



## 220 MHz FM AMATEUR TRANSCEIVER



MODEL HR-220

# INSTRUCTION MANUAL

## UNPACKING

- 1 - Transceiver Unit
- 1 - Microphone Assembly
- 1 - DC Power Cord with Fuse Holder
- 1 - Mobile Mounting Bracket
- 1 - Security Bracket (See page 14 for Installation)
- 1 - Instruction Manual
- 1 - Warranty Card

To be filled out and returned to:

Regency Electronics, Inc.

7707 Records Street

Indianapolis, Indiana 46226

## MAINTENANCE

It is recommended that the services of a qualified electronic technician be used for troubleshooting.

## DESCRIPTION

The Regency HR-220 is a 12-channel, all-transistor, narrowband FM transceiver designed for use in the 220-225 MHz Amateur Band. Its receiver section is a double-conversion, super-hetrodyne type with plug-in crystal-controlled frequency selection.

The transmitter section is also crystal controlled on each channel. The transmitter employs phase modulation, using varactor diodes. Internal controls are provided for adjusting the deviation from 0 to 10 KHz. This control is factory adjusted for approximately 5 KHz deviation.

The transmitter and receiver sections both employ band-pass circuitry so that maximum transmitter power and receiver sensitivity are maintained across the entire band (220-225 MHz).

The HR -220 utilizes silicon transistors (24) throughout for dependability. The use of two Integrated Circuits provides for compactness and circuit reliability. In addition, two ceramic filters employed in the receiver's first and second I.F. ensures optimum performance in areas of the country where channels are closely grouped together.

The transmitter employs 2 ruggedized, Balanced Emitter RF power transistors for high power output (10 Watts). A large, copper heat sink plus a SWR bridge limiting circuit ensures maximum protection even under long periods of "key down" operation and open or shorted antenna conditions. Also, there is virtually no power drop off during lengthy transmissions. In addition, the attenuation of spurious emissions from the transmitter exceed the FCC limits as would be required for Type Acceptance. The receiver section is Certified under Part 15, Subpart C of the FCC Rules and Regulations.

Some EXTRA features include:

1. A HI-LO Power Switch (approximately 1 Watt RF output in LO position).
2. Provision for connection of an external or remote speaker (such as Regency's MA -8).
3. A Mobile Mounting Bracket for easy installation in a car or truck.
4. A Security Bracket, which will help minimize the possibility of theft. See installation illustration on page 14

5. A plug-in, high-impedance microphone with a right-angle connector.

## SPECIFICATIONS

### RECEIVER

Antenna Impedance .....	50 Ohms
Frequency Range .....	220-225 MHz
Sensitivity .....	0.4 $\mu$ v (nom.), 20 DB Quieting
Selectivity .....	6 DB Down $\pm$ 7 KHz 50 DB Down $\pm$ 20 KHz
Spurious Rejections .....	60 DB
Modulation Acceptance .....	$\pm$ 7.5 KHz
I.F. Frequencies .....	10.7 MHz & 455 KHz
Audio Output .....	3 Watts @ 10%, or less, Distortion; (3-4 $\Omega$ Speaker) 5 Watts Maximum
Squelch System .....	"Noise" Operated
Channels .....	12; Crystal Controlled
Crystal Installed .....	223.50 MHz in Channel 1

### TRANSMITTER

Antenna Impedance .....	50 Ohms
Frequency Range .....	220-225 MHz

Power Output (HI power)..... 10 Watts (min.) @ 13.8 VDC

Power Output (LO power)..... 1 Watt (approx.) @ 13.8 VDC

Power Bandwidth..... 10 Watts from 220-225 MHz

Power Amp Protection..... SWR Bridge Limiting Circuit

Harmonic and Spurious Emissions..... 55 DB, or more,  
below carrier

Modulation..... Phase Modulation with  
automatic deviation limiting

Deviation..... Factory adjusted to 5 KHz; internal  
adjustment of 0-10 KHz deviation

Mike Pre-Amp..... FET Input with internal level control

Microphone..... Plug-in, hand held, high-Z ceramic

Channels..... 12; Crystal Controlled with individual  
trimmer capacitors for Frequency netting

Crystal Multiplication..... 18

Crystal Installed..... 223.50 MHz in Channel 1

## POWER

Voltage Requirements . 11.5 VDC (min.) – 14.5 VDC (max.)

