ALIGNMENT

The coils and transformers in your Transceiver have been preset at the factory. Only slight readjustments should be necessary during the following alignment procedure.

The following equipment is necessary for alignment of the Transceiver.

1. An 11 megohm input VTVM (a 20 KΩ/V VOM may also be used).
2. A 50 Ω nonreactive dummy load that is capable of 100 watts dissipation, such as the Heathkit Model HN-31. Do not use light bulbs as a dummy load, as their resistance varies radically with voltage.
3. A receiver capable of receiving WWV at 2.5, 5, 10, or 15 mc. If this type of receiver is not available, a receiver tunable to a standard broadcast station that is operating at an even multiple of 100 kc (such as 600 kc, 1000 kc, etc.) can be used.

For the alignment of the transmitter section it is recommended that you use an oscilloscope, such as the Heathkit Model HO-10 Monitor Scope to observe the output RF envelope.

WARNING: Do not place the Transceiver in the transmit mode of operation until directed to do so or the Transceiver may be seriously damaged.

( ) Set the ANTENNA switch (located on rear of chassis) to the COM position.

( ) Connect a 50 Ω dummy load, capable of 100 watts dissipation, to the RF OUT jack on the rear of the chassis. CAUTION: Do not use light bulbs as a dummy load.

( ) Be sure an 8 Ω speaker is connected to the 8 Ω jack on the rear of the chassis.

( ) Preset the CAL XTAL trimmer so its notch is towards the 100 kc crystal as shown in Figure 1-1 (fold-out from Page 80).

( ) Preset the front panel controls as follows:

DRIVER PRESELECTOR - 12 o'clock position (3.7, 7.2, 14.2).

MIC/CW LEVEL - fully counterclockwise.

MODE - LSB

BAND - 3.5

Main tuning dial (LMO) - 3.7 mc (upper dial pointer at 2, and the circular dial at 0).

FUNCTION - PTT.

OSC MODE - LMO.

RF GAIN - fully clockwise.

METER - ALC.

AF GAIN - 9 o'clock position.

S-METER ADJUSTMENT

( ) After a few minutes warmup, adjust the METER ZERO control (on the IF circuit board directly behind the OSC MODE switch) for a zero reading on the panel meter.

RECEIVER ALIGNMENT

( ) Set the VTVM switches so the meter will indicate a negative (-) DC voltage.

( ) Connect the common lead of the VTVM to the chassis and the other lead to the circuit board foil at TP on the screened side of the bandpass circuit board near tube V19.

The heterodyne oscillator output will be checked at each position of the BAND switch in the following steps. If necessary, the heterodyne oscillator coils will be adjusted to obtain an output voltage reading.

( ) With the BAND switch at 3.5, the VTVM should indicate about -0.5 to -2 volts DC. If necessary, adjust coil 3.5 (near tube V11 on the top side of the RF-driver circuit board) for the proper VTVM reading. NOTE: When adjusting this coil in one direction, the oscillator output voltage will change rapidly; when adjusting the coil in the opposite direction from the peak, the output voltage will change slowly. Adjust the coil in the direction that gives the slower change in output voltage.

( ) Similarly, check the heterodyne oscillator output voltage at all positions of the BAND switch. If necessary, adjust the correct heterodyne oscillator coil for any BAND switch position that does not give an indication of about -0.5 to -2 volts DC on the VTVM. The heterodyne oscillator coils for bands 3.5, 14, and 28.5 are marked, and adjusted at the top side of the RF-driver circuit board; the coils for the other bands are marked on the shield cover, and are adjusted from the bottom of the chassis.

Band switch 3.5

( ) Set the FUNCTION switch to CAL, then turn the Main Tuning dial back and forth around 3.7 mc to get the loudest signal. Check for the calibrate signal by turning the FUNCTION switch to VOX and back to CAL; the signal should stop and then start again and should peak with the DRIVER PRESELECTOR.

