VOLUME 7 NO. 4

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

APRIL 1975/75c

HOW TO LISTEN TO OUT-OF-STATE AM BROADCASTS

A LOW-COST COMPANDER FOR HI-FI

CAREER GUIDE: FAA ELECTRONICS TECHNICIAN

MINIVOLTER WITH 500 μV FULL-SCALE

LAB TEST REPORTS

Realistic STA-250
Stereo Receiver

Kensonic C-200
Stereo Preamplifier

Stanton 681EEE
Stereo Phono Cartridge

Hy-Gain 623 AM/SSB
CB Base Station

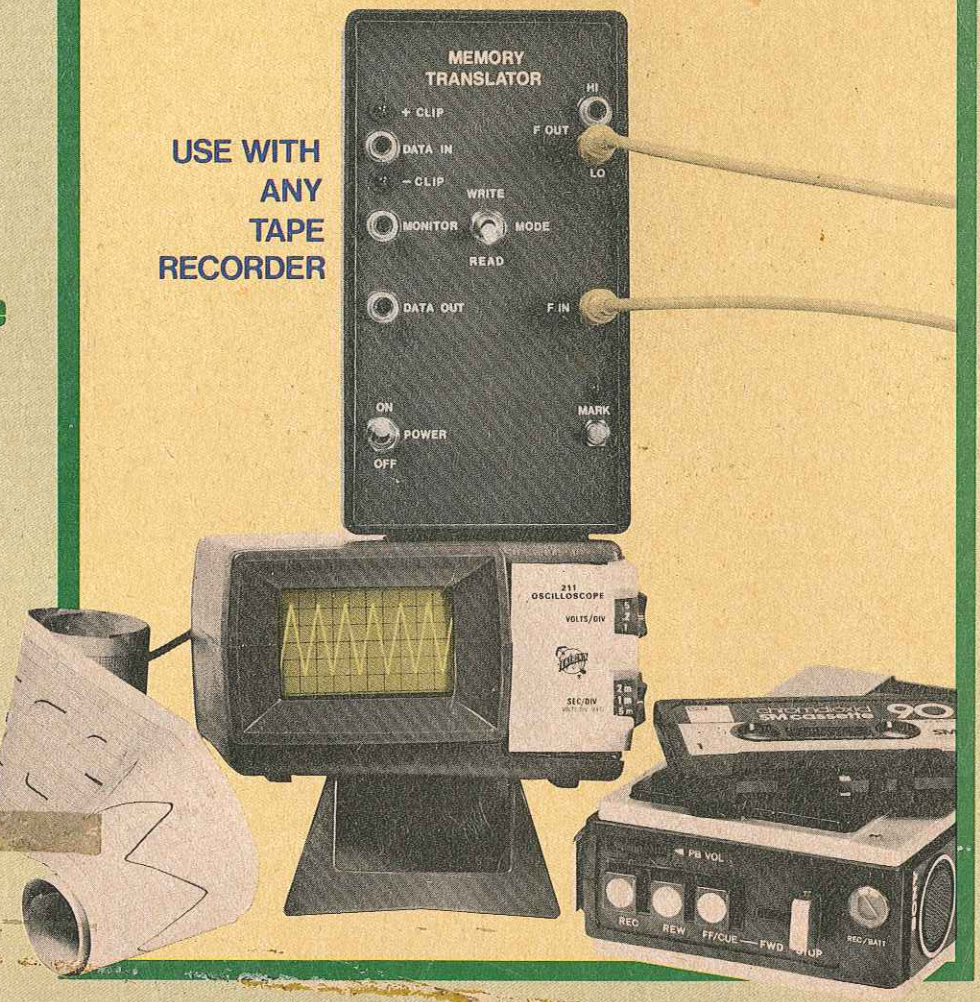
EL Instruments PG-2
Pulse Generator

PORTABLE

Analog/Digital Memory Translator

PE TESTED

USE WITH ANY TAPE RECORDER



A ZIFF-DAVIS PUBLICATION

18101

Heavyweight performance in the lightweight class!

3 great new hand-held transceivers--from Royce.

New, lightweight construction!

