TWIN BANDER MOBILE TRANSCEIVER/REPEATER

Models HW-24/HW-24H

595-4140

HEATH ZENITH

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

Your Heath Twin Bander Mobile Transceiver/Repeater, Model HW-24 or HW-24H, is a highly versatile, yet compact unit that operates on the VHF and UHF FM bands. You may use the two transceivers either separately (for simplex or duplex operation) or together (for crossband repeater operation).

The Transceiver/Repeater is built and tested to stringent specifications, and uses the latest surface mount and microcomputer technologies available to provide you with many useful functions. The following features are built into your unit:

- Individual volume and squelch controls and a status display, which includes the operating frequency plus the "S"-meter/RF output indicator for each band.
- An internal speaker is used for both bands; and if you prefer you can add one or two optional external speakers.
- Hi/lo power output control for each band.
- RMR (repeater memory recall) allows quick access of your favorite repeater. You can use the CALL feature for repeater or simplex operation.
- Two channels, one on each band, may be simultaneously monitored. When one channel is activated, the other channel may be automatically muted.
- Crossband repeater function, with or without "hangtime."

The main microprocessor allows you to:

- Change frequencies in 1 MHz or 100 kHz coarse steps, and choose one of five different fine steps (5, 10, 12.5, 20, or 25 kHz). You can use different fine steps for each of the two bands and you can change frequencies directly from the microphone's Up and Down buttons or via a rotary channel selector.
- Use the 10 memory channels per band (independent of the remaining channels). You can store an operating frequency, a shift (offset) frequency, a shift direction (+ or -), a receive/transmit frequency reversal, and a subaudible tone frequency on each channel.
- Scan a 1 MHz band segment, a full band, all memory channels, or selected memory channels.
- Use tone squelch operation.

The following additional features are also included:

- The DTMF (Dual-Tone Multi-Frequency) function allows you to use your microphone to control some repeaters and make telephone calls.

- A key lock switch allows locking of the microphone up and down buttons to prevent accidental frequency changes while you are making keyboard entries.

The light weight and compact size make this Transceiver/Repeater a handy addition to any amateur radio operator's station equipment.

SPECIFICATIONS

NOTE: The following specifications apply to both the 2 m and 70 cm bands for the Model HW-24 and HW-24H Transceivers, unless otherwise noted.

GENERAL

Frequency Range*	VHF: 144.000 to 147.995 MHz. UHF: 438.000 to 449.995 MHz.
Modulation Type	F3.
Microphone Input Impedance	600 Ω.
Speaker Impedance	8 Ω.
Antenna Impedance	50 Ω.
Input Voltage	12 to 16 volts DC.
Operational Temperature Range	-4 °F to +140 °F (-20 °C to +60 °C).
Antenna Connector	SO-239 type.
Memory Channels	24 memory channels total - 10 per band, VHF and UHF; one CALL memory channel, which may be for a repeater, per band; one RMR memory channel per band.
Scanning	1 MHz segment, all band, all memory channels, or selected memory channels.
Tone Squelch	Simplex/Duplex; user selected.
Automatic Repeater	VHF to UHF, or UHF to VHF.

* May be modified for out-of-amateur-band operation for MARS, CAP, and embassy operators. Contact Heath Customer Service for information on how to do this. Proof of participation in these activities will be required.

Size (excluding knobs and cables)	HW-24: 5-7/8" wide x 2" high x 7-5/16" deep (150 x 50 x 186 mm); HW-24H: 5-7/8" wide x 2" high x 8-1/16" deep (150 x 50 x 205 mm).
Net Weight.....	HW-24: 4 lbs. (1.8 kg). HW-24H: 4 lbs. 7 oz. (2.0 kg).

RECEIVER

Receiver Type	Double-conversion superheterodyne.
First Intermediate Frequency	VHF: 10.7 MHz. UHF: 21.8 MHz.
Second Intermediate Frequency	455 kHz.
Sensitivity	.158 µV for 12 dB SINAD*.
Signal-to-Noise Ratio @ .5 µV input ..	30 dB or better.
Selectivity	12 kHz @ -6 dB; 24 kHz @ -60 dB.
Squelch Sensitivity	.08 µV.
Current Drain (@ 13.8 VDC)	600 mA.
Audio Output Power	3 W into 8 Ω (@ 10% distortion).

TRANSMITTER

RF Output Power.....	HW-24:	10 W (high); 1 W (low).
	HW-24H:	50 W (2 m; high); 40 W (70 cm; high); 5 W (low).

$$*\text{SINAD} = \frac{\text{Signal + Noise + Distortion}}{\text{Noise + Distortion}}$$

Spurious & Harmonic Emissions	Better than -60 dB
Maximum Frequency Deviation	±5 kHz.
Frequency Modulation Method	Reactance
Modulation Distortion	3% or less @ 60% modulation.
Current Drain (approximate)	HW-24 VHF/UHF: 3.4 A @ 10 W RF output; 1.5 A @ 1 W RF output.
	HW-24H VHF: 11.5 A @ 50 W RF output; UHF: 9.5 A @ 40 W RF output.
	HW-24H VHF/UHF: 3.5 A @ 5 W RF output.
DTMF	Built into microphone

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

INSTALLATION

This section of your Manual provides you with the information you will need to install the Transceiver and connect it to your power source and antennas. Practically everything you need to complete the installation, including the mounting hardware, is provided.

GENERAL PRECAUTIONS

Whether you plan to use your Transceiver as a base station or as a mobile station, be sure to consider the following items before you start the actual installation.

- To provide reliable performance, your Transceiver must be operated within its specified temperature range. It is therefore important that it always have adequate ventilation. Be sure that you do not confine it in a small enclosure. Allow at least three inches of free space above the top of the vent holes.

- When you transmit, the Transceiver's power amplifier will generate a certain amount of heat which will be dissipated in the rear panel-mounted heat sink. To permit this heat to escape, allow at least three inches of free space behind it.

- Do not expose the Transceiver to high humidity and salt water mist, as this will eventually result in damage caused by corrosion.

- Do not install and operate the Transceiver where it will be exposed to strong vibrations.

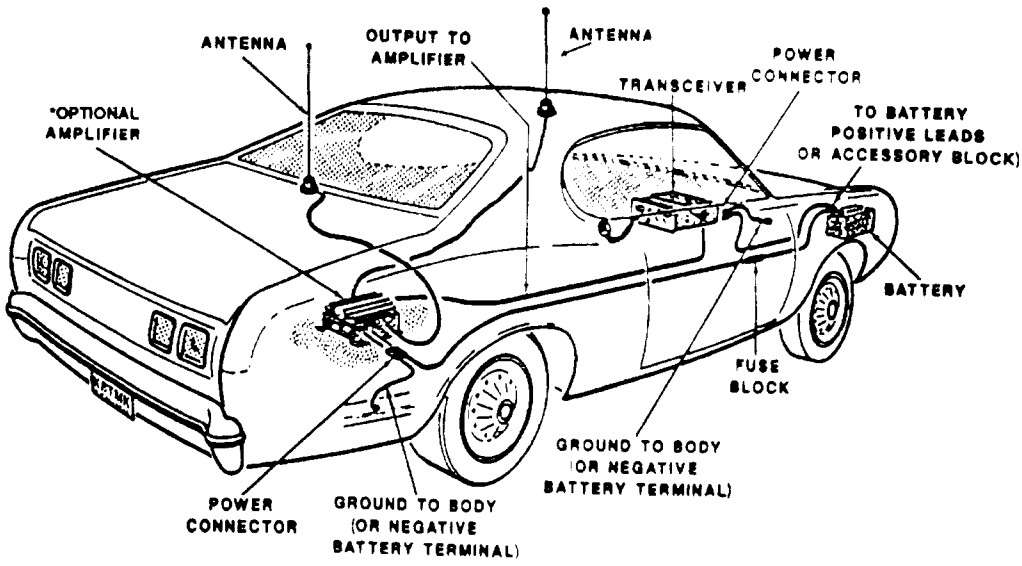
MOBILE STATION INSTALLATION

Most installations can be defined as either a "fixed station" or as a "mobile station," although many operators use their Transceivers in both fixed and mobile service. The power cord that is supplied with your Transceiver will work well in either type of installation.

The following paragraphs will provide details for installing the Transceiver in an automobile; however, the same principles will apply to other installations, such as in a boat or airplane. Read this information carefully before you install your Transceiver.

( ) Make sure the voltage at the output of your battery charging system is at least 12.0 volts and that it does not exceed 16.0 volts under any circumstances. If the voltage is not within these limits, have the system adjusted.

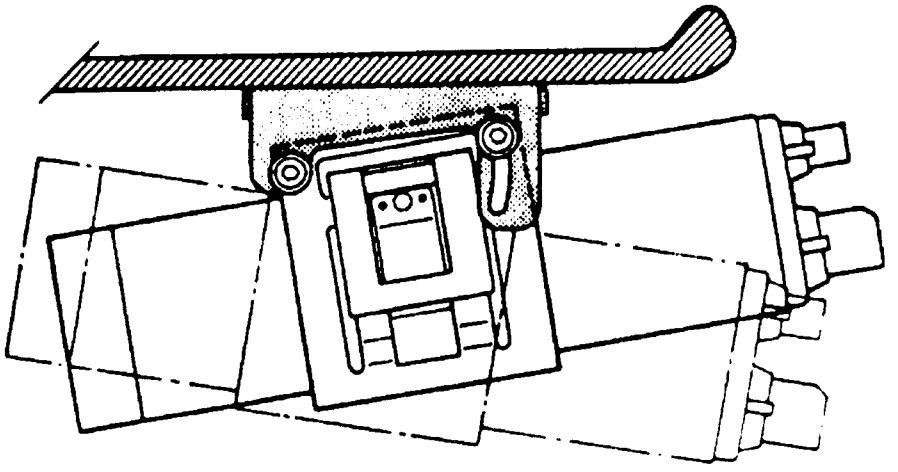
( ) Refer to Pictorial 1-1, a typical "Installation X-Ray View," for a suggested arrangement of components and their interconnections. Then decide where and how you will mount your Transceiver. NOTE: A "home-brew" adapter could be made for the drive shaft hump, and one or both brackets could be mounted on the adapter.



PICTORIAL 1-1

*For Model HW-24

Pictorial 1-2 shows how the Transceiver is installed in the two brackets. You can remove the Transceiver by pushing on both retainer releases and by disconnecting the coaxial cables and the power cable on the rear of the unit.



PICTORIAL 1-2

GENERAL CONSIDERATIONS

A. Decide upon the routing path for the power cable. You can run it through an existing, protected opening in the fire wall directly to the battery. Or, there may be an unused circuit available on the accessory fuse block of your automobile, and you can take the power from this source. The ignition switch will usually control the accessory circuit.

B. If you prefer, you can install an additional fuse in the red power wire near the battery. The in-line fuse already installed will protect the Transceiver in either a fixed or a mobile installation. However, this fuse will not, for example, protect the battery if the power wire short-circuits to the fire wall.

C. Determine the routing of the antennas' transmission lines.

BRACKET INSTALLATION

For mobile installation, both a fixed bracket and a gimbal bracket are provided. You may install the fixed bracket to keep the Transceiver in a fixed position; or if you wish to adjust the unit's viewing angle, you can install the gimbal bracket. Either bracket provides a permanent mount for your Transceiver, but they allow you to easily remove it.

You may install your Transceiver either under the dashboard or on the side of the console (if one is available) between the front seats. Be sure to select a location where the Transceiver will not prevent you from safely operating your automobile.

CAUTION: If you intend to install the Transceiver under the dashboard, first make sure that you will not cut into any single wires or wiring harnesses as you drill through the dashboard. A cut wire may be hard to find or repair later.

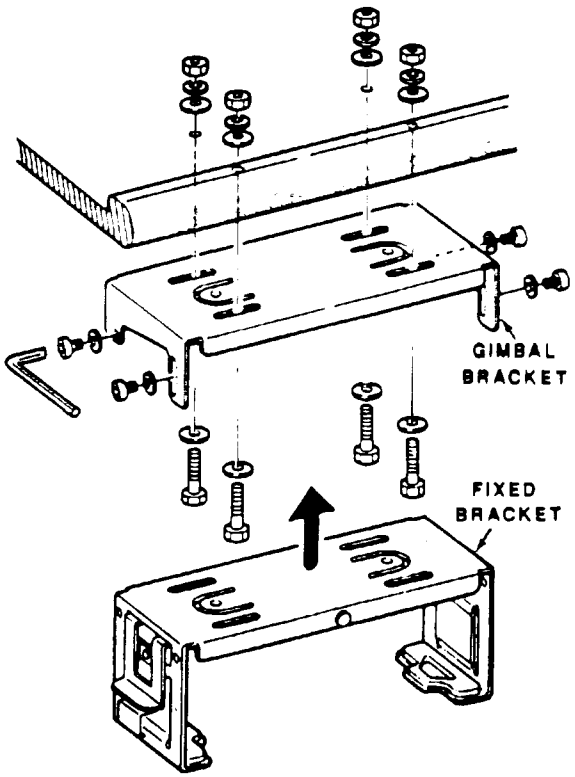
NOTES:

1. Only metric hardware is supplied with your Transceiver. Also, you have the option of using either machine screws (with nuts and washers) or sheet metal screws when you install one of the brackets, as both types of screws are provided.

2. For your convenience, a hole template for both mounting brackets is included on the last page of this Manual.

NOTE: In the following step, be sure to mark the location for each hole at the center of the corresponding long straight bracket slot.

Refer to Pictorial 1-3 for the following steps.



PICTORIAL 1-3

( ) Using the template, use a metal punch to mark the location for each of the four mounting screws.

NOTE: In the following step, use a 1/8" bit if you plan to use sheet metal screws to mount the bracket. If you plan to use machine screws, use a 7/32" bit.

( ) Using the proper size bit, carefully drill a hole at each of the four marked locations.

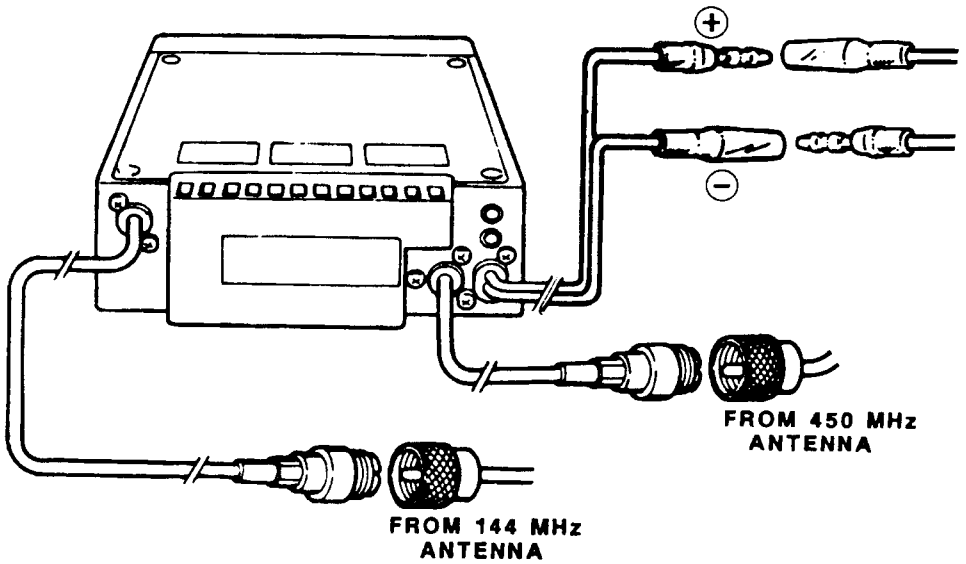
NOTE: In the following step, it is assumed that you will be using both the gimbal bracket and the fixed bracket, as shown in Pictorial 1-3. If you do not want the pivoting feature, however, mount the gimbal bracket directly to the mounting surface. It is further assumed that you will be using M5 x 20 mm hardware at each of the four mounting locations. Instead of using the hardware shown in the Pictorial, you may use #5 x 15 mm sheet metal screws.

( ) Position the gimbal bracket with the slotted holes in the side flanges towards you, as shown. Then line up the long straight slots in the bracket with the corresponding holes that you just drilled. Secure the bracket to the mounting surface with a M5 mm x 20 mm screw, two M5 mm flat washers, one M5 mm split lockwasher, and a M5 mm nut at each location. Be sure to position the hardware as shown.

( ) Place the fixed bracket inside the gimbal bracket, as shown. Place a M4 mm flat washer onto each of the four M4 mm x 10 mm screws. Then, one at a time, pass one of these screws through each of the indicated four holes and into the corresponding holes in the fixed bracket. Use your fingers to tighten the four screws at this time.

CONNECTING THE CABLES

Refer to Pictorial 1-4 for the following steps.



PICTORIAL 1-4

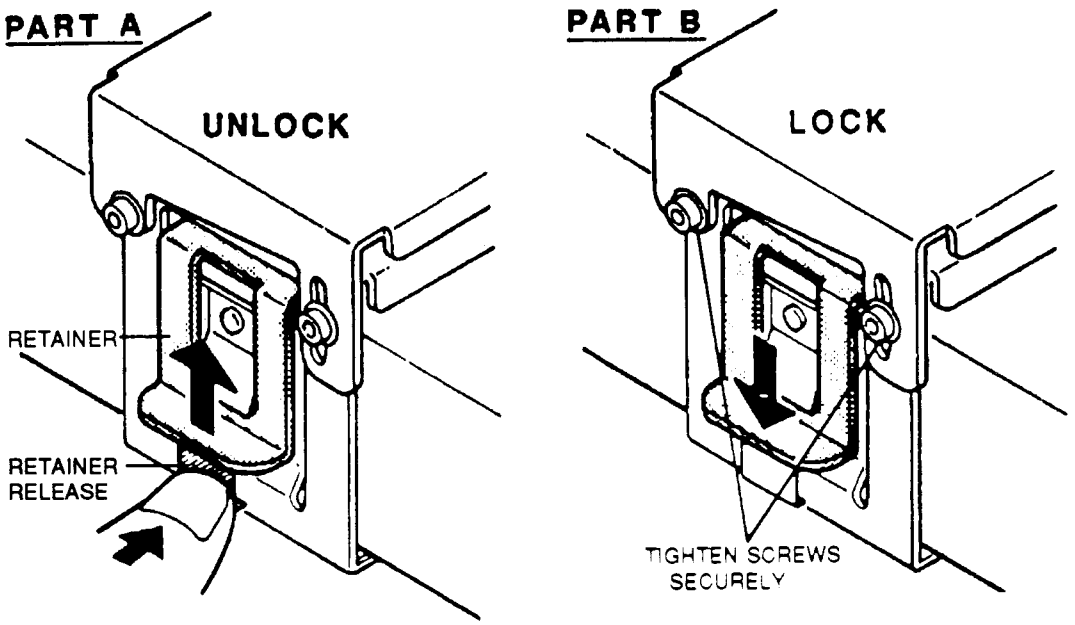
( ) Connect the plug at the free end of the coaxial cable coming from your 144 MHz antenna to the rear panel cable socket labeled 144 MHz.

( ) Similarly, connect the plug at the free end of the coaxial cable coming from your 450 MHz antenna to the rear panel cable socket labeled 450 MHz.

( ) Plug the connectors at the end of the 78" long power cord into the matching connectors at the free end of the cable coming from the rear panel.

SECURING THE TRANSCEIVER

Refer to Pictorial 1-5 for the following steps.



PICTORIAL 1-5

( ) Refer to Part A of Pictorial 1-5 and push the end of the retainer release on each side of the fixed bracket, as shown, to be sure both retainers are unlatched.

( ) Carefully slide the Transceiver about half way into the fixed bracket. Then push each retainer down to lock the Transceiver into place as shown in Part B of Pictorial 1-5.

( ) Tilt the Transceiver front up and down for the most convenient viewing angle; then, using the allen wrench provided, securely tighten the two screws on each side of the gimbal bracket.

POWER WIRING

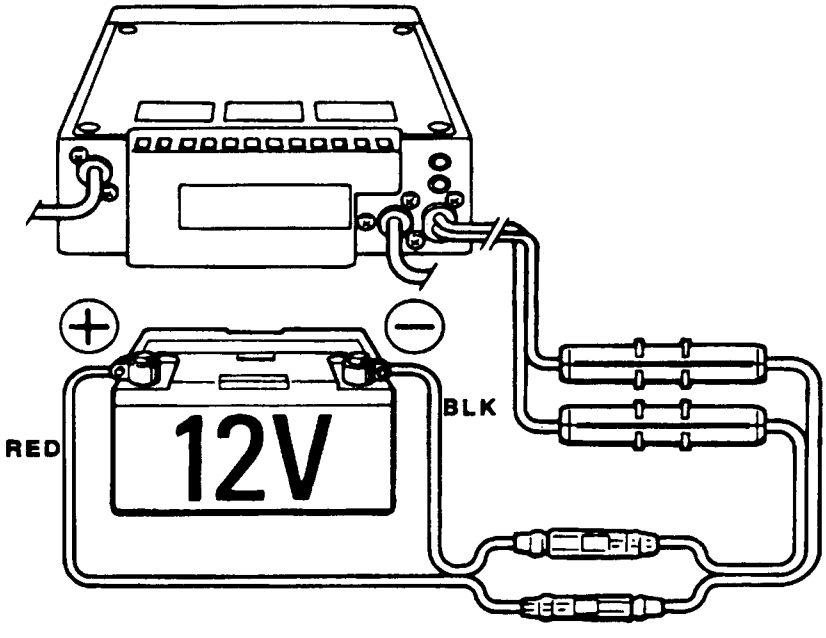
IMPORTANT: Your Transceiver is designed to operate on 12 volts DC from a source with negative ground only.