( ) Disconnect the VTVM leads from the Transceiver.

The S-Meter will be used as an output indicator during the remaining alignment of the Transceiver, and the 100 kc calibrator will be used as a signal source.

( ) Adjust transformer T201 for maximum volume.

( ) Adjust the top and bottom slugs of transformer T102 for a maximum volume or S-Meter indication.

( ) Adjust the slug of transformer T103 for a maximum S-Meter indication.

( ) Repeat the adjustments of transformers T201, T102, and T103 for a maximum S-Meter indication.

The driver grid and driver plate coils will be adjusted in the following steps. The coil locations are marked on the shield cover at the bottom of the chassis. These coils must be adjusted in the proper sequence as follows:

( ) Adjust driver grid coil 3.5 and driver plate coil 3.5 for a maximum S-Meter indication. The S-Meter will move slowly during the adjustment of these two coils.

( ) Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 29.2 position. See the inset drawing on Figure 1-2 (fold-out from Page 97).

BAND - 29.0

Main Tuning dial (LMO) - 29.2 mc

( ) Turn the Main tuning dial back and forth around 29.2 mc to get the loudest signal. Check for the calibrate signal by turning the DRIVER PRESELECTOR to see if there is any variation in volume. Return the DRIVER PRESELECTOR to the 29.2 position.

( ) Adjust driver grid coil 29 and driver plate coil 29 for a maximum S-Meter indication.

( ) Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 21.2 position. See the inset drawing on Figure 1-2.

BAND - 21.0

Main tuning dial - 21.2 mc.

( ) Turn the Main tuning dial back and forth around 21.2 mc for the loudest signal. Check for the calibrate signal by turning the FUNCTION switch to VOX and back to CAL again.

( ) Adjust driver grid coil 21 and driver plate coil 21 for a maximum S-Meter indication.

( ) Turn the BAND switch to 14.0, the Main tuning dial to 14.2 mc, and the DRIVER PRESELECTOR to the 14.2 position.

( ) Tune the Main tuning dial for the loudest signal and check for the calibrate signal.

( ) Adjust driver grid coil 14 and driver plate coil 14 for a maximum S-Meter indication.

( ) Set the BAND switch at 7.0 and the Main tuning dial at 7.2 mc.

( ) Tune the Main tuning dial for the loudest signal.

( ) Adjust driver grid coil 7 and driver plate coil 7 for a maximum S-Meter indication.

( ) Turn the FUNCTION switch to PTT

Proper receiver operation will be indicated by calibrator signals of S9 +30 db at 3700 kc and decreasing to S6 at 29.2 mc.

TRANSMITTER ALIGNMENT

See the "Reading The Meter" section on Page 106 before making any more adjustments.

NOTE: The coil cover must be in place for transmitter operation.

( ) Connect a push-to-talk microphone to the MIC connector on the front panel.

( ) If an oscilloscope is available, connect the oscilloscope between the RF OUT jack and the dummy load. Be sure the dummy load is capable of 100 watts dissipation.

( ) Set the NEUTRALIZING CAPACITOR (on the RF cage) at the 1/2 meshed position. The slot in the shaft should be vertical.

( ) Set the front panel controls as follows:

DRIVER PRESELECTOR - 12 o'clock position.

MIC/CW LEVEL - fully counterclockwise.

FINAL (round knob) - to 80.

FINAL (lever knob) - over the 50 Ω marking.

MODE - LSB.

BAND - 3.5

Main tuning dial - 3.7 mc.

FUNCTION - PTT.

OSC MODE - LMO.

METER - PLATE.

( ) Press the PTT microphone button and turn the BIAS ADJUST control in the Transceiver for a plate current reading of 50 ma. If the meter reads more than 100 ma, do not press the microphone button more than a few seconds at one time, until the plate current has been properly adjusted.

( ) If an oscilloscope is not used, preset the RELATIVE POWER control to the center of its range and turn the METER switch to REL PWR.