Model 1-408 is light in weight, with power to spare. Choice of 5-watt or 2-watt power input—use only the power you need and increase battery life. 3-way meter monitors battery level, power output, incoming signal strength. P.A. switch. 6-channel versatility (Channel 11 crystals supplied). Heavy-duty carrying case. Plus so much more.

Model 1-408
Suggested Retail Price
$109.95

Full, 2-watt transmitter input!

Model 1-402 weighs less than 2 pounds, yet has 3-channel versatility. Fully variable squelch control. Accessory jacks for earphone, external speaker, AC adaptor, battery charger, or external power. Built-in noise limiter. Heavy-duty telescopic antenna. *See the 1-402 before you buy!*

Model 1-402
Suggested Retail Price
$56.95

1-watt, 3-stage!

Model 1-400 features full 1-watt input power in a 3-stage transmitter. Plus high performance receiver chassis with tuned RF stage, and 2-channel versatility. Automatic noise limiter. Jacks for earphone, external speaker, AC adaptor, battery charger, external power. *Truly a deluxe hand-held transceiver!*

Model 1-400
Suggested Retail Price
$43.95

Be sure to see us at the CONSUMER ELECTRONICS SHOW, June 9-12, McCORMICK PLACE, Booth #9842

Royce electronics corporation

DISTRIBUTORS: WRITE FOR COMPLETE INFORMATION! Get all the facts about new products from Royce—the pacesetter in the CB field! Call or telex for complete information on our entire line of CB transceivers.

1142 Clay Street, North Kansas City, Missouri 64116
CALL: (816) 842-0252 • TELEX: 426-145
CIRCLE NO. 50 ON READER SERVICE CARD

Popular Electronics
APRIL 1975

PE TESTED

BUILD A PORTABLE

Analog/Digital Memory Translator

- *Record analog data from dc to 250 Hz.*
- *Record digital data to 500 bits/second.*
- *Transmit data over conventional communication lines.*
- *Scramble speech.*
- *Record computer/calculator programs.*
- *Program lamps, speakers, ovens, etc.*

BY JOE SULMAR AND JAY EISENBERG

THE portable Memory Translator described here is designed to convert dc and low-frequency information to a signal that can be recorded on almost any low-cost cassette. This permits the storage of data (including digital) of a number of different types for future use and reference. (An alternative is the use of a chart recorder—which is not usually portable and is relatively expensive.)

The Memory Translator can handle signals between dc and about 250 Hz and digital data up to about 500 bits per second. The recorded tapes can be played back through the Translator at any time to reproduce the original signal. A simple additional circuit can be used to make the digital output compatible with TTL. In addition, two Memory Translators can be used to transmit data on a standard communication link.

A "marker" pulse can be injected on the tape to identify any particular portion. When the marker is inserted (by means of a pushbutton switch) and when it recurs on playback, an indicator light on the Translator is lit. This feature is especially useful for data alignment and synchronization.

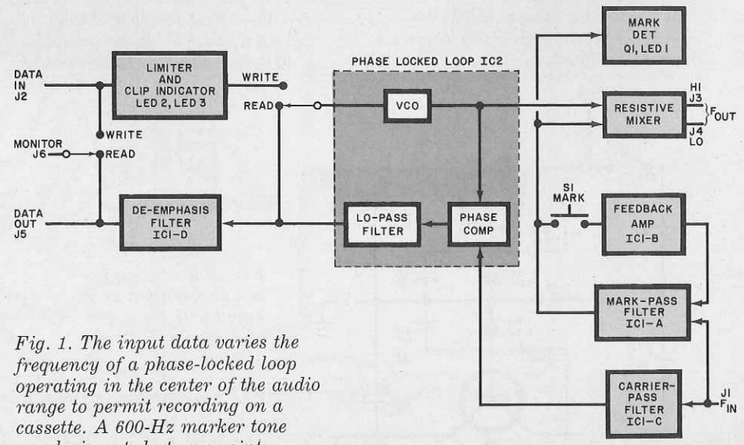


Fig. 1. The input data varies the frequency of a phase-locked loop operating in the center of the audio range to permit recording on a cassette. A 600-Hz marker tone can be inserted at any point.

