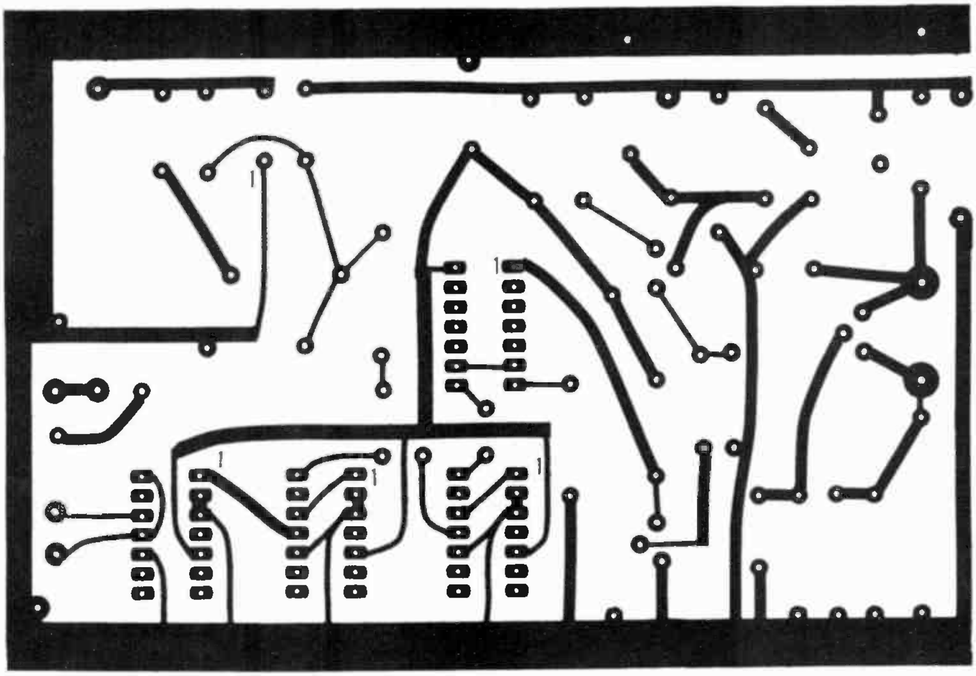
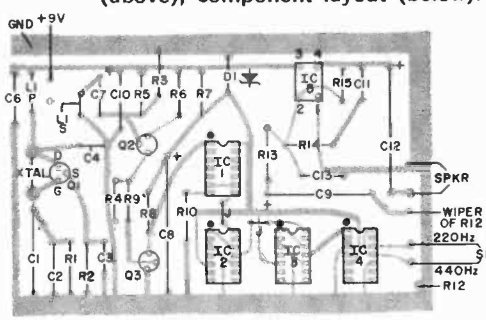


**Fig. 2. Actual size foil pattern (above), component layout (below).**

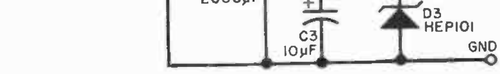



2). A power supply circuit is shown in Fig. 3. Although the photograph of the prototype shows the semiconductors and IC's mounted in sockets, they are optional and the devices may be mounted directly on the PC board.

The power supply transformer and filter capacitor are mounted in any available space on the chassis, with the other components mounted on a multi-lug terminal strip. The PC board is mounted in the chassis on insulated stand-offs. The power on-off switch, the 440/220-Hz selector switch, the volume control, and the speaker are mounted on the front panel.

Once the unit is assembled the frequency can be checked with a frequency counter or by generating Lissajous patterns with a suitable audio generator on a scope. At this point, trimmer capacitor *C1* can be set to adjust the frequency as close as possible.

Operation consists simply of turning on the power, setting the frequency selector switch, and adjusting the volume. ◈




**PARTS LIST**

*C1—0.01-µF, 1-kV ceramic disc capacitor*
*C2—2000-µF, 15-volt electrolytic capacitor*
*C3—10-µF, 15-volt electrolytic capacitor*
*D1,D2—Diode (HEP156, 1N4002, or similar)*
*D3—10-volt, ¼-watt zener diode (HEP101, 1N4104, or similar)*
*F1—1-ampere, 3-AG fuse and holder*
*Q1—Transistor (HEP246, 2N5191, or similar)*
*R1—3900-ohm, ½-watt resistor*
*S1—Spst switch (on volume control)*
*T1—20-volt CT transformer (Triad F90X or similar)*

**Fig. 3. Power supply schematic and parts.**

# Nuclear Radiation & Detection

## Part 3: Radiological Survey Meters

BY J. G. ELLO Radiation Measurements and Instrumentation Electronics Division, Argonne National Laboratory

HOW THE IONIZATION CHAMBER, PROPORTIONAL COUNTER, AND GEIGER-MULLER TUBE OPERATE

SO FAR, we have discussed the phenomenon of radioactivity and found that the three types of radiation are alpha and beta particles and gamma rays. Radiation can ionize atoms. Since the ions have an electrical charge, they can be directed in an electrical field to a positively charged anode (collector) where they are neutralized by supplying the positive ions with electrons from a battery, thus providing a measurable current.

To make use of this detector current, a unit of measurement must be established. Radiological survey meters measure radiation intensity in roentgens per hour (R/hr). A roentgen is the intensity of gamma radiation that will produce one electrostatic unit of ions/cu cm of dry air, or the intensity of radiation that will produce a little over 2 billion ion pairs/cu cm of dry air. The unit of measurement for detectable radioactivity is called the roentgen; the order of magnitude most commonly used is the milliroentgen, or mR.

As an example, a radioactive source is emitting an intensity of 2 mR/hr at a point a certain distance from the source. If you were to stand at this distance for one hour, you would receive a 2 mR/hr exposure. If the intensity were only 1 mR/hr and exposure time were extended to two hours, the radiation dose would be the same since (1 mR/hr) (2 hr) = 2 mR.

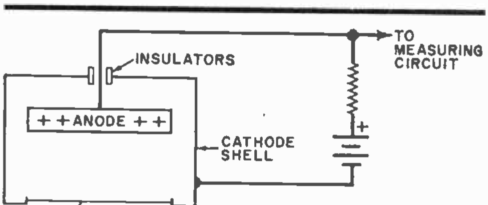



Fig. 1. Ionization chamber.

**Ionization Detector.** The construction of an ionization chamber is quite simple. As shown in Fig. 1, it consists of an insulated central anode enclosed by a shell of conducting material with an alpha window. The ionization chambers used in many commercial survey meters are designed for only beta/gamma radiation. If alpha particles are to be detected, a very thin window is incorporated into one end of the detector to allow the particles to pass into the detector. Most alpha windows are made from 1-mil (0.001") thick Mylar with a coating of conducting material on both sides. In some ionization survey meters, slide-type alpha and beta absorbers are used to permit measuring beta particles in the presence of alpha particles and gamma rays in the presence of beta particles.

An ionization survey meter is shown in Fig. 2. Through use of its built-in absorbers, it can detect and measure alpha, beta, and gamma radiation. This is a self-contained unit, powered by internal batteries. It consists of an ionization chamber, range selector, amplifier, and dc microammeter. The alpha absorber is a 0.01"-thick cellulose sheet, while the beta absorber is a 0.102"-thick plate of aluminum. Its range may vary from about 5 mR/hr to 50 R/hr.

A simplified block diagram of the ionization survey meter is shown in Fig. 3. The ionization detector is maintained at the proper voltage for operation in the ionization-chamber region of the pulse-size/detector-voltage curve. As ions are neutralized at the collector, a small ion-chamber current flows through the selected range

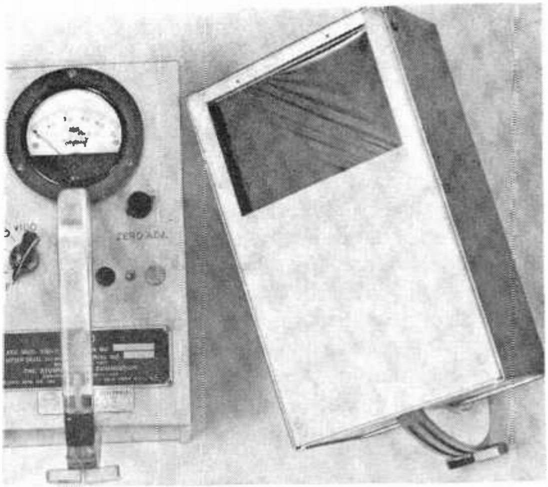



Fig. 2. Two views of ionization survey meter.

resistor. The pulse developed across this resistor is applied to the grid of the amplifier tube or gate of a field-effect transistor. This minute current is amplified and passed through the meter movement which is calibrated in mR/hr.

In use, the ionization chamber is located in the bottom forward position of the instrument with the window on the bottom surface. To detect beta and gamma radiation simultaneously, the aluminum absorber is pulled up; to detect alpha, beta, and gamma radiation simultaneously, both absorber tabs are pulled up.

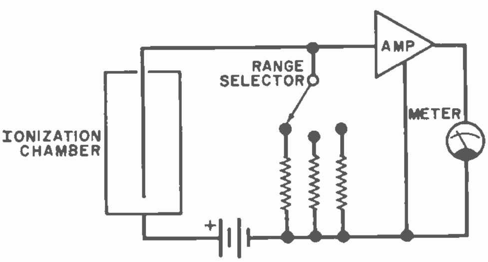



Fig. 3. Schematic of ionization survey meter.

To check the unit's operation, an alpha or beta source is held close to the Mylar window. With the survey meter adjusted to a suitable range, a reading should be indicated on the meter. When making surveys, the unit would be moved across the suspected material at about a 2 in./second scan and close to the material's surface to obtain a true reading. Whenever a rapid jump of the meter pointer is observed, radioactivity is most likely present in the material. To determine if it is gamma radiation, both the alpha and beta absorbers should be in place. To read beta radiation, the alpha absorber is left in place and the beta absorber is removed. To determine beta intensity, the gamma reading is subtracted from the new reading. To check for alpha radiation, both alpha and beta absorbers must be removed. Alpha intensity is determined by subtracting the reading obtained for beta only from the new reading. If no change is observed, there is no detectable alpha radiation present.

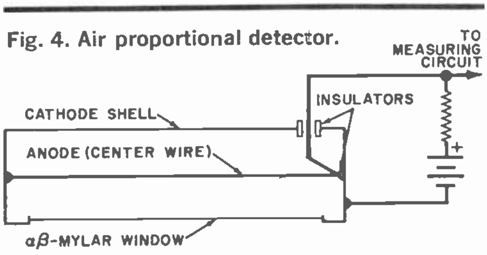
**Proportional Detector.** Although the ionization detector is ideal for detecting the three types of radiation, it needs a very sensitive electrometer tube or field-effect transistor amplifier stage. To eliminate the need for sensitive amplifiers, detectors in which internal amplification takes place have been devised. This amplification is referred to as the proportional region on the pulse-size/detector-voltage curve. In this region, it is possible to differentiate between alpha-, beta-, and gamma-generated pulses.

The internal amplification within the detector is caused by increasing the detector voltage and, hence, the electrical field between the anode and cathode which causes the electrons produced in the primary ionization of the atom to travel at higher velocities. The primary electrons also have sufficient energy to dislodge other electrons in their path and thereby generate larger pulses.

Shown in Fig. 4 is a basic sketch of an air proportional detector. It consists of a 1-mil diameter center anode wire mounted on Teflon insulators. The alpha particle window, fastened to the shell by an adhesive, is made from 0.25-mil thick Mylar. The detector may consist of one center wire or as many as ten wires.

A battery-operated count-rate survey meter and its air proportional detector are shown in Fig. 5. The detector has a metal screen to protect the alpha window against

Fig. 4. Air proportional detector.



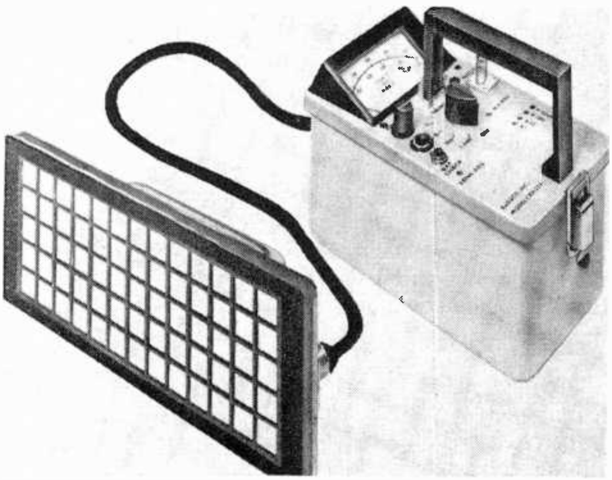


Fig. 5. An air proportional survey meter.

punctures. It is called air proportional because it contains air instead of a counting gas like that used in Geiger-Muller detectors. The detector is capable of responding to all three types of radiation and, through the use of a discriminating control, identify pulses produced by alpha particles and those produced by beta particles.

The survey meter consists of an adjustable detector, high-voltage power supply, range selector, amplifiers, discriminator, and count-rate circuit which supplies current to the dc microammeter. The meter is calibrated in counts/minute instead of mR/hr as in the ionization and Geiger-Muller survey meters.

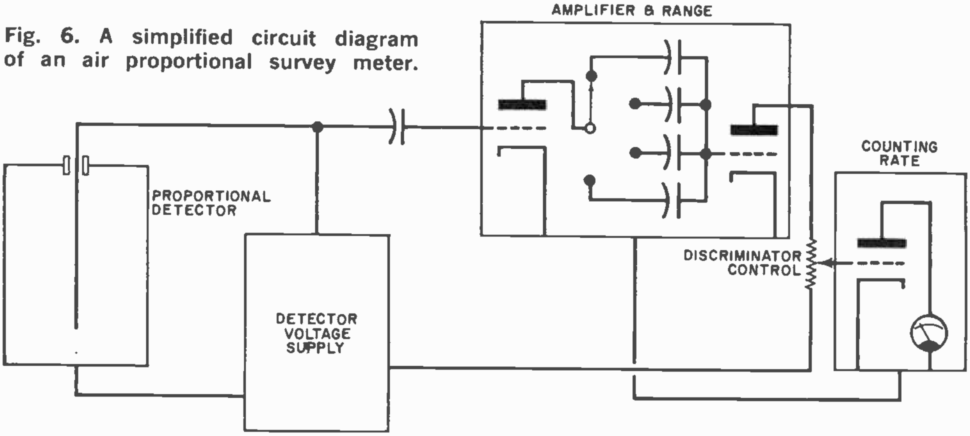
The simplified block diagram of the survey meter is shown in Fig. 6. The detector is set to operate in the proportional region by means of the detector voltage supply. Pulses produced at the center wire (anode) are coupled to the grid of the first amplifier stage and are then coupled to the second amplifier through the range selector circuit. At the discriminator control, pulses of proper size are selected and fed to the count rate circuit which supplies the dc current for the meter.

The average efficiency of an air proportional detector is about 10-15 percent; the detector, therefore, is affected by only 10-15 percent of the total disintegration taking place. For example, if a radioactive source disintegrates at a rate of 1000 disintegrations/minute (d/min), the detector "sees" about 100-150 d/min.

The surveying technique is the same as for ionization survey meters. The proportional survey meter is used mainly in the field for alpha detection and measuring. If beta and/or gamma radiation are to be measured, the discriminator control must be adjusted to pass the smaller pulses they produce. In addition to gamma pulses, beta and alpha pulses, if present, will also be indicated under these conditions. Hence, the unwanted reading (in this case, the alpha reading) must be subtracted from the total reading. Absorbers can also be used as in the ionization survey meters.

**Geiger-Muller Detector.** Often referred to as the "G-M tube," the Geiger-Muller detector is the most often used radiation detection instrument. It operates in the Geiger-Muller region of the pulse-size/detector-voltage curve. The main difference between the proportional detector and the G-M tube is that in the former, the incident radiation produces an avalanche of electrons at only

Fig. 6. A simplified circuit diagram of an air proportional survey meter.



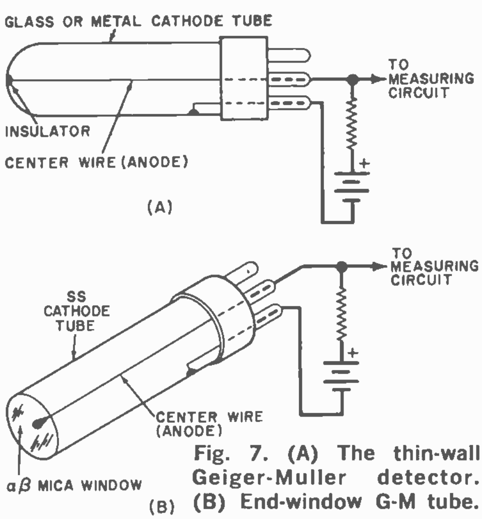



**Fig. 7. (A) The thin-wall Geiger-Muller detector. (B) End-window G-M tube.**

one point in the detector, while in the latter, the electron avalanche spreads along the entire length of the wire anode. The pulse size in the proportional detector varies with the number of secondary electrons produced. In the G-M tube, electron amplification is much larger so that the pulse size is practically independent of the number of electrons produced per nuclear radiation incident. The G-M tube, therefore, cannot discriminate between types of radiation.

The larger pulse size is due to the high electrical field and the fact that the G-M tube is filled with a counting gas, such as neon plus halogen, instead of air. This provides an additional electron amplification factor, referred to as "gas amplification." The main advantage of gas amplification is that the detector itself requires less external amplification.

Shown in Fig. 7A is a basic thin-wall G-M tube, while Fig. 7B depicts a basic end-window G-M tube. The cathode is stainless steel or glass tubing with a conductive coating on the inside.

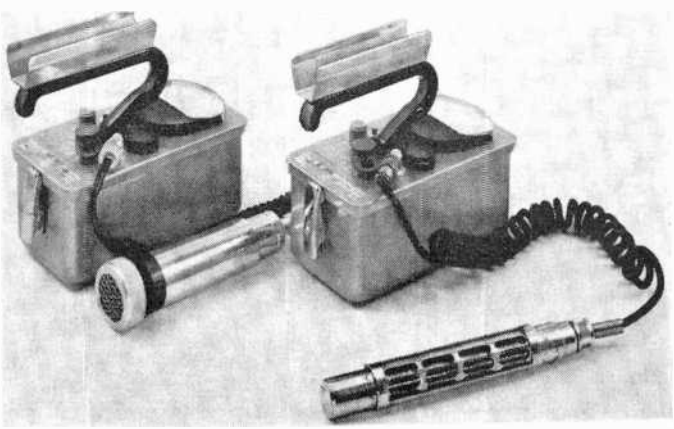
To detect alpha radiation, the wall of the tube must be very thin. For this application, the G-M detector is fabricated with a very thin window as shown in Fig. 7B. The cathode material, usually made from stainless steel, is about 0.003" thick, mainly for strength. The end window is made from very thin mica. The center wire is supported only at the base end, while the free end is tipped with a glass bead to prevent spurious internal discharges.

