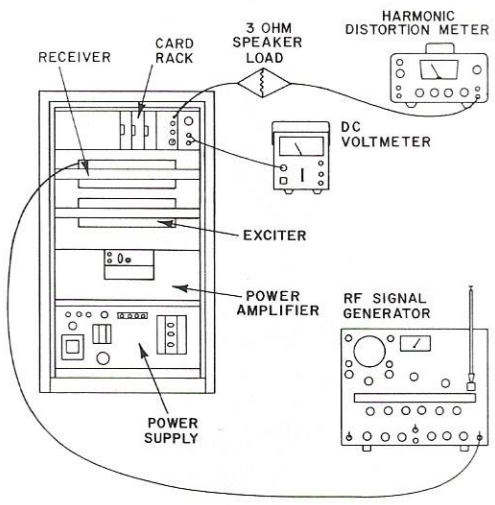
SECTION 5
ALIGNMENT AND PERFORMANCE TESTS

5.1 GENERAL

Test Panel - A test panel on the card rack provides a convenient location for measuring test point voltages used during receiver and transmitter alignment. Plug a high input impedance DC voltmeter into the test jacks and select the test points as indicated in the alignment procedure or in Table 5-1.

TABLE 5-1
TEST PANEL TEST POINTS

Switch Position	
1	TP204 - Second Tripler (Q213) Output TP302 - First Doubler (Q345) Output
2	TP301 - Tripler (Q320) output
3	TP203 - IF Test Point (Q204) Output TP303 First Driver (Q347) Output
4	TP205 - Third Tripler (Q101) Output
5	13.8 V Tx Sw - Q348(C)
6	13.8 V Un Sw - Q348(E)



RECEIVER TEST SETUP
FIGURE 5-1

5.2 RECEIVER ALIGNMENT

Loosen the two retainer screws and slide the receiver assembly outward. Remove the top cover and connect the test equipment as shown in Figure 5-1. Set the control card ACCESS switch to "OPEN" and the REPEAT switch to "OFF". Refer to the receiver alignment points diagram on page 43 for alignment point location.

5.2.1 Oscillator/Tripler and Second Tripler Adjustment

Connect a DC voltmeter to TP204 (position 1 on test panel) and adjust T208, T209 and T210 for a maximum meter reading (typically 1 volt).

5.2.2 Third Tripler Adjustment

Connect a DC voltmeter to TP205 located on the front end strip (test position 4 on the test panel) and adjust C108, C107 and C106 for a maximum meter reading. Repeat until no further increase is obtained.

5.2.3 First Oscillator Frequency Adjustment

Set the communications monitor to the channel frequency -10.7 MHz and place the pickup loop near T210. Adjust C269 for the channel frequency.

To keep the crystal frequency within 5PPM from -30° C - +60° C, the frequency should be set with the ambient temperature in the area of the crystal 25° C (77° F). If the ambient temperature is significantly different than 25° C, consult a Johnson Frequency Offset Chart for the correct frequency setting.

NOTE

C271 is a factory selected component that may be changed to increase or decrease the adjustment range of C269 (see Table 5-2). By increasing the capacitor value the adjustment range is decreased and vice versa.

TABLE 5-2
C271 REPLACEMENT VALUES

Description	Part Number
22 pF ±5% 50V N330 disc	510-3018-220
27 pF ±5% 50V N330 disc	510-3018-270
33 pF ±5% 50V N330 disc	510-3018-330
39 pF ±5% 50V N330 disc	510-3018-390
43 pF ±5% 50V N330 disc	510-3018-430
47 pF ±5% 50V N330 disc	510-3018-470

NOTE

C291 is a temperature compensation capacitor that is supplied with each crystal. If a crystal is moved, the compensating capacitor should also be moved. To verify that the correct capacitor is being used, compare the value to that stamped on the crystal case.

5.2.4 Front End and IF Amplifier Adjustment

a. Connect the RF signal generator to the receiver antenna jack and connect a DC voltmeter to TP203 (position 3 on test panel). Set the generator to the channel frequency with the output modulated with 1000 Hz at 5 kHz deviation.

b. Increase the generator output to obtain an indication on the voltmeter. Adjust C101-C105, T211, T201, L204, L205, T202, T203 and T204 for a maximum meter indication while decreasing the generator output to keep the voltage at TP203 below 1.3 volts.