PARTS LIST

B1, B2—9-volt battery
C1, C2—6800-pF 5% capacitor
C3, C6, C8, C12, C17, C19—0.1-μF capacitor
C4—1.5-μF capacitor
C5—0.01-μF capacitor
C7—1800-pF, 5%, polystyrene capacitor (see text)
C9, C11—430-pF, 5%capacitor (see text)
C10—1500-pF, 5% capacitor (see text)
C13—1000-pF capacitor
C14, C16—5700-pF capacitor (see text)
C15—500-pF capacitor
C18, C20—300-μF, 10-V electrolytic capacitor
D1 to D4—1N4148 diode
D5, D6—5.6-V zener diode
IC1—Quad op amp (National LM324N)
IC2—Phase-locked loop (RCA CD4046)
J1 to J6—Phono connectors
LED1 to LED3—Red light emitting diode
Q1, Q2—Transistor (Motorola MPSA05)
Q3—Transistor (Motorola MPSA70)
Following resistors are all ¼-watt, 10%:
R1, R10, R15, R21, R23—47,000 ohms
R2—680,000 ohms
R3—2000 ohms
R4—1000 ohms
R5, R8, R9, R19—10,000 ohms
R6, R7—200,000 ohms
R11—100,000 ohms
R12—39,000 ohms
R13, R16—82,000 ohms
R14—510 ohms
R17—330,000 ohms
R18—300 ohms
R20—1 megohm
R22, R28, R29—24,000 ohms
R24—22 ohms
R25—240,000 ohms
R26—150,000 ohms
R27—33,000 ohms
S1—Spst normally open pushbutton switch (Alco MSPS-103C or similar)
S2—4pdt, on-none-on subminiature toggle switch (Alco MST405N or similar)
S3—Dpst miniature toggle switch (Alco MST-205N or similar)
Misc.—Suitable chassis, battery holders, rubber feet (4), mounting hardware, wire, solder, etc.

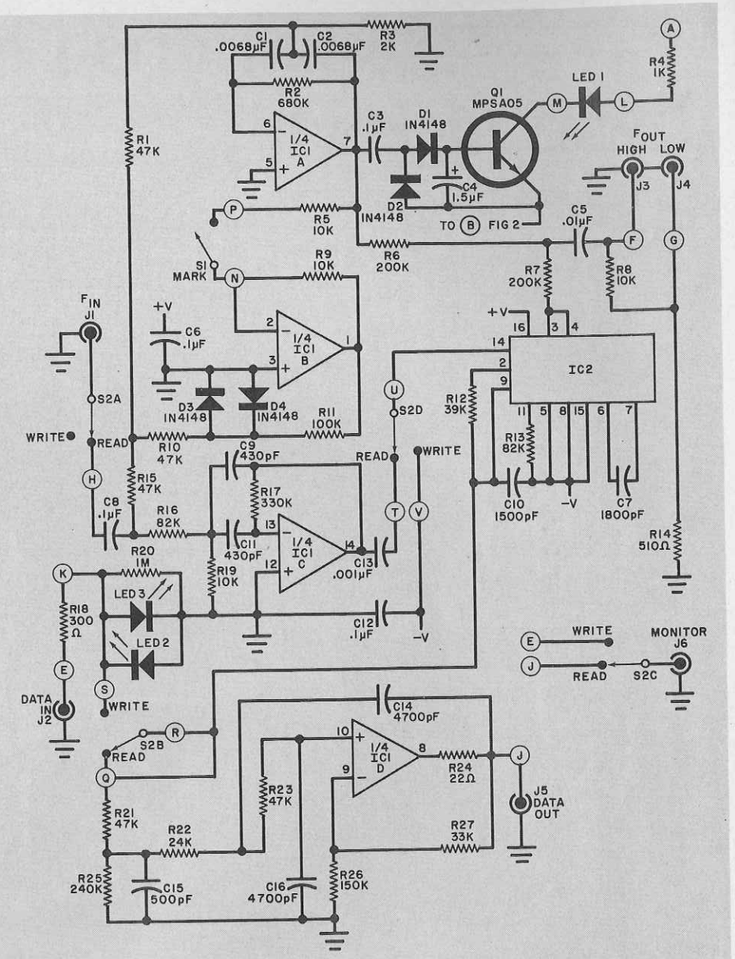


Fig. 2. Schematic of the translator. Letters in circles indicate connections between board and other components.