In Fig. 8 are shown two battery-powered G-M survey meters. The end-window G-M survey meter is at the left; a thin-wall G-M meter is on the right. Both instruments contain a high-voltage detector supply, amplifier and trigger stages, and a drive circuit for the dc microammeter. Like the proportional survey meter, an audio jack is provided for aural monitoring.

A simplified block diagram of a G-M survey meter is shown in Fig. 9. The detector is maintained at a fixed voltage to operate in the Geiger-Muller region of the pulse-size/detector-voltage curve. Due to the detector gas electron amplification, a pulse amplifier is not required; detector pulses are coupled directly to a two-tube trigger circuit which modifies the pulse sizes and feeds them to the metering circuit which is calibrated in mR/hr. The coupling between the trigger tubes serves as the range selector.

The walls and mica windows of the G-M tube are very thin; so, care must be exercised to avoid any physical shock to the detector. Unlike an ionization survey meter which can work if the detector's window

**Fig. 8. (Left) End-window and (right) thin-wall Geiger-Muller survey meters.**



is ruptured, G-M detectors become inoperative if the wall or window is damaged.

Another limitation of G-M detectors is their inability to respond indefinitely to radiation, which can be done by ionization and air proportional detectors. The normal life of a G-M tube is about a billion counts, after which efficiency drops off. Many G-M tubes cease to give any indication and may read zero mR/hr when exposed to a very high radiation intensity.

**Scintillation Detector.** Another type of detector used in surveying radioactivity is known as the "scintillation detector." It is made from a phosphorescent material which gives off flashes of light called scintillations, when exposed to nuclear radiation. Modern scintillation materials are in the form of crystals, liquids, or gases. The most widely used at the present time is a sodium iodide crystal, optically coupled to a #6292 photomultiplier tube.

When exposed to nuclear radiation, the scintillator gives off a glow which is converted into electrical pulses by the photomultiplier tube. The scintillation detector consists of an optical coupling system contained inside a light-tight package. To detect alpha and beta particles, the housing must have a very thin opaque window to exclude all outside light while passing only the radiation particles.

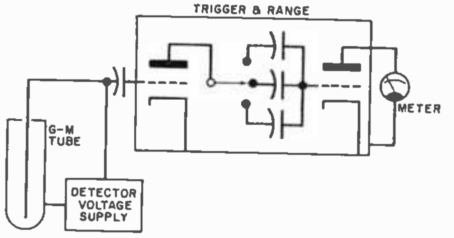



**Fig. 8. Basic diagram of G-M survey meter.**

The magnitude of the electrical pulses generated by the scintillations is proportional to the energy of the radiation. In most cases, the pulse information is analyzed in a multichannel pulse-light analyzer to identify nuclear radiation by type. In addition, the scintillation detector can operate in counting ranges many times higher than the G-M detector.

**Solid-State Detector.** One of the newer developments in radiation detection is the solid-state detector. It operates on basically the same principle as the G-M tube and ionization detector except that it employs a semiconductor material such as silicon instead of a gas for the counting material. When employed as a detector, the silicon is in a highly purified state and, like other detectors, is sensitive to and can measure energy levels of alpha, beta, and gamma radiation.

Silicon diode detectors can be made very small, so small in fact that they can be mounted in hypodermic needles. Most detectors, however, measure about 1" in diameter by 1/16" thick. They are used mainly in the health physics field for counting airborne radioactive particles.

**Non-electronic Detectors.** Radiological survey meters discussed above are electronic instruments used for measuring radiation intensity at a given moment in time. There are, however, devices which measure the total accumulated radiation dosage to which an object is exposed over a period of time (as short as a few minutes or as much as a week or more).

The self-indicating dosimeter is basically a miniature ionization chamber made in the form of a fountain pen. It contains a capacitor which is originally charged up to a fixed voltage. When exposed to radiation the ions formed in the chamber remove some of the capacitor's charge and reduce the voltage. The voltage charge remaining is measured by a movable quartz fiber built into the unit. An internal scale, when held to the light and viewed through a lens magnifier, indicates this voltage drop in mR/hr.

Another type of dosimeter employs the radioluminescence phenomenon. Called a thermoluminescent dosimeter, it works in a manner similar to the scintillation detector. However, external equipment is needed to "develop" the indicating medium and to count the accumulated radiation intensity received.

One of the oldest known types of detectors is the film badge. The radiation received on exposure causes the film to darken in proportion to the amount received. Special film badges have been developed for low-energy beta, gamma, X-ray, and neutron types of radiation. Detection of alpha particles is virtually impossible due to the fact that the film must be packaged in an opaque container. External equipment is needed for developing and interpreting the film's information. ◈

# REPORT ON PROPOSED CLASS "E" CB BAND

WILL THE HAMS LOSE PART OF THEIR 220-TO-225-MHZ BAND? IT'S POSSIBLE UNDER AN EIA PROPOSAL BEFORE THE FCC.

BY RICHARD HUMPHREY

THERE was much weeping and wailing and gnashing of teeth back in 1958 when radio amateurs were elbowed from the 11-meter band to the 10-meter band and the 27-MHz frequencies were given to a fresh upstart called the "Citizen Bander." And it's beginning to sound as if another CB invasion of ham frequencies is about to take place.

While the FCC has yet to issue a Notice of Proposed Rule Making on the Electronic Industries Association's petition to create an 80-channel vhf/CB "Class E" band in the first two MHz of the 220-225-MHz amateur frequencies, a spokesman says "it's due soon."

## No More Frequencies

According to a study prepared for the Department of Commerce, all available radio frequencies had been allocated by 1965. Further, the FCC was beginning to advocate a "use it or lose it" policy. If a communications service or band of frequencies wasn't being used, it was taken away and given to someone who *would* use it. As Irving Brownstein of the FCC staff put it "frequency cannibalism may be a major means of survival."

Surprisingly, even the powerful broadcasting interests got hacked. They had broken their backs to get the uhf TV channels—420 MHz of radio-frequency spectrum that stretched from 470 MHz to 890 MHz—and then had given them little use. Twenty years ago this "grab-it-and-sit-on-it" power play would have made a few people mad but the majority would have shrugged their shoulders and muttered "Why fight City Hall?"

In 1970, though, things were different and the bottom seven channels (14 through 20; 470 MHz to 512 MHz) and the top 14 channels (70 through 83; 806 MHz to 890 MHz) were opened to public safety, industrial, land transportation, land mobile (other than common carriers) and domestic public use with the television interests retaining certain limited rights. The question: if the broadcast industry can lose 126 MHz of radio-frequency spectrum through non-use, what about those 2 MHz in the little-used 220-225 MHz amateur band?

Then, too, the 27-MHz Class-D band frequencies are "skip" frequencies. And it's too much to expect from a CB'er—not interested in "self policing" in any event—that he ignore a juicy (and illegal) DX call. And DX'ing doesn't fit in with the avowed purpose of Citizens Band radio, namely a "short-distance radiocommunications service." The point: the EIA petition might have come at the right moment and the FCC might be inclined not only to take 2 MHz away from radio amateurs but also eliminate Class D entirely and put all Citizens Band activity on 220 MHz.

## Like Marine Band

The FCC—under the press of a tremendous pleasure-boat population—did exactly that with marine communications and

# CB CLASS "E" (VHF BAND)

| CHANNEL | FREQUENCY[1] | USE | NOTES |
|---|---|---|---|
| 1 | 220.000 | Mobile | 2 |
| 2 | 220.025 | " | 2 |
| 3 | 220.050 | " | 2 |
| 4 | 220.075 | " | 2 |
| 5 | 220.100 | " | 2 |
| 6 | 220.125 | " | 2 |
| 7 | 220.150 | " | 2 |
| 8 | 220.175 | " | 2 |
| 9 | 220.200 | Emergency Only | 3 |
| 10 | 220.225 | Mobile | 2 |
| 11 | 220.250 | Mobile Calling | 4, 5 |
| 12 | 220.275 | Travel Assistance Only | 4 |
| 13 | 220.300 | " | 4 |
| 14 | 220.325 | Weather Advisory | 4 |
| 15 | 220.350 | Traffic Advisory | 4 |
| 16 | 220.375 | Mobile | 6 |
| 17 | 220.400 | " | 6 |
| 18 | 220.425 | " | 6 |
| 19 | 220.450 | " | 6 |
| 20 | 220.475 | " | 6 |
| 21 | 220.500 | Mobile Calling | 4, 5 |
| 22 | 220.525 | Mobile | 6 |
| 23 | 220.550 | " | 6 |
| 24 | 220.575 | " | 6 |
| 25 | 220.600 | " | 6 |
| 26 | 220.625 | " | 6 |
| 27 | 220.650 | " | 6 |
| 28 | 220.675 | " | 6 |
| 29 | 220.700 | " | 6 |
| 30 | 220.725 | " | 6 |
| 31 | 220.750 | " | 6 |
| 32 | 220.775 | " | 6 |
| 33 | 220.800 | " | 6 |
| 34 | 220.825 | " | 6 |
| 35 | 220.850 | " | 6 |
| 36 | 220.875 | General Use | 7 |
| 37 | 220.900 | " | 7 |
| 38 | 220.925 | " | 7 |
| 39 | 220.950 | " | 7 |
| 40 | 220.975 | " | 7 |
| 41 | 221.000 | " | 7 |
| 42 | 221.025 | " | 7 |
| 43 | 221.050 | " | 7 |
| 44 | 221.075 | " | 7 |

# CHANNEL ALLOCATION
## (As Proposed by EIA)

| CHANNEL | FREQUENCY[1] | USE | NOTES |
|---|---|---|---|
| 45 | 221.100 | General Calling | 5, 7 |
| 46 | 221.125 | Business | 2, 8 |
| 47 | 221.150 | " | 2, 8 |
| 48 | 221.175 | " | 2, 8 |
| 49 | 221.200 | " | 2, 8 |
| 50 | 221.225 | " | 2, 8 |
| 51 | 221.250 | " | 2, 8 |
| 52 | 221.275 | " | 2, 8 |
| 53 | 221.300 | " | 2, 8 |
| 54 | 221.325 | " | 2, 8 |
| 55 | 221.350 | Calling | 2, 5 |
| 56 | 221.375 | Marine | |
| 57 | 221.400 | " | |
| 58 | 221.425 | " | 9 |
| 59 | 221.450 | " | 9 |
| 60 | 221.475 | " | 9 |
| 61 | 221.500 | Local Area | 9, 10 |
| 62 | 221.525 | " | 9, 10 |
| 63 | 221.550 | " | 9, 10 |
| 64 | 221.575 | " | 9, 10 |
| 65 | 221.600 | " | 9, 10 |
| 66 | 221.625 | In-Plant | 9, 11 |
| 67 | 221.650 | " | 9, 11 |
| 68 | 221.675 | " | 9, 11 |
| 69 | 221.700 | " | 9, 11 |
| 70 | 221.725 | " | 9, 11 |
| 71 | 221.750 | Local Traffic Control | 9 |
| 72 | 221.775 | " | 9 |
| 73 | 221.800 | " | 9 |
| 74 | 221.825 | " | 9 |
| 75 | 221.850 | " | 9 |
| 76 | 221.875 | Road Condition Information | 9, 12 |
| 77 | 221.900 | " | 9, 12 |
| 78 | 221.925 | " | 9, 12 |
| 79 | 221.950 | " | 9, 12 |
| 80 | 221.975 | " | 9, 12 |

NOTES: Use is restrictive, i.e., channels may be used *only* for stated use. 1. Frequency in MHz. 2. Between units under same license. 3. Same use as in channel 9 Class D. 4. General calling permitted. 5. General calling for contact only; units must switch to a working channel for traffic. 6. Between units of same or different licenses. 7. Between units of same or different licenses, base or mobile. 8. Business communications only between units under the same license. 9. Channels 61 through 80 are limited to one-watt output to the antenna. 10. Local use of units with same callsign. 11. For use within plants, factories, etc. 12. TX audio callsigns.

eliminated most of the congestion and interference in the maritime service. As of January 1, 1972 there can be no new installation of 2-3-MHz marine radiotelephones unless the vessel is already equipped with a validly licensed vhf/FM two-way radio operating between 156 and 162 MHz, which are line-of-sight frequencies. The Commission also requires that vhf communications be used when the maritime mobile stations "are within vhf range." By simply taking advantage of a frequency characteristic, the FCC—by January 1, 1977—will have effectively separated "local" and "distance" communications and will slowly be reducing interference in the service during the 1972-1977 period. And don't forget that aeronautical communications in and around airports have been on vhf for years to prevent interference hundreds of miles away.

The EIA petition makes pointed reference to the Commission's action in the vhf/FM marine band and suggests that "the vhf marine regulation be referred to as an excellent example of providing the greatest use to the general public of the limited frequency spectrum available to satisfy the growing need for more short-range 'personal communications.'" We have a hunch the FCC might find this idea attractive.

The political practicalities are rather interesting, too. The Electronic Industries Association represents a financially robust and powerful group. The EIA certainly did not keep its action secret so it must be assumed that the manufacturers are for it as would be the makers of antennas, microphones, and components. Their attitude may change if the 27-MHz band bites the dust for they obviously want *both* "D" and "E." With the large inventory the industry has tied up in 27-MHz equipment, stock, etc., they'd be sure to oppose any move to cut the Class D band.

Against these powerful forces will be the ARRL. The question: Can David once more successfully defend his title?

### Position of the FCC

The function of the FCC in all this is that while it has the right and responsibility to rule "yes" or "no" in the matter, it will—and must—listen to the pro's and con's from all comers. A Notice of Proposed Rule Making is a notice to the public-at-large that the FCC is *considering* a change in its Rules and Regulations. This move can be made on its own initiative or as a result of a petition from the outside.

The Commission allows a reasonable length of time after a Notice of Proposed Rule Making has been issued for comments and yet another length of time for replies to those comments. If you're "fer" or "agin", *write*. While there are definite forms and rules to be followed in filing official comments, the FCC has waived these requirements many times in the past and considered "letters and informal comments."

Another thing about the 27-MHz operation that has irked the FCC and might lead it to favor Class E "only" is the operator who refuses to identify his station. Much work has been going on behind FCC-scenes to require a tamper-proof, computer-coded, automatic-identification module in practically all two-way radio transmitters and a brand-new vhf/CB band would be a great place to start.

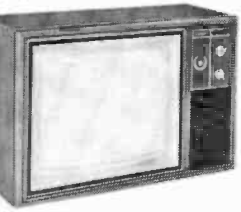
We can't believe the FCC will go along with the simplified licensing procedure suggested in the EIA petition: using the initials of the applicant's state and the last six numbers of his Social Security number. If anything, the Commission will probably stiffen CB licensing. One FCC representative mentioned a simple examination on which "the applicant must get all the answers right. We'll let them use a book, anything they want to, but they've got to get 100%."

The antenna height change asked for by the EIA—20′ limit above the nearest man-made or natural object within 500 yards or 60′ above existing terrain whichever is higher—is not too much different from what is presently required in Class D.

In an editorial, *QST* magazine has criticized the specific uses (see table) presented in the EIA petition. But examination of Parts 81 and 83 covering the maritime mobile service shows that not only does limiting a definite channel(s) to a definite use(s) solve many problems but also that it isn't as complex as it might seem.

One last item which might see the end of 27-MHz operation is that it has been a bobble from beginning-to-end on almost everyone's part and it has left a distinctly bad taste in the FCC's mouth. It may be that the Class-D Citizens Band will end "not with a bang" but a resounding "ptooey!" ◈

# 10 New Heathkit Projects



499.95* less cabinet

## NEW Heathkit 21V Color TV — Solid-State Plus Detent UHF Tuning

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Kit GR-271, less cabinet, 121 lbs. .................................. 499.95*

Assembled GRA-501-21, table model cabinet shown, tough walnut Marlite® finish, 33 lbs. .............................. 54.95*

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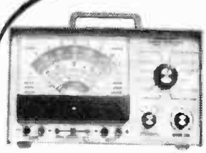
A kit for the whole family to build and enjoy. The all-solid-state TO-1160 Heathkit/Thomas Spinet has full 44-note keyboards for Solo and Accompaniment, exclusive Color-Glo keys that light up to indicate notes and chords. With the Color-Glo course included you'll be playing songs almost instantly. There are six solo stops — flute 16′, 8′ and 4′, trumpet 8′, oboe 8′, and violin 8′. Five accompaniment stops — horn 8′, diapason 8′, melodia 8′, cello 8′, and pedal voice with 16′ & 8′ combined. Plus both regular and a new "light" vibrato effects. Other features include keyboard jacks for private earphone listening or use of a tape cassette deck. The beautiful pecan-veneer cabinet is shipped fully assembled, includes bench. The TO-1160 Spinet organ is one of the most exciting gifts you can give or get for Christmas.

Kit TO-1160, 211 lbs. .......................................... 689.95*



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For 3, 4, 6 and 8-cylinder engines. The CM-1050 includes leads and accessories for testing conventional, transistor, and magneto ignition systems, regardless of voltage or grounding. Uses 3 "C" batteries (not included).

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## NEW Heathkit C-D Ignition System

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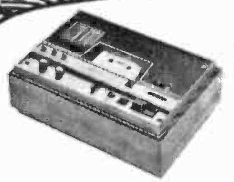

A kit-form cassette deck utilizing the famous Dolby® noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or $CrO_2$ bias control. Domestic-make tape transport comes preassembled for easy kit building.

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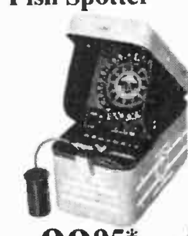

Flasher-type sounder with two ranges reading 0-60′ and 0-240′. Audible alarm can be set to sound at any level in between. Super Bright neon light. Runs on 12 VDC ship's power.

Kit MI-2901, 9 lbs. ....... $99.95*

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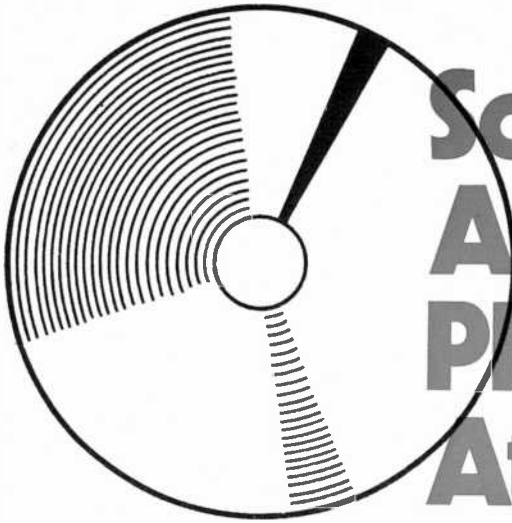


# Sound-Activated Photoflash Attachment

## FREEZE HIGH-SPEED MOTION USING THIS SIMPLE CIRCUIT

**BY VIC LESHKOWITZ**

HAVE you ever wondered how "frozen motion" photographs are made? Like the one that shows a balloon in the process of bursting as a needle penetrates the skin? They are easily made and you can do it yourself if you have a camera with a "bulb" or "time" position, an electronic photoflash (strobe), and the circuit shown below.