Two simple procedures are given for connecting the Transceiver's power cable to a "12 volt" battery system. Complete the steps under "Option A Wiring," the recommended method, if you plan to connect the power cable directly to the battery. Complete the steps under "Option B Wiring" if you do not wish to use the first method and an unused terminal on the accessory fuse block is available. NOTE: The automobile ignition switch will usually control this circuit in the same manner as the other accessory circuits.

Option A Wiring

Refer to Pictorial 1-6 for the following steps.

( ) Temporarily disconnect the ground wire from the negative (-) battery terminal.



PICTORIAL 1-6

( ) Obtain two solder lugs that will be suitable for the free ends of the power cable and the mounting hardware for the battery cables.

( ) Crimp and solder a lug onto each wire at the free end of the power cable.

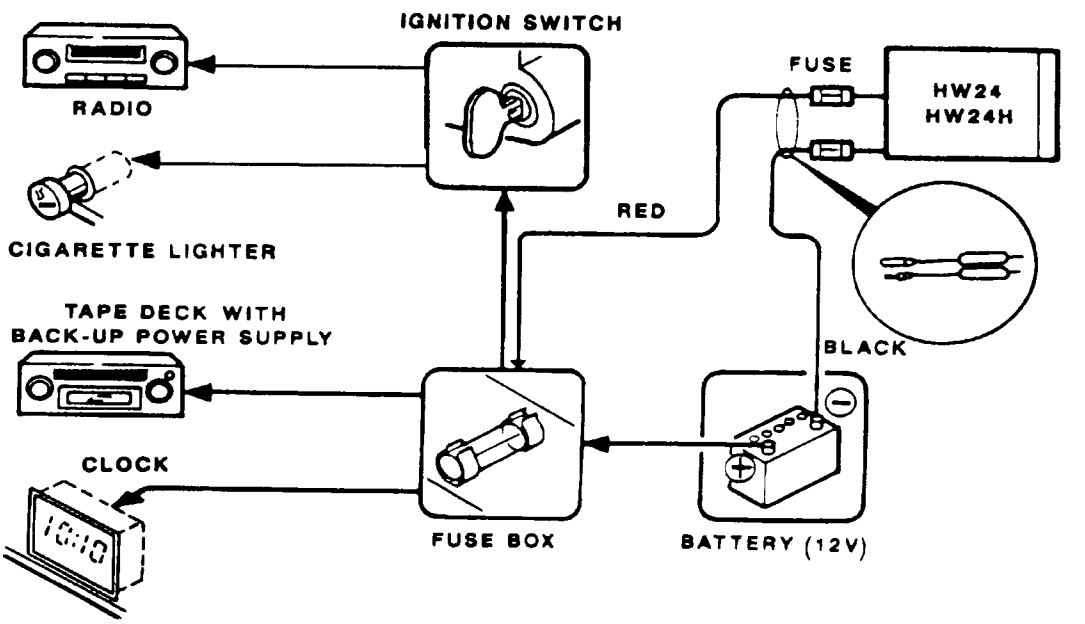
( ) Connect the red power cable wire to the positive (+) battery terminal, as shown. Tighten the hardware securely.

( ) Connect the black power cable wire and the ground wire (disconnected earlier) to the negative (-) battery terminal, as shown. Tighten the hardware securely.

Option B Wiring

( ) To make sure the circuit that is connected to the unused terminal on the accessory fuse block is suitable, connect a voltmeter between the terminal and the automobile body and turn the ignition key either to "on" or to "accessory." If there is no voltage reading, check to make sure a fuse is actually installed. Also be sure the fuse has a rating that is sufficient to handle the Transceiver's current drain (see the "Specifications" section).

Refer to Pictorials 1-7 and 1-8 for the following steps.

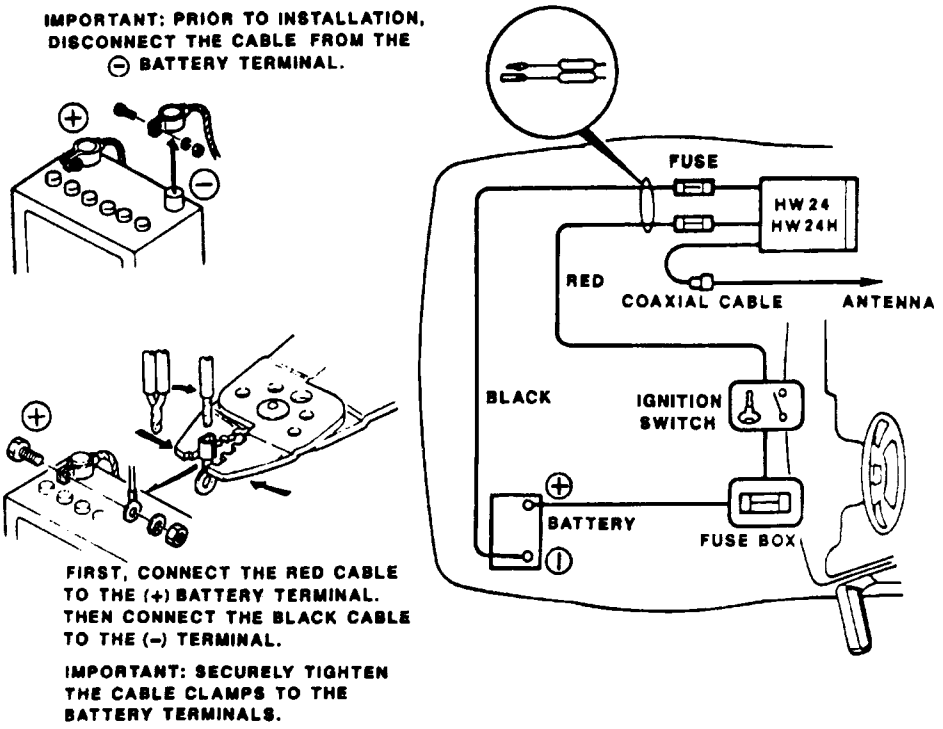


PICTORIAL 1-7

( ) Temporarily disconnect the ground wire from the negative (-) battery terminal.

( ) Obtain a solder lug that will be suitable for the wires at the free end of the power cable and the mounting hardware for the battery cables.

( ) Obtain any connector that you may require for the unused accessory fuse block terminal. NOTE: On some automobiles, the starter relay terminal is a convenient location for obtaining battery power. If you decide to use this connection, obtain a solder lug that will fit the relay terminal.



PICTORIAL 1-8

( ) Crimp and solder the connector that you obtained for the accessory fuse block (or starter relay) terminal onto the red wire at the free end of the power cable. Then connect the red wire to the selected terminal.

( ) Crimp and solder a lug onto the black wire at the free end of the power cable.

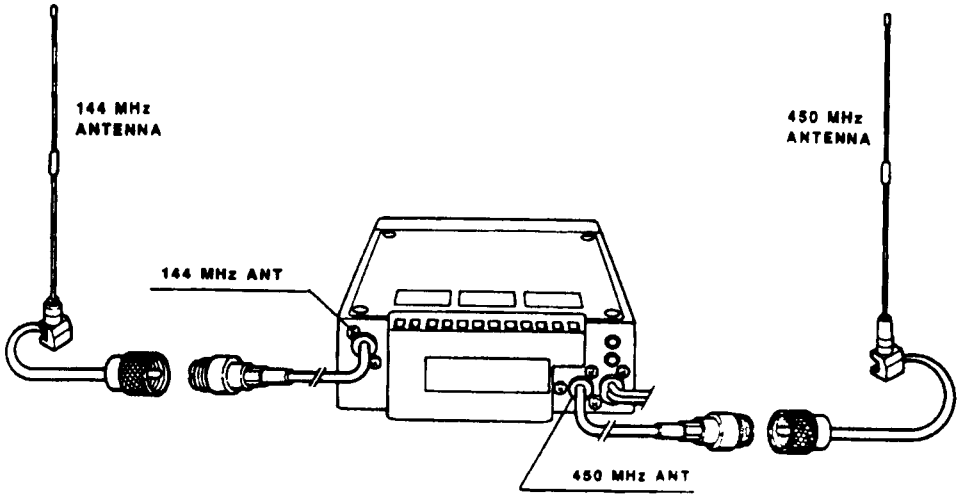
( ) Connect the black power cable wire and the ground wire (disconnected earlier) to the negative (-) battery terminal, as shown. Tighten the hardware securely.

ANTENNA INSTALLATION

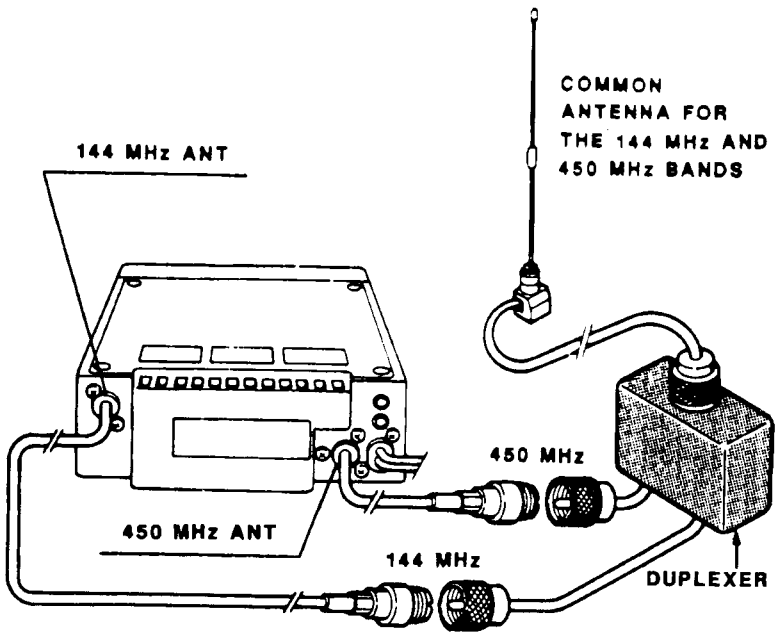
For mobile operation, you can either use two separate antennas, one for each band, or a common antenna for both bands. The pros and cons for each antenna option are outlined as follows.

- Your station will probably perform better with a separate antenna for each band, as shown in Pictorial 1-9. This option may also be the least expensive. A possible drawback is that each antenna could interfere with the radiation pattern of the other.

- A single antenna, as shown in Pictorial 1-10, would require a duplexer. A well-designed duplexer has a loss of only 1 to 2 dB, but these are usually quite expensive. NOTE: Some antennas contain an internal duplexer, which presents a less expensive alternative.

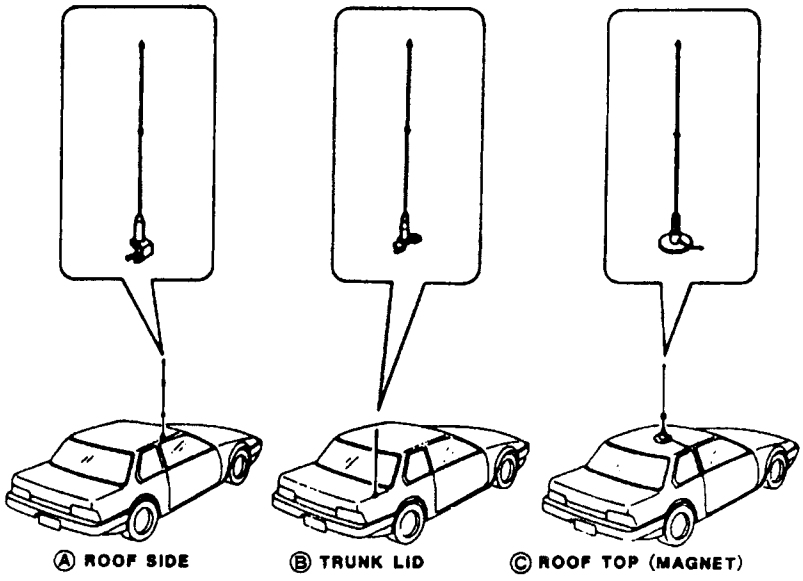


PICTORIAL 1-9



PICTORIAL 1-10

After you decide how many (one or two) antennas you will be using, you must determine where you are going to install them and determine what type of antenna base to use. Pictorial 1-11 shows three possible antenna locations. The roof top location (magnet mount) in Part C of the Pictorial is the most practical option, as it yields the most symmetrical radiation pattern.



PICTORIAL 1-11

Before and after you choose an antenna, keep the following important factors in mind:

- To obtain maximum performance from your Transceiver, select a good quality antenna. After installing it, adjust its length per the manufacturer's instructions (if possible) for a VSWR (voltage standing wave ratio) of 1.5 or less in the middle of the band segment you will use most frequently. A higher VSWR value affects the Transceiver's performance by reducing transmitter output power and degrading receiver sensitivity.

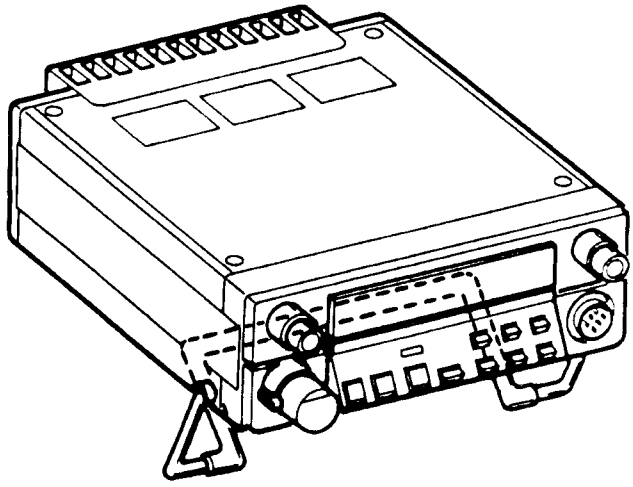
- When you install the antenna on your vehicle, make sure the antenna base makes good electrical contact with the vehicle's body. This will ensure good antenna performance.

- If you have one of the newer cars that is equipped with electronic circuits, be sure to keep the coaxial cable as far as possible away from these circuits. Otherwise, RF may interfere with them and cause the circuits to operate unreliably.

- Route the coaxial cable so that rain does not get inside the vehicle. Support the cable so that it is not damaged when you open or close a door or window.

FIXED STATION INSTALLATION

If you wish to place your Transceiver on a desk, use the wire stand that is supplied with it to place the front of the Transceiver at a more convenient viewing angle; the plastic sleeving will protect the desk's surface. Small rubber feet are used at the bottom rear of the Transceiver. Pictorial 1-12 shows the Transceiver with the stand installed.



PICTORIAL 1-12

POWER SOURCE

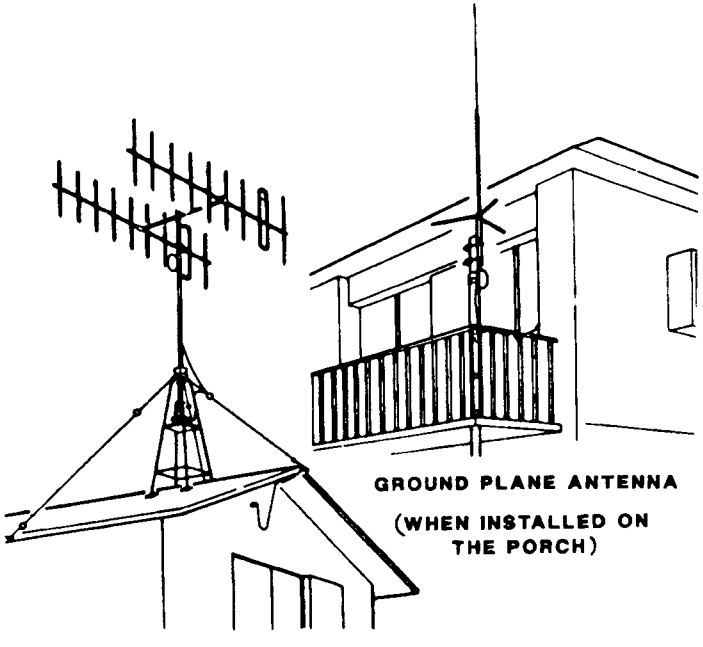
Use an AC power supply that produces a regulated voltage between 12.0 and 16.0 volts (@ 3.5 amperes for HW-24 and @ 10.5 amperes for HW-24H) to operate your Transceiver.

ANTENNA INSTALLATION

For base station operation, you may either use an omnidirectional antenna or a directional antenna. In general, a good ground plane antenna is usually the best choice for local communication. A beam antenna (Yagi) works better over longer distances. Generally, the more elements your antenna has and the higher it is mounted, the longer its range will be. If the antenna has more than 10-12 elements, however, the gain you get for each additional element is rather small. Also, such an antenna will be extremely directional.

Use the shortest length possible for the coaxial cable between the antenna and your Transceiver, since the cable's loss increases with increasing length. For the same cable, the loss also is higher if the operating frequency increases. Therefore, for improved performance, use RG-8214, RG-9913, or a better cable, if possible.

Two common antenna installations, a ground plane antenna and a pair of beam antennas, are shown in Pictorial 1-13. Using two beam antennas improves the forward gain by almost 3 dB over a single antenna, and two antennas are more selective than one. A phasing harness or a power divider must be used to feed the RF signal to the driven element of each beam antenna. A vertically polarized signal will radiate from either antenna system.



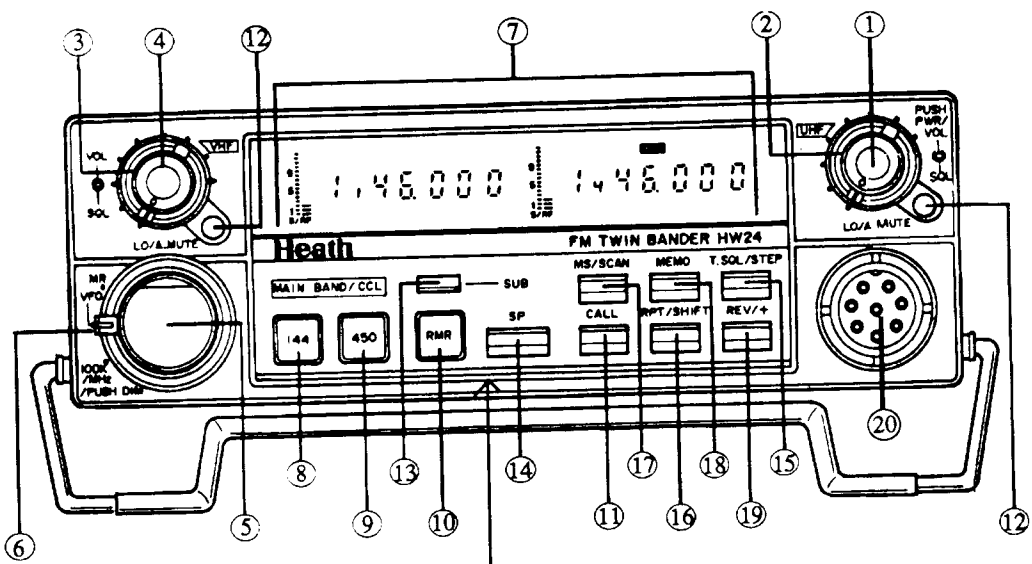
PICTORIAL 1-13

OPERATION

NOTE: You must have an amateur radio operator's license before you place the transmitter section of this Transceiver on the air. You can obtain information about licensing and amateur radio frequencies from the FCC (Federal Communications Commission) as well as from the ARRL (American Radio Relay League) and many other sources.

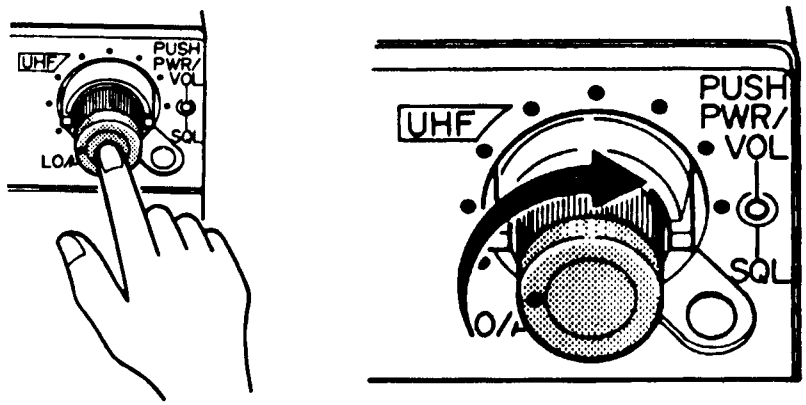
GENERAL

Refer to Pictorial 2-1 and the accompanying illustrations while you read the following descriptions of the front panel controls. The numbers in parentheses refer to the circled numbers on the Pictorial.



PICTORIAL 2-1

(1) **PUSH PWR/VOL** (Power Switch/Volume Control - Detail 2-1A) — Switches the power on and off, and adjusts the volume.

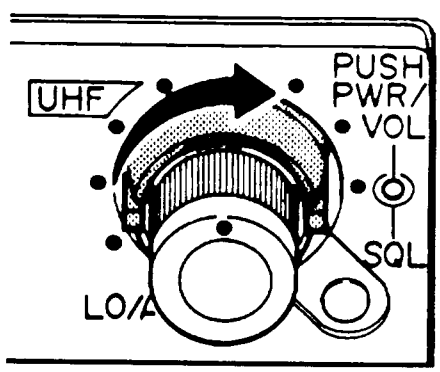


Detail 2-1A

Push this knob in to turn the power on; push it again to turn the power off. NOTE: "146.000" and "446.000" appear on the display when you push this switch on for the very first time, after you initially connect the Transceiver to a power source, or reset its microprocessor.