Note—The following are available from Electronics Research Group, 22 Mill St., Arlington, MA 02174: complete kit of all parts including case, excluding batteries (ER-MT-1) at $69.95 plus $2 shipping and handling; pc board alone (MTPC-1) at $7.50 postpaid; chassis, front panel and hardware (CP1) at $15.00 postpaid.

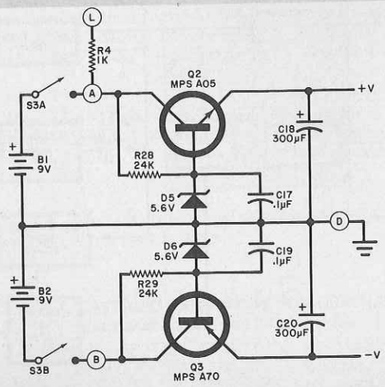


Fig. 3. Power supply can be mounted on pc board with the exception of batteries.

How It Works. Since tape recorders are relatively insensitive to low-frequency audio inputs, it is necessary to convert the data into high-frequency tones. The block diagram in Fig. 1 shows how this is done.

The data input at *J2* is first applied to a level limiter and clip indicator. Light emitting diodes *LED2* and *LED3* are illuminated when negative and positive (respectively) peaks exceed the diode breakdown (1.5 V). With the system in the WRITE mode, the input is then applied to a phased-locked loop

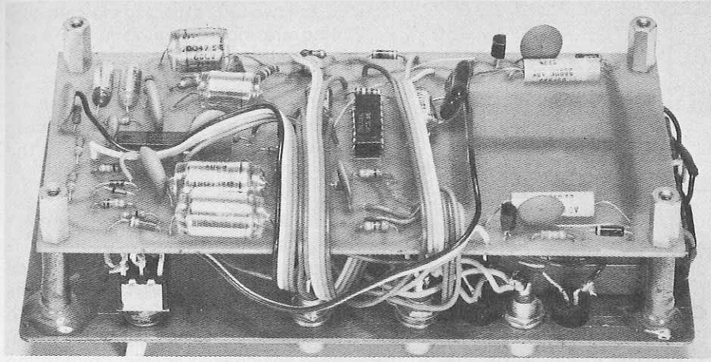


Photo of the prototype shows the pc board connected to the front panel with spacers. Batteries are located between board and panel.

(IC2). The frequency of the internal vco is about 7 kHz when the input signal is zero. Positive and negative variations of the input cause instantaneous frequency deviations of the vco output. The latter is applied to the tape recorder through the output terminals *J3* and *J4*. Connector J3 is a 400-mV rms output for the tape recorder's line input, while *J4* delivers a 30-mV rms signal for the recorder's microphone input. The FM output swings between 5000 and 9000 Hz so it is suitable for low-cost recorders.

With the system in the READ mode, the input *(J1)* from the recorder goes through a carrier-pass filter *(IC1C)* that protects the phase-locked loop from unnecessary noise (especially the 600-Hz marker). The signal from the recorder varies the frequency of