**Theory of Operation.** An electronic strobe uses the closing of a switch within the camera to energize the flashtube circuit. This occurs automatically when the camera shutter release is operated to take a picture. As shown below, an SCR can be used to simulate the camera switch. When the SCR is turned off, it has a very high resistance; when fired, its resistance is very low.

The microphone senses the sound produced by the action to be photographed; and this signal is amplified by the high-gain audio module. Transformer *T1* steps up the output signal and generates the trigger pulse for the SCR. Sensitivity potentiometer *R1* determines the sound level required to trip the SCR and thus determines the moment of firing of the electronic strobe.

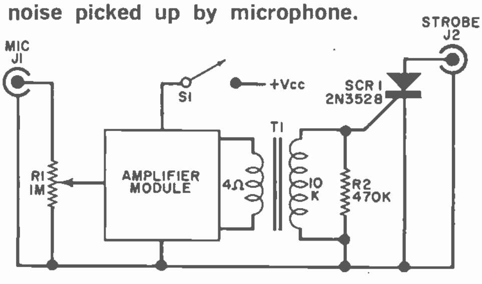
Since sound travels at approximately 1000 ft/s, each foot between the microphone and the sound source represents about 1/1000 of a second in time delay. Thus the positioning of the microphone is very important if high-speed action is desired.

**Construction.** The physical size and power requirements of the circuit are determined by the audio amplifier module

### PARTS LIST

*B1—Battery suitable for audio module used*
*J1—Miniature phone jack*
*J2—Phono connector*
*R1—1-megohm potentiometer with S1 attached*
*R2—470,000-ohm, ½-watt resistor*
*S1—Spst switch on R1*
*SCR1—Silicon controlled rectifier (2N3528, HEP621, or similar)*
*T1—Audio output transformer 4/10,000 ohms (Stancor A3822 or similar)*
*Mic.—Crystal microphone*
*Module—Any solid-state module capable of driving a speaker (Lafayette 19-55103 or similar)*
*Misc.—Electronic flash extension cable (Kaiser 1421 or similar), battery holder, phono plug, suitable chassis, multi-lug terminal strip, mounting hardware, wire, etc.*

**The SCR simulates camera flash switch and is triggered by the noise picked up by microphone.**



used. Although a low-cost Lafayette module (19-55103) was used in the prototype, almost any transistor or IC audio module capable of driving a 4- or 8-ohm speaker will suffice. These are usually battery powered.

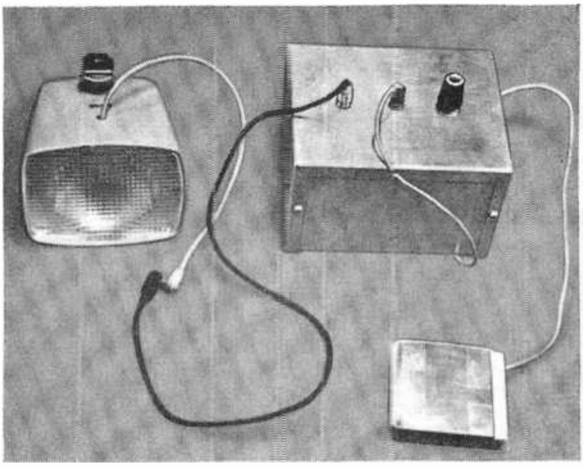
Mount the audio module and battery in a chassis with the input (*J1*) and output (*J2*) connectors, the sensitivity control, and the on-off switch on the front panel. Transformer *T1* is mounted directly on the chassis bottom with a multi-lug terminal strip to hold the remainder of the components.

Secure an electronic flash extension cable from a camera supply house and remove the jack that goes to the camera. Strip the ends of the two leads and temporarily solder-tack the two leads to the connections on a conventional phono plug, which will be inserted in *J2*.

With the microphone connected to *J1* and the strobe attached to *J2*, make sure that the strobe is charged and ready to fire. (The little red light should be on.) Turn on the power to the module and adjust the sensitivity control until a sound activates the flash. If the flash does not occur, the connections to *J2* may be wrong. Unsolder the leads on the *J2* phono connector and reverse them. If the strobe still does not fire, check that there is an audio signal across *R2* with the sensitivity control up and some sounds in the room. If there is an audio signal, then the SCR may be at fault.

**Operation.** The sound-triggered flash pictures should be taken in a reasonably dark room. Total darkness is not essential as you will probably have to stop the camera down to the point where a little light will not register on the film. Place the shutter speed dial in the bulb position; and, using the guide index of the film in conjunction with the indicator on the strobe, set the lens opening for the flash-camera to subject distance. If you are using an SLR, a closeup lens may be used for a more dramatic effect. Try to keep the camera and flash about the same distance from the subject because the dial on the flash is calibrated for this type of use.

With power applied to the sound module and the strobe ready to fire, slowly turn up the sensitivity control and make a sound of about the same volume as the event to be photographed. Adjust the sensitivity control to fire the flash with this sound. Make a note of the sensitivity dial setting and turn the sensitivity down.

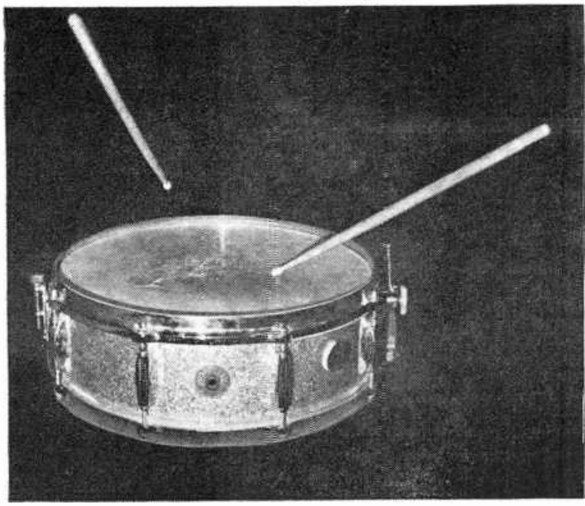


**Strobe (upper left), circuit chassis, and mike are attached as shown here.**

Allow time for the strobe to recharge, position the microphone near the target (but not within the photographed area), and focus the camera on the subject. Open the camera shutter by placing the shutter mechanism in the time or bulb position. Return the sensitivity control to its predetermined position, execute the event, and close the camera shutter. That's all there is to it.

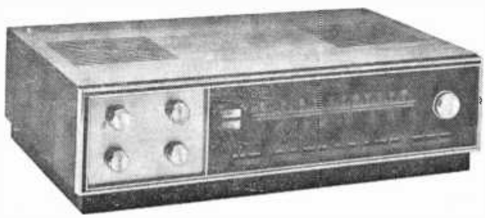
Remember that the microphone-to-noise source distance represents the time delay between the action and the firing of the strobe. This can be adjusted to stop the action at almost any point. ◈

**This photo was taken by dropping the sticks onto drum, triggering flash.**



# Product Test Reports

## HEATHKIT AR-1500 AM/STEREO FM RECEIVER
### (A Hirsch-Houck Lab Report)

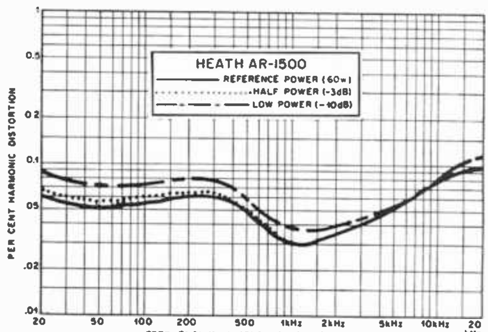


THE NEW Heath AR-1500 stereo receiver is a logical development of their popular AR-15—basically quite similar, yet with a major electrical and mechanical redesign. Although it is at least as complex as the AR-15, the AR-1500 is easier to build. The parts for each of its ten major subassemblies (AM r-f circuit board, phono preamplifier, etc.) are packaged separately, which is an important consideration in a kit comprising many hundreds of components. The final assembly and any subsequent service are further simplified by the extensive use of plug-in circuit boards with hinged sockets, and wiring harnesses connecting the various sections.

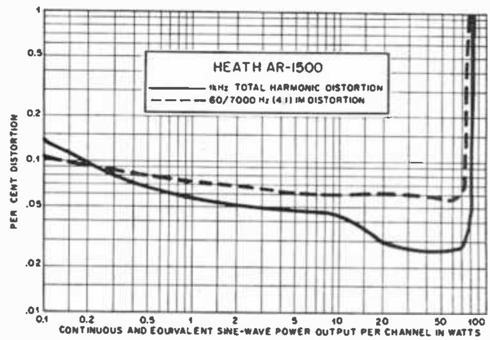
However, construction of the AR-1500 is still a lengthy process. Some 116 pages of the 247-page assembly manual are devoted to the actual wiring and assembly of the kit. It is to Heath's credit that the AR-1500 can be completely tested and adjusted for correct operation by a layman, without using external test instruments. To do this, the receiver's signal-strength meter can be switched to make resistance and voltage measurements, using built-in test leads. Each circuit board is tested separately, and the possible causes of any incorrect meter indications are suggested at each stage of the process.

The FM front end is pre-aligned, and the i-f section uses sealed, fixed-tuned LC filters that never require alignment. So FM alignment is concerned only with the metering and noise squelch circuits. The multiplex adjustments are made with a received stereo FM broadcast signal. The AM tuner also has a fixed-tuned i-f filter, so its alignment consists only of tracking the front end to match the tuning dial calibrations.

Specifications for the AR-1500 are extensive, but a few of the key items show its essential qualities. The FM tuner has a rated IHF usable sensitivity of 1.8 $\mu$V,

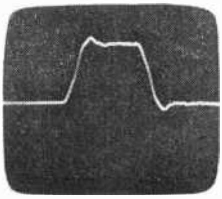



Curves on graph show percent harmonic distortion present at various power levels between 20 and 20,000 Hz.

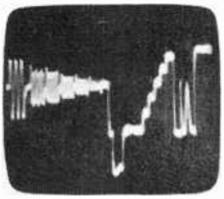



Total harmonic and intermodulation distortion are shown for continuous sine-wave output power per channel.

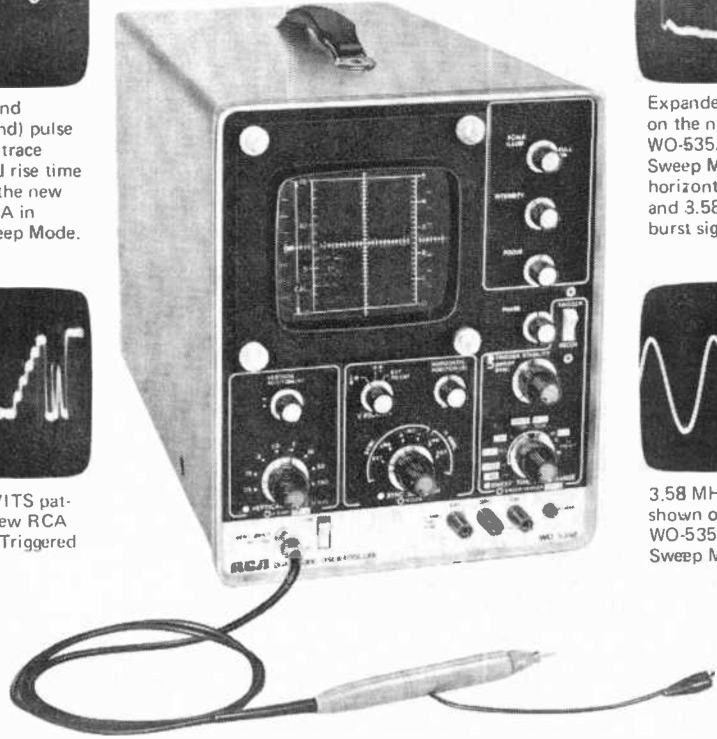
TRIGGERED SWEEP



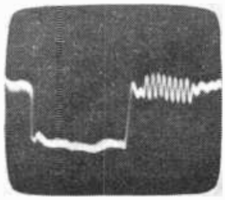
250-nanosecond (¼-microsecond) pulse demonstrates trace expansion and rise time capability of the new RCA WO-535A in Triggered Sweep Mode.



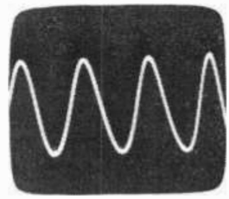
Typical TV VITS pattern on the new RCA WO-535A in Triggered Sweep Mode.




RECURRENT SWEEP



Expanded video signal on the new RCA WO-535A in Recurrent Sweep Mode shows the horizontal sync pulse and 3.58 MHz color-burst signal.



3.58 MHz sine-wave as shown on new RCA WO-535A in Recurrent Sweep Mode.

# Now...a 5-inch triggered/recurrent sweep oscilloscope for only $329*

It's the all solid-state RCA WO-535A featuring one-step calibration for simplified voltage measurements and usable frequency response to 10 MHz.

In the Triggered Sweep Mode, you can lock in waveforms and patterns that cannot be viewed easily using recurrent sweep. Triggered sweep with wide, variable trace expansion permits you to view small segments of complex waveforms, such as vertical-interval test signals (VITS). In the Recurrent Sweep Mode, you get all the advantages of a conventional continuous-sweep oscilloscope.

There are many other features of the WO-535A you'll like – and your RCA Distributor will be glad to supply complete information about this general-purpose oscilloscope that provides high performance in such applications as radio and TV servicing, industrial maintenance, troubleshooting, and general waveform analysis.

Also ask your RCA Distributor for the full story on the RCA WO-505A, priced at $299*, and the RCA WO-33A, priced at $180*. Or write RCA Test Equipment Headquarters, Harrison, N.J. 07029.

*Optional Distributor Resale Price, complete with direct/low capacitance shielded probe and cable.

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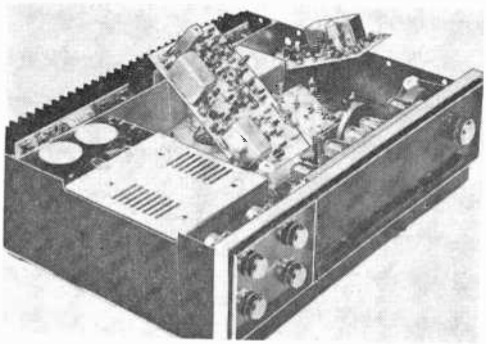
with a 1.5-dB capture ratio. The image and spurious signal rejection are each rated at 100 dB, with 90 dB of alternate channel selectivity. These are outstanding figures—20 to 40 dB better than most manufactured receivers that are priced comparably to the AR-1500 kit.

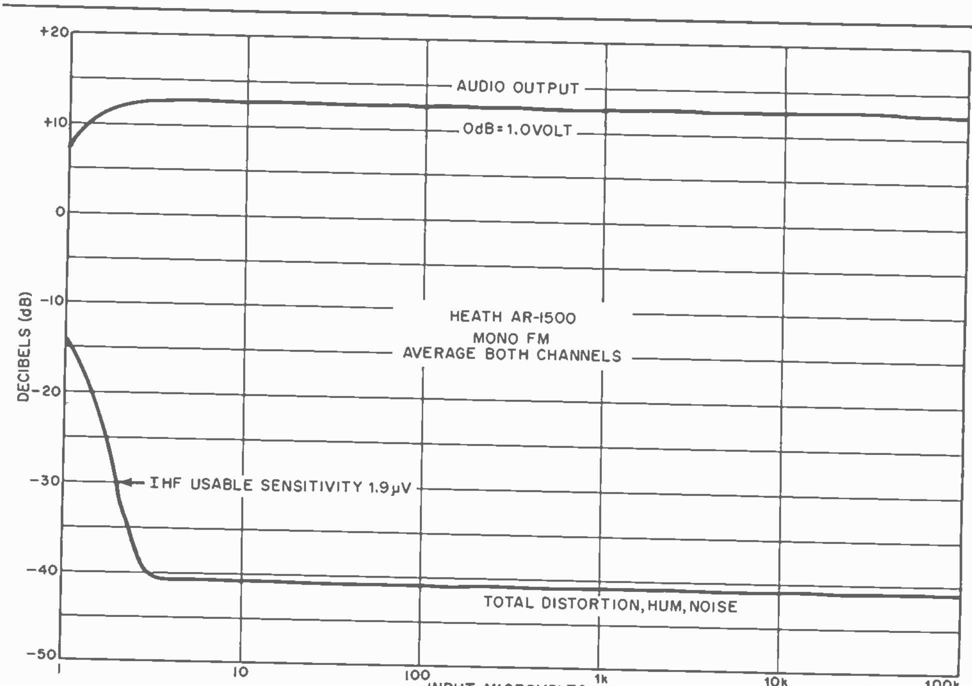


The audio amplifiers are probably the most impressive feature of the AR-1500. They are rated, with extreme conservatism, at 60 watts per channel into 8 ohms, 100 watts per channel into 4 ohms, and 40 watts per channel into 16 ohms, with both channels driven simultaneously. Harmonic distortion is rated at less than 0.25% from 20 to 20,000 Hz at 60 watts; and IM distortion is less than 0.1% at 60 watts.

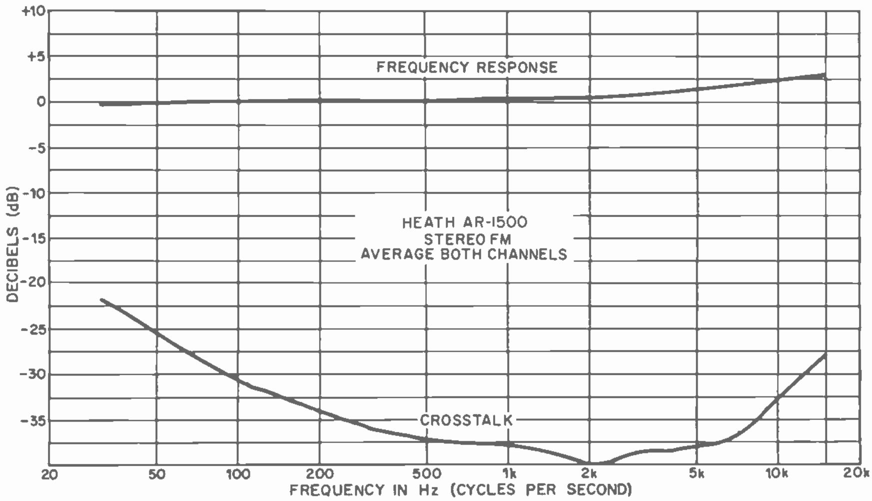
The receiver presents a simple appearance from the front. Four knob controls (bass, treble, volume, and balance) are on the left, with the tuning knob at the right. Between them is the large slide-rule dial, which is blacked out when the receiver is off and softly lit in green when it is on, and two tuning meters (zero center and relative signal strength).