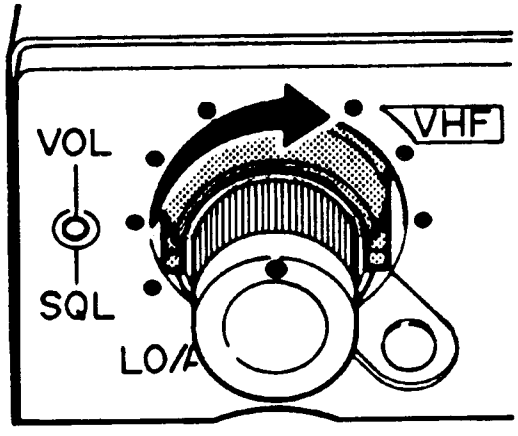
Turn this control to set the volume (sound) to the desired level for the 450 MHz band receiver. Turn the control clockwise to increase the volume; turn it counterclockwise to reduce the volume.

(2) **SQL** (Squelch Control - Detail 2-1B) — Mutes the 450 MHz band receiver when no signal is being received. Start with this control set fully counterclockwise; then rotate it clockwise until the background noise just disappears. NOTE: Further clockwise rotation of this control will reduce the receiver sensitivity.



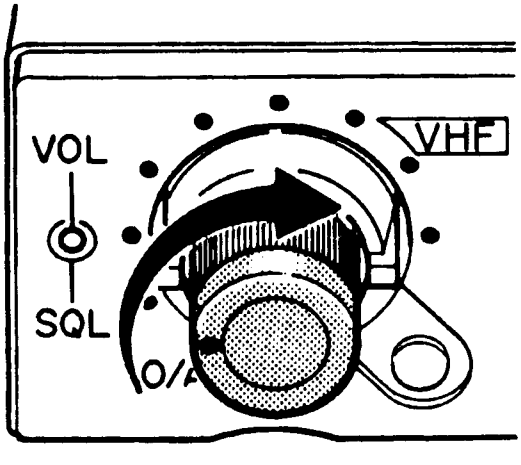
Detail 2-1B

(3) **SQL** (Squelch Control - Detail 2-1C) — Mutes the 144 MHz band receiver. Operation is identical to the Squelch control for the 450 MHz band receiver.



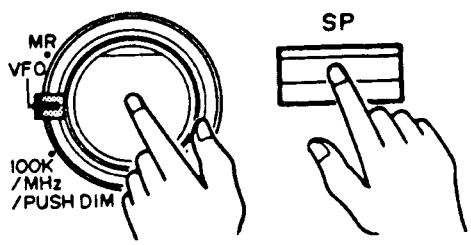
Detail 2-1C

(4) **VOL** (Volume Control - Detail 2-1D) — Sets the volume (sound) to the desired level for the 144 MHz band receiver. Operation is identical to the Volume control for the 450 MHz band receiver.

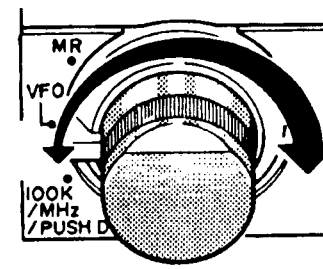


Detail 2-1D

(5) **PUSH DIM/Frequency Tuning** — Changes the display illumination brightness - (Detail 2-1E); also lets you change the displayed frequency (Detail 2-1F).



Detail 2-1E

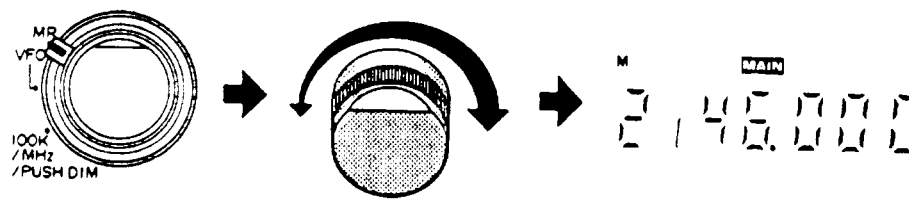


Detail 2-1F

Push this switch, while you hold the SP (special function) button depressed, to change the brightness of the display's illumination.

Turn the Frequency Tuning knob clockwise to increase the frequency; turn it counter-clockwise to decrease the frequency.

(6) **100K/MHz-VFO-MR** (Frequency Selector Lever - Detail 2-1G) — Selects the channel step rate for the Frequency Tuning knob, or selects the memory recall mode.



Detail 2-1G

- **100K/MHz** position: Lets you change the displayed frequency in 100 kHz steps - without "SP" shown on the display.

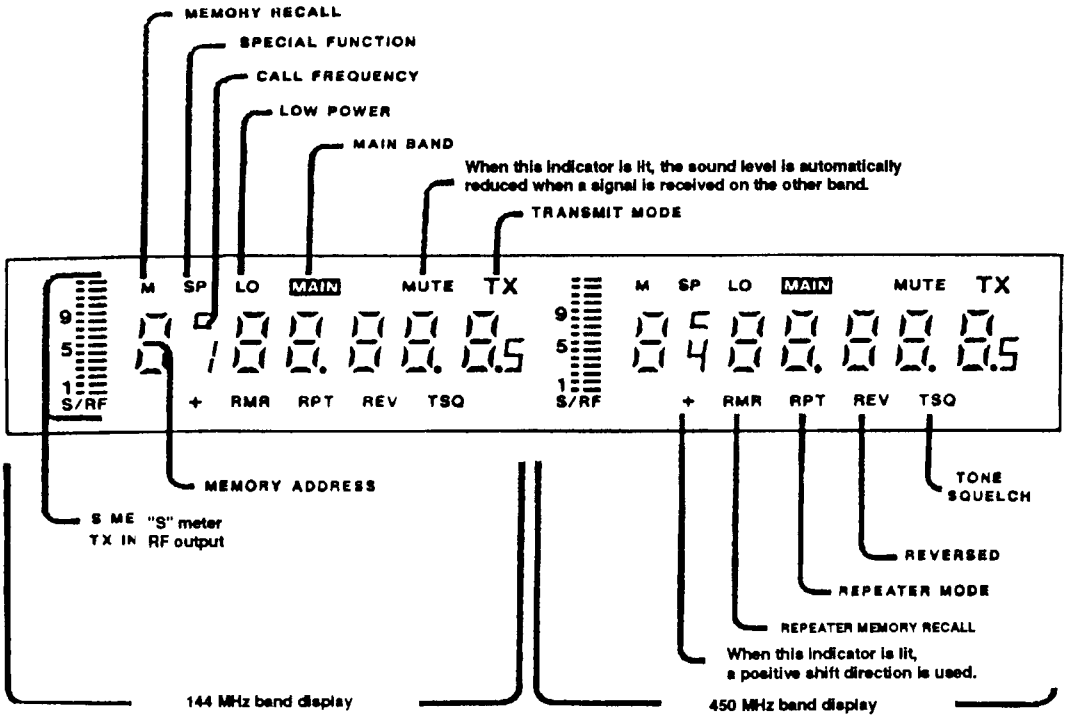
  Lets you change the displayed frequency in 1 MHz steps - with "SP" shown on the display.

- **VFO** position: Lets you change the displayed frequency by using one of five possible channel steps (5, 10, 12.5, 20, or 25 kHz).

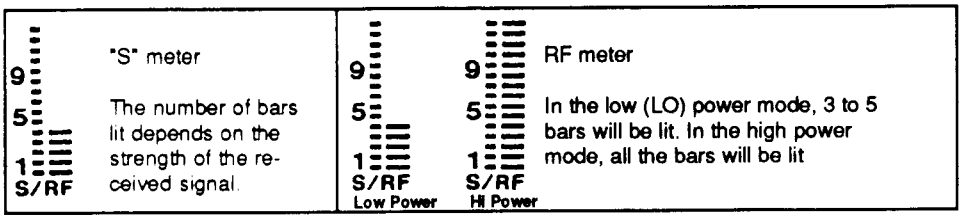
- **MR** position: Lets you recall up to 10 different memory addresses for each band.

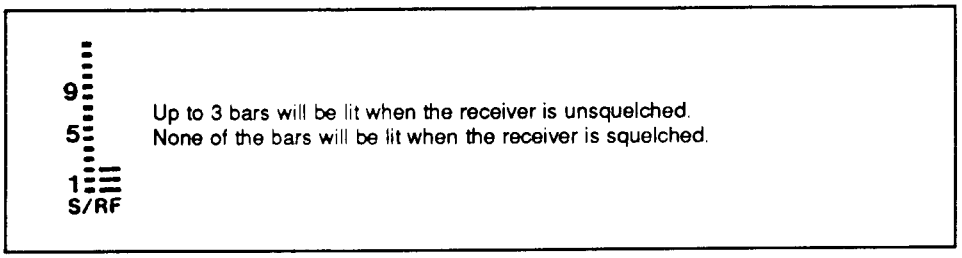
NOTE: Setting the channel step rate is explained under T.SQL/STEP on Page 2-10, while the MR (memory recall) mode is outlined on Page 2-32.

(7) **Display** - Detail 2-1H — Indicates operating frequencies, received signal strength, relative transmit power, and several other operating parameters.



S/RF Meter





Detail 2-1H

(8) **144 Button** — Selects 144 MHz for main band operation. "MAIN" appears in red on the left side of the display, enabling QSOs on the 2 m band when you press this button, and the 450 button will appear in green.

(9) **450 Button** — Selects 450 MHz for main band operation. "MAIN" appears in red on the right side of the display, enabling QSOs on the 70 cm band when you press this button, and the 144 button will appear in green.

NOTES:

1. When your Transceiver leaves the factory or when you reset its microprocessor, the main band is set to 450 MHz.

2. In the procedures and examples given in this Manual, 144 MHz will be used as the main band and 450 MHz as the sub band. However, you may swap the two bands, if you wish.

3. A band is considered the main band when "MAIN" appears on its display; the other band is then the sub band.

IMPORTANT: Transmission on the 144 MHz band may cause interference to reception on the 450 MHz band. Therefore, be sure that you do not use a receive frequency that equals the third harmonic of the transmit frequency.

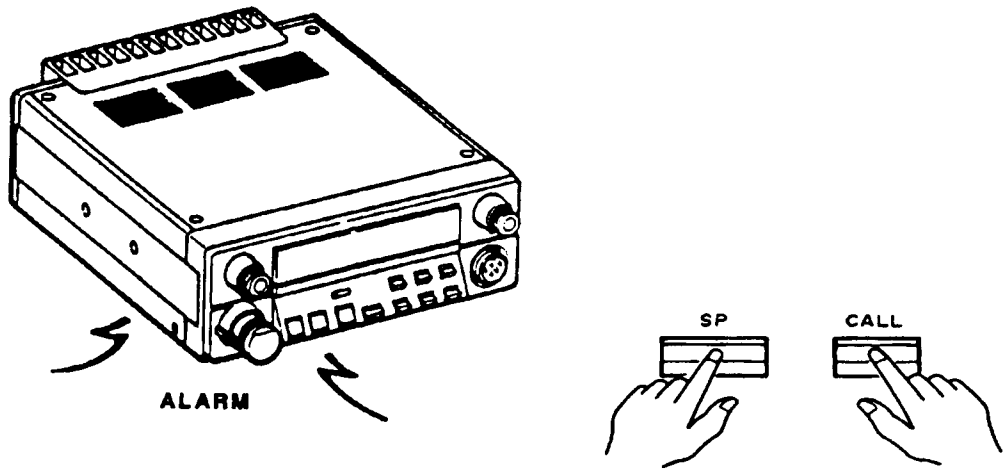
Example:

Do not transmit on	147.500 MHz	(147.500 x 3 = 442.500)
while you receive on	442.500 MHz	

(10) **RMR** (Repeater Memory Recall) Button — Permits recall of one repeater memory frequency on each of the two bands.

NOTE: When you initially power up your Transceiver or when you reset its microprocessor, the settings are 146.000 MHz and 446.000 MHz for the two bands. The tone frequency setting for each band is 88.5 Hz, while the negative (-) shift (offset) frequency is 600 kHz for 144 MHz and 5.000 MHz for 450 MHz.

(11) **CALL** Button (Detail 2-1J) — Sets or accesses a call frequency. Also enables an alarm that will sound whenever a signal is received on a selected sub band frequency.



Detail 2-1J

To enable and disable the alarm:

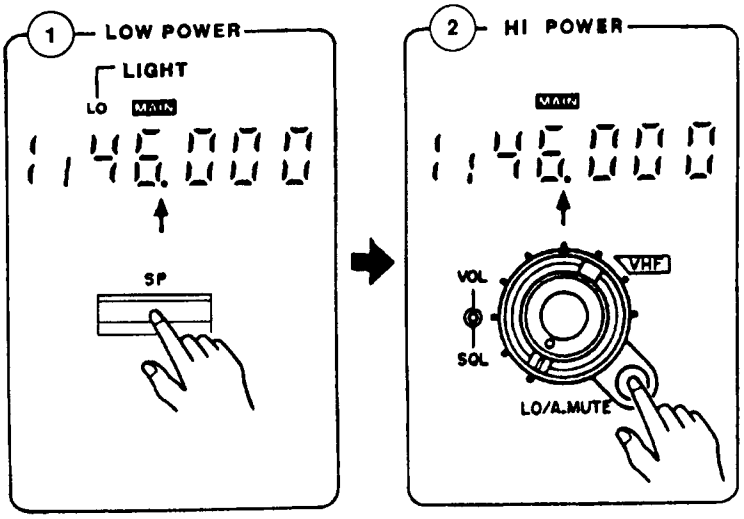
1. To enable the alarm, hold the SP button depressed while you press the CALL button. NOTE: The two alarms sound distinctly different so you can easily tell the two bands apart.

2. To disable the alarm, again hold down the SP button while you press the CALL button.

   Refer to "Setting the Call Frequency" on Page 2-22 for further details on how to use this button.

NOTE: Some of the switches on this Transceiver perform dual functions. To access a second function, as indicated by "/A.MUTE" in LO/A.MUTE below, press the SP button. The "SP" indicator will then appear on the display, allowing you to perform this special function.

(12) LO/A.MUTE (Low Power/Automatic Mute Switch) — Sets the transmitter for low or high power. Also sets the automatic mute. NOTE: Each band has its own LO/A.MUTE switch, allowing independent selection of these functions.



Detail 2-1K

To set the transmitter's RF output power (Detail 2-1K):

1. Be sure "SP" is not displayed. If it is, press the SP button; "SP" will extinguish. NOTE: If "LO" is displayed, the transmitter is set to low power. If "LO" is extinguished, it is set to high power.

2. To change the output power, press the LO/A.MUTE button.

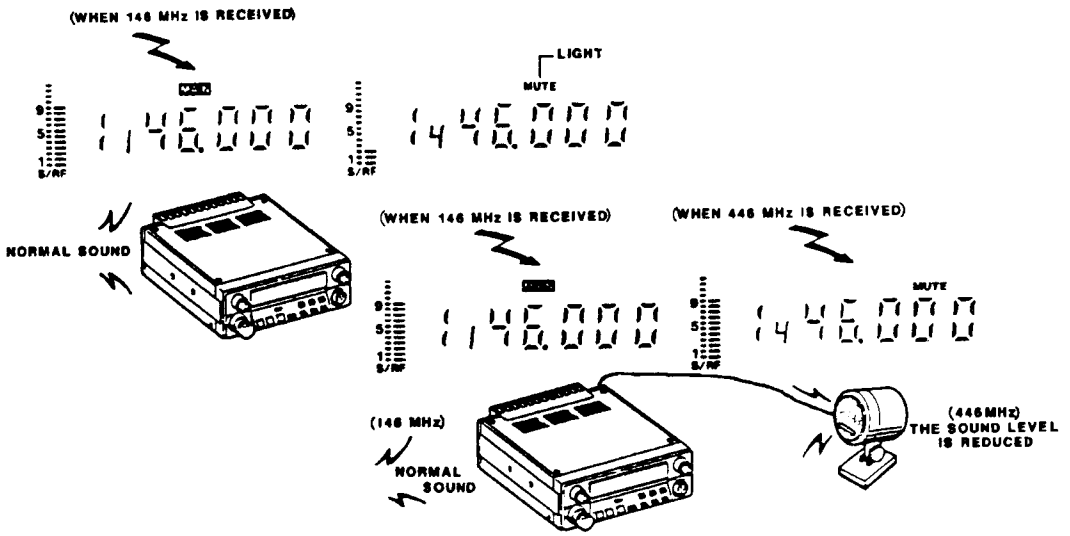
3. To change the power back, again press the LO/A.MUTE button.

NOTES:

1. Always use low power for short-distance communications.

2. If both "SP" and "MUTE" appear on the display when you switch to low power, press the LO/A.MUTE button twice.

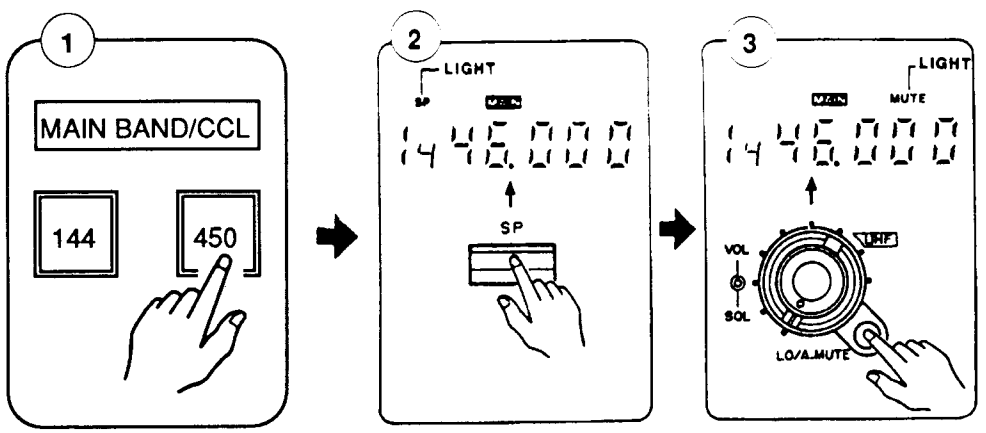
To set the automatic mute for your sub band (Detail 2-1L):



Detail 2-1L

1. Press the 450 band button; "MAIN" for this band will now appear in red on the right side of the display.

2. Press the SP button; "SP" will appear on the 450 MHz display (see Detail 2-1M).



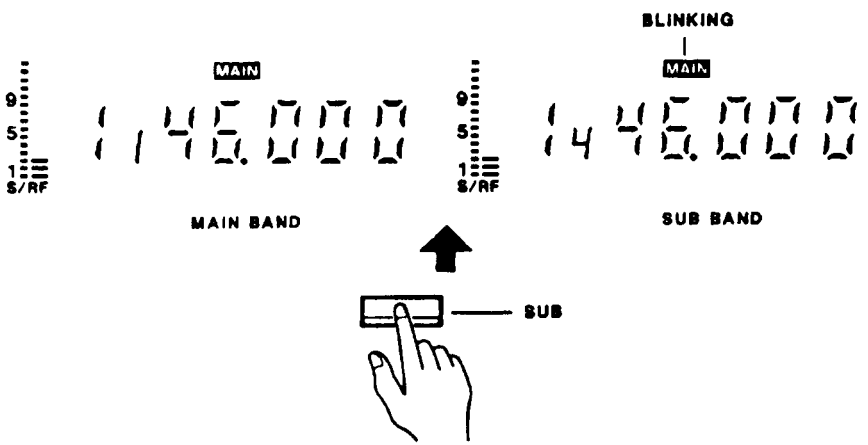
Detail 2-1M

3. Press the LO/A.MUTE button on the right side of the front panel. "MUTE" will appear on the 450 MHz display.

4. Press the 144 button to return to your normal main band.

   Whenever you receive a signal on the displayed sub band frequency, while you are using the main band, the sub band audio signal will be reduced from its normal level.

(13) **SUB** Button (Detail 2-1N) — Accesses the sub band without you having to press the 144 or 450 button.



Detail 2-1N

If you press this button, even while receiving a transmission on the main band, "MAIN" will blink on and off on the sub band display for at least five seconds. NOTE: You may change the displayed sub band frequency or any other operating parameter as long as "MAIN" continues to blink. If you do not make any changes within the five seconds, "MAIN" will automatically extinguish.

(14) **SP** (Special Function Button) — Works in conjunction with other switches to perform special functions.

The following functions are enabled as you set the front panel switches listed.

BUTTON	"SP" NOT DISPLAYED	"SP" DISPLAYED
MS/SCAN	Memory scan	Scan.
RPT/SHIFT	Repeater operation	Displays shift frequency and subaudible tone frequency.
REV/+	Reverses TX and RX	Sets positive shift for any frequency during repeater operation. The transmitter frequency will be above the receiver frequency.
T.SQL/STEP	Tone squelch operation	Sets channel step (receive simplex only).
LO/A.MUTE	Switches TX power	Sets automatic mute.
Frequency Tuning (100K/MHz position)	100 kHz step	1 MHz step.
CALL	Accesses call frequency	Sets alarm for desired main band.

The following features are provided as you hold the SP button depressed while you press the various buttons listed.

SWITCH	FUNCTION
Frequency Tuning	Changes the display's illumination brightness.
144 450	Blanks the corresponding portion of the display.
Power switch	Resets all frequencies to their default values.

(15) T.SQL/STEP — Switches the tone squelch on and off and lets you change the channel step rate.

To turn the tone squelch on and off, press the T.SQL/STEP button. "TSQ" appears on the display when the tone squelch is turned on.

NOTES:

1. The tone squelch feature will not be enabled (and "TSQ" will not appear on the display) if you also select the RPT (repeater) mode. Then, you would hear a low-frequency error "beep" from the speaker.

2. If your tone squelch is switched on, you can hear another station only if that station also has its tone squelch on and both are using the same tone frequency.