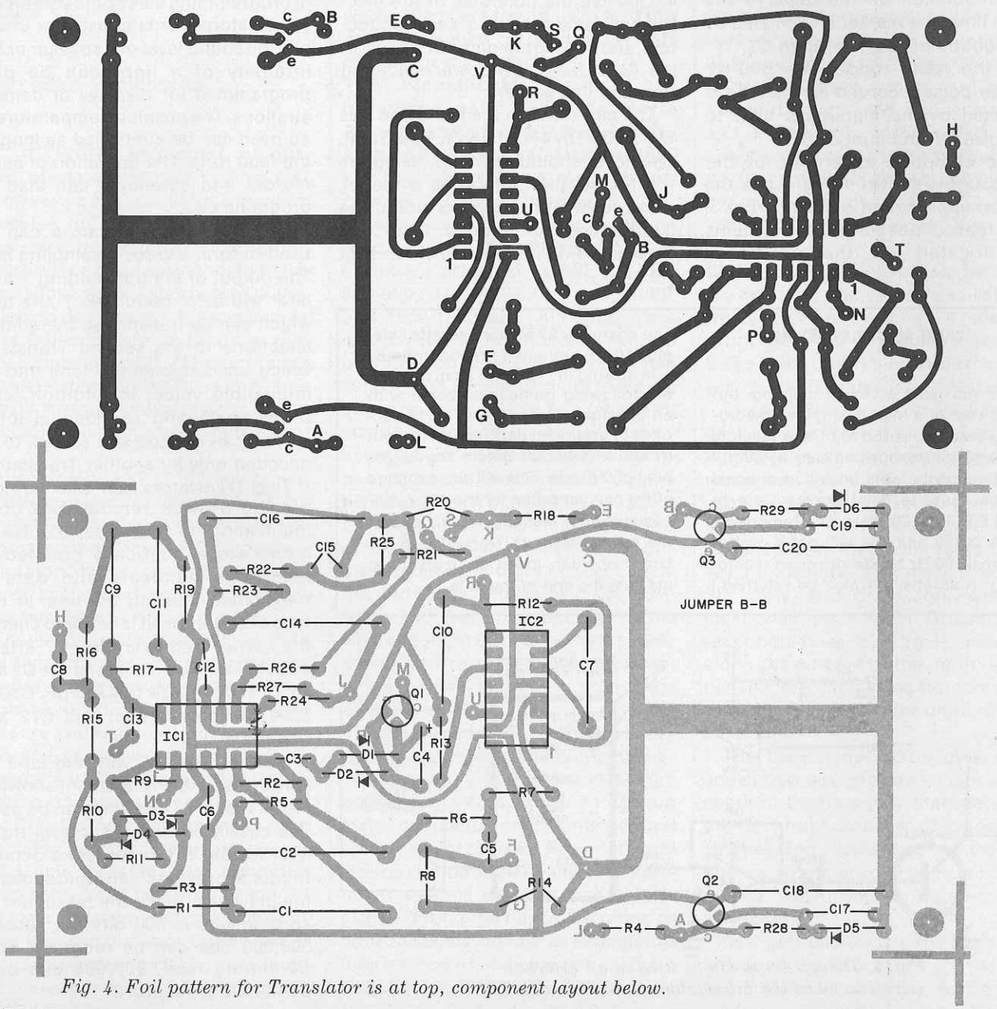


Fig. 4. Foil pattern for Translator is at top, component layout below.

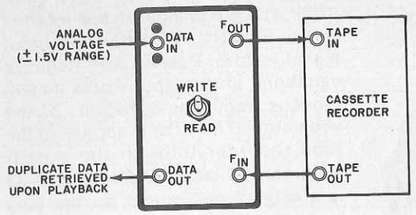


Fig. 5. Use this setup to connect Translator to a tape recorder.

the PLL and the de-emphasis filter *(IC1D)* removes the carrier from the signal. The input from the tape recorder should be about 100 mV rms for dependable data reading.

The mark-pass filter *(IC1A)* is an active, high-Q, 600-Hz bandpass filter. In the WRITE mode, depressing *S1* introduces the filter into the feedback circuit of amplifier *IC1B,* causing it to oscillate at 600 Hz. This tone is resistively added to the main signal output for modulation on the tape. At the same time, the marker is indicated by the lighting of *LED1* through *Q1.*

In the READ mode, the 600-Hz marker pulse recorded on the tape is detected by the mark-pass filter to energize *Q1* and light *LED1.*

The complete schematic of the Translator is shown in Fig. 2 and the power supply circuit is shown in Fig. 3. Note that connections to components not located on the pc board are made to points identified by letters on the schematic.