Current Requirements ..... @ 13.8 Volts

Receive (Squelched)..... 180 MA .

Receive (Max. Audio Output)..... 800 MA .

Transmit (HI power).....	2.5 Amps (max.)
Transmit (LO power).....	0.8 Amps (approx.)
Fuse Size.....	4 Amp. 3AG

## SEMICONDUCTORS

Integrated Circuits.....	2
Silicon Transistors (Total).....	24
Silicon BET Power Transistors.....	2
Field Effect Transistors.....	2
Diodes (Total).....	9
Zener Diodes.....	2
Varactor Diodes.....	2
Signal Diodes.....	4
Rectifier Diodes.....	1

## INSTALLATION

### Mobile (12 VDC) Installation:

The HR -220 transceiver may be used in any car, truck, boat, etc. that has a 12 VDC negative ground system. The RED lead with the fuse holder must be connected to the positive terminal side of the battery. The BLACK lead should be connected to the chassis or negative terminal of the battery.

To reduce the possibility of theft, the Security Bracket should be installed (as shown on page 14). The padlock used should be of substantial construction and can be either a key or combination operated type.

For a quick and easier mobile installation, an accessory 12 VDC power cord with a cigarette lighter plug (Regency MA-10) can be used. In this case, the unit can be operated from on the front seat of the vehicle.

The "mobile" antenna used should be adjusted as closely as possible to present a  $50\Omega$  load to the transceiver. The adjustments recommended by the antenna's manufacturer should be carefully followed to insure that the lowest possible SWR is achieved. It is recommended that any final adjustment to the antenna be made with a reliable SWR indicator in the feedline and with the HR-220 operating. If the SWR is too high, the built-in SWR bridge limiting circuit of the HR-220 will reduce the RF power out, or may even shut off the transmitter entirely.

#### Base Station (117 VAC) Installation:

The HR-220 may be used with any regulated or well filtered DC power supply that can supply at least 3 amperes at 12 to 14.5 VDC. The regulation of the power supply should be such that its output voltage does not get over 14.5 VDC when the transceiver is in the receive mode and is squelched off. Damage to various components may occur if the unit's input voltage exceeds 15 volts for any length of time.

The power supply and/or the power connection to the HR-220 should be properly fused. In addition, the ripple on the supply's output voltage should be less than 1%. It is recommended that Regency's regulated power supply, the P107, be utilized for base station operation of the HR-220.

The antenna impedance should be adjusted or matched as closely as possible for use with 50 ohm coaxial cable. Use of RG-58/U should be considered only if the length of coax needed is 25 feet or less. For longer runs of feedline, it is recommended that a lower-loss cable, such as RG-8/U (especially of the "foam" type) should be used.

## OPERATION

### Volume Control/Off-On Switch:

This control varies the audio output level for the internal speaker. It also varies the level of audio present at the external speaker connection. Clockwise rotation of this control turns the receiver on and increases the volume.

### Squelch Control:

This control eliminates background noise in the absence of a signal. Full clockwise rotation removes all squelch action. Turning this control counter-clockwise until the noise disappears permits the receiver to be "quiet" until an actual signal is received. Even if the squelch control is set fully counter-clockwise, the receiver will still operate properly and not be locked-out or prevented from receiving a signal.

### Channel Selector:

This is a twelve-position rotary switch which enables the operator to select any one of twelve crystal-controlled transmit-receive channels. Each switch position pairs up a specific transmit crystal with its respective receive crystal. For example, position 1 connects transmit crystal No. 1 and receive crystal No. 1 to their respective oscillator circuits.