5.2.5 Discriminator Adjustment

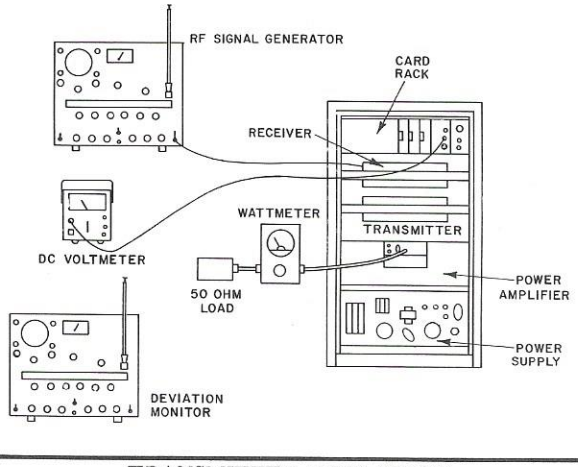
Connect an AC VTVM to the audio test jacks on the card rack. With the RF signal input used in the previous step, adjust T205 for maximum audio output.

5.2.6 Retuning Using Quieting and SINAD Measurements

Retune C101-C105 for maximum quieting. Retune T211 and T201-T204 for best SINAD. Do not retune L204 and L205. Refer to the "Performance Tests" section on page 31 for procedure details.

5.3 TRANSMITTER TUNEUP

Loosen the two retainer screws and slide the exciter assembly outward. Remove the top cover and connect the test equipment as shown in Figure 5-2. Set the control card ACCESS switch to "OPEN" and the REPEAT switch to "OFF". Refer to the exciter alignment points diagram on page 43 for alignment point location. Preset R412 and R420 on the power control board fully counter-clockwise.



TRANSMITTER TEST SETUP
FIGURE 5-2

5.3.1 Oscillator/Tripler Adjustment

Connect a DC voltmeter to TP301 (position 2 on test panel), key the transmitter and adjust L322, L323 and L345 for a maximum meter indication (typically 1.3 volts on a high impedance voltmeter).

5.3.2 First Doubler Adjustment

Connect a DC voltmeter to TP302 (position 1 on test panel), key the transmitter and adjust T346 and L347 for a maximum meter indication (typically 0.6 volt).

5.3.3 Second Doubler Adjustment

Connect a DC voltmeter to TP303 (position 3 on test panel), key the transmitter and adjust T348, L348 and L349 for a maximum meter indication (typically 0.8 volt).

5.3.4 Third Doubler Adjustment

Set the spacing of L353 and L354 as follows:

450-470 MHz - together
470-488 MHz - 1/16 inch apart
488-512 MHz - 1/8 inch apart

5.3.5 TCXO Frequency Adjustment

Set the communications monitor to the channel frequency and monitor the RF signal with a pickup loop. Adjust C705 for the channel frequency. (See "NOTE")

NOTE

C704 is a factory selected component that may be changed to increase or decrease the adjustment range of C705 (see Table 5-3). By increasing the capacitor value, the adjustment range is decreased and vice versa.

TABLE 5-3
C704 REPLACEMENT VALUES

Description	Part Number
22 pF ±5% 50V NPO disc	510-0001-220
27 pF ±5% 50V NPO disc	510-0001-270
33 pF ±5% 50V NPO disc	510-0001-330
39 pF ±5% 50V NPO disc	510-0001-390
47 pF ±5% 50V NPO disc	510-0001-470
56 pF ±5% 50V NPO disc	510-0001-560
62 pF ±5% 50V NPO disc	510-0001-620

5.3.6 Final Amplifier Adjustment

a. Adjust R420 on the power control board fully clockwise.

b. Adjust C924 with a non-metallic screwdriver for maximum power output. C924 is located on the power amplifier board and can be adjusted through the hole in the cover plate.

5.3.7 Power Output Adjustment

NOTE

If the optional duplexer is used, there may normally be up to a 1.5 dB duplexer insertion loss with a channel separation of 3 MHz and with a separation of 5 MHz, the loss may be about 1 dB. With a power input of 75 watts, 1.5 dB loss results in a duplexer power output of 53 watts and a 1 dB loss results in an output of 60 watts. Do not set the power amplifier output for more than 75 watts.

Without Power Switch-Over Option

a. Preset R412 and R420 on the power control board fully counterclockwise.

b. Adjust R420 for 75 watts power output from the power amplifier. Do not readjust R412.

With Power Switch-Over Option

a. Preset R412 and R420 on the power control board fully counterclockwise.

b. On Q403, short the base to the emitter and set the desired low power level using R412.

c. Remove the short from Q403 and set the normal power output from the power amplifier using R420. Do not readjust R412.

5.3.8 Deviation Adjustment

Refer to paragraphs 5.4.1 and 5.4.2.