Construction. The foil pattern for the pc board and component layout are shown in Fig. 4. Be sure to use precision capacitors for *C1, C2, C7, C9, C10, C11,* and *C14.* Also, *C7* must be a polystyrene type to assure temperature and humidity stability. The insulated jumper must be installed between the two points marked B in Fig. 4. Observe the polarities of the electrolytic capacitors and semiconductors and the notch-and-dot codes of the IC's. Use a low-power soldering iron and fine solder.

The case used in the prototype was 6½″ by 3½″ by 1¾″ (16.5 x 8.9 x 4.5 cm). The cover should be metal. Using the front-panel photograph as a model, drill twelve ¼-in. holes to mount the front-panel components. Note that these are laid out in logical order. That is, the two LED's used to indicate clipping are mounted next to the input connector; *LED1* is adjacent to *S1,* etc.

Use spacers in attaching the pc board to the front panel, leaving enough room to accommodate the two 9-V batteries.

Operation. A typical arrangement for low-frequency analog recording is shown in Fig. 5. To record data, place the MODE switch in WRITE, turn on the tape recorder and the Translator. Operate the MARK pushbutton to denote any desired special point in the recording. Use the same interconnection to read the data back, but with the MODE switch on READ.

The system is linear with unity gain for input levels of ±1.5 volts.

Fluctuating voltage for the purpose of programming electronic equipment can be stored for later use. For example, the sound level of a speaker or the intensity of a light can be preprogrammed for displays or demonstrations. The absolute temperature of an oven can be controlled as long as the tape runs. The operation of servo motors and solenoids can also be programmed.

Two Memory Translators can be used to form a voice scrambling link. The output of the transmitting Translator will be a modulated 7-kHz tone which can be transmitted by radio or telephone to the second Translator which unscrambles the tone into an intelligible voice. In addition, cassettes containing confidential information can be filed and stored, to be decoded only by another Translator.

Two Translators can also be coupled to provide remote data communication. In this case, the Translators are acoustically coupled to telephone handsets and data is transmitted through the line. In this type of operation, it is better to change the carrier frequency from 7 kHz to about 2 kHz. To do this, change *C2* and *C7* to 1500 pF, *C9* to 4700 pF, *C10* to 5000 pF (polystyrene) and *C12* and *C14* to 0.0.2 μF.

To interface TTL with the tape recorder, use the arrangement shown in Fig. 6. A dual 741 op amp can be used. The circuit consists of a level translator for the TTL input and a Schmitt trigger to provide clean logic edges on the playback. Since the maximum recording rate is 500 bits per second, 600,000 bits can be recorded on a 20-minute tape, 900,000 bits on a 30-minute tape, etc. ◈

CHART RECORDINGS BY MAIL

If you need a chart recording, but the cost of a high-quality pen recording machine is too high, the Memory Translator provides an easy solution.

Record the data on a conventional tape cassette. Mail the cassette to R.I.E.P. Inc., 29 Ware St., Cambridge, MA 02139 and you will get a professional 100-Hz bandwidth chart recording. (Cassette will also be returned.) The charge is $3.50 per cassette side, plus 10¢ per minute of recorder time.

In making the cassette tape, observe the following guidelines: begin with an initial marker, followed by 15 seconds of grounded data input. Then put in another marker before the beginning of the data. This will allow voltage offset compensation for the difference between your Memory Translator and the master Memory Translator at the chart recorder. Insert six markers to indicate the end of the data.

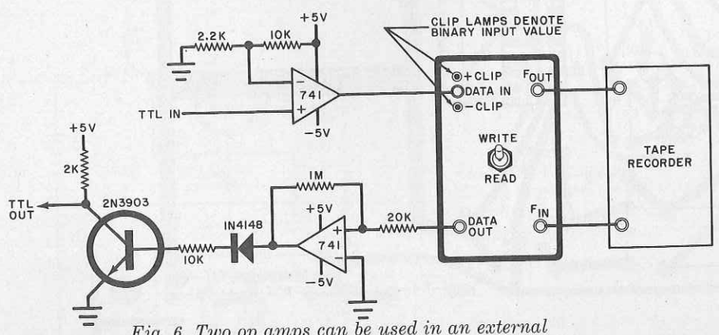


Fig. 6. Two op amps can be used in an external circuit to make the Translator compatible with TTL.