## AVAILABLE ACCESSORIES

<u>Description</u>	<u>Regency Part No.</u>
AC Power Supply - Regulated, 3 Amp.	P107
Remote Speaker with Mounting Bracket	MA -8
DC Power Cord with Cigarette Lighter Plug	MA -10
70 DB Filter (455 KHz) Kit	MA -46

## HI-LO Power Switch:

The HI-LO Power Switch provides the operator with the capability of selecting either one of two RF output power levels. With the switch in the HI position, the transmitter will develop its full rated power output. This power level is useful for mobile-to-mobile and repeater fringe areas. The LO power position limits the transmitter's output to approximately 1 Watt. This power level is generally adequate for working through most repeaters.

## Crystal Specifications:

Due to the numerous frequencies or channels involved, only one pair of crystals is installed by the factory. Miniature, plug-in crystals are simply installed by inserting them in the receptacles on the circuit board. Because of the accuracy required, Shepherd Industries' crystals are recommended. They are usually available at the source from which the radio was purchased. Specify exact frequency.

If desired, the crystals may be purchased from other manufacturers. The following information must be included in the order:

## Receive Crystal:

1. Crystal frequency, determined as follows:

$$\text{Crystal frequency} = \frac{\text{receive frequency (MHz)} + 10.7 \text{ MHz}}{4}$$

Example:

Crystal frequency =

$$\frac{223.5 \text{ MHz} + 10.7 \text{ MHz}}{4} = 58.550 \text{ MHz}$$

2. 3rd Overtone

3. Series resonance - 600 Hz
4. Maximum equivalent series resistance: 35 Ohms
5. Static Capacitance: 5PF  $\pm$ 1PF
6. Drive level: 2 MW
7. Holder: HC-25/U
8. Frequency Calibration:  $\pm$ .001% @ 25°C
9. Frequency Tolerance:  $\pm$ .002% from -10°C to +60°C

Transmit Crystal:

1. Crystal frequency, determined as follows:  

$$\text{Crystal frequency} = \frac{\text{transmit frequency (MHz)}}{18}$$

Example:

$$\begin{aligned} \text{Crystal frequency} &= \\ \frac{223.50 \text{ MHz}}{18} &= 12.416667 \text{ MHz} \end{aligned}$$

2. Fundamental mode
3. Load Capacitance: 32PF
4. Maximum series resistance: 25 Ohms
5. Drive level: 2 MW
6. Holder: HC-25/U
7. Frequency Calibration:  $\pm$ .001% @ 25°C
8. Frequency Tolerance:  $\pm$ .0015 from -10°C to +60°C

## Crystal Installation:

Prior to installing a crystal, the transceiver's cover should be removed. To remove the cover, unscrew the two large bolts located at the sides of the unit. The cover may then be slipped off by sliding it toward the rear of the unit.

Next, the speaker should be removed. Unscrew the two small metal screws (one located on each side) holding the speaker brackets in place. Then carefully place the speaker assembly along side of the unit.

The unit is shipped from the factory with the transmit and receive crystals for 223.50 MHz installed in channel 1.

Insert the crystal, or crystals, in the proper socket pins as indicated on the crystal location drawing. (See page 13). The number by each pair of sockets matches the dial and channel block designation. For each transmit crystal, there is a variable capacitor that can be used for adjusting each transmit crystal to the exact frequency. This adjustment should be made with a frequency counter or by utilizing a receiver which is known to be "on frequency".

Reinstall the speaker; position the speaker assembly so that the cut-off corner is adjacent to the relay lugs. Carefully reinstall the cover.

The channel, or frequency, blocks on the front panel will accept 1/4" wide embossing tape with up to 5 digits, letter, or other characters. These blocks are to be used for identifying the channel frequencies installed in the unit.

### Crystal Jumpering:

Due to the possible excessive "pulling" of the crystal's frequency, jumpering of the RECEIVE crystals is NOT recommended. If jumpering is attempted, the crystal's frequency should be checked with a highly accurate counter to help insure that proper "on channel" operation is possible.

NOTE: Adding a jumper will slightly lower the TRANSMIT crystal's frequency. Adjust the associated trimmer on the transmitter board for correction.