3. Be sure to press the T.SQL/STEP button after you terminate tone squelch operation.

You have the option of setting the step rate to 5 kHz, 10 kHz, 12.5 kHz, 20 kHz, or 25 kHz. (NOTE: You may select a different step rate for VHF and UHF.) To change the step rate:

1. Press the SP button to access the special switch function.

2. Press the T.SQL/STEP button; the current step rate will be displayed. NOTE: When you initially power up the Transceiver or reset (initialize) its microprocessor, the rate is set to 25 kHz.

3. Turn the Frequency Tuning knob, or press the microphone's UP or DOWN buttons, until the selected step rate is displayed. If the microphone's key lock switch lever is in the LOCK position, the UP or DOWN buttons will not work.

4. Press the T.SQL/STEP button again to place the new step rate in memory. The previously displayed operating frequency will again appear on the display.

(16) **RPT/SHIFT** — Turns repeater operation on and off. Also permits you to recall and change the shift (offset) frequency and tone control frequency.

(17) **MS/SCAN** Switch — Starts and stops memory scan and normal scan.

To start or stop memory scan, press the MS/SCAN switch button.

To start normal scan, first press the SP button; then press the MS/SCAN button. NOTE: With "SP" displayed, use the MS/SCAN button to switch between pause scan and busy scan.

(18) **MEMO** (Memory button) — Recalls and memorizes frequencies in up to 20 memory addresses, 10 for each band. Also permits exit from the memory recall mode.

To select a memory address number:

1. Set the Frequency Mode switch to MR.

2. Turn the Frequency Tuning knob until the desired number (0 through 9) is displayed.

To recall a memory frequency in the repeater mode:

1. Press the MEMO button to display the shift frequency.

2. Press the MEMO button again to display the tone frequency.

NOTES:

1. With the Frequency Selector lever in the 100K/MHz or VFO position, you may use the Frequency Tuning knob to change a shift or tone frequency as each one is displayed.

2. A total of 10 memory addresses on both bands are available for a channel's shift frequency and tone frequency.

In addition to the "normal" memory functions previously mentioned in this section of the Manual, additional "special" memory functions are available with the MEMO button. Using one of these **special** functions instead of the corresponding normal function prevents you from accidentally clearing the contents of a memory address. Also, of the two available memory functions, only the special memory function allows you to use the microphone to scan through the ten memory channels on each band. NOTE: All the memory functions are listed in the chart below.

To make the various special memory functions available:

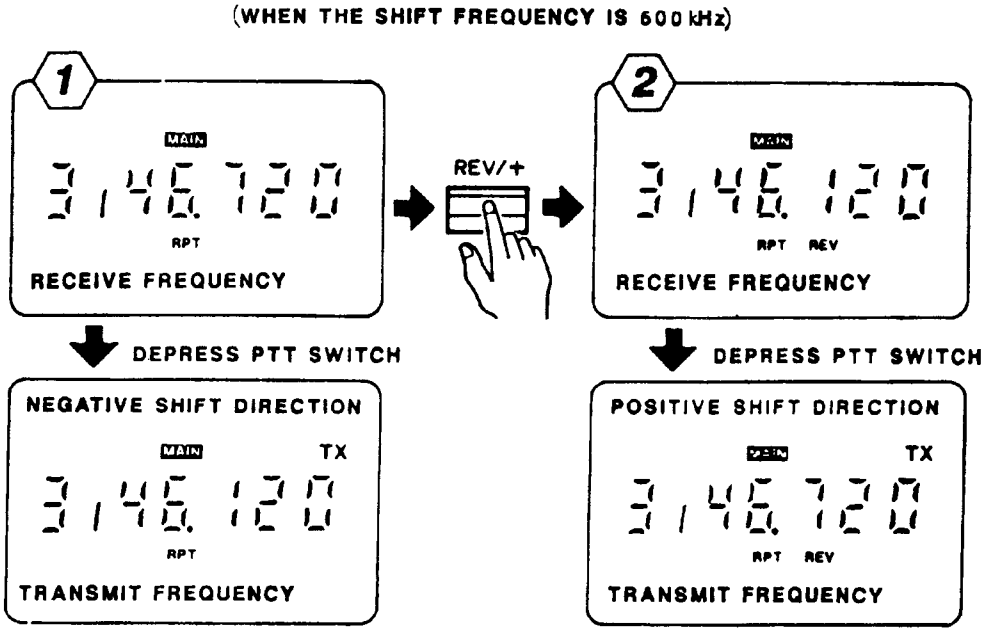
1. Hold down the MEMO button and push the Power switch in (to turn the power off).

2. Release the MEMO button and again push the Power switch in (to turn the power back on). Your Transceiver is now in the **special function** mode.

NOTE: To exit from this special function mode, hold down the MEMO button and again push the Power switch in (to turn the power off).

ITEM	NORMAL FUNCTION	SPECIAL FUNCTION
Memorizing the CALL frequency	Set the frequency and press CALL to memorize.	Set the frequency and press MEMO to memorize.
Memorizing RMR	Set RMR and press RMR to memorize.	Set RMR and press MEMO to memorize.
In the MR mode	The memory address number is increased or decreased with the Frequency Tuning knob.	The memory address number is increased or decreased with the microphone UP/DOWN buttons.
During MS scan	When you press the PTT or MS button, the scan mode is exited, and the VFO mode is entered to set the frequency.	When you press the PTT or MS button, scanning is halted with the MEMO button.

(19) REV/+ (Reverse/Plus Shift - Detail 2-1P) — Reverses the transmit and receive frequencies during repeater operation. Also, when "SP" is lit, the frequency shift (offset) changes direction for repeaters that use a positive frequency shift.



Detail 2-1P

NOTES:

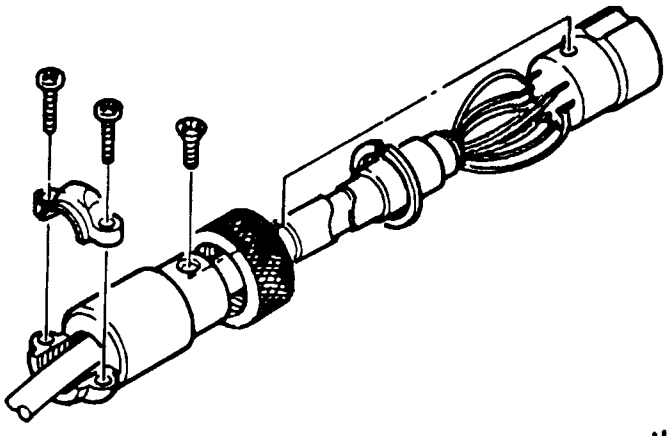
1. The displayed frequency is the receive frequency at all times.

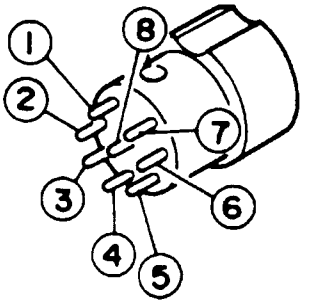
2. The shift direction is initially negative, and no polarity sign will be displayed.

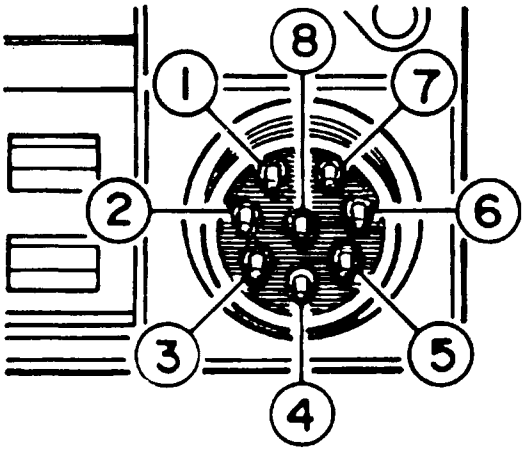
3. A negative (-) shift direction means that you will transmit on a frequency that is lower than your receive frequency. A positive (+) shift direction means that you will transmit on a frequency that is higher than your receive frequency.

4. If you change the displayed frequency while you are in the reverse mode (with "REV" displayed), you will exit the reverse mode ("REV" will extinguish) and return to the default mode.

(20) **Microphone Connector** (Detail 2-1R)— Accepts the 600 Ω microphone supplied with this Transceiver. The microphone plug's pin connections and the corresponding Transceiver microphone socket's pin connections are shown below.







① AUDIO INPUT

② PTT

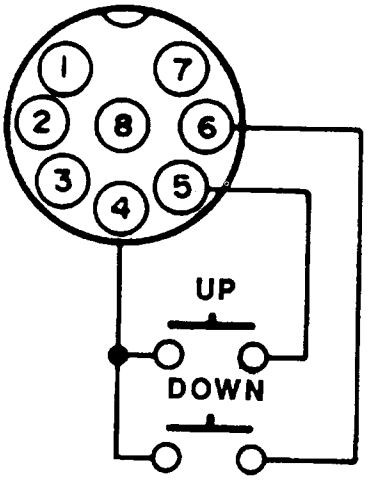
③ 8V

④ ⑤ ⑥ *

⑦ NOT USED

⑧ GROUND

* PINS ④, ⑤, AND ⑥ ARE FOR UP AND DOWN OPERATION.

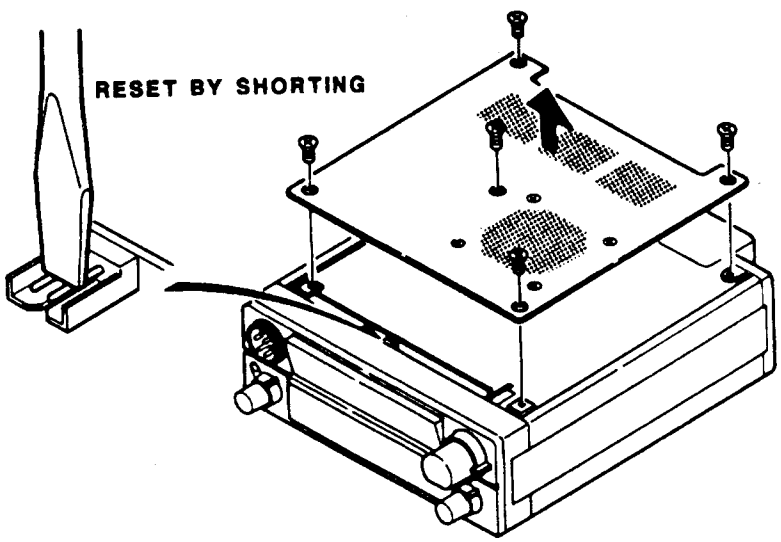


Detail 2-1R

NOTE: If you plan to use a different microphone with this Transceiver, first make sure it has a 600 Ω impedance. Then make sure it is wired as shown in Detail 2-1R.

(21) **RESET** Terminals — Shorting these internal terminals initializes the microprocessor when improper operation occurs, or after the internal memory back-up battery has been replaced.

To gain access to the RESET terminals (Pictorial 2-2):



PICTORIAL 2-2

1. Be sure the Transceiver power is turned off.

2. Place a towel (or piece of carpet) on top of your work area. Then place the Transceiver upside down on top of the towel. NOTE: This will prevent the Transceiver top from becoming scratched as you perform the following steps.

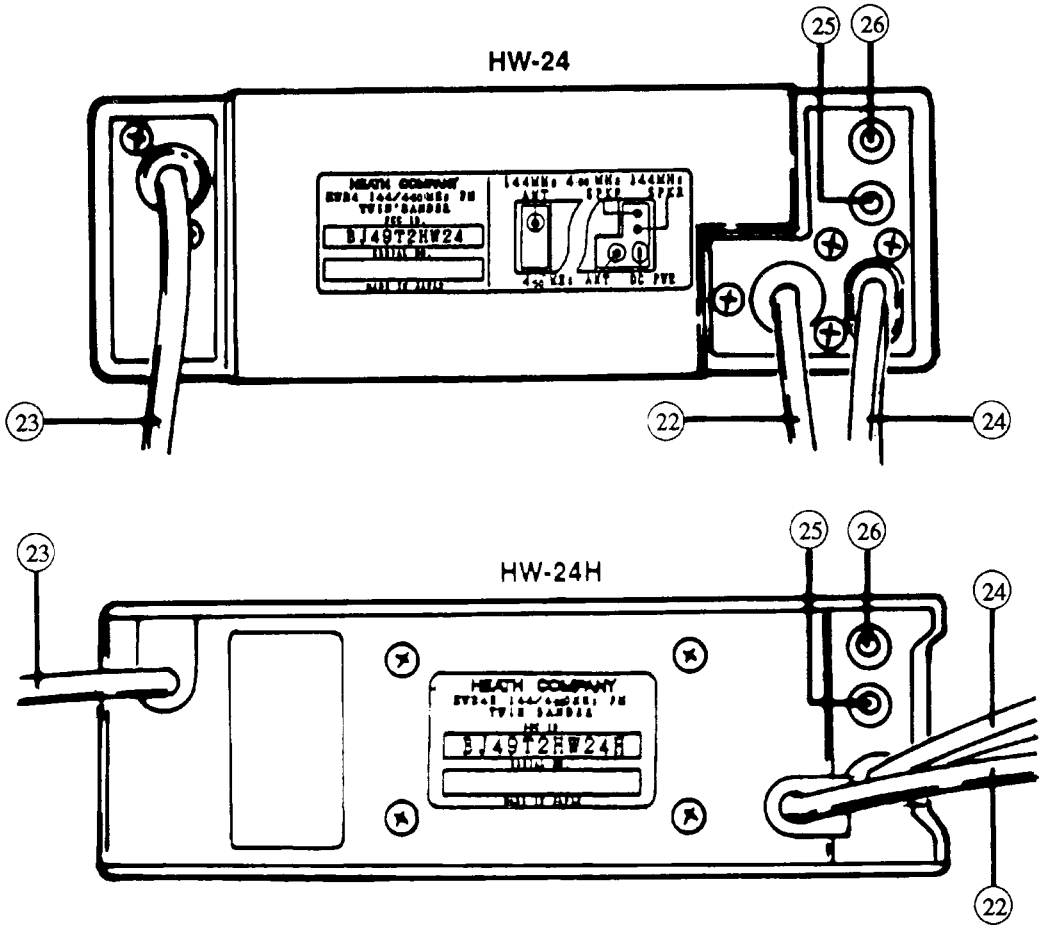
3. Using a #1 (small) Phillips screwdriver, remove the five screws that secure the cover to the bottom of the Transceiver. Carefully place the cover next to the Transceiver, and set the screws aside temporarily.

4. Turn the Transceiver power on.

5. Using the metal tip of a medium size (1/4" or smaller) flat-blade screwdriver, carefully short the two indicated terminals together. Then remove the screwdriver. NOTE: The current display will disappear immediately; the display frequencies will be reset to 146.000 and 446.000, respectively.

6. Using the five screws you removed earlier, reinstall the cover to the bottom of the Transceiver. CAUTION: Be sure none of the speaker wires become pinched.

Refer to that part of Pictorial 2-3 which applies to your particular model while you read the following descriptions of the rear panel cables and connectors.



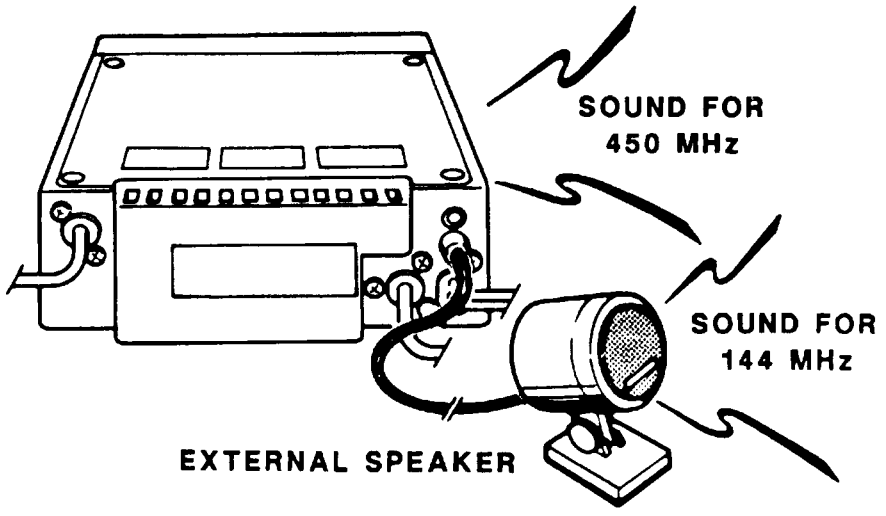
PICTORIAL 2-3

(22) **450 MHz ANT** Cable — Connect a low-loss 50 Ω coaxial cable, coming from your 450 MHz antenna, to this cable. NOTE: Use a PL-259 plug at the free end of the cable coming from the antenna.

(23) **144 MHz ANT** Cable — Connect a low-loss 50 Ω coaxial cable, coming from your 144 MHz antenna, to this cable. NOTE: Use a PL-259 plug at the free end of the cable coming from the antenna.

(24) **DC PWR** (Direct Current Power Cable) — Connect the long power cable that you received between this cable and a 12- to 16-volt DC power source.

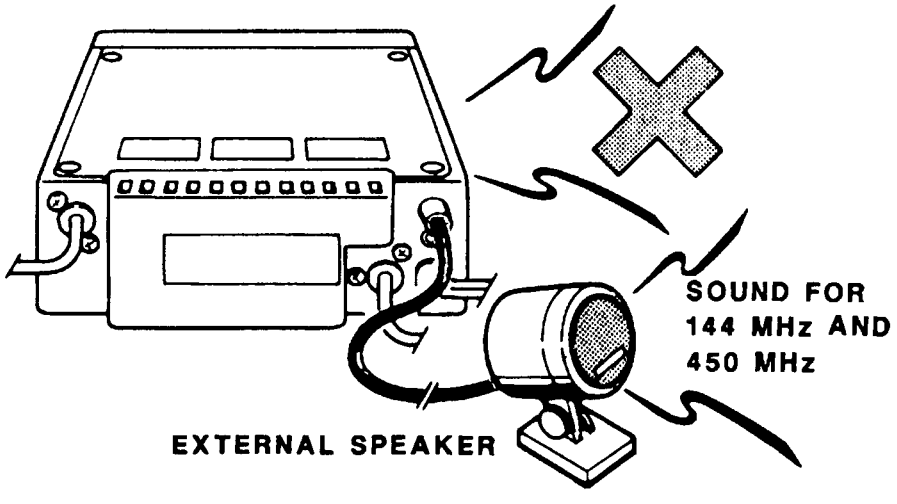
(25) **144 MHz SPKR** Jack (Detail 2-3A) — When you connect an external speaker to this jack, it is used for 144 MHz, while the internal speaker is used for 450 MHz.



Detail 2-3A

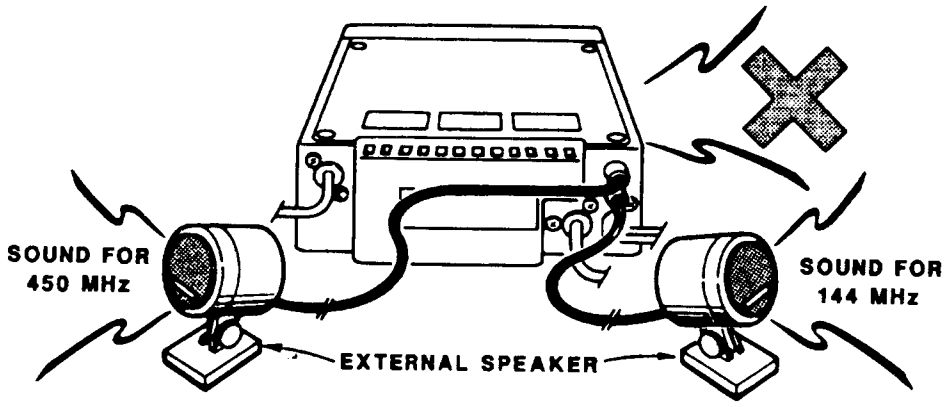
(26) **450 MHz SPKR** Jack (Detail 2-3B) — External speaker connector for both 144 and 450 MHz.

- When you connect a speaker to this jack, it will be on both 144 and 450 MHz and the internal speaker will be disabled.



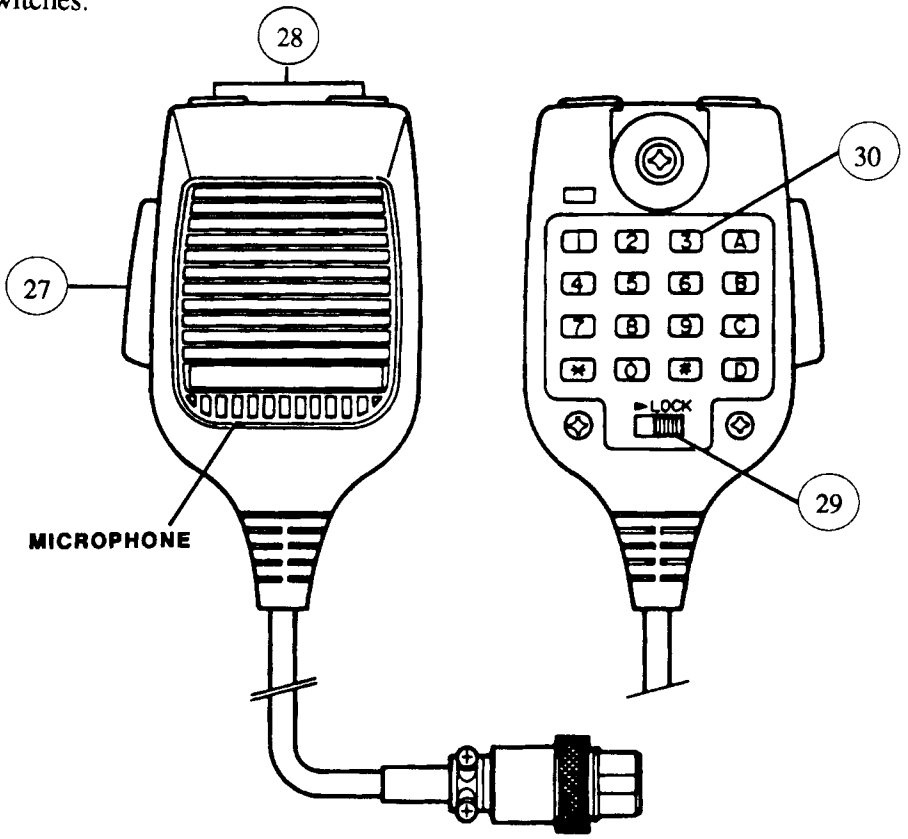
Detail 2-3B

- When you connect a speaker to both the 144 and 450 SPKR jacks, each external speaker will be on its respective band, and the internal speaker is disabled. See Detail 2-3C.