How to Listen to Out-of-State AM Broadcasts

DX'ing the medium-wave band is a fascinating hobby that can be pursued with a minimum of equipment.

BY THOMAS R. SUNDSTROM

LISTENING to distant, or out-of-state, stations in the medium-wave band (DX'ing the medium waves) is an excellent hobby which requires a minimum of radio equipment and is a good springboard to the more sophisticated shortwave DX'ing. Listening to stations a thousand or more miles away may be done with only a small portable AM radio or the nearest table radio. Therefore, one can DX the medium-wave band (535 to 1605 kHz) even on a very limited budget.

At the other end of the equipment spectrum, several hundred MW DX'ers in two MW-oriented listener clubs use sophisticated receivers, frequency calibrators, tape recorders, and a variety of specialized equipment to extract intelligence from the ether.

There's more to MW DX'ing than just trying to see how many stations can be heard or how far away a station might be heard. For example, my wife and I are avid National Hockey League fans and particular games, occuring elsewhere in the country, often have a bearing on the standing of our local favorite. So our enjoyment of this spectator sport is enhanced by our being able to listen (with top-notch equipment) to all but three or four of the stations that broadcast games of other teams in the league. With use of a medium-grade portable, that number increases to only six or so that can't be heard. For sports enthusiasts, we've listed here the prime or feed (if a network) station carrying broadcasts of the four major sports.

By international agreement, the broadcast band (BCB) in North America consists of 107 frequency allocations between 540 kHz and 1600 kHz. There are three major types: clear, regional, and graveyard.

Clear channels are the easiest on which to hear distant stations. The clears are assigned to 540, 640-780, 800-900, 940, 990-1140, 1160-1220, and 1500-1580 kHz. Although there may be many daytime-only stations operating on clear channels between sunrise and sunset, at night there are only one (class I-A) or two (class I-B) stations operating, usually with a maximum power of 50,000 watts. Forty-one states and the District of Columbia have at least one station operating on a clear channel. There are some exceptions to the only-station-on-the-frequency-at-night concept, identified in the FCC rules as class II stations, and these may operate on the clears at night but usually with lower power and restricted directional antenna patterns in order to protect the class I operations.

Regional channels have class III stations operating daytime-only or unlimited (day and night) with a maximum power of 5 kW, intended to serve a major population center and the rural area adjacent thereto. Power at night may be as little as 500 watts, and directional antenna patterns may be employed during the day or the night, or both, in such a manner as to minimize interference on the same or adjacent frequencies. The regional channels are 550-630, 790, 910-980, 1150, 1250-1330, 1350-1390, 1410-1440, 1460-1480, 1590, and 1600 kHz.

Graveyard channels, the third category of frequencies, is the smallest in number of channels, but the largest in terms of number of stations per frequency. Accordingly, with upwards of 150 stations each, all low-power and local service, these probably provide the greatest challenge to listeners specializing in domestic (U.S. and Canadian) DX'ing. The class IV stations have virtually unlimited hours, running 1 kW during the day and 250 watts at night, with a non-directional antenna pattern. There are six graveyard, so named because of the congestion, channels: 1230, 1240, 1340, 1400, 1450, and 1490 kHz.

Listening Tips. When to listen? The old axiom of "the best time to listen is when you have the time" is most appropriate here. Actually, there are three variables to consider: daily, yearly, and the sunspot 11-year cycle.

The nighttime hours, as I'm sure you have already noted through casual listening, provide the best long-range reception. This is due to skywave reception; off the E-layer in the ionosphere, the best signals are from about 1000 miles distant. In New Jersey, for instance, stations in Chicago, St. Louis, and Cuba dominate the clear channels at night. Groundwave reception (that is, signals traveling along the surface of the earth) is enhanced, too, increasing from an average 100 miles during the day to 500 or so at night.

The transitional hours of sunrise and sunset also provide enhanced reception. Daytime-only stations offer an excellent source of good DX catches and, depending on the frequency, daytimers can be heard up to a 1000 miles away during these twilight hours.

As it gets dark first in the East, daytimers on the East Coast are the first to go off the air each day. As the sun-