( ) With the MODE switch set at the TUNE position, slowly turn the MIC/CW LEVEL control in a clockwise direction until there is an indication of RF output on the meter or oscilloscope.

( ) Turn the MIC/CW LEVEL control for a low level of RF output, then adjust the DRIVER PRESELECTOR control for maximum RF output.

( ) Adjust the FINAL tune (round knob) control for maximum RF output.

( ) Turn the MIC/CW LEVEL control counterclockwise to obtain approximately 1/4 maximum output.

( ) Adjust transformer T1 for maximum RF output. It should not be necessary to adjust this transformer more than one complete turn.

( ) Turn the MIC/CW LEVEL control to obtain maximum RF output on the meter or oscilloscope. Then turn the METER switch to GRID (grid current); the meter should indicate full scale.

( ) Turn the METER switch to the PLATE position.

( ) Adjust the FINAL tune control for minimum plate current. Turn the METER switch to REL PWR or observe the output on an oscilloscope. Adjust the FINAL tune control for maximum meter indication and note the position of the FINAL tune control. (If necessary, readjust the RELATIVE POWER control so the meter does not indicate beyond full scale.) If maximum relative power and minimum plate current do not occur at the same point of tuning, then turn the neutralizing capacitor a small amount. Check the position of the FINAL tune control at minimum plate current and also at the maximum relative power indication. The neutralizing capacitor should be adjusted a small amount at a time until minimum plate current and maximum relative power occur at the same point of tuning the FINAL tune control.

( ) Turn the MIC/CW LEVEL control fully clockwise.

( ) Turn the MODE switch to LSB, push the PTT switch on the microphone, then adjust the CARRIER NULL control for minimum RF output. NOTE: Readjust the RELATIVE POWER control for more sensitivity if the panel meter is used to indicate relative power.

( ) Adjust the CARRIER NULL capacitor for minimum RF output.

( ) If necessary, repeat the adjustments of the CARRIER NULL control, and the CARRIER NULL capacitor until the RF output or null reading is about the same on both the LSB and USB positions of the MODE switch. (The output should null down to a quarter of a volt or less, if an RF voltmeter is available.)

CAUTION: The 6.8 mc trap coil is sealed, and should not be turned.

( ) Turn the OSC MODE switch to LMO. Tune for maximum output, and adjust the RELATIVE POWER control for a 6 to 8 meter reading.

( ) Leave the BAND switch at 3.5, and adjust for a maximum output. Then set the MIC/CW LEVEL control for a grid current reading of about 0.3 ma.

( ) Adjust heterodyne oscillator coil 3.5 for maximum grid current, with the tuning on the "slow" side of the peak.

( ) At each position of the BAND switch, adjust the heterodyne oscillator coil for maximum grid current. Adjust the coil that has the same number as the BAND switch position.

( ) Check the grid current at each position of the BAND switch. The maximum grid current reading should be near or over full scale on each band.

( ) Set the BAND switch at 21.0 and turn the Main tuning dial to read 21.2 mc.

( ) Position the free end of the driver neutralizing wire into hole W in the RF-driver circuit board as shown in Figure 1-1 (fold-out from Page 80).

( ) Adjust the DRIVER PRESELECTOR control for maximum RF output; then turn the control back and forth to see if this produces a smooth peaking in RF output.

( ) If the turning of the DRIVER PRESELECTOR control causes ragged changes in the RF output, readjust the position of, or bend, the driver neutralizing wire to produce a smooth peaking in RF output.

( ) Check the final neutralizing again at 14.2 mc as in the first step on this page.

CRYSTAL CALIBRATOR ALIGNMENT

In the following steps, the 100 kc crystal calibrator signal is adjusted by "zero beating" it against the accurate signal from WWV on another receiver, or against the signal from a standard broadcast station that is on a multiple of 100 kc.