Below the dial are 14 pushbuttons. Six of them select the input source: tape, auxiliary, phono, AM, FM stereo, and FM auto. In the FM stereo mode, the receiver responds only to stereo transmissions. One switch turns the receiver on and off, and two others connect either, both, or neither of two pairs of speaker outputs. Tape monitoring, high-frequency blending for stereo FM noise reduction, and mono/stereo mode selection are controlled by three other switches, while the remaining two switch on the loudness compensation and bypass the tone control circuits. Beneath the pushbutton switches are two stereo headphone jacks and a small, unmarked knob that varies the FM muting threshold.

Most of the rear of the receiver is occupied by the heavy finned heat sink for the output power transistors. Below them is a hinged AM ferrite antenna, the vari-




**Mono output from tuner was relatively flat for inputs between 1.9 uV and 100,000 uV.**




**The frequency response (top) and crosstalk (bottom) are shown for the stereo FM tuner section of the Heath AR-1500 AM/stereo FM receiver.**

ous input and output jacks, and antenna terminals. There are vertical and horizontal outputs for connecting an oscilloscope to monitor FM multipath distortion. The preamp outputs and main amplifier inputs are brought out to separate jacks, but they are normally wired together internally. There are two ac outlets, one of them switched. The AR-1500 is 18½" × 5⅛" × 13⅞" and weighs 32 lb.

**Laboratory Tests.** In our tests, the audio amplifiers clipped at 76 watts per channel into 8-ohm loads, 117 watts per channel into 4 ohms, and 45.5 watts per channel into 16 ohms. Both the IM and 1000-Hz harmonic distortion were under 0.1% (typically about 0.05%) from 0.1 watt to between 75 and 80 watts. At the rated 60 watts per channel (or any smaller output) the distortion was between 0.03% and 0.1% at all frequencies from 20 to 20,000 Hz. The complete freedom from crossover distortion at low levels was shown by our IM measurements, with less than 0.18% distortion from 2 milliwatts to 75 watts output.

The tone controls and loudness compensation had conventional characteristics. The RIAA phono equalization was very accurate, within ±1 dB from 30 to 15,000 Hz. Hum and noise were 76 dB below 10 watts on the auxiliary inputs and from 62 to 71 dB below 10 watts on the phono inputs.

The AR-1500 is unique among receivers in that it has separate input level adjustments for each channel of each input (accessible through the bottom plate). Not only can all program levels be matched and balanced, but overloading by an excessive input voltage is virtually impossible. The phono sensitivity, for 10 watts output, can be adjusted from 0.63 mV to about 4.5 mV, with corresponding overload levels of 20 mV to 140 mV. The noise level varies slightly with the control settings: hence the range of our measurements. Even at maximum auxiliary sensitivity, where only 48 mV is needed for 10 watts output, the overload point is a safe 1.5 volts, which increases linearly as the sensitivity setting is reduced.

The FM tuner had an IHF usable sensitivity of 1.9 microvolts, with 50 dB of noise quieting at only 3 microvolts input. The ultimate S/N ratio was 72 dB, at inputs of 70 microvolts or more. The frequency response was within ±0.5 dB from 30 Hz to 4000 Hz, rising very slightly to +2.5 dB at 15,000 Hz (where most FM tuners show a falling response). The stereo separation was very good—between 35 and 40 dB from 250 to 8500 Hz, and better than 22 dB from 30 to 15,000 Hz. The capture ratio was 2 dB. Image rejection was 92 dB, and AM rejection was 53 dB. The muting system of the AR-1500 cannot be disabled, although its threshold can be varied from 1 to 10 microvolts. The presence of the muting action prevented measurement of selectivity, but this was obviously exceptionally good, judging by the on-the-air performance.

The AM tuner of the AR-1500 was unequivocally the best we have ever seen. With a frequency response within ±3 dB from 20 to 9000 Hz, its sound quality truly approached that of the FM tuner, and the sensitivity and freedom from whistles and birdies were excellent.

**Performance Comments.** Overall, the Heath AR-1500 impressed us by its sheer performance as a tuner and as an amplifier. In these areas, which are the really important ones, it is clearly one of the most refined receivers on the market. It does have a few minor idiosyncrasies, such as the non-defeatable muting, which had a very positive action but also tended to produce a "clunk" in the speakers when tuning on or off a station. We also found the push-button control settings a little hard to determine, due to the lack of contrast between the buttons and the black panel and the small size of the identifying markings.

In terms of operating flexibility, the AR-1500 is average; however, it is certainly adequate for the vast majority of audio enthusiasts. Not everyone feels the need to interconnect two or three tape recorders, a half a dozen assorted program sources, and more than two pairs of speakers to his receiver!

In use tests, the receiver was as outstanding as it was on the test bench. It is an ideal receiver for use with low-efficiency speakers (particularly 4-ohm types) since it is by far the most powerful receiver we know of for driving 4-ohm loads.

The Heath AR-1500 kit sells for $379.95. An optional walnut cabinet is $24.95. The AR-1500 is also available in wired and tested form, complete with the cabinet, for $649.95.

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## LAFAYETTE SQ-M 4-CHANNEL DECODER
## (A Hirsch-Houck Lab Report)


ALL four-channel matrix techniques (CBS SQ, E-V Stereo 4, and Sansui QS are the principal ones) are somewhat similar, combining four channels with specific amplitude and phase relationships to form a two-channel stereo program that can be recorded on discs and played back with conventional stereo cartridges. When played through a two-channel stereo system, the left and right back channels are combined with the corresponding front channels, so that the complete program is heard through the two front speakers. For quadraphonic playback, the two stereo channels are processed by a decoder which divides them and recombines them with the proper phase and amplitude relationships to recreate the original four channels.

Ideally, the decoder phase and amplitude coefficients should be inversely related to those in the encoding matrix. Fortunately, even if they are not, four somewhat different channels will be derived. The practical effect is a change in spacial relationships, so that instruments are not necessarily heard in the intended locations, but may appear elsewhere in the listening area. In most cases, this does not seriously diminish the major benefit of quadraphonic sound, which is principally to provide a greatly enhanced sense of presence and involvement with the performers.

**Product Description.** The Lafayette SQ-M four-channel decoder is a simple, inexpensive ($44.95) device for decoding matrixed programs with the CBS SQ parameters. It is a small ac-powered unit, about 6″ × 3″ × 7½″, in a metal case with a simulated wood-grain finish. The auxiliary inputs of the SQ-M are driven from the tape recorder outputs of a stereo amplifier or receiver. A pair of jacks marked REC in the rear of the SQ-M replaces the normal tape output jacks of the system. There are four output jacks. The front outputs go to the tape recorder inputs of the front-channel amplifier (the regular stereo system amplifier). The rear outputs go to the high-level inputs of a second stereo amplifier, which drive the two speakers in the back of the room. Finally, there is a pair of phono inputs (MAG). If the regular amplifier has magnetic phono inputs, these increase its flexibility by permitting the use of a second record player.

On the front panel are two pushbuttons for power switching and AUX/MAG input selection. A FUNCTION switch selects the operating mode: F + R, COMPOSER, and SQ; and a MASTER VOLUME knob controls the volume for all four speakers. In the F + R mode, the stereo inputs are heard normally, except that the front and back speakers on each side of the room carry the same program. The COMPOSER mode derives a simulated four-channel signal from ordinary two-channel stereo programs, driving the rear speakers with a difference (L−R) signal. Many records have a considerable amount of out-of-phase, or L−R, information containing the ambience, or reverberant sounds from the recording environment. The SQ mode provides the correct coefficients for decoding CBS SQ records, a number of which are presently on the market.

**Laboratory Tests.** The decoder required an input of 0.38 volt (AUX) or 2.2 mV (MAG) for 1 volt output. The maximum undistorted output was about 8 volts—far more than would be required by any receiver or amplifier. Phono overload occurred at 50 mV, a safe margin with practically any modern cartridge. The phono equalization was within +2.5 dB of the RIAA curve from 50 to 15,000 Hz. Output hum and noise was about 63 dB below 1 volt output, using either input. Harmonic distortion in the output was typically about 0.1% up to 5 volts output, although it was masked by power supply hum at low levels. (The hum was not audible in normal use.)

With only a left channel input (using the SQ mode), the left front output was flat within +2 dB from 30 to 20,000 Hz. The right front output was down 15 to 20 dB across the full frequency range. The level of the back output was typically about 6 dB under the front level. The phase angles among the four outputs were reasonably constant over most of the audio range, though the phase shift between the input signal and each of the outputs changes with frequency. Our measurements showed about 50 degrees of phase shift between the two front outputs, about 60 degrees between the two back outputs, and 65 to 70 degrees between front and back outputs on the same side.

In the COMPOSER mode, the front outputs are completely isolated, with the front and back outputs at approximately the same levels. However, the two back channels are 180 degrees out of phase with each other and with the diagonally opposite front channels. Applying a mono (L + R) input, the back outputs are some 17 dB below the front outputs in the COMPOSER mode and 6 to 10 dB down in the SQ mode.

We used the Lafayette SQ-M with a variety of front and rear amplifiers and speakers. A number of CBS SQ records were played, with a satisfactory and pleasing quadraphonic effect. We also played other records, made with the E-V and Sansui matrices, with very similar results. Using two-channel input material, either the SQ or the COMPOSER mode produced a simulation of quadraphonic sound, sometimes as effective as specially encoded records. There were differences in sound between the two modes; and one or the other was often more effective.



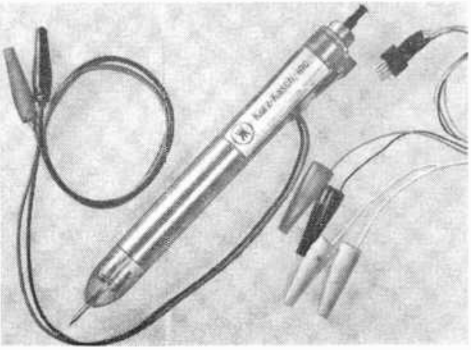
## KURZ-KASCH LP-520-GM LOGIC PROBE

WHEN an experimenter or service technician who deals with digital equipment has a lot of flip-flops in a multi-IC arrangement and they suddenly stop flipping and flopping, that's when you'll hear loud cries of anguish. The problem is in knowing where to start troubleshooting.

There are several in-circuit digital logic testers available, and they come in a wide range of prices; but the latest one that we have examined (from Kurz-Kasch, Inc.) seems to provide the greatest flexibility. The particular model we tested is somewhat more expensive ($69.95) than most others, but it has a number of advantages. The probe-like instrument is 6" long and ⅝" in diameter and derives its power and signal ground through a pair of long flexible leads terminated with alligator clips.

Readout is through three subminiature lamps enclosed in the transparent plastic tip and located just above the needle-sharp metal probe. One lamp (red) comes on for a logic 1, indicating that there are 2.4 volts or more on the probe tip. The second lamp (clear) comes on when there is less than 0.8 volt at the tip. A third lamp (blue) comes on to indicate a positive- or negative-going pulse of at least 40 nanoseconds duration. The blue lamp remains on for 200 milliseconds despite the short duration of the pulse. Designed for DTL, TTL, and similer 4.75-to-5.5-volt dc logic families, the input impedance is greater than 35,000 ohms for the logic 1 signal, while overload protection is to ±100 volts dc intermittent.

The basic probe comes with three options: the "M" feature uses a push-pull switch at the upper end of the probe to permit selection of either "stretch" or "memory" modes. In the stretch mode, the



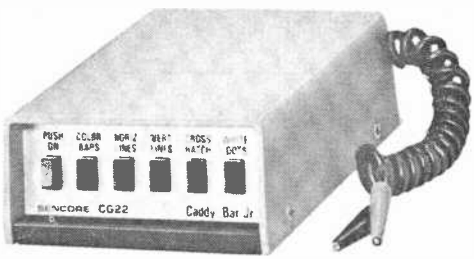
probe detects a high-speed pulse of 50 ns or greater and turns on the blue lamp for 200 ms. In the memory mode, the probe detects a high-speed pulse and keeps the blue lamp lit until the probe switch is reset. The "G" feature simulates a three-input scope with a special four-clip connector that couples to the probe. This mode is used to detect pulse coincidence in those circuits where it should appear. The "S" feature is designed to detect the presence of a 5-ns pulse which will illuminate the blue lamp. Each option adds $10 to the basic price of the probe.

Besides the LP-520, Kurz-Kasch also has an LP-510 ($44.95) for use with 4.75-to-5.5-volt dc logic families, with only 1 and 0 indicators; the Model LP-530 ($44.95) for 12-to-15 volt logic families, with only 1 and 0 indicators; and the Model 540 ($69.95) also for 12-to-15-volt logic, but with the blue pulse indicator.

**Use Tests.** We used the LP-520-GM to troubleshoot the complex PC board of our favorite frequency counter (which was out of order). We found that using the probe is very simple; and having the bright, easily read display right down at the probe tip was a real help. It was very easy to trace the path of the logic flow around the IC's and the foil patterns. In our case, when we didn't get a red indication (logic 1) on a particlar B+ line, we knew where the trouble was located. Using the counter manufacturer's schematic, it was a snap to follow the logic around the circuit. This clearly demonstrated the value of the probe in finding malfunctions.

Circle No. 67 on Reader Service Card

## SENCORE CG-22 COLOR-BAR GENERATOR




THERE are many times during the service technician's work when he wishes he had a color generator in his pocket for those convergence touchups that are needed in the customer's home. The idea of dragging along the shop generator is too much to consider, what with its size, the need for ac power, and the fact that the generator always seems to be needed back at the shop at the same time. The idea of a small, battery-powered generator has always intrigued us; and we have tried a few in the past—with unspectacular results.

Not long ago, we were introduced to the Sencore Caddy Bar Jr. (Model CG-22) Color Generator. This dandy, small, battery-powered unit may be the answer to the technician's dream. Packed into the 2″ × 4″ × 6″ generator (weighing less than 2 lb) is a pushbutton array which permits selection of ten standard color bars, horizontal lines, vertical lines, crosshatch, and white dots. Obviously, the unit is all solid-state and uses crystal-controlled timing and color-bar generation. The internal power source is a pair of conventional 5.6-volt mercury batteries, with power consumption a low 14 mA on color and 12 mA for the other displays.

**Design Features.** There are several interesting features in the CG-22. One is an automatic built-in timer that shuts the generator off after about 15 minutes, in case you forget to do so. This can be quite a battery saver for the forgetful service technician. Then, if you have used solid-state generators and the idea of the unit's not working properly after being left in the truck over a cold winter night worries you, the Sencore engineers have taken care of that problem, too. They have included a simple built-in heater and all you have to do is plug the TV set's cheater cord into a rear-panel receptacle and allow the CG-22 to warm up for a few minutes. Also on the rear panel is a set of battery test points so that you can keep tabs on the built-in power source.

The r-f cable (which often gets in the way) is no problem here since it is a coiled cable (similar to a telephone cable) terminated with alligator clips and easily retracted and stored in a special chamber in the generator.

In use, both in the field and on the bench, the CG-22 has proved to be very handy (small enough to sit on top of a small color portable) and easy to carry from job to job. Incidentally, have you ever tried using the crosshatch signal to set the linearity controls on monochrome receivers? Try it and you'll be surprised at how easy it is.

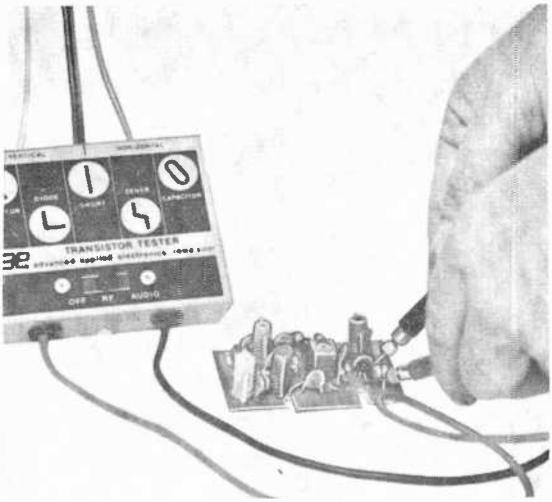
All the patterns produced by the CG-22 were clear and stable, making it well worth its price of $89.

Circle No. 68 on Reader Service Card

## A. A. E. MODEL T-101 TRANSISTOR TESTER

IN-CIRCUIT transistor testers, particularly those producing characteristic curves on a scope, are becoming very popular. This is because removing suspect transistors from a small cramped board is difficult and may also do additional harm to the transistor. The latest instrument of this type to come to our attention is the Advanced Applied Electronics Model T-101.

The metal-cased unit measures 4½" × 3" × 1" and is designed to be mounted to the underside of the workbench shelf where it is out of the way. It has leads long enough to reach the ac socket, the scope,




and the circuit under test. The two test leads are terminated in probes with needle tips to break through any PC board coating compound and make good electrical contact with the transistor leads.

**Use Results.** The T-101 is very simple to use. It is merely necessary to get the probes on either the base and emitter or base and collector terminals. It is not necessary to determine which is which. The waveform displayed on the scope tells you the condition of the junction being tested. Diodes can also be tested in the same way. Both good junctions and leaking junctions have their own peculiar waveforms. Shorted or open junctions cause straight lines on the scope—vertical for a short and horizontal for an open.

A diode having a resistor or capacitor in parallel with it can also be checked. Capacitors, including electrolytics, can be checked for quality; and low resistances from 1 to 200 ohms can be checked by observing the waveform across them.

Provisions are also made for checking either small-signal r-f transistors or audio power transistors. The case of the T-101 has the various displays produced on the scope printed on the front panel. There is also an instruction manual.

We have been using the tester for several weeks and find that it does what the manufacturer claims and that it has saved quite a bit of time ordinarily spent in unsoldering and resoldering transistors. Price of the tester is $29.95.

Circle No. 69 on Reader Service Card

MAC'S SERVICE SHOP

# A New TV Antenna

By John T. Frye, W9EGV, KHD4167

BARNEY stood in the doorway of the service department staring at Mac, his employer, who was down on his knees on the floor unpacking a carton containing an object that seemed to be mostly gold-colored tubing.