Detail 2-3C

Refer to Pictorial 2-4 while you read the following descriptions of the microphone keyboard and switches.



PICTORIAL 2-4

(27) **PTT** (Push-to-Talk) Switch — Press this switch lever to place the Transceiver in the transmit mode.

(28) **UP** and **DOWN** buttons — The microphone UP and DOWN switch buttons function as follows:

- During normal operation, use these buttons to change the displayed frequency up or down with the selected channel steps.
- During the "special function" mode (see Page 2-12), these buttons select the memory channels (provided the Frequency Selector lever is in the "MR" position).
- In the MEMO (memory recall) mode, use these buttons to memorize a memory frequency. Refer to the chart on Page 2-46 for information on how to change a displayed memory address number up or down.
- In the scanning mode, use these buttons to scan the frequencies from low to high (UP) or from high to low (DOWN). NOTE: If you continue to keep one of these buttons depressed while in this mode, the displayed frequency will continuously change (increase or decrease).
- In the CALL or RMR modes, use one or the other of these buttons to exit each of these modes. The displayed frequency will start increasing or decreasing when you press the UP or DOWN button, respectively.
- When you wish to change the channel step (by using the SP and T.SQL/STEP buttons), use these buttons to increase or decrease the displayed channel step (5, 10, 12.5, 20, 25, for example).
- When you wish to change the repeater shift (offset) frequency, use these buttons to increase or decrease the displayed shift frequency.

(29) **LOCK** (Key Lock) Switch — Locks out the microphone UP and DOWN switches, preventing you from changing the displayed frequency.

(30) **KEYPAD** — Allows you to place phone calls, using a 16-character DTMF (dual-tone, multi-frequency) Touch-Tone™ encoder, through repeaters set up for auto-patch operation.

When you place the Transceiver in the transmit mode, the LED above the keypad lights whenever you press one of the keypad keys, indicating that a two-tone signal is being generated. NOTE: The generated signals have the standard Touch-Tone frequencies, and meet the telephone system specification of ±1.5% accuracy.

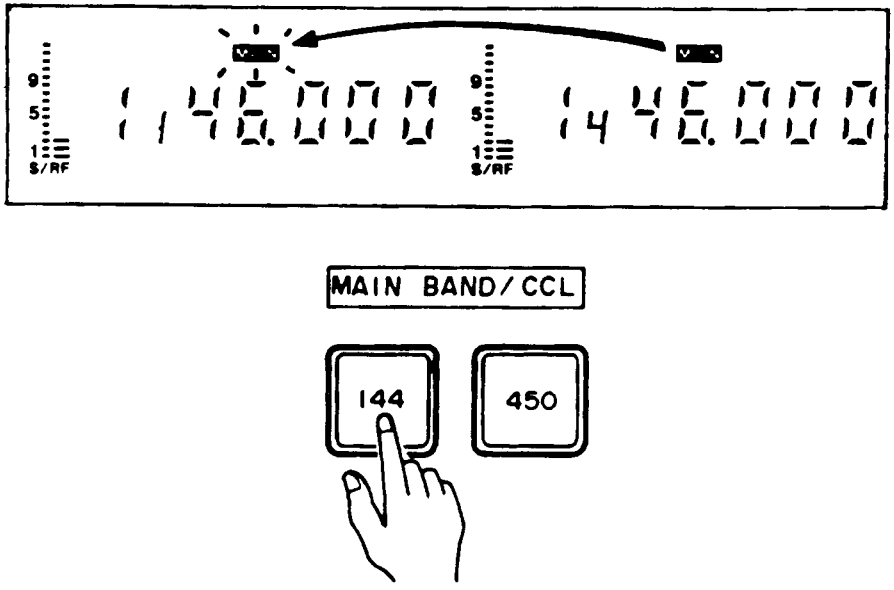
CHANGING THE MAIN BAND

NOTE: When you power up your Transceiver for the first time, "MAIN" will appear in red above the frequency display for the 450 MHz band (right side). Both band indicators (buttons) will be lit; the 450 indicator will be red, while the 144 sub band indicator will be green.

To change the main band (Pictorial 2-5):

Press the band button for the sub band (green indicator); the color of this indicator will turn red, while the other band indicator will turn green. "MAIN" will appear above the frequency for the selected main band.

(WITH THE CHANNEL SELECTOR IN THE VFO OR 100K/MHz POSITION)



PICTORIAL 2-5

CHANGING THE CHANNEL STEP

You have the option of setting your Transceiver's step rate to 5 kHz, 10 kHz, 12.5 kHz, 20 kHz, or 25 kHz. (NOTE: You may select a different step rate for VHF and UHF).

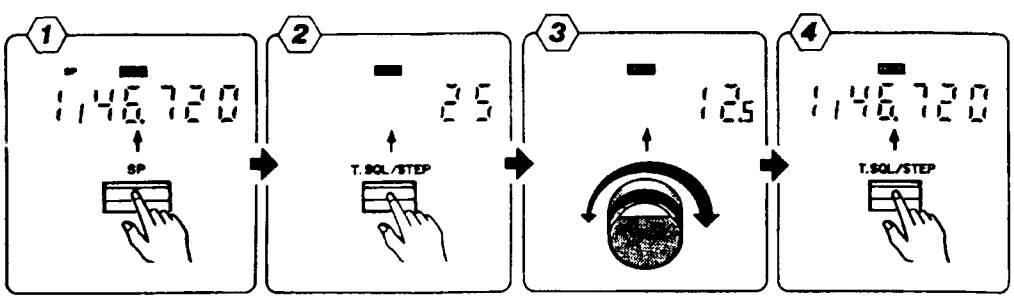
To change the step rate (Detail 2-5A):

1. Press the SP (special function) button; "SP" will be displayed.

2. Press the T.SQL/STEP button; the present step rate will be displayed. NOTE: When you initially power up the Transceiver (or after you initialize the microprocessor), it will be set to 25 kHz.

3. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN button) until the selected step rate is displayed.

4. Press the T.SQL/STEP button again to store the selected step rate in memory. The initial operating frequency will again be displayed.



Detail 2-5A

SETTING THE CALL FREQUENCY

NOTES:

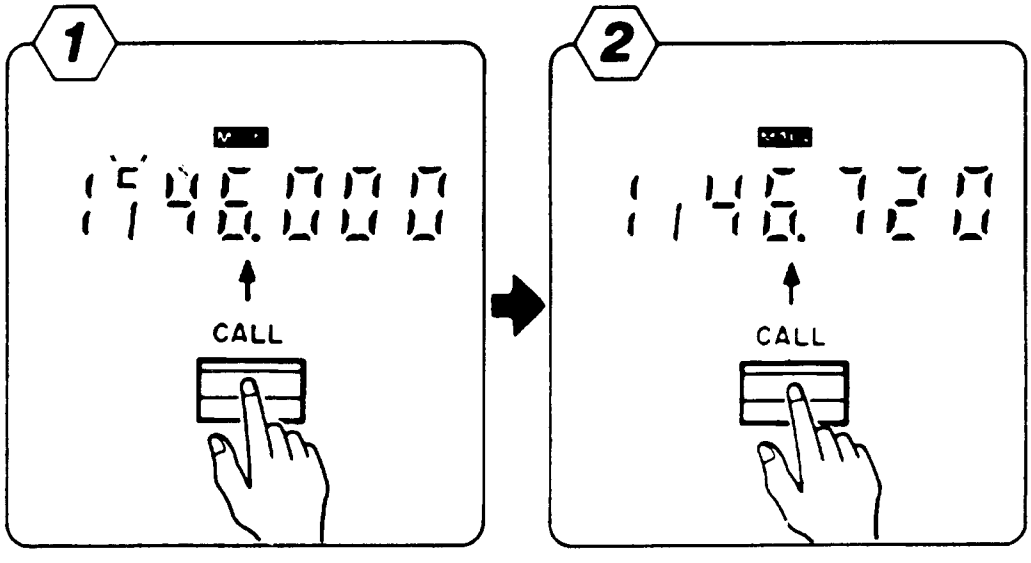
1. If you have not previously selected a call frequency, "146.000" (MHz) will be displayed for 2 m and "446.000" (MHz) will be displayed for 70 cm when you press the CALL button. These frequencies will also be displayed when you reset the microprocessor in your Transceiver.

2. A simplex frequency (146.52 MHz, for example) is most often used as a call frequency. However, you may instead use a repeater frequency.

To recall the call frequency from memory (Detail 2-5B):

1. Press the CALL button; a small "c" will be lit above the first digit on the frequency display for the selected band.

2. Press the CALL button again; the previous receive frequency will be displayed.



Detail 2-5B

To place a new call frequency in memory (Detail 2-5C):

1. Press the CALL button.

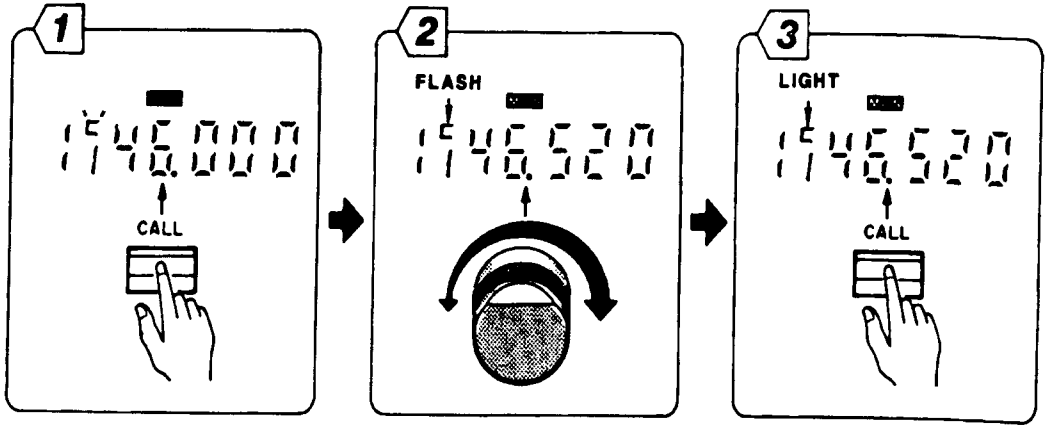
2. Set the desired call frequency. If necessary, refer to "Setting the Operating Frequency." NOTE: As soon as you start turning the Frequency Tuning knob, the small "c" will begin to blink.

3. Press the CALL button again to store the call frequency in memory. The "c" will stay lit and, provided the receiver section is squelched, you will hear a long beep.

NOTES:

1. To exit this mode, press the band button for the band you are using. The small "c" will now extinguish, and the initial operating frequency will again be displayed.

2. If you wish to use the MEMO button to memorize the call frequency, refer to Page 2-12.



Detail 2-5C

SETTING THE OPERATING FREQUENCY

NOTES:

1. When you change the operating (transmit and/or receive) frequency, you may use 1 MHz and 100 kHz steps for the coarse steps. In addition, you may select a fine step from five possible options. These options, and how to set the one you select, are outlined under "Changing the Channel Step" on Page 2-21.

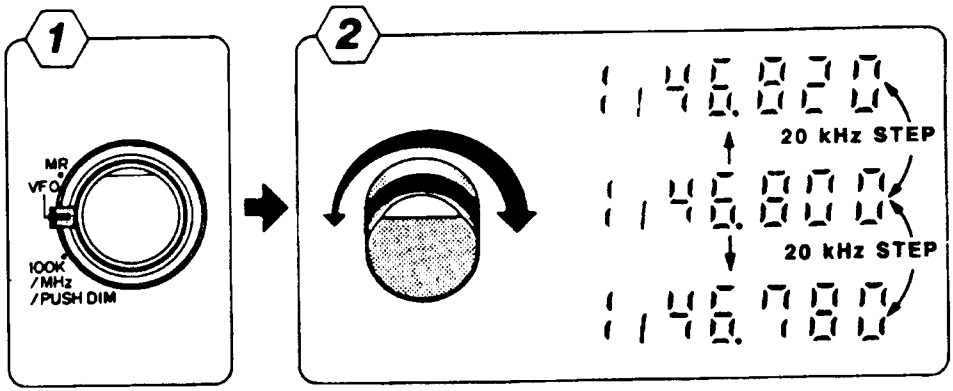
2. The following procedure uses a step rate of 20 kHz; however, you may use any one of the other four available step rate options.

20 kHz Steps

To change the displayed frequency in 20 kHz steps (Detail 2-5D):

1. Set the Frequency Selector lever to the VFO position, if this has not already been done.

2. Turn the Frequency Tuning knob clockwise (or counterclockwise) several steps. The displayed frequency will increase (or decrease) in 20 kHz steps.



Detail 2-5D

100 kHz Steps

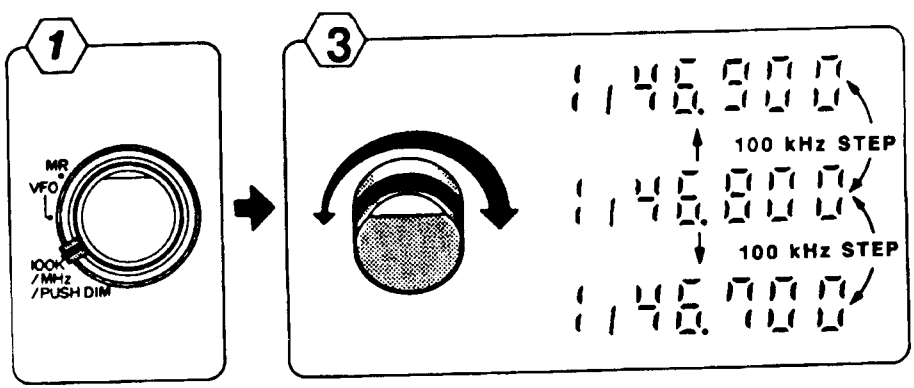
To change the displayed frequency in 100 kHz steps (Detail 2-5E):

1. Set the Frequency Selector lever to the 100K/MHz position, if this has not already been done.

2. Be sure "SP" is not displayed. If it is, press the SP button; "SP" will extinguish.

3. Turn the Frequency Tuning knob clockwise (or counterclockwise) several steps. The displayed frequency will increase (or decrease) in 100 kHz steps.

NOTE: With the Frequency Selector lever in the 100K/MHz position, you may still use the microphone's UP and DOWN buttons to change the displayed frequency in 20 kHz steps.



Detail 2-5E

1 MHz Steps

To change the displayed frequency in 1 MHz steps (Detail 2-5F):

1. Set the Frequency Selector lever to the 100K/MHz position, if this has not already been done.

2. Press the SP button; "SP" will be displayed.

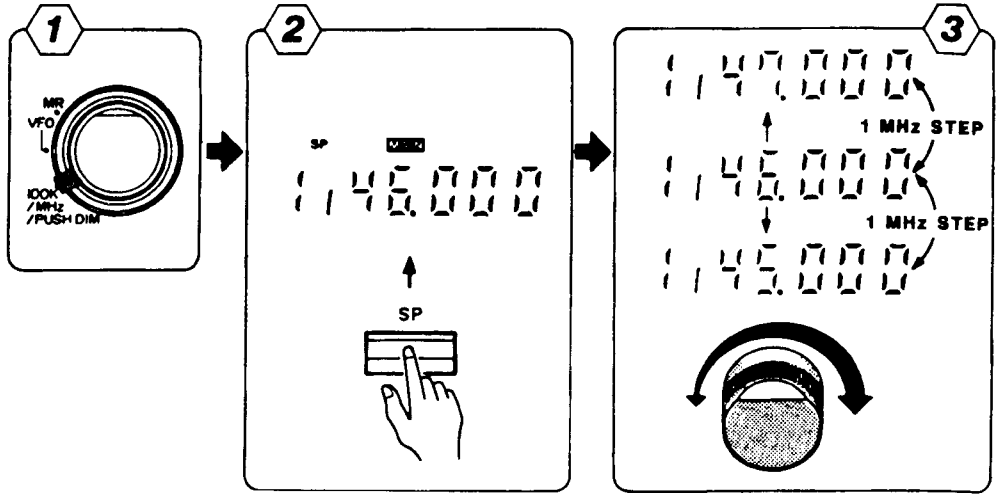
3. Turn the Frequency Tuning knob clockwise (or counterclockwise) several steps. The displayed frequency will increase (or decrease) in 1 MHz steps.

NOTES:

1. With the Frequency Selector lever in the 100K/MHz position, you may still use the microphone's UP and DOWN buttons to change the displayed frequency in 20 kHz steps.

2. To change the displayed frequency in 20 kHz steps, again set the Frequency Selector lever to the VFO position.

3. To change the displayed frequency in 100 kHz steps, press the SP button (with the Frequency Selector lever in the 100K/MHz position). "SP" will extinguish.



Detail 2-5F

REPEATER OPERATION

Your Transceiver responds to the need for diversification by providing two independent "modes" for repeater operation. By setting the various operating parameters (receive frequency, shift or offset frequency, shift direction, and possibly tone frequency), you can easily access most repeaters within your range. The RMR (repeater memory recall) function makes it especially convenient to place the operating parameters for your favorite repeater in memory. By pressing the RMR button, you can then quickly access this repeater.

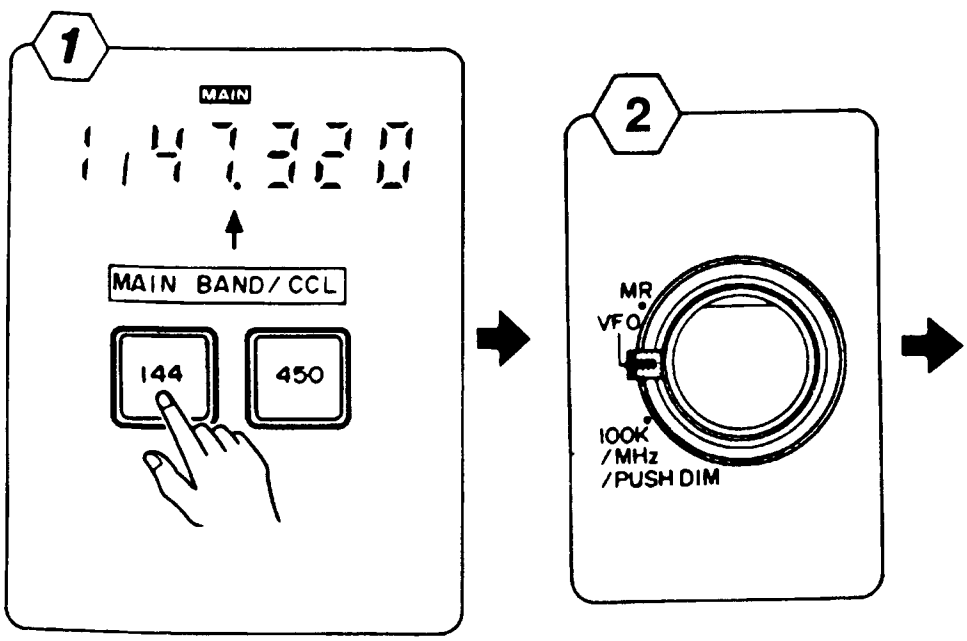
NOTE: When you power up your Transceiver for the first time, the RMR and RPT switches provide a transmit frequency of 146.000 MHz and a shift frequency of 600 kHz on the 2 meter band. On the 70 cm band, a transmit frequency of 446.000 MHz and a shift frequency of 5.000 MHz are provided. The shift direction for both bands is negative; that is, the transmit frequency is lower than the receive frequency. The subaudible tone frequency for both bands is 88.5 Hz.

RMR MODE

NOTE: In this mode, you can store only one repeater frequency in memory per band.

To recall a repeater operating frequency from memory (Detail 2-5G):

1. Select the desired main band by pressing the proper band button (144, for example); "MAIN" will appear in red on the display for that band.