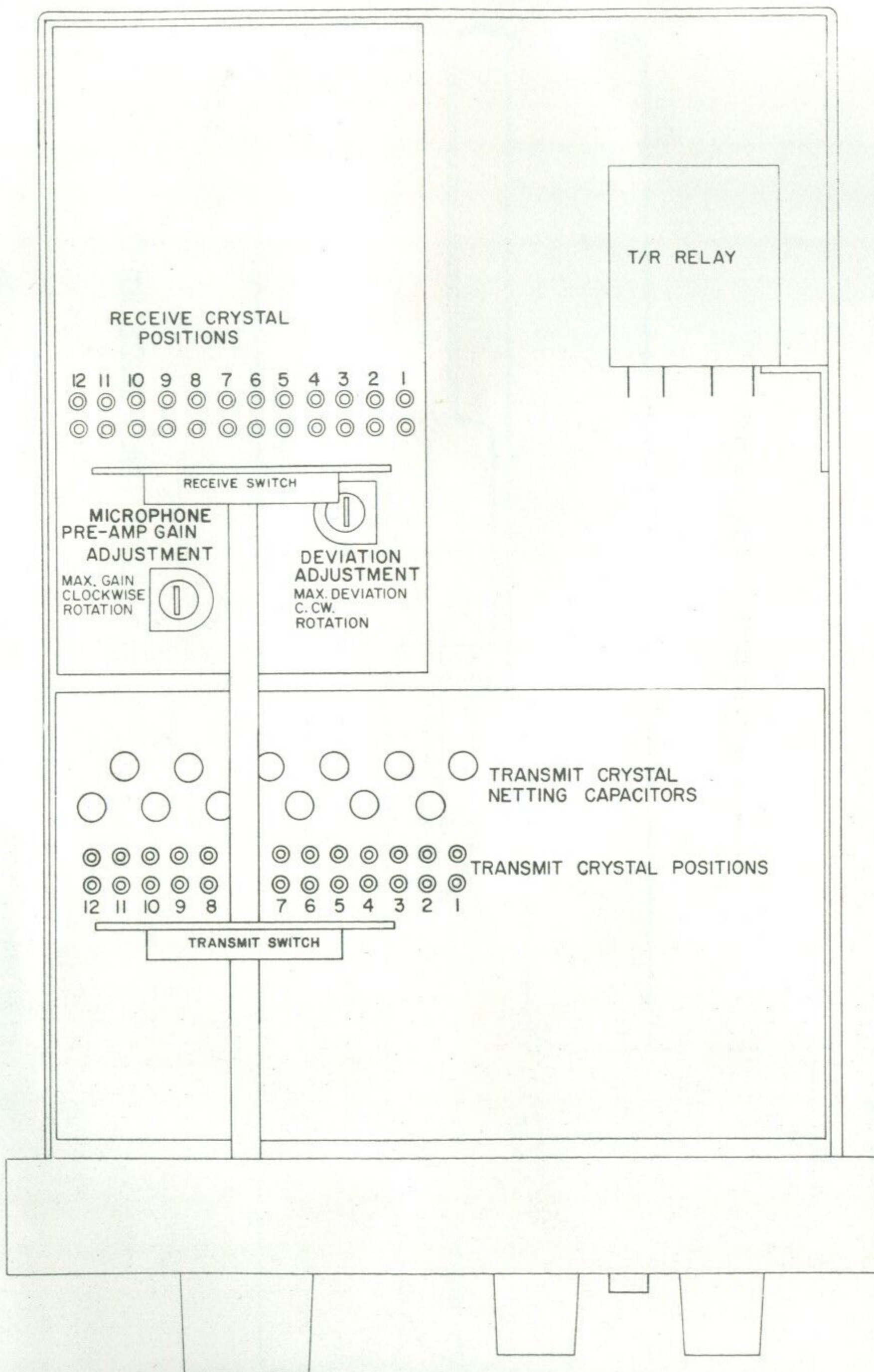
### Crystal Table:

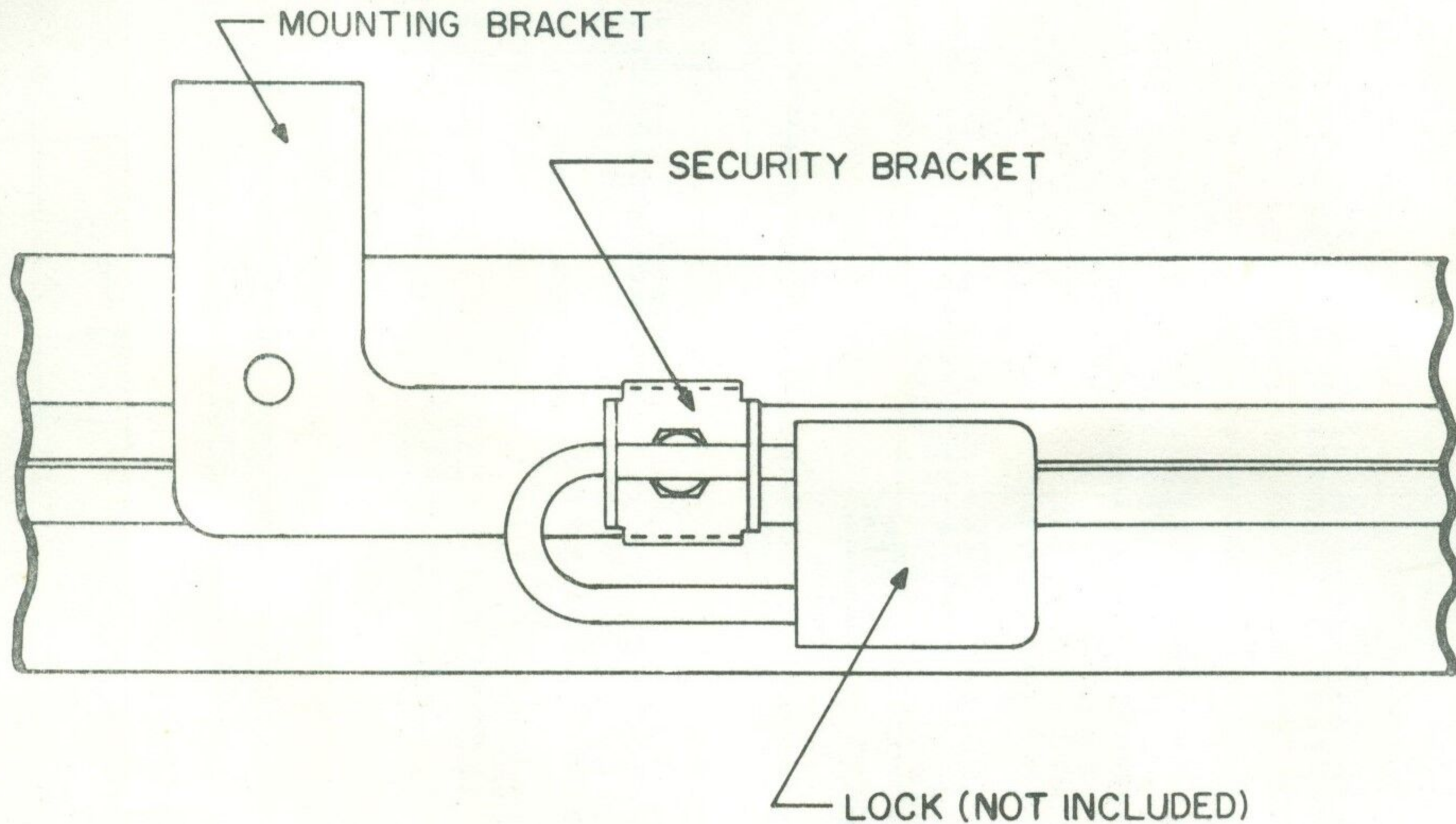
On page 12, there is a table of common channel frequencies and their respective Transmit and Receive crystal frequencies. This list is based upon the 40 KHz channel spacing that most amateur groups will be following.