5.4 CARD RACK ADJUSTMENTS

5.4.1 Preliminary Settings

Control Card

Set the REPEAT switch to "ON" and the ACCESS switch to "OPEN".

Level Adjust Card

1. Set the XMIT AUDIO control (R714) to maximum (fully clockwise).

2. Set the CALL GUARD LEVEL control (R705) to minimum (fully counterclockwise).

3. Set the SQU ADJ control (R717) fully counterclockwise (the squelch should open and the repeater should key up).

4. Set the LOCAL AUDIO control (R710) so the background noise is audible.

5. Readjust the SQU ADJ control (R717) for threshold squelch (the repeater should unkey).

5.4.2 Transmitter Deviation Adjustment

a. Connect an RF signal generator to the receiver antenna jack. Set the signal generator to the receive channel frequency with an output of 100 μV modulated with 1000 Hz at 5 kHz deviation.

b. Monitor the transmitter output with a communications monitor and adjust R702 on the TCXO board for a transmitter deviation of 5 kHz.

c. Reset the signal generator to 4 kHz deviation. Adjust the XMIT AUDIO LEVEL control (R714) on the level adjust card for a transmitter deviation of 4 kHz.

5.4.3 Call Guard Tone Deviation Adjustment (Decode Mode)

a. Reset the signal generator for an output of 100 μV modulated with 150 Hz audio at 600 Hz deviation.

b. Monitor the transmitter output with a communications monitor and adjust the CALL GUARD LEVEL control (R705) on the level adjust card for a transmitter deviation of 600 Hz.

5.4.4 Call Guard Tone Deviation Adjustment (Encode Mode)

a. Leave the signal generator output as set in the previous step. Remove the level adjust card and reinsert with the extender card.

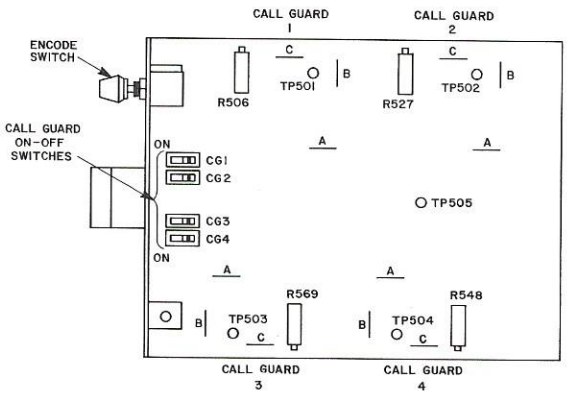
b. Turn the ENCODE switch on the Call Guard card to any Call Guard with a tone frequency of 60-250 Hz.

c. Monitor the transmitter output with a communications monitor and adjust R700 on the level adjust card for a transmitter deviation of 600 Hz (refer to the level adjust card component layout on page 54 for the location of R700).

d. Return the ENCODE switch to "OFF".

5.4.5 Call Guard Tone Frequency Adjustment

Refer to Figure 5-3 for alignment point location.



CALL GUARD ADJUSTMENT POINTS
FIGURE 5-3

a. Insert the Call Guard card into the card rack with an extender card. Cut the frequency range jumpers for each Call Guard as shown in Table 5-5.

TABLE 5-5
CALL GUARD JUMPER PROGRAMMING

Frequency Range	Jumpers A	B	C
65 - 73 Hz	Open	Open	Open
73 - 90 Hz	Open	Open	Closed
90 - 125 Hz	Open	Closed	Open
125 - 187 Hz	Open	Closed	Closed
187 - 251 Hz	Closed	Closed	Closed

b. Turn the ENCODE switch to the Call Guard to be adjusted. Connect the vertical input of an oscilloscope to the test point indicated in Table 5-6.

c. Connect the audio generator to the horizontal input of the oscilloscope and set the generator to the Call Guard frequency. (To set the Call Guard to the required tolerance, the audio generator output must be within ± 0.5% of the Call Guard frequency.)

d. Adjust the potentiometer indicated in Table 5-6 to stop the rotation of the circular Lissajous figure. (Distortion of the circular figure is caused by differences in amplitude, not frequency.)

NOTE

A communications monitor with a CRT, set to monitor the transmit signal, can also be used for the following procedure.

TABLE 5-6
CALL GUARD ADJUSTMENT POINTS

Encode Switch Position	Test Point	Frequency Adjust
1	TP501 (brown)	R506
2	TP502 (red)	R527
3	TP503 (orange)	R548
4	TP504 (yellow)	R569

NOTE

An alternate adjustment method is to measure the frequency at the indicated test point with a period counter (Time = 1 ÷ frequency).

e. After setting the frequency of the Call Guards, return the ENCODE switch to "OFF" and verify that all Call Guard ON-OFF switches on the PC board are "ON" unless the Call Guard is not being used.