"It never fails," Barney sighed resignedly. "We're having a regular blizzard outside, and you're thinking about putting up a new TV antenna. Just once I wish you'd get this urge on a nice balmy summer day. What's wrong with the old antenna?"

"Nothing," Mac replied, "but these Quantum antennas by Channel Master represent a new concept in TV antenna design, and I want to see if they're as good at noise reduction as claimed."

"How can a TV antenna reduce noise?" Barney scoffed. "That's like saying the windmills make the wind blow."

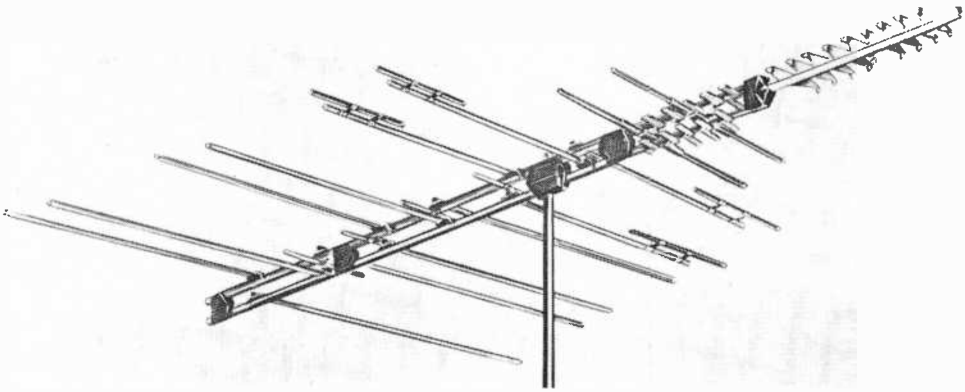
"Not true," Mac denied. "The IEEE defines noise as, 'unwanted disturbances superposed upon a useful signal that tend to obscure its information content.' That's a very broad definition and, as far as TV reception is concerned, includes interference from such diverse sources as electrical ignition systems, all kinds of switches, diathermy, X-ray, electronic ovens, universal motors, CB-amateur-police-taxicab transmitters, FM broadcasts, static, power transmission lines, reflection ghosts, and adjacent and co-channel interference. So an antenna that discriminates strongly between a desired signal off the front and undesired noise off the sides or back can have a marked effect on noise reduction. Such discrimination is achieved by: (1) providing maximum antenna directivity, and (2) minimizing feedline pickup—which, of course, degrades directivity."

"You're right about the noise level coming up all the time," Barney said. "We hams will testify to that. And it's getting tougher and tougher to find a relatively quiet location for a radio telescope, like the immense parabolic array at Green Bank, West Virginia. Scientists are already turning to space to escape this 'ether pollution.' Noise is especially bad on channels 2 through 6. That's where you see the most—but not all—of the streaking, the herringbone and moire patterns, the venetian blind and windshield wiper effects, the shadowy sync bars, etc. This condition is worst in the metropolitan areas, but it is getting worse in the suburban areas, too, as the use of electrical appliances proliferates and factories move out into the suburban and rural areas."

"Glad to see you appreciate the problem," Mac commented. "Little can be done if the source of interference is directly in line with the desired signal, but there's at least a 50-50 chance the interference will come in off the sides or back of the antenna. In the case of co-channel or adjacent channel, probably 90% of the undesired signals come in from the rear because of the FCC's channel allocations. The set owner should, therefore, without sacrificing gain, select an antenna designed for high intereference rejection.

"The Interference Rejection Factor of an antenna is defined as the ratio of the antenna's maximum sensitivity (normally at the front) to its peak sensitivity in the rear 180° sector. Note this is not, necessarily, the same thing as front-to-back ratio. Quite often high gain antennas will have secondary lobes not directly opposite the primary front lobe. Such an antenna may have a very high front-to-back ratio, but the ratio of the front response to the response of say 30° either side of the rear will be much lower.

"Up to now, according to Channel Master, the peak IRF of high gain antennas has been 15 to 18 dB. This Quantum Model 1160 I am unpacking is claimed to have an IRF of 35 dB. It is further claimed that,



when the predominant interference originates at the rear or sides of the antenna, an improvement of 10 dB in signal-to-noise ratio will occur. This is equivalent to a 10 dB increase in antenna gain. In a deep fringe area the elimination of interference by this high IRF can bring about the same dramatic improvement you'd expect from a higher gain antenna. And in near-fringe suburban areas, where you have enough TV signal but there are lots of intereference sources, the high IRF should usually eliminate all signs of interference."

"Sounds great, but how do they do it?" Barney said skeptically.

Mac had been busy unpacking the antenna and assembling it as he talked. This did not take long because the elements snapped out and the boom sections were fastened together with bolts and wing nuts.

"According to Channel Master, the extremely high IRF is achieved by the application of the Fourier Transform Theory to TV antenna design. The way current distributes over the elements of an antenna determines its gain, bandwidth, and pickup patterns. In the past, uniform current distribution has been the key to high broadband gain; but the Transform Theory, widely applied to radio telescopes and space communication, states a *tapered*, symmetrical distribution of current over an antenna's elements will yield patterns with the smallest side and rear lobes. As one CM engineer puts it: 'Just as the amplitude function of a waveform is transformed into the frequency spectrum, so the distribution of current over an antenna array is transformed into the radiation pattern by the Fourier Transform.'

"Until recently almost all work in this connection has been done on broadside arrays of the parabolic and 'bed-spring' types. Very little application has been attempted on end-fire yagi-style arrays. One reason has been the lack of instrumentation to measure accurately the amplitude and phase differences in the antenna elements. But with the development about five years ago of the Hewlett-Packard Model 8405 Vector Voltmeter, which allows measurement of amplitude and phase differences of two signals up to 1000 MHz, the roadblock was removed.

**Experimental Development.** "Even so, CM spent three years of experimental effort to develop the Quantum line of antennas—work consisting of painstaking adjustment of element configurations, lengths, and spacings, and testing, testing, testing. When you consider that this top-of-the-line Model 1160 has 16 fed elements and 26 parasitic elements and that a change in any one affects the others, you get some idea of the enormity of the job."

"I still am not sure what you mean by 'tapered currents over the antenna elements.' "

"Let me try to explain. First note that this antenna does not consist of a single divided 'driven' element connected to the feed line and a bunch of solid parasitic directors and reflectors. Instead the boom is divided lengthways into an upper and lower section separated by heavy-duty insulating blocks to provide a modified truss construction. Each fed element is cut in two in the middle and has one half connected to the top part of the boom and the other directly beneath to the lower half. Since the feed-line is connected to the two parts of the boom, that means all divided elements connect to this line.

"Now if we measure the currents in these elements in the presence of a signal, we find not all elements carry significant current at all frequencies. By proper design we can produce currents that gradually increase as we go down the elements and then fall off to produce a curve that satisfies the Fourier Transform Theory. From one channel to another, the peak of this tapered current may fall on different fed elements, but we must maintain the tapered distribution that provides the maximum IRF. You will find more about this in *Antennas* by J. D. Kraus (McGraw-Hill 1950). And in *Microwave Antenna Theory and Design* by S. Silver (McGraw-Hill 1950). And when it is crystal clear to you, I wish you'd explain it to me!"

"Don't hold your breath," Barney warned, grinning. "I notice you speak of a 'Quantum Line' of antennas. I take it CM makes several using this principle."

"That's right. They market fifteen different models designed to fit all receiving conditions from the near suburban to the deepest fringe areas. The set owner can order an antenna fitted to his needs as far as uhf, vhf, and FM reception in his area is concerned—which brings up another point: with FM stations springing up all over the place, FM interference with TV reception is an increasing problem. So the Quantum, designed to furnish excellent FM reception normally, provides for FM trapping if you need it. An optional FM trap that can be installed in the weatherproof terminal housing located between the boom elements gives 20-dB attenuation of FM signals without affecting the IRF of the antenna. Another feature is this front-end section that looks like a sawfish's snout. It's actually a tunable uhf sector adjustable for peak reception of the uhf channels."

"How is feedline pickup prevented with this antenna?"

"First, the antenna is electrically balanced. By connecting the right-hand sides of the split elements alternately to the top and bottom portions of the boom we achieve transposition in the feed. Also note these controlled-impedance transmission rods that run from the feed points to the weatherproof plastic terminal housing. And see how the boom is insulated from the mast? But even though the antenna itself is carefully balanced, the receiver input may be unbalanced, in which case the feedline will still pick up interference. In that event you may want to employ shielded coaxial cable, and there is an optional balun transformer designed to fit into the terminal housing."

"Those engineers seem to have thought of everything," Barney commented.

"Well, this antenna is certainly a far cry from the first two-element TV antenna I ever saw. Personally, I'm delighted to see serious engineering going into TV antennas by several manufacturers. Optimum TV reception is impossible without a good antenna. I want to get this antenna up on the roof so we'll have a signal to check on cable performance when we need it. You know how that goes. If we have good reason to suspect the CATV signal is not up to par and call Fred, the manager, he reacts as though you doubted his virtue."

"Yeah, I know," Barney agreed with a chuckle. "He is either seeing a perfect picture down there in his office, or something must be wrong with the TV transmitter. Nothing is *ever* wrong with the cable. He feels so sure of this there is no point in sending a technician out to check. But if we can get a perfect picture off the antenna and a lousy picture off the cable, we can make old Fred sweat." ◈

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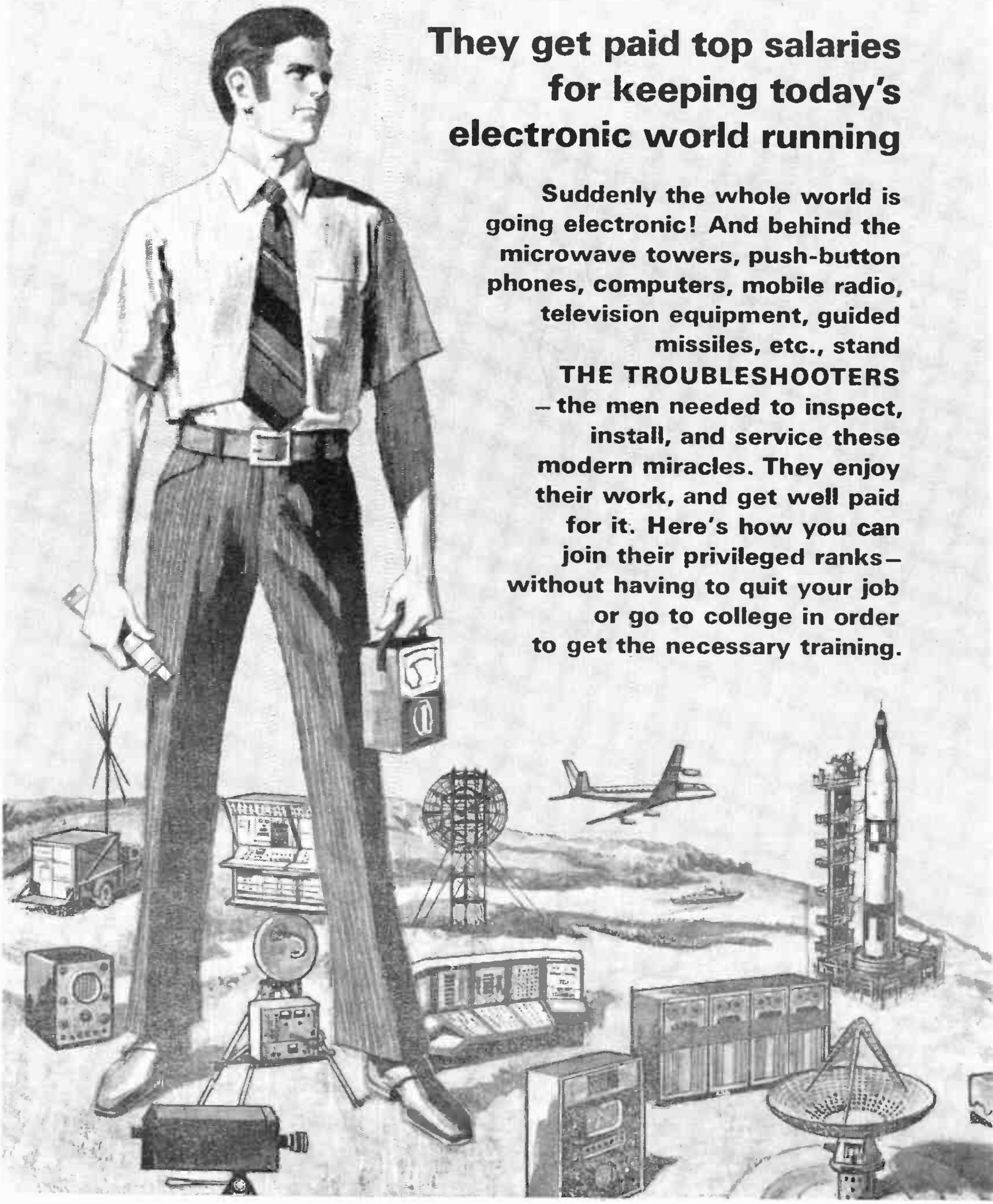

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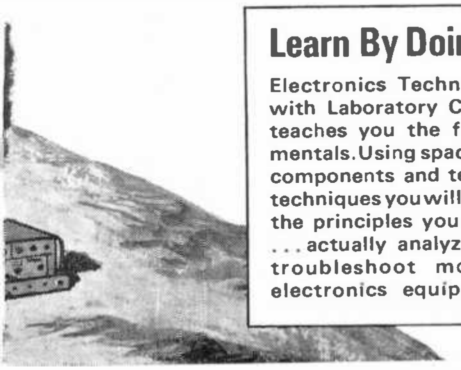

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**CIRCLE NO. 9 ON READER SERVICE CARD**

# Ampere's Law

BY DAVID L. HEISERMAN

AMPERE'S Law states that a pair of conductors carrying electrical currents exert magnetic forces upon one another. Furthermore, the amount of that force depends upon the amount of current flowing in each conductor, and the distance and angle between them. Andre Marie Ampere, a French physicist and mathematician, announced this new law of nature on September 18, 1820. As if discovering such a law weren't enough, Ampere used it to lay the theoretical foundations for a whole new branch of electricity and physics called electro-dynamics—and he did it in just seven years.

**Early Years.** Looking back at Ampere's work from our present-day point of view, it appears that the man spent the first forty-five years of his life preparing for his seven years of discovery. Born into a moderately well-to-do and educated family, young Ampere had most of the advantages available to French children reared during the Great Revolution. Moreover, he was a child prodigy who learned geometry and calculus at the age of twelve by reading texts that were written in their original Latin.

When Ampere was eighteen, his father was executed during the bloody "Reign of Terror" that swept France. The sights and sounds of the revolution, topped off by his father's violent death, shocked Ampere's mind. He spent the following six years of his life wandering aimlessly about the countryside, building sand castles by the sea and composing nonsense poetry.

At the end of that lost period of time, Ampere married and settled down to a more conventional style of living. His brilliant mind had returned, but the family money was gone. So, Ampere took his first job as a professor at the University of Bourgen-Bresses. Barely three years passed before his wife died, shocking Ampere's mind into a stupor for another year.

Napoleon had heard about the talents of this unfortunate young genius, and he offered Ampere a teaching position at a school in Paris. Discouraged with life, but anxious to return to his work, Ampere accepted the position and he remained there for the rest of his professional life.

Ampere began contributing papers on a wide variety of subjects, including chemistry, mathematics, molecular physics and biology. At the time, his special interest was in the theory of games. These papers were important to other scientists, but they were not the sort that fall into the category of special greatness.

**A New Discovery.** On September 11, 1820, Ampere happened to attend a demonstration of Oersted's new discovery. The demonstration showed that a current flowing through a straight piece of wire makes a compass needle turn to a position at right angles to the conductor. Even while this demonstration was still in progress, Ampere must have thought, "Since one conductor carrying an electrical current can exert a force upon a compass needle, why can't two current-carrying conductors exert forces upon one another?"

Excited by the notion that current-carrying wires produce exactly the same kind of magnetic forces as loadstones and permanent magnets, Ampere immediately dropped all his other work and began investigating this "artificial" source of magnetism. In seven days, Ampere developed the fundamental theories of electrodynamics, designed and built the experimental setups, performed the necessary experiments, and presented his findings to the scientific world. No other major scientific discovery has ever been conceived and tested in such a short period of time. Ampere was, indeed, fully primed for this week of great discoveries.

Two highly significant ideas emerged from Ampere's mind and experiments that week. For one thing, he developed what we now commonly call the "right-hand rule." According to this rule, with the thumb of the right hand pointing in the direction of conventional current flow (positive to negative) through a wire, the curled fingers of that hand indicate the direction of the resulting magnetic field. Oersted had already concluded that magnetic lines of force emerge at right angles from the conductor. Ampere, however, perfected the notion by making it possible to predict the sense, or polarity, of that field.

The other important idea in Ampere's first paper concerned the attraction and repulsion of two parallel wires carrying an electrical current. Ampere showed that currents flowing through the wires in the same direction made them attract one another, while currents flowing in opposite directions made the wires repel.

Ampere's discoveries about the direction of magnetic fields around a conductor and the forces acting upon a pair of current-carrying wires are just as important today as they were 150 years ago. What is perhaps even more remarkable is the almost unbelievable simplicity of the lab equipment he used. He managed to open a whole new technology using nothing more than a few lengths of copper wire, a compass, and a couple of Volta batteries.

During the seven years after his preliminary announcement, Ampere's papers became increasingly spiked with complicated equations. His early studies of geometry and calculus were paying off. Other researchers in Europe had picked up some good ideas from Oersted's work, too; but most of these people lacked the high level of mathematical sophistication and creative insight Ampere possessed.

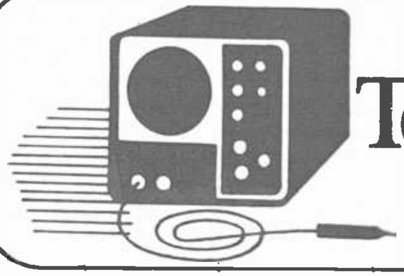
**Back to the Laboratory.** His work soon reached a point where he had to return to the laboratory to confirm his equations. This time he had to obtain precise figures for the amounts of current flow and forces between the conductors. Using what was then a revolutionary new measuring instrument, the galvanometer, Ampere was able to measure the amount of current flowing through the wires. His own original work with coils of wire and solenoids, by the way, was directly responsible for the invention of the very galvanometer he used.