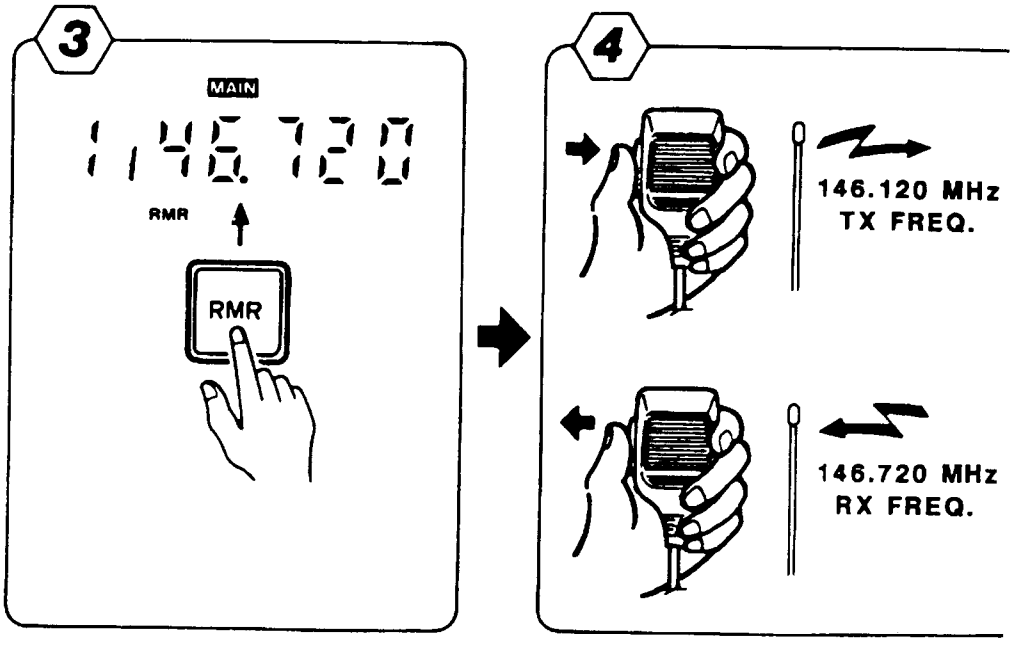


Detail 2-5G

2. Set the Frequency Selector lever to the VFO or 100K/MHz position, if this has not already been done.

3. Press the RMR button (Detail 2-5H) to select the "repeater memory recall" mode; RMR and the operating frequency stored in memory will be displayed.

4. Press the microphone PTT switch to access your repeater.



Detail 2-5H

Changing the Operating Frequency

To change the operating frequency:

1. Be sure "SP" is not displayed; if it is, press the SP button until it is extinguished.

2. Set the frequency for the selected repeater as outlined in "Setting the Operating Frequency" on Page 2-24. "RMR" will be blinking, indicating that the memory is now ready to accept the new operating frequency. NOTE: You can not use the microphone's UP and DOWN buttons to change the frequency, as they are disabled for the RMR function.

3. Press the RMR button again; "RMR" will stay lit, indicating that the new operating frequency is now stored in memory.

NOTES:

1. Refer to Page 2-11 if you wish to use the MEMO button to place the RMR frequency in memory.

2. If you wish to change the shift and tone frequencies, refer to Page 2-30.

Changing the Shift Direction

NOTE: Initially, your Transceiver is set for a negative shift direction. This means that you are transmitting on a frequency that is lower than your receive frequency. A negative shift direction usually is used on the low end of a band. However, to access a repeater at the high end of a band (above 147.400 MHz, for example), you must use a positive shift direction.

To change to a positive shift direction:

1. Be sure the "SP" and "RMR" indicators are displayed.

2. Press the REV/+ button; "RMR" will blink and "+" will be lit, indicating that the memory is now ready to accept the new shift direction.

4. Press the RMR button again; "RMR" will now be lit, indicating that the new shift direction is stored in memory.

NOTE: If the shifted frequency falls outside the amateur band when you press the microphone's PTT button, the displayed frequency will not change (even if you are in the repeater mode), and the Transceiver will remain in the receive mode. In this case, reset the frequency so the shifted frequency falls inside the amateur band. NOTE: If necessary, find the band limits for each band in the "Specifications" section of this Manual.

RPT MODE

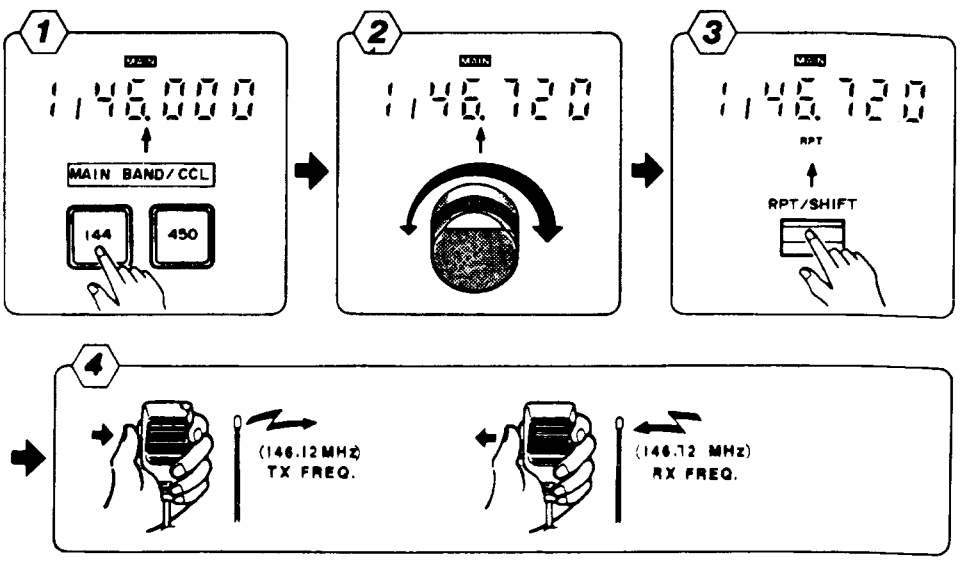
To prepare for normal repeater operation (Detail 2-5I):

1. Select the desired main band by pressing the proper band button (144, for example); "MAIN" will appear in red on the display for that band.

2. Set the frequency for the selected repeater as outlined in "Setting the Operating Frequency" on Page 2-24. NOTE: This will be your receive frequency.

3. Press the RPT/SHIFT button to select the normal repeater mode; "RPT" will be displayed.

4. Press the microphone PTT switch to access your repeater.



Detail 2-5I

Changing the Shift Direction

NOTE: Initially, your Transceiver is set for a negative shift direction. This means that you are transmitting on a frequency that is lower than your receive frequency. A negative shift direction usually is used on the low end of a band. However, to access a repeater at the high end of a band (above 147.400 MHz, for example), you must use a positive shift.

To change to a positive shift direction:

1. Press the SP button; the "SP" (special function) indicator will be displayed.

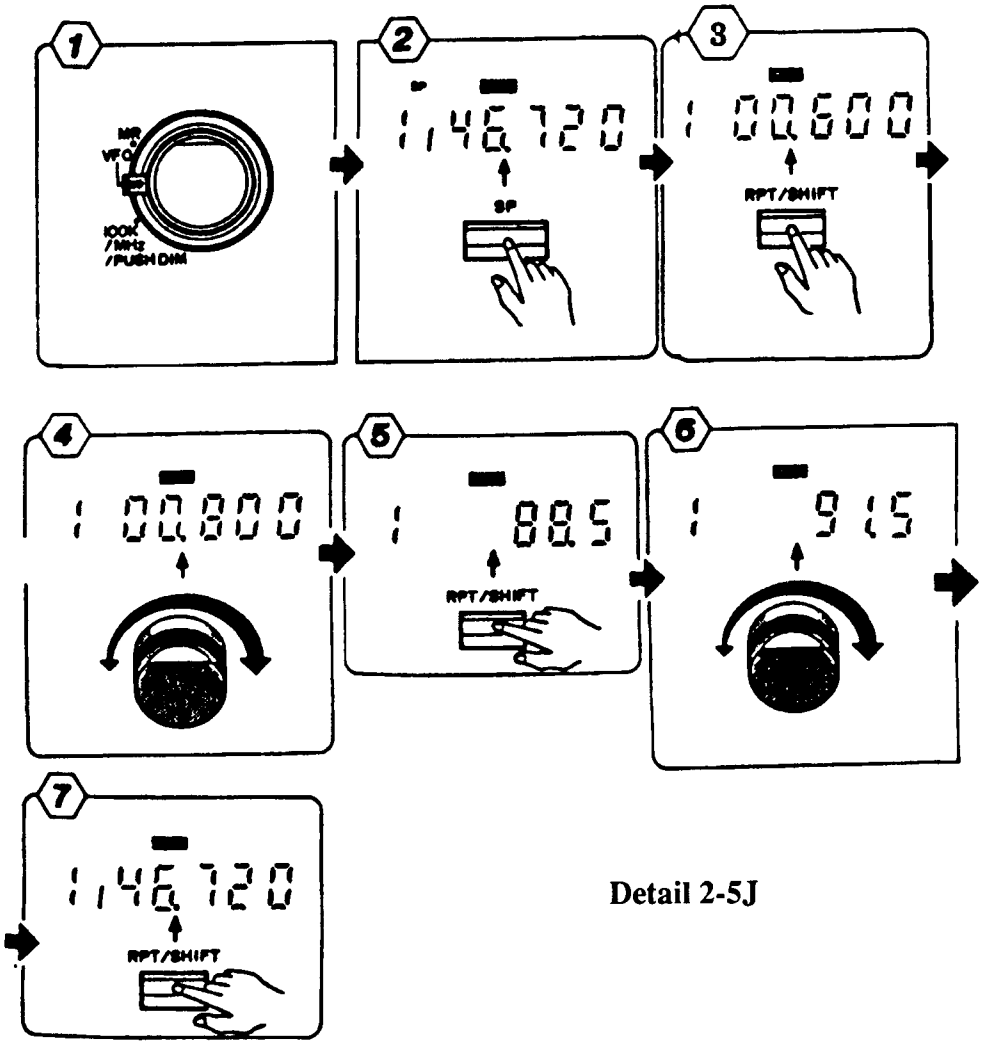
2. Press the REV/+ button; the "+" sign will be displayed.

NOTE: If the shifted frequency falls outside the amateur band when you press the microphone's PTT button, the displayed frequency will not change (even if you are in the repeater mode), and the Transceiver will remain in the receive mode. In this case, reset the frequency so the shifted frequency falls inside the amateur band. NOTE: If necessary, find the band limits for each band in the "Specifications" section of this Manual.

Changing Shift and Tone Frequencies

To change the shift frequency (Detail 2-5J):

1. Set the Frequency Selector lever to the VFO position, if this has not already been done.
2. Press the SP button to display the "SP" indicator, if this has not already been done.
3. Press the RPT/SHIFT button; the current shift frequency ("00.600" on 2 m, and "05.000" on 70 cm) will be displayed.



Detail 2-5J

4. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN buttons), as necessary, until the desired shift frequency is displayed.

5. Press the RPT/SHIFT button again; the current tone frequency ("88.5" for 88.5 Hz) will be displayed.

6. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN buttons), as necessary, until the desired tone frequency is displayed. NOTE: You may select a frequency from 37 available options, including 0 Hz (if you do not wish to transmit a subaudible tone).

7. To complete the change (store it in memory), press the RPT/SHIFT button again. The initial operating frequency will be displayed.

NOTES:

1. You can set shift and tone frequencies independently for VHF and UHF.

2. The shift frequency initially is set to 600 kHz on 2 m, and to 5.000 MHz on 70 cm.

3. When you change the shift and tone frequencies, they are also changed for RMR.

USING A MEMORIZED FREQUENCY

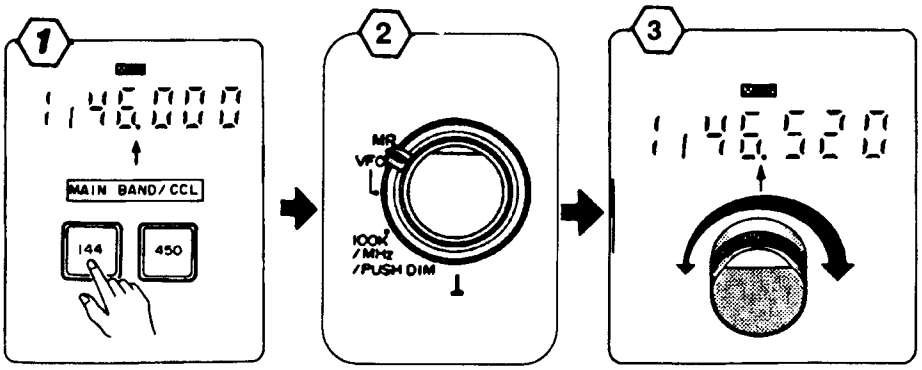
NOTE: Before you continue with the following procedure, first refer to "Placing Frequencies in Memory" on Page 2-35.

If you plan to operate on a repeater frequency that you have stored in memory (Detail 2-5K):

1. Press the button for the selected main band (144, for example); "MAIN" will again appear in red on the display for that band.

2. Set the Frequency selector lever to the MR position.

3. Turn the Frequency Tuning knob until the selected memory address, indicated by channel numbers 0 through 9, is displayed.



Detail 2-5K

REVERSING TRANSMIT AND RECEIVE FREQUENCIES

Use the following procedure to reverse the transmit and receive frequencies. This feature is handy for listening to the other station without going through a repeater.

1. Be sure "SP" is not displayed. If it is, press the SP button to extinguish it.

2. Press the REV/+ button; "REV" will be displayed.

NOTES:

1. To exit from the reverse mode, simply press the REV/+ button.

2. If necessary, refer to Page 2-13.

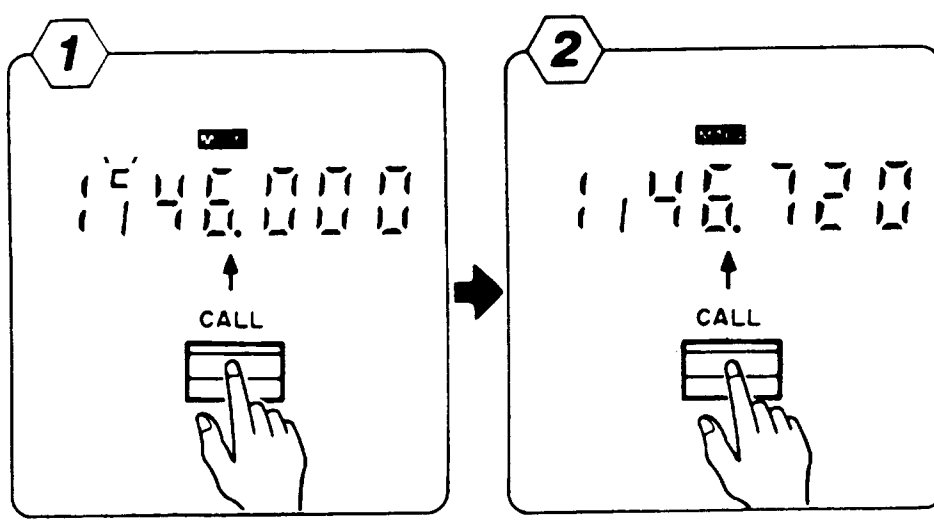
USING THE CALL FREQUENCY

As stated under "Setting the Call Frequency" on Page 2-22, you may use a repeater frequency as your call frequency.

To recall the call frequency from memory (Detail 2-5L):

1. Press the CALL button; a small "c" will be lit above the first digit on the frequency display for the selected band.

2. Press the CALL button again; the previous receive frequency will be displayed.



Detail 2-5L

To place a new call frequency in memory (Detail 2-5M):

1. Press the CALL button. The operating frequency currently stored in memory will be displayed.

2. Set the desired call frequency. If necessary, refer to "Setting the Operating Frequency" on Page 2-24. As soon as you start turning the Frequency Tuning knob, the small "c" will begin to blink.

3. Press the CALL button again to store the call frequency in memory. The "c" will stay lit and, provided the receiver section is squelched, you will hear a long beep.

4. Press the RPT/SHIFT button to enter the repeater mode; "RPT" will be displayed.

5. To change the shift direction, which is initially negative, complete steps A through B below.

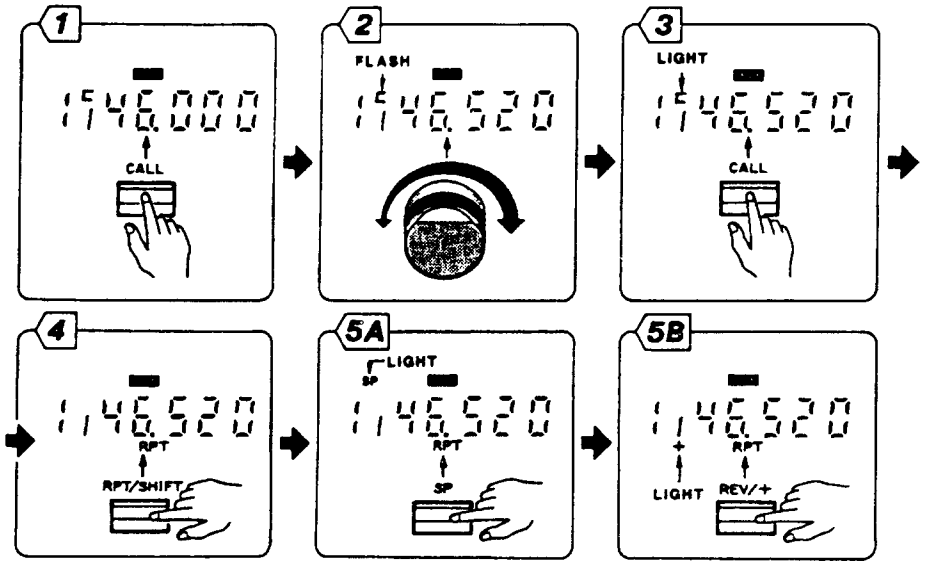
A. Press the SP button; "SP" will be displayed.

B. Press the REV/+ button; a "+" sign will be displayed.

6. Press the CALL button to place the frequency into memory. You will hear a long beep and the small "c" will be lit, indicating that memorization is complete.

7. To exit the call mode and return to the conventional repeater mode, press the CALL button again.

By storing the frequency of your favorite repeater in one memory (RMR); and by using the call frequency for a second repeater and storing its frequency in another memory (CALL), you can very quickly switch between the two repeaters. NOTE: The same shift and tone frequencies are used for both CALL and RMR.



Detail 2-5M

PLACING FREQUENCIES IN MEMORY

STORING A SIMPLEX FREQUENCY

Use the following procedure to place a simplex frequency in memory (Detail 2-5N):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for the selected band.

2. Set the Frequency Selector lever to the MR (memory recall) position.

NOTE: As you continue to turn the Frequency Tuning knob in the following step, each of the 10 memory address numbers (0 through 9) will, in turn, be displayed. Also, an "M" will appear above the memory address number. This "M" will be blinking for every empty memory address. It will, however, stay lit for every full memory address.

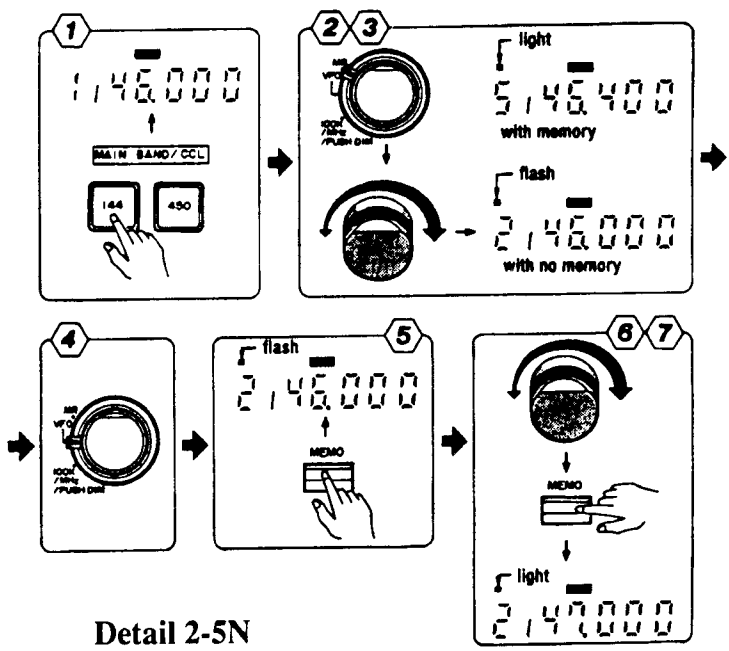
3. Turn the Frequency Tuning knob to an empty memory address.

4. Set the Frequency Selector lever to the VFO position.

5. Press the MEMO button; the "M" on the display will be blinking.

6. Turn the Frequency Tuning knob until the frequency that you wish to place in memory is displayed.

7. To place the displayed frequency in memory, press the MEMO button again. You will hear a long beep, signifying that memorization is complete. The displayed "M" will now be lit.



Detail 2-5N

NOTES:

1. You can not place a frequency in memory with the Frequency Selector lever in the MR position.

2. If you wish to use the microphone to recall the contents of a memory address, refer to the instructions on Page 2-12.

STORING A REPEATER FREQUENCY

To place a repeater frequency in memory (Detail 2-5O):

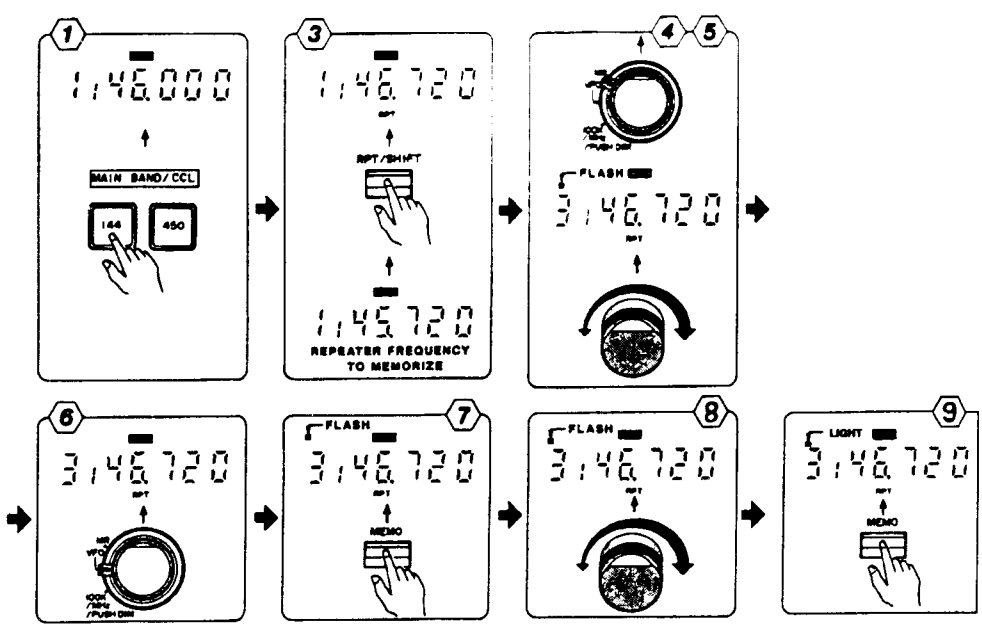
1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.