5.5 DUPLEXER ALIGNMENT

CAUTION

Major equipment damage could result if the duplexer is improperly tuned.

5.5.1 General

The duplexer is factory tuned to the exact operating frequencies and should not require any further field tuning. However, under certain conditions such as a frequency change or a severe shock to the duplexer, some realignment may be necessary. In this case, it is recommended that the duplexer be sent back to the factory for realignment. If this is not possible, carefully follow this procedure while using the proper equipment. This procedure pertains to Part No. 532-4001-004 and the location of adjustment points varies between vendors.

5.5.2 Equipment Required

RF signal generator - 50 ohm impedance with variable output

6 dB, 50 ohm pad - assures a 50 ohm load

Receiver - tuned to transmit frequency

Receiver - tuned to receive frequency

Spectrum analyzer - can be used in place of receivers

5.5.3 Alignment of Transmit Cavities

General

The transmit cavities are those connected between the ANTENNA jack and TRANSMITTER jack of the duplexer. Each cavity is aligned individually using the test setup shown in Figure 5-4. In this procedure, the bandpass of each cavity is adjusted and then the notch of each cavity is adjusted.

Bandpass Adjustment

a. Connect either jack of a transmit cavity to the receiver tuned to the transmit frequency. Use a 6 dB pad as shown in Figure 5-4 and connect a DC voltmeter to the IF test point (TP203) of the receiver.

b. Set the RF signal generator to the transmit frequency and connect it to the other jack of the cavity.

c. Adjust the bandpass adjusting screw in the center of the cavity for a maximum reading at TP203 (decrease the generator output as necessary).

d. Adjust the bandpass of the other transmit cavity using the same procedure.

Notch Filter Adjustment

a. Connect the receiver tuned to the receive frequency to the cavity tuned in the previous step.

b. Set the signal generator to the receive frequency and adjust the notch filter adjustment for a minimum reading at TP203 (increase the generator output as necessary). On a Decibel Products duplexer, a non-metallic screwdriver must be used.

c. Connect the other transmit cavity and adjust the notch filter using the same procedure. The alignment of the transmit cavities is now complete.

5.5.4 Alignment of Receive Cavities

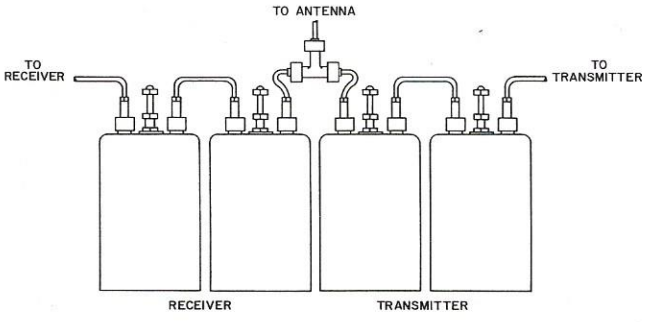
General

The receive cavities are those connected between the ANTENNA jack and the RECEIVE jack. The procedure is similar to that used to align the transmit cavities.

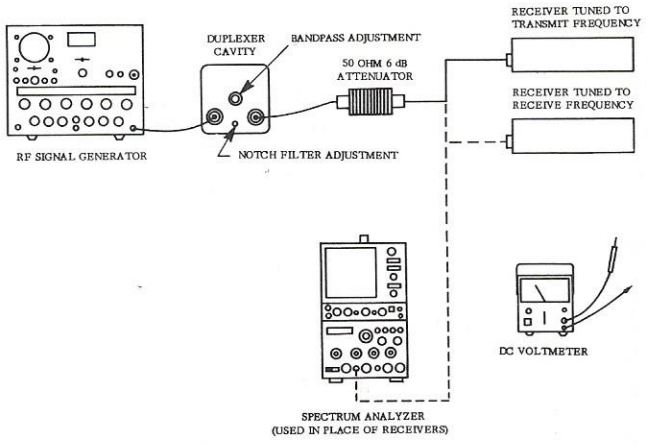
Bandpass Adjustment

a. Connect either jack of a receive cavity to the receiver tuned to the receive frequency. Use a 6 dB pad as shown in Figure 5-4 and connect a DC voltmeter to the IF test point (TP203) of the receiver.

b. Set the RF signal generator to the receive frequency and connect it to the other jack of the cavity.