Since he also had to know the exact amount of force two conductors exerted upon one another, Ampere devised a couple of specialized instruments. One of them was an ordinary laboratory balance that had a solenoid attached to one side of the beam. This solenoid fit inside a larger one fixed to the bottom of the balance. Current flowing through the two solenoids made the smaller one move inside the larger. By placing calibrated weights upon a weighing pan on the opposite end of the beam, Ampere could determine the exact amount of force the two sets of conductors exerted upon one another.

According to the famous scientist, James Clerk Maxwell, Ampere's fundamental equations had "leaped full grown and fully armed from the brain of the Newton of electricity." Ampere's equations were practically complete even before he set out to demonstrate their validity in the laboratory. Making up equations before running the experiments was contrary to the accepted scientific procedure of the time, but one simple fact silenced all critics—the equations and laboratory experiments always agreed. And to honor this "Newton of Electricity," the International Congress of Electricians named the basic unit of current, the ampere, after him.

Ampere was a hard worker as well as a scientific genius. Even while he was concentrating on the job of building the foundations of electrodynamics, he taught classes at the university. Perhaps this was a mistake. Ampere was noted for stopping his lectures in the middle of a sentence while his mind wandered off onto some new idea or equation. He also had a habit of letting his work at the blackboard meander into some new line of mathematical reasoning, leaving his students to puzzle over the jumble of incomprehensible figures related to some new idea in electrodynamics.

Ampere was, indeed, a classic example of an absent-minded professor. There can be no doubt, though, that he was one of the most successful absent-minded professors of all time. Unlike the blackboards that carried his ideas off into oblivion, Ampere's basic equations stand essentially unchanged to this day. ◈



# Test Equipment Scene

**By Leslie Solomon, Technical Editor**

# Semiconductor Testing

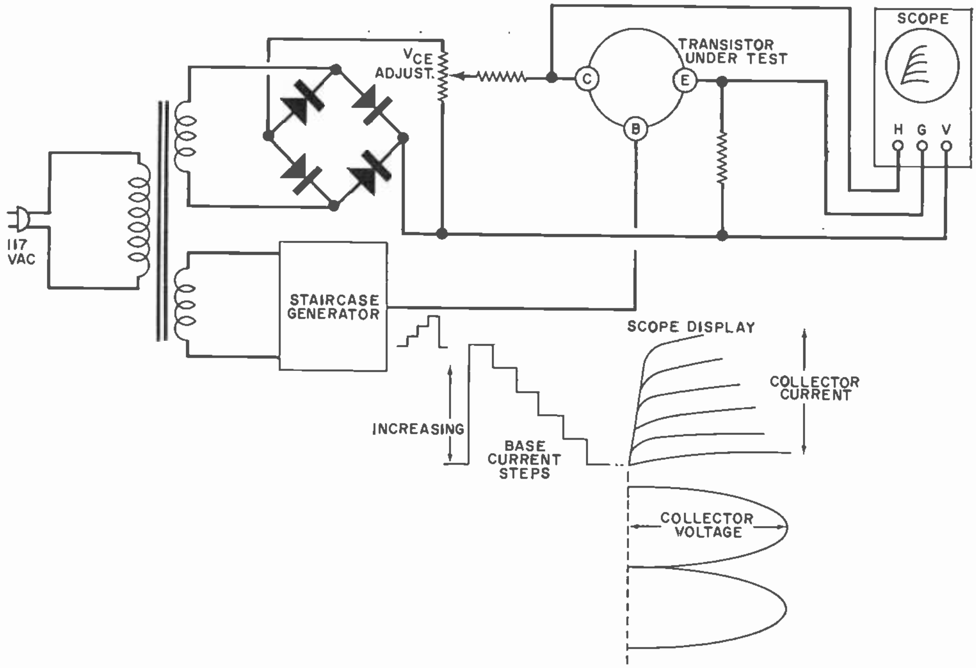
THERE are four ways to test a transistor. The first is to plug the transistor into a known operating circuit and see what happens; the second is to use the trusty old VOM to measure forward and reverse resistances and hope you don't burn out a junction in the process; the third is to use any of the excellent meter (or tone) readout in- or out-of-circuit transistor testers; while the fourth is to use a curve tracer.

We can find no fault in the first approach as long as the transistor uses a socket and can easily be replaced; but this method can become troublesome when suspect transistors have to be unsoldered, with the attendant possibilities of circuit board damage in this and the replacement process. The VOM approach is a form of electronic Russian roulette and, unless a low-current, low-voltage ohmmeter is used, should be avoided. The transistor tester using meter or tone readout is excellent as long as all you want to know is whether a particular transistor is good or bad; and this approach can be used in the majority of cases. However, it is the last method—the curve tracer—that we feel presents an excellent approach and opens up new areas of semiconductor testing. Note also that the first three approaches may be used to test bipolars and conventional diodes, but cannot usually be used to test other semiconductors such as FET's, zeners, SCR's etc. However, the latter can be tested on a curve tracer.

**Lack of Knowledge.** It would appear that the main reason many people don't use curve tracers is that they don't understand how the devices work. To clear up the mystery, consider the circuit shown here. The collector-to-emitter junction of the tested transistor is swept with a 120-Hz pulsating dc voltage device from an unfiltered full-wave rectifier, while the base is supplied with a number of calibrated steps of low current (usually switch selectable). When the results are displayed on an oscilloscope, a "family" of curves is obtained—one for each step of base current with the vertical representing the collector current and the horizontal the applied collector voltage.

Using this approach, the beta of the transistor can be determined at the desired operating voltage, the breakdown/avalanche voltage can be identified, the amount of leakage can be determined, and the type npn or pnp) can be ascertained. It is also possible to check saturation voltage, output admittance, and the effects of temperature. Using a pair of switchable sockets, the curve tracer can accurately match a pair of transistors for special audio applications. Most curve tracers can accurately plot voltages for an unknown zener diode and they can be used to test (nondestructively) FET's, UJT's, SCR's, triac's, tunnel diodes, and some types of IC's.

Curve tracers have one more use that can save a lot of time and worry. Have you ever wondered what kind of replacement you would need for an unmarked device? You no longer have to waste time writing all over creation for a replacement or wonder which of the vast number of readily available, low-cost "replacement" transistors you can use. All you have to do is plug the unmarked device into one of the sockets on




**The full-wave rectified 120 Hz is used as the collector voltage, while a multi-step staircase voltage is used as base drive. The scope displays a family of curves.**

the curve tracer and look at its family of curves. Then start inserting possible replacements in the other socket until you find one replacement that closely matches the unknown's family of curves. Then start keeping records. You will be surprised how much time and money you can save, especially if you have a service shop.

**Signature Diagnosis.** Unfortunately, the most useful function of a curve tracer has not yet been exploited. This is in an area sometimes called "signature" or "interpretive diagnosis." It involves displaying the family of curves of a transistor when it is tested in the circuit with all the required circuit components attached and working properly. Signature testing provides all the stage information at a glance: Is the transistor good or bad; and are the passive components associated with that particular transistor good or bad?

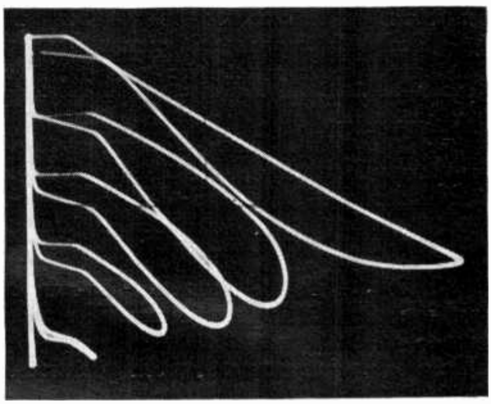
To conduct a signature test, connect the curve tracer to a known good transistor operating in a circuit that is known to be operating properly. Without supplying power to the circuit, record the transistor trace on the scope. The basic transistor curve will vary according to the types and values of the associated passive components associated with it; but the curve will be the same for similar stages in similar models. The signature is recorded on the schematic (perhaps using Polaroid film) so that it can be compared with the signatures found when the circuit stops working properly. Armed with the signature of each stage, it is a simple matter to move the probe through each stage until an incorrect one is found. We feel that this approach is so time-saving that schematic publishers will soon start including signatures of TV sets and other types of solid-state equipment.

**What About IC's?** Until recently, IC testers have been few and far between (and very costly), so most hobbyists and technicians have had to do a lot of improvising. We have been experimenting with the use of a curve tracer to check out some of the less-complex linear IC's—where we could gain access to base, collector, and emitter (usually through the substrate). We have come up with a family of curves that permit us to check these types of IC's, both in and out of the circuit. (In the circuit, we used the signature approach.)

Some digital IC's, especially the various forms of gates, are easy to check with a curve tracer. Other, more complex IC's, both linear and digital, still present problems; but further investigation is warranted.

If the idea of signatures intrigues you, note that RCA provides some of this data with their new transistor tester, while the Jud Williams Co. is presently compiling a series of signature patterns for the bulk of major semiconductor TV chassis.

You may have heard a lot of talk about having to use a dc-coupled scope with a curve tracer; and this may have deterred you from trying one. Although a dc-coupled scope is desirable, there is no reason why you can't use an ac-coupled scope and operate the shift controls to re-position the family of curves. In some ac scopes, there may be a slight "looping" of the curves; but if you use the same scope to record and later observe the signatures, the problem disappears because the curves are all relative.



The above photograph shows a typical "signature" pattern (courtesy of Jud Williams) obtained in an in-circuit test of a solid-state TV chassis. Note that the conventional transistor family of curves has been distorted due to the impedances of the associated passive components. This shows that the transistor is good. The pattern is unique to this circuit, and similar circuits having the same manufacturer's model number. Comparable "looping," although not as great, occurs when an ac-coupled scope is used in conventional transistor testing.

So, take a look at the curve tracers now being sold by B & K, Eico, Jud Williams, Leader, and RCA. (Perhaps others by the time you read this, so keep an eye on your distributor's shelves and catalogs.) If you do a lot of work with semiconductors, you may be overlooking a very useful tool. ◈

# Build an Audio Level Meter

## ADDING MULTI RANGES TO A LOW-COST DB METER

BY SAMUEL C. MILBOURNE

USERS of audio equipment often have a need to know the level of the audio signal at various points within a system. For this reason, many units come with built-in level (dB) meters. If your present system does not have a level meter, or if you need an extra one, here is your chance to construct one at low cost.

The actual meter used in the prototype is a low-cost panel meter having a −10/0/+6 dB scale, built-in rectifier, and series resistor for the basic range. (The meter is available from such surplus dealers as Fair Radio Sales, 1016 E. Eureka St., Lima, OH 45802, for about $5.) It used 6 mW into a 600-ohm line as 0 dB; but information is supplied here for both 500-ohm and 1-mW circuits.

**Calibration.** The accompanying table shows the calibration voltages required to cause the meter to indicate at the 0-dB mark for ranges up to +32 dB.

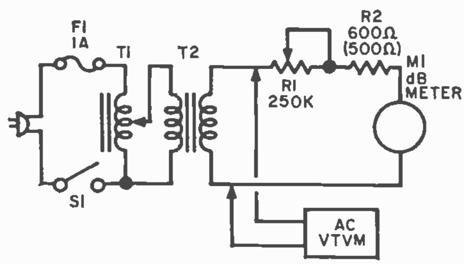
Determine the highest range to which you will want to calibrate, pick a transformer having at least the necessary voltage output and build the circuit shown in Fig. 1. Set the voltage-adjustable transformer for minimum output and *R1* for zero resistance. Only the 600 ohms of *R2* (500 ohms if your meter requires it) should be in the circuit. For a 6-mW/600-ohm meter, the application of 1.90 volts (from *T2*) should cause the meter to indicate 0 dB. Raise the voltage to that required for +4 dB and adjust *R1* until the meter reads **0 dB**. Accurately measure and record the resistance of *R1* for this setting.

Increase the voltage in the steps shown in the table, measuring and recording the resistance of *R1* for each step. These values determine the final resistors that are used in the meter circuit shown in Fig. 2. The final accuracy of the meter depends on how close you can set and read the ac voltage applied in Fig. 1 and how close you can come in selecting the final values of the fixed resistor.

In the prototype, we used the closest standard 5% resistors, obtaining reasonably accurate scale indications. Odd values of resistance can be made by combining two resistors. (For example, to get 51k, use 47k and 3.9k in series. Of course, paralleling can also be used.) Be careful not to overheat resistors when building up pairs as they may change value with heat.

The resistor network may be attached directly to the switch contacts or mounted on a piece of perf board. Use a pair of conventional banana jacks for the connectors.

When the meter is complete, re-run the voltage steps, changing the switch at each range, to check that the meter indicates at the 0-dB point at each switch position. If




**PARTS LIST**

*F1—1A fuse and holder*
*M1—dB meter being tested*
*R1—250,000-ohm potentiometer*
*R2—600-ohm, 2-watt resistor (see text)*
*S1—Spst slide or toggle switch*
*T1—Variable autotransformer*
*T2—Transformer with 117V primary; see text for secondary*
*Misc.—Accurate ac vtvm, line cord.*

**Fig. 1. Circuit to determine resistances.**

| CALIBRATION VOLTAGES | | | |
|---|---|---|---|
| Range (dB) | 6mW/600 ohms (volts) | 6 mW/500 ohms (volts) | 1 mW/600 ohms (volts) |
| 0 | 1.90 | 1.73 | 0.774 |
| +4 | 3.01 | 2.75 | 1.228 |
| +8 | 4.77 | 4.35 | 1.946 |
| +12 | 7.55 | 6.90 | 3.084 |
| +16 | 12.00 | 10.93 | 4.887 |
| +20 | 19.00 | 17.32 | 7.746 |
| +24 | 30.10 | 27.50 | 12.28 |
| +28 | 47.70 | 43.50 | 19.46 |
| +32 | 75.50 | 69.00 | 30.84 |

the meter does not indicate directly on the 0-dB mark, the value of resistance at that switch position will have to be adjusted. Lower the resistance if the meter indicates in the negative dB region; increase it if the meter is positive.

The finished level meter can be assembled in any type of case, plastic or metal, and each switch position should be marked in some manner.

**Use.** With a signal applied, set the range switch until the meter is as close to 0 dB as possible. The actual dB level is then the sum of the meter reading and the switch setting. For example, assume the range switch is on +12 dB and the meter indicates −3 dB. The actual level is then +9 dB. ◈

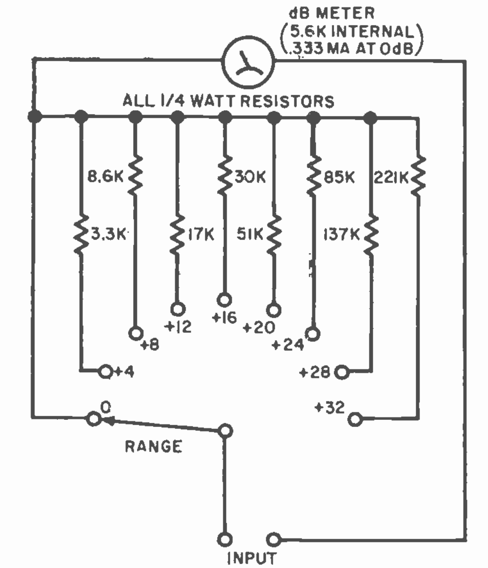


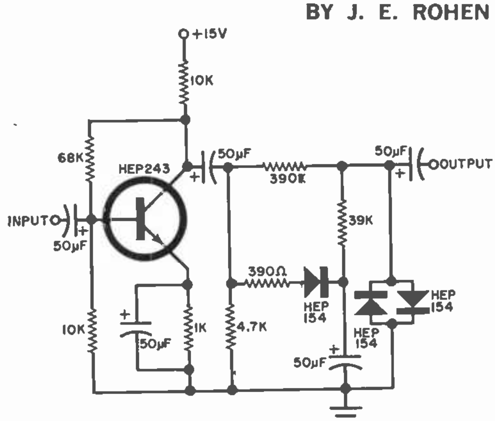

**Fig. 2. Final circuit uses resistors as close as possible to test values.**

# ADD A COMPRESSION AMPLIFIER TO YOUR ELECTRONIC ORGAN

**BY J. E. ROHEN**

THE OUTPUT signal level of an electronic organ is dependent upon the setting of the foot-pedal volume control, the number of stops or voices switched in, and the number of keys depressed at a given moment. For a fixed volume setting and a fixed number of stops on line, the volume level heard will vary considerably, depending on how many keys are depressed simultaneously. Although the organist can compensate for the changes in volume by using the volume pedal, on a fast change of stops or a quick switch from solo to rhythm, the audio change is too fast for him to react, and a choppy audio burst results.

It is desirable to have a means for keeping the volume level constant when such rapid changes are made. To accomplish this, a compression amplifier like the Organ Leveler shown in the schematic can be used. Unlike compressors used for PA applications, the Organ Leveler can respond to the entire range of frequencies generated by the organ without adding coloring to the voices. It can handle large fluctuations in input signal without clipping. ◈




**Leveling circuit does not affect volume or change the frequency response.**

# New Products

### ELECTRO-VOICE SPEAKER SYSTEM

"Interface:A", a new speaker system announced by Electro-Voice, is a direct radiating vented system which is said to have a virtually flat response to below 40 Hz, is down 3 dB at 32.7 Hz and cuts off sharply below 30 Hz. With an 8" woofer, the system has a vent substitute radiator and an active electronic equalizer. A 2½" cone tweeter on the front has an absorbent ring which in effect decreases the size of the tweeter as the frequency increases. A second tweeter at the back of the cabinet reinforces the front tweeter with no on-axis high-frequency boost. The speaker is 22" x 14" x 7¾" and the separate equalizer box is installed using tape input and output jacks or between preamp and amplifier. The equalizer has a rolloff control which slopes high-frequency response (3 or 6 dB down at 10,000 Hz) if room or program material require it.

Circle No. 70 on Reader Service Card

### CASIO MINIATURE CALCULATOR

The Mini Calculator, made by Casio, Inc., is suggested for retail at $59.95. This six-digit-in/twelve-digit-out "four banger" (add, subtract, multiply, and divide) is battery operated on four conventional AA cells. In continuous use, the batteries will last about 11 hours; with intermittent duty, about 14 hours. No decimal point—either fixed or floating—is provided. However,


when performing division, the numbers displayed in the answer are the nearest whole-digit figures, while decimal figures are displayed by depressing the shift key. For all other arithmetic operations, the decimal point is located by interpolation. The readout indicators are 7-segment miniatures.

Circle No. 71 on Reader Service Card

### BROWNING MARK III SSB CB BASE STATION

The new Mark III SSB transmitter from Browning Laboratories provides top-notch AM performance plus pure single sideband with 15 watts peak-to-peak input. The 8-step crystal lattice

filter is designed to provide up to 80-dB rejection of the unused portion of the channel to develop maximum voice power. Adjacent channel rejection and sensitivity are high—permitting tuning to very weak signals.