2. Set the displayed frequency as explained under "Setting the Operating Frequency" on Page 2-24.

3. Be sure "RPT" is displayed, indicating that the Transceiver is in the repeater mode. If "RPT" is not displayed, press the RPT button to turn this indicator on.

NOTE: If a "+" sign is not displayed for the band that you have selected for repeater operation, a negative (-) shift will be used. This means that the transmit frequency is lower than the receive frequency. You can, however, change to a positive (+) shift. To do this, refer to "Changing the Shift Direction" on Page 2-30.

4. Set the Frequency Selector lever to the MR (memory recall) position.



Detail 2-5O

NOTE: As you continue to turn the Frequency Tuning knob in the following step, each of the 10 memory address numbers (0 through 9) will, in turn, be displayed. Also, an "M" will appear above the address number. The "M" will be blinking for every empty memory address that is displayed. The "M" will, however, remain lit if the memory address is full.

5. Turn the Frequency Tuning knob to an empty memory address.

6. Set the Frequency Selector lever to the VFO position; the "M" will extinguish.

7. Press the MEMO button; the "M" will be blinking.

8. Turn the Frequency Tuning knob until the desired operating frequency is displayed.

9. To place the displayed frequency in memory, press the MEMO button again. You will hear a long beep, signifying that memorization is complete. The "M" will now stay lit.

If you wish to change the shift frequency immediately after you place the repeater frequency in memory:

1. Press the MEMO button again; the current shift frequency will be displayed.

2. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN button), as necessary, until the selected shift frequency is displayed.

3. To place the new shift frequency in memory, press the MEMO button again. You will hear a long beep, signifying that memorization is complete.

If you wish to change the tone frequency immediately after you place the repeater frequency in memory:

1. Press the MEMO button again; the current tone frequency will be displayed.

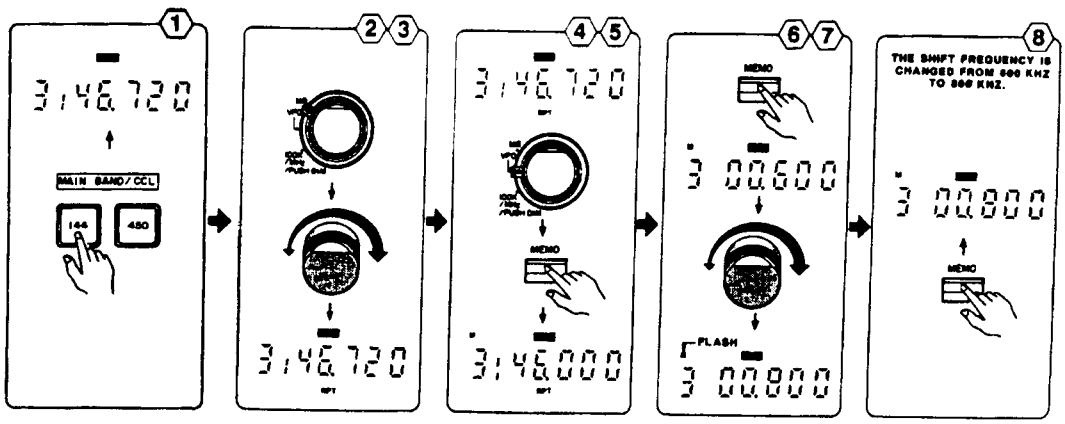
2. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN button), as necessary, until the selected tone frequency is displayed.

3. To place the new tone frequency in memory, press the MEMO button again. You will hear a long beep, signifying that memorization is complete.

CHANGING THE SHIFT FREQUENCY

To change the shift frequency stored at a repeater memory address (Detail 2-5P):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.
2. Set the Frequency Selector lever to the MR (memory recall) position.
3. Turn the Frequency Tuning knob until the number for the selected memory address is displayed.
4. Set the Frequency Selector lever to the VFO position.
5. Press the MEMO button; the "M" on the display will be lit.
6. Press the MEMO button again; the current shift frequency will be displayed.
7. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN button), as necessary, until the desired shift frequency is displayed. At this time, the "M" will still be blinking.
8. To place the new shift frequency in memory, again press the MEMO button. You will hear a long beep, signifying that memorization is complete.
9. Press the MEMO button twice to return to the conventional repeater mode.



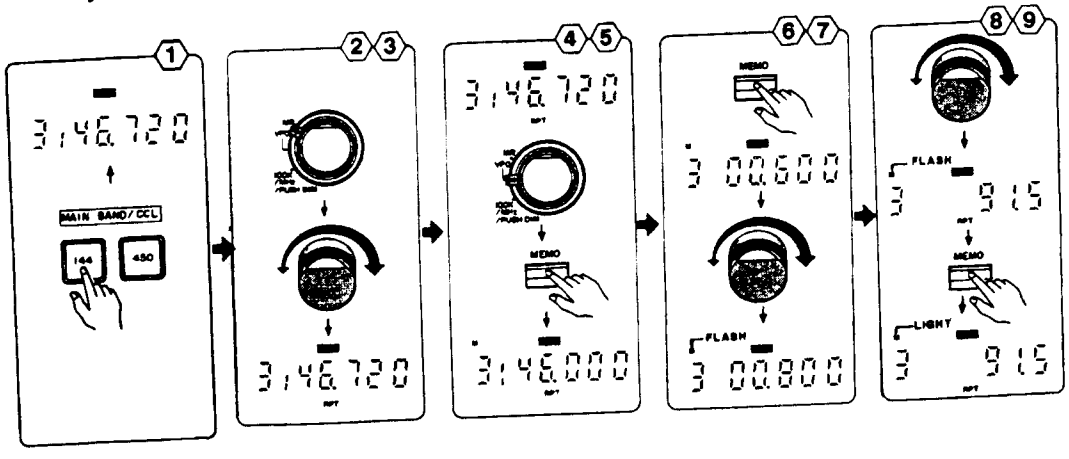
Detail 2-5P

CHANGING THE TONE FREQUENCY

To change the tone frequency at a repeater memory address (Detail 2-5Q):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.
2. Set the Frequency Selector lever to the MR (memory recall) position.
3. Turn the Frequency Tuning Knob until the number for the selected memory address is displayed.
4. Set the Frequency Selector lever to the VFO position.
5. Press the MEMO button; the "M" on the display will be lit.
6. Press the MEMO button again; the current shift frequency will be displayed.
7. Press the MEMO button again; the current tone frequency will be displayed.
8. Turn the Frequency Tuning knob (or press the microphone's UP or DOWN button), as necessary, until the selected tone frequency is displayed. At this time, the "M" on the display will still be blinking. NOTE: You may select a frequency from 37 available options, including 0 Hz (if you do not wish to transmit a subaudible tone).
9. To place the new tone frequency in memory, again press the MEMO lever. You will hear a long beep, signifying that memorization is complete.

NOTE: You can place a total of ten different pairs of shift and tone frequencies for both bands in memory. In addition, "CALL" and "RMR" provide two additional dedicated memory addresses.



Detail 2-5Q

CLEARING A MEMORY ADDRESS

To clear a memory address:

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.

2. Set the Frequency Selector button to the MR (memory recall) position.

3. Turn the Frequency Tuning knob until the number for the selected memory address (containing the memorized frequency) is displayed.

4. Set the Frequency Selector lever to the VFO position.

5. Press the button for the selected main band while you hold the MEMO lever depressed. The "M" above the memory address number on the display will now blink, indicating that the selected memory address is cleared.

6. To exit from this mode, press the button for the selected main band.

SCANNING

You can make your Transceiver scan in the memory-frequency mode or the dial-frequency mode. No matter which mode you choose, you can either pause scan or busy scan.

Pause scan ceases when a signal is received. Scanning will then resume five seconds later or when the signal disappears, whichever occurs first.

Busy scan stops scanning when a signal is received, but scanning resumes only 1-1/2 seconds after the signal disappears. NOTE: The display has no indicators for pause and busy scan.

SCANNING THE MEMORY CHANNELS

To scan the memory channels (Detail 2-5S):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.

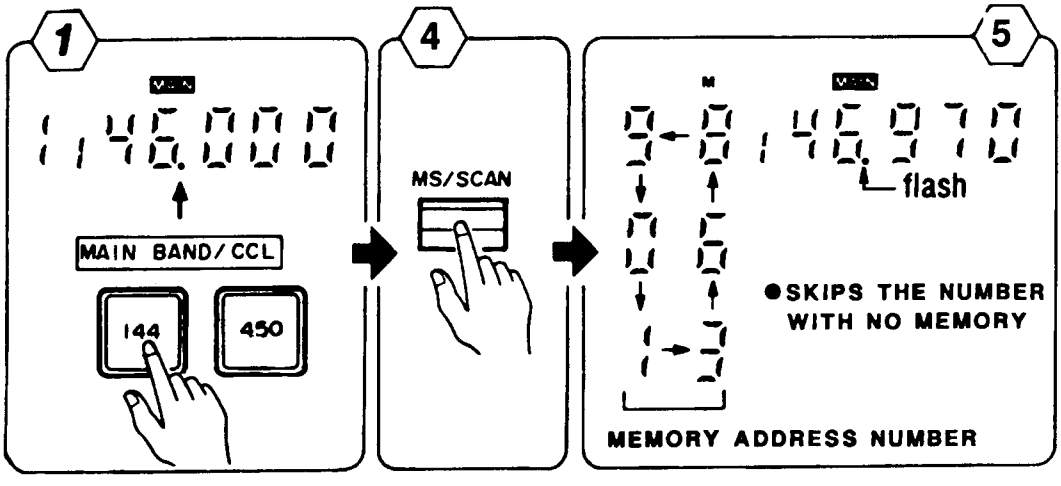
2. Be sure "SP" does not appear on the display. If it does, press the SP button; "SP" will extinguish.

3. Set the Frequency Selector lever to the VFO or 100 k/MHz position, if this has not already been done.

4. Press the MS/SCAN button.

5. Scanning of the memory channels will now start with the highest numbered memory channel and continue in descending order, only skipping the empty ones. Also, the decimal point in the displayed frequency will be blinking during the scanning.

6. To exit the memory scanning mode, press the MS/SCAN button again.



Detail 2-5S

DIAL-FREQUENCY SCANNING

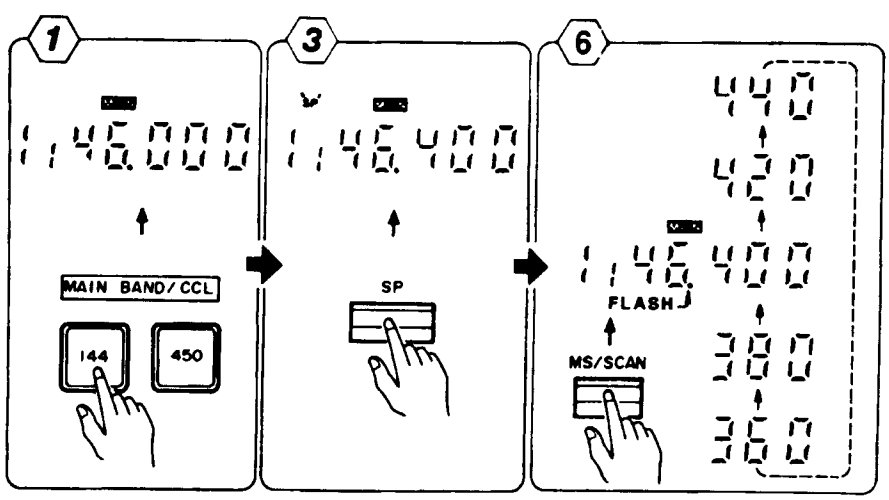
NOTES:

1. The display has no indicators for dial-frequency scanning.
2. Your Transceiver only scans between whole multiples of 1 MHz.

1 MHz Scan

To scan any 1 MHz segment of a selected band (Detail 2-5T):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.
2. Be sure the receiver section is squelched.
3. Press the SP button; "SP" will be displayed.
4. Set the Frequency Selector lever to the VFO or 100K/MHz position, if this has not already been done.
5. Turn the Frequency Tuning knob until the lower frequency limit of the 1 MHz band segment that you wish to scan is displayed.
6. Press the MS/SCAN button; scanning will start at the displayed frequency.

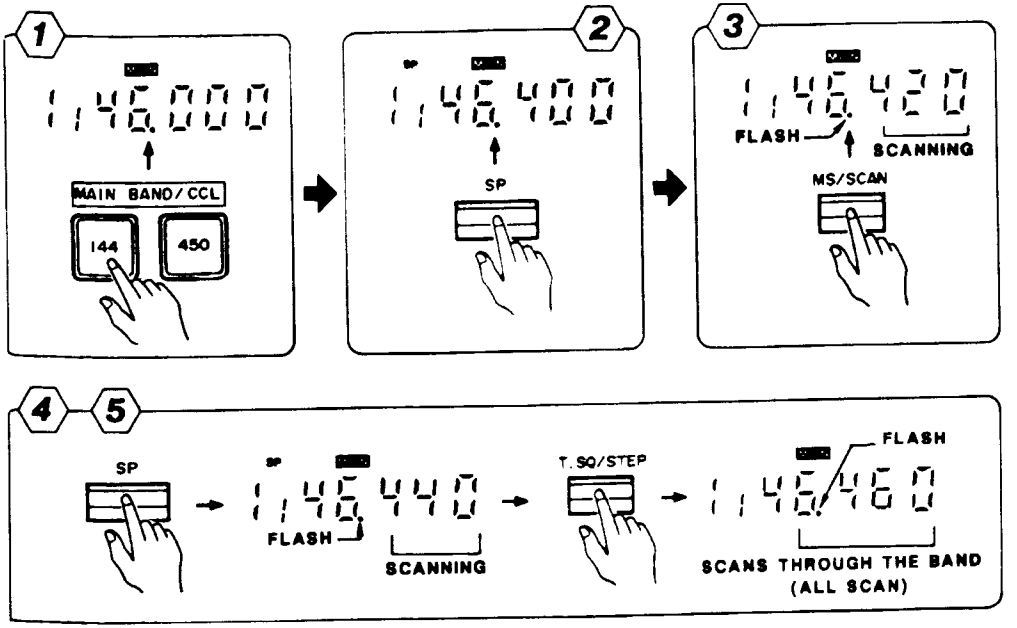


Detail 2-5T

All Band Scan

To scan the selected band from one end to the other (Detail 2-5V):

1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.
2. Press the SP button; "SP" will be displayed.
3. Press the MS/SCAN button; 1 MHz scanning will start.
4. Press the SP button during 1 MHz scanning.
5. Press the T.SQL/STEP button; scanning of the entire band will start.

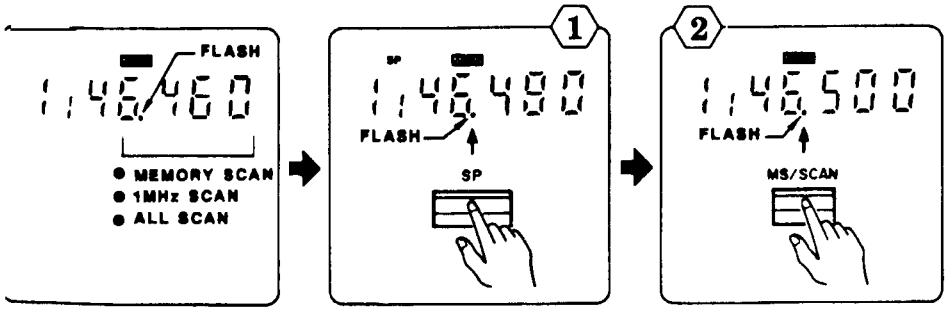


Detail 2-5V

SWITCHING PAUSE AND BUSY SCAN

To switch pause scan and busy scan (Detail 2-5W):

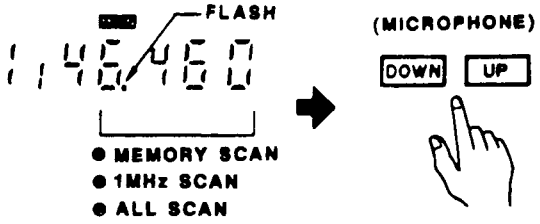
1. Press the SP button during scanning (memory scan, 1 MHz scan, or all scan).
2. Press the MS/SCAN button to switch pause scan and busy scan.



Detail 2-5W

UP OR DOWN SCANNING

To scan upwards, press the microphone UP button during scanning (memory scan, 1 MHz scan, and all scan). In the same manner, press the DOWN button to scan downwards (Detail 2-5X).



Detail 2-5X

TONE SQUELCH SCANNING

To use tone squelch scanning (Detail 2-5Y):

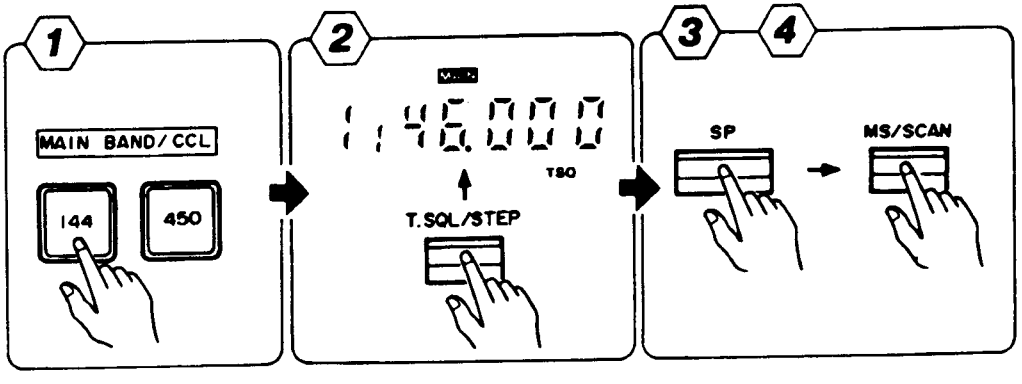
1. Press the button for the selected main band (144, for example); "MAIN" will appear in red on the display for that band.

2. Press the T.SQL/STEP button to enter the tone squelch mode; "SQL" will be displayed.

3. Be sure "SP" is not displayed. If it is, press the SP button; "SP" will extinguish.

4. Press the MS/SCAN button to start scanning (memory, 1 MHz, or all scan). Scanning will stop only when the tone that modulates the received signal matches the tone that you selected for your Transceiver.

NOTE: The scan modes listed above are independently set and memorized for the 144 MHz and 450 MHz bands, respectively. Also, you can set a different scan mode for each band.



Detail 2-5Y

MEMO Scan Operation				Normal Scan Operation			
mode	PAUSE/BUSY switching	UP/DOWN switching	T.SQL ON/OFF	mode variety	PAUSE/BUSY switching	UP/DOWN switching	T.SQL ON/OFF
MEMO	PAUSE	UP	OFF ON	1MHz	PAUSE	UP	OFF ON
		DOWN	OFF ON			DOWN	OFF ON
	BUSY	UP	OFF ON		BUSY	UP	OFF ON
		DOWN	OFF ON			DOWN	OFF ON
				ALL	PAUSE	UP	OFF ON
						DOWN	OFF ON
					BUSY	UP	OFF ON
						DOWN	OFF ON

Scan for both bands: Example 1

144 MHz band	450 MHz band
memory scan	normal scan (All)
BUSY	PAUSE
DOWN	UP
T.SQL OFF	T.SQL ON

Scan for both bands: Example 2

144 MHz band	450 MHz band
memory scan	normal scan (All)
PAUSE	BUSY
DOWN	UP
T.SQL ON	T.SQL OFF

Scan for both bands: Example 3

144 MHz band	450 MHz band
memory scan (All)	normal scan (1MHz)
BUSY	PAUSE
UP	DOWN
T.SQL OFF	T.SQL OFF

USING YOUR TRANSCEIVER WITH A REPEATER

In normal (simplex) communication, both your transmitter and receiver operate on the same frequency.

Repeaters (automatic relay stations), which use antennas that are usually located on a tall building or tower, allow you to communicate over longer distances than you can during simplex operation. This is particularly true when either your station or the other station (or both) are mobile stations. As far as your Transceiver is concerned, one of the major differences between the two types of communication is that the transmitter and receiver use different frequencies during repeater operation.

To set up your Transceiver for repeater operation on the VHF band (Pictorial 2-6 and Detail 2-6A):

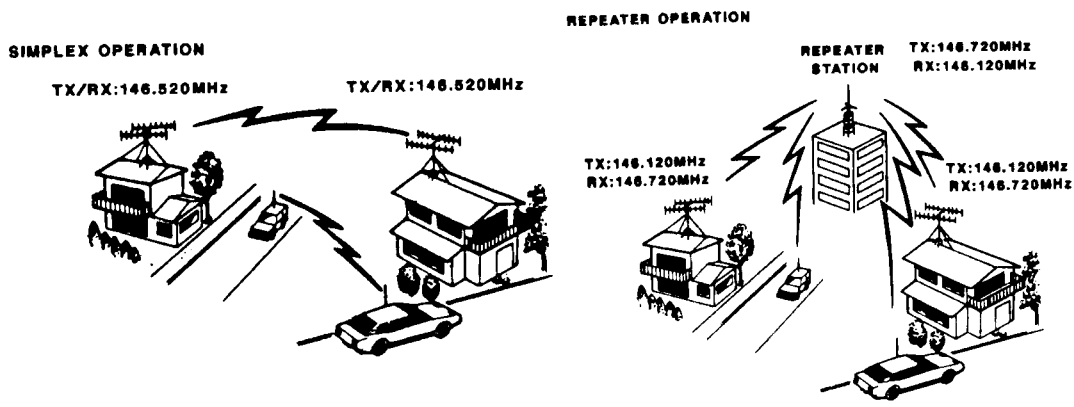
1. Press the 144 band button to select the VHF band. "MAIN" will appear on the display for that band.