Zero beat will occur when a harmonic of the 100 kc crystal calibrator signal corresponds to the frequency of the station tuned in on the external receiver. As zero beat is approached, a tone will be heard that decreases in frequency until it stops completely at the zero beat point; then the tone begins to increase again.

If the external receiver has an S-Meter, accurate alignment can be achieved by observing the S-Meter as zero beat is approached. When you tune close to zero beat, the S-Meter will start to pulsate. The closer you approach zero beat, the slower the pulsations will become. At zero beat the pulsations will stop.

IMPORTANT: For greatest accuracy, be sure to adjust the crystal calibrator as close to zero beat as possible. A 20 cps error at the 100 kc calibrator frequency, for example, would cause a 740 cps error at 3.7 mc (where the 37th harmonic of 100 kc would be used for dial calibration purposes; 100 kc x 37 = 3.7 mc; 20 cps x 37 = 740 cps).

( ) Connect the free end of the antenna wire from the external receiver to the REC ANT jack at the rear of the Transceiver.

( ) Set the Transceiver controls as follows:

FUNCTION switch - CAL.

AF GAIN control - full counterclockwise.

ANTENNA switch (at rear of Transceiver) - REC.

MODE switch - SW, LSB, or USB.

( ) Tune the external receiver to WWV; or a standard broadcast station broadcasting at a frequency which is a multiple of 100 kc.

( ) Carefully adjust the CAL XTAL trimmer capacitor (on the bandpass circuit board) for a "zero beat" in the external receiver. When WWV is tuned in, the period when no tone modulation is present allows the zero beat to be more easily heard.

( ) Switch the Transceiver FUNCTION switch between VOX and CAL to be sure the external receiver S-Meter stays steady, thus insuring a true zero beat.

( ) Remove the external receiver antenna wire from the REC ANT jack on the Transceiver.

NOTE: To make sure it is heard on each band, a high content of harmonic energy is needed in the 100 kc calibrate signal. Because of this, some spurious signals may also appear when tuning across some segments of the bands. The desired 100 kc calibrate signals are easily identified by their greater signal strength. Also, the proper harmonics may be peaked by the DRIVER PRESELECTOR.

LMO SHIFTER ADJUSTMENT

( ) Adjust the Main tuning dial to 3.7 mc (BAND switch to 3.5, the upper dial at 2, and the circular dial to 0).

( ) Set the FUNCTION switch to CAL.

( ) Turn the MODE switch to USB.

( ) Carefully zero beat the calibrator signal (using the Main Tuning dial) and peak the DRIVER PRESELECTOR control.

( ) Set the MODE switch to LSB. Be careful not to touch the Main Tuning dial. Note that the calibrator signal may or may not be exactly at zero beat in the LSB position.

( ) Turn the frequency shifter adjustment on the LMO for an exact zero beat in the LSB mode. See Figure 1-1 (fold-out from Page 80).

( ) Recheck the zero beat in the USB mode to be certain of the adjustment. Repeat the procedure if necessary.

DIAL CALIBRATION

( ) Zero beat the Main Tuning dial at 3.7 mc.

( ) Check for the calibrate signal and set the Zero Set dial. If the hairline is not close to the window center, proceed with the following steps.

( ) Remove the knob from the Main Tuning shaft without disturbing the zero beat setting.

( ) Place a screwdriver through the hole in the dial escutcheon (directly above the main tuning shaft) and into the LMO dial drive shaft.

( ) Hold the LMO dial drive shaft on zero beat and loosen the setscrew in the circular dial. Turn the circular dial until the 0 is directly behind the line on the zero set dial. Now retighten the setscrew in the circular dial. Be careful not to short circuit the pilot lamp socket with the allen wrench.

( ) Make sure the circular dial turns freely and the nylon spiral follower is properly engaged in the spiral groove before proceeding.

( ) Replace the knob on the Main Tuning shaft.

This completes the alignment of your Transceiver.