Circle No. 72 on Reader Service Card

### E.S. JOHNSON CASSETTE CABINETS

E.S. Johnson Co., Inc., has announced the availability of two cassette cabinet models for luxurious storage of cassette tapes. The design of the units make them ideal for use in the home, office, or school. The cabinets have formed acrylic smoked gray dust covers and side plates of high-impact styrene plastic with wood-grain styrene inserts. The Model CC-12 holds 12 cassettes, while the Model CC-24 holds 24 cassettes in stepped fashion.

Circle No. 73 on Reader Service Card

### PERCY HARMS AEROSOL CLEANER

A new aerosol cleaning fluid has been developed by Percy Harms Corp. for use in and on electronic equipment. The cleaner is specially designed to clean without any deleterious effects on plastic, rubber, or painted surfaces. Called Slide-Electronic Contact Cleaner, it will remove oils, greases, fingerprints, dirt, waxy deposits, etc., without leaving a residue. It provides a constant source of clean solvent for selective delivery to chosen areas to be cleaned. It can be used on circuit boards, tape heads, switches, tuners, motors, and other precision components and equipment.

Circle No. 74 on Reader Service Card

### TDK CHROMIUM-DIOXIDE TAPE CASSETTES

The first chromium-dioxide cassettes to embody the reliability and quality assurance of TDK design and construction were announced recently by TDK Electronics Corp. The TDK Krom-$0_2$ cassettes are recommended only for use on those recorders specifically designed to match the characteristics of $Cr0_2$ tape. On such equipment, the TDK Krom-$0_2$ cassettes will establish new performance standards with respect to frequency response, signal-to-noise ratio, distortion, and output uniformity. High frequency output in the range between 10 kHz and 15 kHz is about 9 dB higher than with conventional ferric-oxide cassettes. Signal-to-noise ratio is improved by 3 dB or better.

Circle No. 75 on Reader Service Card

## KOSS INTRODUCES "HEAR-THROUGH" PHONES

For those listeners who want the full sound reproduction of fine stereo headphones but also desire to hear some outside noises, Koss Corp. has introduced a new concept in high-velocity, micro-weight headphones. The Model HV-1 phones provide wide-range, extended bass sound reproduction while allowing the listener to hear noises such as a telephone or doorbell. A high-velocity driver element is featured in each earcup; it was specially developed by Koss to achieve lighter weight without sacrificing high performance standards. The Model HV-1 phones weigh only 9 ounces.

Circle No. 76 on Reader Service Card

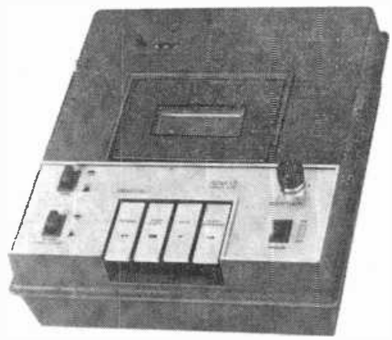
## MOBILE SSB ANTENNA FROM SWAN

The first mobile single-sideband antenna that automatically adjusts to the frequency selected by the radio operator has been announced by Swan Electronics. Designated the Model 55B antenna, it has a motor drive control unit that remotely stops at the selected switch position. According to Swan, one antenna can service five ham bands and tune to them automatically. With a high-Q coil, the new antenna will not heat up during operation or tune-up. It operates on a 1000-watt peak envelope power rating with an unbreakable Lexan center post. The antenna covers the 10-, 15-, 20-, 40-, and 75-meter amateur bands and can be used on surface vehicles, mobile homes, trailers, and boats.

Circle No. 77 on Reader Service Card

## ADVENT STEREO CASSETTE PLAYER

The Advent Model 202 is the first stereo cassette player to incorporate the Dolby System of noise reduction and is the first device to exploit the full potential of cassettes as a



uniquely convenient, flexible high-performance playback medium. In addition to the Dolby System, the Model 202 incorporates low-noise wideband electronics, quality transport mechanism with inaudible wow and flutter, and special playback equalization to take full advantage of chromium-dioxide tapes. The Model 202's technical specifications are extremely impressive for a cassette player.

Circle No. 79 on Reader Service Card

### MARANTZ LOW-PRICED STEREO RECEIVER

The new Marantz Model 2010 AM/stereo FM receiver delivers 20 continuous watts at all frequencies between 40 Hz and 16,000 Hz into 8-ohm speaker loads. IM distortion and THD are typically 0.5 percent at full rated

output. The receiver has tape monitoring for a three-head tape deck, switching for main and remote speakers, loudness and FM muting switches, separate bass and treble tone controls, slide-type balance control, and a phone jack. An illuminated dial pointer backs up the black-out dial which is set into a gold-anodized front panel.

Circle No. 80 on Reader Service Card

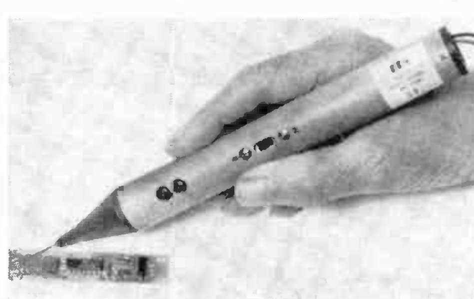
### MOODY MACHINE PRODUCTS SCREWDRIVERS

Moody Machine Products Co., Inc., is offering a small high-quality No. 52 utility screwdriver set for use by hobbyists and do-it-yourselfers. The set contains six interchangeable screwdriver blades in sizes 0.025", 0.040", 0.055", 0.070", 0.080", and 0.10". Each blade is made of hardened nickel plated tempered tool steel. The set comes with a securely locking chuck-type handle with a swivel top and a knurled grip. The blades and handle fit neatly into a pocket-size plastic case.

Circle No. 81 on Reader Service Card

### NU-CONCEPT DTL/TTL TESTER

A rugged pocket-size digital test probe, the "Dy-Nos-Stick," marketed by Nu-Concept Computer Systems, Inc., enables service personnel and design technicians to trace elec-



tronic logic quickly and simply and to diagnose digital malfunctions. The probe contains color-coded lamps which indicate logic levels. A memory feature which detects pulses as low as 3 ns in duration permits the tester to be used unattended. A gating feature allows the probe tip to be activated only when an auxiliary lead is in the selected logic state.

Circle No. 81 on Reader Service Card

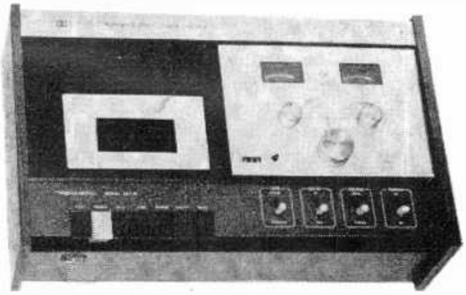
### JERROLD ALL-CHANNEL ANTENNA AMPLIFIER

A new two-receiver antenna signal amplifier —the Model TA-82 Colorcaster II—which amplifies all vhf and uhf TV and FM broadcast signals is available from Jerrold Electronics. Its gain at each output is stated as 8 dB in the vhf-TV and FM broadcast bands, and 5 dB in the uhf-TV band. The Colorcaster II's input and output impedances are nominally 300 ohms, providing for a quick match to commonly used twin-lead cable. The response of the amplifier is said to be flat within 0.5 dB/channel, while isolation between outputs is stated at not less than 15 dB.

Circle No. 82 on Reader Service Card

### REALISTIC DOLBY CASSETTE TAPE DECK

Dolby noise reduction circuitry is featured in Radio Shack's new Realistic Model SCT-6 stereo cassette tape deck for "at home" recordings that are said to be as good as professionally made tapes. During playback of Dolby-ized tapes, the built-in Dolby system



reduces the noise introduced by the recording process and at the same time provides truer high-fidelity reproduction than is possible through conventional tape recording processes. A tape bias switch on the SCT-6 permits the use of either standard or chromium-dioxide tape formulations.

Circle No. 83 on Reader Service Card

### SBE ANNOUNCES NEW HAM TRANSCEIVER

A new uhf amateur receiver designed for operation in the 420- to 450-MHz band was recently announced by Linear Systems, Inc., with the advance information on their Model SB-450. The SBE SB-450 comes equipped with two crystals already installed for operation on two of the 12 channels alloted.

Circle No. 84 on Reader Service Card

# Electronics Library

## BASIC ELECTRONIC INSTRUMENT HANDBOOK

*edited by Clyde F. Coombs, Jr., et al.*

As the editor points out, this is not a book about "measurements" but an attempt to give the reader a clear understanding of the instruments themselves and how they work together. Instruments covered range from ac and dc voltmeters and ammeters to counters, frequency analyzers, function generators, and waveguide devices. In all cases, theory of operation and typical uses of the instruments are given.

*Published by McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. Hard cover. 800 pages $28.50.*

## 99 WAYS TO IMPROVE YOUR SHORTWAVE LISTENING

*by Len Buckwalter*

Divided into ten sections, each of which deals with a particular phase of shortwave listening, this book covers antennas and their installation, receivers, accessories, listening techniques, special signals and frequency bands, interference sources, troubleshooting tips, etc. Supported by numerous photographs and line illustrations, it is easy to understand and should be a good source of information for the newcomer to SWL'ing, the established hobbyist, or the technician.

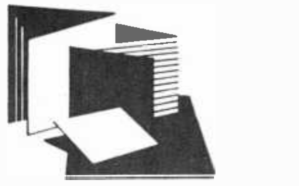
*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN46268. Soft cover. 144 pages. $3.95.*

## MODERN SOUND REPRODUCTION

*by Harry F. Olson*

Written for the layman as well as the engineer or technician, this book describes the newest and most important elements, systems, and accessories used in high-quality sound reproducing. It highlights such things as the effects of electrical and acoustical noise; quadraphonic sound reproduction on magnetic tapes and discs; theory and performance of transistor and integrated circuit audio amplifiers; and the modifications and embellishments that are used to heighten the impact of recordings.

*Published by Van Nostrand Reinhold Co., 450 W. 33 St., New York, NY 10001. Hard cover. 328 pages. $17.50.*



# New Literature

### SUPEREX STEREOPHONES CATALOG

Listed and fully described in the new No. 5733 catalog from Superex are the company's entire line of stereo headphones ranging from top-of-the-line electrostatic and dynamic types to budget-priced dynamics. Also listed are a compact stereo amplifier and accessories such as a headphone volume control box with extender cord, 20' and 15' extender cords, ear cushion covers, and a control box for amplifiers and receivers that do not have headphone jack outputs. Address: Superex Electronics Corp., 151 Ludlow St., Yonkers, NY 10705.

### PEARCE-SIMPSON CB RADIO CATALOG

Antennas and antenna mounts and mobile and base-station transceivers for the CB'er as well as a 144-175-MHz scanning monitor receiver and a 146-148-MHz, 25-/1-watt ham transceiver are described in a new catalog available from Pearce-Simpson. The catalog gives complete specifications and price information for all listings. Address: Pearce-Simpson, P.O. Box 800, Biscayne Annex, Miami, FL 33152.

### PIONEER SPEAKER SYSTEMS DATA SHEET

A full-color brochure which employs photos, text, technical specifications lists, and graphs to describe the R Series speaker systems can be obtained from Pioneer. Described in detail are the company's Model CS-R700 system employing a 12" woofer and horn-type midrange and tweeter drivers in a three-way arrangement; Model CS-R500 system employing cone-type woofer and midrange speaker and horn-type tweeter in a three-way set-up; and the Model CS-R300 two-way system employing cone-type drivers. Address: U.S. Pioneer Electronic Corp., 178 Commerce Rd., Carlstadt, NJ 07072.

### FIRST ANNUAL OLSON CATALOG

Olson Electronics has published its first annual catalog. Featuring products of many major brands, as well as their own brand names, it includes audio components, CB equipment, TV, kits and hobby items, antennas, tools and hardware, parts, tubes, and books. Olson will continue to publish tabloids to supplement the catalog. Address: Olson Electronics, 260 S. Forge St., Akron, OH 44327.

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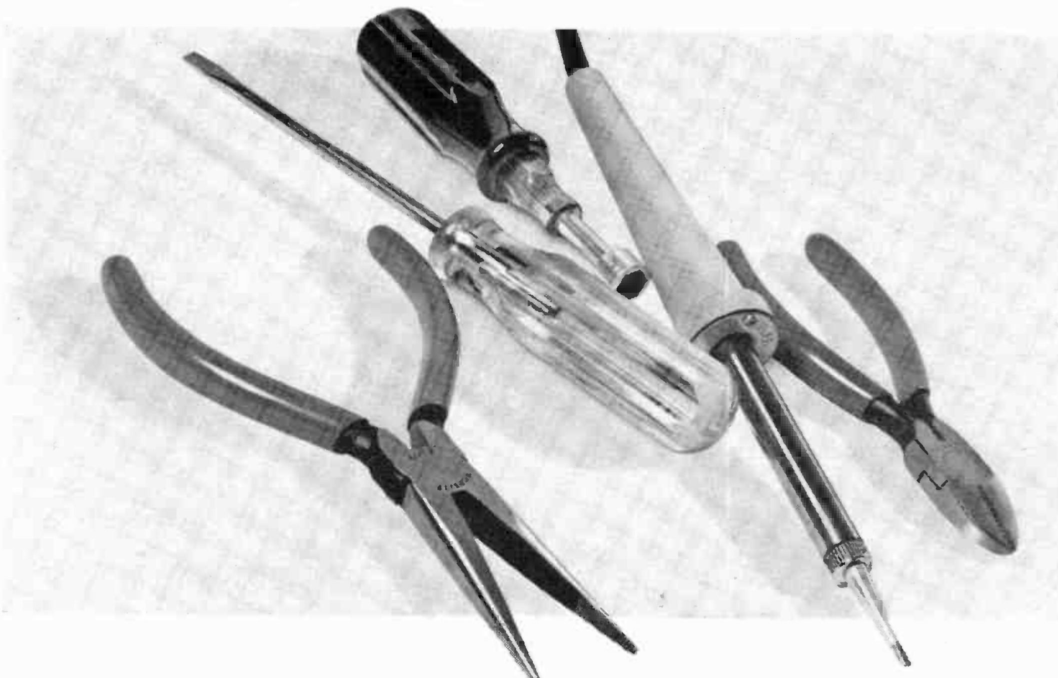

## ...you can build yourself a Bell & Howell solid state 25-inch color TV...

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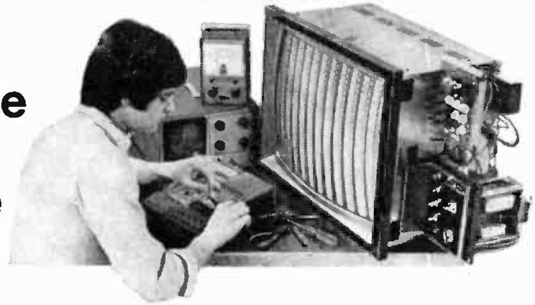

# Popular Electronics

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## TUTORIAL

# Surplus Scene

By Alexander W. Burawa, Associate Editor

## NEW YORK'S WALK-IN DEALERS

THERE was a time—and not too long ago, either—when hobbyists, experimenters, and hams could take New York City's subway downtown, get off at Canal or Cortlandt Street, and be in the heart of Surplus Row. Now, the situation has changed drastically. Forced out by the World Trade Center complex, many dealers have been forced to relocate, while a few have abandoned the scene altogether.

Where once Cortlandt Street used to be Surplus Row, no surplus dealers now exist. The situation is basically the same on Vesey Street. But Canal Street is holding its own; perhaps because it is too far uptown to be in the way of "progress." Be that as it may, not even Canal Street has even a ghost of a resemblance to old Surplus Row.

On the south side of Canal is Richman Electronic Trading Corp. (380 Canal St., New York, NY 10013), which deals in all types of electronic devices, including test instruments, parts, 7400 series digital and 700 series linear IC's, and even kits. Under the last heading, they have a 0-9 decimal counting unit kit which retails for $7.00. It includes a Nixie® readout tube with socket, circuit board, and three IC's (7441, 7445, and 7490). By the time this column appears, Richman will be well into the mail-order business.

At 32 Canal St. is American Surplus Trading Co. While they are in the mail-order business, they deal mostly with companies in need of sophisticated radar, communication, test equipment gear, etc. However, they do have a walk-in section where customers can buy anything in stock from radar equipment to grab-bag specials on components.

On the north side of the street, there are Omnibus Electronic Industries, Inc., (383 Canal) and Charles Rosen Communication Equipment Co., Inc. (343 Canal). Omnibus is primarily an outlet for sophisticated, used test equipment, but they also have a large, diversified stock of transistors and diodes, RTL, TTL, and linear IC's, and standard components and hardware. They do mail-order business and will send a large current flyer on request.

Charles Rosen handles nothing but parts and communication equipment. He has pulled out of the mail-order business and is now strictly a local walk-in. He is one of the casualties of the tight-money situation. Says Mr. Rosen, "The equipment just isn't there." Which means that since government has been economizing, little in the way of communication gear is being dumped on the surplus market.

Still in the downtown area of Manhattan is Cortlandt Electronics Inc. (16 Hudson St., New York, NY 10013). They're in the kit business, too, with an inventory of 25 different kits available. In addition, they are big on solid-state components and fluorescent and gas-discharge alpha-numeric readout devices.

For our last entry, we had to travel up to the Midtown area to drop in on Advance Electronics Co. (54 West 45 St., New York, NY 10036) where we were met with a real surprise. From having dealt (anonymously, of course) with Advance for many years, we were prepared to find the usual stock of surplus test equipment, parts, and chassis. However, here too, we also found them in the kit business. For example, they are currently marketing a complete 20-MHz (with 50-100-MHz option built in) 5-digit frequency counter kit for about $150. Advance is a mail-order company which, in addition to their inventory of test gear, is a supplier of transistors. RTL and TTL digital IC's, and 741 Op-Amp IC's. ◈

# ELECTRONICS MARKET PLACE

**NON-DISPLAY CLASSIFIED: COMMERCIAL RATE:** For firms or individuals offering commercial products or services, $1.50 per word (including name and address). Minimum order $15.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance. **READER RATE:** For individuals with a personal item to buy or sell. $1.00 per word (including name and address.) No minimum! Payment must accompany copy. **DISPLAY CLASSIFIED:** 1" by 1 column (2⅝" wide), $185.00. 2" by 1 column, $370.00. 3" by 1 column, $555.00. Advertiser to supply cuts. For frequency rates, please inquire.

**GENERAL INFORMATION:** First word in all ads set in bold caps at no extra charge. 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. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Hal Cymes. **POPULAR ELECTRONICS** Including **ELECTRONICS WORLD**, One Park Avenue, New York, New York 10016.