2. Set your Transceiver to the output frequency of the repeater you wish to use.

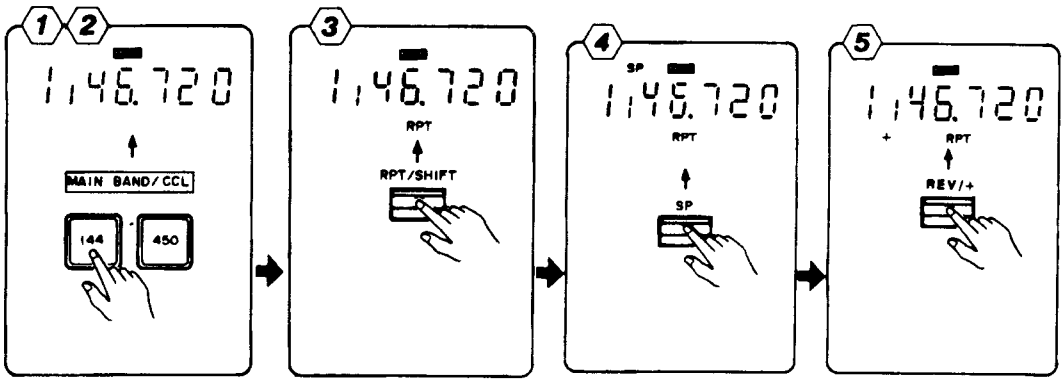
3. Press the RPT/SHIFT button. "RPT" will appear on the display to indicate that repeater operation is enabled. Initially, the shift frequency is 600 kHz, the shift direction is negative (-), and the tone frequency is set to 88.5 Hz. NOTE: If the repeater requires a positive shift direction, complete steps 4 and 5 below. Otherwise, skip these steps.

4. Press the SP button; "SP" will appear on the display, indicating that the special function mode is enabled.

5. Press the REV/+ button; a "+" will appear on the display to indicate that a positive shift direction will be used (in the transmit mode).



PICTORIAL 2-6



Detail 2-6A

HOW TO USE THE CROSSBAND REPEATER

In addition to accessing a conventional repeater, which transmits and receives on frequencies on the same band (VHF and UHF), you may also set up your Transceiver so it will act as an automatic crossband repeater.

To use the crossband repeater:

1. Select the desired operating frequency and shift frequency for each band.
2. Turn the Squelch controls for both bands fully counterclockwise.
3. Turn the Volume controls for both bands for a pleasant listening level.
4. Turn each of the two Squelch controls clockwise just past the point where the band noise disappears.
5. With the SP button held depressed, press the RMR button three times. "MAIN" on the display for both bands will be blinking.

- As soon as a signal is received on the displayed frequency on the VHF band and its squelch opens, a signal (which is being modulated with the incoming VHF signal's audio) is transmitted on the displayed frequency on the UHF band.

- As soon as a signal is received on the displayed frequency on the UHF band and its squelch opens, a signal (which is being modulated with the incoming UHF signal's audio) is transmitted on the displayed frequency on the VHF band.

NOTE: Under the above stated condition, the repeater's hang time is two seconds. To reduce the hang time to zero seconds, press the T.SQL/STEP button. To revert to a two-second hang time, press the T.SQL/STEP button again.

5. To exit the crossband repeater mode, press the RMR button again. NOTE: The crossband repeater actions are kept in memory.

6. To operate the crossband repeater with the CTCSS (continuous tone-controlled squelch system), first enable this function by pressing the T.SQL/STEP button.

CONVENIENT FEATURES

Your Transceiver has been designed to provide the ultimate in operating convenience. In addition to being able to operate on one band while you monitor another, you may use it for single band operation, split frequency operation, or as an automatic cross-band repeater. The following paragraphs explain these features.

SINGLE BAND OPERATION

While you operate on one band, you may wish to blank out the display for the other band. You may also mute the sound on the band that you do not wish to use.

To blank out the display (Figure 2-7A):

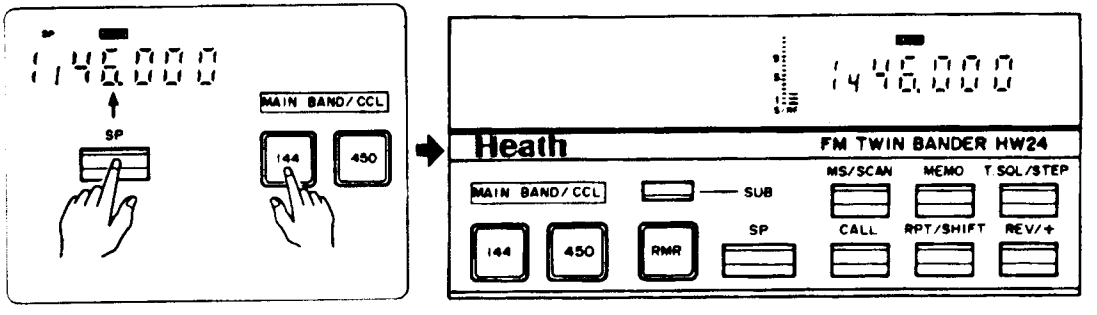


Figure 2-7A

1. Press the band (144 or 450) button for the band that you wish to blank the display for, (or press the SUB lever to enter the sub band mode). "MAIN" will appear on the display for the band you wish to blank out.

2. While holding the SP button depressed, press the band (144 or 450) button for the display you wish to blank out. The display for the "undesired" band will extinguish, and "MAIN" will appear on the display for the desired band.

3. To make the display for the "undesired" band reappear, again press the button for that band.

SPLIT FREQUENCY OPERATION

You may set up your Transceiver for split frequency operation. This allows you and another station to operate on two different frequencies on the same band. NOTE: The following example assumes that you will not be using the tone frequency feature. However, you may use it, if you wish.

For example (Figure 2-7B):

- Station A will: Place 146.100 MHz in memory address #3, using the repeater (RPT) mode. A shift frequency of 500 kHz, a positive (+) shift direction, and a tone frequency of 0.0 Hz should be memorized together.

- Station B will: Place 146.600 MHz in memory address #3, using the repeater mode. A shift frequency of 500 kHz, a negative (-) shift direction, and a tone frequency of 0.0 Hz should be memorized together.

A STATION

146.100 (DISPLAYED FREQ.)
146.600 (TX FREQUENCY)

B STATION

146.600 (DISPLAYED FREQ.)
146.100 (TX FREQUENCY)

Figure 2-7B

SETTING THE TONE SQUELCH FREQUENCY

Just like a repeater may require that you transmit a certain subaudible tone to access it, you may set up your Transceiver so that any station that wishes to contact you must transmit a specific tone to access your Transceiver. The same 37 CTCSS frequency options are available for both functions.

Your Transceiver's tone squelch, which can only be used for nonrepeater operation, allows your receiver to remain quiet except when certain stations using CTCSS tone frequencies call you. NOTE: You may use a different tone squelch frequency for each band.

To set the tone squelch frequency (Figure 2-8):

1. Press the SP button; "SP" will be displayed.
2. Press the RPT/SHIFT button; the repeater shift frequency ("00.600" for 600 kHz, for example) will be displayed.
3. Press the T.SQL/STEP button; the tone squelch frequency ("88.5" for 88.5 Hz, for example) will be displayed.
4. Turn the Frequency Tuning knob to set the desired frequency.
5. Press the T.SQL/STEP button again to place the new tone squelch frequency in memory. The initial operating frequency will again be displayed.

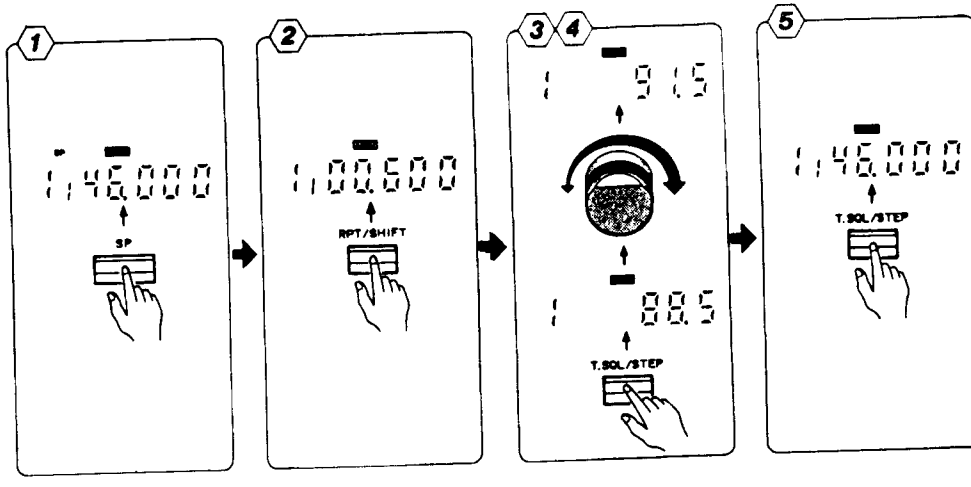


Figure 2-8

TONE SQUELCH OPERATION

To operate with tone squelch:

1. Press the button for the selected band (where you wish to use the tone squelch); "MAIN" will appear in red on the display for that band.

2. Press the T.SQL/STEP button to enter the tone squelch mode.

Your Transceiver is now set up for tone squelch operation. When you are tuned to any frequency within this band and another station transmits on this frequency, you will not hear him unless he is transmitting the same tone frequency that your receiver requires.

CLEARING ALL MEMORIES

To clear the contents of all 10 memory locations on each band (Figure 2-9):

Press and hold the SP button. Then, with the SP button depressed, push the Power Switch knob to turn the power off.

NOTE: To initialize the microprocessor when improper operation occurs or after the internal battery has been replaced, use the procedure given under "RESET Terminals" on Page 2-15.

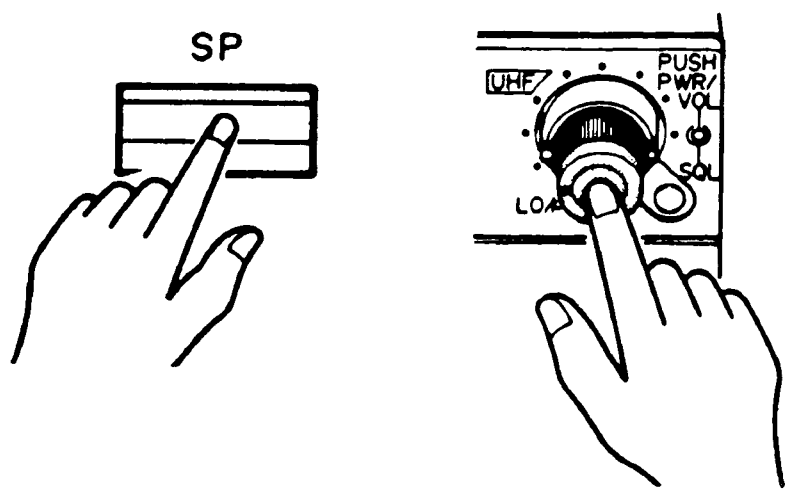


Figure 2-9

POWER SOURCES

Use a DC power source with a negative ground that produces between 12.0 and 16.0 volts (@ 3.5 amperes for HW-24 and @ 10.5 amperes for HW-24H) to operate your Transceiver. The operating power can be provided by an AC-operated power supply or a 12-volt system, such as an automobile battery.

CAUTION: Before you connect this Transceiver/Repeater to a mobile "12-volt" power source, check the voltage at the battery with the engine running above a fast idle. The voltage must not exceed 16.0 volts or the Transceiver may be damaged.

BATTERY REPLACEMENT

The information stored in your Transceiver's memory is retained even after you turn its power off. A lithium-type battery is used to provide back-up power for its microprocessor. Under normal use, this battery should last for at least five years.

When the battery voltage drops below a certain level, the displayed frequency may no longer be correct, or the memory addresses will no longer be able to retain their information. At that time, the lithium battery should be replaced by the Heath Company or by a Heath/Zenith Computers and Electronics Center. Do not attempt to replace this battery yourself.

MAINTENANCE

The high-powered Transceiver/Repeater version, Model HW-24H, uses a cooling fan to assure that its inside temperature does not exceed a safe level. Whenever the heat sink temperature reaches its high limit, a sensing device automatically causes the cooling fan to turn on. As soon as the monitored temperature reaches its low limit, the cooling fan will turn off.

To prevent dust from entering into the fan assembly, a reusable filter element is placed in front of the fan, in the rear cover. A dirty filter adversely affects the fan's cooling efficiency. Therefore, always keep the filter clean.

To remove and clean the filter (Pictorial 2-10):

1. Remove the indicated six screws from the rear cover. Save the screws for use later.

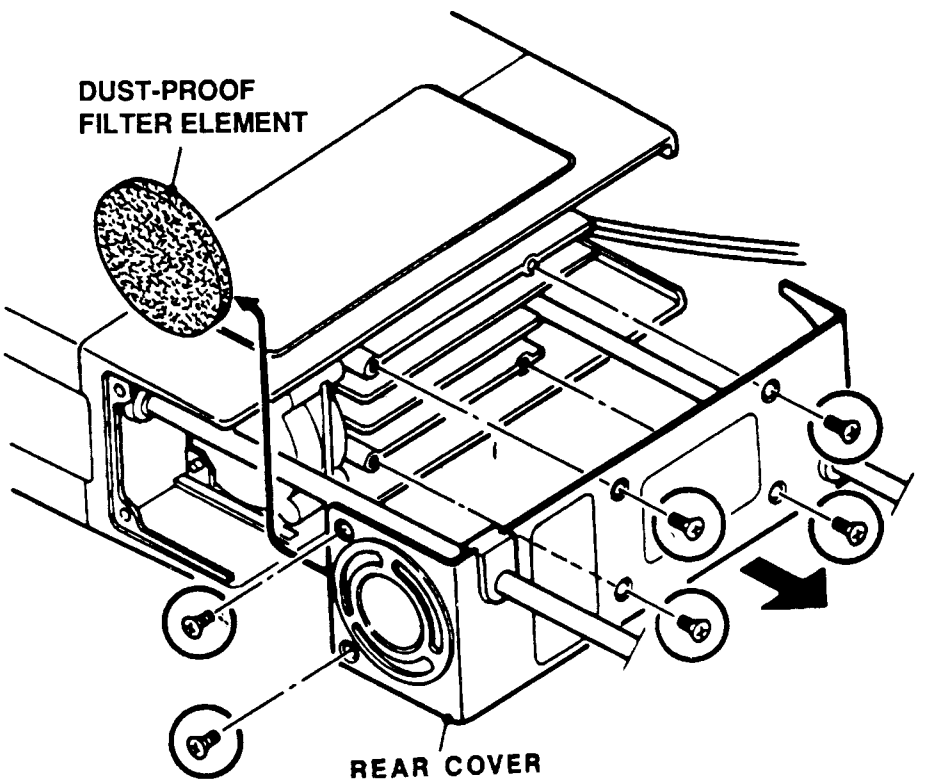
2. Carefully pull the rear cover straight out and away from the heat sink. Then remove the filter from the cover and set the cover aside.

3. Wash the filter in lukewarm water. If the filter is especially dirty, use a mild detergent to wash it. Then rinse it well in clean water.

4. Drain the water from the filter, and allow it to dry thoroughly.

5. After the filter is completely dry, reinstall it in the rear cover.

6. Reinstall the rear cover onto the heat sink with the six screws that you removed earlier.



PICTORIAL 2-10

IN CASE OF DIFFICULTY

CONDITION	POSSIBLE CAUSE
The unit is completely dead.	A. Blown fuse(s) in the unit's power wires. B. Blown fuse in the unit's power source. C. Connections to the unit's power source are reversed.
The unit does not receive, but it appears to transmit okay (as indicated by the front panel RF meter).	A. The SQL (squelch) control for the affected band is turned too far clockwise. B. You are not using the Squelch control for the selected band. C. The band in use is set up for tone squelch operation, allowing you to only receive stations that are using a subaudible tone with the correct frequency. D. The sub band is muted as indicated by MUTE being displayed.
The unit appears to receive only the strongest signals on the band.	A. The antenna for the affected band is improperly assembled, connected, or adjusted. B. The unit's antenna connections are reversed. C. The SQL (squelch) control for the affected band is turned too far clockwise.
The sound from the speaker is sometimes weak with the same volume control setting.	A. The sub band is muted as indicated by MUTE being displayed.
The alarm does not sound when a signal is received on the sub band.	A. The Volume control for the sub band is turned too far counterclockwise.
The unit does not transmit, but it receives okay.	A. MAIN is not displayed for the selected band. B. The choice of transmitter shift (offset) frequency would produce out-of-band operation (in the repeater mode). C. The shift frequency, tone frequency, or step rate frequency is displayed. NOTE: To allow you to transmit, press the band button (144 or 450) for the selected band.

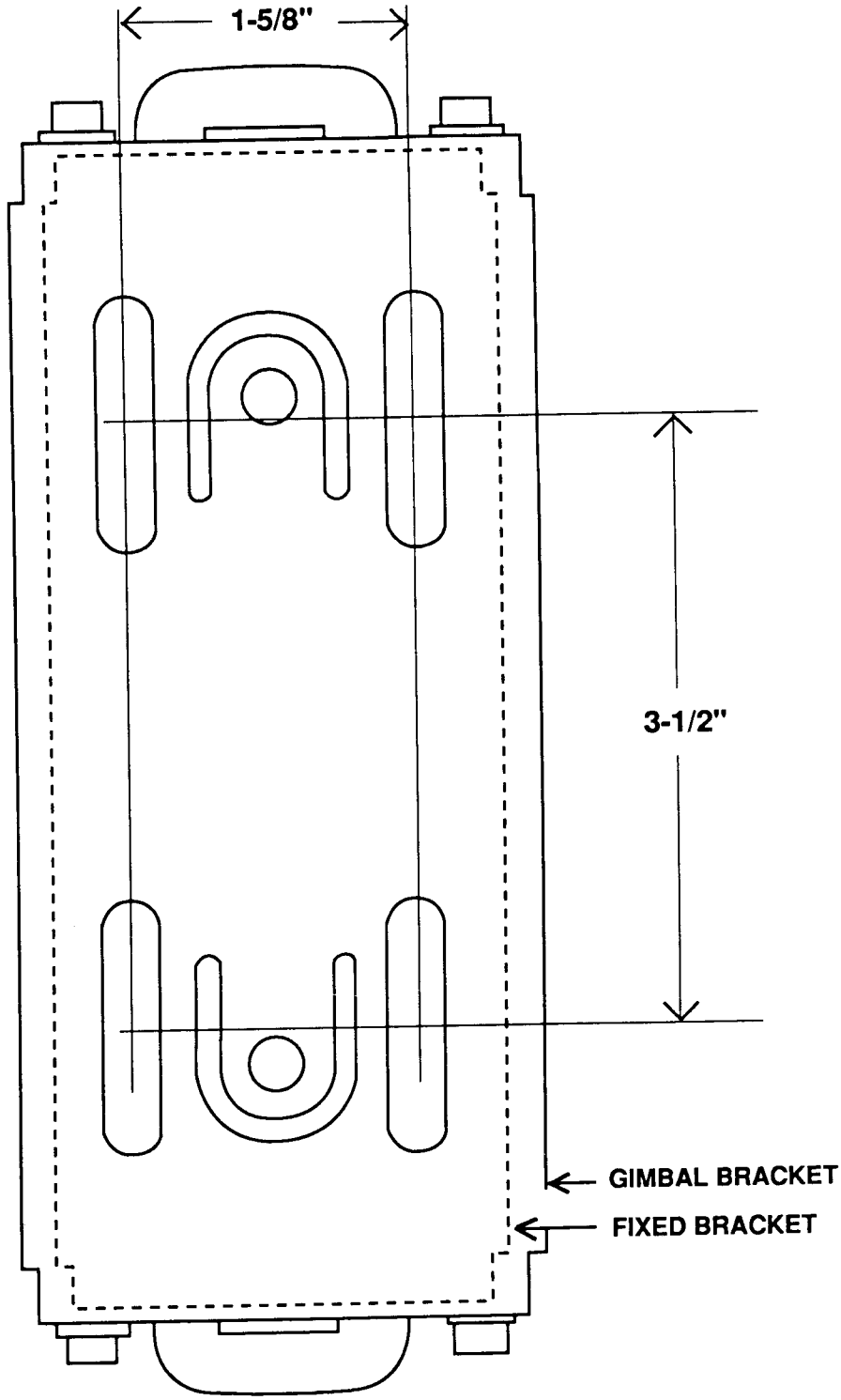
CONDITION	POSSIBLE CAUSE
The unit can not access a specific repeater.	A. A subaudible tone frequency may be required to access it. B. The repeater is out of your range. NOTE: Increase your transmit power, if possible.
The whole display for one of the bands is blank.	A. The Band button (144 or 450) for the affected band's display was (accidentally) pressed. To "reactivate" this portion of the display, press the same band button again.
The displayed frequency is incorrect.	A. The microprocessor must be reset. Use the procedure given on Page 2-15.
The displayed frequency changes when power is being turned off and back on again.	A. The internal lithium battery is weak. NOTE: Have the unit serviced by the Heath Company or by a Heath/Zenith Computers and Electronics Center.

EQUIVALENT [illegible]

STANDARD [illegible]

MOBILE BRACKET HOLE TEMPLATE

CUT ALONG DOTTED LINE



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