SPECIAL CRYSTAL CONSIDERATIONS

CRYSTAL CONTROL FOR MARS OR NET OPERATION

With the Mode switch of the Transceiver in the AUX T position, the transmitter operates at a fixed frequency that is determined by crystal Y5 in the crystal oscillator circuit of tube V5B. The receiver is still tuned by the LMO.

By placing the Mode switch in the XTAL position, both the transmitter and receiver frequencies are determined by crystal Y5.

IMPORTANT: Because of the steep-sided characteristics of Bandpass filter T202, operation of the Transceiver using a crystal at Y5 will be limited to approximately 25 kilocycles out of each band. Also, since the DRIVER PRESELECTOR tunes the same circuit for both transmit and receive, the frequency spread between the transmit and receive frequencies is limited to about 20 kc at 3.5 mc, 40 kc at 7 mc, etc.

Select the crystal frequency for Y5 for the sideband to be used, or for CW operation. The examples below are for one of the MARS channels located at 7.305 mc.

For USB and compatible USB-CW operation:

$f_{x\,(USB)} = f_h - f_m - 3.3964$

For LSB operation:

$f_{x\,(LSB)} = f_h - f_m - 3.3936$

For CW Net operation:

$f_{x\,(CW)} = f_h - f_n - 3.3954$

Definition of terms:

f_x = Crystal frequency in mc, for crystal Y5.

f_h = heterodyne crystal frequency, different for each band:

BAND	f_h
3.5	12.3950
7.0	15.8950
14.0	22.8950
21.0	29.8950
28.0	36.8950
28.5	37.3950
29.0	37.8950
29.5	38.3950

f_m = carrier frequency of desired SSB operation, further specified by LSB or USB designations. This is the operating frequency for SSB.

f_n = Exact transmitter frequency for CW Nets. Use this where CW only is used on a specific frequency. This operation is not compatible with USB operation, as the receiving station would have to retune his receiver 1 kc lower to receive SSB, and this would be impossible if he were crystal controlled.

Compatible USB-CW operation is used in some MARS Nets. In this service, a channel is specified which is wide enough for only one sideband. The carrier frequency is specified at the lower edge of the channel, and CW transmission is 1 kc higher than the carrier frequency. This 1 kc offset then produces a 1 kc beat note in the receivers set to USB or CW without any tuning. Either USB or CW can then be transmitted or received.

When using auxiliary crystal control, switching modes will cause the transmitting frequency to change, except for compatible USB-CW operation. Therefore, care must be taken to avoid out-of-band operation by inadvertently switching to the wrong mode.

Example: Mars SSB on USB at 7.305 mc.

$f_{h(7.0)}$ = 15.8950

$f_{m(USB)}$ = − 7.3050

8.5900

8.5900

− 3.3964

$f_{x(USB)}$ = 5.1936 mc

Caution: Always be sure to use the correct heterodyne crystal frequency.

When purchasing crystals for Y5, specify the frequency and the following characteristics:

Operation Mode.	Fundamental.
Tolerance.	.01 %.
Holder	HC-6/U.
Pin Diameter	.050".
Pin Spacing	.486.
Load Capacity (C_L). .	32 $\mu\mu$f.
Internal Capacity (C_O).	7 $\mu\mu$f maximum.
Series Resistance (R_S).	25 Ω maximum.
Drive Level	10 milliwatts.

The trimmer capacitor next to Y5 (AUX TRIM) can be adjusted for an exact MARS or Net frequency.

HETERODYNE OSCILLATOR

The heterodyne oscillator crystals that are supplied with the Transceiver provide coverage from 3.5 to 4.0 mc, 7.0 to 7.3 mc, 14.0 to 14.5 mc, 21.0 to 21.5 mc, and 28.0 to 30.0 mc. Since the driver grid and driver plate coils must be sequence-tuned, because of their series-parallel arrangement, other heterodyne crystals for out-of-band operation could introduce a wide variety of possible tuning conditions. Therefore, the use of crystals of frequencies other than those supplied are not recommended.