## FOR SALE

**FREE!** bargain catalog. Fiber optics. LED's, transistors, diodes. rectifiers. SCR's, triacs, parts. Poly Paks, Box 942, Lynnfield, Mass. 01940.

**GOVERNMENT** Surplus Receivers. Transmitters, Snooperscopes, Radios, Parts. Picture Catalog 25¢. Meshna, Nahant. Mass. 01908.

**ROCKETS:** Ideal for miniature transmitter tests. New illustrated catalog. 25¢. Single and multistage kits, cones, engines. launchers, trackers, rocket aerial cameras. technical information. Fast service. Estes Industries, Dept. 18-D, Penrose, Colorado 81240.

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**RADIO—T.V.** Tubes—36¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

**CONVERT** any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans. $2.00. Relco-A33, Box 10563, Houston, Texas 77018.

**MECHANICAL, ELECTRONIC** devices catalog 10¢. Greatest Values —Lowest Prices. Fertik's, 5249 "D", Philadelphia, Pa. 19120.

**SENCORE,** B&K Test Equipment Unbelievable Prices. Free Catalog and Price Sheet. Fordham Radio, 265 East 149th Street, Bronx, N.Y. 10451.

**METERS**—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

**PYROTECHNICAL** chemicals, casings, tools, supplies, fuse, literature. Giant, illustrated catalogue/handbook includes formulas, instructions—50¢, with samples—$1.00. Westech, Box 593, Logan, Utah 84321.

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**JAPAN HONG KONG DIRECTORY.** World products information. $1.00 today. Sekai Shogyo Annai, Hillyard, Washington 99207.

**EUROPEAN** and Japanese bargains catalogs. $1 each. Dee, P.O. Box 9308. North Hollywood, Calif. 91609.

**BURGLAR** Alarm Systems equipment, dealers and private. Write: United Security, Box 2428, Dublin, Calif. 94566.

**FREE** Catalog. Parts, circuit boards for Popular Electronics projects. PAIA Electronics, Box C14359, Oklahoma City, OK 73114.

## 50 MEGAHERTZ LOW COST COUNTER


Here is a new item, featured because of numerous customer suggestions. We have taken the basic power supply, chassis and cover from our clock kit, and by substituting a new front panel and printed circuit board, have made a lowest cost frequency counter. The unbelievable low cost is due to our use of our large stock of unused surplus nixies, the new 74196 50 MHz decade counter, and the commonality of parts with our other kits. Readout is to six decades, time base is 1 second, 0.1 seconds, or external. Design is modular, for ease of construction, compactness, and expandability.

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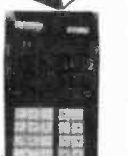
- ☐ Cover, blue or black anodized . . . . . . . . . . . . $ 4.50

## BUILD YOUR OWN ELECTRONIC CALCULATOR FOR ONLY $108.00!



A complete calculator kit, complete with self contained power supply and case. Indispensible in the home, office or school. Simple enough for a child to build. Some of the features of the calculator are as follows:
• MOS Integrated circuits (extra large scale integration) reduce the number of components to a minimum, for easy assembly • Displays eight digits on large size seven segment displays. • Full function complement keyboard features addition, subtraction, multiplication, division, alternate display, multiplication by a constant, clear all, clear entry, and decimal point set. • Sixteen digit entry and sixteen digit results are possible with alternate display key. • Leading zeroes suppressed • Chain operation • All integrated circuits and displays are socket mounted and replaceable.

So reliable and simple to build, we can make this guarantee: If for any reason you cannot succeed in getting your calculator to function properly after completing construction, for a flat handling fee of $10.00, B and F will repair and ship back your calculator anywhere in the USA. This applies regardless of the age of the assembler, barring gross negligence or the use of acid core solder in construction.

## DIGITAL CLOCK KIT WITH NIXIE DISPLAY

We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

- ☐ Clock Kit, complete less outside cover . . . . . . . . . $57.50
- ☐ Aluminum blue or black anodized cover (specify) . . . . $ 4.50
- ☐ SHRINK TUBING SPECIAL. Assortment of 200 pieces of shrink tubing, diameters 1/8" to 1/2", length 1/2" to 2" . $1.25 Price . . . . . . . . . . . . . . . . . . . . . . . . . . . $1.25

## KEYBOARDS

Three keyboards are available; 20 key calculator keyboard, 40 key alphanumeric, and 12 key touch tone. All have separate contacts carried out to edge connector.

- ☐ Touch Tone Keyboard . $ 9.50
- ☐ Calculator Keyboard . $14.50
- ☐ Alphanumeric Keyboard $29.00

## *LIGHT EMITTING DIODE NUMERIC DISPLAY*

This display is excellent for small portable electronics, such as DVM's, calculators, etc. Equivalent to Montsanto MAN 3A. Operates from 5 volts, 20 milliamperes, with 47 ohm dropping resistor.

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10 For $27.50

☐ Complete counter kit, 7490, 7475 latch 7447, printed circuit board, led readout . . . $9.50

## LATEST HARD-TO-GET SEMICONDUCTORS

- ☐ MUS 4988 silicon uni-lateral switch. Useful for voltage sensitive switch, sweep generators, etc. . . . $1.00
- ☐ MIS A64 PNP high current Darlington transistor. Super-high gain in small package. . . . . . . 2/$1.00
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## THIS MONTHS FEATURE ITEM

### POCKET CALCULATOR KIT

This is the kit you have been waiting for. So compact it actually fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4). It performs every function you would expect in a desk calculator, including constant and chain operation, and full floating decimal. The unit is powered by self contained batteries, and uses 8 digit LED displays. The calculations are performed by a single 40 pin integrated circuit, which can truly be called large scale integration (LSI). As a student, engineer, salesman, accountant, or anyone who would like fast accurate answers, this calculator fills the bill, and at a price that unquestionably makes this the lowest price high quality calculator available.

- ☐ Pocket Calculator Kit . . . . . . . . . . . . $75.00

### RECHARGEABLE BATTERY/CHARGER KIT

This option allows the throw-away alkiline battery to be replaced with a nicad battery, and includes a charger to recharge this battery. The unit may be run during the recharge cycle.

- ☐ Battery/Charger Kit . . . . . . . . . . . . . $17.50

### LOGIC AND OPERATIONAL AMP SUPPLIES

- ☐ Figure A, potted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple . . . . . . . . . . . . . . . . . . . . . . . $16.00
- ☐ Figure A, potted Op Amp supply, +15 Volts and -15 Volts at 0.5 Amperes. Mfg. by Analog Devices, similiar to their model 902. Short circuit proof, ultra high performance. . . . . . . . . . . . . . . . . . . . . . $29.00
- ☐ Figure B, 5 Volt 1Amp supply, regulated by Fairchild 9305, short circuit protected. . . . . . . . . . . . $9.75
- ☐ Same as above, in kit form . . . . . . . . . . $7.75
- ☐ Mating connector for above . . . . . . . . . . $1.00
- ☐ 5 Volt 5 Amp regulated supply, by Blulyne, (not shown). . . . . . . . . . . . . . . . . . . . . . $29.00

### LIGHT EMITTING DIODES

Montsanto MV 50 or equivalent LED's. Now less expensive than filamentary bulbs. At this price wire them into logic circuits as status indicators, build low cost counters or use them as panel lites. Rated at 10 - 40 Ma @2V.

- ☐ 10 LED's . . . . . . . . . . . . . . . . . . . $3.00
- ☐ 100 LED's . . . . . . . . . . . . . . . . . . $25.00
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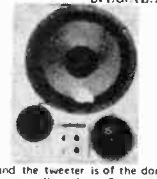
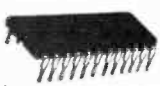
### LOUDSPEAKER SYSTEM COMPONENT SPECIAL!!



We have made an excellent purchase of an excess inventory of a local manufacturers speaker systems although we aren't allowed to mention the manufacturers name, the specs should make it self evident. The woofer is a 12" free-edge (acoustic suspension) unit, with 2" voice coil and a 2 lb. magnet. The mid-range is a 5" unit and the tweeter is of the dome type, for best high frequency dispersion. Crossover between woofer and mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided.

- ☐ Speaker System . . . . . . $29.00 ea./2 for $55.00

### CALCULATOR CHIP SPECIAL



B and F has purchased a quantity of MOS large scale integration chips for calculators. We are not allowed to mention the manufacturers name, however, the specs should make them self-evident.

- ☐ Set "X" - Four 24 pin I.C.'s, BCD output, 16 digit, fixed automatic decimal point, possible memory expansion, constant . . . . . . . . . . . . . $29.00
- ☐ Set "Y" - Single 40 pin, 7 segment output, 12 digit, fixed automatic decimal, no constant . . . $15.00
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Fairchild UGH7805 5 Volt 1 amp voltage regulator. Perfect for logic supplies, very compact . . . . . . $1.95

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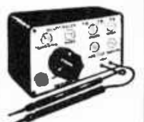

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THIS OFFER GOOD UNTIL DECEMBER 1, 1972

| Catalog Number | Any Quantity Per Item (Mix) 1-99 | 100-999 | 1000 up | Multiples of 10 Per Item (Mix) 100-990 | 1000-9990 | 10000 up |
|---|---|---|---|---|---|---|
| 7400 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7401 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7402 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7403 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7404 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7405 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7406 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7407 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7408 | .32 | .30 | .29 | .27 | .26 | .24 |
| 7409 | .32 | .30 | .29 | .27 | .26 | .24 |
| 7410 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7411 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7413 | .58 | .55 | .52 | .49 | .46 | .44 |
| 7416 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7417 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7420 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7421 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7423 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7425 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7426 | .34 | .32 | .31 | .29 | .27 | .26 |
| 7430 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7437 | .56 | .54 | .50 | .48 | .45 | .42 |
| 7438 | .56 | .54 | .50 | .48 | .45 | .42 |
| 7440 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7441 | 1.73 | 1.64 | 1.55 | 1.46 | 1.37 | 1.27 |
| 7442 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7443 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7444 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7445 | 1.71 | 1.62 | 1.53 | 1.44 | 1.35 | 1.26 |
| 7446 | 1.24 | 1.17 | 1.11 | 1.04 | .98 | .91 |
| 7447 | 1.16 | 1.10 | 1.04 | .98 | .92 | .85 |
| 7448 | 1.44 | 1.37 | 1.29 | 1.22 | 1.14 | 1.06 |
| 7450 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7451 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7453 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7454 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7460 | .26 | .25 | .24 | .22 | .21 | .20 |
| 7470 | .42 | .40 | .38 | .36 | .34 | .32 |
| 7472 | .48 | .46 | .44 | .42 | .40 | .39 |
| 7473 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7474 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7475 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7476 | .56 | .53 | .50 | .48 | .45 | .42 |
| 7480 | .76 | .72 | .68 | .65 | .61 | .57 |
| 7482 | .99 | .94 | .88 | .83 | .78 | .73 |
| 7483 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 7485 | 1.43 | 1.35 | 1.28 | 1.20 | 1.13 | 1.05 |
| 7486 | .58 | .55 | .52 | .49 | .46 | .44 |
| 7490 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7491 | 1.43 | 1.35 | 1.28 | 1.20 | 1.13 | 1.05 |
| 7492 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7493 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7494 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 7495 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 7496 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 74100 | 1.52 | 1.44 | 1.36 | 1.28 | 1.20 | 1.12 |
| 74107 | .52 | .49 | .47 | .44 | .42 | .39 |
| 74121 | .56 | .53 | .50 | .48 | .45 | .42 |
| 74122 | .70 | .67 | .63 | .60 | .56 | .53 |
| 74123 | 1.21 | 1.06 | 1.00 | .94 | .89 | .83 |
| 74141 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 74145 | 1.41 | 1.33 | 1.26 | 1.18 | 1.11 | 1.04 |
| 74150 | 1.63 | 1.54 | 1.46 | 1.38 | 1.29 | 1.20 |
| 74151 | 1.20 | 1.14 | 1.07 | 1.01 | .95 | .88 |
| 74153 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 74154 | 2.43 | 2.30 | 2.16 | 2.03 | 1.89 | 1.76 |
| 74155 | 1.46 | 1.39 | 1.31 | 1.23 | 1.16 | 1.08 |
| 74156 | 1.46 | 1.39 | 1.31 | 1.23 | 1.16 | 1.08 |
| 74157 | 1.56 | 1.48 | 1.39 | 1.31 | 1.23 | 1.15 |
| 74158 | 1.56 | 1.48 | 1.39 | 1.31 | 1.23 | 1.15 |

| Catalog Number | Any Quantity Per Item (Mix) 1-99 | 100-999 | 1000 up | Multiples of 10 Per Item (Mix) 100-990 | 1000-9990 | 10000 up |
|---|---|---|---|---|---|---|
| 74160 | 1.89 | 1.79 | 1.68 | 1.58 | 1.47 | 1.37 |
| 74161 | 1.89 | 1.79 | 1.68 | 1.58 | 1.47 | 1.37 |
| 74166 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74176 | 1.62 | 1.54 | 1.45 | 1.36 | 1.28 | 1.19 |
| 74177 | 1.62 | 1.54 | 1.45 | 1.36 | 1.28 | 1.19 |
| 74180 | 1.20 | 1.14 | 1.07 | 1.01 | .95 | .88 |
| 74181 | 3.20 | [illegible] | [illegible] | [illegible] | [illegible] | 1.67 |
| 74182 | 1.20 | 1.14 | 1.07 | 1.01 | .95 | .88 |
| 74192 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74193 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74195 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74197 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74198 | 2.81 | 2.65 | 2.50 | 2.34 | 2.18 | 2.04 |
| 74199 | 2.81 | 2.65 | 2.50 | 2.34 | 2.18 | 2.04 |
| **SCHOTTKY TTL** | | | | | | |
| 74S00 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S02 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S03 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S04 | 1.17 | 1.10 | 1.22 | 1.15 | 1.08 | 1.01 |
| 74S05 | 1.17 | 1.10 | 1.22 | 1.15 | 1.08 | 1.01 |
| 74S08 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S09 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S10 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S15 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S20 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S22 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S40 | 1.17 | 1.10 | 1.22 | 1.15 | 1.08 | 1.01 |
| 74S50 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S51 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S60 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S64 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S65 | 1.14 | 1.08 | 1.02 | .96 | .90 | .84 |
| 74S74 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S74 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S76 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S78 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S107 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S112 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S113 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S114 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.44 |
| 74S140 | 1.17 | 1.10 | 1.22 | 1.15 | 1.08 | 1.01 |
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| NE501 | 2.99 | 2.82 | 2.66 | 2.49 | 2.32 | 2.16 |
| NE526 | 3.79 | 3.38 | 3.17 | 2.97 | 2.74 | 2.55 |
| NE531 | 3.81 | 3.58 | 3.36 | 3.14 | 2.91 | 2.69 |
| NE533 | 3.81 | 3.58 | 3.36 | 3.14 | 2.91 | 2.69 |
| NE536 | 7.31 | 6.88 | 6.45 | 6.02 | 5.59 | 5.16 |
| NE537 | 7.51 | 7.09 | 6.67 | 6.29 | 5.76 | 5.32 |
| NE540 | 2.16 | 2.04 | 1.92 | 1.80 | 1.68 | 1.56 |
| NE555 | .98 | .93 | .88 | .83 | .78 | .74 |
| NE560 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE561 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE562 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE565 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE566 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE567 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| N5111 | .90 | .86 | .81 | .77 | .72 | .68 |
| N5556 | 1.87 | 1.77 | 1.66 | 1.56 | 1.46 | 1.35 |
| N5558 | .80 | .76 | .72 | .68 | .64 | .60 |
| N5595 | 3.40 | 3.20 | 3.00 | 2.80 | 2.60 | 2.40 |
| N5596 | 1.87 | 1.77 | 1.66 | 1.56 | 1.46 | 1.35 |
| 709 | .42 | .40 | .38 | .36 | .34 | .32 |
| 710 | .42 | .40 | .38 | .36 | .34 | .32 |
| 711 | .44 | .42 | .40 | .37 | .35 | .33 |
| 723 | 1.00 | .95 | .90 | .85 | .80 | .75 |
| 733 | 1.90 | 1.80 | 1.70 | 1.60 | 1.50 | 1.40 |
| 741 | .44 | .42 | .40 | .37 | .35 | .33 |
| 747 | 1.05 | .99 | .94 | .88 | .83 | .77 |
| 748 | .48 | .46 | .43 | .41 | .38 | .36 |

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| Catalog Number | 1-99 | 100-999 | 1000 up | 100-990 | 1000-9990 | 10000 up |
|---|---|---|---|---|---|---|
| 1N270 | .15 | .14 | .13 | .12 | .11 | .10 |
| 1N751A | .30 | .28 | .26 | .24 | .22 | .20 |
| 1N914 | .10 | .09 | .08 | .07 | .06 | .05 |
| 1N4001 | .10 | .09 | .08 | .07 | .06 | .05 |
| 1N4002 | .11 | .10 | .09 | .08 | .07 | .06 |
| 1N4004 | .13 | .12 | .11 | .10 | .09 | .08 |
| 1N4006 | .15 | .14 | .14 | .12 | .11 | .10 |
| 1N4154 | .15 | .14 | .14 | .12 | .11 | .10 |
| 2N4060 | .25 | .24 | .21 | .19 | .17 | .15 |

All IC's are supplied in 8-, 14-, 16-, or 24- pin DIP (Dual-in-line) plastic or ceramic package except for NE533, NE536, NE537, and NE540 which come in TO-5 package.

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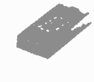

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| 20μF, 25V | 15¢ | 50μF, 50V | 20¢ |
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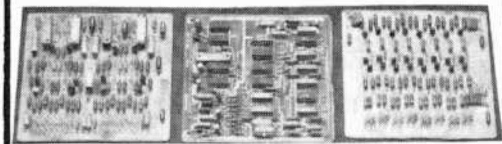

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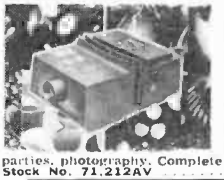

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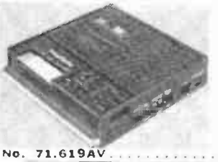

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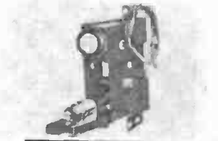

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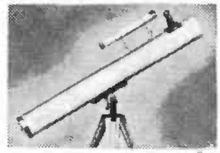

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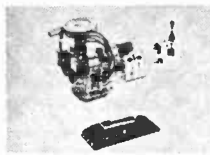

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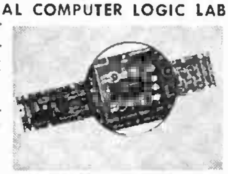

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