HR -220 CRYSTAL FREQUENCY (MHz) TABLE

Channel Frequency	Transmit Crystal	Receive Crystal	Channel Frequency	Transmit Crystal	Receive Crystal
222.02	12.334444	58.180	223.54	12.418888	58.560
222.06	12.336666	58.190	223.58	12.421111	58.570
222.10	12.338888	58.200	223.62	12.423333	58.580
222.14	12.341111	58.210	223.66	12.425555	58.590
222.18	12.343333	58.220	223.70	12.427777	58.600
222.22	12.345555	58.230	223.74	12.430000	58.610
222.26	12.347777	58.240	223.78	12.432222	58.620
222.30	12.350000	58.250	223.82	12.434444	58.630
222.34	12.352222	58.260	223.86	12.436666	58.640
222.38	12.354444	58.270	223.90	12.438888	58.650
222.42	12.356666	58.280	223.94	12.441111	58.660
222.46	12.358888	58.290	223.98	12.443333	58.670
222.50	12.361111	58.300	224.02	12.445555	58.680
222.54	12.363333	58.310	224.06	12.447777	58.690
222.58	12.365555	58.320	224.10	12.450000	58.700
222.62	12.367777	58.330	224.14	12.452222	58.710
222.66	12.370000	58.340	224.18	12.454444	58.720
222.70	12.372222	58.350	224.22	12.456666	58.730
222.74	12.374444	58.360	224.26	12.458888	58.740
222.78	12.376666	58.370	224.30	12.461111	58.750
222.82	12.378888	58.380	224.34	12.463333	58.760
222.86	12.381111	58.390	224.38	12.465555	58.770
222.90	12.383333	58.400	224.42	12.467777	58.780
222.94	12.385555	58.410	224.46	12.470000	58.790
222.98	12.387777	58.420	224.50	12.472222	58.800
223.02	12.390000	58.430	224.54	12.474444	58.810
223.06	12.392222	58.440	224.58	12.476666	58.820
223.10	12.394444	58.450	224.62	12.478888	58.830
223.14	12.396666	58.460	224.66	12.481111	58.840
223.18	12.398888	58.470	224.70	12.483333	58.850
223.22	12.401111	58.480	224.74	12.485555	58.860
223.26	12.403333	58.490	224.78	12.487777	58.870
223.30	12.405555	58.500	224.82	12.490000	58.880
223.34	12.407777	58.510	224.86	12.492222	58.890
223.38	12.410000	58.520	224.90	12.494444	58.900
223.42	12.412222	58.530	224.94	12.496666	58.910
223.46	12.414444	58.540	224.98	12.498888	58.920
223.50	12.416666	58.550			

# CRYSTAL LOCATION AND ADJUSTMENT DIAGRAM





SIDE VIEW SHOWING SECURITY BRACKET INSTALLATION

### WARRANTY

This Transceiver is sold under a 90 day warranty, which warrants it to be free from defects in material and workmanship. We agree to repair or replace at the point of manufacture, without charge, all parts showing such defects, provided the unit is delivered to us, intact for our examination, with all transportation charges prepaid to our factory, within 90 days from the date of sale to the original purchaser, and provided such examination discloses in our final judgement, that it is thus defective. Pilot lights, tubes, vibrator, fuses and diodes shall be covered by the manufacturer's standard EIA warranty and such items shall be excluded from the provisions of this warranty.

This warranty does not apply if the Transceiver has been subjected to misuse, neglect, accidents, incorrect wiring not our own, improper installation, or put to use in violation of instructions furnished by us, nor to Transceivers that have been damaged by lightning, excess current, repaired or altered outside our factory, nor to the Transceiver that has had its serial number altered or removed.

### CHANGES

The Company reserves the right to modify or change the equipment, in whole or in part, at any time prior to delivery in order to include refinements deemed appropriate by the Company, but without incurring any liability to modify or change any equipment previously delivered, or to supply new equipment in accordance with earlier specifications.

### WARNING

ALL TRANSMITTER FINAL ADJUSTMENTS ARE SEALED AT THE FACTORY. IF ANY OF THESE SEALS ARE BROKEN, THE WARRANTY ON ALL POWER SEMI-CONDUCTORS IS VOIDED.