DUPLEXER



TEST SETUP

DUPLEXER TEST SETUP
FIGURE 5-4

c. Adjust the bandpass adjusting screw in the center of the cavity for a maximum reading at TP203 (decrease the generator output as necessary).

d. Adjust the bandpass of the other receive cavity using the same procedure.

Notch Filter Adjustment

a. Connect the receiver tuned to the transmit frequency to the cavity adjusted in the previous step.

b. Set the signal generator to the transmit frequency and adjust the notch filter adjustment for a minimum reading at TP203 (increase the generator output as necessary). On a Decibel Products duplexer, a non-metallic screwdriver must be used.

c. Connect the other receive cavity and adjust the notch filter using the same procedure. The alignment of the duplexer is now complete.

5.6 RECEIVER PERFORMANCE TESTS

5.6.1 General

On the control card, set the REPEAT switch to "OFF" and the ACCESS switch to "OPEN". Connect the RF signal generator to the antenna jack on the receiver subassembly.

5.6.2 Quieting Sensitivity

a. Connect an AC VTVM to the AUDIO OUTPUT jacks on the card rack panel or across a 3 ohm speaker load plugged into the EXTERNAL SPEAKER jack.

b. Set the SQU ADJ control on the level adjust card fully counterclockwise. With no RF signal input, adjust the LOCAL AUDIO control for a 0 dB indication on the meter.

c. Increase the unmodulated signal generator output to 0.5 μV. The meter indication should drop 20 dB minimum.

5.6.3 EIA SINAD Sensitivity

a. Set the RF signal generator for an output of 0.35 μV, modulated with 1 kHz at 3 kHz deviation.

b. Connect a distortion meter to the AUDIO OUTPUT jacks or across a 3 ohm speaker load plugged into the EXTERNAL SPEAKER jack.

c. Adjust the LOCAL AUDIO control for an output of 0.77 V (200 mW).

d. Adjust the distortion meter for a 0 dB reference. Null out the 1000 Hz signal and the meter indication should drop 12 dB minimum, i.e.:

$$\frac{\text{Signal + Noise + Distortion}}{\text{Noise + Distortion}} = 12 \text{ dB or more}$$

5.6.4 Squelch Sensitivity

a. With no RF signal input, adjust the SQU ADJ control for threshold squelch (audio just quieted).

b. Set the signal generator modulation for 1 kHz at 3 kHz deviation and increase the output until the squelch just opens. The squelch should open at 0.25 μV maximum.

c. Change the signal generator modulation to 5 kHz deviation and adjust the SQU ADJ control to maximum (fully clockwise). The squelch should open at 2 μV or less.

5.6.5 Call Guard Sensitivity

a. Set the SQU ADJ control for threshold squelch and the ACCESS switch to "TONE".

b. Modulate the RF signal generator output with a Call Guard tone at ± 600 Hz deviation. Increase the signal generator output and the squelch should open at 0.5 μV maximum.

c. Repeat for each Call Guard tone.

5.7 TRANSMITTER PERFORMANCE TESTS

On the control card, set the REPEAT switch to "OFF" and the ACCESS switch to "OPEN". Connect a wattmeter and dummy load to the power amplifier antenna jack.

5.7.1 Transmitter Frequency

Key the transmitter with the local microphone and monitor the output with a communications monitor. The transmitter frequency should be within ± 2.5 PPM (0.00025%).

5.7.2 Transmitter Power Output

Key the transmitter and after one minute the power output should be 75 watts.

NOTE

If the optional duplexer is used, there may be up to a 1.5 dB insertion loss. Refer to paragraph 5.3.7 for more information.

5.7.3 Transmitter Deviation

a. Set the SQU ADJ control for threshold squelch and the REPEAT switch to "ON".

b. Set the RF signal generator to the receiver frequency with an output of 100 μV modulated with 1 kHz at 5 kHz deviation. Connect the generator to the receiver jack.

c. Monitor the transmitter deviation. The deviation should be ± 4.5 - 5.0 kHz and assymmetry should be less than 500 Hz.

d. Decrease the generator modulation to ± 4 kHz and the transmitter deviation should be ± 4 kHz.

5.7.4 Call Guard Tone Deviation

a. Set the REPEAT switch to "ON", the ACCESS switch to "TONE" and adjust the SQU ADJ control for threshold squelch.

b. Set the RF signal generator for an output of 100 μV, modulated with any Call Guard tone from 60-250 Hz at a deviation of ± 600 Hz. Connect the generator to the receiver antenna jack.

c. Monitor the transmitter deviation with a deviation monitor. The transmitter deviation should be ± 600 Hz.